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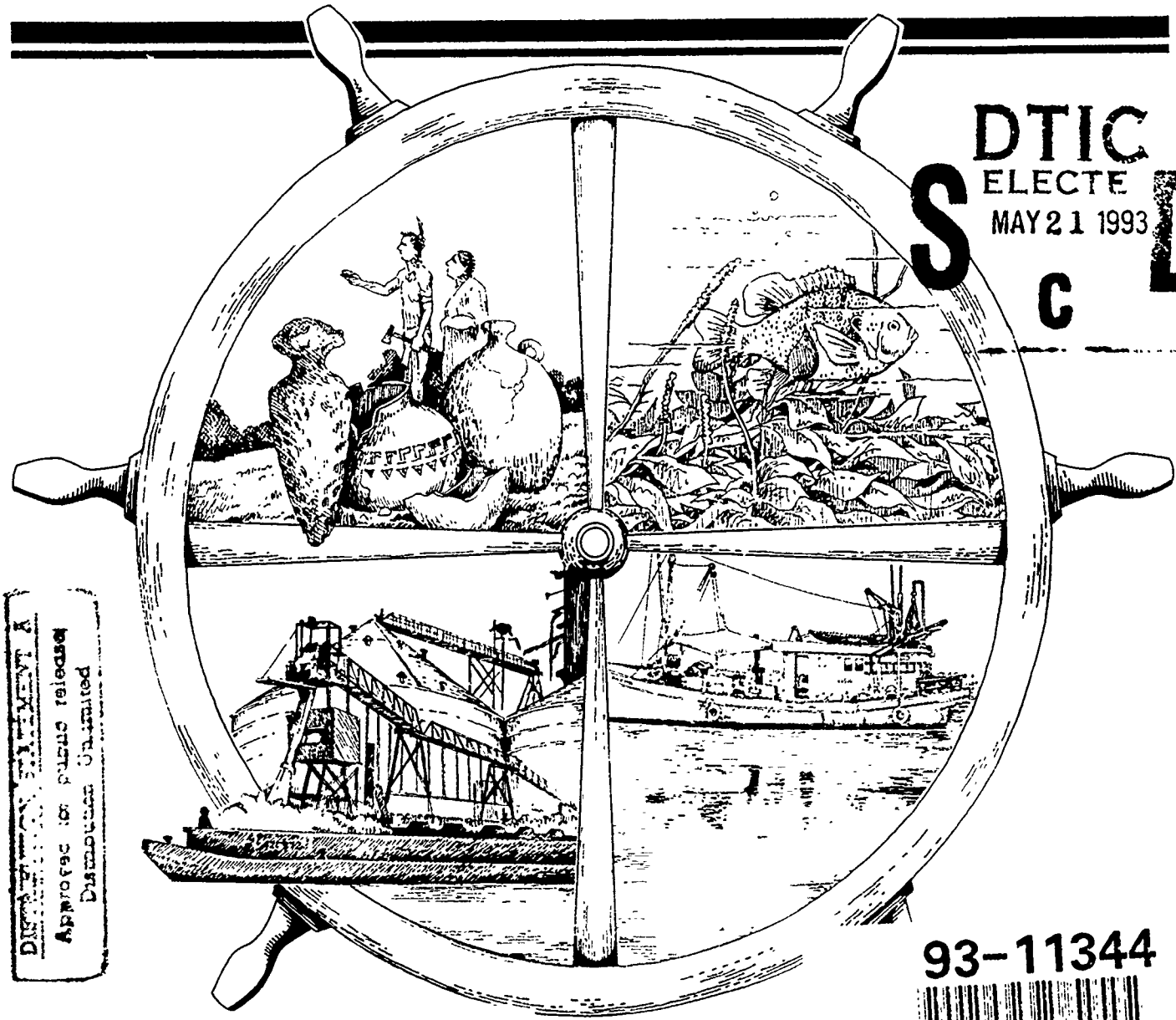
UPPER MISSISSIPPI RIVER NAVIGATION STUDY RECONNAISSANCE REPORT



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JUNE 1991

REVISED SEPTEMBER 1992

DEPARTMENT OF THE ARMY
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RECONNAISSANCE REPORT

FOR

UPPER MISSISSIPPI RIVER NAVIGATION STUDY

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Acknowledgement

This report reflects the coordinated efforts of three U.S. Army Corps of Engineers Districts: St. Paul, Rock Island, and St. Louis. Many people contributed to the Upper Mississippi River Navigation Reconnaissance Study, and each endeavor is greatly appreciated. The following individuals are directly responsible for the contents of this document and can serve as points of contact in their respective areas of expertise:

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Syllabus

This reconnaissance-phase study addresses the problems, needs, and opportunities associated with capacity increases to the Upper Mississippi River Navigation System and has established a Federal interest for making structural and/or nonstructural improvements to the system. For the U.S. Army Corps of Engineers, a Federal interest is established when a proposed improvement has high-priority outputs, such as flood control or navigation, and is economically feasible and environmentally acceptable. The study concludes that projected system traffic delays in the year 2000 will economically justify providing additional capacity increases for the lower three sites (Locks and Dams 22, 24, and 25). The analysis indicates the feasibility of adding capacity improvements at Locks and Dams 11 through 21 between the years 2000 and 2050. It also recognizes that recreational conflicts with commercial traffic in the upper portion of the system will continue.

Authority for the Upper Mississippi River Navigation Study is contained in Section 216 of the Flood Control Act of 1970 (Public Law 91-611). The Act authorizes the Secretary of the Army, acting through the Chief of Engineers, to review the operation of completed projects in the interest of navigation, flood control, water supply, and related purposes.

The Upper Mississippi River Navigation System consists of 669 miles of navigable water and a series of 29 locks and dams, beginning just above Minneapolis-St. Paul, Minnesota, and continuing southward to below St. Louis, Missouri. The Upper Mississippi River has been designated in the Water Resources Development Act of 1986 as a "nationally significant ecosystem" and a "nationally significant commercial navigation system." This study addresses the upper 615 miles of the system (from immediately downstream of Lock and Dam 25 northward).

This study's multi-disciplinary staff from St. Paul, Rock Island, and St. Louis Districts investigated both system-wide and site-specific problems associated with navigation on the Upper Mississippi River. The navigation system's principal problem discussed and investigated was its inadequate lockage capacity, with its resultant navigation traffic congestion and delays at locks, including competition between commercial and recreational craft at some locks.

It is recommended that a feasibility study begin in Fiscal Year 1992. The objectives of that recommended feasibility study will be to perform detailed engineering, economic, and environmental studies for the three highest priority sites, Locks 22, 24, and 25; to perform system-wide economic and environmental analyses; and to prepare appropriate NEPA documentation (System EIS). In addition, the study will assess the possible timing of future capacity improvements at Locks 21 through 11, as well as potential measures to reduce conflicts between recreational and commercial traffic in the upper portion of the system. The result will be a prioritization of capital investments on the Upper Mississippi River Navigation System for the 50-year planning horizon.

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Section 1 - Introduction

BACKGROUND

The Mississippi River, commonly referred to as the "Father of Waters," is distinctively beautiful and has a rich history. It was borne out of glaciers that periodically covered the upper half of North America for a span of more than a million years. Today, the Mississippi River is one of the best examples of a multi-purpose river in the Nation, serving as an inland navigation system and a national fish and wildlife refuge. The river and its environs are ecologically rich and diverse, providing habitat for hundreds of species of fish and wildlife. The Mississippi River Valley's abundance of cultural resources has contributed to our understanding of the history of the Midwestern United States. The river and its tributaries constitute one of the most scenic corridors in the world and offer excellent boating, hunting, and fishing opportunities.

The Mississippi's headwaters begin at Lake Itasca in northern Minnesota. From there, the river meanders north to Lake Bemidji and then east and south nearly 500 miles to the Twin Cities, passing from the forested north to agriculturally developed central Minnesota. South of Minneapolis-St. Paul, the Mississippi River forms the Minnesota-Wisconsin state line. It continues southward, and near Genoa, Wisconsin, becomes the state line dividing Iowa and Wisconsin. The river forms the entire eastern boundaries of the states of Iowa and Missouri and the entire western boundary of the state of Illinois. Along this reach, major Illinois tributaries and several Iowa tributaries flow into the river. The Upper Mississippi River region ends at Cairo, Illinois, (see plate 1) but the mighty Mississippi itself continues southward, passing through or past five more states on its journey to the Gulf of Mexico. The entire river travels a distance of about 2,350 miles.

The Mississippi is generally divided into two segments: the Upper and Lower Mississippi River. This navigation study centers on that portion of the Upper Mississippi River which begins at Minneapolis-St. Paul, Minnesota (River Mile 853.9) and ends just downstream of Lock and Dam 25 (River Mile 200.8) at Winfield, Missouri. Because of the geographical extent of the study in relation to the U.S. Army Corps of Engineers' jurisdictional boundaries, the St. Paul, Rock Island, and St. Louis Districts worked together to complete this phase of the study.

As early as the 1820's, the Federal Government began constructing Mississippi River navigation improvements. The first construction efforts consisted of removing the most menacing snags, shoals, and sand bars; dynamiting and excavating rocks to clear passages; and closing off meandering sloughs and backwaters to confine flows to the main channel. In 1878, Congress authorized the first comprehensive project on the Upper Mississippi River – the 4-1/2-foot channel – and in 1907, the 6-foot channel. In the next

two decades, Locks and Dams 1, 2, and what is now Lock and Dam 19 were authorized. Since 1930, when Congress authorized the 9-Foot Channel Navigation Project, the remaining 26 locks and dams were constructed between Minneapolis, Minnesota, and St. Louis, Missouri. That project, in operation since 1940, extends from below the Mississippi River's junction with the Missouri River at Lock and Dam 27 to Minneapolis, Minnesota. Construction of the locks and dams, as well as dredging, was necessary to form the 9-foot channel. Below St. Louis, Missouri, "open channel" techniques, such as stone dikes, bank revetment, and dredging, are used to maintain the channel. Plate 2 shows the existing Mississippi River navigation system profile. All of the locks and dams on the system are federally owned and operated, with the exception of Dam 19, located at River Mile 364.2.

Dam 19, owned by Union Electric Company, is the only site generating hydropower (since 1913). Its existing capability is 128,000 KW and has an additional potential of 103,831 KW. In the early 1980's, several preliminary permits and license applications were filed on Upper Mississippi River projects. At this time, only two license applications, one for Lock and Dam 14 and the other for Lock and Dam 15, are currently active. The city of Le Claire, Iowa, is actively pursuing a license for Dam 14, proposing a 24 MW powerhouse, and Davenport Hydro Associates proposes a 28 MW powerhouse at Dam 15. Future development of hydropower on the Upper Mississippi River depends upon the successful resolution of environmental concerns.

The physical characteristics of the locks on the Upper Mississippi River are summarized in table 1. The Mississippi River falls nearly 420 feet in the 669 miles between the upper and lower locks of the project. The dams and the locks, spaced at irregular intervals along the waterway, provide the means for waterway traffic to move from one pool to another. For reference, River Mile 0.0 is the confluence of the Ohio and Mississippi Rivers.

The entire Upper Mississippi River System, including navigable tributaries such as the Illinois Waterway above the Ohio River, consists of 1,250 miles of navigable waterway. The importance of the river as a shipping artery is reflected in the continual increase in tonnage shipped. Waterborne commerce on the Upper Mississippi River has increased from about 27.4 million tons in 1960 (waterborne commerce), to 54.0 million tons in 1970, to a record 84.1 million tons in 1983 (*1988 Inland Waterway Review*, Institute for Water Resources Report 88-R-7). Twelve of the 29 Upper Mississippi River locks have been identified by the *1988 Inland Waterway Review* as being among the top 40 locks having either the highest average delays, total delays, total processing times, or lock utilization in the entire inland waterway system. Continued commercial and recreational traffic growth will intensify current delays and create an acute problem.

TABLE 1

Physical Characteristics of Locks
Upper Mississippi River [1]

Lock Name or Number	Age as of 1990	Width (Feet)	Length (Feet)	Lift (Feet)	River Mile
Upper St. Anthony Falls	27	56	400	49	853.9
Lower St. Anthony Falls	31	56	400	25	853.3
1 Main Chamber	60	56	400	38	847.6
1 Aux. Chamber	58	56	400	38	847.6
2 Main Chamber	42	110	600	12	815.0
2 Aux. Chamber	60	110	500	12	815.0
3	52	110	600	8	769.0
4	55	110	600	7	752.8
5	55	110	600	9	738.1
5A	54	110	600	5	728.5
6	54	110	600	6	714.0
7	53	110	600	8	702.0
8	53	110	600	11	679.0
9	52	110	600	9	647.0
10	54	110	600	8	615.0
11	53	110	600	11	583.0
12	52	110	600	9	556.0
13	52	110	600	11	522.0
14 Main Chamber	51	110	600	11	493.0
14 Aux. Chamber	68	80	320	11	493.3
15 Main Chamber	56	110	600	16	482.9
15 Aux. Chamber	56	110	360	16	482.9
16	53	110	600	9	457.2
17	51	110	600	8	437.1
18	52	110	600	10	410.5
19	32	110	1,200	38	364.2
20	54	110	600	10	343.2
21	52	110	600	10	324.9
22	52	110	600	10	301.2
24	54	110	600	15	273.4
25	51	110	600	15	241.4
Melvin Price Main Chamber	2	110	1,200	24	200.8
Melvin Price Aux. Chamber	*	110	600	24	200.8
27	36	110	1,200	21	185.1
27 Aux. Chamber	26	110	600	21	185.1

[1] Source: *1988 Inland Waterway Review.*
* Under construction

This study was initiated to address the problems, needs, and opportunities associated with maintaining an efficient navigation system in furtherance of environmentally sustainable development of the Upper Mississippi River. Environmentally sustainable development means "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (World Commission on Environment and Development, 1987, cited by Chief of Engineers LTG Henry J. Hatch, October 8, 1989, before the American Society of Civil Engineers, New Orleans, LA.) This reconnaissance report defines the problems, establishes needs, and identifies potential solutions. It presents the determination of Federal interest in making navigation improvements, discusses priorities for improvements, and addresses future studies needed to protect environmental resources associated with the waterway.

STUDY AUTHORITY

Authority for the Upper Mississippi River Navigation Study is contained in Section 216 of the Flood Control Act of 1970 (Public Law 91-611) which states:

> The Secretary of the Army, acting through the Chief of Engineers, is authorized to review the operation of projects, the construction of which has been completed and which were constructed by the Corps of Engineers in the interest of navigation, flood control, water supply, and related purposes, which when found advisable due to significantly changed physical or economic conditions, and to report thereon to Congress with recommendations on the advisability of modifying the structures or their operation, and for improving the quality of the environment in the overall public interest.

STUDY PURPOSE AND SCOPE

The principal purpose of this study is to determine if there is a Federal interest in making structural and/or nonstructural improvements to the Upper Mississippi River Navigation System. The study scope includes economic, environmental, recreational, engineering, and operational issues. Both site-specific and system-wide navigation issues were examined in a preliminary manner in order to evaluate the impacts of the alternatives. Each issue and potential solution was analyzed for its impact on system navigation, recreation, the riverine environment, and economic considerations.

While this document examines several concepts and offers alternatives for capital improvements, it should not, in any way, be construed as a final assessment. Rather, the reconnaissance-level data are intended to indicate typical solutions and the costs and

benefits of these solutions, and to provide direction for more detailed feasibility level studies.

PRIOR STUDIES, REPORTS, AND EXISTING WATER PROJECTS

Numerous studies and documents have been completed for the Upper Mississippi River. It would be a significant task to include a summary of each Federal, State, and private study about the river or its navigation system. An attempt has been made, however, to include studies undertaken and/or completed which are most applicable to this one. A chronology and summary are included in the following paragraphs.

The *Mississippi River - Illinois Waterway 12-Foot Channel Study* was a joint effort between the North Central Division, Corps of Engineers, in Chicago, Illinois, and the Lower Mississippi Valley Division in Vicksburg, Mississippi. Work tasks were accomplished by the St. Paul, Rock Island, St. Louis, and Chicago Districts. The study findings were published in a September 1972 report (revised May 1973) which concluded that the costs and impacts associated with maintaining a 12-foot channel on the Mississippi River upstream of Grafton, Illinois, would exceed the benefits based on the traffic projections at that time.

An Environmental Impact Statement was prepared for *Operation and Maintenance of the 9-Foot Channel, Upper Mississippi River, Head of Navigation to Guttenberg, Iowa,* by the St. Paul District, Corps of Engineers. It was filed with the Council on Environmental Quality in August 1974.

The Environmental Impact Statement for *Operation and Maintenance of the 9-Foot Channel, Upper Mississippi River, Pools 11 through 22* was prepared by the Rock Island District, Corps of Engineers. The document was subsequently filed with the Council on Environmental Quality in January 1975.

In April 1975, the Missouri Botanical Garden published a report entitled, *Environmental Inventory and Assessment of Navigation Pools 24, 25, and 26, Upper Mississippi and Lower Illinois Rivers, a Vegetational Study.*

A Plan of Study for a Feasibility Study for the Upper Mississippi River, *Small Craft Lock Study,* was prepared in June 1975.

An *Environmental Inventory and Assessment of Navigation Pools 24, 25, and 26, Upper Mississippi and Lower Illinois Rivers; A Geomorphic Study* was published in July 1975.

In September 1977, a *Recreational Craft Locks Study, Stage II Report - Upper Mississippi River (Draft)* was published. The study determined where an independent means of moving pleasure craft from pool to pool is desired, needed, and economically justified.

The consulting firm of Howard, Needles, Tammen, and Bergendoff, Minneapolis, Minnesota, conducted a study for the St. Paul District entitled, *Recreational Craft Locks Study, Selected Alternatives - Upper Mississippi River, Minneapolis to Guttenberg,* completed in October 1978. The purpose of this effort was to conduct a more detailed engineering analysis of selected alternatives and to identify several lock waiting area sites worthy of further study since the September 1977 effort.

Howard, Needles, Tammen, and Bergendoff also provided technical assistance to the St. Paul District in accomplishing the *Recreational Craft Locks Study, Design of Lockage Waiting Areas at Lower St. Anthony Falls Lock, Lock 2, and Lock 3 - Upper Mississippi River.* The January 1980 report, following the study effort, included detailed designs and costs for the construction of five proposed lock waiting area beaches and appurtenances.

In November 1980, a report was published entitled, *Mississippi River Year-Round Navigation Study, Stage 2, Final Feasibility Study.* The study was a joint effort by the Corps of Engineers North Central and Lower Mississippi Valley Divisions. The purpose of the study was to explore the possibility of extending the navigation season on the Mississippi River and to include economic justification and environmental impacts for each means. The study findings detailed different types of engineering solutions such as gate modifications, gate replacements, lock and approach modifications, and channel modifications. The conclusions determined that year-round navigation on the river was technically feasible, but navigation interests did not express support for extending the navigation season.

The Upper Mississippi River Basin Commission (UMRBC) published a final report in November 1980 entitled, *The Upper Mississippi River Main Stem Level B Study.* The study participants included diverse representation from Federal, State, and local governmental entities, regional planning agencies, county representatives, universities, and private firms. The major recommendations regarded flood damage reduction, recreational boating safety, the relationship between navigation and the environment, water quality management planning, sedimentation analysis and control, and land-use management planning needs.

Under the auspices of the National Waterways Study, the Corps of Engineers Institute for Water Resources prepared, with the contracted assistance of A. T. Kearney, Inc., an *Evaluation of Present Waterways System,* dated March 1981. The report discusses commodity flow projections through 2003, lock capacity shortfalls, transportation

capability of the present system, and potential actions to maintain or improve its capability. After evaluating the 8 regions and 31 separate facility locations in the present waterways system, the Institute for Water Resources identified Lock and Dam 26 as the most constraining structure on the Upper Mississippi River. Locks 15, 16, 17, 18, 19, 20, 21, 22, 24, and 25 also were identified as having increased delay times and possible sites needing additional capacity based on detailed project-level analysis of the relative benefits and costs using one or more scenarios or sensitivity analyses.

In April 1981, Louis Berger and Associates, Inc., under contract with the Upper Mississippi River Basin Commission Navigation and Transportation Work Team, prepared the *Final Report, Inventory of Potential Structural and Non-Structural Alternatives for Increasing Navigation Capacity - Upper Mississippi River System Master Plan*. This report assesses structural and nonstructural methods to increase capacity of existing locks on the Upper Mississippi River System.

Between 1977 and 1982, the *Great River Resource Management Study*, conducted by the St. Paul, Rock Island, and St. Louis Districts of the U.S. Army Corps of Engineers, with assistance from the U.S. Fish and Wildlife Service and the UMRBC, investigated several areas of river management. The studies focused on how to conduct channel maintenance practices, most importantly, dredged material placement, in an environmentally acceptable manner. The recommendations and techniques offered in the Great River Environmental Action Teams (GREAT I, II, and III) reports were approved by the Board of Engineers for Rivers and Harbors in 1982. Most suggestions were subsequently incorporated into the Corps of Engineers' channel maintenance program.

The UMRBC, responding to a congressional directive contained in Public Law 95-502, published its January 1982 *Comprehensive Master Plan for the Management of the Upper Mississippi River System*. The 3-year effort, undertaken by Federal, State, and local officials, produced several studies and recommendations. The comprehensive plan contains a management framework for resolving differences among competing interests and implementing the recommendations. The study provided the basis for Section 1103 of the 1986 Water Resources Development Act, which included authorization for a second lock at Melvin Price Locks and Dam and the Upper Mississippi River System Environmental Management Program. Section 1103 refers to the Master Plan as the guide for future water policy on the Upper Mississippi River System.

Another St. Louis District report entitled, *Mississippi River Navigation System, Adequate Mooring Facilities for Watercraft - 81181*, was published in September 1982.

A July 1983 document entitled, *Recreation in the Upper Mississippi River System: An Overview of Facility Needs*, was published by the Upper Mississippi River Basin Association. It contains a list of projects within individual states eligible for public funding. The Upper Mississippi River potential projects included park improvements, park land

acquisition or development, boat access, lock waiting or holding areas, small boat harbors and marinas, fishing areas, hiking trails and bikeways, scenic overlooks and wayside rests, interpretive centers, historical site restoration, and beach creation or enhancement.

In September 1983, Jon Gjerde prepared a report entitled, *Historical Resources Evaluation, St. Paul District Locks and Dams on the Mississippi River and Two Structures at St. Anthony Falls.* This report is discussed in more detail in the historical properties section.

The St. Louis District published in April 1985 a *Reconnaissance Report - Lock and Dam 24, Station Service Hydropower.*

The Rock Island District locks and dams were studied, evaluated, and described by Rathbun Associates in the report entitled, *Historical-Architectural and Engineering Study, Locks and Dams 11-22, Nine-Foot Navigation Project, Mississippi River*, dated December 1985.

The Rock Island District, in cooperation with the St. Paul District, prepared the *Final Report for the Mississippi River, Coon Rapids Dam to the Ohio River*, in July 1986. The report summarized the efforts to improve the flood control systems and cited hydroelectric power potential for 24 Mississippi River navigation projects within the study area.

The *Upper Mississippi River System - Environmental Management Program (UMRS-EMP)* was authorized in the Water Resources Development Act of 1986 (Public Law 99-662). This program, which includes the Mississippi River and the Illinois Waterway, seeks to rehabilitate and enhance environmental resources of both rivers. Several activities are currently under way to accomplish its purpose, which include:

a. Habitat Rehabilitation and Enhancement Projects are proposed by states and the U.S. Fish and Wildlife Service and are engineered and constructed by the U.S. Army Corps of Engineers. Most of these projects are designed to counteract side channel and backwater sedimentation. The projects typically involve dredging and alteration of flow patterns by channel structures, construction of enclosed levee systems with pumping facilities for water level control, or island construction.

b. Long-Term Resource Monitoring will provide for more informed management of the Upper Mississippi River System and is being implemented by the U.S. Fish and Wildlife Service with funds transferred by the U.S. Army Corps of Engineers. Computerized Inventory and Analysis is being implemented as a component of Long-Term Resource Monitoring.

A contracted effort between the St. Louis District, U.S. Army Corps of Engineers, and Simons and Associates, Inc., led to a report entitled, *Physical Impact of Navigation of the Upper Mississippi River System,* May 1988.

A *Final Environmental Impact Statement (FEIS), Second Lock at Locks and Dam No. 26 (Replacement), Mississippi River, Alton, Illinois and Missouri,* was published in July 1988. It was the St. Louis District's opinion that overall system-wide impacts of the second lock were minor. However, the district could not unequivocally state whether or not the system-wide incremental navigational impacts were negligible, minor, or significant. Consequently, an interagency Plan of Study (POS) is being prepared to identify studies needed to better quantify navigation impacts on the Upper Mississippi River System due to the operation of the second lock. Results of the POS will be used to prepare a mitigation plan, if appropriate.

The *1988 Inland Waterway Review* (November 1988) was prepared by the Institute for Water Resources for the Chief of Engineers. While this document does not constitute a system plan, it does provide a 10-year outlook as to the priority needs for planning, design, construction, and operation of the entire inland waterway system. The review addresses the physical system, traffic levels, system/lock performance, and financial resource availability for waterways investment.

The Rock Island District Navigation System Support Center, established in 1988, prepared a *Report on the Upper Mississippi River and Illinois Waterway Navigation System* in 1989. The report is a historical and statistical overview of both navigation systems. It also forecasts growth and performance capability at each navigation structure.

A *Final Programmatic Environmental Impact Statement, Major Rehabilitation Effort, Mississippi River Locks and Dams 2-22; and the Illinois Waterway from LaGrange to Lockport Locks and Dams; Iowa, Illinois, Missouri, Minnesota, and Wisconsin*, was completed in March 1989. Typical rehabilitative work included replacement and maintenance of machinery, removal and replacement of deteriorated concrete, reconstruction of dam piers and gate sills, and replacement of electro-mechanical systems.

The states of Illinois, Iowa, Wisconsin, Missouri, and Minnesota, with the U.S. Department of Agriculture and U.S. Maritime Administration, investigated low-cost measures to maximize efficiency and productivity of the Upper Mississippi River Navigation System. A five-volume report was published in April 1989 entitled, *Upper Mississippi River Transportation Economics Study.* The primary product of the study was a computer evaluation model called Waterway Efficiency Evaluation Model (WEEM) which encompasses all aspects of barge operation and could be adapted for future use on other waterway systems. Study findings and recommendations included uniform application of fixed barge/tow rigging, fuel monitoring systems, stacking of empty backhaul barges, hull

treatments, new barge and boathull designs, reduced crew size, sequencing waiting tows, improving lock approaches, lock automation, and others.

A *Plan of Study (POS) for Upper Mississippi River and Illinois Waterway Navigation Studies* was distributed to the public on August 7, 1989. The POS provided the framework for U.S. Army Corps of Engineers' reconnaissance-phase planning studies for both waterways. It detailed the study authority, purpose, and how the engineering, economic, and environmental components would be addressed.

In December 1989, the U.S. Army Corps of Engineers published an *Analysis of Recreational Boating Impact on Navigation Lock Performance.*

A *Plan of Study for Navigation Effects of the Second Lock, Melvin Price Locks and Dam* was completed in February 1991 and is currently undergoing U.S. Army Corps of Engineers' Washington-level review. The report, developed by the Corps' Lower Mississippi Valley Division, with input from an interagency study team, identifies studies which would quantify navigation traffic impacts to significant Upper Mississippi River System natural resources.

THE IMPLEMENTATION AND REPORT PROCESS

This report represents one step in the U.S. Army Corps of Engineers' project implementation process, a process designed to ensure that only worthwhile projects with a Federal interest are undertaken in a timely manner. The first step in that process was preparation of an initial appraisal, published as the Plan of Study for the Upper Mississippi River and Illinois Waterway Navigation Studies in August 1989. This reconnaissance report investigates the navigation and related environmental problems of the Upper Mississippi River in greater detail. In doing so, it has involved extensive public involvement, both with the interested individuals, groups, waterway users, and user public and with State and Federal agencies.

Upon approval and certification of this reconnaissance report, a feasibility phase study will be undertaken at one or more of the top priority sites recommended later in this report. The feasibility study will include a system economic analysis and a system environmental analysis for the Upper Mississippi River. These analyses will firmly establish the improvements needed system-wide for navigation. Subsequent feasibility studies will use the system-wide analyses as a base from which to evaluate impacts of proposed improvements. The feasibility study also will investigate, in detail, the engineering parameters, costs, and benefits associated with improvements at the top priority site(s) so that a recommendation can be made for project authorization.

Following congressional authorization, the project then becomes eligible for funding of final engineering, plans and specifications, and construction. Financing for navigation improvements is provided from Federal tax revenues and the Inland Waterway Trust Fund. The Trust Fund, established in Public Law 95-502, consists of monies collected as a fuel tax from the commercial users of inland waterways. Improvements are 50-50 cost-shared between the Trust Fund and the Federal Government.

This report is designed to document the planning process employed in this preliminary (reconnaissance) investigation of the Upper Mississippi River Navigation System. Because cost and time considerations necessarily limit the depth of reconnaissance investigations, no new data gathering or extensive, in-depth analyses have been undertaken. This effort has been a coordinated effort between two U.S. Army Corps of Engineers Divisions: the North Central Division and the Lower Mississippi Valley Division; and three U.S. Army Corps of Engineers Districts: St. Paul District, Rock Island District, and St. Louis District.

The reconnaissance phase has four essential tasks, as outlined in ER 1105-2-100:

a. Define problems and opportunities and identify potential solutions.

b. Determine whether planning should proceed further into a feasibility phase study, based on preliminary appraisal consistent with Army policies, and the costs, benefits, and environmental impacts of the identified potential solutions.

c. Estimate the time and costs needed for a feasibility phase study.

d. Assess the level of interest and support of non-Federal interests in the identified potential solutions.

DESCRIPTION OF STUDY AREA

The study area (plate 1) is defined as that segment of the Upper Mississippi River basin from Upper St. Anthony Falls Lock, near Minneapolis-St. Paul, to Lock and Dam 25 just above the confluence of the Illinois and Mississippi Rivers. A total of 29 locks and dams is located along the Mississippi River above St. Louis, Missouri. Each dam creates one of a series of "steps" that river vessels climb or descend as they travel upstream or downstream. Each dam controls the level of its pool, and the locks lift or lower vessels from one pool to the next. Within each pool, portions of the channel were excavated to maintain a minimum 400-foot width and a 9-foot depth. The first pool formed on the Upper Mississippi River was created in 1913 when Lock and Dam 19 at Keokuk, Iowa, was completed.

GEOLOGY, TOPOGRAPHY, AND SOILS

During the Ice Age, about a million years ago, four great glaciers advanced and retreated across most of the Upper Mississippi River drainage basin. The last of the glaciers left this area about 11,000 years ago. The movement of these great sheets of ice created the basin's gentle, rolling hills and level plains, studded with thousands of lakes. As the glaciers melted and receded northward, drift was deposited, forming till plains over the southern part of the basin and moraines, which are belts of hills, in other regions.

Steep bluffs delineate the dominant landform, the Mississippi River floodplain. Large and small tributaries of the Upper Mississippi River dissect the region. Major wetlands are found on the bottomlands of the northern and middle reaches. Soils in the Minnesota and Wisconsin area are highly susceptible to erosion. The river valley is narrow and bounded by steep slopes. The terrain consists principally of rolling land, with elevations ranging between 280 and 1,940 feet above mean sea level.

The area is underlain by about 2,000 feet of Paleozoic sedimentary rocks overlying the Precambrian basement. The unconsolidated sediments which fill the present Mississippi River Valley resulted from both past glacial activity and modern river deposition. The preglacial Mississippi River bedrock valley is filled with over 100 feet of glacial and alluvial sediments. These typically consist of fine-grained floodplain deposits overlying coarse-grained channel, point bar and chutes and bar deposits. The deepest sections of the valley fill are composed of coarse-grained glacial valley deposits. This produces a typical section of alluvial silts and clays overlying fine to coarse sands and some gravel. These alluvial deposits are underlain by medium to coarse outwash sand and gravels. A coarser channel lag deposit containing gravel, cobbles, and even some boulders often will be encountered first at the maximum extent of modern river scour and fill and another immediately above bedrock.

CLIMATE

Because of its location midway between the Atlantic and Pacific Oceans, the Upper Mississippi River basin has a marked continental climate that reflects the constant movement of large air masses from both northern and southern regions. These movements result in warm, humid summers and moderately cold winters, along with sufficient rainfall to grow many different crops. There are comparatively large fluctuations of precipitation from year to year in the Upper Mississippi River basin. The variation from minimum to maximum precipitation is over 20 inches in the upper part of the basin and about 40 inches in the lower part. Generally, the total annual precipitation increases from north to south and is sufficient to make this one of the more important agricultural regions of the country. The precipitation provides runoff to support navigation and

hydroelectrical plants and to fulfill municipal and industrial requirements. Precipitation in the area averages about 36 inches per year. Monthly average temperatures range from 20-26 degrees Fahrenheit (F) for January to 70-78 degrees F in July, with a year-round average of about 52 degrees F.

HYDROLOGY

The Mississippi River has a total drainage area of 697,000 square miles at St. Louis, Missouri. Plate 3 shows the major streams and tributaries. In the 669 miles of river between the first lock (Upper St. Anthony Falls) and the last lock of the 9-Foot Channel Navigation Project, Dam 27, the Mississippi falls about 420 feet, with an average slope of approximately 6 inches per mile. Average flow of the Upper Mississippi River ranges from 10,000 cubic feet per second in the upper reach to 175,000 cubic feet per second at St. Louis, Missouri.

Navigation seasons extend generally from March through December in the upper pools and from February through December in the lower pools. On the river, ice thickness varies with location and time. Usually, ice begins to form in December and reaches maximum thickness in February. It is not uncommon to have 2 feet of ice within Pool 19.

WATER QUALITY

The following summary of water quality on the Upper Mississippi River is largely derived from the documentation produced by the Great River Environmental Action Team studies, the Nine-Foot Navigation Channel Environmental Impact Statements, and other readily available resource documents.

The Upper Mississippi River's water quality reflects the natural geological, climatological, and vegetative characteristics of the watershed and changes induced by man's commercial/industrial and residential use of the watershed and the river. As one progresses from the head of navigation in Minneapolis, Minnesota, downstream to St. Louis, Missouri, the effects of man's activities on the river are intuitively perceived to intensify. Although the degree of intensity is relative, most observers would classify man's use of the river as heavy. Despite this heavy use, water quality generally has been good. Major reasons for the overall good quality of the river water have been attributed to its large size, and, hence, the capacity to assimilate and dilute large amounts of waste, along with State and Federal water cleanup programs.

However, this is not to say that the river does not have water quality problems which are often categorized as either common to most or all of the river, or localized problems.

The most prominent sources of water pollution identified are point source municipal and industrial discharges and erosion from agricultural land. Further discussion of water quality can be found in the U.S. Fish and Wildlife Service Planning Aid Report located in appendix A.

ENVIRONMENTAL RESOURCES

Fish and Wildlife

Resource managers consider the Upper Mississippi River System to be a tremendous natural resource. The Upper Mississippi River represents a major portion of that system. In accordance, the U.S. Congress, in the Water Resources Development Act of 1986, recognized the Upper Mississippi River System as a "nationally significant ecosystem" as well as a "nationally significant commercial navigation system."

Much of the federally owned land and water areas between Pool 4 (Lake Pepin) and Pool 14 are part of the Upper Mississippi River National Wildlife and Fish Refuge. Most Corps of Engineers fee title lands are outgranted to the U.S. Fish and Wildlife Service under the Cooperative Agreement. These outgrants complement the U.S. Fish and Wildlife Service fee title holdings and are incorporated into the refuge. The Mark Twain National Wildlife and Fish Refuge is composed of nine separate divisions which lie between Davenport, Iowa, and St. Louis, Missouri. In addition, State agencies manage many smaller units for fish and wildlife purposes. Some of these areas are outgranted to the State conservation agencies by the U.S. Fish and Wildlife Service.

The presence of three national wildlife refuges on the Upper Mississippi River reinforces this value placed on the system as a natural resource:

* **Trempealeau National Wildlife Refuge** - The Trempealeau National Wildlife Refuge is located on the Wisconsin side of the Upper Mississippi River in Pool 6. Initially established in 1936 at 700 acres, the refuge expanded in 1978 to its present size of approximately 5,900 acres. About 460 acres of the refuge is upland, while the remainder is aquatic or wetland habitat. The refuge wetlands provide excellent habitat for a wide variety of wildlife, including waterfowl, Federal and State protected species, and a resident deer herd. Fishery habitat on the refuge is limited because of shallow water and winterkill conditions. Because the Trempealeau National Wildlife Refuge is essentially isolated from the Upper Mississippi and Trempealeau Rivers by railroad grades and dikes, sedimentation of the refuge's aquatic and wetland habitats is not a problem.

* **The Upper Mississippi River National Wildlife and Fish Refuge** - Established in 1924 by an Act of the U.S. Congress, the refuge today consists of about 200,000 acres of

wooded islands, waters, and marshes extending more than 260 miles along the river corridor from Wabasha, Minnesota, to near Rock Island, Illinois. The refuge is a unique resource and preserves scenic, recreational, and wildlife resources amid river development promoted by the needs of a modern society. The refuge borders the states of Minnesota, Wisconsin, Iowa, and Illinois and is reported to totally or partially fulfill the habitat needs of 270 species of birds, 57 species of mammals, 45 species of amphibians and reptiles, and 113 species of fish. The refuge provides fishing, boating, camping, hunting, trapping, and nature study opportunities.

* **The Mark Twain National Wildlife and Fish Refuge** - The Mark Twain National Wildlife and Fish Refuge is located along the Illinois and Mississippi Rivers in the heart of the Midwest. The refuge is made up of nine separate divisions, or management units, located along the Mississippi River between Davenport, Iowa, and St. Louis, Missouri, and on the lower 10 miles on the Illinois River. The refuge encompasses approximately 23,500 acres. There are many backwater sloughs and lakes, brush areas, farm fields, bottomland hardwood, timber, and marsh areas, managed forb communities, grassy areas, and moist soil units.

Interspersed with the National Wildlife Refuge lands up and down the river are State-managed wildlife areas.

The Upper Mississippi River ecosystem has international significance because of its use as a major migration route by migratory birds. Its use by migratory waterfowl is of special significance, and this significance is accentuated in the North American Waterfowl Management Plan. As described in the management plan, waterfowl are the most prominent and economically important group of migratory birds in North America. They are highly prized as game birds by millions of hunters in Canada, the United States, and Mexico and attract the attention of even larger numbers of people who enjoy observing them. Waterfowl generate a direct expenditure in excess of several billion dollars annually. The plan is a cooperative effort between the United States and Canada (and hopes are high that Mexico will soon become an active participant) that promotes a broad policy framework describing the overall scope of requirements for management of migratory waterfowl in Canada and the United States.

Although rich in terrestrial resources, the concerns about the effects of navigation resulting from navigation improvements will primarily center on the aquatic resources of the system. These aquatic resources have traditionally been described in terms of the main channel, main channel border, side channels, back waters, and adjacent wetlands. The Long-Term Resources Monitoring component of the Upper Mississippi River System-Environmental Management Program is currently refining these general categories into a standardized classification system that will be used in a Geographic Information System by the various entities that manage natural resources on the Upper Mississippi River. During feasibility studies, this classification system will be used to the fullest extent possible in describing the fish and wildlife resources of the system.

The Planning Aid Report provided by the U.S. Fish and Wildlife Service contains more detailed descriptions of the fish and wildlife resources of the Upper Mississippi River and can be found in appendix A.

Other recent publications that provide detailed descriptions of fish and wildlife resources on the Upper Mississippi River include:

a. The *Comprehensive Master Plan for the Management of the Upper Mississippi River System,* prepared by the Upper Mississippi River Basin Commission and completed in 1982.

b. The *Great River Resource Management Studies; GREAT I,* completed in 1980, *GREAT II,* completed in 1980, and *GREAT III,* completed in 1982.

c. The *Environmental Impact Statement for the Second Lock at Locks and Dam 26 (Replacement),* completed in July 1988.

d. The *Final Programmatic Environmental Impact Statement; Major Rehabilitation Effort; Mississippi River Locks and Dams 2-22, Illinois Waterway from La Grange to Lockport Locks and Dams; Iowa, Illinois, Missouri, Minnesota, and Wisconsin,* completed in March 1989.

Threatened and Endangered Species

a. **Federally Protected Species.** The U.S. Fish and Wildlife Service, in its Planning Aid Report (appendix A), provided the following tabulation of federally listed "threatened and endangered" species whose habitat requirement might be affected by the proposed navigation improvements.

Species	Status
Fat pocketbook pearly mussel (*Potamilus capax*)	Endangered
Higgins' eye pearly mussel (*Lampsilis higginsi*)	Endangered
Indiana bat (*Myotis sodalis*)	Endangered
Bald eagle (*Haliaeetus leucocephalus*)	Threatened in Wisconsin and Minnesota – Endangered in rest of UMR study area
Least tern (*Sterna antillarum*)	Endangered
Pallid sturgeon (*Scaphirynchus albus*)	Endangered
Paddlefish (*Polyodon spathula*)	Under review
Decurrent false aster (*Boltonia decurrens*)	Endangered

Except for the pallid sturgeon and the decurrent false aster, similar species designations had been provided during the preparation of the *Environmental Impact Statement (EIS) for the 2nd Lock at Lock and Dam 26 (R)* (dated July 1988) and for the *EIS for Major Rehabilitation, Mississippi River, Locks 2-22* (dated September 1988). Biological assessments were prepared during both efforts. As a result of the biological assessments and the endangered species coordination with the U.S. Fish and Wildlife Service, a determination was made that the only species likely to be affected was the Higgins' eye pearly mussel. The U.S. Fish and Wildlife Service, in its Biological Opinion on the Effects of the 2nd Lock and Lock and Dam 26, rendered the opinion that there would be an "incidental take," i.e., there would be some adverse effect but not to the extent that the continued existence of the species would be threatened. As a result, the St. Louis District has committed to extended site-specific studies designed to assess the impact that the increment of traffic increase generated by the 2nd Lock at Lock and Dam 26 (R) would have on the species. In its Biological Opinion on the Rock Island District's Major Rehabilitation Program, the U.S. Fish and Wildlife Service rendered the opinion that the Major Rehabilitation Program also would result in an "incidental take" of the species, but no additional impact studies beyond those being conducted by the St. Louis District would be necessary. In addition, the U.S. Fish and Wildlife Service thought the "first-in time, first-in right" concept was applicable. In essence, this concept advocates that in a sequential manner the authorization of Federal projects may proceed until it is determined that further actions are likely to jeopardize the continued existence of a listed species or adversely modify its critical habitat.

Impacts to the Higgins' eye pearly mussel are thus likely to be a concern for the Mississippi River Navigation Studies and will probably follow the 2nd Lock at Lock and Dam 26(R) project and Rock Island District's Major Rehabilitation Program in a sequential manner for allowable "incidental take." Depending on the results of St. Louis District's endangered species studies for the 2nd Lock at Lock and Dam 26(R) (Melvin Price Lock and Dam) and any studies which might be implemented for the Mississippi River Navigation Studies, impacts to the Higgins' eye pearly mussel could develop into a significant issue that could substantially affect the study outcome.

The pallid sturgeon and the decurrent false aster were listed as endangered species after the preparation of the 2nd Lock at Lock and Dam 26(R) and the Major Rehabilitation Program EISs had been completed.

The decurrent false aster is a floodplain species and probably only would be affected by a navigation improvement resulting in a pool raise. Since this species is only found in Mississippi River floodplain areas south of the Mississippi River Navigation Study area, it is not likely to be affected by any recommended improvements.

The pallid sturgeon also is found downstream of the study area in general proximity to the mouth of the Missouri River. It is a rare, bottom-dwelling species and, although it

is not reported to be found in the study area, it could be of concern if a navigation improvement project were determined to have far-reaching downstream effects.

No naturally occurring populations of the fat pocketbook pearly mussel have been reported for the Upper Mississippi River in the recent past, and it has not been determined to be a species of concern in recent navigation improvements studies. However, the Missouri Department of Conservation has initiated a restoration project for the species in Pools 20 and 24 with the transplanting of over 2,000 individuals. Therefore, coordination and evaluation during the feasibility studies will be needed to determine if proposed navigation improvements may adversely affect this species.

The paddlefish was formerly much more abundant in the Mississippi Valley than it is today, and it has only been in the recent past that its early life history has come to be understood. In addition to habitat loss, a major concern for the species is whether its spawning behavior may be thwarted by instream structures such as dams which prevent upstream migration. If this species were to become listed as endangered, the biological assessment concerning the impacts of navigation on the species could evolve to a major study item.

Additional discussions concerning federally protected species can be found in the U.S. Fish and Wildlife Service's Planning Aid Report in appendix A.

b. **State Protected Species.** Lists of state protected species usually are longer than those for federally protected species, and this is true for the Upper Mississippi River corridor. A listing of protected species for the five Upper Mississippi River states can be found in the Planning Aid Report in appendix A. Through a coordination and assessment process, these species will need to be evaluated during feasibility studies to determine which might be affected by proposed navigation improvements. If potential adverse effects are identified, coordination would be conducted with biologists from the U.S. Fish and Wildlife Service and the respective state(s) to identify measures to avoid or minimize adverse effects.

HISTORIC PROPERTIES

The Upper Mississippi River and adjacent environs have served as important transportation routes, resource procurement areas, and geographical markers since human populations first came to the Midwest approximately 12,000 years ago. Significant information concerning the importance of this ecosystem and transportation route to our Nation's past is contained in the archeological sites, standing structures, and historic documents which have survived to the present.

Several thousand prehistoric archeological sites have been recorded during the past 100 years, representing at least eight cultural periods. The presence of these cultural periods generally applies throughout the Upper Mississippi River region, although there are significant variations from north to south within the 669 miles of project area.

Historic period sites span the period from early French exploration (ca. 1680's) through the military frontier, early pioneering, farmsteading, commercial development, and urbanization periods. During each occupation, humans left behind evidence of their presence. Some of this evidence is contained in books and other written records, while other evidence is stored in archeological deposits. Historic period sites include forts, churches, schools, quarries, farmsteads, mills, potteries, ferry landings, commercial buildings/districts, and cemeteries, to name a few. Most prominent on the landscape are the locks and dams of the Upper Mississippi River 9-Foot Navigation System, the focus of this study.

Substantial documentation is available on the Upper Mississippi River Navigation System. The Rock Island and St. Paul Districts arranged for historical, architectural, and engineering history studies to be conducted for Mississippi River Locks and Dams 3 through 22. Locks and Dams 3 through 10 were described in a Jon Gjerde report dated September 1983. Rock Island District locks and dams were studied, evaluated, and described by Rathbun Associates in a December 1985 report. These reports summarize the social, political, technological, and transportation histories of the navigation system. References are made to Corps of Engineers records, comprised of original shop drawings, project reports/notes, construction photographs, and motion picture films.

The majority of historical properties data is included in appendix D, which contains a summary of significant previous studies of Upper Mississippi River cultural resources.

SOCIOECONOMIC RESOURCES

Demographics

The Upper Mississippi River extends from the head of navigation at St. Anthony Falls, Minnesota, to the Mississippi River's confluence with the Missouri River upstream of St. Louis, Missouri. In total, this stretch of river is 651 miles long. Forty-five counties and 23 major river communities lie on the banks of the Upper Mississippi River, including the cities of Minneapolis, St. Paul, Red Wing, and Winona, Minnesota; La Crosse and Prairie du Chien, Wisconsin; Dubuque, Davenport, Muscatine, and Keokuk, Iowa; Moline, Rock Island, Quincy, and Alton, Illinois; and Hannibal, Missouri. The combined 1990 population of the Upper Mississippi River counties was estimated at 3,789,700, with nearly 80 percent of this population residing in urban areas (see table 2).

TABLE 2

Population Trends for
Upper Mississippi River System (UMRS) Counties,
1985 through 2000

UMRS Counties	1985	1990	2000	Estimated 1990 Urban Population (%)
MINNESOTA:				
Dakota	223,100	256,500	318,200	92
Goodhue	40,300	42,100	45,300	44
Hennepin	951,400	953,500	928,300	99
Houston	18,800	19,300	20,100	36
Ramsey	461,000	459,200	437,800	99
Wabasha	20,200	21,200	22,900	21
Washington	127,400	143,100	172,100	77
Winona	47,300	47,800	48,400	60
WISCONSIN:				
Buffalo	14,400	14,700	15,100	18
Grant	52,300	54,100	56,600	32
La Crosse	96,600	101,400	110,700	74
Pepin	7,500	7,700	8,000	0
Pierce	32,200	33,900	37,300	33
Trempealeau	26,900	27,900	29,300	0
Vernon	25,900	26,700	27,600	15
IOWA:				
Allamakee	14,900	14,800	15,000	27
Clayton	20,900	20,900	21,200	0
Clinton	56,800	56,800	57,400	74
Des Moines	44,900	44,000	43,300	/1
Dubuque	91,400	90,700	92,300	74
Jackson	22,300	22,300	22,900	28
Lee	42,700	42,600	42,800	63
Louisa	12,400	12,600	13,300	0
Muscatine	43,500	46,400	51,000	71
Scott	162,900	166,600	176,000	88

TABLE 2 (Cont'd)

UMRS Counties	1985	1990	2000	Estimated 1990 Urban Population (%)
ILLINOIS:				
Adams	69,400	67,600	64,500	59
Calhoun	37,700	36,800	35,200	0
Carroll	18,000	17,500	16,800	24
Hancock	23,300	23,100	22,700	27
Henderson	9,100	9,100	9,100	0
Henry	53,900	51,400	48,300	51
Jersey	20,300	20,200	20,100	37
Jo Daviess	23,400	23,400	23,200	26
Madison	248,400	249,900	249,000	82
Mercer	19,000	18,800	18,600	20
Pike	18,200	17,600	16,800	22
Rock Island	164,200	163,600	161,400	86
Whiteside	63,600	62,100	59,100	54
MISSOURI:				
Clark	8,500	7,900	7,500	0
Lewis	11,500	10,200	9,400	0
Lincoln	22,900	27,500	32,600	12
Marion	29,800	29,200	29,900	79
Pike	17,400	17,300	18,400	42
Ralls	8,900	9,200	9,600	2
St. Charles	152,100	200,500	253,400	79
TOTALS:	3,677,600	3,789,700	3,918,500	79

Economic activities along the Upper Mississippi River revolve around machinery manufacturing, food and beverage processing, and crop, dairy, and livestock production. Regional industries produce canned, frozen, and dairy foods, and manufacture broadcast equipment, construction equipment, agricultural machinery, ammunitions, chemicals, and aluminum sheet.

RECREATION RESOURCES

The Upper Mississippi River provides unlimited opportunity for recreation. The navigation system's ever-changing characteristics offer a wide variety of recreational opportunities. There are large expanses of open water that are ideal for sailing; myriads of backwater lakes and channels for fishing, hunting, and wildlife observation; sandy islands and beaches for swimming, picnicking, and camping; and miles of open water for high speed "running about," waterskiing, and cruising. The types and sizes of recreational craft vary widely from inner tubes to homemade rafts and personal water craft (jet skis), canoes and sailboats to high speed runabouts and jet boats, and jon boats for day fishing trips to large houseboats and cabin cruisers capable of ocean travel for extended cruising.

The upper reaches of the Upper Mississippi River Navigation System include the Lower St. Croix River National Recreational Riverway (part of the National Wild and Scenic River System). The Mississippi River within the Minneapolis-St. Paul metropolitan area was recently designated as a National Recreation Area.

The navigable portion of the Minnesota River is within the Minnesota Valley National Wildlife Refuge, Recreation Area, and State trail. Between the three districts, there are approximately 365,000 surface acres of water and 3,515 miles of shoreline. The shoreline includes many islands scattered throughout the 27 pools. These resources, in combination, provide tremendous opportunities for land- and water-based recreation.

The three districts operate and maintain 31 recreation areas along the river. Seventy-three other recreation areas are located on Corps lands but are leased to other organizations that are responsible for operation and maintenance. In addition to recreational facilities on Corps lands, other Federal, State, and local agencies, as well as private interests, operate and maintain recreation areas. These recreation areas range from major parks to primitive, and even temporary, facilities. The facilities range from "full service" areas offering picnicking, swimming, camping, etc., with waterborne restrooms, to simple gravel parking lots and launching ramps. There are 22 major public park areas located along the river.

Boating access to the river is provided by approximately 360 boat access points and/or marinas and 11,500 marina slips along the Upper Mississippi River, excluding the St. Croix and Minnesota Rivers.

In addition to the "operated" areas, the numerous dredged material placement sites provide almost unlimited opportunities for recreation.

Given the length of the river, the number of recreation providers, and the array of facilities, maintaining current inventories is very difficult. The number of accesses and

marina slips increases each year as the demand for access to the river's resources continues to grow. Determining the overall recreational use of the river is complex due to the patchwork pattern of ownership and responsibilities. There is no central clearinghouse for recreation use information. Each managing agency has its own (or lack of) reporting requirements. The Corps maintains an accurate system to monitor lockages, the Performance Monitoring System (PMS), which tallies the number of recreational craft using the locks. However, many recreational craft never use the locks while on the river. Therefore, the PMS data only indicate the trends and not total boating use. In 1988, nearly 174,000 individual recreational craft locked through on the Upper Mississippi River. Based on the PMS data, boating use is increasing.

The Corps reports recreational use of the projects that it administers as part of the data entered into the Natural Resource Management System (NRMS). For 1989, NRMS reported over 80,000,000 visitor hours of recreational use on Corps lands along the Upper Mississippi River. Of that total, approximately 22.6 million visitor hours were spent boating, 20 million visitor hours fishing, and 6 million visitor hours hunting. Most of the boating hours (13 million) were spent in the St. Paul District.

The NRMS probably does not account for all the recreational use that is occurring on the system. For example, the recreational use generated by the riparian landowners must be considered. Further, statistical use measurements at many non-Corps sites need to be upgraded. However, as with PMS, NRMS does provide an indication of the trends in recreational use. The trend is that recreational use of the navigation system is increasing.

Many studies have been conducted over the past 20 years which examined recreational opportunities along the Upper Mississippi River. Some of these studies are listed earlier in this section under "Prior Studies, Reports, and Existing Water Projects." A St. Paul District effort which summarizes many of the earlier studies and provides a framework for future recreational developments on Corps lands is the *Master Plan for Public Use Development and Resource Management for the Upper Mississippi River*. Parts I and II of this Master Plan, the Land Use Allocation Plan (LUAP), were developed in 1983, and Part III, the Plan of Development, in 1988. The Operational Management Plan for the river, the document which details how the Master Plan will be implemented, is currently being developed.

The Rock Island District completed the LUAP in October 1989, and the Operational Management Plan was completed in 1986. The St. Louis District is currently developing a Plan of Study to completely update the Master Plan and begin developing an Operational Management Plan.

Additional recreational facilities and opportunities are needed along the Upper Mississippi River; the specific needs vary by location. These needs were extensively

documented in the GREAT studies of the late 1970's. The GREAT study teams developed extensive demand-supply-needs information for a variety of recreational activities. This information has served as the basis for subsequent planning efforts and remains the only extensive study of its type for the entire river.

Other recreation-related studies have examined the potential growth of recreational boating activities, recreational use of the locks, the need and benefits associated with small boat harbors, the placement of dredged material and recreational beach development, and the cumulative impacts of continued marina development. An ongoing system-wide study will provide information regarding the economic impact of recreation along the river.

Section 2 - Problem Identification (Existing and Projected)

EXISTING PROBLEMS AND NEEDS

SYSTEM-WIDE NAVIGATION PROBLEMS

Lockage Delays

Lockage delays occur on the Upper Mississippi River System predominantly due to the high volume of commodity tonnage processed relative to the carrying capacity of the locks in the system. Most locks in the system were designed to process 600-foot-long tows, causing today's standard 1,200-foot-long tow to require a time-consuming double lockage to pass. Table 3 below displays the tonnage processed and average delays (exclusive of processing time) in 1989 for each lock in the Upper Mississippi River System. Locks 26 were used through December 1989, at which time the 1,200-foot-long chamber at the New Melvin Price Locks and Dam was put in service. The average delay (waiting time for service) approached 5 hours at Lock 22 in 1989 and, with the exception of Lock 19 which has a 1,200-foot-long chamber, averaged over 1 hour at all locks in the system downstream of Lock 13. These lockage delays impose additional costs for commodity movements transitting the navigation system.

Total system traffic for selected years is displayed in table 4. Since 1965, traffic in the system has been increasing at an average annual rate of approximately 3.7 percent compounded annually (1965-1990). Continued growth in traffic will further strain the ability of the system to efficiently process this traffic, causing lockage delays to greatly increase from existing levels.

Lock Capacity

Directly related to the problem of large delays at system locks is the capacity of the locks to process traffic. Currently, tonnages at the five most downstream locks, Locks 20, 21, 22, 24, and 25, are beginning to approach the estimated existing capacities. Three of the five, Locks 22, 24, and 25, are quickly approaching the estimated existing capacities at those structures. Delays increase dramatically when traffic transitting a lock approaches the capacity of that lock.

TABLE 3

1989 Upper Mississippi River System
Lock Tonnages and Average Delays

Lock No.	Tonnage (k/tons)	Average Lockage Time (min./tow)	Average Delay Time (min./tow)	Estimated Capacity (k/tons)
Upper St. Anthony Falls	657	26	1	16,070
Lower St. Anthony Falls	1,207	28	3	16,520
1	1,202	31	3	13,820
2	11,488	80	39	50,230
3	11,519	77	34	39,330
4	12,038	79	25	44,010
5	12,158	77	29	45,040
5A	12,203	72	25	46,670
6	14,125	83	34	42,600
7	14,084	81	35	42,430
8	14,674	86	40	46,300
9	15,557	88	32	48,480
10	17,868	74	30	51,630
11	17,395	86	55	41,800
12	21,089	80	68	46,120
13	21,534	77	52	48,580
14	26,843	79	102	48,200
15	26,967	86	110	46,300
16	28,771	84	93	48,800
17	30,857	98	157	45,300
18	31,370	88	99	50,100
19	32,908	62	43	68,900
20	33,524	89	169	47,200
21	34,362	101	151	48,700
22	34,938	106	369	44,600
24	36,138	99	287	44,100
25	36,219	95	238	41,700
26	68,431	109	1,427	N/A

Source: Performance Monitoring System

TABLE 4

Upper Mississippi River System Annual Commodity Tonnages (millions)

Year	Tonnage
1965	37.8
1970	54.0
1975	63.1
1980	76.3
1985	72.0
1986	73.7
1987	81.6
1988	82.0
1989 (estimate)	85.0
1990 (estimate)	90.8

Source: Waterborne Commerce Statistics Center

Changes in either the distribution of commodities, carrier operating procedures, or lock operating procedures may cause these capacity estimates to change. For example, an increase in the percentage of empty barges processed through a given lock will decrease the capacity of that lock to process traffic.

Recreation/Commercial Locking Conflict

Recreational boaters have been discovering, or rediscovering, the Upper Mississippi River over the past decade. This has been particularly true in the St. Paul District (Minneapolis, Minnesota, to Guttenberg, Iowa). During the late 1970's, much attention was given to crowded recreational boating conditions on the Lower St. Croix River as a result of the rapid growth in use. In the 1980's, the St. Paul District began to hear the same concerns from the boating public on the Mississippi River – the river was becoming crowded. The number of recreational craft using the locks increased approximately 75 percent for the entire Upper Mississippi River. Use at Lock and Dam 3 nearly doubled from 1987 to 1989.

While the increased use of the river has the potential to cause congestion-related problems throughout the system, the problems are most acute at the locks and dams. The locks are the major congestion points along the system as both commercial and recreational craft arrive and wait their turn to lock through. The major cause of delays at the locks is the time required to accomplish a single lockage.

Factors compounding the problem include the double lockages required to move a "full sized" tow through (three cycles) and the randomness by which vessels arrive at the lock. Other factors involving recreational craft are the handling lines used and the time needed to raft similar-sized boats together for the lockage. There may be 40 to 70 craft in one lockage.

The recreational user group most dependent on the locks is the marina-based boatowners. Boats may be moored in a different pool, where a lockage is required to reach the preferred use areas. For example, many boats moored at marinas in Pool 2 travel to the St. Croix River through Lock and Dam 2. Lock and Dam 3 accommodates recreation traffic upbound from Pool 4 toward the St. Croix River and downbound from Pool 3 to Lake Pepin.

There are distinct differences between recreational and commercial navigation. For a shipment of grain to move from St. Paul to New Orleans by water, there is only one starting point, one route, and one destination. Delays along that route are costly and are generally accepted by the operators as part of the cost of doing business.

For recreational users, there is more freedom in terms of marinas, launching areas, trip destinations, and routes. However, recreational boaters can also experience costly delays in terms of lost recreation time and enjoyment. No one likes to be "stuck in traffic" when they could be picnicking or fishing. Unlike the commercial operator, the recreational boater may be able to choose to do something different if the delay is deemed too lengthy. However, given the investment that recreational boaters have made in equipment and mooring facilities, it is very likely that they will continue to demand access to the river and its resources.

Another difference between commercial and recreational traffic is that commercial operators work 24 hours a day, 7 days a week, regardless of the weather. The resulting commercial use of the river is relatively constant, with some peaks and valleys related to cargo. Recreational use, on the other hand, is leisure travel, mostly evenings, weekends, and holidays, with virtually no recreational traffic between midnight and 6 a.m.

By law, commercial traffic has priority at the locks. However, to avoid undue delays, the procedure at many sites (with industry support) is to accomplish a recreational craft lockage after every commercial lockage, which could require up to three cycles. At Lock and Dam 3 during high use periods, a recreation lockage each way is accomplished after each commercial lockage. During these periods, commercial craft may be delayed up to an hour due to recreational lockages. Most operators are willing to waive their priority in order to avoid undue delays in locking recreational craft and for the safety of the recreational boaters.

SYSTEM-WIDE ENVIRONMENTAL PROBLEMS

The need to assess cumulative impacts is included in the Initial Project Management Plan.

Fish and Wildlife

In accordance with the recognition as a "nationally significant ecosystem" given the Upper Mississippi River by the U.S. Congress, the subcomponents of the system can be considered to be nationally significant resources. Discussions of fish and wildlife resources provided in Section 1 of this report support this concept. These significant resources are those major resources of concern that are recognized as such for institutional, public, and technical reasons. The effects of navigation on these significant resources can be viewed as system-wide environmental problems or concerns.

Table 6 of the Planning Aid Report (appendix A) summarizes significant resources as follows: backwaters, side channels, and associated wetlands; fish eggs, larvae, and adults; mussels; aquatic macrophytes; macroinvertebrates; and waterfowl.

This listing of significant resources is essentially mirrored by the resources of concern selected for study by the development group that formulated the "Plan of Study" (POS) for measuring the navigation effects of the 2nd Lock, Melvin Price Locks and Dam (i.e., 2nd lock at Lock and Dam 26 (R)). The 2nd Lock POS was the product of an interagency effort on the part of the Federal agencies and states concerned with the care and management of natural resources on the Upper Mississippi River. The POS was finalized during the Second Quarter of Fiscal Year 1991 and is currently undergoing review by higher authority.

An additional resource identified by the 2nd Lock POS development group was "phytoplankton." Phytoplankton was not recommended for implementation in the final version of the POS. However, this should not be interpreted that the resource is any less important, but, more likely, a realization that it would be an extremely difficult resource to study and that the quantification of the effects of navigation on the resource may not be feasible.

The aforementioned significant resources of the Upper Mississippi River should not be considered an exhaustive listing. There are other significant components of the river ecosystem, but these have been identified, at least at this early stage in study development, as those significant resources most likely to be affected by traffic increases that might result from navigation improvements.

Historical Properties

Previous investigations indicate that the Upper Mississippi River System and adjacent environs contain some of the most significant archeological deposits to be encountered in the entire midwestern United States. Sites present on and adjacent to the Mississippi River hold the secrets of 10,000 years of American history and prehistory. Systematic sample surveys conducted in selected pools indicate that significant archeological sites are eminently threatened by both natural and cultural (man-made) forces. The major destructive force is thought to be shoreline erosion. Other significant impacts are caused by persons intentionally digging into and looting archeological deposits which are made visible by shoreline erosion. The digging further increases erosion and damages vegetation, causing additional impacts. Direct physical impacts to sites also occur from barges queuing into shore while waiting for a lock chamber to become available. Prop wash associated with queuing also can exacerbate shoreline erosion. Other direct impacts result from earth-moving construction activities and other forms of development.

The sensitivity of a certain location to erosional forces is dependent on a number of factors, including the geomorphological landform involved, soil type, hydrology, vegetative cover, wind fetch, water level, commercial traffic, recreational traffic, and a myriad of other factors. Likewise, the potential of a certain area to contain significant archeological deposits is dependent on a series of geographical and ecological factors, all of which may vary over time. Thus, our ability to identify and predict impacts to archeological sites requires a substantial understanding of the geomorphology of an area as well as the physical and cultural forces acting upon the geomorphological landforms.

SYSTEM-WIDE SOCIOECONOMIC ASSESSMENT

An assessment of system-wide socioeconomic effects would need to be completed as part of the System-Wide Environmental Impact Statement for the Upper Mississippi River navigation feasibility studies. This comprehensive assessment will identify the system-wide socioeconomic impacts associated with the navigation improvements proposed for the Upper Mississippi River Navigation System. Socioeconomic impacts assessed will include those categories required by the National Environmental Policy Act (e.g., property values, employment, business activity, noise levels). Additional categories evaluated will include public health and safety and regional economic impacts.

SITE-SPECIFIC NAVIGATION PROBLEMS

Besides the lockage delays explained earlier in this section, each of the Upper Mississippi River lock sites experiences navigation problems. Table 4 summarizes commercial locking delays at each site, and the following paragraphs contain a site-specific discussion about those sites on the system. Upper and Lower St. Anthony Falls, Locks 1, 4, 5, 8, and 11 through 19 experience navigation problems and delays, but to a lesser degree than other sites on the system, and are not discussed in detail here.

Lock and Dam 2

The primary concern at Lock and Dam 2 is the heavy recreational traffic during peak periods and the related congestion and safety problems. The problem here is not considered to be quite as serious as the same problem at Lock and Dam 3.

Lock and Dam 3

The major concern at Lock and Dam 3 involves heavy recreational traffic during peak periods and the related congestion and safety problems. This lock processes the most recreational craft in the St. Paul District and would be the focus of any attention regarding the system's recreational/commercial traffic conflict problem.

Another major concern involves the outdraft problem. During flows greater than 20,000 cfs, the outdraft force will tend to pull an approaching downbound tow away from the guidewall towards the dam. Currently, a helper boat is used to help align the tows properly for entry into the lock chamber. Without the helper boat, an approach by a downbound tow can take 2 to 4 hours. A safety study is currently ongoing with the purpose of finding a solution to the outdraft problem.

A third navigation related concern at Lock and Dam 3 pertains to the tow waiting area below the lock at Diamond Island. Upbound tows waiting to lock through will push into the bank and remain there with engines running until they are able to proceed to the lock. If the wait is long enough, they will tie up to trees along the shoreline. In the process, fuel is wasted and localized environmental damage occurs in the form of damaged trees, river bank degradation, and sediment resuspension. The Minnesota Department of Natural Resources has expressed concern over this issue, but it currently remains unresolved.

Lock and Dam 5A

An outdraft condition exists at Lock and Dam 5A during flows greater than 26,000 cfs. It ranks second in severity in St. Paul District (behind that of Lock and Dam 3). Most

downbound tows use a helper boat to assist with their lock approach. Approach times without a helper boat average approximately 1-1/2 hours longer than those with a helper boat. This lock is the only lock in the upper portion of the river that has special tow haulage equipment at the end of the upper guidewall to help facilitate the locking process for upbound tows requiring double lockages. This equipment prevents the outdraft from seizing the first cut of an upbound double lockage as it emerges from the lock chamber and rests along the upper guidewall.

Lock and Dam 6

A marina exists just upstream of, and on the same side of the river as, Lock and Dam 6. During high flows, conflicts arise between downbound tows and recreational traffic using the marina.

Lock and Dam 7

At Lock and Dam 7, the primary concern is the heavy recreational traffic during peak periods and the related congestion and safety problems. The problem here is not considered to be as serious as the same problem at Lock and Dam 3.

Lock and Dam 9

Currently, tows waiting to transit the lock must either idle in the channel or push up against the shoreline. If the wait is long enough, the tows will tie off to trees along the shoreline. This wastes fuel and causes localized environmental damage. A proposal currently under study which addresses this issue involves the installation of mooring buoys above and below the lock. A tow could tie off to a buoy while waiting its turn to lock through, thereby saving fuel and minimizing environmental impact. The design is based on a similar structure employed by the St. Louis District for the same purpose. The project is funded under the Corps of Engineers' operation and maintenance program. It is scheduled for installation in the fall of 1991. If this measure proves to be successful, tow waiting facilities will be considered at other locks in the St. Paul District.

Lock and Dam 10

The tow waiting problem described for Lock and Dam 9 also exists at Lock and Dam 10. The same proposal for solving the problem at Lock 9 is being considered for Lock 10. Mooring buoys would be installed above and below the lock from which tows could tie off while waiting to lock through. The project is funded under the Corps of Engineers' operation and maintenance program. It is scheduled for installation in the spring of 1992. If this measure proves to be successful, tow waiting facilities will be considered at other locks in the St. Paul District.

Another problem at Lock and Dam 10 is the outdraft condition that starts at flows above 47,000 cfs. Under these conditions, a helper boat occasionally is used to prevent downbound tows from losing control as they approach the lock. The outdraft force tends to pull the tow away from the guidewall towards the dam. Downbound approaches take a minimum of 45 minutes longer without the helper boat than they do with a helper boat.

Lock and Dam 20

This lock was completed in 1936 and is located at river mile 343.2 near Canton, Missouri. Although this lock underwent major rehabilitation between 1986 and 1991, the condition of the structure and mechanical/electrical components will continue to be monitored as part of the Periodic Inspection Program. The upper approach to the lock is subjected to outdrafts that pull tows towards the dam. The outdrafts extend approach time and often result in accidents which damage the upper end of the lock. The upper approach is plagued with ice and debris blockages from the Des Moines River that restricts access to the lock. There are no mooring sites above or below the lock that allow for efficient exchange of tows and transit of the lock.

Lock and Dam 21

Lock and Dam 21 is located at river mile 324.9 on the Illinois shore at the city of Quincy, Illinois. It was rehabilitated between 1987 and 1990. The upper and lower approaches to the lock are subjected to outdrafts that pull tows towards the dam. The outdrafts extend approach time and often result in accidents that damage the lock and dam. There are no mooring sites above or below the lock that allow for efficient exchange of tows and transit of the lock.

Lock and Dam 22

Completed in 1938, Lock and Dam 22 is located at river mile 301.2, and the lock is on the Missouri side of the river near the town of Saverton. Major rehabilitation was accomplished between 1987 and 1990 to extend its useful life. The upper and lower approaches to the lock are subjected to outdrafts that pull tows towards the dam. The outdrafts extend approach time and often result in accidents that damage the lock and dam. There is one mooring cell above the lock and none below the lock that allow for an exchange of tows and entering or transitting of the lock. The downstream approach is restricted by the channel width and bend above the lock.

Lock and Dam 24

Outdraft at Lock and Dam 24 during high flows seems to be the most serious problem. This outdraft pulls the tows away from the guidewall along the shore, making it very difficult to bring a downbound tow safely into the lock. The auxiliary guidewall at

Lock and Dam 24 may be a safety problem. Tows hit the wall due to outdraft and sometimes break apart, sending barges into the dam gates. More tie-off buoys are needed, especially upstream. Presently there are two tie-off buoys, but more would help. The additional buoys would allow the tows to tie off without using shoreline trees. Drift (floating logs and in winter ice) clogs the lock. An existing trash opening in the guidewall is too small to be useful. Recreational craft usage continues to increase, adding congestion to the lock operation for commercial traffic.

Lock and Dam 25

As with Lock and Dam 24, additional tie-off buoys are needed. A staging area for making up couplings is needed as well. The existing trash chute is too small to be useful. There are outdraft problems at this site, although not as serious as at Lock and Dam 24.

SITE-SPECIFIC ENVIRONMENTAL PROBLEMS

Site-specific impacts are those localized effects which can be observed or measured as a fairly direct result of a localized activity. In the discussion provided in the Planning Aid Report, these effects have been grouped as follows: construction at the locks and dams; newly impounded areas; mooring areas; channel improvements; and operational procedures.

Preliminary analyses to date indicate that the most probable need for navigation improvements would arise at Locks and Dams 3, 7, 20, 21, 22, 24, and 25. Additional discussions of site-specific impacts can be found in the Planning Aid Report (appendix A).

SITE-SPECIFIC HISTORIC PROPERTY PROBLEMS

Site-specific, existing cultural resource concerns relate to resources known to be present at the lock and dam sites. Locks and Dams 2 through 24 are themselves determined to be significant historic properties eligible for listing on the National Register of Historic Places. As a component of ongoing major rehabilitation to these structures, a Programmatic Memorandum of Agreement (PMOA) was executed with five State Historic Preservation Officers, the Advisory Council on Historic Preservation, and the Rock Island and St. Paul Districts of the U.S. Army Corps of Engineers. Compliance with the conditions set forth in the PMOA assures that significant elements of the locks and dams are considered in the design and construction of rehabilitation measures.

SITE-SPECIFIC SOCIOECONOMIC ASSESSMENT

An assessment of socioeconomic impacts will be performed for each site-specific Upper Mississippi River navigation feasibility study. These socioeconomic assessments will identify the impacts resulting from proposed navigation improvement alternatives at specific navigation facilities and locations. Data gathered during the comprehensive, system-wide socioeconomic assessment will be used as the basis of each site-specific assessment. These data will be supplemented by more detailed information regarding the project area and surrounding communities.

SITE-SPECIFIC RECREATION PROBLEMS

The congestion problems for recreational craft are most notable at Lock and Dam 2 (Hastings, Minnesota), Lock and Dam 3 (Red Wing, Minnesota), and Lock and Dam 7 (La Crosse, Wisconsin). The figures in table 5 illustrate the growth in recreational traffic from 1979 to 1989.

TABLE 5

Recreational Craft Growth, 1979-1989

Lock and Dam	Small Craft Locked Through 1979	1984	1989
2	5,794	5,868	13,991
3	8,891	9,760	19,581
7	7,699	9,025	13,712

PROJECTED FUTURE PROBLEMS AND NEEDS (Without Improvements)

SYSTEM-WIDE NAVIGATION PROBLEMS

Projected Traffic Demand

The Waterborne Commerce Statistics Center data report that total system (Minneapolis, Minnesota, to mouth of Missouri River) waterborne traffic amounted to over 82.0 million tons for calendar year 1988 (the most recent year available). Approximately 90 percent of this tonnage is composed of four primary groups of commodities. Movements of farm products (grain) in 1988 amounted to 43.0 million tons, comprising 52 percent of the total system traffic in that year. Coal movements accounted for 9.6 million tons in 1988, or approximately 12 percent of the total volume of traffic. Movements of nonmetallic minerals amounted to 4.0 million tons (5 percent) in 1988. Finally, movements of crude petroleum and petroleum products totaled 11.1 million tons (14 percent), and miscellaneous commodities (i.e., wood, gravel, scrap, and chemicals) comprised the remaining 17 percent in 1988.

The *1988 Inland Waterway Review* (published by the Water Resources Support Center, Institute for Water Resources, U.S. Army Corps of Engineers, IWR Report 88-R-7, November 1988) projects tonnage transported on the Upper Mississippi River to increase at an average annual rate between a low of 1.5 and a high of 2.7 percent through the year 2000, with the growth averaging near 2.0 percent annually. This range of annual rates of growth in traffic is well below the historic average annual growth rate since 1965 of over 3.7 percent.

Farm products are the largest factor affecting future traffic projections. By the year 2000, movements of farm products on the Upper Mississippi River are forecast to range between 47.5 and 55.8 million tons. Traffic of coal and petroleum products is projected to experience slow, steady growth, while the movement of nonmetallic minerals is projected to remain static. Total system traffic by the year 2000 is estimated at 110 million tons annually.

Lock Capacity Problems

As traffic in the system continues to increase through time, levels of congestion in the system also will increase. The increased levels of congestion will be evidenced primarily by greater delays at system locks,increased transit times, and decreased systemic efficiency.

Many locks in the system do not have sufficient capacity to handle the ever increasing demands placed on them by the growing levels of system traffic. Delays will markedly increase as the existing navigation system congests under the weight of increased demands for lockages. By the year 2000, in the absence of measures to increase existing capacities, delays at Locks 22-25 will total 96 hours per tow, thus significantly increasing the costs of transportation through the navigation system.

RECREATION/COMMERCIAL LOCKING CONFLICT

The growth in use of the Mississippi River as a recreational resource is expected to continue in the future. Evidence of this can be seen by the number of private interests that have applied for permits to develop new marinas or expand existing ones in Pools 2 through 4. The total number of boat slips involved would nearly double the amount already in place in these pools, indicating that there is still a strong demand for access to the river.

As traffic at the locks increase, delay times for recreational and commercial craft will get longer. Some believe that the increased waiting time will discourage recreational boaters from using the locks, making them more available for commercial craft. This may have happened to some extent in the lower portions of the river where commercial traffic is greater and recreational lockages have increased only slightly or remained constant. Given the multiple use emphasis that we find on the river today, we do not believe this will, or should, happen on the upper river. As delays resulting from greater recreational use increase, the cost of doing business will increase for the commercial user. It can be assumed that the current level of tolerance of congestion by the commercial operators will also decrease; their willingness to allow recreational lockages "out of turn" will decrease. The commercial operators will want to minimize their costs, with the possible indirect result of a decrease in the quality of the recreational experience. Recreational users, however, will not likely accept increased delays without increased protests and congressional contacts.

With this increasing use, conflicts between users and resource uses are bound to occur. In the ideal world, there would be an infinite amount of water areas to satisfy all users, from wide open areas for the high speed cruisers, to quiet areas for fishing, from unlimited beaches for large gregarious groups, to backwaters for watching wildlife, and unlimited lockage capacity to allow all traffic to move freely throughout the system. Unfortunately, the river is a finite system and the locks have limited capacity. As learned on the St. Croix, as use increased, those users wanting less crowded conditions were displaced. Those seeking solitude began to use the Mississippi backwater areas. As use on the Mississippi increased, the backwater areas received greater use, resulting in conflicts between users and conflicts over resource use. Resource managers responsible for wildlife resources are concerned that the increasing use of the backwaters is negatively

affecting the habitat of those areas. Managers responsible for recreation are concerned about the loss of areas for quiet recreation. The result is that any solutions proposed to help alleviate crowded conditions on the river and to make the entire navigation system more efficient also must examine the effects of those solutions on the entire river ecosystem, both man-made and natural.

SIGNIFICANT ENVIRONMENTAL RESOURCES

Fish and Wildlife

The significant resources of the Upper Mississippi River were discussed previously in Section 1, "Description of Study Area; Environmental Resources." These significant resources are: backwaters, side channels and associated wetlands; fish eggs, larvae, and adults; mussels; aquatic macrophytes; macroinvertebrates; and waterfowl.

Two major societal influences will substantially affect the significant resources of the Upper Mississippi River System in a competitive manner. One influence will tend to degrade or diminish the resources, while the other will tend to conserve or restore the resources.

The influence tending to degrade or diminish the resources is a growing U.S. population coupled with the constant driving force in a free enterprise economy to achieve a higher standard of living. Even without an increase in the standard of living, a growing population will naturally result in an increased use of the resources of the Upper Mississippi River, its shoreline, and its watershed, with consequent detrimental effects. Pursuing a higher standard of living adds to the detrimental effects. One aspect of an increased standard of living is the very noticeable increase in the recreational use of the river. The number of recreational craft is increasing and providing a corresponding greater need for boat launches, trailer parking, and docking facilities. Competition with commercial craft for use of the navigation channel and locking facilities is becoming a concern for economic and safety reasons. Another growing concern is that since recreational craft, unlike commercial craft, have access to the biologically productive and sensitive backwaters, there may be an increasing adverse natural resource impact that has not received adequate attention.

The positive long-term influence is a growing concern expressed by the public (and thus reflected indirectly though the Executive Branch and the U.S. Congress) for the natural resources of the country as a whole. There is a public realization that natural resources are finite, that, to date, there has been substantial loss and degradation, and that without effective regulation the process is likely to continue. The Executive Branch and the U.S. Congress have responded to these public concerns in recent years by establishing

policy and passing legislation intended to counteract and reverse this trend of adverse effects on natural resources.

Thus, these two major influences are currently at work and will continue to have an effect far into the future. The question is, which will have the greater influence and thus produce the net effect. The conclusion is probably more subjective and intuitive than analytical and is perceived to be a net adverse long-term effect. However, the rate of adverse change can be substantially slowed if public awareness and concern persist and all levels of government respond with appropriate policies and programs.

The following discussion specifically addresses the previously identified significant resources in the "future without" condition:

a. **Backwaters, Side Channels, and Associated Wetlands.** At present, the biggest concern for these components of the river system is sedimentation. When the pools of the existing lock and dam system were first filled, the impounded water created extensive backwater and adjacent wetland complexes with numerous fish and wildlife benefits. In the intervening years, these backwaters have filled in at what is perceived to be a rate that increases with time. Estimates made during the GREAT studies predicted that the backwaters would be lost to sedimentation in 50 to 200 years. Agencies concerned with natural resource management on the Upper Mississippi River consider this to be the number one problem on the river. Sedimentation occurring in the river, though, is only the effect, with the cause being land use in the watershed. Ultimately, then, the watershed is where the problem must be addressed.

As discussed previously, the increasing number of recreational craft on the river with access to backwaters and side channels is a growing concern. Depending on the size and configuration of the craft, its speed, and the depth, cross section, and substrate material of the backwater or side channel, sediment resuspension and bank erosion can result to varying degrees.

For the foreseeable future, the detrimental effects of sedimentation and increased recreational use of backwaters, side channels, and associated wetlands are expected to continue and possibly increase.

b. **Fish Eggs, Larvae, and Adults.** Fish and their different life stages are very difficult to study in a quantitative manner. Numerous naturally occurring variables can affect each life stage, and natural mortality rates are very high in the pre-adult stages. Thus, there are large natural population fluctuations, and a quantitative relationship between the pre-adult and adult stages is very difficult to establish. With these large, naturally occurring population fluctuations, it is difficult to evaluate a population effect induced by human activities. This is true even though the effects of human activities can be demonstrated by laboratory studies or site-specific field studies. Thus, until now, the

end or resultant effects of perturbations like navigation traffic on fish populations in the Upper Mississippi River have been an elusive target.

What is easier to demonstrate are the changes in species composition and the abundance of certain species, likely as a result of habitat change or the introduction of exotic species. Examples of habitat changes would be the original conversion of the free-flowing river to a series of pools by the construction of the lock and dam system, and the loss of backwaters and deep water habitat through sedimentation.

For the foreseeable future, continued sedimentation will continue to adversely affect or change fish habitat and populations. The effects of factors like navigation traffic (although a specific adverse effect can be demonstrated) will be difficult to translate into a net or total effect on adult fish populations.

c. **Mussels.** Mussels have an indirect life cycle (i.e., the larval stage is parasitic on fairly specific fish host species) and have relatively poor motility. Thus, the group in general is slow to recover from adverse impacts. The organisms are bottom dwelling "filter feeders," i.e., they filter particulate matter out of the water column as a nutrition source and thus may exhibit more sensitivity to pollutants that adsorb to particulate matter washed into the waterways, as well as the abrasive effects of suspended sediments. The conversion of the river from a free-flowing system to a series of pools probably resulted in habitat changes that substantially affected species composition. In recent years, there have been extensive unexplained die-offs of mussels in long stretches of the river, and certain species have been selectively harvested to provide "seed material" for the Asian cultured pearl industry.

For all, or a combination, of the above reasons, mussels in general might not be expected to fare well in the future. Any additional stresses placed on the group as a whole could result in catastrophic adverse results.

d. **Aquatic Macrophytes.** Aquatic macrophytes (i.e., plants) are a normal and necessary component of a naturally balanced aquatic ecosystem. An unnatural excess of nutrients can result in "blooms" or excess growths that increase the percent of total aquatic habitat that this element of the system occupies, thus unbalancing the system in an unnatural and possibly objectionable way. Examples of objectionable plant growth would be the choking of an aquatic body of water to the point that recreational craft cannot navigate, or that the "open water" needs of species like large fish cannot be satisfied. In the event that plant growth has been excessive and the nutrient supply becomes abruptly depleted, a large plant die-off can result and the subsequent decomposition of a large organic mass can deplete dissolved oxygen in the water column. The loss of dissolved oxygen can have catastrophically fatal results on other oxygen-dependent aquatic organisms.

On the other hand, some adverse effects can result in a dramatic decline in aquatic vegetation. An example of this could be an increase in turbidity that prevents sunlight from penetrating the water column and thus preventing the growth of photosynthetic plants. A consequence could be an extensive decline in the plant population. If other organisms using the system depend on the plants as a food source, there could be substantial indirect adverse effects. A situation similar to this has occurred in Pool 8, the plant being wild celery (*Vallisneria americana*) and the organism using the wild celery as a food source being the canvasback duck (*Aythya valisineria*).

The above two examples have both occurred in the Upper Mississippi River, the first (i.e., excessive plant growth) seeming to be associated with the low water levels of drought years, and the second (i.e., a decline in aquatic macrophytes) suspected to be associated with perturbations to the system. These types of problems may be cyclic or may yet be attributed to other causes; however, their continuance or reoccurrence in the future seems likely.

e. **Macroinvertebrates.** Mussels are macroinvertebrates but deserve individual discussion and were addressed in a preceding section.

Another group of macroinvertebrates that is currently of concern and receiving considerable attention is the fingernail clam. Fingernail clams are small (i.e., maximum size about 0.8 inch) and exhibit a hermaphroditic method of reproduction. Under suitable conditions, they occur in tremendous numbers and have been an important diet item for organisms like diving ducks. The fingernail clams have largely disappeared from the Illinois River and thus have affected the migratory habits of diving ducks. As a consequence, fingernail clam populations on the Mississippi River have evolved as a more valued resource, especially in Pool 19. Recent observations by researchers and resource managers have led to concerns that fingernail clam populations on the Mississippi River also may be declining. The status of fingernail clams on the Upper Mississippi River is currently under investigation, and its future as a resource is in question.

Other macroinvertebrate populations in the Upper Mississippi River are considered to be important components of the system and are the subjects of considerable interest. Two such groups are the aquatic immature life stages of the mayflies (*Ephemeroptera*) and the caddis flies (*Tricnoptera*). These organisms are abundant, have short life cycles, and recover relatively quickly from adverse impacts. At present, there have been no indications that these groups are in danger, and their future seems secure.

f. **Waterfowl.** There is considerable concern in North America over the status of waterfowl, so much so that the United States and Canada have entered into an agreement called The North American Waterfowl Management Plan. The plan is an overall scope of requirements for the management of migratory waterfowl. The problems faced by waterfowl are perceived to be primarily a loss or degradation of nesting habitat. The waterfowl

populations and the areas used to satisfy habitat requirements span three countries (i.e., Mexico, the United States, and Canada) from coast to coast. The importance of the Upper Mississippi River System to the whole picture is as a major, north-south migration route. As a major migration route, the river system would have to satisfy resting and feeding requirements for waterfowl. The apparent decline in vital food sources (i.e., wild celery and fingernail clams) has recently become an issue of concern, and studies currently being planned or conducted will contribute to determining whether this is a long-term problem or just the low point of a natural cycle.

Historic Properties

Impacts to cultural resources discussed in the "Existing Problems and Needs" section are expected to continue. The districts will continue to request funding to identify, evaluate, preserve, and protect significant historic properties in compliance with Sections 106 and 110 of the National Historic Preservation Act. As funds are available, appropriate identification and protection measures will be taken.

A concerted nation-wide educational effort is needed to educate the public concerning the value of the fragile nonrenewable cultural resource base. Only through education can any real long-term reduction of archeological site looting be accomplished. In concert with the educational effort, continued and increased law enforcement efforts are required to apprehend and prosecute looters of archeological sites. The districts will continue, on a local level, with public education and law enforcement efforts. However, existing evidence indicates that significant sites will continue to be lost to physical and cultural forces as well as site looting.

SITE-SPECIFIC NAVIGATION PROBLEMS

Future site-specific problems are the same as mentioned under "Existing Problems and Needs," except that the problems will be further aggravated over time.

SITE-SPECIFIC ENVIRONMENTAL PROBLEMS

Preliminary investigations indicate that recommendations for commercial navigation improvements are most needed at Locks and Dams 20 through 25. The following narrative discusses the "future without" condition in the immediate vicinity of these lock and dam sites.

There is a general perception that activities around lock and dam facilities adversely affect the natural environment. The lock and its approach areas would tend to contribute

to congestion, which is intensified by the delay time at that particular lock. During delays, the prolonged prop wash from waiting tows may have a greater adverse effect than tows that pass straight through the lock area. Also, tows that tie off along the shoreline may be harming trees. In the "future without" condition, if traffic increases, these adverse effects would increase.

Lock and Dam 3

Lock and Dam 3 is located in a rural area approximately 6 miles above Red Wing, Minnesota. Aside from an expected increase in recreational traffic levels in the future, there is no information available that indicates any other land-use or water-use changes in the immediate vicinity of the facility.

Lock and Dam 7

Lock and Dam 7 is located in a semi-rural area near La Crosse, Wisconsin. Aside from an expected increase in recreational traffic in the future, there is no information available that indicates any other land-use or water-use changes in the immediate vicinity of the facility.

Lock and Dam 20

Lock and Dam 20 is located in an agricultural area near two small rural communities. The closest large metropolitan areas are Keokuk, Iowa, located approximately 18 miles upstream, and Quincy, Illinois, located approximately 15 miles downstream. Beyond a possible increase in navigation traffic that might occur without navigation improvements, there is no information available that indicates any other land-use or water-use changes in the immediate vicinity.

Lock and Dam 21

Lock and Dam 21 is located just downstream from the Quincy, Illinois, metropolitan area and its industrialized riverfront. Floodplain areas and bluffs to the east of the lock and dam complex also contain large industrial and commercial operations. Thus, even without navigation improvements, there will be a tendency for commercial/industrial development of the riverfront in the general vicinity of the lock and dam complex. This development would take the form of barge terminals or docking areas and would probably have accompanying mooring or fleeting needs. The shoreline development and increased usage of the immediate river area probably would take place gradually, in a piecemeal manner, and likely would be limited in nature.

Lock and Dam 22

Lock and Dam 22 is located about 8 miles south of Hannibal, Missouri, the largest metropolitan area in the vicinity. Land use is agricultural to the east of the lock and dam complex and wooded/residential in an uneven topography to the west. Beyond any increase in navigation traffic that might occur without any navigation improvements, there are no indications of any land-use or water-use changes that might occur in the immediate vicinity.

Lock and Dam 24

Lock and Dam 24 is located on the Mississippi River adjacent to Clarksville, Missouri. The wide floodplain to the east of the pool is leveed and cropped, while the lands to the west are primarily hill lands consisting of row crops, pasture, and forest. Considerable portions of the floodplain also are devoted to state and federally managed wildlife refuges.

There are no indications that significant land-use or water-use changes will occur within the forseeable future. However, sedimentation of backwater/wetland habitat has been, and will continue to be, a significant problem. Two EMP-HREP projects immediately upstream from the dam, Clarksville Refuge (constructed) and Pharrs Island (nearing construction), serve to rehabilitate and enhance such degraded habitat.

Lock and Dam 25

Lock and Dam 25 is located on the Mississippi River near Winfield, Missouri, roughly 23 river miles above the Mississippi's confluence with the Illinois River. The land to the east is hilly and is comprised of row crops, pasture, and forest. The floodplain to the west is leveed and is used primarily for crops and recreation (hunting). Considerable portions of the floodplain also are managed as wildlife refuges.

There are no indications that significant land-use or water-use changes will occur within the foreseeable future. However, sedimentation of backwater/wetland habitat has been and will continue to be a significant problem. Two EMP-HREP projects, Batchtown Refuge (immediately upstream from the dam) and Cuivre Island (3 miles downstream from the dam), will attempt to rehabilitate and enhance habitat degraded by sedimentation.

HISTORIC PROPERTY PROBLEMS

In the short term, lack of improvements will maintain the historical integrity of the nationally significant locks and dams, assuming continued maintenance and repair. Archeological resources located in near-shore settings will continue to be threatened by erosion caused by fluctuating water levels, prop wash from commercial and recreation vehicles, and the tieing-off of barges.

PLANNING OBJECTIVES

The planning objectives for the Upper Mississippi River Navigation Reconnaissance Study are listed below:

a. Identify means to maintain and increase the efficiency of the navigation locks on the Upper Mississippi River, consistent with protecting the Nation's environment pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements.

b. Provide a safe and dependable navigation system throughout the Upper Mississippi River during the period 2000 to 2050 using O&M, major rehabilitation, and capital improvements, where appropriate. This will be accomplished consistent with protecting the Nation's environment pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements.

c. Restore and/or preserve fish and wildlife habitat and other natural resources at lock sites and identify and preserve significant historic properties at lock sites on the Upper Mississippi River.

d. Work to resolve the problem of recreation traffic delays and congestion.

e. Establish a preliminary prioritization schedule for evaluating sites where improvements may be needed.

PLANNING CONSTRAINTS

The fish and wildlife significance of the river system places constraints on the planning process. The fish and wildlife values of the system have public, technical, and institutional significance.

Public recognition is provided by the extensive use of the river for fishing, hunting, trapping, and mussel harvesting. This public recognition also is reflected in nonconsumptive activities such as camping, recreational boating, swimming, and nature appreciation (e.g., nature hikes or bird watching).

Technical recognition is realized by the tremendous value placed on the fish and wildlife resources of the system by Federal and State agencies charged with resource management and by private organizations whose central focus is the conservation of natural resources.

Institutional recognition is demonstrated by the U.S. Congress in the Water Resources Development Act of 1986, recognizing the Upper Mississippi River System as a "nationally significant ecosystem" as well as a "nationally significant commercial navigation system." Additional recognition was provided in the same legislation by the authorization of the "Environmental Management Program" which (1) plans, constructs, and evaluates measures for fish and wildlife habitat rehabilitation and enhancement; (2) implements a long-term resource monitoring program; and (3) implements a computerized inventory and analysis system.

The planning process is further constrained by the 1930 River and Harbor Act and a subsequent 1932 Joint Resolution of Congress which authorized the construction and mandated the maintenance of a 9-foot navigation channel on the Upper Mississippi River System.

Section 3 - Preliminary Plan Formulation

MEASURES AVAILABLE

MAJOR STRUCTURAL

Major structural measures designed to reduce delays to commercial traffic include the following:

a. Adding a 1,200-foot lock at an existing lock and dam facility;

b. Replacing existing locks and dams with new locks and dams which include a 1,200-foot lock;

c. Consolidating the function and purpose of two existing lock and dam structures into one new lock and dam, thereby eliminating the existing structures; and

d. Expanding existing 600-foot locks to 1,200 feet.

Measures designed to alleviate congestion and delays of recreational craft include the following:

a. Completion of auxiliary locks at those locations where an incomplete facility is in place; and

b. Any of a variety of lifts or carriers designed to move recreational craft from one side of the dam to the other.

MINOR STRUCTURAL

Minor modifications to the existing locks are designed to improve the efficiency of lock operations without changing lock size. Based on the projected traffic levels, these measures would be considered short-term improvements designed to extend the useful life of existing structures. These short-term alternatives will receive full consideration during the feasibility study.

a. **Guidewall Extensions.** Extended guidewalls (1,200 feet long) would assist in recoupling tows after a double lockage and would provide more landing area during difficult approach conditions. An extended guidewall would allow the second cut of a double lockage to totally vacate the lock chamber so that it may be prepared to accept a tow in the same direction.

b. **Mooring Cells.** Mooring cells would allow double-locked tows to be recoupled away from the lock area and let the next lockage proceed in a more efficient manner. They also would allow approaching tows a place to tie up while waiting their turn to lock through, resulting in fuel savings. They could be placed in closer proximity to the lock than existing waiting areas, thus speeding up the locking process.

c. **Powered Traveling Kevels.** This is a motorized version of the traveling mooring bitt currently in use at several locks on the Upper Mississippi River. The kevel can be installed on rails running along the entire length of the guidewall. It pulls an unpowered cut into, through, and out of the chamber to the end of the guidewall more quickly and in a more controlled manner than using winches located on the lock walls.

d. **Improved Lock Approaches.** These would consist of measures to improve the efficiency of lockages by providing faster and more easily navigable approaches. Possible improvements include:

* widening of approach channel;

* realignment of the approach channels;

* realignment or modification of the auxiliary walls;

* installation of river training structures;

* installation of submerged dikes; and

* installation of guard cells angled towards the center of the river from the upstream end of the river guardwall.

e. **Mobile Floating Locks.** This would be designed for locking recreational craft. A mobile floating lock is a self-contained, fully operational lock structure which can be positioned behind the existing upper miter gates for the auxiliary chamber. This device would be approximately the size of three barges abreast (105 feet by 200 feet).

NONSTRUCTURAL

Nonstructural measures which measurably reduce lockage delays to commercial traffic include the following:

a. **Helper Boats.** Helper boats can assist tows in approaching locks under difficult navigation conditions or assist in removing unpowered first cuts from the lock chamber during a double lockage.

b. **N-Up/N-Down Locking Policy.** The common locking policy at locks when tows are in queue in each direction is to lock tows in the order in which they arrive at the locks (a first-come, first-served procedure). However, at high traffic levels, an N-up/N-down locking policy can increase capacity by reducing average processing time. This will be effective only where navigation characteristics make it easier and less time-consuming for one tow to follow another in line rather than to have two opposing tows pass each other.

c. **Congestion Fees for Commercial Tows.** This would consist of assessing a fee for commercial tows awaiting lockage during congested periods on the Upper Mississippi River.

Nonstructural measures which may relieve congestion of recreational craft at the locks include the following:

a. **Lock Waiting Areas.** Lock waiting ares are beach-type areas where recreational craft may wait their turn to lock through. The areas may be developed to the extent of including picnic tables, trash barrels, toilets, and stairways. The areas likely would include a communication link with the lock to notify users of the next available lockage time.

b. **Scheduled Lockages.** Scheduling recreational lockages may be implemented during periods of peak lockage demand. Time would be set aside during which the lock would be dedicated to the service based on the normal locking policy.

c. **Recreational Lockage Fees.** Currently, recreational craft benefit from using the locks free of charge. This encourages use regardless of the beneficiaries' willingness to pay for the benefit. A result of this alternative would be reduced use and congestion by imposing lockage fees and thus limiting use of the lock to only those willing to pay for the benefit.

DO NOTHING

In the case of the "Do Nothing" alternative, the without-project condition will prevail as the assumed future condition for the navigation system. This alternative may be selected if an economically feasible plan cannot be found or if the environmental or social impacts of a plan are so severe that maintaining the status quo would be preferable. Selection of this alternative means that there is no Federal interest in improving the Upper Mississippi River Navigation System. However, operation, maintenance, and repair and rehabilitation costs would increase as the system grew older, with a corresponding decrease in "downtime."

ENVIRONMENTAL RESTORATION/ENHANCEMENT MEASURES

While the identification of fish and wildlife restoration and enhancement opportunities is an integral part of the Corps' planning process, no specific environmental measures were identified in the reconnaissance phase. Rather, the identification of these opportunities will be pursued during feasibility phase studies.

The U.S. Fish and Wildlife Service has been asked to provide a listing of identified fish and wildlife restoration/enhancement opportunities and initiated an approach to accomplish this in its Planning Aid Report, which can be found in appendix A. The U.S. Fish and Wildlife Service is proposing a tiered approach with an overall strategic plan compiled from the natural resource objectives of the concerned Federal agencies and the five Upper Mississippi River states. This overall strategic plan would yield reach-specific or regional operational plans. In turn, these regional operational plans could provide guidance which agencies could use to develop or modify strategies, programs, or plans for resources which the agency directly manages or controls. The strategy of the plan would evolve from the general to the specific during feasibility studies and be guided by 19 generalized goals that could apply to multiple sites in the river system or watershed. The Planning Aid Report (appendix A) lists these 19 goals.

CONSIDERATION OF MEASURES

The measures described above compose the range of alternatives available as potential solutions for identified system-wide or site-specific problems. The goal of the formulation process is to develop a comprehensive system-wide plan by incorporating measures which address the identified problems. To be recommended for implementation, a measure must be incrementally justified and environmentally and socially acceptable. Due to the limited scope of this study, an exhaustive incremental analysis of

all measures addressing all identified problems is not possible. The purpose of the reconnaissance study is simply to determine if a feasible plan exists for improvement of the navigation system. Therefore, some judgment was employed in developing a preliminary plan that addresses the problem and has good prospects for economic feasibility. A more rigorous formulation process will be followed in the feasibility stage.

EVALUATION AND SCREENING OF IMPROVEMENT MEASURES

COMMERCIAL NAVIGATION EVALUATION

The estimated National Economic Development (NED) benefits of the recommended plan are entirely general navigation. The procedures outlined in the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation - Studies*, dated March 10, 1983, for the estimation of NED benefits attributable to inland waterway navigation projects are employed to evaluate the economic impacts of potential system actions.

Benefits for navigation projects consist of two distinct, but related, components: first, transportation cost savings to existing or projected traffic from reduced levels of systemic congestion (delay reduction); and, second, transportation cost savings over an alternative mode of transport for movements now utilizing the navigation system because of the reduced transportation costs resulting from the projects (rate differential).

The General Equilibrium Model (GEM) is used to evaluate the existing conditions, the future without-project conditions, and the future conditions with alternative system configurations in effect. The GEM model is a tool used by the Corps of Engineers for the economic evaluation of potential changes to various components of a navigation system. The model estimates the total transportation costs including congestion costs incurred by individual movements desirous of using all or portions of a navigation system. Transport costs for these individual movements are then compared to the total transport costs of that movement via the least cost alternative mode. If the alternative mode of transport has lower costs than water transport for a given movement, then that movement is presumed to be diverted from the navigation system to the alternative mode. This potential movement enjoys no transport cost reductions resulting from the navigation system. Conversely, movements enjoying less costly transportation on the navigation system are presumed to use the navigation system realizing net savings of the difference between the total cost of water transport and the total cost of the next least costly alternative mode of movement. The sum of all these transportation cost savings represents the total savings to the Nation attributable to the navigation system.

For a given level of traffic, the greater the carrying capacity of the navigation system the lower the total unit transport costs. This is a consequence of decreased levels of congestion in the system, allowing potential movements quicker and more efficient transport from origin to destination. The transportation costs of individual movements through the navigation system are inversely related to total system traffic. In other words, individual movement transportation costs depend not only on the economics of each individual movement, but also on the levels of congestion in those portions of the transportation system used by each individual movement. The levels of congestion in each component of the navigation system are increasing functions of the total volume of traffic processed by each component of the system.

One of the first steps in the evaluation process is to identify the most likely condition expected to exist in the future in the absence of any improvements to the existing navigation system. The without-project condition serves as a baseline against which alternative improvements are evaluated. The increment of change between an alternative plan and the without-project condition provides the basis for evaluating the economic, environmental, and social effects of the considered plan.

Consequently, the subset of existing and projected system traffic not impacted by increasing levels of congestion may be excluded from the economic analysis of potential actions to alleviate systemic congestion. There is no impact to this traffic of reducing congestion at constraint points in the system. Accordingly, movements on the Upper Mississippi River system that do not pass through any system lock and movements in the system that will use only the new Melvin Price Locks are excluded from the economic analysis. Movements that use no system locks will not be impacted by actions at locks to reduce congestion. Similarly, traffic using only the new Melvin Price Locks in the system, which includes most Illinois Waterway traffic, will not be affected by possible system actions as these recently constructed chambers will show no significant changes in congestion levels over the period of analysis, with or without actions to alleviate congestion elsewhere in the system.

It has long been recognized that any significant modification to the Nation's waterway system can have far-reaching impacts that can be either negative or positive. The NED benefits of a project, principal evaluation criteria for water resources studies, are then determined by computing the net difference of the average annual transportation costs and navigation system savings for with- and without-project conditions.

The analytical assumptions defining the without-project condition are presented below. The without-project condition selected for use in this study includes the following analytical assumptions:

a. Operation and maintenance of Upper Mississippi River system locks and dams will be continued through the 50-year period (2000 through 2050) of economic analysis to ensure continued navigability.

b. All existing waterway projects or those under construction are to be considered in place and will be operated and maintained through the period of analysis.

c. All locks on the Upper Mississippi River navigation system are assumed to be using the most efficient locking policies.

d. Waterway user taxes will continue in the form of the towboat fuel tax prescribed by the Water Resources Development Act of 1986, Public Law 99-662.

e. Alternative surface transportation systems (rail, truck) are assumed to have sufficient capacity to move diverted waterway traffic at current costs over the period of analysis.

f. The capacities of locks are as presented in tables 3 and 6.

g. Traffic demands on the system will grow at the medium growth rates presented in the *1988 Inland Waterway Review*.

h. Real unit (hourly) costs of delay will remain unchanged.

i. Delay and congestion costs at other system constraint points not directly modeled will not change significantly.

To evaluate potential Federal actions to relieve expected system congestion, capacity and delay at 50 percent utilization were estimated for additional 110- by 1,200-foot lock chambers at existing sites from Lock 11 through Lock 25. The 50 percent utilization is required for the capacity calculation and is further explained in the Economic Work Plan of the Initial Project Management Plan. Then, the GEM system model was run with various combinations of the additional chambers assumed in place. Additional lock chambers were added at sites in the decade when the net incremental transportation cost savings attributable to the additional chambers first exceeded the annual costs of constructing the chambers.

Capacity and delay at 50 percent utilization estimated for dual lock chamber sites are displayed in table 6. Note that capacities shown in this table account for both the capacity of the existing lock and the proposed improvement, where appropriate.

TABLE 6

Capacity and Delay Parameters for Locks with Additional Chambers

Lock No.	Capacity > (millions of tons)	Delay at 50% Utilization (hours)
11	143.00	0.42
12	147.30	0.42
13	149.80	0.42
14	166.10	0.39
15	147.50	0.42
16	167.40	0.42
17	152.00	0.50
18	172.80	0.39
19	110.60*	0.66
20	168.10	0.36
21	173.40	0.37
22	150.30	0.64
24	166.10	0.50
25	167.70	0.50

* As there is already a 110' x 1,200' chamber at Lock 19, the addition of a 110' x 600' chamber is used for this estimate. It should be understood, however, that the difficult approach and high lift at Lock 19 significantly reduce its capacity. In the feasibility study, the possibility of an additional 1,200' lock, as well as approach improvements, will be evaluated.

ENVIRONMENTAL IMPACTS EVALUATION

A two-part approach to impact assessment regarding navigation improvements is used:

a. Site-specific impact assessment from the direct or secondary effects of construction associated with the proposed navigation improvement; and

b. System-wide assessment from traffic increase or other identified secondary impacts associated with the proposed navigation improvement.

The site-specific impacts occur within a much smaller geographic area than the system-wide impacts, and the limits of the impact area are fairly well defined. Within this construction area, the activities being proposed are clearly defined, and the impacts or effects are readily identified.

The system-wide effects, on the other hand, are occurring over a much larger area. The knowledge of the extent and magnitude of the physical forces producing the effect or impact is not well developed at this time, and how these physical forces translate into a biological effect is not an easily achieved conclusion. Ideally, an impact that is identified is quantified so that the full extent of the impact is known. As in most analytical processes, the effort can be subdivided into qualitative and quantitative parts – the qualitative part being easier and the quantitative part being much more difficult. In the case of assessing the system-wide effects of navigation, even the qualitative part is not easy and there is no guarantee at this time that it can be done.

One example of why the assessment of navigation effects can be so difficult is that in a large river system there are natural perturbations such as high discharges with increased velocities, or backwater flooding with consequent sedimentation or wind-generated waves that can have similar effects on the resources as those effects produced by navigation traffic. It could be difficult or even impossible to separate the effects of natural perturbations from the effects of navigation.

The U.S. Fish and Wildlife Service has addressed the potential effects of navigation improvements in this two-part approach – site-specific and system-wide – in its Planning Aid Report found in appendix A. The following discussion covers the main concerns raised in the Planning Aid Report.

SITE-SPECIFIC CONCERNS

Construction at Locks and Dams

There would be a permanent loss of aquatic habitat from those areas where new construction would take place. A temporary loss or permanent change in aquatic habitat would occur in peripheral areas affected by excavation, disposal, fill, or altered hydraulic regimes.

A change in the operation of the facility (e.g., tow approaches, increased bank erosion, maintenance dredging and disposal, addressing recreational craft needs) also may have associated environmental effects.

With a large construction project there is a natural need for access, staging, and storage areas that also can create concerns.

New Impoundments

A new lock and dam facility that combines two existing facilities would have to be built to the pool level of the upper dam. For instance, if a new facility was constructed to replace Locks 24 and 25, it would have to be built to the Pool 24 level to allow for elimination of that facility. This would result in a pool raise to Pool 25. This new combined facility could be constructed either above or below the existing Lock 25. Lower water depths in a tailwater of an existing site make construction of new lock and dam facilities easier.

Mooring Areas

Navigation improvements may result in the construction of new mooring or guard cells. If navigation improvements were determined to cause increases in navigation traffic, there might be a secondary impact of increased barge fleeting elsewhere in the system.

Channel Improvements

A need for channel improvements at various points in the system could be identified. These could involve tow waiting and passing areas or improvements in the navigation channel itself. All of these might involve dredging and disposal, the possible removal of bedrock, constructing mooring facilities, or the construction of closure dams or wing dikes, which, in turn, would have some environmental effects, primarily from construction activities.

Operational Procedures

Any change in the way tows approach a lock and dam facility, lock through, or a change in the way the facility is operated (e.g., water releases through the dam) could fall into this category. Effects could be adverse or beneficial and might relate to the local hydraulic regime, prop wash, or bank erosion.

An evaluation of the impacts of these site-specific activities will depend on the resources present. A before and after quantitative evaluation is needed to determine the net impact of the proposed action. Early attention to environmental concerns often can result in a project design or methodology that avoids or minimizes an impact.

SYSTEM-WIDE CONCERNS

Physical Impacts of Tows

a. **Drawdowns.** A phenomenon observed as a tow passes a point on the river is a temporary lowering of the water level at that point. How far this effect extends into the backwaters is disputed and might be site-specific. Biological effects of this phenomenon are of concern, such as the stranding of organisms or the sucking of larval fish out of a backwater.

b. **Waves.** The effect of tow-induced waves on shoreline stability and shallow shoreline areas is a concern.

c. **Velocity Changes and Turbulence.** These forces produced by tows raise questions about the potential effects on bottom-dwelling organisms and nesting fish, especially in the shallower areas of the river.

d. **Ice Movement.** The effect of ice movement induced by vessel passage on bank stability and on the substrate from abrasion is of concern. Also, the potential for contributing to ice jams could have flooding or dewatering effects. Since navigation does not normally occur when the Upper Mississippi River is "iced over," the frequency of these type events would be rare and the duration short. Thus, the potential significance of the impact would need to be evaluated.

e. **Erosion.** The closer a tow operates to a shoreline the greater its erosion potential is perceived to be.

f. **Resuspension of Sediments.** Sediments may enter the river system from other causes, but once in the system they may be resuspended by the physical forces generated by tows and thus produce an adverse effect again and again.

g. **Sediment Deposition.** There is concern with the resuspension of sediments and their redeposition in backwaters and other valuable habitats.

Chemical Impacts of Tows

The physical forces produced by tows can alter the natural chemical equilibria of the water column and the water column/substrate interface. The end result could be changes in dissolved oxygen or changes in the uptake or release of other chemical constituents of the water column or the substrate.

Biological Impacts of Tows

The following list of biological components of the river system has been preliminarily identified with respect to potential adverse effects from navigation traffic:

a. **Terrestrial Habitat.** A primary concern would be the loss of terrestrial habitat due to tow-induced bank erosion.

b. **Aquatic Habitat.** Tow passage may have certain physical/chemical effects such as drawdown, induced wave action, or sediment resuspension which are perceived to adversely affect aquatic habitat.

c. **Plankton.** The effects of navigation on plankton are envisioned as occurring directly from tow props or indirectly through reduced productivity from induced changes in the water column such as increased turbidity. Plankton are an ecologically important component of aquatic systems but can fluctuate dramatically under the influence of natural variables. Thus, although impacts to plankton would be of concern, the effect of navigation traffic on this resource may be extremely difficult to establish.

d. **Aquatic Macrophytes.** Potential effects on aquatic macrophytes could include physical effects from wave action and reduced productivity due to increased turbidity.

e. **Benthos.** Potential effects on benthos could include direct effects from scour and dislodgement; habitat changes induced by turbulence and waves; or reduced productivity from disturbances or effects on host species such as fish in the case of Unionid mussels.

f. **Fish.** Potential navigation effects on fish could occur directly from the physical forces produced by tows, from the disruption of spawning activities, or from habitat changes. However, the measurement of an impact may be difficult to relate to other life stages or overall population levels since fish in general have the potential for a high fecundity rate, experience high mortality rates in the early life stages, and different species may exhibit different reproductive strategies.

g. **Birds.** Tow traffic impacts to birds could occur when passing tows flush feeding or resting birds, disrupting the behavior pattern and possibly wasting critical energy reserves prior to migration. An indirect impact would occur if tow passage were determined to adversely affect food supplies or nesting habitat.

h. **Furbearers.** The effects of tow traffic are perceived to be greatest in the main channel and main channel border areas. Since these areas are not thought to be preferred furbearer habitats, the effects on furbearers are anticipated to be limited.

i. **Other Wildlife.** A multitude of other wildlife depend either directly or indirectly on the river system but do not receive a lot of attention because they may be unknown, unobserved, or lacking in political or economic importance. Other species may be so numerous that they may be overlooked just because they are so numerous. The impacts that navigation may have on this vast array of species of the ecosystem are largely unknown. It might be assumed that the majority of these species will fare as well as the general health of the system, while other less-tolerant species may be more severely affected by navigation improvements.

The assessment of the effects of navigation on these types of resources can be an involved and time-consuming process. The best available example is the Plan of Study developed as an interagency effort to evaluate the incremental effects of additional navigation traffic generated by the 2nd Lock at Melvin Price Lock and Dam. Resources similar to those above were identified as concerns, and the associated studies and administrative and interpretive tasks needed were estimated to cost in excess of $20 million and in total could require approximately 9 years to complete.

Human Use or Recreational Aspects

The following list of human use activities associated with the river system has been identified.

a. **Sport and Commercial Fishing.** These activities harvest a biological resource of the river. Previous comments under "Biological Impacts of Tows - **Fish**" would apply to this resource, and it follows that, as the resource is affected, so might the activity be. Other ways that navigation might affect these activities are by the effect of tow-induced waves or wakes on small fishing boats and by fleeting or the need for lockages affecting access to desirable fishing areas. There also have been reports of commercial fishing gear being lost due to commercial barge traffic.

b. **Hunting and Trapping.** These activities also harvest biological resources of the river system. Thus, previous discussions under "Biological Impacts of Tows" with respect to terrestrial and aquatic habitat, birds, furbearers, and other wildlife all could apply to these activities, with the assumption that as the resource is affected so might the activity be.

c. **Commercial Shellfishing.** This activity also harvests a biological resource of the river. If navigation traffic and associated activities like fleeting were determined to have significant adverse effects on mussels, the effect on commercial shellfishing would be evident. However, such conclusions will likely be complicated by suspicions that commercial shellfishing itself is having significant adverse effects on the resource.

d. **Pleasure Boating.** At some places on the river system, the incidence of pleasure or recreational boating is increasing so dramatically that concerns are rising over the safety of smaller pleasure craft when operated near commercial tows and the potential for conflict or competition between commercial craft and pleasure craft both wanting to use the same lockage facility. There is also a concern that recreational craft themselves may be causing adverse environmental impacts. An example would be recreational craft operating in shallow backwater or side channel areas and producing waves that promote bank erosion.

e. **Passive Recreation.** The impact of navigation traffic on passive recreation would be difficult and elusive to pursue. It would intuitively seem that any degradation of natural resources would reduce the enjoyment for the nature lover. Such experiences are very subjective, and, for some, the sight of a tow navigating one of the mightiest rivers in the world may contribute to the enjoyment of the moment.

Federal planning of water resources projects not only evaluates a proposed project's effects on these types of activities, but in addition usually tries to identify opportunities to contribute to their betterment.

IMPACT EVALUATION OF HISTORIC PROPERTIES

Navigation impacts to historic properties can be assigned to either site-specific impacts caused by new construction, or system-wide and cumulative impacts caused by an increased number of tows transitting the navigation system. Site-specific impacts to historic properties are relatively easy to evaluate. An archeological and structural inventory and evaluation of the proposed construction site, combined with an assessment of the submerged and/or buried resource potential of the construction site and any associated borrow, disposal, or construction easement area, will determine the impact of the proposed construction to significant historic properties. Potential site-specific impacts to historic properties will be discussed by district below.

Determining system-wide impacts related to navigation is much more difficult. Several State and Federal research efforts have been conducted to address navigation impacts to environmental resources along major waterways. Issues related to these studies remain controversial at present. Please refer to the Environmental Resources area in Section 1 of this report for a brief discussion of these issues.

System-wide impacts resulting from navigation are most likely to affect archeological sites much more than other forms of historic properties. These impacts include site inundation, alluviation, burial, and erosion. The single-most destroyer of archeological sites along the Mississippi waterway is thought to be streambank erosion.

A study conducted for the Illinois Department of Energy and Natural Resources (Warren 1987) indicated that four out of five sites located on the banks of the lower Illinois River were experiencing substantial loss due to average streambank erosion equating to 35 cm per year, with documentation for 90 cm per year for some sites. At this rate, sites will be completely destroyed in as little as 15 years, with remote portions of the larger sites surviving 80 years. Although the Illinois River information is not directly applicable to the Mississippi River, an idea of the magnitude of this problem can be illustrated by these data.

It is clear that numerous potentially significant sites are being impacted by streambank erosion along the Mississippi River. The physical causes of streambank erosion have been the topic of lengthy ongoing debate. Warren (1987:144) concludes: "... much of the erosion problem is caused by artificial, rather than natural, erosional processes. In all probability, the inflated water-surface elevations of the river created by dams, the heightened flood stages of the river caused by levees, and the powerful waves and drawdowns generated by vessel traffic are all important factors."

The physical effects of primary importance to the present study are those associated with increased vessel traffic, predominantly wave action and draw down. Warren's (1987) conclusions relied heavily on a series of reports prepared by Bhowmik, *et al.* (1980, 1982, 1984). This same problem has been addressed in reports by Simons, *et al.* (1981, 1988). Simons (1981), as cited in the *Final Environmental Impact Statement, Second Lock at Locks and Dam 26 (Replacement) Mississippi River, Alton, Illinois and Missouri* (EIS page 181) indicated that traffic increases resulting from the second lock could result in a 3 percent increase in shoreline erosion on the Mississippi River in year 2040. The effect of river traffic on bank erosion and archeological sites also is addressed in Technical Note ASPPN 1-11 in *The Archaeological Sites Protection and Preservation Notebook* published by the U.S. Army Corps of Engineers Waterways Experiment Station.

The results of the physical effects studies may help clarify and predict those conditions under which vessel traffic has a significant effect on shoreline erosion. This information, combined with geomorphological and archeological studies, will form a basis for determination of effect during the feasibility phase of the navigation study.

Potential impacts of alternatives currently being considered will be addressed below for each Corps of Engineers district.

St. Paul District

The preliminary reconnaissance analysis does not anticipate an increase in commercial traffic in the St. Paul District on a scale that would necessitate major lock improvements. Consequently, the St. Paul District has not assessed the alternatives that call for major or minor structural changes to the locks and dams. If later feasibility studies of

major or minor structural changes are conducted at these sites, the effect of this work on significant historic properties would have to be examined. The establishment of lock waiting areas at Locks and Dams 2, 3, and 7 is being considered and could result in site-specific impacts to submerged resources, archeological deposits, and the historic locks and dams themselves. The balance of the cultural resources discussion for the St. Paul District, including the Initial Project Management Plan (IPMP), assumes that no new locks will be proposed for the St. Paul District during the feasibility study.

Preliminary reconnaissance traffic projections indicate a potential increase in commercial navigation into Pool 10 as a result of proposed downstream improvements to the system. If traffic increases in Pool 10 or in other pools in the St. Paul District as a result of downstream improvements, streambank erosion could increase, and the systemic effect of increased navigation will have to be assessed.

Rock Island District

The study team will determine economic justification for constructing 1,200-foot locks at Locks and Dams 20, 21, and 22 in the Rock Island District. The addition of 1,200-foot locks at these National Register-eligible sites will require careful design and considerable coordination in an attempt to minimize impacts to the integrity of the historic structures. Site-specific construction activities also will have the potential to affect significant submerged resources and archeological deposits.

Systemic impacts resulting from increased traffic may occur in Rock Island District Pools 11 through 22 based on traffic projections. Greater impacts are anticipated in the downstream pools due to heavier traffic increases in these areas. Any system-wide impacts related to navigation traffic increases will affect archeological sites much more than other types of historic properties. Evaluation of system-wide impacts will require an integrated evaluation of physical effects to shoreline information, along with existing and yet to be collected information on geomorphology, archeological sites, soils, vegetation, and other cultural and physical factors.

St. Louis District

The study team will determine economic justification for constructing 1,200-foot locks at Locks and Dams 24 and 25 in the St. Louis District. Site-specific construction has the potential to impact significant archeological, structural, and submerged historic properties. An inventory and evaluation of the proposed construction sites would be required during the feasibility phase to identify any impacts to significant historic properties.

Construction of a new impoundment to replace Dams 24 and 25 would have the same site-specific impacts identified above, as well as impacts associated with raising

water levels in a reservoir. Foremost would be the inundation of several miles of shoreline. The effort required to accomplish the archeological inventory and evaluation needed to establish mitigation requirements for this alternative could be very intensive. Further evaluation of this alternative for preliminary cultural impact assessment will not be attempted at the reconnaissance level. Neither the recommended studies section below nor the IPMP reflect studies or costs which would be associated with the evaluation of the replacement alternative.

Any systemic impacts resulting from increased traffic within the system may occur in St. Louis District Pools 24 and 25 based on current traffic projections. Any system-wide impacts related to navigation traffic increases will affect archeological sites much more than other types of historic properties. Evaluation of system-wide impacts will require an integrated evaluation of physical effects to shoreline data along with existing and yet to be collected information on geomorphology, archeological sites, soils, vegetation, and other cultural and physical factors.

SOCIOECONOMIC EFFECTS

The Upper Mississippi River Navigation System helps maintain the economic viability of the Midwest by providing cost-effective transportation for goods that are either produced or consumed in the region. The navigation system positively impacts business and industrial activity by fulfilling a need for low-cost, accessible transportation for shipping large quantities of low-value bulk commodities. Regional industries and businesses rely on the Upper Mississippi River for distribution and receipt of agricultural and industrial products and supplies, petroleum, coal, and chemicals. For example, in 1988, 82 million tons of commodities valued at $12 billion were transported on the Upper Mississippi River.

Increasing the capacity of the navigation system would assure the efficiency of the system, while maintaining and enhancing growth opportunities for river communities and the entire Midwest region. Without increasing its current capacity, the Upper Mississippi River Navigation System will be unable to accommodate the demand for grain, petroleum, minerals, coal, and related commodity shipments.

Other modes of transportation could provide the needed service for some commodities. However, the increase in shipping expenses and the excess demand on the transportation system could adversely impact the local, state, regional, or national economies. In addition, a reduction in the supply and cost-effectiveness of water transportation could impact the Nation's capability to compete in the international market as a leading supplier of grains and other commodities.

Improving the Upper Mississippi River Navigation System would maintain and increase other positive, economic benefits realized by river communities and the region. Direct navigation system benefits include spending and employment generated by the commercial navigation industry, for example, wages, rents, and terminal expenses. Indirect economic effects include the inter-industry activities supported by the purchases of supplies, services, labor, and other inputs. Induced effects include economic activities resulting from household purchases of goods and services made possible because of the wages generated by the direct and indirect economic activities.

Upgrading the navigation facilities would likely result in limited impacts to the residents in nearby communities or the region. No residential, business, or farm relocations would be required, and no significant impacts to community cohesion would result. Improvements to the system could indirectly increase property values and related tax revenues by stimulating business and industrial growth along the river and in nearby communities.

Recreational users of the river also could benefit from any improvements to the navigation system. For example, reduced competition between recreational and commercial users of the locks might be achieved by implementating measures to speed the lockage process. Facility improvements could, therefore, provide an enhanced recreation experience and increased recreation opportunities on the Upper Mississippi River.

Modifications to the navigation system would likely reduce life, health, and safety threats of current operations on the Upper Mississippi River. Facility upgrading measures (e.g., eliminating double lockages) would reduce the likelihood of injury to lock and towing industry personnel or recreationists using these public facilities.

During the construction process, an increase in business and industrial activity would be noticed in the vicinity of each project area. A portion of this impact would be attributable to the purchases made for the facility upgrades. The remaining increase would result from purchases made by construction workers (i.e., meals and lodging). It is anticipated that between 50 and 300 workers would be employed during upgrading activities. Workers would be hired through labor unions in nearby communities.

Long-term impacts to business and industrial activity, employment, and the labor force would be related to community and regional growth. These impacts would be directly related to the scope and scale of facility improvement activities at each facility.

Heavy machinery would generate a temporary increase in noise levels during the construction process at each site. This increase in noise would result in limited impacts to area residents, because the project sites are generally rural in nature, featuring large spans of open fields and low density residential development. Construction noise could, however, disturb recreationists pursuing boating, fishing, hiking, and camping in close

proximity to the construction. No significant impacts to area aesthetics would be expected as a result of any proposed facility upgrades.

An assessment of system-wide socioeconomic effects will be completed as part of the system-wide Environmental Impact Statement for the Upper Mississippi River navigation feasibility studies. This comprehensive assessment will identify the system-wide socioeconomic impacts associated with the navigation improvements proposed for the Upper Mississippi River Navigation System. Socioeconomic impacts assessed will include those categories required by the National Environmental Protection Act (e.g., property values, employment, business activity, noise levels). Additional categories evaluated will include public health and safety, and regional economic impacts.

ENGINEERING CONSIDERATIONS

Do Nothing

Under this alternative, continued repair of deteriorating structural features of existing locks and dams items would be undertaken.

Nonstructural Measures

Nonstructural measures (helper boats, N-up/N-down policy, etc.) would help to increase locking capacity slightly. No physical changes would be made to the locks other than continued repair of deteriorating features.

Minor Structural Measures

a. **Guidewall Extensions.** Primary concern for this alternative would be to keep at least two lanes of traffic open during the navigation season. Construction during the non-navigation season would be difficult and slow because of the cold weather.

b. **Mooring Cells.** Construction of mooring cells probably would not interfere with navigation. The cells would have to be armored to withstand impact from barges.

c. **Lock Approach and/or Other Channel Improvements.** Construction of tie-off buoys would probably not interfere with navigation. The buoys, or any other type of tie-off device, would have to be strong enough to withstand some impact and be anchored firmly.

d. **Powered Traveling Kevels.** The stability of the guidewalls would have to be reviewed to assure that the wall would be able to withstand a pull on top of the wall.

e. **Dam 20 Ice Gate.** The addition of an ice gate at Lock and Dam 20 would allow passage of ice and debris which currently collects in the upper approach to the lock. This measure would reduce approach and lockage times.

f. **Waiting Areas Upstream and Downstream of Locks for Recreation Craft.** Suitable areas would have to be available without causing expensive relocations.

g. **Mobile Floating Locks.** More detailed designs for this structure are needed. Final design features such as type of gates, filling and emptying system, valving system, operating techniques, and installation methods have not been selected.

Major Structural Measures

a. **Add 1,200-Foot Locks to Existing Facilities.** A major concern is the ability of the existing structure to withstand the cofferdam loads and construction vibrations produced by the new construction. This would especially be a concern when constructing a new lock in the middle of the dam. If the lock would be placed on either side of the existing structure, any existing buildings, highways, and railroad or other items to be relocated must be considered. The topography would be a factor, and the removal of hills or rock bluffs would increase costs. Access may not be readily available to both sides of existing facilities for construction purposes. For any plan which would move the main channel to the opposite side of the river, extensive channel work and river training works would be required to accommodate navigation entering and exiting the lock. In addition, construction within an existing structure always poses unforeseen difficulties. No rehabilitation of the existing structures was included as all repairs were considered to be accomplished under the Operations and Maintenance (O&M) program.

b. **Replace Existing Lock and Dam with a New Lock and Dam.** The location of the new facility would be in the vicinity of the existing facility since the pool elevations are already established; however, the location could be upstream or downstream of the existing structure. Extensive foundation exploration would have to be undertaken to avoid problem areas and to develop foundation criteria. The location of the lock would have to provide good navigation conditions during construction and after the lock becomes operational. Structural, mechanical, and electrical design would be in accordance with the latest design criteria.

c. **Replace Two Locks and Dams with One High Lift Lock and Dam.** Under this plan, a high lift lock and dam would be constructed in the vicinity of an existing dam, since the new dam would have to be located consistent with the pool elevations of the next dam downstream. In addition to all the considerations discussed previously for replacing a lock and dam with another, this alternative would have to resolve all the changes that would be needed as a result of raising water levels in the lower of the two pools. For example, if a new lock and dam were to be constructed in the vicinity of Lock and Dam 25 to replace

both Locks and Dams 24 and 25, it is expected that the water level in Pool 24 would be extended downstream to the new dam. The effects would be investigated of the raised water level on existing towns, buildings, roads, railroads, bridges, and any other structures, as well as existing wetlands and wildlife areas. Since groundwater adjacent to the new pool would be affected, the effects of the raised groundwater on farm productivity and basements would be studied. The raised groundwater does, however, present the possibility of creating additional wetlands. A levee system at this site also could be upgraded to contain Pool 25, thus avoiding flooding large areas of farmland, wildlife areas, portions of highways, towns, and a railroad.

d. **Small Recreational Craft Locks.** An accessible and convenient location for both users and operators would be necessary. Foundation conditions would have to be assessed and studies would have to be made to determine a filling and emptying system and other hydraulic requirements. Design of the structure and operating system would follow standard design practices.

e. **Lifts/Carriers/Railways for Moving Recreation Craft.** Like the lock, an accessible and convenient location for both users and operators would be necessary. Since there are few, if any, of these systems operating in the United States, much investigation would have to be undertaken. The reliability of the systems also would have to be reviewed.

PRELIMINARY ECONOMIC EVALUATION

NAVIGATION IMPROVEMENT COSTS (FIRST COSTS, ANNUAL COSTS, Etc.)

The estimated first costs (October 1990 price level) of construction and the corresponding average annual costs for the potential additional 110- by 1,200-foot chambers at existing dam sites are displayed in table 7. The 110- by 1,200-foot lock chambers are evaluated as they represent the most costly means of achieving relief of system congestion. Consequently, if additions of these most costly measures to relieve lock congestion produce a net economic gain, then optimizing on chamber size, timing of implementation, or alternative constructural measures to alleviate congestion only will increase the net benefits of the system. Average annual costs for all additional lock chambers considered were computed using an 8-7/8 percent interest rate, a 50-year project life, and October 1990 price level. Interest during construction was calculated based on a 4-year construction period and is included in the average annual costs.

TABLE 7

Summary of First Costs and Annual Costs
($1,000,000)

Lock No.	First Cost	Average Annual Cost
11	380.0	39.0
12	380.0	39.0
13	380.0	39.0
14	380.0	39.0
15	380.0	39.0
16	380.0	39.0
17	380.0	39.0
18	380.0	39.0
19	380.0*	39.0
20	380.0	39.0
21	380.0	39.0
22	320.0	32.9
24	370.0	38.0
25	367.2	37.7

* Although the analysis was conducted under the assumption that a 600-foot lock would be added at Lock 19, it was realized that a 1,200-foot lock may be necessary and, hence, costs for this measure were used. This has little impact on the overall analysis, as Lock 19 does not warrant an additional chamber until the year 2030.

NAVIGATION IMPROVEMENTS BENEFIT - COST ANALYSIS

As previously described, to establish the without-project condition, the General Equilibrium System Navigation Model (GEM) was run using the existing system inputs with 1987 traffic, and projected traffic using the medium growth rates in 2000 and in 10-year increments through 2050. The locks which appear to be the major system constraints in each time period (the locks with the highest delays during the period of analysis) are analyzed for alternative solutions to reduce or eliminate the delays. The alternative solutions involve the possible addition of 110- by 1,200-foot lock chambers (with the exception of Lock 19 which already has a 110- by 1,200-foot chamber in service) where warranted by systemic congestion.

On the Upper Mississippi River, Locks 22 through 25 are clearly identified as being the first major constraints showing large delays by the year 2000. Removing a constraint on the system reduces the costs of delay, allowing commodities to move on the waterway at reduced total costs. When the net present value of the cost of removing the constraint(s) first becomes less than the net present value of the delay costs imposed by the constraint(s), then the constraint(s) should be relieved (lock chambers should be added) at that time to maximize the net benefits of the system. The new system with the already warranted lock chamber additions then becomes the base case for successive possible chamber additions in later years. This iterative technique is sequentially applied over the 50-year period of analysis to "optimize" the timing of supplying additional lock chambers. Table 8 displays the results of this optimization.

TABLE 8

Sequence of Provision of Additional Lock Chambers and Systemic Costs and Benefits (October 1990 Price Level, in $ millions)

Year	Locks With Additional Chamber	Lock Cost	Without System Benefits	With System Benefits	Project Benefits	Net Benefits	Cum. Net Benefits
1996	22,24,25	264.3				-264.3	-264.3
1997		264.3				-264.3	-528.6
1998		264.3				-264.3	-792.9
1999		264.3				-264.3	-1057.2
2000			426.6	571.6	145.0	145.0	-912.2
2001			421.7	566.2	144.5	144.5	-767.7
2002			416.9	560.9	144.0	144.0	-623.7
2003			412.1	555.7	143.5	143.5	-480.2
2004			407.4	550.5	143.0	143.0	-337.2
2005			402.8	545.3	142.5	142.5	-194.7
2006	17,18,20,21	380.0	398.2	540.2	142.0	-238.0	-432.7
2007		380.0	393.6	535.1	141.5	-238.5	-671.2
2008		380.0	389.1	530.1	141.0	-239.0	-910.2
2009		380.0	384.7	525.1	140.4	-239.6	-1149.8
2010			380.3	728.0	347.7	347.7	-802.1
2011			378.7	723.0	344.3	344.3	-457.8
2012			377.1	718.1	341.0	341.0	-116.8
2013			375.5	713.2	337.6	337.6	220.8
2014			373.9	708.3	334.3	334.3	555.1
2015			372.4	703.4	331.1	331.1	886.2
2016	14,15,16	285.0	370.8	698.6	327.8	42.8	929.0
2017		285.0	369.2	693.8	324.6	39.6	968.6
2018		285.0	367.7	689.1	321.4	36.4	1005.0

TABLE 8 (Cont'd)

Year	Locks With Additional Chamber	Lock Cost	Without System Benefits	With System Benefits	Project Benefits	Net Benefits	Cum. Net Benefits
2019		285.0	366.1	684.4	318.2	33.2	1038.2
2020			364.6	922.2	557.6	557.6	1595.8
2021			362.1	909.9	547.7	547.7	2143.5
2022			359.7	897.7	538.0	538.0	2681.5
2023			357.3	885.7	528.5	528.5	3210.0
2024			354.9	873.9	519.0	519.0	3729.0
2025			352.5	862.3	509.8	509.8	4238.8
2026	12,13,19	285.0	350.1	850.7	500.6	215.6	4454.4
2027		285.0	347.8	839.4	491.6	206.6	4661.0
2028		285.0	345.4	828.2	482.7	197.7	4858.7
2029		285.0	343.1	817.1	474.0	189.0	5047.7
2030			340.8	1131.3	790.5	790.5	5838.2
2031			333.9	1136.6	802.6	802.6	6640.8
2032			327.2	1141.9	814.7	814.7	7455.5
2033			320.6	1147.2	826.6	826.6	8282.1
2034			314.2	1152.6	838.4	838.4	9128.5
2035			307.9	1158.0	850.1	850.1	9970.6
2036	11	95.0	301.7	1163.4	861.7	766.7	10737.3
2037		95.0	295.6	1168.8	873.2	778.2	11515.5
2038		95.0	289.6	1174.3	884.7	789.7	12305.2
2039		95.0	283.8	1179.8	896.0	801.0	13106.2
2040			278.1	1362.6	1084.5	1084.5	14190.7
2041			269.4	1353.1	1083.7	1083.7	15274.4
2042			261.0	1343.7	1082.8	1082.8	16357.2
2043			252.8	1334.4	1081.6	1081.6	17438.8
2044			244.9	1325.2	1080.2	1080.2	18519.0
2045			237.2	1316.0	1078.7	1078.7	19597.7
2046			229.8	1306.8	1077.0	1077.0	20674.7
2047			222.6	1297.7	1075.1	1075.1	21749.8
2048			215.7	1288.7	1073.1	1073.1	22822.9
2049			208.9	1279.8	1070.9	1070.9	23893.8
2050			202.4	1270.9	1068.5	1068.5	24962.3

	Chamber Costs	Transport Benefits	Net Benefits
Net Present Value	1637.2	2226.6	588.9
Average Annual	146.7	199.5	52.8

Table 8 displays the "optimal" sequence of the provision of additional chambers at Upper Mississippi River system sites. The column labeled "Locks with Additional Chamber" shows the lock number(s) where an additional chamber is warranted in the year when construction on the additional chamber would begin. All chambers are assumed to require 4 years for construction. System transportation cost savings begin to accrue to the new chambers in the year following their completion.

Figure 1 displays the total annual costs for providing the indicated additional chambers, total annual system transportation benefits for the base case or without-project condition, total annual system transportation benefits with additional chambers at the indicated sites, and annual net system benefits incremental to the base case over the 50-year period of analysis. As previously explained, system transportation benefits are the gross cost savings water transport has over rail minus the delay costs on the waterway summed for all water movements in the analysis. The net present value (as of 1996) of the costs of the additional chambers, the transportation costs savings, and the net benefit stream are summarized. The corresponding average annual computations also are displayed.

As previously explained, incremental benefits include only those system benefits attributable to the improvements called for under each plan. They represent the difference between without- and with-project system model runs.

The "optimal" capacity expansion plan involves the provision of 14 new lock chambers over the 50-year period of analysis at existing Locks 11 through 25. Three new chambers are needed immediately in the year 2000 at the three most downstream sites, Locks 22, 24, and 25. By 2010, additional chambers are needed at Locks 17, 18, 20, and 21. In 2020, three more chambers are justified at Locks 14, 15, and 16. By 2030, new chambers at Locks 12, 13, and 19 are warranted, and in 2040 a new chamber at Lock 11 is needed. The investment in the 14 new chambers would have an average annual cost of $146.7 million, average annual transportation benefits of $199.5 million, and net average annual (NED) benefits of $52.8 million. The benefit-to-cost ratio of this investment sequence is approximately 1.4 to 1.

SENSITIVITY ANALYSIS

The sensitivity of the benefits and costs of possible system actions is explored using low traffic growth rates, high traffic growth rates, and the possible costless expansion of existing system capacity by 25 percent. Under the medium and low growth scenarios, Federal action is warranted at Locks 22, 24, and 25 by the year 2000. Under the high growth scenario, congestion at Locks 20 and 21 also warrants Federal action by the year 2000. More detailed sensitivity analysis is provided in appendix B. Federal action is warranted under all analyzed possibilities.

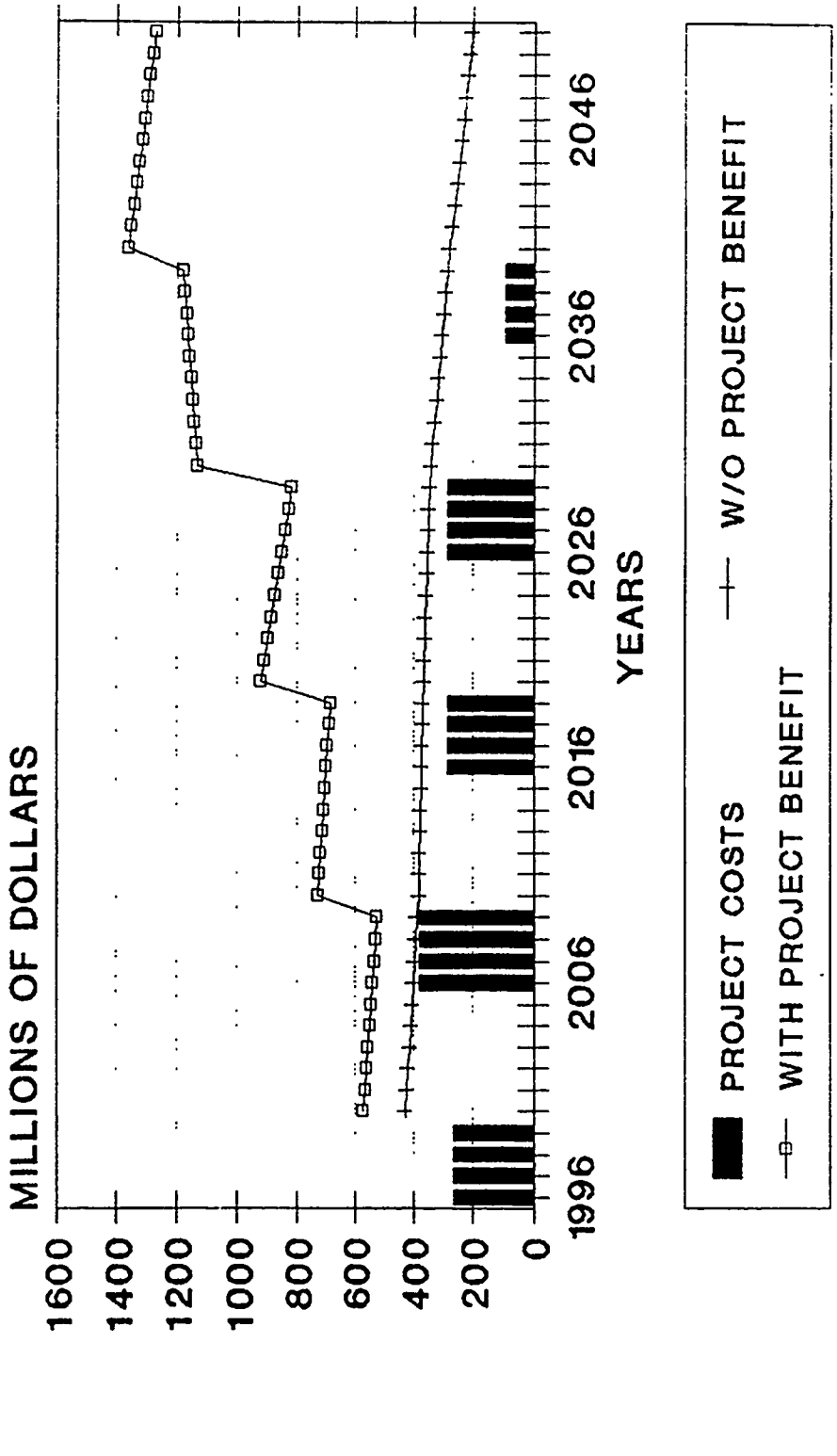
UPPER MISSISSIPPI RIVER
SEQUENCE OF ADDITIONAL LOCK CHAMBERS
AND SYSTEMIC COSTS AND BENEFITS
MILLIONS OF DOLLARS
1600
1400
1200
1000
800
600
400
200
0
1996
2006
2016
2026
2036
2046
YEARS
PROJECT COSTS
WITH PROJECT BENEFIT
W/O PROJECT BENEFIT
1996: Locks 22,24,25
2006: Locks 17,18,20,21
2016: Locks 14,15,16
2026: Locks 12,13,19
2036: Lock 11

Figure 1

RECREATIONAL BENEFITS

The navigation study was initiated to identify economically and environmentally feasible alternatives to improve the efficiency of the system. As part of that effort, ways to reduce conflicts between commercial and recreational users were examined. The greatest benefits are associated with the locks and dams portion of the system and related to commercial navigation. Most of the alternatives proposed would reduce delays for commercial navigation, such as providing 1,200-foot locks at sites that are nearing capacity. Benefits to commercial navigation also would benefit recreation. If the time required for commercial lockages were reduced, then the time between recreational lockages would be reduced. Conversely, an alternative that is recreational in nature, such as lock waiting areas or separate locking facilities for recreational craft, may benefit commercial navigation by reducing the congestion in the immediate vicinity of the lock. Due to time and cost constraints, a detailed analysis of the commercial benefits for an alternative of this type was not undertaken.

At sites where the new 1,200-foot chamber is proposed, it may be possible to use the existing 600-foot chamber for recreational lockages. A number of factors would need to be considered before this could be implemented, including traffic approach/departure patterns, river currents, and sight lines, and the economics of operating two chambers. A methodology for computing recreation benefits at sites where 1,200-foot locks are constructed will be researched and developed.

Most of the recreation-related alternatives proposed for sites where a 1,200-foot lock cannot be justified center on reducing the commercial-recreational traffic conflicts. These conflicts occur in the vicinity of the locks and dams, at constricted or confined areas of the main channel and main channel border, and near high use areas. A number of alternatives have been proposed over the years by various agencies and publics that would, in part, relieve some of the congestion. These proposals have included separate facilities (locks, railways, etc.) to allow passage of recreational craft at the dams, creating separate channels at selected locations, and lock waiting areas.

For the reconnaissance study, emphasis in evaluating the recreation congestion problem in the St. Paul District was limited to a nonstructural alternative that could be easily implemented – the lock waiting area. These areas would serve two basic functions: (1) recreational boaters could beach or moor their boats while waiting to lock; and (2) recreational boating and locking information could be disseminated. This alternative could help reduce congestion in the vicinity of the lock. It would not reduce the waiting times. To evaluate the potential economic feasibility of lock waiting areas, a preliminary economic analysis was conducted for Locks and Dams 3 and 7 where the greatest conflicts now exist.

Lock waiting areas would increase recreational boating benefits. By providing a location to wait for a lockage, the overall recreational experience would be somewhat improved. The information provided would allow the boaters to make better decisions regarding whether or not to wait for the next lock time and possibly consider other places to recreate. It also may reduce any anxiety about using the lock. At this time, given the lack of available data, it is virtually impossible to estimate what these incremental increases (decreases) in recreational benefits may be. However, an illustration of potential benefits is presented below.

Assuming each person in a recreational craft (average of 3.5/craft) that used Locks 3 and 7 in 1989 were willing to pay $1.00 ($3.50/craft minimum FY 89 Unit Day Value was $2.05/visitor day) for lock waiting areas, and visitation did not increase over the life of the project, the average annual recreation benefits would be approximately $116,800. This is computed as follows:

(19,629 rec craft through L/D 3 + 13,751 rec craft through L/D 7) x 3.5 persons/craft x $1.00/person = $116,800

RECREATION IMPROVEMENT COSTS

Conceptual plans for lock waiting areas developed over the years have included sanitary facilities and picnic tables. The basic facility, as proposed in this study, would consist of a beaching area and automated signage that would inform the recreational boater of the estimated time of the next recreational craft lockage. The first costs for the lock waiting areas are summarized in table 9.

TABLE 9

Summary of First Costs for Lock Waiting Areas

Item	Lock and Dam 3	Lock and Dam 7
Dredging and Placement	$245,100	$ 75,300
Signs and Miscellaneous	61,400	68,000
Contingencies	109,000	77,700
Subtotal	$415,500	$221,000
Planning, Engineering, and Design (29.6%)	$123,100	$ 65,500
Construction Management (5.9%)	24,600	13,100
TOTAL	$563,200	$299,600

Average annual cost for the lock waiting areas is $87,900, computed as follows:

Construction Cost = $864,000
Interest and Amortization
@ 8-3/4%, 50-yr life = $864,000 x .08885 = $76,800
Operation and Maintenance = 11,100

Total Average Annual Cost $87,900

RECREATION IMPROVEMENT BENEFIT COST ANALYSIS

Using the scenario described above for benefits and costs, the benefit-cost ratio for the lock waiting areas at Upper Mississippi River Locks 3 and 7 equals $116,800/$87,900 = 1.33 to 1.

ADDITIONAL STUDIES REQUIRED FOR FEASIBILITY PHASE

ENGINEERING

The requirements for additional engineering information during the feasibility study will be divided into four separate phases. The first phase will provide the preliminary engineering required to narrow down the viable alternatives and select a preferred plan. The second, third, and fourth phases will provide detailed engineering data for the selected plan at each of the three sites. Listed below is the outline to accomplish the engineering studies required for Phases 1, 2, 3, and 4.

a. **Phase 1.**

(1) Develop alternatives at each lock and dam site.

(2) Perform initial site surveys at each site.

(3) Determine real estate requirements, including relocations.

(4) Perform preliminary geotechnical analysis based on available information or with minor field investigations.

(5) Perform preliminary hydraulic analysis.

(6) Provide preliminary project design.

(7) Refine cost estimates.

b. **Phases 2, 3, and 4.**

(1) Perform detailed site surveys of selected site(s).

(2) Prepare preliminary right-of-way drawings if required.

(3) Perform detailed geotechnical analysis including extensive foundation investigations and pile load tests as needed. This analysis will most likely be in the detail required in a General Design Memorandum.

(4) Perform detailed hydraulic analysis and model testing.

(5) Provide project design for feasibility study report.

(6) Develop final project costs.

ENVIRONMENTAL

The U.S. Fish and Wildlife Service, in its Planning Aid Report (appendix A), which has been coordinated with the five Upper Mississippi River states, recommended that certain studies and data-gathering efforts take place during the feasibility phase of the study. These recommendations are summarized below.

Site-Specific Concerns

A survey of freshwater mussels and other invertebrates and a bioassay of the sediments and suspended sediments may need to be conducted in the vicinity of each lock and dam or proposed construction area. At each site where dredging is proposed, the dredging requirements, disposal alternatives, and sediment quality should be determined. The effect of each proposed alternative on river hydraulics and its riparian effects (including bank erosion from tow operation) should be determined. A creel census of the tailwater sport fishery and the impacts on this sport fishery and on fish passage should be evaluated.

Systemic Effects

The Plan of Study developed to assess the effects of the increment of traffic generated by the 2nd Lock at Locks and Dam 26 (Replacement), i.e., the Melvin Price Locks and Dam, should be completed.

An Environmental Impact Statement (EIS) that addresses navigation improvements would need to include an assessment of systemic or system-wide impacts. The data gathering and analysis that accompanies the preparation of an EIS should include:

* Extending the study area south to the mouth of the Ohio River, i.e., an additional 241 miles beyond the originally defined study area.

* Effects on bank erosion and resulting riparian effects, including bald eagle perches, colonial nesting areas, mudflat shorebird use, furbearer dens, and catfish spawning habitat.

* A freshwater mussel and fingernail clam survey of the main channel and channel border with priority given to Pools 24, 25, and 26.

* An evaluation of effects on walleye, sauger, and paddlefish spawning habitat and juvenile catfish main channel habitat.

* Evaluations of sediment quality and the effects of increases in suspended sediments or the redistribution of contaminated sediments.

* An identification of potential barge fleeting needs in each pool.

* An assessment of the potential for accidental spills.

* An assessment of the potential for increased winter navigation and an evaluation of any potential subsequent effects on aquatic habitat.

* An assessment of potential recreation effects.

* An assessment of cumulative effects that includes navigation traffic, hydropower, channel maintenance activities, induced development, and increases in barge fleeting.

* Adapting the Louisville District's Navigation Predictive Analysis Technique (NAVPAT), or a similar model, for use on the Upper Mississippi River.

Endangered Species

A biological assessment would need to be prepared addressing the potential effects to the bald eagle, pallid sturgeon, Higgins' eye pearly mussel, and fat pocketbook pearly mussel. Depending on construction site alternatives, a biological assessment on the Indiana bat and the decurrent false aster also may be required. The need for formal consultation in accordance with Section 7 of the Endangered Species Act would be addressed, as well as the potential effects to State-listed endangered species.

Long-Term Enhancement Strategy

The Corps of Engineers should assist in the development of a two-tiered, long-term plan for the management of fish and wildlife on the Upper Mississippi River as well as developing its own plan for lands or resources owned or managed by the Corps of Engineers. Potential enhancement measures identified through these plans then could be incorporated into future navigation plans.

Coordination

Future coordination should include:

* Continued coordination with the U.S. Fish and Wildlife Service;

* Continued coordination with the State conservation agencies;

* Coordination with the Long-Term Resources Monitoring Program (LTRM) of the Upper Mississippi River System - Environmental Management Program to facilitate the long-term enhancement strategy by using resource trends data or collecting new data with consideration given to funding assistance to the LTRM for their efforts;

* Maintain a program to "Avoid and Minimize" the effects of tow traffic; and

* Keep the Inland Waterway Users Board informed on the environmental requirements of the planning process and facilitate dialogue between the industry and environmental organizations.

Feasibility Phase Studies

The aforementioned recommendations from the U.S. Fish and Wildlife Service's Planning Aid Report have been considered in conjunction with coordination and consultation among the St. Paul, Rock Island, and St. Louis U.S. Army Corps of Engineers Districts and Corps higher authority to compile a listing of environmental studies and efforts deemed necessary to satisfy the environmental requirements of proposed feasibility studies. These studies and efforts, along with cost estimates and time schedules, are discussed in the Initial Project Management Plan found later in this volume.

HISTORIC PROPERTIES STUDIES

Accomplishment of required historic properties studies will depend on the availability of information early in the study process which can be used to identify areas of potential impact. Assessment of system impacts will require information on physical effects to shorelines similar to that proposed in the Plan of Study (discussed in the Environmental Section of this report). Once available, this information will be used to develop archeological and geomorphological sample survey and evaluation methodologies to identify archeological sites in the Upper Mississippi River study area which will be potentially impacted. System impact assessment for historic properties will occur proportional to projected bank erosion. Thus, the greatest effort likely will take place in the downstream Pools 20 through 25, with increasingly less effort in Pools 19 through 10.

REAL ESTATE

Real estate requirements for the selected plans and/or alternatives will be addressed in the feasibility report. Real estate requirements such as relocations, interests to be acquired, etc., will be described at that time.

SUGGESTED PRIORITIES/SCHEDULE FOR FEASIBILITY STUDIES

The suggested priorities and schedule for the feasibility phase of this study are contained in the Initial Project Management Plan located following Section 6 of this report.

Section 4 - Coordination, Public Views, and Comments

PUBLIC PARTICIPATION

Public participation is of critical importance during project planning. Public input provides valuable information about public support or opposition to potential solutions during all phases of the study process. Public comments provide information regarding the publics' concerns, values, interests, goals, opinions, and understanding of alternatives and issues. In addition, public coordination assures that the study addresses all significant concerns, considers all possible solutions, and maximizes information available to decision makers.

The Administrative Procedures Act, National Environmental Policy Act, National Historic Preservation Act, and additional Federal planning policies and regulations require and encourage extensive public coordination. In terms of the Upper Mississippi River Navigation Reconnaissance Study, the consequences and public acceptability of each potential alternative must be evaluated and considered as part of the reconnaissance study and any potential feasibility study.

Reconnaissance study public involvement efforts and public input are summarized in appendix E. Public coordination efforts have included distribution of a Plan of Study and a Notice of Initiation to the public, press releases, public workshops, and speaking engagements. Public coordination for the Upper Mississippi River Navigation Reconnaissance Study will conclude with the distribution of a U.S. Army Corps of Engineers North Central Division Commander's Notice of Completion.

Public comments and input have been considered during the formulation of alternative plans to address the future of the Upper Mississippi River Navigation System. Public views and comments received as of December 31, 1990, generally indicated support for the Upper Mississippi River Navigation Study. Additional concerns regarded environmental, cultural, sedimentation, and recreational issues. Specific concerns or questions from the public have been addressed in this reconnaissance report or will be addressed in any future feasibility studies for the Upper Mississippi River System.

CULTURAL RESOURCES COORDINATION

Coordination with the Illinois, Iowa, Minnesota, Wisconsin and Missouri State Historic Preservation Offices (SHPO), the Advisory Council on Historic Preservation, and other interested parties shall continue throughout the planning phases of this study. In a letter dated October 17, 1990, the Rock Island District solicited preliminary comments from the these agencies. Their responses are included in Appendix F - Pertinent Correspondence located in Volume 2 and will be considered in designing evaluation methodology in the next study phase.

Section 5 - Conclusions

The reconnaissance-level investigation of the Upper Mississippi River Navigation System is complete. This section summarizes the findings of this investigation. The conclusions shown in this portion of the report are intended to indicate typical structural solutions and to provide a foundation and direction for more comprehensive feasibility level studies. A comprehensive evaluation of alternatives at each site will be accomplished during feasibility studies, including combinations of structural and nonstructural measures to alleviate navigation constraints.

*Based on the preliminary economic analysis, traffic in the year 2000 will justify providing additional capacity increases for the lower three sites (Locks and Dams 25, 24, and 22). The analysis further indicates a need, based on future projections, for additional capacity improvements at Locks and Dams 21 through 11 between the years 2000 and 2050.

*The Corps has concluded that, based on projected traffic demand, nonstructural and minor structural measures should be used to increase the capacity of existing structures.

*Pursuant to Section 102(c) of the National Environmental Policy Act, Federal agencies, in reports or proposals for legislation, shall include a detailed statement on the environmental impact of the proposed action. In following this guidance, the three Upper Mississippi River districts have identified studies needed to supply data necessary for the environmental impact analysis. These studies are listed in the Initial Project Management Plan.

*Competition between recreational craft and commercial traffic in the upper portion of the system will continue to grow as reflected in the 100 percent increase in recreational boating in the last 5 years.

*Public meetings and separate meetings with State and Federal agencies have established a high level of interest and support for investigation of both navigation and environmental problems on the river. Industry representation at public meetings has indicated support for navigation improvements.

Section 6 - Recommendations

The Upper Mississippi River Navigation Reconnaissance Study indicates that delays to commercial navigation traffic at locks result in significant losses to the national and regional economies. Economic analyses further indicate feasible alternative plans for reducing delays to commercial and recreational traffic and improving the efficiency of the existing system. Since there is a Federal interest in improving the navigation system, it is recommended that this reconnaissance report be approved and that a feasibility study be undertaken.

An inventory and evaluation of all archeological, structural, and submerged resources in site-specific construction zones is recommended. Site-specific construction associated with the development of new locks is anticipated at Locks and Dams 22, 24, and 25. Site-specific construction of waiting areas may occur at Locks 2, 3, and 7.

It is recommended that feasibility studies for sites where 1,200-foot chambers are to be considered also should give consideration to the use of the existing 600-foot chambers for recreational lockages during high recreational use periods. The 600-foot chambers also could be available for commercial lockages during other times.

In addition, a feasibility study should be conducted to evaluate in more detail the need for lock waiting areas or other nonstructural or structural measures to reduce congestion at locks and dams where 1,200-foot locks are not being considered.

The objectives of that recommended feasibility study will be to perform detailed engineering, economic, and environmental studies for the three highest priority sites, Locks 22, 24, and 25; to perform system-wide economic and environmental analyses; and to prepare appropriate NEPA documentation (system EIS). In addition, the study will assess the future need and timing for capacity improvements at Locks 21 through 11, as well as the need for measures to reduce conflicts between recreational and commercial traffic in the upper portion of the system. The result will be a prioritization of capital investments needed on the Upper Mississippi River Navigation System for the 50-year planning horizon.

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GLOSSARY

Delay Time (same as Wait Time) - The time elapsed from the arrival of a tow or single vessel at a lock to the start of its approach to a lock chamber. Delay time for a queue of vessels or tows is the cumulative total for all vessels and tows waiting.

Lockage - The series of events required to transfer a vessel or tow (with all barges) through a lock in a single direction. More than one vessel can be processed during the lockage, and a tow may require several cycles to be completely processed.

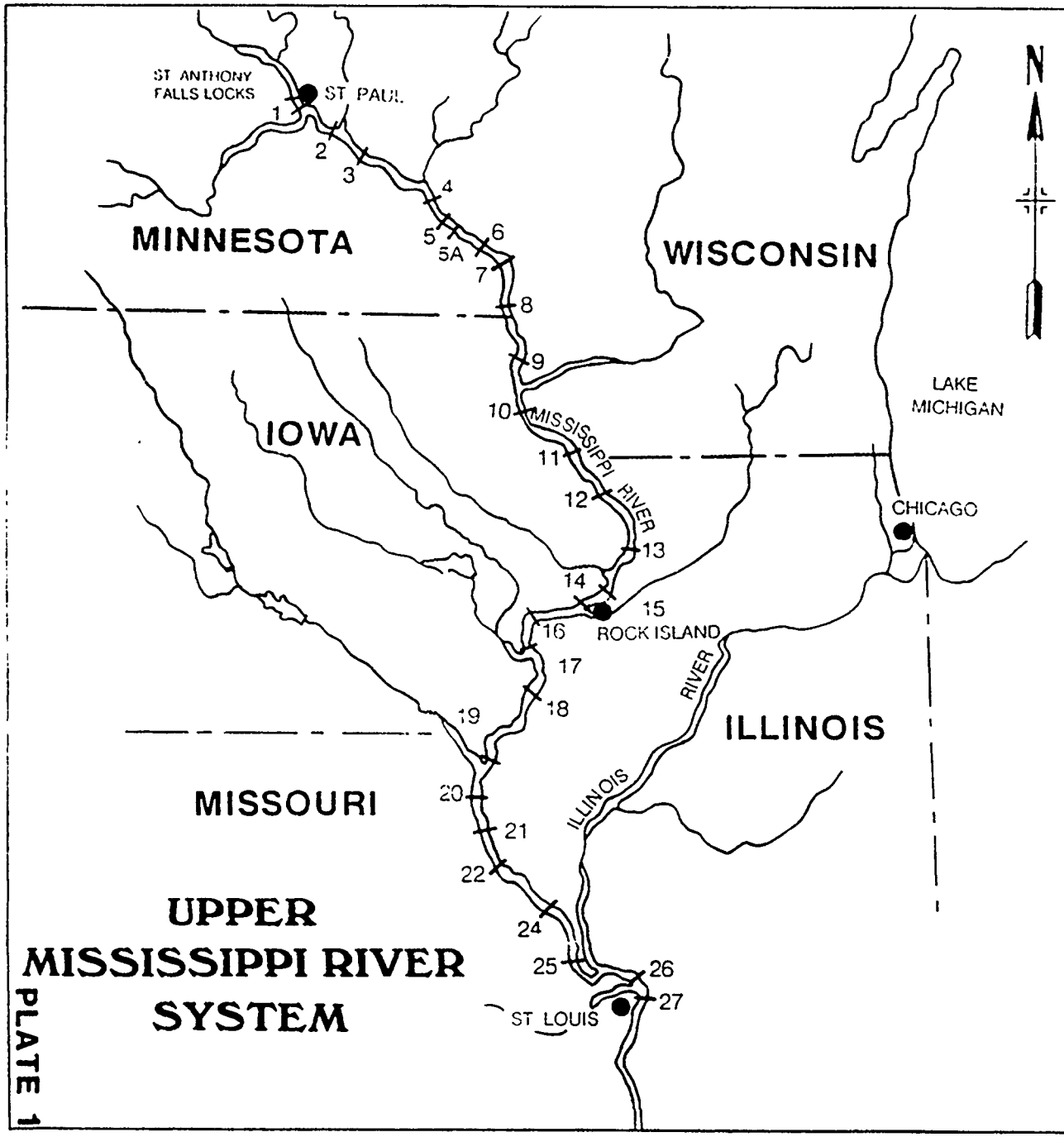
Stall - An occurrence which stops lock operation (due to either a lock malfunction, weather conditions, a vessel problem, or seasonal or part-time lock operations). Stalls during idle time are still accounted for as stalls.

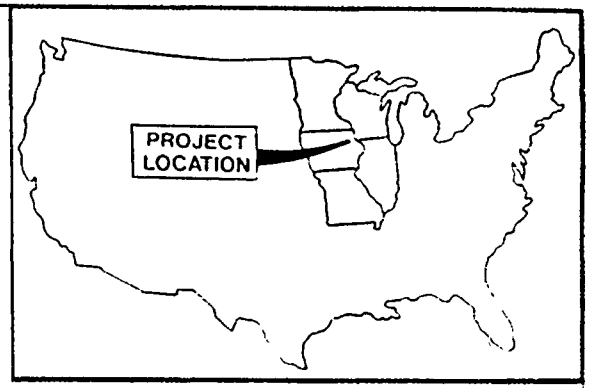
Transit Time - Time required for a vessel to transit a lock, including waiting or delay time and processing time excluding stalls.

Lock Utilization Time/Rate - Utilization time is a derived number based on the total operating time (vessel and lock processing time and open pass operation) entered into the data base via individual lockage records. The utilization rate is the percentage produced by dividing total operating time by the total time in the reporting period (usually monthly).

Idle Time - This is the interval between lockages when the lock or chamber is available for service. It is a derived number produced by subtracting all stall time (including stall time that occurs when no vessels are awaiting lockage) and total operating or utilization time for the reporting period, from total chronological time in the period.

Available Time - This is the amount of time in a reporting period that a lock chamber is in service, operating and idle. This number is derived by subtracting all stall time from total chronological time.





VICINITY MAP

AREA OF RESPONSIBILITY

LOCKS & DAMS 1-10	ST. PAUL DISTRICT
LOCKS & DAMS 11-22	ROCK ISLAND DISTRICT
LOCKS & DAMS 24-27	ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER SYSTEM

PLATE 1

Upper Mississippi River

NAVIGATION STUDY

US Army Corps of Engineers
Rock Island District
Planning Division
April 1991

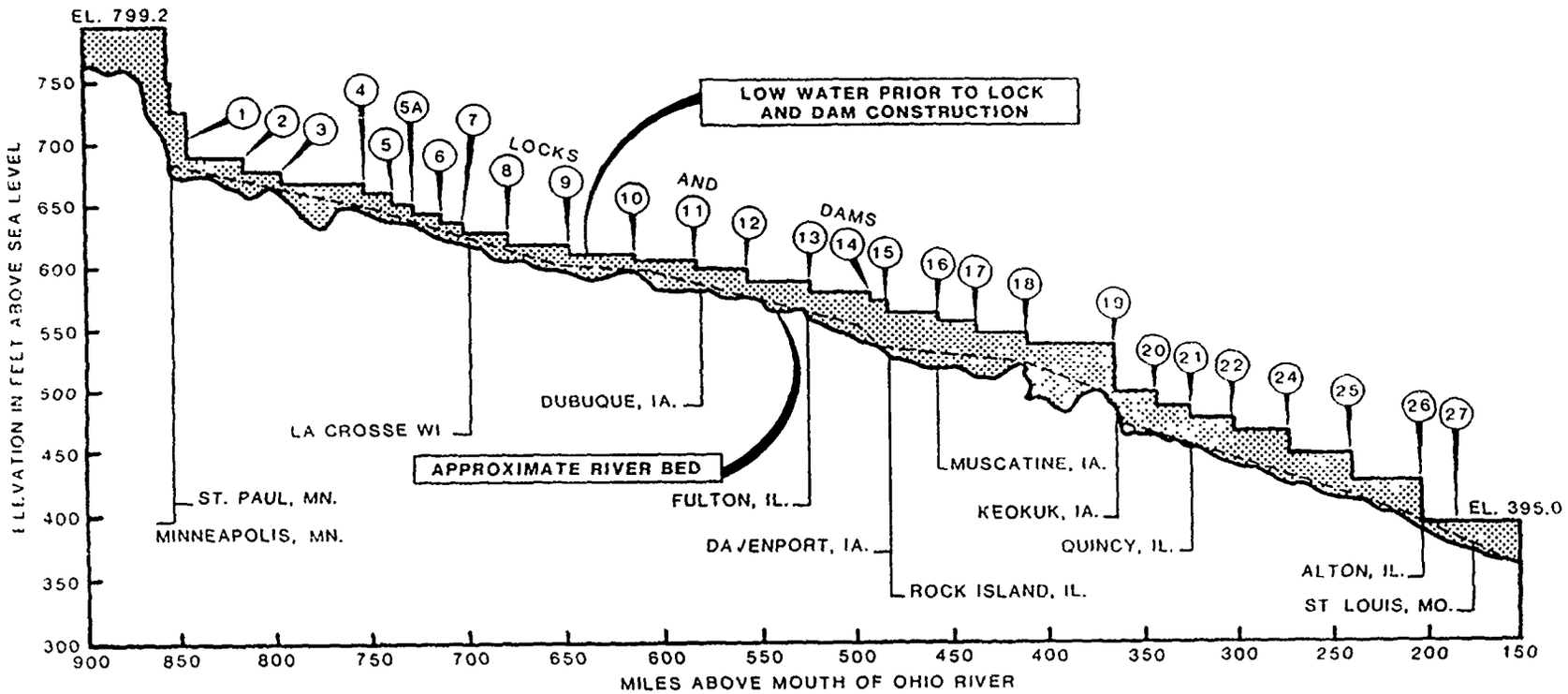
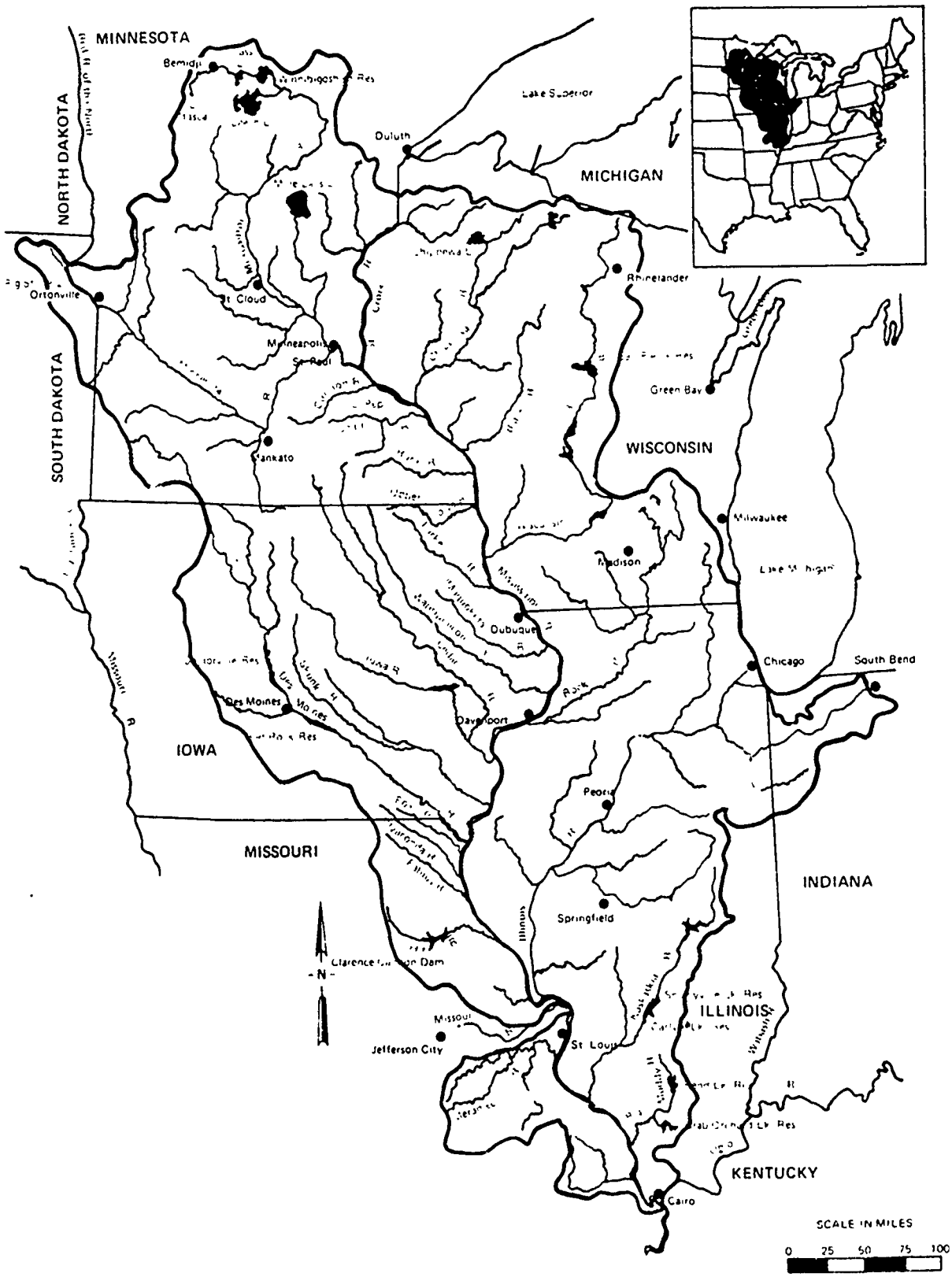


PLATE 2

EXISTING MISSISSIPPI RIVER NAVIGATION SYSTEM PROFILE

US Army Corps of Engineers
Rock Island District
Planning Division
April 1991



Upper Mississippi River Basin major streams and tributaries.

PLATE 3

INITIAL PROJECT MANAGEMENT PLAN

Initial Project Management Plan

The Initial Project Management Plan originally found in this portion of the Upper Mississippi River Navigation Study Reconnaissance Report has been superseded by the *Upper Mississippi River-Illinois Waterway System Navigation Study Initial Project Management Plan*, dated September 1992, which was prepared by the St. Paul, Rock Island, and St. Louis Districts. This action was prompted by a Headquarters, U.S. Army Corps of Engineers' decision in October 1991 recommending expansion of the study scope of the detailed engineering, economic, and environmental investigations planned for the feasibility phase navigation study.

Please refer to the September 1992 *Upper Mississippi River-Illinois Waterway System Navigation Study Initial Project Management Plan* for more detail.

PLANNING AID REPORT

APPENDIX A

Upper Mississippi River

Navigation Studies

PLANNING AID REPORT

U.S. Fish and Wildlife Service
1830 Second Avenue
Rock Island, Illinois 61201

June 1991

United States Department of the Interior
Fish and Wildlife Service
Rock Island Field Office (ES)
1830 Second Avenue, Second Floor
Rock Island, Illinois 61201

TAKE PRIDE IN AMERICA

In Reply Refer to:

COM: 309/793-5800
FTS: 782-5800

June 10, 1991

Colonel John R. Brown
District Engineer
U.S. Army Engineer District
Rock Island
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61204-2004

Dear Colonel Brown:

In accordance with our transfer fund agreement, we have completed the enclosed Planning Aid Report for the Upper Mississippi River Navigation Reconnaissance planning.

Congress has designated the Upper Mississippi River System a nationally significant ecosystem. Our primary concern in these navigation studies is the potential effects to fish and wildlife from any increases in commercial navigation traffic. Although the U.S. Fish and Wildlife Service has raised this concern to the Corps of Engineers on numerous occasions in the last 20 years, the environmental effects of any increases in navigation traffic remain largely unknown.

The potential for significant impacts are great on the Upper Mississippi River at sites with a narrow channel, fine sediments, and/or important main channel and channel border habitats. The effects or potential limits that may be placed on this ecosystem as a result of increases in commercial tow traffic need to be defined.

The following recommendations should be completed as a part of any feasibility study. This additional information is necessary to insure protection of the nationally significant ecosystem in concert with future navigation expansion. All should be initiated as soon as possible in order to complete feasibility planning in a timely manner.

Most important among these recommendations is the completion of the St. Louis District Plan of Study (POS) which is necessary for us to complete our Fish and Wildlife Coordination Act requirements. Any further delay in implementation of this study will only serve to delay future feasibility planning.

In addition, we are concerned that Corps programs to address measures to avoid and minimize impacts of tow traffic are progressing slowly on the UMRS. This program was agreed to in the Records of Decision for the Lock and Dam Major Rehabilitation Program and the Second Lock at Lock and Dam 26. The Corps should undertake implementation of this program immediately.

The recommendations are divided into several categories.

1. DATA COLLECTION AND IMPACT ANALYSIS FOR SITE SPECIFIC EFFECTS

a. Conduct a survey of freshwater mussels and other benthic invertebrates near each lock and dam or proposed construction area. Specific survey area requirements should be coordinated with this office and adjacent State conservation agencies.

b. Conduct a bioassay of the sediments and suspended sediments within one half mile upstream and one half mile downstream of each lock and dam or proposed construction area.

c. Determine dredging requirements, disposal alternatives and sediment quality at each site proposed to be dredged.

d. Depict changes in river hydraulics for each proposed alternative.

e. Evaluate riparian effects, including tow induced bank erosion from tow operation, for each proposed alternative.

f. Complete a creel census of tailwater sport fishing and evaluate impacts to fish passage and to sport fishing from construction and operation of each alternative.

2. DATA COLLECTION AND IMPACT ANALYSIS FOR SYSTEMIC EFFECTS

a. Include in the study area the UMR between Cairo, Illinois and St. Paul, Minnesota. The entire area is subject to affects of increasing traffic. In fact, Pool 26 and below may be affected by increases in traffic from improvements on either the Mississippi or Illinois rivers.

b. Complete all 16 work units of the St. Louis District POS.

c. Assess potential effects on bank erosion from increases in tow traffic and recreational boating. Evaluate resulting riparian effects, including bald eagle perches, colonial nesting areas, mud flat

shorebird use, furbearer dens, and catfish spawning habitat.

d. Complete a freshwater mussel and fingernail clam survey of the main channel and channel border to identify beds and assess condition; priority should be given to Pools 24, 25, and 26.

e. Evaluate the effect of tows on walleye, sauger and paddlefish spawning habitat and juvenile catfish main channel habitat.

f. Adapt Louisville District Navigation Predictive Analysis Technique (NAVPAT), or similar model, to Upper Mississippi River to assess relative differences of planning alternatives and potential mitigation alternatives. Assumptions need to be evaluated and validated for Upper Mississippi River.

g. Complete bioassay of sediment quality and potential effects of increasing suspended sediment concentrations. Priority should be given to Lake Pepin and areas where the main channel width may expand due to increased tow passing requirements. The use of sediment traps to conduct a system-wide evaluation should be explored. All sediment and water quality work should be coordinated with the U.S. Geological Survey.

h. Evaluate the potential systemic effects of redistribution of contaminated sediments by tows.

i. Identify potential barge fleeting needs in each pool.

j. Assess the potential for accidental spills from increasing traffic or induced development.

k. Assess the potential for increased winter navigation and evaluate potential effects on aquatic habitat.

l. Assess potential recreation effects from increasing navigation, including constraints on recreational lockages or enhancement of recreational locking opportunities.

m. Complete a systemic Environmental Statement (EIS) to address the potential effects of increases in vessel movement. This EIS should include the potential cumulative effects of not only navigation traffic, but also recreation traffic, hydropower, channel maintenance activities and other perturbations to the river environment. It should also address secondary

effects of induced development and increases in barge fleeting.

3. ENDANGERED SPECIES COORDINATION

a. Conduct a biological assessment on the potential effects to the bald eagle, pallid sturgeon, Higgins' eye pearly mussel, and fat pocketbook pearly mussel. Depending on construction site alternatives, a biological assessment on the potential effects to the Indiana bat and decurrent false aster may also be required.

b. Evaluate the need for formal consultation in accordance with Section 7 of the Endangered Species Act of 1973, as amended.

c. Assess the potential effects of construction alternatives and increasing traffic on State listed species.

4. LONG TERM ENHANCEMENT STRATEGY

a. Assist in the development and coordination of a strategic plan for the Upper Mississippi River. Such a plan would describe the long-term preservation, protection, restoration, and enhancement of the fish and wildlife resources of the river. The strategic plan should have quantifiable goals and objectives for fish and wildlife management.

b. Assist in the development of reach specific operational plans based on the fish and wildlife management strategic plan.

c. Complete a Corps of Engineers operational plan for fish and wildlife lands owned or managed by the Corps or for resources under the authority of the Corps. The plan should be based on the regional operational plans.

d. Incorporate into future navigation plans potential enhancement measures identified in the strategic planning process.

5. COORDINATION

a. Continue coordination with the Rock Island Field Office to address the above considerations.

b. Ensure active coordination by the State conservation agencies. A feasibility study of this magnitude will require close coordination, particularly with regard to the long term enhancement strategy. However, the

State's personnel and funding resources to provide such assistance is limited. The Corps should be prepared to fund State work.

c. Request and fund assistance from the Long Term Resource Monitoring Program to collect data as required, and to address the long term enhancement strategy through use of resource trends data being collected by the field stations.

d. Devote staff time to a program to avoid and minimize the effects of tow traffic.

e. Keep the Inland Waterways Users Board up to date on environmental analysis and planning requirements. Facilitate discussions between the industry and environmental organizations to develop a planning schedule both can subscribe to.

We would like to express our concerns regarding the proposed schedule for future feasibility planning. We understand that the Office of the Chief of Engineers has mandated that feasibility planning be accomplished within three years. We believe this is an unrealistic schedule considering the importance of the Upper Mississippi River and the magnitude of additional information that needs to be collected in order to make a sound choice among alternatives. For instance, consistent with our position on the Second Lock at Mel Price Locks and Dam, we will be unable to complete a final Fish and Wildlife Coordination Act Report on any feasibility study resulting from the Upper Mississippi River reconnaissance studies until the St. Louis District Plan of Study is completed. We recommend that you facilitate discussions among interested parties, including industry representatives and environmental organizations, to work out a planning schedule that all can subscribe to.

If you have any questions, please contact me.

Sincerely,

Richard C. Nelson
Field Supervisor

cc: Illinois Department of Conservation (Lutz, Bertrand)
Iowa Dept. of Nat. Res. (Anderson, Schonhoff)
Minnesota Dept. of Nat. Res. (Skrypek, Herde, Davis)
Missouri Dept. of Cons. (Dieffenbach, Stucky, Farabee)
Wisconsin Dept. of Nat. Res. (Neuman, Moe, G. Benjamin)
Plan of Study Team
American Waterways Operators (Smith)
Upper Mississippi Waterways Association (Hertzberg)
Izaak Walton League (Hansen)
Sierra Club (Ettinger, Hulsey)

GC:hw

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I. INTRODUCTION

The Congress has designated the UMRS (Figure 1) as a nationally significant ecosystem in Public Laws 99-88 and 99-662 and mandated that the rivers be managed to balance navigation and environmental interests. The system is comprised of the commercially navigable portions of the Upper Mississippi River (UMR), St. Paul, MN to confluence with the Ohio River, Minnesota River, St. Croix River, Black River, Illinois River and Waterway and the Kaskaskia River.

The Corps of Engineers has initiated two reconnaissance studies to address future strategic planning for the Upper Mississippi River System (UMRS). One study will be done for the Illinois River and one for the Upper Mississippi River. This report addresses the Upper Mississippi River study only.

The Upper Mississippi River has had a long history of navigation development. Between the 1820's and the 1920's, numerous alterations were made to the river to assist navigation. In 1930 the Corps of Engineers was authorized to complete the existing nine-foot navigation project that includes 27 lock and dam complexes, including the recently completed replacement for Lock and Dam 26.

The purpose of the reconnaissance study is to determine if there is a Federal interest in making capital improvements to the existing system. In addition, environmental objectives will be pursued to ensure that commercial navigation and environmental concerns receive equal consideration during the planning process. The reconnaissance report will identify potential new locks, dams, guidewalls, or operating procedures that could be addressed in detailed feasibility planning. It is during the feasibility stage that an environmental impact statement would be prepared and specific enhancement opportunities identified.

The purpose of this Planning Aid Report is to identify fish and wildlife related problems, needs, and opportunities as they relate to the Upper Mississippi River Navigation study. It includes a general appraisal of the study area, identification of significant resources, potential site specific impacts, potential systemic effects, data gaps, methods to complete impact analysis and mitigation planning, potential enhancement measures, and recommendations for feasibility planning.

This report is submitted in accordance with the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) It has been reviewed by the Illinois and Missouri Departments of Conservation and the Iowa, Minnesota, and Wisconsin Departments of Natural Resources. Their letters of comment are included as Appendix A.

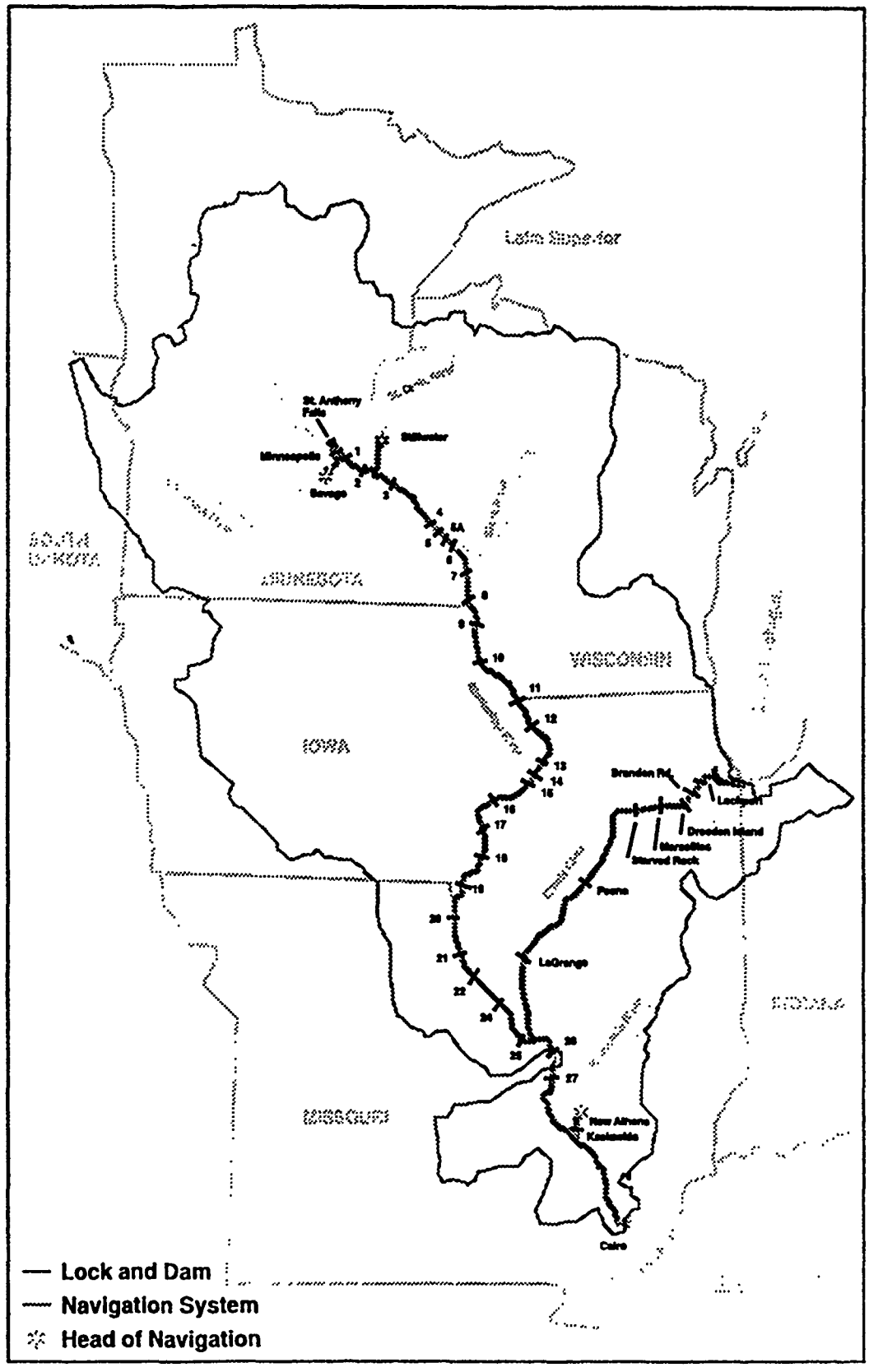


figure 1. Upper Mississippi River System

II. DESCRIPTION OF THE STUDY AREA

The study area is considered to be the Upper Mississippi River (UMR) from St. Paul, Minnesota to Cairo, Illinois, a distance of 866 river miles. The river below Lock and Dam 25 (the current downstream limit of the Corp's study area) is included because potential increase in tow traffic may affect the area. The navigable tributaries, Kaskaskia River, Black River, St. Croix River and Minnesota River are not included because the Corps cannot correlate changes in tow traffic on the UMR with changes in tow traffic on these rivers.

II.A. FISH AND WILDLIFE RESOURCES WITHOUT THE PROJECT

Numerous authors have described reaches of the UMR, their fish and wildlife resources, and the effects man has had on use of the system as a multipurpose resource (Carlander, 1954; Johnson et al., 1974; Brunet, 1977; Rassmussen, 1979; GREAT I, 1980; GREAT II, 1980; and GREAT III, 1981; Jackson et al., 1981; Gilbertson & Kelly, 1981; UMRBC, 1982; Rahn, 1983; Bade and Rassmussen, 1986; U.S. Fish and Wildlife Service, 1987; and Fremling et al. 1989.

The river floodplain corridor consists of over 400,000 acres of open water and wetland habitat and over 400,000 acres of terrestrial habitat (table 1). The percentage of habitat types within each pool varies (figure 2).

II.A.1. UMR - Head of Navigation to L/D 10

This reach is characterized by high bluffs and extensive wetland habitat. Its 243 miles consist of 137,000 acres of open water habitat and 121,000 acres of wetland and bottomland forest habitat. Much of the total area is included in either the Upper Mississippi River National Wildlife and Fish Refuge or the Trempealeau National Wildlife and Fish Refuge. This river reach is highly productive aquatic habitat with about 77% of its total open water area consisting of side channel and backwater habitats. There have been 103 fish species, 57 mammal species, and 35 reptile or amphibian species recorded in the reach. About 260 bird species frequent the area. About 100 of these birds nest in the reach. There are 30 species of mussels occurring within the reach. The endangered Higgins' eye mussel has been collected in Pools 3 and 7 through 10. Nesting, feeding, and wintering habitat for bald eagles can be found in this reach.

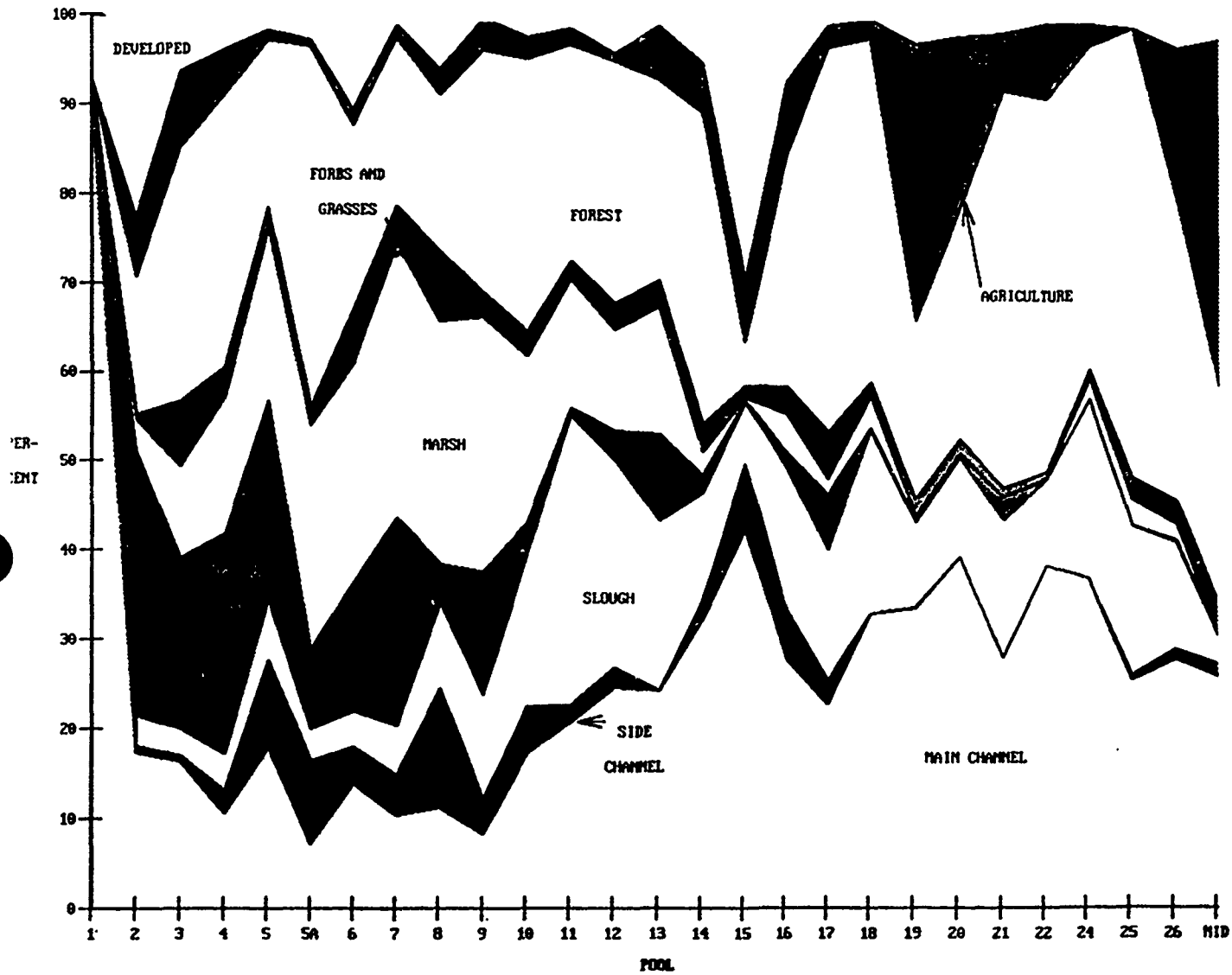
Pools 7 and 8 have become a focal point of the diving duck (canvasback, redhead, scaup, etc.) population of the Mississippi Flyway. These birds rely on the large beds of wild celery plants and invertebrates for food during the fall migration.

Table 1. Summary of UMR acres for significant habitat types (from U.S. Army Corps of Engineers, 1988)

River Reach (Pools)	Main Channel	Main Channel Border	Side Channels	Backwaters	Marsh Wetland	Bottom-land Forest
Pooled River[1]						
1-10	11,771	19,140	13,130	92,607	46,853	73,650
11-13	3,376	11,013	4,464	35,925	7,381	22,753
14-19	5,515	21,493	10,987	32,551	4,045	38,796
20-25	4,962	25,897	10,955	5,603	1,323	36,920
26	1,500	10,296	3,818	1,280	974	13,005
Open River [2,3]	21,037	26,481	5,054	(-)[4]	(-)	23,641
UMRS Totals	48,161	114,320	48,408	167,966	60,576	208,765
Percent	7%	18%	7%	26%	9%	32%

[1] U.S. Army Corps of Engineers (1977 and 1980)
[2] Environmental Science and Engineering (1982)
[3] Terpening (1974)
[4] No data available, but probably minor marsh vegetation occurrence due to swift river flow and few side channel and backwater areas.

figure 2. Cumulative percent of habitat on the Upper Mississippi River (except sand and mud)



II.A.2. UMR - L/D 10 TO L/D 19

This reach is characterized by river bluffs in the northern section which gradually transform into a rolling, wide floodplain that has been extensively levied in the downstream section. Its 251 miles include about 125,000 acres of open water habitat and 73,000 acres of wetlands and bottomland forest habitat.

Much of the total area of the reach is included in either the Upper Mississippi River National Wildlife and Fish Refuge, the Mark Twain National Wildlife Refuge, or wildlife areas managed by State conservation agencies. This river reach is also highly productive for fish and wildlife resources with 67% of its open water area consisting of side channel and backwater habitat. There have been over 107 fish species recorded in the reach. About 250 bird species frequent the area with about 100 of these birds using the reach for nesting. The reach provides an important wintering area for bald eagles, with concentrations of 30 or more in an area not uncommon. There are 52 mammal species, 61 reptile and amphibian species and 32 mussel species occurring in the reach. The endangered Higgins' eye mussel has been collected in Pools 11, 12, 16, and 17.

Pool 19 has been termed the most important inland migratory staging area for migrating diving ducks in North America (Thornberg, 1973). In the past, the birds fed primarily on fingernail clams, that were abundant in the pool. However, a recent drastic decline in fingernail clams has resulted in redheads, canvasbacks, and ring-neck ducks eating more aquatic plants. Lesser scaup are eating other invertebrates (Steve Havera, personal communication). This pool is mostly in the private ownership of Union Electric Company.

II.A.3. UMR - L/D 19 TO L/D 26

This reach has a wide floodplain that has been extensively altered by levee construction and conversion to agricultural use. Its 161 miles consist of 49,000 acres of open water habitat and 52,000 acres of wetland and bottomland forest habitat. Much of the total area is included in the Mark Twain National Wildlife Refuge or State managed areas. Only 44% of the total open water area is side channel or backwater habitat. There have been 96 fish species recorded in the reach and about 230 bird species frequent the area. This reach also provides wintering habitat for bald eagles. There are 28 mammal species, at least 27 reptile and amphibian species, and 29 mussel species occurring in the reach. The endangered fat pocketbook mussel has recently been transplanted to Pools 20 and 24. Success of the transplant is still under evaluation.

Pool 26 includes the confluence with the Illinois River. Due to this fact and its proximity to urban areas, the pool has high amounts of both commercial tow traffic and recreational boating.

II.A.4. UMR - Middle River

This reach is from Mel Price Lock and Dam (L/D 26) to the confluence of the Ohio River with the Mississippi River at Cario, Illinois. It is characterized by extensive channelization caused by emergent closing and wing dikes, revetments, and levees. Its 202 miles consist of 53,000 acres of open water habitat and 24,000 acres of bottomland forest habitat. Less than 10% of the total open water area is side channel habitat. At low river stage many of the side channels have been isolated from the main river by dikes. No portion of this reach is included in the National Wildlife Refuge System. There have been 114 fish species recorded in the reach, and about 142 bird species frequent the area. There are 50 mammal species, and 86 reptile and amphibian species occurring in the reach. The mussel fauna of the reach is not very diverse and of low densities. Most of the mussels present are fragile shell species associated with no or low velocity conditions found in the remaining side channels of the reach (T. Keevin, pers. comm.).

II.B. SEDIMENT AND WATER QUALITY

Summarizing sediment quality and water quality of the Upper Mississippi River is difficult due to the lack of coordinated data collection, analyses, and reporting. Differences in sampling techniques and analytical procedures make comparison of reported values difficult. The following overview was adapted from the GREAT II Water Quality Work Group Appendix (1980).

For purposes of this report, sediment quality of the UMR may be of greater concern due to the potential to disturb sediments during construction or by tow operation. Sediment quality data indicate that certain areas have contaminated bottom sediments. Contaminants may include ammonia, arsenic, cadmium, chlordane, chromium, copper, dioxins, lead, nickel, nitrogen, PCBs, phosphorus, zinc, various volatile organics, and polynuclear aromatic hydrocarbons. The extent of these concerns is unknown because the majority of the river has not been sampled.

A known site of specific concern is Lake Pepin, Pool 4, of the UMR. Lake Pepin is the major sink for Twin Cities area sewage and industrial discharge, and agricultural runoff from the Minnesota River watershed. Sediments in Lake Pepin are not subject to the frequent natural physical forces which commonly redistribute sediment in the river. These contaminated sediments tend to remain sequestered unless physically disturbed. Of particular concern is the potential for tow traffic to promote the release of phosphorus stored in the sediments. In November

1990, the Pool 4 Long Term Resource Monitoring station measured turbidity behind a loaded tow in 23 feet of water. They found turbidity of 200 NTU's behind the tow and a range of 5-23 NTU at other stations in the Lake.

The water quality of the river reflects geological, climatological and more recently, agricultural and industrial inputs. Despite urbanization, intensive agriculture and commercial navigation, water quality in many areas has generally been good. Major reasons for the overall quality is the river's large size, hence a large capacity for waste dilution, chemical processing and biological renovation or assimilation.

Iron, manganese, and mercury frequently are in violation of water quality standards throughout the length of the river. The effects of these metals on aquatic organisms of the UMR is not well known. Violations of the copper standard for aquatic life occur from Dubuque to Burlington, Iowa, and from Alton to Cairo, Illinois. The importance of copper as a toxic substance is unknown. The standard for aquatic life for lead has been violated in areas between Dubuque and Burlington.

Although a suspended sediment standard of practical value has yet to be developed, the large sediment load of the UMR could be classified as a pollutant. Average suspended sediment loads appear to contribute to a reduction in abundance of certain fish species in the lower reaches of the river (Carmody et al. 1986).

Bacterial contamination is found below major urban areas. However, below St. Louis, high fecal coliform counts are found for the remaining 200 miles. The reach from St. Louis to the mouth of the Meramac River is regarded by the Illinois Environmental Protection Agency as having the lowest water quality in all of the Illinois UMR (ILEPA 1990).

Chlorinated hydrocarbons pose great threats to aquatic life. Goolsby and Thurman (1990) reported that significant levels of herbicides occur in the UMR at least for short periods of time following application to cropland. Concentrations of some herbicides (e.g. atrazine) may occasionally exceed Federal standards.

Additional UMR concerns have been expressed for recorded levels of ammonia and phosphorus. Dissolved oxygen may also be below standards in certain areas of the river. Dissolved oxygen levels as low as 3.5 mg/l in the St. Louis area and 2.4 mg/l at Cape Girardeau, Missouri, have been recorded by U.S.G.S. The dissolved oxygen standard for freshwater aquatic life is 5.0 mg/l.

Sediment and water quality of the UMR is of national concern. USGS is initiating a study of the Mississippi River to evaluate

overall sediment and water quality of the river. In addition, the USFWS and State agencies are conducting a number of site specific analyses. The Upper Mississippi River Conservation Committee and the Long Term Resource Monitoring Program are compiling a sediment quality database of the UMR.

Sediment and water quality affects the type and rate of contaminant accumulation in fish and wildlife. For example, elevated PCB levels in fish are common throughout the UMR (USFWS, in preparation). Of particular concern is the human health impact of eating sport fish. Each UMR State has issued fish consumption advisories when contaminants in representative fish tissue samples reach a level that may be a public health concern. These are summarized in Appendix C. All are based on organochlorine (PCBs and pesticides) contamination.

II.C. PROTECTED SPECIES AND UNIQUE COMMUNITIES

II.C.1. Federally Protected Species

In accordance with Section 7(c) of the Endangered Species Act of 1973, there are several federally listed species found in the study area (the UMR floodplain corridor). The habitat requirements of those species that may be affected by the proposed action are discussed below.

The bald eagle is listed as threatened in Wisconsin and Minnesota and as endangered in Iowa, Illinois, and Missouri. The bald eagle frequents the Upper Mississippi River valley in winter, feeding on fish in open, ice free areas and roosting in protected ravines leading away from the River. Depending on conditions, several hundred to over a thousand eagles winter in the UMR floodplain corridor. High concentrations of eagles can normally be found in the winter at Clarksville, Missouri; Keokuk, Iowa; Quincy, Illinois; Clinton, Iowa; Guttenberg, Iowa; and Reads Landing, Minnesota. The river is also being used more for nesting as bald eagle numbers increase nationwide. Last year over 35 active nesting territories fledged 39 eagles. All successful nests were between St.Paul, Minnesota and Rock Island, Illinois. The status of the bald eagle is currently under review. The Service has proposed that the species be down listed to "threatened" due to its improving continental population. A decision regarding any change in status will be made in the next few months.

The interior least tern has been determined to be endangered. It historically nested along the Mississippi River system, breeding on bare or nearly bare alluvial islands or sand bars. It requires favorable water levels during the nesting season. Little is known of least tern feeding preferences. Small fish are a likely prey. Channel modifications for commercial navigation have eliminated most sand bar islands used as nesting

habitat. Only two colonies have been documented for the Upper Mississippi River since 1985. Both are in the open river below St. Louis. Existing sand bars are either too low (subject to inundation during nesting), or they adjoin mainland making their nests vulnerable to mammalian predation and human disturbance.

The Indiana bat is endangered and may be found in the riparian corridors of tributaries to the river. There are no documented records of the bat in the Mississippi floodplain. The Indiana bat prefers small stream corridors with well developed riparian forests and an enclosed tree canopy. This bat roosts under the loose bark of dead or decaying trees that are 16 inches or greater in diameter. No critical habitat is listed on the Upper Mississippi River.

The pallid sturgeon was recently listed as an endangered species. Critical habitat was not designated. The pallid sturgeon is known only to occur in the Missouri River, the Mississippi River downstream of the Missouri River, and the lower Yellowstone River. The species has been threatened by habitat modification, apparent lack of natural reproduction, commercial harvest, and hybridization in parts of its range. It has been documented near Chester, Illinois.

Two freshwater mussels are listed as endangered. The Higgins' eye pearly mussel is a large river species. It is likely to be found in areas of high current velocity, in five to 20 feet of water, between the main channel and three feet of shore and in a sand-mud-gravel well graded substrate. It has been collected at about 40 sites since 1965 but only about 10 sites contain more than a few living specimens. The recovery plan for the Higgins' eye identifies seven essential habitat sites which are believed to contain viable reproductive populations and which represent the best chances for the continued survival of the species. It should be noted that intensive searches for this species have been conducted at only a few sites on the UMR.

The fat pocketbook pearly mussel is another endangered mussel historically found on the river. No naturally occurring populations are known on the UMR; however, recently dead valves have been retrieved. The Missouri Department of Conservation has started a fat pocketbook restoration project in Pools 20 and 24. Over 2000 individuals were transplanted from the St. Francis River. Success of the transplant is still under evaluation.

The decurrent false aster is listed as endangered. It is found in several floodplain locations in St. Clair County, Illinois, and St. Charles County, Missouri. This plant is a wet prairie perennial found on disturbed alluvial ground and open muddy shores of the floodplain forest. It seems to be most common in lowland areas disturbed by periodic cropping that controls plant succession and keeps the habitat relatively open. A proposed

The U.S. Fish and Wildlife Service has been petitioned to list the paddlefish as endangered. The status of this species is currently under review.

The above species and documented occurences are listed in Appendix D. This information is based on state natural heritage databases. Additional search of published and unpublished information may result in additional occurrences being identified.

In accordance with Section 7(c) of the Endangered Species Act of 1973, as amended, the Federal agency responsible for actions authorized, funded or carried out in furtherance of a construction project that significantly affects the quality of the human environment is required to conduct a biological assessment. The purpose of the assessment is to identify listed or proposed species likely to be adversely affected by its action and to assist the Federal agency in making a decision as to whether it should initiate consultation. The biological assessment is to be completed within 180 days of initiation and before contracts are entered into or construction begun.

When conducting a biological assessment, the following steps should be taken:

1. Conduct an on-site inspection of the area affected by the proposed activity or program. This may include a detailed survey to determine if species are present and whether suitable habitat exists for either expanding the existing population or potential reintroduction of populations.

2. Interview recognized experts on the species at issue, including those within the Fish and Wildlife Service, State conservation department, universities and others who may have data not yet found in scientific literature.

3. Review literature and other scientific data to determine the species' distribution, habitat needs and other biological requirements.

4. Review and analyze the effects of the proposal on the species in terms of individuals and populations, including consideration for the cumulative effects of the proposal on the species and its habitat.

5. Analyze alternative actions that may provide conservation measures.

Section 7(d) of the Act underscores the requirement that the Federal agency and permit or license applicant shall not make any irreversible or irretrievable commitment of resources during the consultation period which in effect would deny the formulation or

implementation of reasonable alternatives regarding their actions on any endangered or threatened species.

II.C.2. State Protected

Each State has legislation to protect species that have been identified as threatened, endangered, or otherwise deserving of special consideration. Appendix D has been compiled using information contained in the State natural heritage data bases. The table lists all species protected by State law and where they have been documented in that state since 1940. There are eight mammals, 23 birds, 27 reptiles or amphibians, 38 fish, 20 mussels or other invertebrates, and 65 plants.

It should be noted that many of these species also occur in other parts of the study area, but are not specifically protected in those areas. These occurrences are not listed in the table.

Appendix D should not be a substitute for site specific analysis. The compiled data is likely incomplete as no comprehensive studies have been conducted by any of the five States. Known deficiencies are listings for plants in Wisconsin, fish in Minnesota, and freshwater mussels in Iowa.

II.C.3. Unique Communities

Each State has identified areas on the UMR that are representative or unique habitats and communities that should be protected.

Those included in the State natural heritage databases for the UMR are:

Minnesota	-	dry sand prairie, bluff prairie, maple-basswood forest, moist cliff, mixed oak forest, dry cliff, submergent marsh, floodplain forest, sand beach riverine subtype, colonial waterbird nesting site, upland white cedar forest.
Wisconsin	-	northern wet mesic forest, floodplain forest, great blue heron rookery, southern mesic forest.
Iowa	-	talus slope (midwest type), southern dry sand prairie (central midwest type), poor shrub/herb fen.
Illinois	-	central midwest type flooded forest, central midwest type shrub swamp, central midwest type barrens, central midwest type permanent marsh, midwest

type wet prairie, midwest type high prairie, midwest type alkaline high prairie.

Missouri - shrub swamp, wet bottomland forest, wet-mesic bottomland forest, mesic forest, dry-mesic forest, bald eagle night roost, great blue heron rookery.

Some of these areas under State ownership and are identified in the section of this report, titled "Resource Management." Other area have been designated as natural areas or natural landmarks, but do not have any legal protection.

Another unique community designation is that of mussel sanctuary. These important mussel beds have been designated as areas where commercial shelling is prohibited. They are:

Pool	State	River Mile
12	IL	556.7-558.4
15	IL	482.6-485.8
18	IL	433.0-433.8
19	IL	388.0-390.2
20	IL	361.7-364.5
22	IL	314.0-316.0
24	MO	298.0-301.0
26	IL	238.4-240.8

II.D. HUMAN USE AND ECONOMIC EVALUATION

Tables 2 and 3, summarize available data for various recreational and commercial uses of fish and wildlife resources on the Upper Mississippi River. Figure 3 demonstrates the importance of commercial fishing throughout the river, particularly in Pools 8 and 18.

It should be pointed out that tables 2 and 3 are derived from an incomplete database. No data are available for some reaches and data shown are considered to be minimal due to limitations in sampling efforts and the reporting of consumptive harvests.

Human use of the natural resources of the Upper Mississippi River takes many forms, in addition to the more traditional uses of water supply and navigation. We are just beginning to appreciate and understand the full extent and importance of these other uses to the regional economy, and indeed, to our own mental and economic well being.

Table 2. Annual recreational use and expenditures on the Upper Mississippi River.

	Activity Days[1]	Annual Expenditures[2]
Sport Fishing	8,396,000	$ 193.1 million
Waterfowl Hunting	276,300	$ 7.2 million
Deer hunting	NO DATA	NO DATA
Small game	NO DATA	NO DATA
Other Recreation	21,433,000	$ 321.5 million
Total Recreation	30,105,300	$ 521.8 million

[1]From UMRCC 1982

[2]From USFWS 1988 ($23/day freshwater sportfishing, $26/day migratory birds and UMRCC 1982 ($15/day other recreation).

Table 3. Annual commercial tonnage and first market value of fish and wildlife resources taken from Upper Mississippi River.

	Total Tons	Ist Market Value
Commercial Fishing[1]	5,700	$ 2.4 million
Commercial Trapping	NA	$ 2.1 million[2]
Commercial Musseling[3]	2,800	$ 4.9 million[4]
Total Commercial		$ 9.4 million

[1]UMRCC 1989

[2]UMRCC 1982

[3]UMRCC (unpublished)

[4]Assumes average current value of $1.00/lb. washboards, $0.40/lb. three-ridge, and $0.10/lb. all others.

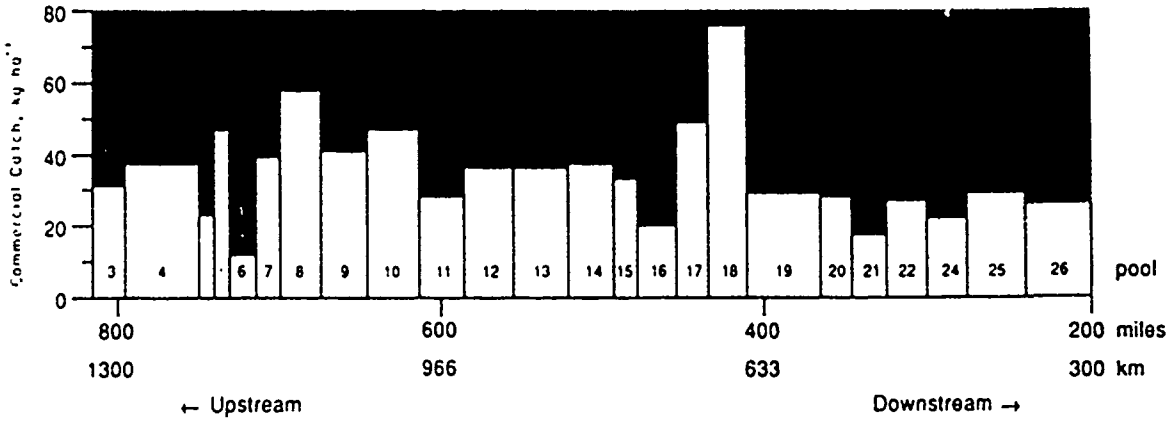


Figure 3. Commercial catch, CPUA (kg/ha) in Upper Mississippi River pools based on several year averages (graphic from Fremling et al 1989 data from Lubinski et al. 1981).

By combining available estimates, human use in the form of recreation and commercial uses can be valued at the first point of sale at over $531 million annually. Applying the 1.5 multiplier factor used by the UMRCC (1982), this approaches $800 million in annual benefits to the regional economy. If all activities on all river reaches were included, this total would be even higher.

The Environmental Management Program is in the process of completing an Impacts of Recreation study which will provide additional information on the probable value of recreation in the region. No data will be collected on actual recreation use in the corridor by this study. Use data has been collected for Pools 2, 3, and upper 4 (Mississippi River Marina Cumulative Impacts Task Force 1990). In addition, recreation use surveys have been completed for Pool 5 (Watson and Hawkision 1979), Pool 5a (Benjamin, in preparation), Pool 9 (Ackelson 1979), and Pool 24 (Farabee, in preparation).

II.E. RESOURCE MANAGEMENT

Congress mandated a dual role for the Upper Mississippi River by establishing and funding both national wildlife refuges and a commercial navigation system. Furthermore, a variety of other interests, including agriculture, industry, recreation and water supply, make legitimate claims on the system's resources. The needs, demands and expectations of these interests frequently conflict and, in some instances, appear to be incompatible.

Land management authorities vary in the river corridor. The U.S. Army Corps of Engineers and U.S. Fish and Wildlife Service have

jurisdiction over much of the public land in the floodplain of the UMR. Most of these lands are included as a part of the National Wildlife Refuge System. Management responsibility is either directly by the Fish and Wildlife Service or by the States under cooperative agreement. In all, over 50% of the river floodplain corridor is managed for fish and wildlife.

II.E.1. Federal Management

The mainstem floodplain of the Upper Mississippi River contains about 650,000 acres of bottomland and aquatic habitat. Congress has placed about 328,000 acres of this land and water into a complex of national wildlife refuges (figure 4 and table 4).

Table 4. Summary of acres in National Wildlife Refuge System along the Upper Mississippi River.

	Direct Management	State Coop Agreement*	Total Acres
Mark Twain NWR	21,000 acres	64,000 acres	85,000
Trempealeau NWR	5,670	---	5,670
Upper Mississippi River National Wildlife and Fish Refuge	194,500	3,500	198,000

* These lands are also identified in table 5.

The Federal lands on the river are managed primarily for the benefit of fish and wildlife, but contribute greatly to recreation, flood storage and water supply functions of the system. The commercial navigation channel passes along or through most of these river reaches. The refuge lands provide significant habitat for many animal and plant species and are of particular importance to species which depend on floodplain habitat. Such habitat has been largely eliminated, or is being developed or modified in many non-refuge areas.

The gradual elimination of waterfowl nesting sites in the north and wintering habitat in the south and east is placing severe strains on many important migratory species. The decline in quantity and quality of floodplain habitats has increased this strain. The situation is worsened by increasing sedimentation and pressure to use Federal lands for recreational purposes.

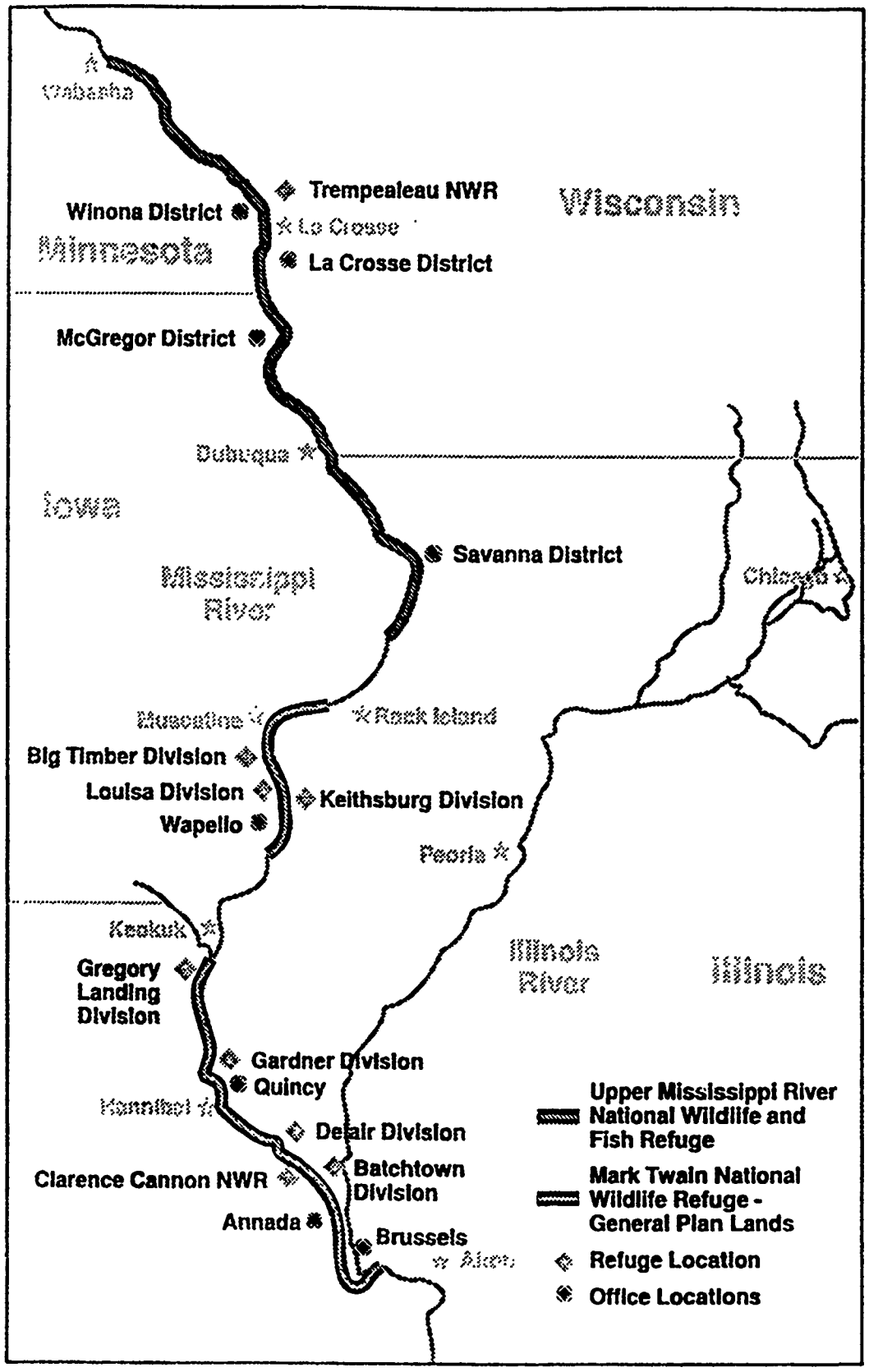


Figure 4. Location of national wildlife refuges of the Upper Mississippi River.

Sedimentation and public use also affect important fish spawning and nursery habitats. Reduction in upland erosion and protection of the refuge system is essential if habitat for these species is to be maintained.

The Mark Twain National Wildlife Refuge (MTNWR) includes several divisions on the Upper Mississippi River (figure 3). It stretches 254 miles from Rock Island, Illinois to Grafton, Illinois. Most of the 85,000 acres refuge areas were included in the National Wildlife Refuge system in 1958, and occupy land purchased for the nine-foot navigation project. In addition two of the divisions (Delair and Gregory) were purchased with Federal Duck Stamp funds. MTNWR is managed to provide and protect wintering habitat for the bald eagle, to provide food and shelter for migratory birds, and to provide other compatible uses. About 3000 acres are used for moist soil management.

The Upper Mississippi River Wildlife and Fish Refuge, established in 1924, consists of 198,000 acres of wooded islands, water, and marshes, extending 284 miles between Wabasha, Minnesota and Rock Island, Illinois. It is the nation's longest inland federal refuge. The management mission statement for the refuge is "to provide for public benefits associated with fish, wildlife, and wildlife areas, by preserving the Upper Mississippi River floodplain ecosystem for the enjoyment and use of this and future generations."

The Trempealeau National Wildlife Refuge occupies about 5,670 acres near Trempealeau, Wisconsin. It was established in 1936 by Executive Order but the major portion was not purchased until 1979. This backwater area has been isolated from the river since 1911 and includes breeding, nesting, and feeding habitat for migratory birds and marsh wildlife. Prairie habitat is also managed on this refuge.

II.E.2. State Management

Over 140,000 acres of the floodplain corridor are managed by the State Conservation agencies (table 5). These lands are either owned in fee title by the State or are Corps of Engineers General Plan lands being managed under cooperative agreement with the Corps and the U.S. Fish and Wildlife Service. General Plan lands are considered to be part of the National Wildlife Refuge System.

The Iowa Department of Natural Resources manages 17,172 acres in Pools 9, 10, 13, 14, 16, 17, 18 and 19. Its management objectives are the production and harvest of waterfowl as well as total resource maintenance.

The Illinois Department of Conservation (ILDOC) manages numerous sites on the UMR for a total of 53,857 acres. Much is Corps owned General Plan lands managed under Cooperative Agreement in

Table 5. State wildlife management and natural areas in Upper Mississippi River floodplain corridor (October 1990).

Pool/ Reach	State	Site Name	Acres	Objectives
2	MN	Fort Snelling State Park	500	6
2	MN	Pig's Eye Lake SNA	100	9
3	MN	Gores WMA	6861	2, 6
3	MN	Hastings SNA	46	9
4	WI	Lake Pepin State Park	219	6
4	WI	Rush River Delta SNA	325	2, 9
4	WI	Pierce County Islands Wildlife Area	831	2, 6, 10
4	WI	Nelson-Trevino Bottoms SNA	3740	2, 9, 10
4	MN	Frontenac State Park	209	6
4	WI	Tiffany Wildlife Area	420	2,5,6,7,8,9
5	MN	Kellogg-Weaver Dunes Scientific and Natural Area	206	9
5	MN	Whitewater WMA	27400	7, 1, 8
5	MN	McCarthy Lake WMA	2850	2, 6
5a	WI	Whitman Bottoms Floodplain Forest SNA	154	2, 9, 10
5a	WI	Merrick State Park	350	6
5a	WI	Whitman Wildlife Area	1861	2,5,6,8,9
5a	MN	Thorpe WMA	95	2, 6
6	WI	Perrot State Park	1100	6
7	WI	Mississippi River Islands WMA	55	2,5,6,8,9
8	MN	Blue Lake WMA	15	2, 6
9	IA	Duck Lake	420	2,6
9	IA	Pool Slough	555	2,6
9	IA	Kain's Lake	814	2,6

Table 5 Cont'd				
Pool/ Reach	State	Site Name	Acres	Objectives
9	IA	Lansing Big Lake	630	2,6
10	IA	Waukon Junction Access	203	2,6
10	IA	Mud Hen Lake	215	2,6
10	WI	Wyalusing State Park	600	6
12	IL	Savanna Army Depot FL	1086	1, 2, 3
13	IA	Green Island Wildlife Area	3722	2,6
13	IA	Sabula Lakes	493	10
14	IA	Princeton Wildlife Area	1190	2,6
16	IL	Mississippi River Pool 16 FL	8933	1, 2, 3, 5
16/17 /18	IA	General Plan Lands	4700	2,6
17	IL	Mississippi River Pool 17 FL	4812	1, 2, 3, 5
17/18	IA	Lake Odessa	3828	2, 6
18	IL	Mississippi River Pool 18 FL	6381	1, 2, 3, 5
19	IA	Blackhawk Bottoms	402	2, 6
19	IL	Mississippi River Pool 19 FL	700	1, 3
20	MO	Rose Pond Natural History Area	380	1, 2, 9
21	MO	Pool 21 WMA	747	1, 2, 6
21	IL	Mississippi River Pool 21 FL	8467	1, 2, 3
22	MO	Pool 22 WMA	1789	1,2,3,6,9
22	IL	Mississippi River Pool 22 FL	6200	1, 2, 3
24	MO	Edward Anderson WMA	1045	2, 6, 7
24	MO	Ted Shanks WMA	6636	1,2,3,6,8,9

Table 5 Cont'd				
Pool/ Reach	State	Site Name	Acres	Objectives
24	MO	Pool 24 WMA	1281	1,2,3,6,8,9
24	IL	Mississippi River Pool 24	10211	1, 2, 3
25	MO	Sandy Island Natural Area	575	2, 9, 10
25	MO	B.K. Leach Memorial WMA	690	1,2,3,6,8
25	MO	Prairie Slough WMA	584	1, 2, 6, 8
25	MO	Pool 25 WMA	2955	1,2,6,8,10
25	IL	Mississippi River Pool 25	500	1, 2, 3
25	IL	Riprap Landing	1231	1, 2, 3
25	IL	Batchtown WMA	1701	1, 2, 3, 5
25	IL	Red's Landing	669	1, 2, 3
26	MO	Cuivre Island WMA	1567	1, 2, 3, 6, 8, 9, 10
26	MO	Upper Mississippi Waterfowl Area	139	1, 10
26	MO	Pool 26 WMA	4242	1, 2, 3, 6, 8, 9, 10
26	MO	Marais Temp Clair Wildlife Area	918	1,2,6,8
26	IL	Mississippi River Pool 26	2313	1, 2, 3
26	IL	Piasa Island	653	1, 2, 3
D	MO	Tower Rock NA	31	9, 10
Total Acres			142,545	

Reaches:

A - River mile 170 - 190 (St. Louis Harbor Area)
B - River mile 125 - 170
C - River mile 75 - 125
D - River mile 30 - 75 (LTRM Stations)
E - River mile 0 - 30

Site Names:

WMA - Wildlife Management Area
FL - Federal Lands
SNA - Scientific and Natural Area

Objectives:

1) midmigration duck habitat
2) public hunting and/or trapping
3) wood duck production
4) wintering duck/goose habitat
5) duck/goose production
6) general preservation and enhancement of wildlife habitat
7) forest wildlife
8) furbearers
9) protection of rare, threatened, or endangered species or unique habitats
10) fish production and harvest

Pools 16, 17, 18, 21, 22, 24, 25 and 26. In general, management objectives of these lands are to provide refuge for fish and wildlife and to provide access and enhance opportunities for outdoor recreation including camping, hiking, boating, hunting, fishing, trapping and wildlife observation. The number and placement of duck hunting blinds are also regulated.

The Missouri Department of Conservation (MODOC) manages 22,230 acres of land and water on the UMR. About half is land in Cooperative Agreement with the Corps of Engineers and the USFWS. As with other States, Missouri's management objectives include the control, conservation, restoration and regulation of birds, fish, game and forestry.

The Minnesota Department of Natural Resources (MNDNR) has 38,282 acres of land on UMR floodplain. These include wildlife management areas, scientific and natural areas and portions of State parks.

State managed land in Wisconsin includes 9655 acres in State parks, fish or wildlife management areas, boat landing/access sites and two natural areas. The Wisconsin Department of Natural Resources (WIDNR) objectives for these lands include public hunting and fishing and protection of wildlife habitat.

II.E.3. Private Management

There are some significant fish and wildlife areas on the UMR that are not managed by a State or Federal agency. For instance in Missouri, there are 36 private duck clubs in Lincoln and St. Charles Counties (adjacent to Pools 25 and 26). Over 22,000 acres of wetland, forest, and agricultural habitat are owned and managed by these clubs. In Minnesota, the Red Wing Wildlife Protection League owns about 2600 acres of bottomland forest, wetlands, and backwater lakes in Pool 4.

II.F. SIGNIFICANT RESOURCES OF THE UPPER MISSISSIPPI RIVER

The national and regional significance of the fish and wildlife resources of the Upper Mississippi River are described above. Site specific information on these resources has been summarized (U.S. FWS 1987, Peterson, 1984, USFWS, in preparation). However, these reports should not be a substitute for site specific review. The absence of information for a particular area does not necessarily mean that the area is less significant. There simply may be no information available.

In accordance with U.S. Army Corps of Engineers planning guidelines, table 6 has been prepared to demonstrate significance of resources based on their institutional, public concern, national economic development benefits, and ecological significance.

Table 6. Significant resources of the Upper Mississippi River that may be affected by increases in navigation traffic.

Resource	Institutional	Public	Technical	NED Resources
Backwaters and side channels and associated wetlands.	Nationally significant ecosystem (P.L. 99-662) E.O. 11990, Protection of Wetlands; E.O 11988, Flood Plain Management; Executive Branch "no net loss" wetland policy; UMR NWR's established to protect habitat (Refuge Acts of 1924 and 1958 and Fish and Wildlife Coord. Act of 1934).	A concern identified by public participation on Master Plan and Second Lock EIS.	Nesting, spawning, rearing, feeding and cover for a variety of fish species. Nesting, rearing feeding and cover for migratory birds including waterfowl.	Recreational boating. Total recreation use on river may have annual benefits of over $800 million annually.
Fish eggs, larvae, and adults.	Species on Federal and/or State Threatened or Endangered Species Lists; National Recreational Policy.	A concern identified by public on Master Plan and Second Lock EIS.	Important component of UMR ecosystem.	Total sport fishing use on UMR is 8.4 million days annually representing $193.1 million in expenditures. 1987 commercial harvest was 5700 million tons having a first market value of 2.4 million.
Mussels.	Several species protected by Federal and/or State Endangered Species Acts.	A concern identified by public on Master Plan and Second Lock EIS.	Food source for many vertebrates; intermediate step in aquatic food chain.	1989 UMR harvest 2,800 tons having a first market value of $4.9 million.
Aquatic Macrophytes.	E.O. 11990, Protection of Wetlands. Several species protected by Federal and/or State Endangered Species Acts.	A concern identified by public on Master Plan and Second Lock EIS.	Important link in life cycles of plankton, benthos, fish, waterfowl and furbearers.	
Macroinvertebrates.			Intermediate step in UMR aquatic food chain.	
Waterfowl.	Migratory Bird Treaty Act, 3 National Wildlife Refuges, North American Waterfowl Management Plan.	A concern identified by public on Master Plan and Second Lock EIS	International flyway.	276,300 activity days annually at representing $7.2 million annually in expenditures.

III. SITE SPECIFIC OVERVIEW

III.A. ALTERNATIVES BEING CONSIDERED

The following alternatives have been identified by the Rock Island District as having the potential to reduce future inefficiencies in the Upper Mississippi River navigation system. Each alternative is being evaluated by the District for purposes of reconnaissance planning.

1. New 1200-foot long lock chamber at **each site.**
2. Replacement of two locks and dams (e.g. LD 24 and LD 25) with a single new facility.
3. Extending the existing 600' chamber to 1200' at **each site.**
4. Extending chambers less than 600' to at least 600'.
5. Completion of auxiliary chambers.
6. Mobile floating dock.
7. Small scale steel or concrete recreation locks.
8. Waiting areas for recreational craft.
9. Lifts, carriers, or railways for recreational craft.
10. Guidewall extensions upstream and downstream at **each site.**
11. Mooring cells upstream and downstream at **each site.**
12. Powered travelling kevels/mooring bits.
13. Helper boats.
14. Additional waiting or passing areas.
15. Non-structural, cperational procedures.
16. Approach and channel improvements.
17. Increased frequency of lock approach dredging.

III.B. POTENTIAL SITE SPECIFIC EFFECTS OF CONCERN

At this time the District's assessments of the various alternatives are broad and very general in nature with greatest emphasis on Locks and Dams 20, 21, 22, 24, and 25 to relieve the most severe constraints on the system. Therefore, little site specific impact analysis can be done. For discussion purposes, we have grouped the alternatives being considered into a) construction at the lock and dams, b) newly impounded areas, c) mooring areas, d) channel improvements, and e) operational procedures.

III.B.1. Construction at Locks and Dams

Construction at the locks and dams could range from a new 1200-foot lock, extension of 600-foot locks to 1200 feet, extension of smaller locks to 600 feet or more, completion of auxiliary locks, recreational locks or carriers, or guidewall extensions. Each of these measures would result in the permanent loss of aquatic habitat and any benthic macroinvertebrates at the site. The extent and significance of these losses are unknown. In addition, any changes in the dam structure or operation could result in changes in tailwater velocities and alteration of general tailwater habitat suitability for a number of fish species including walleye/sauger, catfish and white bass.

Any changes in operation of the tows due to the improved facility may cause adverse aquatic impacts. These include riparian losses from increased erosion and changes in aquatic habitat from new approach characteristics.

Additional concerns regarding construction at the lock and dam site include land acquisition requirements, dredging requirements, contaminated sediments, dredged material disposal options and construction activity impacts. Effects on recreational boating and use need to be evaluated.

Adverse effects of these construction alternatives can be largely avoided or minimized by proper site selection. Opportunities for enhancement of aquatic habitat and fish passage may be possible to incorporate in project design.

III.B.2. New Impoundments

Construction of a new lock and dam facility to replace two existing facilities would have construction site effects and operational effects. Construction effects would be similar to those described above, including permanent loss of aquatic habitat and resources and dredging and disposal impacts.

Operation of the new lock and dam facility could have a number of environmental effects depending on location and extent of impoundment required. A new dam would change the river hydraulics and may result in a variety of changes in aquatic habitat. New dikes or revetments may be required, and land acquisition requirements are unknown.

Water depths will change with impoundment. It is assumed that a new dam would result in expanded aquatic habitat and/or increased depths, depending on extent of adjacent bluffs and levees. Wetland habitat may be replaced by deepwater habitat. Depending on the amount of additional impoundment, backwater habitats could be enhanced by increased water depths. Overall an increase in shallow aquatic and wetland habitat is likely. However, water level management in important wetland areas could be adversely affected. Additional concerns are for 1) habitat changes that may result from bed aggradation or degradation, 2) loss of existing tailwater fisheries, 3) changes in sedimentation patterns of backwaters, 4) changes in substrate composition in important aquatic habitats and 5) additional channel maintenance needs. Of particular importance in Pools 24 and 25 are adverse impacts on mussel sanctuaries, lake sturgeon, fat pocketbook mussel restoration areas, tributary spawning sites, and on the State managed wetlands.

The potential magnitude of effects of new impoundment requires thorough study and compensation for unavoidable losses. Adverse impacts from construction of a new dam can be avoided or minimized by timing, careful site selection, and by not significantly affecting normal pool water levels or current river hydraulics. Opportunities for habitat enhancement are likely depending on sites selected.

III.B.3. Mooring Areas

Construction of mooring cells could result in permanent loss of aquatic habitat. The significance of this loss will vary by location, and is dependent on substrate conditions or presence of invertebrates. Construction may also involve dredging, which raises concerns regarding contaminated sediments and disposal alternatives.

Operation of mooring cells, a mobile floating dock, or recreation craft waiting areas may result in adverse impacts associated with movement of craft in and out of areas not previously used by tows or recreational boats. These effects are described in the following section. A mooring cell should reduce tie-offs to trees and reduce any adverse effects to bald eagle feeding perches. Overall impacts to the riparian zone and channel border will be concentrated in a single area, thereby reducing effects in other areas.

Mooring areas should be located to avoid entrances to side channels or sloughs. Depths should be adequate to preclude maintenance dredging. Sites should avoid existing eagle perch trees, important benthic habitat, or recreational access areas. Banks at the site should be stabilized to minimize future erosion damage.

III.B.4. Channel Improvements

Channel improvements include creation of additional tow waiting or passing areas, increased frequency of lock approach dredging, and other lock approach or channel improvements (e.g. straightening). Such improvements will require additional dredging in the main channel and/or main channel border. The significance of these effects depends on the specific location. Adverse impacts to freshwater mussels, other benthos, and fish spawning and feeding habitat may result. Also of concern is the disposal of dredged material and the effects of tow operations in these areas.

Significant resources need to be inventoried at each channel improvement site. Waiting and passing areas should have adequate depths to preclude maintenance dredging. Sites should minimize the potential for increased erosion and recreational boating conflicts. Disposal of dredged material should be in accordance with Great River Environmental Action Team standards (GREAT I 1980, GREAT II 1980, and GREAT III 1980).

III.B.5. Operational Procedures

Locking procedure changes could be done to increase locking efficiency. These include a) queuing policies, b) switchboats or helper boats, c) increased lock staffing, d) lock scheduling, e) "ready to serve" policy and/or other traffic management and control systems. Implementation of one or more of the procedures could cause changes in tow traffic patterns approaching or exiting the locks. Impacts could include changes in bank erosion, suspended sediment concentrations, or substrate scouring. Any changes in tainter or roller gate operation could affect important fish passage. Changes could be adverse or beneficial, depending on locations.

III.C. SITE SPECIFIC SIGNIFICANT RESOURCES

Significant fish and wildlife resources that may be affected directly by any of the planning alternatives include backwater and wetland habitats, tailwater fisheries, freshwater mussels, other benthic macroinvertebrates, and bald eagle perch trees.

IV. SYSTEMIC EFFECTS OF TOW TRAFFIC

The environmental effects of a tow transversing a riverine system has been the subject of much debate, including litigation, over the past 20 years. During this period, a number of effects have been hypothesized. However, no complete quantitative analysis has been undertaken. Several fragmented studies indicate potential effects (Carmody et al. 1986), and others have indicated insignificant effects (Simmons et al. 1988).

In completion of future environmental impact statements, it will be necessary to: 1) identify significant effects along the entire course of the Upper Mississippi River, 2) quantify impacts of incremental increases in tow traffic, and 3) determine mitigation requirements for any significant impacts that are identified. The remainder of this section addresses the current state-of-the-art.

IV.A. INCREMENTAL INCREASES IN TOW TRAFFIC

The Rock Island District has projected unconstrained (i.e. as if lockage was not required) commercial tow traffic growth for the Upper Mississippi River (table 7). This information is based on the 1988 Inland Waterway Review and assumes unconstrained demand. Also assumed are increasing numbers of barges per tow and changes in potential back haul opportunities. It should be emphasized that these projections are not adjusted for physical constraints, such as locks or reduced depths, on the system. These assumptions and estimates will be evaluated and refined by the Corps during future feasibility planning.

High and low estimates of growth have been projected. Both show relatively small increases in the early years. A much larger increase is possible in the out years, especially for the high growth projections. This is due to the fact that tonnage growth in the early years can be accommodated, in large part, by increased tow size (more barges per tow). In later years, however, tow sizes will reach practical maximums and hence tonnage growth will be accommodated solely by increasing the number of tows.

In making an analysis of the biological impacts from an incremental increase in tow traffic, it is helpful to put the number of tows in a common frame of reference, such as tows per day by season. This data has not been completed for the reconnaissance study; however, table 8 will provide some comparison over time. This estimate assumes equally distributed tows during a nine month navigation season. This may or may not be true, depending on month, economic demands and ice conditions.

Table 7. Projected number of tows transitting Upper Mississippi River locks in an unconstrained system, includes both high growth and low growth scenarios.

UPPER MISSISSIPPI RIVER NAVIGATION STUDIES
(Preliminary)

September 26, 1990

FUTURE YEAR NUMBER OF TOWS - HIGH GROWTH *

YEAR	LOCK 51	52	1	2	3	4	5	5A	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	24	25
2000	775	1132	1131	1833	1809	1797	1790	1794	1794	1843	1777	1777	2202	2199	2592	2691	3318	3468	3391	3401	3456	3646	3722	3780	3852	3974	3975
2005	865	1229	1232	2033	2008	1998	1988	1992	1992	2140	2113	2113	2621	2579	2955	3031	3556	3827	3787	4054	4122	4350	4440	4511	4593	4738	4740
2010	971	1340	1347	2285	2273	2320	2300	2305	2305	2545	2516	2516	3123	3072	3526	3614	4229	4560	4516	4836	4920	5192	5299	5386	5479	5652	5654
2015	1093	1468	1479	2715	2700	2758	2735	2739	2739	3029	2997	2997	3723	3662	4208	4311	5032	5435	5389	5771	5873	6200	6326	6434	6538	6744	6747
2020	1240	1516	1632	3229	3210	3280	3254	3258	3258	3608	3572	3572	4441	4368	5025	5145	5994	6480	6434	6890	7015	7406	7556	7687	7807	8053	8056
2025	1413	1786	1810	3842	3818	3904	3874	3877	3877	4299	4260	4260	5299	5213	6003	6144	7144	7728	7684	8228	8380	8849	9028	9188	9325	9619	9623
2030	1616	1983	2016	4574	4545	4649	4616	4618	4618	5126	5082	5082	6327	6224	7173	7339	8520	9217	9180	9830	10015	10577	10789	10985	11142	11494	11498
2035	1853	2213	2255	5450	5413	5539	5501	5503	5503	6114	6066	6066	7556	7434	8574	8769	10166	10995	10971	11747	11972	12645	12898	13136	13317	13737	13742
2040	2132	2486	2556	6496	6450	6603	6561	6560	6560	7296	7244	7244	9027	8883	10250	10482	12137	13116	13115	14042	14314	15122	15423	15712	15921	16423	16429

FUTURE YEAR NUMBER OF TOWS - LOW GROWTH

YEAR	LOCK 51	52	1	2	3	4	5	5A	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	24	25
2000	661	976	975	1683	1658	1648	1642	1645	1645	1693	1610	1610	2046	2053	2450	2550	3203	3314	3284	3165	3174	3162	3317	3276	3341	3446	3448
2005	687	990	992	1808	1781	1772	1765	1767	1767	1820	1730	1730	2180	2186	2587	2686	3320	3467	3402	3297	3353	3538	3607	3667	3735	3853	3854
2010	717	1008	1013	1938	1909	1902	1894	1896	1896	1952	1923	1923	2386	2348	2725	2821	3434	3619	3517	3689	3753	3961	4037	4106	4179	4311	4312
2015	751	1031	1039	2074	2043	2037	2029	2030	2030	2170	2150	2150	2669	2627	3017	3091	3605	3899	3857	4130	4203	4437	4522	4601	4679	4827	4828
2020	790	1059	1071	2314	2182	2205	2186	2185	2185	2425	2404	2404	2988	2940	3380	3462	4029	4365	4320	4626	4710	4973	5067	5158	5242	5407	5409
2025	838	1092	1108	2427	2404	2462	2443	2440	2440	2712	2691	2691	3346	3293	3789	3879	4506	4888	4841	5184	5280	5577	5681	5785	5876	6061	6064
2030	891	1132	1151	2712	2685	2751	2731	2727	2727	3034	3013	3013	3749	3690	4249	4348	5043	5477	5428	5812	5922	6256	6372	6491	6589	6797	6799
2035	951	1177	1202	3032	3001	3076	3055	3050	3050	3397	3375	3375	4202	4136	4766	4876	5647	6138	6088	6518	6644	7020	7150	7286	7393	7626	7629
2040	1018	1230	1260	3392	3355	3441	3419	3413	3413	3805	3782	3782	4712	4638	5348	5470	6328	6881	6831	7313	7456	7880	8025	8180	8297	8559	8562

1. *Projected unconstrained demand at all lock sites on the UMR through year 2040. This table was prepared using the high and low growth rates by commodity (extended to 2040) published in the 1988 Inland Waterway Review, along with internally prepared estimates of increasing tow size and changes in potential back haul opportunities. It should be emphasized that these projections are not adjusted for physical constraints, such as locks, on the system.

2. An interesting feature of the projection is the smaller increase in number of tows in early years as compared to the out years. This is due to the fact that tonnage growth in the earlier years can be accommodated, in some part, by increased tow size. In later years, however, tow sizes will reach their practical maximums and hence tonnage growth will have to be accommodated solely by increasing the number of tows.

3. It should be noted that this is not traffic growth constrained by existing conditions (i.e. 600-foot locks).

Table 8. Projected unconstrained number of tows per day (excluding winter season) in selected pools of the Upper Mississippi River.

YEAR	High Growth[1]	Low Growth[1]	Master Plan[2]
		POOL 8	
1990	7[3]	7[3]	10
2000	6	6	12
2010	9	7	
2020	13	9	
2030	18	11	
2040	26	14	11
		POOL 13	
1990	10[3]	10[3]	9
2000	10	9	12
2010	13	10	
2020	19	13	
2030	27	16	
2040	38	20	15
		POOL 25	
1990	13[3]	13[3]	14
2000	13	11	18
2010	19	14	
2020	26	18	
2030	38	22	
2040	54	28	23

[1]Data provided by U.S. Army Corps of Engineers, Rock Island District. Calculations for Pools 8 and 13 assumes even distribution of tows over an average 275 day season, Pool 25 assumes 90% distribution of tows over an average 275 day season.

[2]Upper Mississippi River Basin Commission (1982) summer tows per day Scenario IV.

[3]Actual summer tows per day 1990. Rock Island District omni reports.

Unconstrained incremental increases in tow traffic on the UMR by 2040 have the potential to range from 122% to 333% under unconstrained conditions. It should be recognized that these figures are based on national trends, numerous economic assumptions and an unconstrained system. Further refinement will be necessary to more accurately predict future growth of traffic if capital improvements are made. Since achieving an unconstrained system is an ideal, traffic projections in future feasibility planning will be much less than shown on table 10.

IV.B. IMPACTS TO RECREATIONAL BOATERS

A more efficient navigation system for commercial tows may also accommodate an increase in recreational boat lockages. The potential for a directly related incremental increase in recreation traffic is unknown. Also, it is unknown if boaters may be redistributed among pools and backwater habitats. If recreational lockages are precluded due to full utilization of a lock by commercial tows , boaters may concentrate activities in a single pool. Additional study is required to determine the significance of potential changes in boating use on the river.

IV.C. SUMMARY OF PHYSICOCHEMICAL IMPACTS AND GENERAL IMPACTS TO FISH AND WILDLIFE RESOURCES

Evaluation of the impacts of increasing vessel traffic on a river ecosystem involves many complex issues, as demonstrated by figure 5. A number of these impacts have been documented, but significant data gaps still exist (Rasmussen 1983 and U.S. Army Corps of Engineers, 1990a).

It should be stressed that the following summary of impacts is based on the best available information, and is drawn from an incomplete database. Much of the missing data are relevant to understanding the incremental impacts of increased navigation on the river environment. The impacts of tow movement have been the primary focus of previous studies. Little information is available on the effects of recreational boats. The following discussion summarizes the impacts of concern with regard to tows:

1. Physical Impacts

The relationship of tow movement to actual physical changes is dependent on a number of factors. These include 1) number of tows per day in an area, 2) size and direction of each tow, 3) distance between actual sailing line and shoreline, 4) erodibility of banks, 5) sinuosity of channel, 6) channel cross-sectional area, 7) depth of channel, 8) size of bottom sediments, 9) flow conditions, 10) habitats impacted, and 11) time of year.

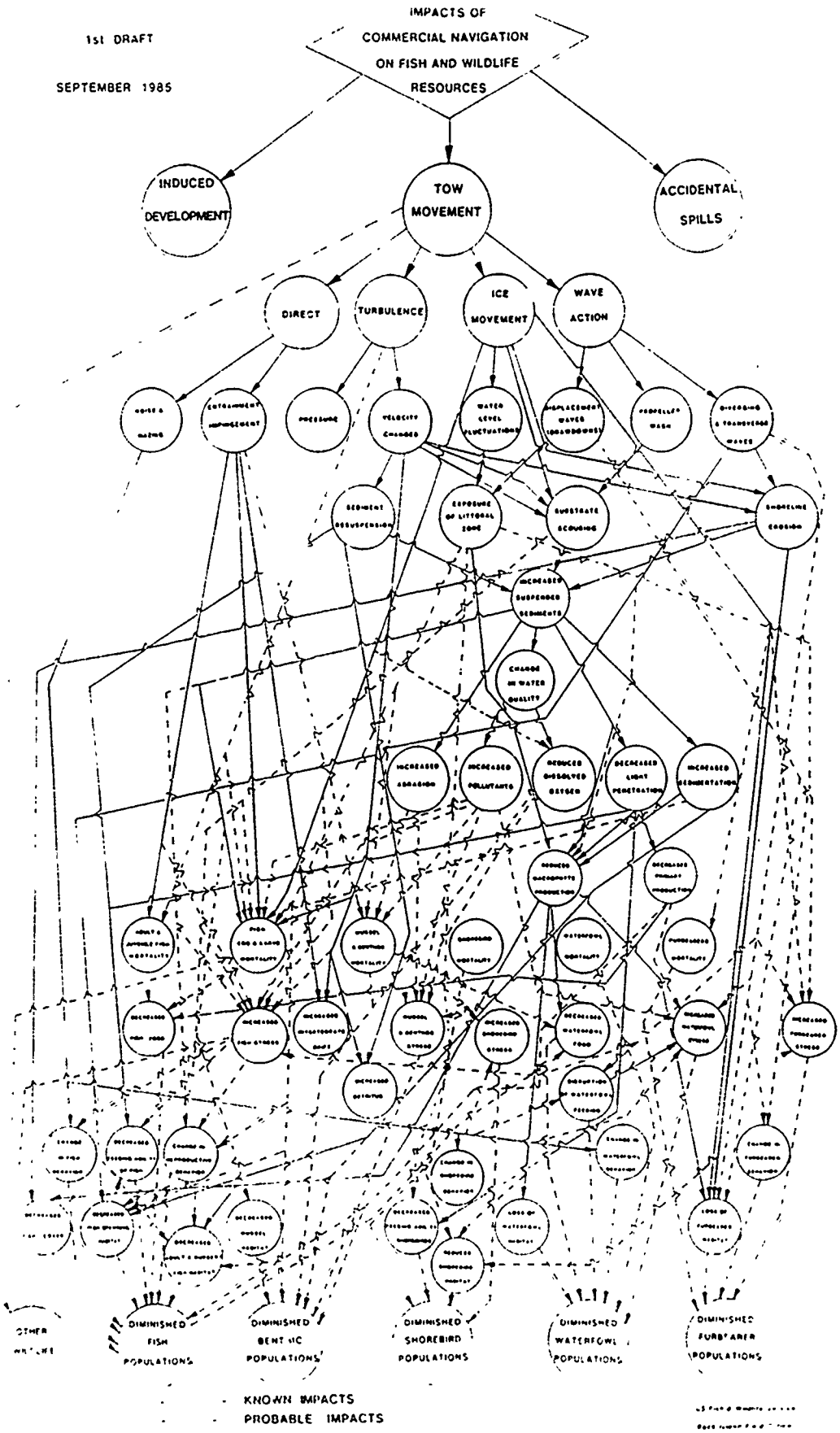


Figure 5. Inter-relationship of physical effects of tow movement and possible biological effects.

Drawdowns - The extent of tow induced water level fluctuations depends on vessel speed and length, the ratio of river cross-sectional area to submerged cross-sectional area to submerged cross-sectional area of the tow and barges (blocking factor), and distance from shore to the sailing line. Drawdowns observed on the UMRS range from 0.7 to 1.5 feet. Greater effects were observed in backwater areas away from the navigation channel. Depending on slope, a portion of river bottom may be exposed for a short period of time.

Waves - Tow movement causes bow, stern, side diverging and transverse waves. Prop wash turbulence also generates some minor waves. Near shore wave heights generated by tows on the UMRS range from 0.1 feet to 1.5 feet. Maximum wave height is a function of vessel speed, length, and blocking factor. Observed wave heights and energies are sufficient to cause bank erosion.

Velocity Changes and Turbulence - Tow movement can significantly alter water velocities. Acceleration of flow is primarily dependent on the proximity of the tow to the riverbed. Increases in velocity from an upbound tow of up to three times ambient have been observed on the UMRS. Downbound tows can actually reverse the flow. Tow propellers can have inflow velocities ranging from 1000 to 1500 c.f.s. per propeller depending on horsepower and rpm.

Turbulence is a shear force created mainly by the propellers. It is dependent on propeller diameter and pitch, rpm, and speed of the vessel. Turbulence caused by tows can cause significant vertical mixing of the river.

Ice Movement - Vessel passage during winter causes ice to break and move laterally. Significant benthic, riparian, and terrestrial habitat damage may occur due to ice pile-up and gouging of the shore. Broken ice may form large ice jams that cause dewatering of backwaters and tailwaters. Ice build-up on towboat and barge hulls (up to several feet in thickness) may scour bottom sediments and exacerbate other physical impacts due to the increased blocking factor. In addition, navigation channel buoys are not placed until after ice-out. Thus, early season navigation may be out of channel and result in numerous adverse effects.

Erosion - Streambank erosion results when forces exerted on the bank exceed soil strength. Tow induced waves contribute to this erosive energy on shorelines. Increased erosion increases sediment transport. Impacts are dependent on size of the tow, bank stability and the distance between the tow

and the shoreline. Erosion impacts are significantly greater when a tow passes within 150 feet of the shore.

Estimates of erosion impacts have been made for selected UMRS reaches. These impacts will vary by location and level of tow traffic. The lesser distance between the sailing line and shore of the Illinois River and Pools 2-10 result in greater impacts. It is estimated that 15.4 - 20.1% of the erosion on the Illinois River is due to current levels of tow traffic (Simons et al., 1981b). Future increases in tow traffic may increase this proportion to an annual average of 17.4 to 29.3% (Simons et al., 1981b) and will result in an overall increase in erosion.

Resuspension of Sediments - Increased water velocities due to tow movement resuspend bottom sediments and increase ambient suspended sediment concentrations. Suspended sediment concentrations following tow passage are greater in the main channel border than in the main channel itself. Fine sediments of the main channel are transported laterally to the main channel border. Increased suspended sediment concentrations are directly proportional to turbidity.

Elevated levels in the main channel of 40-125% greater than pre-passage levels are observed for an average of 20 minutes following tow passage and do not return to pre-passage concentrations for about 90 minutes following passage. Successive tow passage prolongs the period of increased suspended sediment concentrations and has an additive effect.

Resuspension by tows is a function of the physical factors which alter water velocities and varies by location, tow size, and tow frequency. The effect of tow passage is significantly greater on the Illinois River due to the greater percent of finer bed material and a narrower cross-sectional area.

Existing levels of tow traffic account for 27-84% of the suspended sediment (or turbidity) on the Illinois River. Future levels of tow traffic will increase the theoretical ambient (no tow traffic) level by an average of 40-93% on the Illinois River (Simons et al. 1981b).

Potential suspension of contaminated sediments are also a concern.

Sediment Deposition - Increased suspended sediments due to tow movement and the resulting increased mass transport of sediments may cause increased sediment deposition in the main channel border and backwater areas. It is thought that most sediments are redeposited between 0.5 minutes and 2.5

hours following tow passage, provided no additional tows pass. In effect, tows may add to the annual volume of sediment entering backwater areas. The percent contribution depends on physical characteristics of the site and the number of tows and barges moving past the site. Also, the percent increases dependent on the relative change in water velocities due to tow traffic and the volume of sediment entering side channels and backwaters. Tow-induced increases in sediment volume could increase the sediment deposition rate and reduce the life of valuable backwater areas.

It is estimated that tows currently add two to 28% to the annual sediment volume entering UMRS backwaters (Simons et al., 1981b). Projected increases in tow traffic will add six - 44% (Simons et al., 1981b). Resulting increases in sedimentation are dependent on trapping efficiency of a given backwater.

Potential redistribution of contaminated sediments are also a concern.

2. Chemical Impacts

Changes in D.O., potential releases of toxicants, and alterations of temperature regimes all may be caused by increased tow traffic. Also, tow passage may significantly alter mixing zones calculated for wastewater outfalls. The relative significance of these impacts is unknown. Tow mixing may help eliminate stratification and be beneficial to benthic invertebrates.

3. Biological Impacts

The following significant biological impacts may result from the above physical impacts and may occur at varying levels depending on channel configuration, the number of tows and barges, direction of travel, draft, width, speed and sailing position of the tows:

Terrestrial Habitat - Losses of habitat will occur primarily from increased bank erosion or wave run-up. It is estimated that about 650 bank miles of the UMRS are eroding of which 390 bank miles may be considered severe (Corps of Engineers, 1969). Tow-induced waves and ice movement will accelerate the rate of erosion and may increase total erodible banks.

Accretion of sediments along the channel border and in backwaters eventually will lead to expansion of terrestrial habitat at the expense of valuable aquatic habitat. Although wetlands will be established for a short period, net diversity will be reduced as bottomland forests succeed.

The net loss in terrestrial habitat acreage and value is unknown. Additional loss of important island habitat is of concern.

Aquatic Habitat - Aquatic habitat could be impacted in a number of ways by navigation traffic. The extent of impacts is dependent on the characteristics of an area, its proximity to the sailing line and frequency of tow passage.

One of the most significant impacts results from increased turbidity, and reduction of the photic zone. Sediment deposition due to tow traffic degrades and destroys backwaters and main channel border habitats by decreasing depth and altering substrates. Erosion and bank slumping result in the loss of overhanging and aquatic cover and loss of important catfish spawning sites. Waves and turbidity may reduce aquatic vegetation. All impacts are accentuated during winter navigation.

Plankton - Populations could be reduced or limited by elevated levels of suspended solids and turbidity. Vertical mixing by tows could induce movement of phytoplankton into areas unsuitable for photosynthesis. Additional impacts could result from adverse changes in water quality.

Aquatic Macrophytes - As tow traffic alters the physical and chemical ecosystem components, aquatic plants can be significantly impacted. Reduction in the photic zone due to increased turbidity will reduce available suitable habitat. Additional impacts result from increased wave action, sedimentation, and/or change in substrate.

Benthos - Tow traffic may directly affect survival of benthic organisms by causing physical damage to individuals and by causing alterations of habitat. Also, any impact that reduces abundance of host fish species may affect mussel recruitment. Mussel shell damage and increased mortality have been observed in areas of frequent tow movement. In the laboratory, elevated suspended sediment concentrations at a frequency of once every three hours caused a significant drop in food clearance rates of mussels. A frequency of once every 0.5 hours caused mussels to cease feeding. The level of traffic or threshold level that first results in either response is unknown as is the potential impact to larval or juvenile mussels. Sedimentation may change suitable substrate. Other changes in water quality, particularly due to accidental spills, could have highly significant impacts on benthic organisms.

Fish - Impacts from tow traffic are caused both directly by the tow passage and indirectly through habitat degradation. Areas of primary concern are loss of vegetation, loss of

habitat or physical burial of eggs due to sedimentation, turbidity, drawdown, impingement and entrainment, degradation of water quality, and a complexity of issues associated with winter navigation.

Increased turbidity, in part due to tow traffic, appears to play a role in the abundance of turbidity tolerant fish species on the UMRS. Turbidity interferes with vital life processes such as respiration, feeding, and reproduction. Tow traffic levels on the UMRS and corresponding increases in turbidity variously affect habitat suitability; however, overall reduction in habitat and its translation to reduced abundance is unknown.

Drawdowns due to tows cause frequent, short-term exposure of substrate and biota in main channel border and backwater habitats that are used by fish for spawning and as nursery areas. Laboratory studies indicate that dewatering due to drawdown may have little direct impact on fish egg hatchability. However, dewatering of larvae for two minutes every three hours caused a significant drop in survival. Again the threshold level causing this response is unknown.

Tow passage directly impacts fish in the main channel. This habitat has been shown to be critical to the maintenance of certain valuable fisheries. Depending on densities and mortality from entrainment and impingement, tows may kill a number of eggs and larval fish per each mile of passage. Replacement value of these fish may be costly. In addition, mortality of large fish due to propellers has been observed. The relative significance of prop damage and mortality of adult fish is unknown.

Birds - The primary impact of tow traffic on waterfowl, shore birds and other migratory birds is the accelerated degradation of aquatic habitats essential for feeding and nesting. Noises due to tow traffic may decrease nesting productivity and increase stress. Tow search lights have been observed to flush feeding tundra swans. Tow passage infrequently disturbs diving ducks. The impact of underwater tow noise on feeding diving ducks is unknown. Due to the importance of migratory feeding habitat in providing sufficient energy reserves, any hazing due to tows is viewed as significant.

Furbearers - A major effect of navigation on furbearers is related to changes in plant community distribution and productivity. Muskrat reproduction and survival is related to the quality of emergent marshes for food and house construction and the availability of bank denning areas. Furbearers living in dens are quite vulnerable to water level fluctuations, especially in winter months.

Other Wildlife - Impacts from navigation on terrestrial mammals, amphibians, and reptiles are largely unknown. However any degradation of habitat or water quality will affect these species.

4. Induced Activities

Terminal Development - This induced activity may result in filling of wetlands and conversion of aquatic habitat to developed terrestrial habitat, thus affecting biological productivity and diversity. Such habitat conversions result in reduction and/or relocation of fish and wildlife. Operation of a terminal may increase barge traffic in side channels and backwater areas causing subsequent traffic related impacts (see above). The potential for spillage and/or leaking of toxic materials into the aquatic environment is increased locally. Declining air quality may result. Construction and operation of the facility may increase erosion.

Any dredging required may reduce benthic populations. Other impacts include disturbance to birds, especially waterfowl and colonial birds, increase in ambient noise levels, aesthetic impacts, and impacts on local recreational use.

Fleeting - Fleeting may degrade or alter terrestrial and aquatic habitat. Operation of the site may have similar effects as navigation traffic described above. Dredging may be required to create and maintain the fleeting area and may reduce benthic populations.

Accidents - Increasing navigation traffic and induced activities will increase the potential for accidental spills and groundings. Spills may degrade water quality and aquatic habitat. There is always a potential for mortality of aquatic organisms. Collisions with bridges and groundings comprise nearly 80% of the total reported accidents. Most of the pollution incidents reported involve petroleum based materials. Impact to fish and wildlife are dependent on the material spilled, the time of year, and river flow. Winter tow operation during ice conditions increases the potential for significant accidental spills. Groundings result in a redistribution of sediments. Tows trying to become free after grounding may increase suspended sediment concentrations. Benthic organisms may be covered. Dredging may be required at the site, and habitat may be adversely affected by disposal of the dredged material.

5. Human Use Impacts

Sport fishing - Sport fishing may be impacted both directly and indirectly by increased navigation. The indirect

impacts are the most important and are primarily expressed in reduced fishing quality. This is due to potential changes in species composition and reduced abundance of fish. Direct impacts include disruption of fishing activity by tow wakes, inaccessibility of fishing areas due to terminals and fleeting, and inability to reach quality fishing areas due to lockage delays.

Commercial Fishing - Indirect impacts from degradation of fish habitat due to tow traffic are the most significant to commercial fishing. Additional impacts are noted due to loss of gear, and direct interference with tow traffic and fleeting.

Hunting - The primary impact of tow traffic on hunting is the degradation of habitats, which result in reduced hunting quality and decreases in abundance of species hunted. Interference with tow traffic, hazing, and interference at access sites are also noted.

Trapping - The primary impact of tow traffic on trapping is degradation of furbearer habitats and reduced trapping quality. Secondary impacts related to ice jams induced by tows may also occur.

Commercial Shellfishing - The primary impact of tow traffic is degradation of mussel habitats. Additionally, direct interference from tow passage, tow wakes, or fleeting could be significant. In fact, some fleet sites could make any mussel harvest physically impossible at adjacent beds.

Pleasure Boating - Tow traffic may reduce the aesthetic experience, interfere with locking, interfere with main channel use, interfere at access sites, and reduce the quality of recreational beaches.

Passive Recreation - Increases in tow traffic and subsequent habitat loss or degradation may reduce the recreational experience.

IV.D. IDENTIFICATION AND QUANTIFICATION OF IMPACTS

An interagency team assisting the U.S. Army Corps of Engineers, St. Louis District, has identified a number of study hypotheses that must be tested to fully understand the effects of increasing tow traffic on the UMRS, and to determine potential mitigation requirements. These hypotheses are listed in table 9. Proposed studies to test the hypotheses are contained in the St. Louis District Plan of Study (POS) (U.S. Army Corps of Engineers 1990a).

Table 9. Work unit (WU) hypotheses to be tested as described in Second Lock Plan of Study, Lock and Dam 26, Upper Mississippi River (U.S. Army Corps of Engineers 1990a).

WU1:	Movement of barge tows in inland waterways results in measurable changes in the water velocity, surge and drawdown, surface waves and propeller jet flows.
WU2:	Movement of barge tows in inland waterways results in pulse inputs of water and associated dissolved and suspended materials to side channels and backwaters.
WU3:	The early life stages of fish, eggs, and larvae, termed ichthyoplankton, are particularly vulnerable to injury or death caused by vessel passage effects because they are unable to swim away; therefore, placing the ichthyoplankton at significant excess risk.
WU4:	Turbulence, currents, sedimentation, and other effects of tow passage significantly reduce the ability of freshwater mussels to feed, and thereby cause significant physiological changes due to starvation.
WU5:	Effects due to passage of commercial and recreation craft adversely affect backwater habitats critical to spawning and maintenance of larval fish.
WU6:	Certain tow passage events increase net mortality, injury, or incapacitation of the fish populations which they affect.
WU7:	Drawdown from tow passage will cause significant stranding, and consequently damage or death, of fish eggs and larvae.
WU8:	Tow passage causes reductions in light levels which reduce the depth of the photic zone, thereby appreciably reducing the habitat available for rooted aquatic plants (macrophytes).
WU9:	Wave action caused by tow passage causes environmentally significant reductions in the diversity, density, and productivity of rooted aquatic plants.
WU10:	Turbulence created by vessel passage produces disturbances which both directly and indirectly significantly reduce the diversity, density, and productivity of macroinvertebrates inhabiting rock substrates.
WU11:	Hazing caused by tows results in ecologically significant losses of energy reserves in migrating waterfowl.
WU12:	Direct effects of tows such as shear forces, and indirect effects such as increased suspended sediment levels, reduce the base of the food chain through reductions in phytoplankton density, diversity, and productivity.
WU13:	Increases in tow traffic appreciably affect commercial fishing through reduced catch sizes and site availability, and increased costs to replace damaged or lost gear.
WU14.	Commercial navigation causes resuspension of sediments to increase ambient levels to levels known to cause reduction in the growth of sight feeding fish.
WU15:	Data from the Work Units, in conjunction with other published and unpublished data, can be used to develop models which provide accurate quantitative predictions of tow-related physical forces, and which relate these forces to biological changes in the UMRS.
WU16.	The increase in traffic due to the Second Lock will be accompanied by the development of terminals and other facilities which will change the economy and character of the UMRS

An integral part of the St. Louis District POS is development of a model to quantify impacts of incremental increases in tow traffic. Such a model is necessary to compare the relative differences among planning alternatives. It is also necessary due to the large geographic scope of the potential effects of increasing tow traffic. A model would be useful in identifying significant impact sites and assisting in mitigation planning. Selection of a model framework early in POS implementation could assist in developing study priorities.

A number of mathematical models have been developed to assess potential environmental impacts. These range from Habitat Evaluation Procedures (HEP) to energy flow models. Several models were described in Appendix B to our planning aid report for the Illinois River navigation studies (USFWS 1990). Advantages and disadvantages were documented. The POS Team also evaluated the models described. The team concluded originally that a site specific physical-biological approach to identifying impacts was a necessary first step. However, the team ultimately acknowledged the need for some sort of systemic model, as the cost of a site specific approach is likely prohibitive.

During the same time that the POS was being developed, the Louisville District refined its Navigation Predictive Analysis Technique (NAVPAT). This model offers several advantages worth noting:

1. Predictive capabilities to understand the relative difference between planning alternatives.

2. Ability to identify system-wide impacts and site specific problem areas and possible ways to avoid or minimize impacts.

3. Acceptance of output (habitat units) by Chief of Engineers for mitigation planning.

4. Many of the bugs in the application have already been worked out. A large amount of the physical effects modelling is complete.

5. Demonstration by Long Term Resource Monitoring Program (LTRMP) is occurring on Pool 13 of Upper Mississippi River.

6. Data proposed in the POS will validate many model assumptions for use on UMRS.

7. Data collected by LTRMP field stations may be able to be used in development of biological suitability indices for model application on the Upper Mississippi River.

Major disadvantages to using NAVPAT for future feasibility planning include:

1. Model is still in development stage.

2. Links between physical and biological impacts need to be verified

3. Many sample sites may be needed to account for highly variable UMR cross-sections, sediment type, discharge, and tow configuration.

4. Current model does not address impacts to wing dams, side channels, or backwaters.

5. Regression equations used in the model may not be sufficiently accurate to quantify effects of small increases in tow traffic.

IV.E. MITIGATION REQUIREMENTS AND OPPORTUNITIES

Site specific recommendations to avoid or minimize effects of potential construction alternatives have been identified in the previous chapter. Additional mitigation measures were summarized by Schnick et al. (1982). Potential measures to avoid or minimize effects of tow traffic were outlined by Carmody et al (1986) and further developed by the U.S. Army Corps of Engineers St. Louis District (in preparation). Once site specific and effects of any incremental increase in tow traffic are identified and quantified, the various planning alternatives can be assessed, and a mitigation strategy can be developed. This strategy should address measures to, in priority, 1) avoid, 2) minimize, 3) rectify over time, or 4) compensate for impacts identified.

Some mitigation measures, such as deadmen, can be done at minimal costs. Other measures, such as habitat compensation, may have high costs. The goal of any mitigation strategy for the Upper Mississippi River navigation improvements should be to reduce or offset any identified significant adverse effects in the most cost effective manner possible.

IV.F. RELATED STUDIES

There are several studies underway or recommended that may assist in identification and quantification of any increases in navigation traffic on the Upper Mississippi River. However, none of these are likely to address all of the impacts noted above.

IV.F.1. Illinois River Navigation Reconnaissance Study

A similar study to the one discussed herein is underway for the Illinois River and Waterway. This study is about six months ahead in the planning process. A reconnaissance report was scheduled for completion in October 1990.

IV.F.2. Long Term Resource Monitoring Program

The LTRMP is a component of the Environmental Management Program (EMP) authorized in the Water Resources Development Act of 1986. The LTRMP Operating Plan (1991) describes the goals and objectives of the program. However, inadequate appropriations will limit the number of tasks accomplished and the data available for use in future navigation improvement planning.

The following is to be accomplished during the 15-year study authorization and will be useful in addressing the effects of increases in navigation traffic on the Upper Mississippi River:

1. A better understanding of the ecology of the UMRS ecosystem and its resource problems primarily sedimentation and sediment transport, navigation, and water levels and discharges.

2. Monitoring and evaluation of the condition of the UMRS ecosystem with a focus on Pools 4, 8, 13, 26, La Grange Pool, and a section of the open river below St. Louis.

3. Development of alternatives to better manage the UMRS natural resources.

4. Data management.

The LTRMP will not provide a complete analysis of the effects of future increases in navigation and any needed mitigation planning. The St. Louis District Plan of Study (POS) is the LTRMP guideline for selecting problem analysis tasks. However, funding constraints limit the number of tasks that may be addressed under the LTRMP. In addition, much of the LTRMP trends analysis data is necessary for completing the POS.

IV.F.3. St. Louis District Plan of Study

As described above, the POS is a comprehensive study plan to identify and quantify high priority navigation effects (see table 9). Completion of the plan is imperative in fully understanding the physical and biological dynamics surrounding tow movement and multiple tow events.

Once the POS has been approved by higher authority and funded, the majority of the plan can be completed in five years.

Approximately, three additional years are necessary to fully understand effects to aquatic macrophyte beds.

The POS does not address some effects that may be significant at some sites on the Upper Mississippi River. These include potential riparian impacts to eagles, herons, egrets, furbearer dens and catfish, and from any increases in bank erosion. In addition, the POS does not address the potential for resuspending contaminated sediments.

IV.F.4. Waterways Experiment Station

The Waterways Experiment Station - Environmental Laboratory conducted a number of navigation effects related studies. However, funding under this program has ceased. No additional work or funding is anticipated.

The Hydraulics Laboratory completed several flow visualization studies for the Louisville District. Recently, funding was made available through the Chief of Engineers to pursue additional physical effects modelling.

IV.F.5. Other Corps of Engineers Districts

As discussed above, the Louisville District is developing a navigation predictive analysis (NAVPAT) designed for the Ohio River. Additional data collection model verification and validation will be required before it is suitable for use on the Upper Mississippi River.

The Huntington and Pittsburgh Districts are also reviewing potential applications of NAVPAT. The Huntington District is completing some site specific analysis.

V. ENHANCEMENT STRATEGY FOR THE UPPER MISSISSIPPI RIVER

An important, but frequently overlooked component of the Upper Mississippi River Navigation Study is to identify enhancement measures of a broad scope. As the reconnaissance study addresses the future needs of the navigation system, it must also address the future fish and wildlife conservation and management needs of the river. Potential enhancement recommendations are opportunities beyond any project mitigation requirements. The recommendations contribute to the conservation or "wise use" of the existing resources or to restoration of fish and wildlife resources to modern historic levels of environmental value.

V. A. HISTORICAL VALUE

The Upper Mississippi River has two distinct biological "histories." For the pooled river, it is before impoundment and after impoundment. For the river below St. Louis, it is before

channelization and after channelization. Greene (1960) summarized the conditions pre-impoundment when water quality was poor and water levels highly variable:

> At the time the refuge was established (1924) the river bottoms were primarily wooded islands, with deep sloughs the rule, but with hundreds of lakes and ponds scattered through the wooded areas. There were some hay meadows on the islands, together with some small farming areas, but the bottoms were essentially wooded. Marsh development was limited to the shores of the lakes and guts leading off the sloughs. Marsh flora was also limited, with river bulrush making up the dominant habitat. These marshes often dried up completely by the end of the summer. Also, many lakes and ponds dried up completely, while water levels in others receded markedly. Fish rescue work was a big activity, with crews rescuing fish trapped in bottomland lakes and ponds when the river receded.
>
> Early investigators such as Vernon Bailey, F.M. Uhler, and A.O. Stevens found there was a nucleus of marsh and aquatic species present in the bottoms, but not in great abundance. Further, because most of the lakes and marshes were subject to periodic flooding and dried out in the summer and fall, marsh and aquatic development was limited. Bailey suggested whatever means possible to insure water in the lakes and marshes, and advocated construction of retaining dams to hold back flood waters.
>
> Uhler also considered frequent changes in water levels of the flowing channels and the periodical or seasonal fluctuations in the lakes and ponds to have a great effect on the development of aquatic plants in general than any other factor. He, too, suggested construction of small dams to hold water in lakes and ponds when the water receded in the summer.
>
> Constant drying out of marsh areas and ponds resulted in considerable loss to marsh and aquatic species, especially the annual plants. Re-seeding occurred during periods of floods in the spring and fall, but good aquatic beds were limited, and before they became well established recurring drying out would again eliminate or greatly reduce such growth.
>
> At the time the refuge was established, the main species of waterfowl taken were divers, with scaup predominant. Puddlers were taken to a lesser extent because of generally poor habitat for them during the fall. In the spring, when the bottoms were flooded, a greater variety of waterfowl came through. Hunting was limited, and comparatively few hunters frequented the river area. Sporadic shooting often obtained during a few days of the "flight", but then shooting dropped off until the next movement occurred. Few birds remained in the area for any length of time because of the dearth of food [and likely the greater availability of wetland habitat in the flyway].

The high, semi-dry bottoms at one time held higher populations of skunks, badgers, foxes, rabbits, etc., than occur at present as the habitat was more suitable for such animals. Present inundation has restricted high lands and has limited populations of upland species.

Prairie chickens once utilized the bottomland meadows, but, with the elimination of such areas, prairie chickens have vanished.

Muskrats were common even prior to flooding impoundment, but then a higher proportion of bank rats occurred than at present, and house rats were in the minority because of the lack of suitable marsh habitat with accompanying house-building material.

In the early thirties the Corps of Engineers initiated work on the 9-foot channel project for the Upper Mississippi. Thirteen of the 26 locks and dams constructed in connection with this project are located on the Upper Mississippi Refuge, and the first pool within the limits of the refuge was filled on May 29, 1935. The last pool on the refuge was filled in 1939.

This impoundment abruptly changed the river bottoms from an area of wide fluctuations in pool levels ranging from floods in the spring to drying out in the summer, to an area of semi-stabilized water in which, while spring floods still occur, the bottoms do not dry out in the summer. Thus, instead of wooded islands and dry marshes, we now have excellent marsh and aquatic habitat, with fairly stable water levels throughout the year. Even the two record floods in the spring of 1951 and again in 1952 do not alter the fact that water conditions are much more stable now than they were prior to impoundment. Spring floods always occurred, and they can be expected annually. However, instead of drying up in the summer and winter, there is now water available throughout the year in the marshes, lakes, and ponds. Lack of marsh and aquatic plants is no longer a problem, and fish rescue is a thing of the past. Hay meadows and timbered areas are now in marsh, which offers excellent habitat for furbearers and waterfowl.

Calander (1954) described the changes in the river's fishery due to the first dam constructed at Keokuk in 1913:

There was evidence that the dam was a barrier to extensive upstream migration of paddlefish, American eel, skipjack, Ohio shad, buffalo, shortnose gar, freshwater drum, carp, shovelnose sturgeon, and three species of catfishes. Sauger movements were interfered with during the winter. The only fish likely to have their spawning interfered with were the skipjack, the Ohio shad, and the blue sucker, none of which were very important as commercial or sport fishes. However, this interference was of great importance in the case of the skipjack, because it is the host for the larval form of the important ebony shell mussel, so valuable in the button industry (Coker, 1930, p. 106.) The

American eel spawns in the ocean and then migrates up the Mississippi River to live for several years before returning to the sea. Only the females come to the Upper Mississippi whereas the males remain near the sea. Coker predicted that the exclusion of the American eel, the blue catfish, and the paddlefish from the upper river would result in the loss of fishery products valued at several thousand dollars annually (Coker, 1930, p. 106). In the 1930's and 1940's there apparently were fewer paddlefish, no skipjacks, probable fewer blue catfish and fewer American eels above Keokuk Dam than prior to 1910. However there were other factors which changed after the dam was built and these may also have influenced the decline of these species.

The blue sucker (Cycleptus elongatus) was at one time a fairly important commercial species in swift parts of the river (Barnickol and Starrett, 1951, p. 292). By 1926 it virtually had disappeared and in that year Coker found practically no fishermen in the Keokuk area who had seen more than two or three blue suckers a year. In an interview with Dr. William Starrett (personal communication, 1953), Mr. Knipe, a commercial fisherman at Nauvoo, Illinois, stated that before 1910 the Keokuk Rapids was a great producer of blue suckers and buffalofishes, but that after 1910 the catch of blue suckers dwindled rapidly. The removal of the Le Claire and Keokuk Rapids and the construction of the Keokuk Dam were considered important factors in the decline of the blue sucker in the section of the river between Dubuque and the Missouri River. However, Coker found that this species had declined also in the Mississippi between the Missouri River and Caruthersville, indicating that there were other causes for its decline (Barnickol and Starrett, 1951, p. 293).

Boyd (1981) further described the river below St. Louis:

The Middle Mississippi River is bounded at either end by two other major tributaries: the Missouri and Ohio Rivers. Its waters and floodplains once supported one of the richest and most productive ecosystems in North America. Its currents and backwaters once supported a fishery so bountiful that early travelers were attracted to its shores to exploit this resource. It played an important role in the early fur-trade industry. It served as a highway for travel and its floodplains provided the medium for food production. The resources provided attracted settlement and, because of this, the middle Mississippi has undergone development surpassing that of all upstream reaches. Stated simply, this development has been to provide flood protection for people and property and a suitable channel for navigation.

Human disturbance in the Upper Mississippi River Basin over the last century have greatly altered both positively and negatively the abundance of fish and wildlife. The damming of the river stabilized water levels to the benefit of many species. However, these dams have precluded some fish migration and the natural

scouring of backwater areas. The degradation of backwater habitats due to an increase of the river's sediment trapping efficiency is of great concern. Other adverse changes include excessive sewage and industrial waste, increased agricultural runoff, and a greatly modified hydrology and landscape due to drainage and levee districts. While it is recognized that the river can never be as pristine as it once was, many actions are reversible and could result in restoration of areas along the river.

V. B. FUTURE WITHOUT ENHANCEMENT

The future without a comprehensive enhancement strategy for the Upper Mississippi River will depend upon many fragmented efforts including those identified in Appendix B, enforcement of water quality and erosion control regulations, the EMP, and the numerous efforts by local governments and individuals.

Ultimately, the biological productivity of the river is linked to the sedimentation rates in the backwater lakes. The Upper Mississippi River Basin Commission (1982) summarized:

> The GREAT sediment rate studies performed in the upper reaches of the Mississippi River indicate that the life expectancy of many of the large river pools created by the navigation dams is very short. It is expected that unless upland soil conservation practices are greatly intensified and expanded beginning immediately, major segments of the rich, diverse, accessible fish and wildlife habitats, including national refuges, and recreation areas will become shallow marshes, mudflats, or even dry land within only 50 to 250 years. Streambank and tributary bedload control may also help reduce navigation channel maintenance dredging requirements. The relationship between dredging and sediment inputs is difficult to determine and correlation can be overshadowed by other factors.

The life expectancy of important aquatic habitats of the Open River side channels may be even less. Simons et al. (1974) concluded:

> The contraction of the Middle Mississippi River with dikes has eliminated most of the natural side channels...The main problem is that the life of a side channel produced by dike fields is usually short. The dike fields and the side channels fill with sediment rapidly because dike fields are usually located in areas of natural deposition. Once the side channel is filled with sediment, there is easy access to the island area. In many cases, the filled side channel area and island area are converted to agricultural use. Thus, the areas are no longer suitable as fish and wildlife habitats.

V. C. OPPORTUNITIES FOR ENHANCEMENT

A comprehensive quantitative long term enhancement strategy for the Upper Mississippi River needs to be integrated from the various government and public objectives (Appendix B). In addition, an ecosystem perspective needs to be addressed in an overall conservation and management strategy. The strategy should address the feasibility of and specific actions for:

1. Restoration of segments of the river to certain floodplain river ecosystem values.
2. Point source and nonpoint source pollution control.
3. Watershed soil conservation and wetland protection.
4. Closing structures to protect important side channels.
5. Periodic and selective dredging of aquatic habitats.
6. Artificial island creation.
7. Diversion of high flows away from backwater habitats.
8. Wetland development.
9. Beneficial uses for dredged sediments including channel maintenance sediments.
10. Removal or detoxification of toxic sediments.
11. Restoration or creation of backwater lakes.
12. Restoration of historic side channels.
13. Protection and creation of contiguous habitats.
14. Restoration or simulation of rapids habitat.
15. Restoration of endemic fish populations.
16. Restoration or enhancement of fish passage through dams.
17. Identifying and reducing factors constraining re-establishment of aquatic macrophytes and restoration to historic wetland conditions or similar.
18. Identifying and reducing factors limiting other important fish and wildlife species.
19. Exotic species control.

20. Public education and information on fish and wildlife protection and enhancement.

Some site specific enhancement measures have been identified in past planning efforts. Habitat rehabilitation and enhancement projects being considered under the EMP are identified in the Fifth Annual Addendum (US COE, 1990b). Additional opportunities may be found in reports listed in Appendix B, Schnick et al. (1981), UMRCC (1983) and Carmody et al. (1986). A compiled summary of these projects/ideas is beyond the scope of this report.

V. D. STRATEGY DEVELOPMENT AND ENHANCEMENT IMPLEMENTATION

A comprehensive quantitive long term enhancement strategy needs to be developed jointly by all the agencies with authority for fish and wildlife management on the Upper Mississippi River. Consensus is needed on an overall framework for a UMRS strategy. From this general strategy regional operation plans for specific UMRS reaches could be developed by multi-agency, multi-disciplined teams. However, the only way such plans can ultimately benefit future fish and wildlife resources is for agencies to develop their own strategies, programs, and operational plans. Finally, commitment of funds ultimately dictates successful implementation of the enhancement strategy.

The authority to accomplish enhancement planning is contained in the Water Resources Development Act of 1986 (Section 1103(h)(2) and (3) which states:

> (2) The Secretary [of the Army], in consultation with the Secretary of the Interior and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin shall determine the need for river rehabilitation and environmental enhancement and protection based on the condition of the environment, project developments, and projected environmental impacts from implementing any proposals resulting from recommendations made under subsection (g) [identify measures to increase the tow capacity of specific locks by employing nonstructural measures and making minor structural improvements] and paragraph (1) of this subsection [verify the need for future traffic capacity expansion of the system].
>
> (3) There is authorized to be appropriated to the Secretary such sums as may be necessary to carry out this subsection.

VI. CONCLUSIONS AND RECOMMENDATIONS

VI.A. CONCLUSIONS

Congress has designated the Upper Mississippi River System a nationally significant ecosystem. Our primary concern in these navigation studies is the potential effects to fish and wildlife from any increases in commercial navigation traffic. Although the U.S. Fish and Wildlife Service has raised this concern to the Corps of Engineers on numerous occasions in the last 20 years, the environmental effects of any increases in navigation traffic remain largely unknown.

The potential for significant impacts are great at sites with a narrow channel, fine sediments, and/or important main channel and channel border habitats. The effects or potential limits that may be placed on this ecosystem as a result of increases in commercial tow traffic need to be defined.

VI.B. RECOMMENDATIONS

The following recommendations should be completed as a part of the feasibility study. This additional information is necessary to insure protection of the UMRS nationally significant ecosystem in concert with future navigation. All should be initiated as soon as possible in order to complete feasibility planning in a timely manner.

Most important among these recommendations is the completion of the St. Louis District POS, so that we can complete our Fish and Wildlife Coordination Act requirements. Any further delay in implementation of this study will only serve to delay future feasibility planning.

In addition, we are concerned that Corps programs to address measures to avoid and minimize impacts of tow traffic are progressing slowly on the UMRS. This program was agreed to in the Records of Decision for the Lock and Dam Major Rehabilitation Program and the Second Lock at Lock and Dam 26. The Corps must undertake implementation of this program immediately.

The recommendations are divided into several categories.

1. DATA COLLECTION AND IMPACT ANALYSIS FOR SITE SPECIFIC EFFECTS

    a. Conduct a survey of freshwater mussels and other benthic invertebrates near each lock and dam or proposed construction area. Specific survey area requirements should be coordinated with this office and adjacent State conservation agencies.

b. Conduct a bioassay of the sediments and suspended sediments within one half mile upstream and one half mile downstream of each lock and dam or proposed construction area.

c. Determine dredging requirements, disposal alternatives and sediment quality at each site proposed to be dredged.

d. Depict changes in river hydraulics for each proposed alternative.

e. Evaluate riparian effects, including tow induced bank erosion from tow operation, for each proposed alternative.

f. Complete a creel census of tailwater sport fishing and evaluate impacts to fish passage and to sport fishing from construction and operation of each alternative.

2. DATA COLLECTION AND IMPACT ANALYSIS FOR SYSTEMIC EFFECTS

a. Include in the study area the UMR from Cairo, Illinois, to St.Paul, Minnesota. The entire area is subject to effects of increasing tow traffic. In fact, Pool 26 and below may be affected by increases in tow traffic from improvements on either the Mississippi or Illinois rivers.

b. Complete all 16 work units of the St. Louis District POS.

c. Assess potential effects on bank erosion from increases in tow traffic and recreational boating. Evaluate resulting riparian effects, including aquatic vegetation, bald eagle perches, colonial nesting bird areas, mud flat shorebird use, furbearer dens, and catfish spawning habitat.

d. Complete a freshwater mussel and fingernail clam survey of the main channel and channel border to identify beds and assess condition, priority should be given to Pools 24, 25, and 26.

e. Evaluate the effect of tows on walleye, sauger, sturgeon, and paddlefish spawning habitat and juvenile catfish main channel habitat.

f. Adapt Louisville District Navigation Predictive Analysis Technique (NAVPAT), or similar model, to Upper Mississippi River to assess relative differences of planning alternatives and potential mitigation

alternatives. Assumptions need to be evaluated and validated for Upper Mississippi River.

g. Complete bioassay of sediment quality and potential effects of increasing suspended sediment concentrations. Priority should be given to Lake Pepin and areas where the main channel width may expand due to increased tow passing requirements. The use of sediment traps to conduct a system-wide evaluation should be explored. All sediment and water quality work should be coordinated with the U.S. Geological Survey.

h. Evaluate the potential systemic effects of redistribution of contaminated sediments by tows.

i. Identify potential barge fleeting needs in each pool.

j. Assess the potential for accidental spills from increasing traffic or induced development.

k. Assess the potential for increased winter navigation and evaluate potential effects on aquatic habitat and wintering fish.

l. Assess potential recreation effects from increasing navigation, including constraints on recreational lockages or enhancement of recreational locking opportunities.

m. Complete a systemic Environmental Statement (EIS) to address the potential effects of increases in vessel movement. This EIS should include the potential cumulative effects of not only navigation traffic, but also recreation traffic, hydropower, channel maintenance activities and other perturbations to the river environment. It should also address secondary effects of induced development and increases in barge fleeting.

3. ENDANGERED SPECIES COORDINATION

a. Conduct a biological assessment on the potential effects to the bald eagle, pallid sturgeon, Higgins' eye pearly mussel, and fat pocketbook pearly mussel. Depending on construction site alternatives, a biological assessment on the potential effects to the Indiana bat and decurrent false aster may also be required.

b. Evaluate the need for formal consultation in accordance with Section 7 of the Endangered Species Act of 1973, as amended.

c. Assess the potential effects of construction alternatives and increasing traffic on State listed species.

4. LONG TERM ENHANCEMENT STRATEGY

a. Assist in the development and coordination of a strategic plan for the Upper Mississippi River. Such a plan would describe the long-term preservation, protection, restoration, and enhancement of the fish and wildlife resources of the river. The strategic plan should have quantifiable goals and objectives for fish and wildlife management.

b. Assist in the development of reach specific operational plans based on the fish and wildlife management strategic plan.

c. Complete a Corps of Engineers operational plan for fish and wildlife lands owned or managed by the Corps or for resources under the authority of the Corps. The plan should be based on the regional operational plans and coordinated with affected State and Federal agencies.

d. Incorporate into future navigation plans potential enhancement measures identified in the strategic planning process.

5. COORDINATION

a. Continue coordination with the Rock Island Field Office to address the above considerations.

b. Ensure active coordination by the State conservation agencies. A feasibility study of this magnitude will require close coordination, particularly with regard to the long term enhancement strategy. However, the State's personnel and funding resources to provide such assistance is limited. The Corps should be prepared to fund State work.

c. Request and fund assistance from the Long Term Resource Monitoring Program to collect data as required, and to address the long term enhancement strategy through use of resource trends data being collected by the field stations.

d. Devote staff time to a program to avoid and minimize the effects of tow traffic.

e. Keep the Inland Waterways Users Board up to date on environmental analysis and planning requirements. Facilitate discussions between the industry and environmental organizations to develop a planning schedule both can subscribe to.

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APPENDIX A

LETTERS OF COMMENT

FROM THE STATE CONSERVATION AGENCIES

Illinois Department of Conservation

Iowa Department of Natural Resources

Minnesota Department of [illegible] Resources

Wisconsin Department of Natural Resources

Missouri Department of Conservation

Illinois Department of Conservation
life and land together

LINCOLN TOWER PLAZA • 524 SOUTH SECOND STREET • SPRINGFIELD 62701-1787
CHICAGO OFFICE • ROOM 4-300 • 100 WEST RANDOLPH 60601
MARK FRECH, DIRECTOR - KATHY SELCKE, ASSISTANT DIRECTOR

February 1, 1991

Mr. Richard C. Nelson
Field Supervisor
USDI-FWS
Rock Island Field Office (ES)
1830 Second Ave., Second Floor
Rock Island, IL 61201

Dear Mr. Nelson:

Department staff have been given an opportunity to review your January 7, 1991 Draft Planning Aid Report for the U.S. Army Corps of Engineers Upper Mississippi River Navigation Reconnaissance Study.

We are pleased with the thoroughness of the document and its recommendations, its attention to state-listed threatened and endangered species, and also the opportunity you afforded staff to discuss the report with your staff and other interested agencies.

Relative to Table 3 on page 19 please change the status of the Illinois chorus frog from R (rare) to T (threatened).

Thank you for the opportunity to comment.

Sincerely,

Mark Frech

Mark Frech
Director

MF:RWL:ts

cc: Rock Island Corps, Vanderjack

STATE OF IOWA

TERRY E. BRANSTAD, GOVERNOR

DEPARTMENT OF NATURAL RESOURCES
LARRY J. WILSON, DIRECTOR

January 31, 1991

Richard C. Nelson
Field Supervisor
U.S. Fish and Wildlife Service
Rock Island Office (ES)
1830 Second Avenue, Second Floor
Rock Island, IL 61201

Dear Mr. Nelson,

The Iowa Department of Natural Resources has reviewed the Planning Aid Report as it pertains to the Upper Mississippi River Navigation Reconnaissance Study. IDNR concurs with the recommendations set forth. It is critical to acquire a thorough understanding of the impact natural resources of the Upper Mississippi River will experience resulting from any increases in navigation traffic.

Funding, sufficient to implement all work units recommended by the Interagency Study Team for the Plan of Study, is also critical to the proper management of the Upper Mississippi River. A system-wide implementation philosophy for the POS should be maintained. Much needed understanding of the effects of increased navigation traffic on the UMRS would be gained by the system-wide approach. To limit the recommended work units of the POS to the second lock would be tragic. The Iowa Department of Natural Resources stresses the need for funding the Plan of Study as recommended by the Interagency Study Team.

Sincerely,

LARRY J. WILSON
DIRECTOR

WALLACE STATE OFFICE BUILDING / DES MOINES, IOWA 50319 / [illegible]

STATE OF
MINNESOTA
DEPARTMENT OF NATURAL RESOURCES

500 LAFAYETTE ROAD, ST. PAUL, MINNESOTA 55155-4037

OFFICE OF THE
COMMISSIONER

DNR INFORMATION
(612) 296-6157

May 30, 1991

Mr. Richard C. Nelson
Field Supervisor
U.S. Fish and Wildlife Service
Rock Island Office (ES)
1830 Second Ave., Second Floor
Rock Island, Illinois 61201

Re: Additional Comments
Draft Planning Aid Report
Upper Mississippi River Navigation Reconnaissance Study

Dear Mr. Nelson:

The Minnesota Department of Natural Resources (DNR) would like to add the following comments to those provided to you in our letter of February 12, 1991 concerning the above-referenced report.

Environmental impacts associated with increasing river traffic are a long-standing concern of ours. We have participated in many interagency efforts to define navigation impacts and to design studies to quantify them. The most recent product of these efforts is the work units contained in the St. Louis District Plan Of Study for navigation effects of the Second Lock at Melvin Price Locks and Dam (Locks and Dam 26).

It is essential that this Plan of Study be funded and implemented. Future Environmental Impact Statements for projects that will increase the navigation capacity of the Upper Mississippi River System cannot be completed without the information that the Plan Of Study will provide.

Yours truly,

by Ron Nargang

Rodney W. Sando
Commissioner

AN EQUAL OPPORTUNITY EMPLOYER

STATE OF
MINNESOTA
DEPARTMENT OF NATURAL RESOURCES

DNR INFORMATION
(612) 296-6157

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Celebrate MINNESOTA 1990

February 12, 1991

Mr. Richard C. Nelson
Field Supervisor
United States Department of the Interior
Fish and Wildlife Service
Rock Island Field Office (ES)
1830 Second Avenue, Second Floor
Rock Island, Illinois 61201

Re: Draft Planning Aid Report
Upper Mississippi River Navigation Reconnaissance Study

Dear Mr. Nelson:

The Minnesota Department of Natural Resources (DNR) has completed a review of the above referenced report. The following comments are provided for your consideration in finalizing the report.

Page iv, c. We recommend that loss of riparian aquatic vegetation be included in riparian effects.

Page iv, e. We recommend that the list of fish to be evaluated for tow effects be expanded to include sturgeon.

Page iv k. We suggest that the sentence be modified to read "...on aquatic habitat and wintering fish".

Page 41. III.B.1. In the last paragraph, we suggest that the sentence be modified to read "...enhancement of aquatic habitat and fish passage...".

Page 61. In the third paragraph, it should be noted that more recent research has shown that the periodic drying up of marsh soils is required for the germination of aquatic plant seed banks. Permanent inundation of these marshes may be complicit in the recent observed decline in extent and vigor of aquatic vegetation in the river's pools.

Page 65. Item 16 should be modified by inserting the word "of" between "enhancement" and "fish".

AN EQUAL OPPORTUNITY EMPLOYER

If you require information from the DNR concerning any of our comments, please contact Cheryl Heide from my staff at (612)296-9228.

Sincerely,

Thomas W. Balcom

Thomas W. Balcom, Supervisor
Natural Resources Planning and Review Services

c. Bill Johnson
Karen Bowen
Steve Colvin
Tom Lutgen
Bonita Eliason
Steve Johnson

910132-1

MISSOURI DEPARTMENT OF CONSERVATION

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Jefferson City, Missouri

Telephone: 314/751-4115
JERRY J. PRESLEY, Director

February 8, 1991

Mr. Richard C. Nelson
Field Supervisor
U. S. Fish and Wildlife Service
1830 Second Ave., Second Floor
Rock Island, Illinois 61201

Dear Mr. Nelson:

In response to your January 14, 1991 letter, members of the Department staff reviewed the planning aid report for the Upper Mississippi River Navigation Reconnaissance Study. The opportunity to review an early draft of the planning aid report expedited our review.

We concur in the report and look forward to working with you and your staff as this very important study progresses.

Sincerely,

JERRY J. PRESLEY
DIRECTOR

COMMISSION

JERRY P. COMBS ANDY DALTON JAY HENGES JOHN POWELL

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Carroll D. Besadny, Secretary
Box 7921
Madison, Wisconsin 53707
TELEFAX NO. 608-267-3579
TDD NO. 608-267-6897

February 8, 1991 File Ref: 3500

Mr. Richard C. Nelson
Fish and Wildlife Service
Rock Island Field Office (ES)
1830 Second Avenue, Second Floor
Rock Island, IL 61201

Dear Mr. Nelson,

The Wisconsin Department of Natural Resources (WDNR) has reviewed the Planning Aids Report for the U. S. Army Corps of Engineers Upper Mississippi River Navigation Reconnaissance Study. We concur with the recommendations and conclusions in the Planning Aids Report and we appreciate the opportunity to work in concert with U. S. Fish and Wildlife Service on this effort.

The Planning Aids Report contains several recommendations/conclusions which are particularly important in our view, and which will guide our evaluation of the implementation of this Report:

> Congress has mandated the Upper Mississippi River as a dual purpose resource serving both commercial navigation and a nationally significant wildlife refuge. This mandate should be foremost in the Corps' mind as their study proceeds. Environmental concerns must receive equal consideration with navigation concerns.
>
> The Department advises the U. S. Army Corps of Engineers to proceed with implementation of the St. Louis District Lock and Dam 26 Plan of Study (POS). The sixteen POS work units will help determine the effects of increased navigation and must be implemented before moving into the feasibility stage of the Navigation Reconnaissance Study.
>
> At this time a complete list of endangered / threatened / special concern resources cannot be generated for the Mississippi River floodplain. Therefore the Corps must be prepared to inventory these resources within 1/2 mile of any construction site.

Because the Navigation Reconnaissance Study is a Corps initiated activity, funding must be provided by the Corps to the cooperating agencies to maintain their part in this immense effort.

The time planned to conduct the feasibility study should be flexible. Environmental resource concerns can not be realistically addressed in the three years allotted for the feasibility study.

Again, our thanks for including the Wisconsin Department of Natural Resources in your review of the Planning Aids Report. We look forward to continued cooperation with the Fish and Wildlife Service in the Navigation Effects Study.

Sincerely,

C. D. Besadny
Secretary

cc: Kathy Curtner-EA/C
Jim Lissack-WD
Gretchen Benjamin-La Crosse

APPENDIX B

Synopsis of Documents That Outline

Potential Fish and Wildlife Management Goals and Objectives

for the Upper Mississippi River

Appendix B

SYNOPSIS OF DOCUMENTS THAT OUTLINE POTENTIAL FISH AND WILDLIFE MANAGEMENT GOALS AND OBJECTIVES FOR THE UPPER MISSISSIPPI RIVER

CITIZEN/NON-GOVERNMENTAL

River Country Voices. 1981. Visions for our rivers - a citizen's proposal for the Upper Mississippi And Illinois rivers. Madison, WI. 48+pp.

Produced by a coalition of conservation, environmental and recreation organizations, the report summarizes the results of a major survey designed to answer the question, "What are the environmental objectives of the Upper Mississippi River System, as defined by the environmental community itself?" It discusses and makes river management recommendations with regard to commercial navigation, fish and wildlife, recreation, energy production, water quality, flood control programs, floodplain management, and river corridor management.

River Country Voices. 1982. Our rivers, a citizen's plan for the Upper Mississippi and Illinois rivers. Madison, WI. 51+pp.

This plan was developed by a coalition of conservation, environmental, and recreational organizations. It is an alternate plan to the UMRBC Master Plan. It includes a number of recommendations on issues not addressed in the Master Plan. General goals for wildlife refuge management are outlined.

LOCAL/REGIONAL

None located

STATE

<u>Missouri</u>

Missouri Department of Conservation. 1988. Lighting the Way. Jefferson City, MO. 20pp.

This is a general plan of the Missouri Department of Conservation that describes fish and wildlife management issues and the overall goals of the Department. No specific goals were identified relative to the UMR.

Missouri Department of Conservation. 1989. Strategic plan, fiscal years 1990-1994. Jefferson City, MO. 56pp.

The plan identifies a series of strategic issues likely to impact the Missouri Department of Conservation over the next decade. Future direction is defined by goals and objectives for each functional administrative area. Specific geographic areas, such as the Upper Mississippi River, are not addressed.

Missouri Department of Conservation. 1989. Missouri Department of Conservation wetland management plan. Jefferson City, MO. 157pp.

This plan is a guide to the Missouri Department of Conservation for restoration and management of wetlands in Missouri to the year 2000. It addresses participation in the North American Waterfowl Management Plan; protection, restoration, and improvement of wetland habitat; population objectives for wetland dependent species; sustained recreational opportunities; and essential research and surveys. Specific to the UMR, it recommends. 1) a management plan for the Mississippi Valley population of Canada geese, 2) improvement of UMR wetland areas, 3) habitat research and surveys at Ted Shanks Wildlife Area.

Missouri Department of Conservation. 1981. Prairie Slough Wildlife Area area plan. Jefferson City, MO. 22pp.

Plan describes management objectives for Prairie Slough Wildlife Area (Pool 25). Priorities include public fishing access and wildlife use.

Illinois

Illinois Department of Conservation. 1990. Action for the nineties ...and beyond. Volume I, a strategic plan for Illinois fisheries resources. FY90-FY94. Springfield, IL. 21pp.

Public report describes overall Illinois Department of Conservation goals and objectives to provide for protection, enhancement, and utilization of the fisheries resources of the State. It states specific objectives for river and stream species including catfish, black bass, panfish, coolwater fish, trout, rough fish, and other fish. Objectives are statewide and not specific to UMR.

Illinois Department of Conservation. 1989. Strategic plan for fish in streams, FY90-94, working document. Aledo, IL.

Working document used to develop 1990 public report. Identifies species specific strategies and strategies to reduce loss of backwater lakes.

Illinois Department of Conservation. 1990. Action for the nineties ...and beyond, Volume II, a strategic plan for Illinois wildlife resources, FY90-94. Springfield, IL. 17pp.+ detailed plan supplement.

Public report describes overall Illinois Department of Conservation goals and objectives to provide for the protection, enhancement, and proper utilization of the wildlife resources of Illinois. It states specific objectives for waterfowl (ducks, geese, and coots), upland game (rabbits, pheasants, bobwhite quail, gray partridge, mourning doves, woodcock, common snipe, crows, woodchucks), forest game (squirrel, white-tailed deer, wild turkey, ruffed grouse), and furbearers (raccoon, muskrat, opossum, mink, red fox, gray fox, coyote, beaver, weasel, skunk). Objectives are statewide and not specific to UMR.

Illinois Department of Conservation. 1987. Action plan for the eighties ...and beyond, Volume III, a strategic plan for Illinois heritage, endangered, and threatened species, FY87-91. Springfield, IL. 8pp.

Public report describes overall Illinois Department of Conservation goals and objectives related to heritage, endangered, and threatened species. Specific objectives for selected mammals (including bats, squirrels, and badgers), birds, reptiles, amphibians, mussels, crayfish, and endangered or threatened species. Objectives are statewide and not specific to UMR. Update for nineties not anticipated as plan for eighties still applies.

Illinois Department of Conservation. 1990. Mississippi River State Fish and Wildlife Area, wetland management task force study. Springfield, IL.

Task force report to identify future wetland management potential of Mississippi River State Fish and Wildlife Management Area (Pools 21-26). Task force included sportsmen and state biologists. Specific project recommendations for protection and enhancement made.

Harper, D.A. 1975. Master management plan, Mississippi River Fish and Waterfowl Management Area. Illinois Department of Conservation, Alton, IL. 25pp.

Plan outlines objectives for management of Mississippi River Fish and Waterfowl Management Area (Pools 21-26). Describes specific priority work.

Iowa

Iowa Department of Natural Resources. 1988. Iowa SCORP, statewide comprehensive outdoor recreation plan. Des Moines, Iowa.

The goals of this statewide plan is to 1) summarize public and private outdoor recreation lands, facilities, and programs; 2) assess public recreation demand; 3) summarize research and planning activities; 4) list issues; 5) examine roles in meeting recreational demands; and 6) recommend actions for development and management of outdoor recreation in Iowa. Fish and wildlife management issues are described and priorities listed. Mississippi River coordination is an identified program. No specific goals or objectives are identified for the UMR.

Iowa Department of Natural Resources. 1988. Iowa open spaces plan. Des Moines, Ia. 69pp.

This plan describes a program to increase the amount of land in Iowa under public protection by the year 2000. Specific proposals for expansions of parks, recreation areas, fish and wildlife management areas, and state forest lands are identified for a Mississippi River unit of the plan. The Mississippi River unit also describes conceptual proposals for bluff protection, trails, the Great River Road, and cultural resources.

Iowa Conservation Commission. 1982. Fisheries Section program assessment. Unpublished report. Des Moines, Iowa.

Statewide goals and objectives for management of fisheries resources are identified. Several short-term objectives are listed for the Mississippi River.

Iowa Conservation Commission. 1980. Green Island Wildlife Area, Jackson County, Iowa, development plan. Des Moines, IA. 17+pp.

Report describes specific management recommendations for the Green Island Wildlife Area, Pool 13.

Wisconsin

Wisconsin Department of Natural Resources. 1988. A course for the future, strategic direction of the Department of Natural Resources. Madison, WI.

This document contains the Department's strategic direction and operating philosophy. Specific geographic areas, such as the Mississippi River, are not addressed.

Wisconsin Department of Natural Resources. 1986. Resource Management 2000, a strategic plan for the division of resource management: goals and strategies. Draft prepared May 1986. Madison, WI. 14pp.

Plan is to guide Division programs to the year 2000. Nine broad goals are described.

Wisconsin Department of Natural Resources. Undated. Fish Wisconsin 2000: a proposed strategic plan for fisheries management in Wisconsin: strategies and goals. 5th edition. Madison, WI. 12pp.

This plan proposes six broad strategies to guide Wisconsin's Fishery Management program beyond the year 2000. No goals are specific to the Mississippi River.

Wisconsin Department of Natural Resources. Undated. Wildlife 2000, a strategic plan for wildlife management. Madison, WI. 8pp.

This strategic plan sets the direction for the Bureau of Wildlife Management through the year 2000. Goals are listed that will provide or facilitate a wider range of wildlife management and wildlife recreational opportunity. Specific geographic areas, such as the Mississippi River, are not addressed.

Wisconsin Department of Natural Resources. 1988. Endangered resources 2000, a strategic plan for Wisconsin's endangered resources. Madison, WI. 11pp.

This strategic plan describes Wisconsin's Endangered Resources program and implications for endangered resources of a number of trends. Goals and strategies to deal with issues are listed. No strategies are specific to the Mississippi River.

Wisconsin Department of Natural Resources. 1988. Environmental quality 2000: a strategic plan for managing Wisconsin's environment into the next century. Division of Environmental Quality, Madison, WI.

This is a strategic plan to direct the Division of Environmental Quality program and individual employee responsibilities. Broad goals are described. Accomplishments towards a 1983 strategic plan are reviewed. No geographic areas, such as the Mississippi River, are identified.

Minnesota

Minnesota Department of Natural Resources. 1986. Plan for Minnesota fish and wildlife resources, strategic plan, July 1986, public review draft.

This document represents the Department's vision of the future for fish, wildlife, and native plant resource management. Twenty-year goals, strategic issues, and alternative strategies are identified.

Minnesota Department of Natural Resources. 1987. Planning for Minnesota fish, wildlife and native plant resources. Division of Fish and Wildlife, St. Paul, MN. [Vol. 1 and 2. Dynamic document with sections added as completed.]

These volumes include the strategic plan described above and long range planning documents for many fish and wildlife species. Products, goals, objectives, and strategies are described for each species (i.e. walleye/sauger, catfish, furbearers, ducks, and endangered fauna. Measurable objectives are described by administrative region. The portion of the Mississippi River of concern in the Corp's navigation studies is in Region 5.

FEDERAL

U.S. Fish and Wildlife Service

U.S. Fish and Wildlife Service. 1987. Final environmental impact statement master plan, Upper Mississippi River National Wildlife and Fish Refuge. Twin Cities, MN.

The document describes the Upper Mississippi River National Wildlife and Fish Refuge (Pools 4-14), its background, the management alternatives considered for the refuge, and their potential consequences. It identifies specific goals, objectives, and management projects for the refuge. The

Master Plan Technical Appendix I describes quantifiable objectives and specific candidate implementation strategies for wildlife and habitat management.

Fish and Wildlife Interagency Committee. 1987. Draft report, goals for management of fish and wildlife resources and habitat rehabilitation and enhancement for Pools 11-22. U.S. Fish and Wildlife Service, Rock Island, IL.

Draft report describes overall goals and objectives for fish, wildlife, and their habitats in Pools 11-22. Relative importance of objectives geographically is described. Potential management objectives and possible enhancement projects for specific areas are described. Report was never finaled. Currently used as a working document by Rock Island District to assist in selection of HREP project funding.

U.S. Fish and Wildlife Service. 1983. Proposed ten year action strategy, Upper Mississippi River. Twin Cities, MN. 25pp.

The report provides a broad conceptual framework and basis for further FWS program development should substantial Federal funding (i.e. EMP) be made available. Outlines overall goals and objectives for UMR.

Stanley Consultants. 1979. Master plan for the Mark Twain National Wildlife Refuge, Volumes I and II. U.S. Fish and Wildlife Service, Twin Cities, MN.

Plan provides a comprehensive long-range plan for management practices and facilities for the Mark Twain National Wildlife Refuge (Pools 16-26). It provides specific guidelines and recommendations for the enhancement of wildlife management and public use opportunities on the refuge. Objectives are addressed in terms of refuge outputs and conflict resolution.

U.S. Fish and Wildlife Service. 1986. Upper Mississippi River land use allocation plan, Pools 11-14. 9+pp. Winona, MN.

Report and maps represent priority resource management guidance for COE and FWS - owned lands in Pools 11-14. General objectives for wildlife management and natural areas are described.

U.S. Fish and Wildlife Service. 1983. Trempealeau National Wildlife Refuge master plan. Twin Cities, MN.

Plan outlines habitat objectives for the refuge and management strategies. It describes projects to accomplish objectives.

Bolton, Hannibal. 1982. Fishery management recommendations, Upper Mississippi River National Wildlife and Fish Refuge, LaCrosse County, Wisconsin. U.S. Fish and Wildlife Service, Winona, MN. 8+pp.

The report describes fishery management goals for Lake Onalaska, Pool 8. Specific objectives and management recommendations are included.

U.S. Army Corps of Engineers

U.S. Army Corps of Engineers. 1990. Upper Mississippi River system environmental management program, fifth annual addendum. North Central Division, Chicago, IL. 53+pp.

Report describes work underway to implement the Environmental Management Program including objectives of habitat rehabilitation and enhancement projects for UMR.

U.S. Army Corps of Engineers. 1988-1990. Upper Mississippi River system environmental management program definite project reports/environmental assessments for habitat rehabilitation and enhancement projects. St. Paul District, Rock Island District, St. Louis District.

HREP Detailed Project Reports describe fish and wildlife management objects for each project. Completed reports include:

Andalusia Refuge, IL	Guttenberg Ponds, IA
Bay Island, MO	Indian Slough, WI
Bertom/McCartney, WI	Island 42, MN
Big Timber, IA	Lake Onalaska, WI
Blackhawk Park, WI	Monkey Chute, MO
Brown's Lake, IA	Peoria Lake, IL
Clarksville, MO	Pharrs Island, MO
Dresser Island, MO	Pool 8 Islands, WI
Finger Lakes, MN	

Many other projects are in various stages of planning.

U.S. Army Corps of Engineers. 1988. Upper Mississippi River shoreline management plan. St. Paul District, MN. Various pagings.

The purpose of the Shoreline Management Plan is to permit and regulate private exclusive use, consisting primarily of docks and stairways, boathouses, and associated structures and activities, on lands and waters that are administered by the U.S. Army Corps of Engineers along the Mississippi River between Minneapolis, MN, and Guttenberg, IA. Provisions are included for protection of biologically valuable areas, specific natural areas, and other lands of aesthetic, environmental and fish and wildlife values. The only area specifically identified is a voluntary avoidance area for Lake Onalaska.

U.S. Army Corps of Engineers. 1983. Upper Mississippi River land use allocation plan, master plan for public use development and resource management, part I and Part II. St. Paul District, MN. 91pp.

The Land Use Allocation Plan is to provide balanced distribution of the Federal lands needed to preserve the natural riverine resources for wildlife production and management, to satisfy public recreational demands, and to insure continued river navigation. General objectives for wildlife management are described. Specific locations zoned as natural area or wildlife management are identified.

U.S. Army Corps of Engineers. 1989. Land Use Allocation Plan, Mississippi River, Pools 11-22, nine-foot channel navigation project. Rock Island District, IL. 11+pp.

The Land Use Allocation Plan allocates all public land (Pools 11-22) acquired for the 9-foot Channel Navigation project into six land-use categories. General wildlife management objectives are described. Specific areas are classified for fish and wildlife management, related recreational opportunities, and vegetation control involving intensive forest management (for purposes of improving wildlife habitat). Also, unique scientific, ecological, scenic resources or habitat of threatened or endangered species are classified as natural areas. All lands in the District are classified in the plan.

U.S. Army Corps of Engineers. 1989. Shoreline management plan, Mississippi River, nine-foot channel navigation project, Pools 11-22. Rock Island District, IL. 14+pp.

Plan furnishes guidance for the management, protection, and preservation of the Mississippi River's environment, Pools

11-22. ...The plan discusses the conditions and restrictions for private recreational structures and limited private uses. Provisions are included to designate areas to maintain or restore aesthetic, fish and wildlife, cultural, or other environmental values.

U.S. Army Corps of Engineers. 1990. Natural Resource Management, Operational Management Plan I, Update for FY91', Mississippi River. Rock Island District, IL. Various pagings.

The purpose of the Operational Management Plan is to update management prescriptions for natural resources. Goals and objectives for long-term management of Corps-owned lands are described. Specific goals and objectives for forestry management are identified. These include objectives to protect endangered species habitat, improve colonial nesting bird habitat, and to manage migratory bird nesting habitat. A five-year implementation plan is included.

U.S. Army Corps of Engineers - St. Louis District

[no information obtained]

Upper Mississippi River Basin Commission

Upper Mississippi River Basin Commission. 1982. Comprehensive Master Plan for the management of the Upper Mississippi River system. Minneapolis, MN. 193pp.

The Master Plan presents the results of Congressionally mandated studies and makes technical recommendations. It outlines general system environmental objectives.

Bather, Ringrose, Wolsfeld, Jarvis, Gardner, Inc. 1981. Technical report K, system objectives for comprehensive master plan for the management of the Upper Mississippi River system. UMRBC, Minneapolis, MN. 620pp.

Report reviews over 2000 documents to identify current and projected uses, needs, conflicts, and stated objectives related to UMRS. General objectives for resource protection and enhancement by pool are outlined. Primary input provided by Federal and State agencies. Few specific objectives or strategies are described.

U.S. Environmental Protection Agency

No published regional or UMR specific plans

National Park Service

Plan for Mississippi National River and Recreation Area (Pools 1-3) is under development.

National Park Service. 1990. Draft general management plan/environmental assessment for Effigy Mounds National Monument, Iowa. Omaha, NE.

The plan is to guide resource protection and visitor use of the Effigy Mounds National Monument for the next 10 to 45 years. It includes specific recommendations for the Sny Magill Unit, a backwater area of Pool 10.

APPENDIX C

Fish Consumption Advisories

for the Upper Mississippi River

Appendix C. Fish consumption advisories (based on organochlorine contamination) for people who eat sport fish from the Upper Mississippi River (October 1990).

Pool/Reach	Level I	Level II	Level III
1		MN-All species	
2		MN-All species	
3	WI-Drum, Walleye, Sauger, Channel cat (to 16"), Flathead cat (to 30"), White bass, (to 13"), Buffalo (to 18"), Carp (to 21")	MN-All species WI-Channel cat (16-23")	WI-White bass (>13"), Channel cat (>23"), Carp (>21"), Buffalo (>18"), Flathead cat (>30")
4	WI-Drum, Walleye, Channel cat (to 21"), Flathead cat (to 30"), White bass (to 13"), Buffalo (to 20"), Carp (to 21"), Sauger	MN-All species WI-Channel cat (21-23")	WI-White bass (>13"), Channel cat (>23"), Carp (>21"), Buffalo (>20"), Flathead cat (>30")
5	WI-Flathead cat, carp (to 24"), Channel cat (to 21"), White bass, Drum, Walleye, Sauger, Buffalo	MN-All species WI-Carp (>24"), Channel cat (21-25")	WI-Channel cat (>25")
5a	WI-Flathead cat, carp (to 24"), Channel cat (to 21"), White bass, Drum, Walleye, Sauger, Buffalo,	MN-All species WI-Carp (>24"), Channel cat (21-25")	WI-Channel cat (>25")
6	WI-Flathead cat, carp (to 24"), Channel cat (to 21"), White bass, Drum, Walleye, Sauger, Buffalo	MN-All species WI-Carp (>24"), Channel cat (21-25")	WI-Channel cat (>25")
7	WI-Crappie, Buffalo, Drum, Flathead cat, Carp, Channel cat (to 24"), Walleye, White bass	MN-All species, WI-Channel cat (>24")	
8	WI-Crappie, Buffalo, Flathead cat, Carp, Channel cat (to 24"), Walleye, White bass, Drum	MN-All species WI-Channel cat (>24")	

Table 2. Continued.

Pool/Reach	Level I	Level II	Level III
9	WI-Crappie, Buffalo, Flathead cat, Carp, Channel cat (to 24"), Walleye, White bass, Drum	MN-All species WI-Channel cat (>24")	
10			
11			
12			
13			
14			
15			IA-Carp, Carpsuckers
16			
17			
18			
19			
20	MO-none	IL-Carp, Channel cat	MO-Carp, Channel cat
21		MO-Carp, Channel cat	
22		MO-Carp, Channel cat	
24		IL, MO-Carp, Channel cat	
25		MO-Carp, Channel cat	
26		IL, MO-Carp, Channel cat	IL, MO-Shovelnose sturgeon and eggs (from confluence of Illinois)

Table 2. Continued.

Pool/Reach	Level I	Level II	Level III
27		MO-Carp, Channel cat	IL, MO-Shovelnose sturgeon and eggs
A (RM 170-190, St. Louis Harbor)			MO-Carp, Channel cat: IL, MO-Shovelnose sturgeon and eggs
B (RM 125-170)		IL (0-132)-Carp, Channel cat	MO-Carp, Channel cat; IL, MO-Shovelnose sturgeon and eggs
C (RM 75-125)		IL (0-132) & MO (RM 0-110)-Carp, Channel cat	MO (to RM 110)-Carp, Channel cat; IL, MO-Shovelnose sturgeon and eggs
D (RM 30-75, LTRM Station)		IL, MO Carp, Channel cat	IL, MO-Shovelnose sturgeon and eggs
(RM 0-30)		IL, MO Carp, Channel cat	IL, MO-Shovelnose sturgeon and eggs

A-96

I - Fish safe to eat, lowest level of contaminants — IL, MO, WI

II - Limit consumption of fish, moderate level of contaminants (see State notices for specific consumption advisories) — IL, MN, MO, WI

III - Do not eat specified fish, highest level of contaminants — IA, IL, MO, WI

APPENDIX D

Federal and State Protected Species

in the Upper Mississippi River Floodplain Corridor

Appendix D. Documented occurrences since 1940 of Federal and State protected species in the Upper Mississippi River floodplain corridor as recorded in state data bases (September 1990).[1]

Common Name / Scientific Name	Status						Pool																																
	FED	MN	WI	IA	IL	MO	1	2	3	4	5	5a	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	24	25	26	27	A	B	C	D	I
MAMMALS																																							
Badger *Taxidea taxus*			SC		W																		16																
Bobcat *Lynx rufus*			SC		T															13																			
Long-tailed Weasel *Mustela frenata*						R																								24	25								
Plains pocket mouse *Perognathus flavescens*				E		R																	16																
Prairie vole *Microtus ochrogaster*		SC												7*																									
River Otter *Lutra canadensis*				T	E	WL											10		12	13*	14					19		21		24*									
Western Harvest Mouse *Reithrodontomys megalotis*		R												7																									
White-tailed Jackrabbit *Lepus townsendii*			R		E	EX														13										24									
BIRDS																																							
American Bittern *Botaurus lentiginosus*		SC			E	E																								24									
Bald Eagle *Haliaectus leucocephalus*	E/T[2]	T	T	E	E	E		2		4*	5*	5a	6	7	8	9	10		12	13*	14*	15*	16*	17*	18*	19*	20*	21		24	25	26	27		B		D	
Bell's Vireo *Vireo belli*		R	T			EX								7																									
Black-crowned Night Heron *Nycticorax nycticorax*			R		E	R																													B			
Brown Creeper *Certhia americana*					T	SU																						21										

Appendix D continued.

Common Name / Scientific Name	Status						Pool																															
	FED	MN	WI	IA	IL	MO	1	2	3	4	5	5a	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	24	25	26	27	A	B	C	D	E
Common Moorhen Galinula chloropus		SC	SC		T	R					5																			24								
Cooper's Hawk Accipiter cooperii			SC	E	E	R										9		11*																				
Cerulean Warbler Dendroica cerulea			T			SU											10	11																				
Double-crested cormorant Phalacrocorax auritus			SC	E	E															13																		
Forster's Tern Sterna forsteri		SC	E	SC	E						5				8	9																						
Great Blue Heron Ardea herodias			SC	R												9		11	12	13	14		16			19												
Great Egret Casmeroides albus			T	R	E	R					5*	5a				9	10	11	12				16	17	18	19		22	24	25	26		B				
Interior Least Tern **Sterna antillarum antillarum**	E			E	E	E																													D	E
Kentucky Warbler Oporornis formosus			T															11*																			
King Rail Rallus elegans		SC	R	E		E										9													24								
Least Bittern Ixobrychus exilis						WL																							24								
Little Blue Heron Egretta caerulea					E	R																							24								
Mississippi Kite Ictina mississippiensis					E	R																					21		24					C	D	E
Osprey Pandion haliaetus		SC	T		E	EX																					21										
Peregrine falcon **Falco peregrinus**	E	E	E	E	E	EX				4*	5	5a*	6	7*	8*	9*	10																				
Red-shouldered hawk Buteo lineatus		SC	T	E	E	WL			3	4	5*						9	10	11*		13	14			17*												

Appendix D continued.

Common Name / Scientific Name	Status FED	MN	WI	IA	IL	MO	Pool 1	2	3	4	5	5a	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	24	25	26	27	A	B	C	D	E
Sedge Wren Cistothorus platensis						W																								24								
Yellow-crowned Night Heron Nyctanassa violacea			T	R												9									18													
AMPHIBIANS AND REPTILES																																						
Black Rat Snake Elaphe obsoleta			R												8		10*																					
Blandings Turtle Emydoidea blandingii		T	T	R		E				4	5		6										16			19	20											
Bullfrog Rana catesbeiana		SC	SC											7	8																							
Coachwhip Masticophis flagellum					T																													B			
Crawfish Frog Rana areolata var. (circulsa)				E		E																				19											
Diamondback Water Snake Nerodia rhombifera				T																				17		19											
Eastern Hognose Snake Heterodon platyrhinos		SC									5																										
False Map Turtle Graptemys pseudogeographica		R								4																											
Fox (Western) Snake Elaphe vulpina vulpina		SC				E		2			5			7*																							
Gopher (bull) snake Pituophis melanoleucus		SC	SC					2						7																							
Illinois Mud Turtle Kinosternon flavescen spooneri	38			E	E	E																		17	18	19											
Massasauga Sistrurus catenatus	2	SC	E	E		E				4						9					14																	

Appendix D continued.

Common Name / Scientific Name	Status					Pool																																	
	FED	MN	WI	IA	IL	MO	1	2	3	4	5	5a	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	24	25	26	27	A	B	C	D	E
Milk Snake *Lampropeltis triangulum*		SC								4																													
Mudpuppy *Necturus maculosus*				E												9*																						
Northern Cricket Frog *Acris crepitans*		SC												7																								
Ornate Box Turtle *Terrapene ornata*			E	T																				17														
Pickerel frog *Rana palustris*		SC	SC												8																								
Racer *Coluber constrictor*		SC						2							8																								
Six-lined Racerunner *Cnemidophorus sexlineatus*		R													8*																							
Slider *Pseudemys scripta*				R																				17	18	19												
Smallmouth salamander *Ambystoma texanum*				R																				17														
Stinkpot *Sternotherus odoratus*				T													10*																					
Strecker's (Illinois) Chorus Frog *Pseudacris streckeri (illinoensis)*	2				T	R																													B			
Timber rattlesnake *Crotalus horridus*		SC	SU												8																								
Western Hognose Snake *Heterodon nasicus*		SC		E	T						5													17														
Wood Turtle *Clemmys insculpta*		T	T	E						4*					8*	9																							
Yellowbellied Water Snake *Nerodia erythrogaster*				E																				17														

Appendix D continued.

Common Name / Scientific Name	Status						Pool																															
	FED	MN	WI	IA	IL	MO	1	2	3	4	5	5a	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	24	25	26	27	A	B	C	D	E
FISH																																						
Alabama Shad Alosa alabamae						R																				20									C		
Alligator Gar Lepisosteus spatula					T	R																									26				C	D	F
American eel Anguilla nostrata			R						3	4*	5*	5a		7*	8*	9*	10*	11																			
Bantam Sunfish Lepomis symmetricus					T	R																														D	
Bigeye shiner Notropis boops					T																														C		
Black Buffalo Ictiobus niger			T							4*	5*		6*			9*	10*	11																			
Blue Catfish Ictalurus furcatus		SC								4																												
Blue Sucker **Cycelptus elongatus**	2	SC	T	R		WL	1	2	3	4*	5	5a	6*	7*	8*	9*	10*	11			14	15	16															
Bluntnose Darter Etheostoma chlorosmum		R	E	E												9*	10	11																			
Brown Bullhead Ictalurus nebulosis						R																									26					D	
Central Mudminnow Umbra limi				R		E										9									18												
Crystal Darter Ammocrypta asprella	2	SC	E			E				4*	5	5a	6*					11																				
Flier Centrarchus macropterus						WL																																
Ghost Shiner Notropis buchanni			EX	R		WL								7*		9*	10*	11																			
Goldeye Hiodon alosoides			E						3	4*	5	5a	6*		8	9	10*	11																			

Appendix D continued.

Common Name / Scientific Name	Status FED	MN	WI	IA	IL	MO	Pool 1	2	3	4	5	5a	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	24	25	26	27	A	B	C	D	E
Grass Pickerel *Esox americanus*				T																					18													
Lake Sturgeon *Acipenser fulvescens*	2	SC	R	E	T	E	1	2	3	4*	5	5a	6*	7	8*	9*	10*	11	12*	13*	14*		16*		18*	19	20	21		24*	25*							
Longear Sunfish *Lepomis megalotis*			T												8*	9																					
Mud Darter *Etheostoma asprigene*			R	R						4*	5		6*	7*	8*	9	10*	11*			14																	
Orangethroat Darter *Etheostoma spectabile*				T																					18												
Paddlefish *Polyodon spathula*	3C[3]	SC	T			WL	1	2	3	4*	5	5a	6	7	8	9*	10	11																			
Pallid Sturgeon *Scaphirhynchus albus*	E			E		E																										27			C		
Pallid Shiner (Chub) *Notropis (Hybopsis) amnis*		SC	E	R	E	EX			3	4*	5	5a		7*	8*	9*	10*	11*	12		14							21									
Pirate perch *Aphredoderus sayanus*			R	SC						4			6*	7*	8	9*	10	11								19											
Pugnose Minnow *Notropis emiliae*		SC	R	SC		WL				4*	5	5a	6*	7*	8*	9*	10*	11*					16	17								26						
River Redhorse *Moxostoma carinatum*		R	T		T				3		5	5a		7*	8			11																			
Shovelnose Sturgeon *Scaphirhynchus platorynchus*		SC					1	2	3	4	5	5a	6	7	8	9																					
Sicklefin Chub *Hybopsis meeki*	2					R																										27		B		D	E
Silver Jaw Minnow *Ericymba buccata*						WL																														D	
Skipjack Herring *Alosa chrysochloris*		EX	E							4*	5					9	10																				
Speckled Chub *Hybopsis aestivalis*			T							4*	5		6*		8	9*	10*	11																			

Appendix D continued.

Common Name Scientific Name	Status						Pool																																			
	FED	MN	WI	IA	IL	MO	1	2	3	4	5	5a	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	24	25	26	27	A	B	C	D	E					
Spotted sucker *Minytrema melanops*				R													10															.										
Starhead Topminnow *Fundulus dispar*						WL																										26										
Sturgeon Chub *Hybopsis gelida*	2					R																											27			C	D	E				
Trout-perch *Percopsis omiscomaycus*				R		R											10																									
Weed Shiner *Notropis texanus*			SC	E												9	10																									
Western Sand Darter *Ammocrypta clara*			R	T	E	WL				4*	5	5a	6*	7*	8*	9*	10*	11*		13					18			21*	22	24*	25*	26			B	C						
Yellow Bass *Morone mississippiersis*		SC								4																															
Mussels																																									
Black sandshell *Ligumia recta*		R								4			6	7*	8*																										
Butterfly *Ellipsaria lineolata*		R	E	T	W							5a*	6	7*			10	11				15																				
Ebonyshell *Fusconaia ebena*		SC	E			E											10	11*							•																
Elephant Ear *Elliptio crassidens (crassidens)*		SC	E		T	E											10																								
Fat Pocketbook *Potamilus capax*	E	E	EX		E	E																					20		22*	24											
Hickory Nut *Obovaria olivaria*						WL																								24	25										
Higgins' Eye Pearly Mussel *Lampsilis higginsi*	E	E	E	E	E	E			3					7	8	9*	10*	11*	12*		14	15*	16	17	18	19	20		22	24											
Monkeyface *Quadrula metanerva*		R	T							4			6	7	8*	9*	10	11																							

Appendix D continued.

Common Name / Scientific Name	Status FED	MN	WI	IA	IL	MO	Pool 1	2	3	4	5	5a	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	24	25	26	27	A	B	C	D	E
Mucket Actinonaias ligamentina		R							3*	4																												
Ohio Pigtoe Pleurobema cordlatum		R								4	5																											
Purple Wartyback Cyclonaias tuberculata		R	E							4							10																					
Rock Pocketbook Arcidens confragosus		R	T			R					5				8*	9	10*													24							
Round Pigtoe Pleurobema sintoxia			R														10																				
Salamander mussel **Simpsonaias ambigua**	**2**		**T**		**E**	**E**											**10**	**11**																			
Sheepnose Plethobasus cyphyus			E		T	R																15															
Spectaclecase **Cumberlandia monodonta**	**2**		**E**	**E**	**E**	**WL**											**10**					**15**	**16**	**17**		**19**	**20**				**25***	**26**					
Wartyback Quadrula nodulata			T		-	R									8*	9*	10	11*													25						
Yellow Sandshell Lampsilis teres (anodontoides)		R	E	E						4																											
Other Invertebrates					-																																
Crayfish Orconectes placidus					E																														C		
Ottoe Skipper Hesperia ottoe		T	R		T	R					5		7																								
PLANTS																																					
Amethyst (Jewelled) Shooting Star Dodecatheon amethystinum		R		T		R								7															22								
Arrow Arum Peltranda virginica			SC	E		R																			18												

Appendix D continued.

Common Name / Scientific Name	Status						Pool																																
	FED	MN	WI	IA	IL	MO	1	2	3	4	5	5a	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	24	25	26	27	A	B	C	D	E
Beech Drops Epifagus virginiana						R																														D	
Black snakeroot Sanicula trifoliata		SC												7																							
Blue Sage Salvia azurea subsp. pitcheri					T															13																	
Buttonbush Cephalanthus occidentalis		SC									5			7	8																						
Catchfly grass Leersia Lenticularis		SC												7																							
Cattail sedge Carex typhina		R													8																						
Cliff goldenrod Solidago sciophila		SC	R											7																							
Decurrent False Aster (Starwort) Boltonia decurrens	E				T	E																										26*					
Dwarf Dandelion Krigia virginica				E																				17	18												
Fameflower Talinum calycinum					E															13																	
Fragile (Brittle) Prickly Pear Opuntia fragilis			T	T	E															13												26					
Goat's Rue Tephrosia virginiana		SC												7																							
Goldie's Fern Dryopteris goldiana		SC				R								7																					C		
Gray's Sedge Carex grayii		R									5				8																						
Green Dragon Arisaema dracontium		R								4	5			7	8																						
Heart-leaved Plantain Plantago cordata	3C		E		E	WL																												B			

Appendix D continued.

Common Name / Scientific Name	Status FED	MN	WI	IA	IL	MO	Pool 1	2	3	4	5	5a	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	24	25	26	27	A	B	C	D	E
Illinois tick-trefoil *Desmodium illinoense*		T						2																														
James' Cristatella *Polanisia jamesii*		E		E	E															13																		
Little-leaved Alum Root *Huechera parviflora* var. *rugelii*						E																													C		
Longbearded hawkweed *Hieracium longipilum*		R						2			5																										
Louisiana Broom-rape *Orobanche ludoviciana*		SC	R		E	E		2																													
Midland Quillwort *Isoetes melanopoda*		E		E																	14																
Mild Water Pepper *Polygonum hydropiperoides*		R												7																							
Montia *Chamissoi*		E												7																							
Muskingum sedge *Carex muskingumensis*		R								4				7	8																						
Ohio spiderwort *Tradescantia ohiensis*		SC												7																							
Old Field Toadflax *Linaria canadensis*		R									5																										
Ovate-leaved Skullcap *Scutellaria ovata* var. *versicolor*		SC												7																							
Primrose Willow *Ludwigia leptocarpa*						E																														D	
Purple Cliff brake *Pellaea atropurpurea*		T	SC												8																						
Purple sandgrass *Triplasis purpurea*		SC						2		4	5			7	8																						
Quaking Aspen *Populus tremuloides* var. *tremuloides*						R																					20										

Appendix D continued.

Common Name Scientific Name	Status FED	MN	WI	IA	IL	MO	Pool 1	2	3	4	5	5a	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	24	25	26	27	A	B	C	D	E
Red-berried Elder *Sambucus pubens*					T	E																							22									
Redroot *Ceanothus ovatus*					E														13																			
Riverine Clubtail *Stylurus amnicola*			SC							4						9*	10																					
Rock Clubmoss *Lycopodium ponophilium*		T		E		R								7																								
Rose Turtlehead *Chelone obliqua* var. *speciosa*	3C					E																									25	26						
Rough-seeded (Prairie) Fame Flower *Talinum rugospermum*	2	E	SC	E							5																											
Salt Meadow Grass *Leptochloa panicoides*					E	SU																								25*	26							
SandHeather *Hudsonia tomentosa*				E	E															13																		
Schweinitz's Sedge *Carex schweinitzii*						EX																											27*					
Sea-beach needlegrass *Aristida tuberculosa*		SC						2			5																											
Sedge *Carex grayii* var. *hispidula*		R								4																												
Silverleaf (Summer) Grape *Vitis aestivalis* var. *argentinfolia*		R		SC						4				7																								
Slender Cottonweed *Froelichia gracilis*				R																				17		19												
Small Morning Glory *Ipomoea lacunosa*				R																					18	19												
Snowy campion *Silene nivea*		R	R										6*	7																								
Squirrel Corn *Dicentra canadensis*		SC								4				7																								

Appendix D continued.

Common Name / Scientific Name	Status FED	MN	WI	IA	IL	MO	Pool 1	2	3	4	5	5a	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	24	25	26	27	A	B	C	D	i
Sweet-smelling Indian-plantain *Cacalia suaveolens*		E		T										7																							
Tall Corydalis *Corydalis curvisiliqua*				T																				17								26					
Texas Bergia *Bergia texana*						E																															
Umbrella Sedge *Cyperus grayioides*	2				T	E														13																	
Vallerian *Valeriana edulis* ssp. *ciliata*		T		SC										7																						D	
Virginia Pennywort *Obolaria virginica*						R																															
Virginia water horehound *Lycopus virginicus*		R												7																							
Walter's Barnyard Grass *Echinochloa walteri*		SC						2	3																												
Water Starwort *Callitriche heterophylla*		R	R	T												9																					
Weak Nettle *Urtica chamaedryoides*					E	E																													C		
White baneberry *Actea pachypoda*		R												7																							
Wild Indigo *Baptisia bracteata* var. *glabrescens*		SC										5		7															22								
Wild Sarsparilla *Aralia nudicaulis*						R																															
Winterberry *Ilex verticillata* (var. *padifolia*)				E		R										9																					
Witch-hazel *Hamamelis virgininiana*		SC												7																							
Yellowish Gentian *Gentiana alba*			T														10																				

Appendix D continued.

Common Name / Scientific Name	Status						Pool																										
	FED	MN	WI	IA	IL	MO	1	2	3	4	5	5a	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	24	25	26	27	A	B	C	D	E
Yerba de tajo *Eclipta alba*				SC														11																			

LEGEND

REACH:

A - River mile 170 - 190 (St. Louis Harbor area)
B - River mile 125 - 170
C - River mile 75 - 125
D - River mile 30 - 75 (LTRM Station)
E - River mile 0 - 30

STATUS:

1 - Federal candidate species, proposed rule anticipated
2 - Federal candidate species, additional information required
3A - Persuasive evidence of extinction
3B - Do not represent distinct taxa for possible listing
3C - Proven more abundant or widespread than previously believed

E - Endangered
EX - Extripated from State
PE - Proposed endangered
R - Rare (Wisconsin S1, S2, or S3 rank, but not given protected status at this time)
SC - Special concern
SU - Status undetermined
T - Threatened
WL - Watch for possible listing

* - Documented within 2000 feet of lock and dam (upstream and/or downstream)

[1]Species may occur in additional pools or reaches, but do not have any protected status in those areas. Also, documented occurences based on an incomplete data base. No comprehensive surveys have been conducted in study area.

[2]Proposed to be downlisted to threatened throughout its range.

[3]Proposed to be listed. Currently under review.

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MISSISSIPPI

ECONOMIC ANALYSIS

APPENDIX B

RECONNAISSANCE REPORT
FOR
UPPER MISSISSIPPI RIVER NAVIGATION STUDY

APPENDIX B
ECONOMIC ANALYSIS

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RECONNAISSANCE REPORT
FOR
UPPER MISSISSIPPI RIVER NAVIGATION STUDY

APPENDIX B
ECONOMIC ANALYSIS

SECTION 1 - SYSTEM DESCRIPTION

The Upper Mississippi River System contains over 700 miles of navigable channels extending from north of Minneapolis, Minnesota, to the confluence with the Missouri River north of St. Louis, Missouri. Navigable channels are also maintained in the Minnesota River and the St. Croix River, Minnesota. The physical features of the rivers vary considerably throughout the system.

The Upper Mississippi River enjoys a very long history of navigation improvements dating back to 1867 with the opening of the Des Moines Canal. The improvement of the navigation system continues to this day with the ongoing construction of the auxiliary chamber at the new Melvin Price Locks and Dams near Alton, Illinois, on the Mississippi River.

The system provides reliable navigation with a series of 36 locks and 29 dams maintaining a usable channel depth of 9 feet. Physical characteristics and locations of the locks are summarized in table B-1. River mile 0.0 is the confluence of the Ohio and Mississippi Rivers.

Commodities transiting the Upper Mississippi River reflect the region's agriculturally dominated economy. More than 280 permanent terminal facilities on the Upper Mississippi River load and unload the wide variety of products transported on the system.

Modern towboats moving commodities on the Upper Mississippi River may exceed 5,000 horsepower and push a typical tow made up of 10 to 17 barges. The four primary types of barges used are open hopper, covered hopper, deck, and tank. Open hopper barges are used for all types of bulk solid cargo (primarily coal) and account for about 45 percent of the carrying capacity of all barges operating on the inland waterways. Covered hopper barges, carrying mainly grain and fertilizer, account for about 25 percent of the total tonnage capacity. Tank barges, for petroleum and chemicals, and deck barges make up about 22 and 8 percent, respectively.

TABLE B-1

Physical Characteristics of Locks
Upper Mississippi River System

Lock	River Mile	Year Opened	Width (Feet)	Length (Feet)	Lift (Feet)
Upper St. Anthony Falls	853.9	1963	56	400	49
Lower St. Anthony Falls	853.3	1959	56	400	25
No. 1 Main Chamber	847.6	1930	56	400	38
No. 1 Auxiliary Chamber	847.6	1932	56	400	38
No. 2 Main Chamber	815.0	1930	110	600	12
No. 2 Auxiliary Chamber	815.0	1948	110	600	12
No. 3	769.9	1938	110	600	8
No. 4	752.8	1935	110	600	7
No. 5	738.1	1935	110	600	9
No. 5a	728.5	1936	110	600	5
No. 6	714.0	1936	110	600	6
No. 7	702.0	1937	110	600	8
No. 8	679.0	1937	110	600	11
No. 9	647.0	1938	110	600	9
No. 10	615.0	1936	110	600	8
No. 11	583.0	1937	110	600	11
No. 12	556.0	1938	110	600	9
No. 13	522.0	1938	110	600	11
No. 14 Main Chamber	493.9	1922	110	600	11
No. 14 Auxiliary Chamber	493.3	1939	80	320	11
No. 15 Main Chamber	482.9	1934	110	600	16
No. 15 Auxiliary Chamber	482.9	1934	110	360	16
No. 16	457.2	1937	110	600	9
No. 17	437.1	1939	110	600	8
No. 18	410.5	1937	110	600	10
No. 19	364.2	1957	110	1,200	38
No. 20	343.2	1936	110	600	10
No. 21	324.9	1938	110	600	10
No. 22	301.2	1938	110	600	10
No. 24	273.4	1940	110	600	15
No. 25	241.4	1939	110	600	15
Melvin Price Main Chamber	200.8	1989	110	1,200	24
Melvin Price Aux. Chamber	200.8	1992	110	600	24

Waterborne commerce on the Upper Mississippi River System has exhibited steady growth since the completion of the navigation system. Table B-2 below displays the volume of total system traffic for selected years. Since 1965, system tonnage has increased at an average annual rate of 3.7 percent.

TABLE B-2

Upper Mississippi River System
Annual Commodity Tonnages
(millions)

Year	Tonnage
1965	37.8
1970	54.0
1975	63.1
1980	76.3
1985	72.0
1986	73.7
1987	81.6
1988	82.0
1989 (estimate)	85.0
1990 (estimate)	90.8

The Waterborne Commerce Statistics Center reports that total system waterborne traffic amounted to over 82.0 million tons for calendar year 1988 (the most recent year where detailed statistics are available). Approximately 90 percent of this tonnage is composed of four primary groups of commodities. Movements of farm products (grain) in 1988 amounted to 37.7 million tons, comprising 46 percent of the total system traffic in that year. Coal movements accounted for 14.0 million tons in 1988, or approximately 17 percent of the total volume of traffic. Movements of non-metallic minerals amounted to 11.8 million tons (14 percent) in 1988. Finally, movements of crude petroleum and petroleum products totaled 8.9 million tons (11 percent) in 1988.

The *1988 Inland Waterway Review*, published by the Water Resources Support Center, Institute for Water Resources, U.S. Army Corps of Engineers, IWR Report 88-R-7, November 1988, projects tonnage transported on the Upper Mississippi River to increase at an average annual rate between 1.5 and 2.7 percent through the year 2000. Farm products are the largest factor affecting future traffic projections. By the year 2000, movements of farm products on the Upper Mississippi River are forecast to range between 47.5 and 55.8 million tons. Traffic of coal and petroleum products is projected to experience slow, steady growth, while the movement of non-metallic minerals is projected to remain static. Figure B-1 shows historic tonnage for the locks in the Upper Mississippi River System.

As traffic in the system continues to increase through time, levels of congestion in the system also will increase. The increased levels of congestion will be evidenced primarily by greater delays at system locks, increasing transit times and decreasing systemic efficiency. Table B-3 below displays average processing delays at system locks as reported by the Performance Monitoring System (PMS) for 1989.

FIGURE B-1

TRAFFIC BY PROJECT
(MILLION TONS)

MISSISSIPPI RIVER LOCKS AND DAMS

PROJECT	1950	1960	1970	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
UPPER ST. ANTHONY	*	*	*	1.56	0.90	0.71	1.15	1.15	1.12	1.00	0.77	0.71	
LOWER ST. ANTHONY	*	*	*	2.12	1.36	1.34	1.84	1.85	1.68	1.77	1.35	1.22	
LOCK AND DAM #01	*	*	*	2.18	1.44	1.41	1.94	1.83	1.68	1.70	1.35	1.28	
LOCK AND DAM #02	*	*	*	13.60	14.27	13.07	17.09	15.06	13.03	11.41	10.44	11.64	
LOCK AND DAM #03	*	*	*	12.46	13.15	12.09	15.92	14.25	11.67	11.07	10.47	11.60	
LOCK AND DAM #04	*	*	*	13.18	13.96	12.76	16.57	14.83	12.07	11.63	10.99	12.05	
LOCK AND DAM #05	*	*	*	13.19	14.07	12.45	16.64	14.90	11.95	11.76	11.07	12.07	
LOCK AND DAM #5A	*	*	*	13.19	14.08	12.75	16.65	14.89	11.96	11.80	11.20	12.11	
LOCK AND DAM #06	*	*	*	14.81	15.26	13.20	18.09	16.11	12.82	12.76	12.58	13.86	
LOCK AND DAM #07	*	*	*	14.68	15.34	13.47	18.11	16.15	12.81	12.76	12.56	13.82	
LOCK AND DAM #08	*	*	*	15.08	15.75	12.35	18.72	16.82	13.16	13.34	13.09	14.30	
LOCK AND DAM #09	*	*	*	15.95	16.68	14.33	19.48	17.76	13.88	14.42	13.99	15.36	
LOCK AND DAM #10	*	*	*	17.92	18.69	15.79	21.66	19.89	14.46	15.32	15.48	17.52	
LOCK AND DAM #11	3.00	6.99	13.61	18.16	18.89	16.64	22.06	19.56	14.72	15.83	15.81	17.67	
LOCK AND DAM #12	3.21	7.42	14.08	19.29	20.39	18.06	24.39	21.57	16.05	15.53	19.31	20.83	
LOCK AND DAM #13	3.22	7.42	14.09	19.23	20.42	18.08	24.43	21.63	16.05	15.58	19.44	20.98	
LOCK AND DAM #14	3.48	7.89	15.78	21.96	23.82	21.73	28.72	25.19	19.05	18.98	24.51	26.68	
LOCK AND DAM #15	3.90	8.41	16.65	22.67	24.66	22.38	29.27	25.68	19.34	19.56	25.18	27.22	
LOCK AND DAM #16	4.00	8.67	17.55	24.82	27.12	24.69	31.73	28.24	20.71	21.38	27.21	29.27	
LOCK AND DAM #17	4.05	8.69	18.48	26.38	28.37	26.18	33.48	29.38	21.81	22.60	29.23	31.45	
LOCK AND DAM #18	4.07	8.79	18.70	26.56	29.27	27.09	34.16	30.10	22.29	23.11	29.84	32.23	
LOCK AND DAM #19	4.12	8.88	20.03	29.01	30.94	27.88	34.63	32.30	23.24	24.29	31.22	33.90	
LOCK AND DAM #20	4.26	9.27	20.36	29.75	31.57	28.69	35.80	32.96	23.66	24.86	31.95	34.89	
LOCK AND DAM #21	4.32	9.48	20.88	30.93	32.39	29.63	35.81	33.98	24.42	26.04	33.38	36.14	
LOCK AND DAM #22	4.49	9.54	21.26	31.45	32.72	30.24	36.35	34.60	25.07	26.87	34.21	36.78	
LOCK AND DAM #24	4.31	9.71	22.21	32.75	33.91	32.76	37.35	35.96	26.18	28.16	35.31	37.89	
LOCK AND DAM #25	4.32	9.69	22.18	32.74	34.23	32.77	37.44	36.17	26.11	28.16	35.32	37.88	
LOCK AND DAM #26	8.28	23.51	48.67	69.43	70.34	62.53	73.65	70.66	56.95	61.64	69.38	71.38	

TABLE B-3

1989 Upper Mississippi River System
Lock Tonnages and Average Delays

Lock	Tonnage (millions)	Delay (minutes)
Upper St. Anthony Falls	0.7	2
Lower St. Anthony Falls	1.2	4
No. 1 Main Chamber	1.2	1
No. 2 Main Chamber	11.5	25
No. 3	11.5	21
No. 4	12.0	14
No. 5	12.2	17
No. 5a	12.2	14
No. 6	14.1	17
No. 7	14.1	20
No. 8	14.7	24
No. 9	15.6	21
No. 10	17.9	16
No. 11	17.4	25
No. 12	21.1	36
No. 13	21.5	30
No. 14 Main Chamber	26.8	76
No. 14 Auxiliary Chamber	0.0	0
No. 15 Main Chamber	26.6	121
No. 15 Auxiliary Chamber	0.3	1
No. 16	28.8	71
No. 17	30.9	126
No. 18	31.4	72
No. 19	32.9	35
No. 20	33.5	142
No. 21	34.4	141
No. 22	34.9	297
No. 24	36.1	227
No. 25	36.2	173
No. 26 Main Chamber	55.5	1,827
No. 26 Auxiliary Chamber	12.9	697

In addition to being an important segment of the Nation's inland navigation system, the Upper Mississippi River is a major, nationally significant recreational resource. Numerous recreational areas are administered by all levels of government and private organizations which provide for virtually all forms of outdoor recreation common to the Upper Midwest region. The GREAT studies of the 1970's documented and projected the recreational use of the river. This study will focus on recreation navigation. However, all alternatives will be evaluated for their effects on the recreational opportunity spectrum.

Recreational boaters have been discovering, or rediscovering, the Upper Mississippi River over the past decade. This has been particularly true in the St. Paul District (Minneapolis, Minnesota, to Guttenburg, Iowa). During the late 1970's, much attention was given to crowded recreational boating conditions on the Lower St. Croix River as a result of the rapid growth in use. In the 1980's, the St. Paul District began to hear the same concerns from the boating public on the Mississippi River; the river was becoming crowded.

While the increased use of the river has the potential to cause congestion-related problems throughout the system, the problems are most acute at the locks and dams. The locks are the major congestion points along the system as both commercial and recreational craft arrive and wait their turn to lock through. The major cause of delays at the locks is the time that it takes to accomplish a single lockage.

Factors compounding the problem include the double lockages required to move a "full-sized" tow through (in effect, up to three cycles) and the randomness by which vessels arrive at the lock. Another factor with recreational craft is the handling lines used and the time that it takes to raft similar-sized boats together for the lockage. There may be 40 to 70 craft in one lockage.

Comparing 1979 and 1989 (figure B-2), the number of recreational craft using the locks increased approximately 75 percent for the entire Upper Mississippi River. Recreational craft using the locks in the St. Paul District, which is approximately 71 percent of the total recreation craft use of the Upper Mississippi River locks, increased about 92 percent. Lock and Dam 3 has the most recreational traffic, with an annual average increase of 23 percent per year for the last 3 years. This represents almost a 100 percent increase from 1987 to 1989. Heavy use also exists at Lock and Dam 7 at La Crosse, and at Lock and Dam 14 at the Quad Cities. Interestingly, recreation craft locked in the St. Louis District more than doubled between 1979 and 1989, with significant increases at Locks and Dams 26 and 27.

The recreational user group most dependent on the locks is the marina-based boat owners. The demand for larger, marina-based boats appears to be increasing significantly, resulting in a demand for and the development of marina facilities. Currently, there are proposals for expansion or new construction of 16 marinas, between St. Paul and Lake Pepin. Approximately 2,700 new slips are proposed, nearly doubling the current 3,000 slips. There are other marina expansion/construction proposals in the La Crosse upper Pool 8 area.

Boats may be moored in a different pool, where a lockage is required to reach the preferred use areas. For example, any boats moored at marinas in Pool 2 travel to the St. Croix River, through Lock and Dam 2. Lock and Dam 3 accommodates recreation traffic upbound toward the St. Croix and downbound to Lake Pepin.

Number of Recreational Craft Locked
1979-1989

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
USAF	1,884	1,847	2,073	3,368	3,523	2,408	2,657	2,833	4,322	4,182	5,932
LSAF	1,227	1,920	2,077	3,416	3,548	2,565	2,643	2,821	4,187	4,064	5,507
L/D 1	3,250	3,374	3,981	4,069	5,010	5,005	4,824	4,516	6,457	7,097	7,859
L/D 2	5,794	5,657	5,903	5,613	6,536	5,868	7,744	8,555	11,138	12,856	13,991
L/D 3	8,891	8,763	9,215	10,143	10,082	9,760	11,261	12,675	16,397	17,619	19,591
L/D 4	6,073	6,226	6,332	6,672	6,855	6,383	7,616	8,313	10,252	13,227	13,650
L/D 5	4,987	5,368	5,355	5,277	5,287	4,943	5,552	6,454	7,644	8,653	9,309
L/D 5A	4,286	7,032	6,822	7,059	7,032	6,616	7,796	9,046	10,268	11,704	11,916
L/D 6	5,190	5,482	5,298	5,336	6,013	5,407	6,079	8,231	8,991	10,427	10,948
L/D 7	7,699	8,779	8,174	8,297	9,261	9,025	9,470	11,466	12,755	13,681	13,712
L/D 8	4,192	3,799	3,701	2,356	3,776	3,692	4,408	5,353	6,287	7,285	7,876
L/D 9	4,678	4,333	4,108	3,777	3,930	2,659	4,696	5,174	5,876	7,394	7,536
L/D 10	6,712	6,813	6,583	5,000	4,587	4,228	5,280	4,935	5,619	6,497	6,946
L/D 11	5,089	3,772	3,727	3,561	3,414	3,522	4,116	4,252	4,918	6,304	7,552
L/D 12	3,260	2,902	3,583	3,134	3,117	2,791	3,682	3,875	4,096	5,009	5,154
L/D 13	4,828	2,697	3,559	3,427	3,176	3,602	4,102	4,318	4,639	5,492	5,464
L/D 14	4,866	4,784	7,638	8,231	7,332	8,472	9,519	7,978	7,822	9,285	9,040
L/D 15	5,788	5,703	6,217	5,366	5,456	5,894	6,345	6,247	7,206	6,612	7,804
L/D 16	1,346	1,161	1,264	1,119	959	1,177	1,733	1,699	1,676	1,760	1,936
L/D 17	907	920	797	913	544	641	1,170	999	1,172	1,390	1,373
L/D 18	1,645	1,255	1,524	1,082	1,121	1,271	1,832	1,890	1,698	2,251	2,255
L/D 19	839	771	886	730	813	862	1,173	1,012	1,075	1,303	1,498
L/D 20	782	742	720	710	718	760	995	921	658	946	1,200
L/D 21	996	872	876	708	860	805	1,239	1,047	1,059	1,265	1,508
L/D 22	647	895	980	1,049	1,085	1,161	1,386	1,058	1,277	1,280	1,334
L/D 24	982	1,039	923	885	803	922	1,251	1,192	1,407	1,492	1,591
L/D 25	1,912	1,578	448	1,385	1,535	1,628	2,365	2,384	2,555	2,947	3,072
L/D 26	499	449	678	708	629	897	1,826	1,833	1,813	1,947	2,276
L/D 27	640	564	861	944	875	713	1,189	1,480	1,597	1,790	1,870

FIGURE B-2

Distinct differences exist between recreational and commercial navigation. For a shipment of grain to move from St. Paul to New Orleans by water, there is only one starting point, one route, and one destination. Delays along that route are costly and are generally accepted by the operators as part of the cost of doing business.

For recreational users, there is more freedom in terms of marinas, launching areas, trip destinations, and routes. However, like the commercial operators, recreational boaters can experience costly delays in terms of recreation time and enjoyment. Nobody likes to be "stuck in traffic" when they could be picnicking or fishing. Unlike the commercial operator, the recreational boater may be able to choose to do something different if the delay is deemed too lengthy. However, given the investment that recreational boaters have made in equipment and mooring facilities, it is very likely that they will continue to demand access to the river and its resources.

Another difference between commercial and recreational traffic is that commercial operators work 24 hours a day, 7 days a week regardless of the weather. The resulting commercial use of the river is relatively constant, with some peaks and valleys related to cargo. Recreational use, on the other hand, is leisure travel, mostly evenings, weekends, and holidays, with virtually no recreational traffic between midnight and 6 a.m.

By law, commercial traffic has priority at the locks. However, to avoid undue delays, the procedure at many sites, with industry support, is to accomplish a recreation craft lockage after every commercial lockage, which could require up to 3 cycles. At Lock and Dam 3 during high use periods, a recreation lockage each way is accomplished after each commercial lockage. During these periods, commercial craft may be delayed up to an hour due to recreational lockages. While commercial craft have priority, most operators are willing to waive their priority in order to avoid undue delays to lock recreational craft and for safety of the recreational boaters.

As conflicts at the locks increase, delay times for recreational and commercial craft will get longer. Some believe that the increased waiting time will discourage recreation boaters from using the locks, making them more available for commercial craft. This may have happened to some extent in the lower portions of the river where commercial traffic is greater and recreation lockages have increased only slightly or have remained constant. Given the multiple use emphasis we find on the river today, we do not believe this will, or should, happen on the upper river. As delays resulting from greater recreational use increase, the cost of doing business will increase for the commercial user. It can be assumed that the current level of tolerance of congestion by the commercial operators also will decrease; their willingness to allow recreation lockages "out of turn" will decrease. The commercial operators will want to minimize their costs with the possible indirect result of a decrease in the quality of the recreational experience. Recreation users, however, will not likely accept increased delays without increased protests and congressional contacts.

With this increasing use, conflicts between users and resource uses are bound to occur. In the ideal world, there would be an infinite amount of water areas to satisfy all users, from wide open areas for the high speed cruisers, to quiet areas for fishing, from unlimited beaches for large gregarious groups, to backwaters for watching wildlife, and unlimited lockage capacity to allow all traffic to move freely throughout the system. Unfortunately, the river is a finite system and the locks have limited capacity. As learned on the St. Croix, as use increased, those users wanting less crowded conditions were displaced. Those seeking solitude began to use the Mississippi backwater areas. As use on the Mississippi increased, the backwater areas received greater use, resulting in conflicts between users, and conflicts over resource use. Resource managers responsible for wildlife resources are concerned that the increasing use of the backwaters is negatively affecting the habitat of those areas. Managers responsible for recreation are concerned about the loss of areas for quiet recreation. The result is that any solutions proposed to help alleviate crowded conditions on the river and to make the entire system more efficient must also examine the effects of those solutions on the entire river system, both man-made and natural.

SECTION 2 - SYSTEM ANALYSIS

INTRODUCTION

A systems approach is required to evaluate the National Economic Development (NED) benefits of potential navigation improvements to the Upper Mississippi River System. This analytical approach explicitly recognizes that individual locks are only components in a complete navigation system, and that alterations of the traffic processing characteristics of specific components will have impacts throughout the navigation system. The General Equilibrium Model described below is used to perform the systems analysis.

GENERAL EQUILIBRIUM MODEL RATIONALE AND METHODOLOGY

The General Equilibrium Model (GEM) is used to evaluate the existing conditions, the future without-project conditions, and the future conditions with alternative system configurations in effect. The GEM model is a tool used by the Corps of Engineers for the economic evaluation of potential changes to various components of a navigation system. The model estimates the total transportation costs including congestion costs incurred by individual movements desirous of using all or portions of a navigation system. System transport costs for these individual movements are then compared to the total transport costs of that movement via the least-cost alternative mode. If the alternative mode of transport has lower costs than water transport for a given movement, then that movement is presumed to be diverted from the navigation system to the alternative mode. This potential movement enjoys no transport cost reductions resulting from the navigation system. Conversely, movements enjoying less costly transportation on the navigation system are presumed to use the navigation system, realizing net savings of the difference between the costs of water transport and the next least costly alternative mode of movement. The sum of all these transportation cost savings represents the total resource savings to the Nation attributable to the navigation system.

The navigation system transport costs are dependent on three general classes of parameters: first, the operating characteristics of waterway carriers and shippers; second, the operating characteristics of the navigation system itself; and, third, the physical traffic carrying capacities of the components of the navigation system. For the purposes of this reconnaissance study, the first two parametric classes are assumed to be fixed through time. This analytical effort focuses exclusively on the impact on the levels of navigation system transport costs of carrying capacity constraints at system locks. However, changes in operating policies will be incorporated into subsequent analyses.

For a given level of traffic, the greater the carrying capacity of the navigation system the lower the total unit transport costs. This is a consequence of decreased levels of congestion in the system, allowing potential movements quicker and more efficient transport from origin to destination. Hence, the navigation system transportation costs of individual movements are explicitly dependent on total system traffic. In other words, individual movement system transportation costs depend not only on the economics of each individual movement, but also on the levels of congestion in those portions of the transportation system used by each individual movement. The levels of congestion in each component of the navigation system are increasing functions of the total volume of traffic processed by each component of the system.

Each individual potential water movement is assumed to transit the navigation system if, and only if, it has economic incentive to do so. Here, economic incentive to use the navigation system means that a movement is assumed to use the navigation system if water transport provides the cheapest total transportation costs including the congestion costs resulting from carrying capacity constraints.

The total real costs of shipping any given movement via alternative modes of transportation are assumed to be constant through time. Explicitly modeling the costs of alternative modes of transportation is beyond the scope of this reconnaissance report.

In order to reduce the size of the GEM model, only Upper Mississippi River system locks that could possibly sustain significant increases in levels of congestion are explicitly included in the model. Consequently, both chambers of the new Melvin Price locks are excluded from the model. Projected traffic levels at these system components are not expected to cause significant changes in system congestion costs at any time during the planning horizon. This allows traffic using only these structures to be eliminated from the direct system modeling and greatly reduces the size of the GEM model with minimal distortion of the analytical results.

The input requirements of the GEM model are as follows:

a. **Individual Movement Data**: For individual potential system commodity movements, this input requires a waterway routing vector (indicating which system locks the movement will transit if it utilizes the navigation system), the annual volume of the movement measured in kilotons (ktons), the gross transportation cost savings of the movement (defined as the difference between the total uncongested water transportation costs and the total transportation costs of the next least costly alternative mode of transit for that movement), and an indication of whether or not alternate water routings are possible.

b. **Congestion Costs**: Costs per kton per hour of delay for each commodity movement at each system lock transited are inputs required by the GEM model. The model allows these costs to be input by aggregated commodity groupings for each system lock.

c. **Lock Delay Parameters**: Capacity in annual ktons and expected delay in hours per ton at 50 percent utilization for each lock in the system are required by the model. For solution, the model requires that delay be an monotonic nondecreasing function of tonnage. The delay function used in the model's present configuration is:

$$D = k * T / (C - T); \text{ where}$$

D = delay per ton in hours;
k = delay in hours at 50% utilization of capacity;
T = annual lock tonnage; and
C = annual lock capacity in tons.

To use this formulation, Capacity (C) and expected delay at 50 percent utilization (k), for each lock in the system, are required input parameters.

Output from the GEM model includes total system transportation costs including congestion costs, expected delay times at each modeled system lock, annual tonnages moved through each lock, and the net system transportation cost savings for each movement. The net system transportation cost savings are defined as the transportation resource cost savings attributable to the navigation system for that movement accounting for the effects of system congestion on water transportation costs.

Benefits for navigation projects consist of two distinct components: first, transportation resource cost savings to existing system traffic from reduced levels of systemic congestion; and, second, transportation savings over an alternative mode of transport for movements now induced to utilize the navigation system because of the reduced total transportation costs. This idea is graphically demonstrated in figure B-3. The demand curve DD shows for each potential ton of commerce the difference between total water transportation costs (with no congestion costs) and the total costs of movement via the next least costly alternative mode of shipment. This difference is termed the gross cost savings of that ton's potential movement via the waterway. The curve SS represents the congestion costs incurred by each movement as different levels of tonnage transit the system. It is upward sloping to represent the notion that as more tons pass through the navigation system, greater levels of congestion occur, and, consequently, higher unit costs of transportation are incurred by each ton transiting the system. The system equilibrium congestion cost is given at P with tonnage of T actually transiting the system. All tonnage to the "left" of T find it still cheaper to move on the waterway than on the next cheapest alternative mode, whereas all tonnage to the "right" of T find it economically more advantageous to use some transportation mode other than the waterway. Hence, in equilibrium, T tons will pass through the lock and incur delay costs of P dollars.

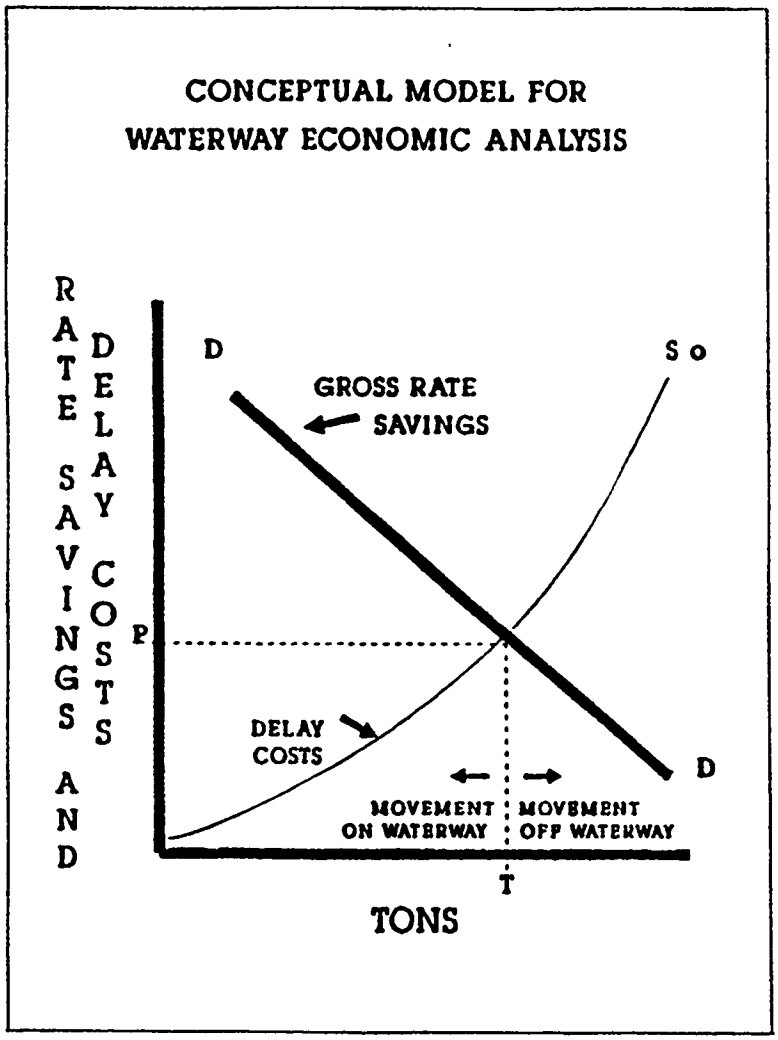
CONCEPTUAL MODEL FOR
WATERWAY ECONOMIC ANALYSIS
RATE SAVINGS AND DELAY COSTS
D
S o
GROSS RATE
SAVINGS
P
DELAY
COSTS
D
MOVEMENT
ON WATERWAY
MOVEMENT
OFF WATERWAY
T
TONS

FIGURE B-3

Now, consider the impact of a system change (such as the installation of a new lock chamber at one lock) on the level of system traffic and shipping costs. Figure B-4 illustrates the effect of the change and the measurement of resulting benefits.

The provision of the new chamber increases the carrying capacity of the system and reduces the unit cost of congestion for any given level of system traffic. The curve labeled S1 depicts the with-project relationship between system traffic levels and the reduced with-project levels of congestion. The new equilibrium level of traffic increases from T0 to T1, with a reduction in congestion costs due to the improvement from P0 to P1. The resulting benefits for this system change may be broken into two components: (1) the cost savings on the pre-improvement level of traffic, T0 x (P0 - P1) (the shaded area to the left of T0); and (2) the benefits to the new traffic that can now move on the waterway, +[(T1 - T0) x (P0 - P1)] (the shaded triangle to the right of T0).

The difference in the total transportation costs between with- and without-project conditions represents the national economic development (NED) benefits of the proposed inland navigation improvement.

The important analytical assumptions employed in this analysis are:

(a) Movements will divert from the waterway when the total system transport costs including expected congestion costs exceed the total costs of shipment via an alternative mode; and

(b) The expected levels of delay and traffic for each component for the system must be logically consistent with the delays and traffic computed for all other components in the system. This requires that the equilibrium calculation at all system locks take place simultaneously.

DATA REQUIREMENTS AND SOURCES

This section describes in more detail the input requirements of the GEM and the sources of data used in the analysis.

COMMODITY MOVEMENT DATA BASE

Origins, Destinations, and Commodity Tonnages

A data file describing commodity movements for each lock in the Upper Mississippi River System was furnished by the Corps of Engineer's Waterborne Commerce Statistics Center (WCSC). These files contain the origin and destination port and dock identification codes, the WCSC

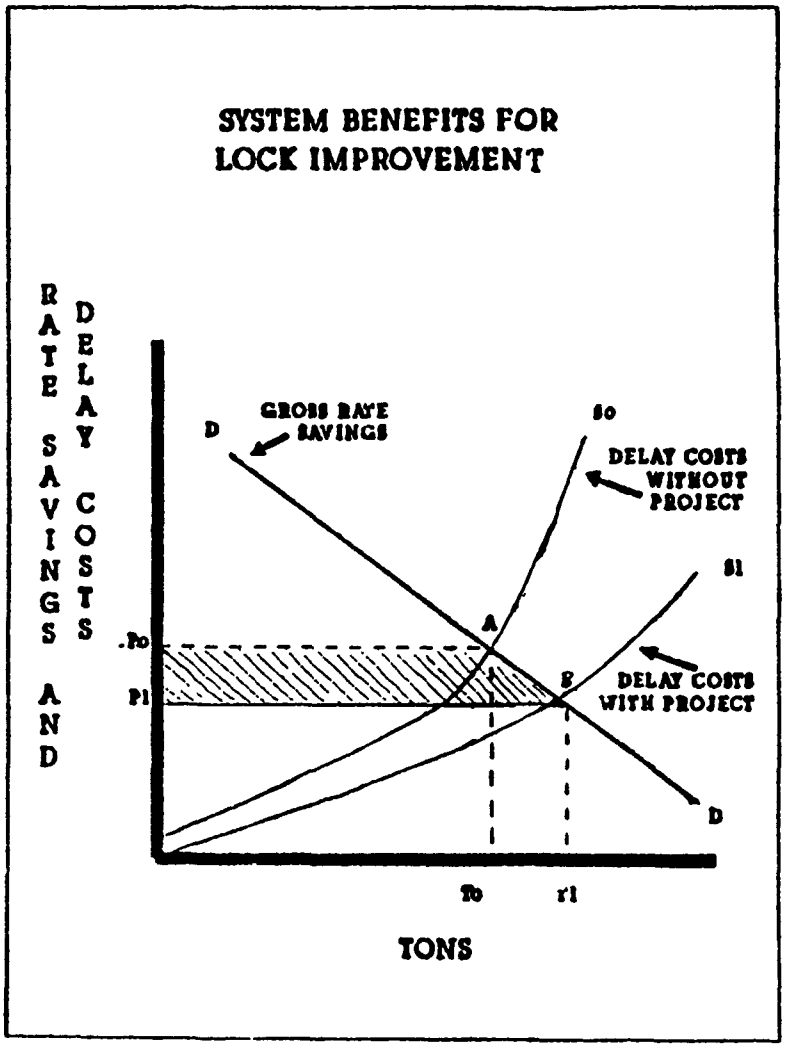
SYSTEM BENEFITS FOR
LOCK IMPROVEMENT
RATE SAVINGS AND DELAY COSTS
D
GROSS RATE SAVINGS
So
DELAY COSTS WITHOUT PROJECT
S1
A
Po
P1
B
DELAY COSTS WITH PROJECT
D
To
r1
TONS

FIGURE B-4

commodity code, and tonnage for all reported movements transiting each lock in 1987.

Initially, these data were compared to the 1987 tonnages recorded in the Lock Performance Monitoring System (PMS) data base. Agreement, adequate for this level of study, was found at all the locks. A comparison of the WCSC and PMS tonnages is presented in table B-4.

TABLE B-4

Comparison of WCSC and
PMS Data, Tonnage Passing UMRS Locks in 1987
(Thousands of Tons)

Lock	WCSC	PMS	Percentage Difference
Upper St. Anthony Falls	789	767	2.8
Lower St. Anthony Falls	1,353	1,347	0.4
No. 1	1,354	1,348	0.4
No. 2	9,892	10,435	-5.5
No. 3	9,928	10,474	-5.5
No. 4	10,422	10,988	-5.4
No. 5	10,629	11,071	-4.2
No. 5a	10,629	11,198	-5.4
No. 6	12,000	12,581	-4.8
No. 7	12,000	12,563	-4.7
No. 8	12,559	13,094	-4.3
No. 9	13,562	13,993	-3.2
No. 10	15,188	15,482	-1.9
No. 11	15,529	15,809	-1.8
No. 12	18,869	19,314	-2.4
No. 13	18,973	19,436	-2.4
No. 14	24,276	24,511	-1.0
No. 15	25,061	25,180	-0.5
No. 16	26,925	27,208	-1.1
No. 17	29,088	29,226	-0.5
No. 18	29,800	29,842	-0.1
No. 19	31,254	31,218	0.1
No. 20	32,002	31,949	0.2
No. 21	33,310	33,383	-0.2
No. 22	34,222	34,210	0.0
No. 24	35,315	35,314	0.0
No. 25	35,302	35,319	0.0
No. 26	68,981	69,375	-0.6

Following the initial check, the data were aggregated into 10 commodity groups for ease in management. The aggregation groupings used are shown in table B-5.

TABLE B-5

Aggregation of WCSC Commodity Groups

	Waterborne Commerce Statistics Center Commodity Code [1]	Commodity Group
1.	1311	Crude Petroleum
2.	1121	Coal
3.	2911-2918, 2920-2921, 2951-2991	Petroleum Products
4.	2810-2861, 2891	Industrial Chemicals
5.	1011, 1021-1091, 3311-3319, 3321-3324,4011, 4012, 3411	Metallic Ores and Products
6.	1411,1412,1442,1451, 1491-1499,3211,3241, 3251,3271,3281,3291	Non-Metallic Minerals
7.	2411-2416,2421-2491, 2511,2611,2621,2631, 4024,0841,0861,2413	Forest Products and Pulp
8.	0101,0103-0107,0111, 0112,0119,0121-0191, 2049,2042,2011-2039, 2061-2099,2111	Farm Products
9.	1471,1479,2871-2879,	Agricultural Chemicals
10.	All other codes.	Miscellaneous & Unknown

[1] Commodity codes are reflective of 1987 WCSC data used in the analysis.

The data then were accumulated into a single file. Duplicate movement records were eliminated, and binary variables were added to indicate the locks that each movement transits. This accumulation yielded a file consisting of 6,749 records. The data then were aggregated geographically by Port Equivalent Codes. This aggregation yielded a file consisting of 2,304 records, representing total movements of approximately 39.0 million tons. This is much less than the 81.6 million tons of total system traffic reported by the WCSC for 1987, since only traffic using at least 1 of the 27 modeled locks in the system is included in this file. All other movements on the Upper Mississippi River System, which consist of those not using any system lock or those using only Locks 26 of the system, are not germane to the analysis. Further aggregation by river reaches also was accomplished where possible. This final aggregation yielded a file consisting of 971 records. At this stage, no movements of petroleum products remained, and, as a result, this group was dropped from the subsequent analysis.

From this file, additional movement files were constructed to estimate future traffic demands by applying commodity group specific high, medium, and low annual growth rates to the 1987 movement tonnages. These growth

rates were compiled from the *1988 Inland Waterway Review* which contains a detailed explanation of their derivation. The growth rates in that report cover projections of traffic through the year 2000. For subsequent years, the growth rate for 2000 is applied. Files for 2000, 2010, 2020, 2030, 2040, and 2050 were compiled. Table B-6 displays the medium annual growth rates for the nine commodity groups. These medium annual rates of growth are used to generate the most likely future system traffic demands at locks included in the model. Table B-7 displays the total potential traffic for the three different sets of projections. The low and high growth rates are employed to test the sensitivity of the valuation of the system to different rates of growth in traffic demands. All files then were appropriately formatted for input into the GEM model.

TABLE B-6

Growth Rates Used to Estimate Future Demands
(Annual Percent Change)

	Period			
Commodity Group	1987-1990	1991-1992	1993-1995	1996-2000
Crude Petroleum	-3.0	-2.0	-2.0	-0.6
Coal	2.5	2.5	2.5	2.5
Petroleum Products	2.0	0.4	0.4	0.4
Industrial Chemicals	2.8	2.8	2.8	2.8
Metallic Minerals	1.5	-0.7	-0.7	-1.1
Non-Metallic Minerals	0.5	0.5	0.5	0.5
Forest Products	2.7	2.7	1.3	1.3
Farm Products	3.4	2.3	2.3	1.9
Agricultural Chemicals	1.5	3.0	3.0	3.0
Miscellaneous	-1.1	-1.1	-1.1	-1.1

TABLE B-7

Total System Traffic for Modeled Locks
(Millions of Tons)

	Year					
Growth Rate	2000	2010	2020	2030	2040	2050
High	56.0	71.9	92.7	120.0	156.1	203.7
Medium	51.6	62.3	75.7	92.2	112.7	138.3
Low	47.6	55.0	63.7	74.0	86.0	100.3

Transportation Cost Analysis

For each individual commodity movement that will use Upper Mississippi River locks in the inland navigation system, the difference between total water transportation cost with no lock delays and total cost for the movement via the next least costly alternative mode of shipment (i.e., rail) is referred to as the gross cost savings of that ton's potential movement via the waterway. *Principles and Guidelines for Water Resource Planning* directs that costs be determined for waterway transport and for the least cost alternative mode of transport (rail, truck, or pipeline).

Transportation Cost Matrix

The overall goal of the cost analysis is the construction of a matrix which accurately reflects the long-term marginal resource costs shippers face in the modal choice decision between waterway transportation and some alternative mode. In constructing this matrix, it is necessary to derive the three categories that comprise total transportation costs, namely, the line haul costs, access costs to or from a particular mode used in a movement, and transfer costs associated with the movement. By ascertaining each of these components, it is then possible to construct total transportation charges by mode.

The GEM requires the gross transportation cost differentials (savings) between water transportation and the next least costly alternative mode of transport for each potential system movement as a model input. These gross savings must not include any system delay costs, as the model, itself, estimates these costs.

a. **Line Haul Costs.** For this analysis, a subset of aggregated commodity-specific movements was identified from the origin-destination data base for each of the major commodities included in this analysis. Movements were aggregated by common pools of origin and destination and by the following commodity groups as detailed in table B-5 above.

(1) Crude Petroleum
(2) Coal
(3) Petroleum Products
(4) Industrial Chemicals
(5) Metallic Minerals
(6) Non-Metallic Minerals (including cement and stone)
(7) Forest Products
(8) Farm Products
(9) Agricultural Chemicals
(10) Miscellaneous and Unknown

These aggregated movements then were compared to a file of movements prepared for the Inland Navigation Investments Needs Analysis study (ININA)

compiled under the direction of the Office of the Chief of Engineers, U.S. Army Corps of Engineers, November 1990, to find matching movements (same commodity group and origin destination Port Equivalent) that had both water and alternative transportation costs estimated in that study. The line haul transportation cost estimates prepared in that study were accomplished using the Reebie and Associates proprietary barge and rail line haul cost estimating models. A detailed discussion of the operations of those models and the modeling assumptions used are presented in that report. Movements that matched then were assigned the line haul costs derived in the ININA study file. These costs are estimated at 1989 price levels. There were 242 matching movements identified, comprising a total of 6.7 million tons.

Movements that did not have a direct or obvious match in the ININA movement file were assigned gross line haul transportation cost savings of water transport based upon the commodity-specific average gross transportation cost savings per barge mile of the matching movements. The source for waterway mileage calculations between points was the Ohio River Company Tariff 100, Section 7, dated October 1983, which gives a geographical listing of locations covered by the tariff along with their specific mile locations on the waterway system. A central point in each Port Equivalent was designated for the point of origin or destination for movements assigned to each Port Equivalent. Table B-8 below shows the average line haul transportation cost savings per barge mile used derived from the matching movements.

TABLE B-8

Average Line Haul Transportation Cost
Savings of ININA Matching Movements
(1989 Price Levels)

Commodity Group	Line Haul Cost Savings Per Ton Per Barge Mile
Agricultural Chemicals	.0918
Farm Products	.0147
Petroleum and Products	.0157
Coal-Western	.0222
Coal-Eastern	.0032
All Other Movements	.0177

One further computation was accomplished to estimate the unconstrained (no system congestion) line haul cost savings of water transportation for potential system movements. The costs of existing delays at locks transited by each movement were added to gross water transportation line haul savings. The GEM estimates these costs for alternative system configurations and includes these costs in the total cost of water transport for each movement.

b. **Access and Transfer Costs.** Access and transfer costs from a particular mode used in a movement, and transfer costs (loading and unloading costs) associated with the movement were determined through telephone survey of the major river terminals on the Upper Mississippi River. A discussion of the results of this survey related to commodity-specific costs follows.

(1) **Grain:** Along the Upper Mississippi River, shipping terminals receive grain primarily by truck from an average distance of about 30 miles. Generally, this grain originates at country elevators, although smaller percentages are shipped directly from farms (approximately 20 percent) or are shipped by rail from much farther distances (approximately 5 percent). Grain mill products often are produced on site and, hence, incur no additional cost of access to barge transportation.

The average cost of the 30-mile truck haul is 10 to 12 cents per bushel ($3.50 to $4.20 per ton). Additionally, there is a cost of between $3.00 and $4.00 per ton to elevate the grain from truck to barge. This cost includes the overhead of terminal operation.

For the purposes of this analysis, it is assumed that rail cars are loaded directly at country elevators at a cost of between $1.00 and $2.00 per ton. Additionally, there is a cost of approximately $2.00 per ton for grain movements to a terminal or subterminal for consolidation into a unit train. For the purposes of the Upper Mississippi River Navigation Study, the net (between water and rail transit) average access and transfer cost differential of $2.80 per ton is used for small farm products shipments (those under 300,000 tons annually).

Large grain shipments (over 300,000 tons annually) are broken into 5 equal tonnage submovements with gross cost differentials for the submovements arrayed at 83, 67, 50, 33 and 17 percent of the difference in line haul costs between water and rail transport. This is done to "smooth" the water transportation demand curve by approximating the increased access charges of grain located further from the point of water origin for these large movements.

(2) **Agricultural Chemicals:** The transportation pattern of agricultural chemicals is generally the reverse of grain movements. The average radius serviced by a river terminal unloading agricultural chemicals is about 50 miles. The larger service radius is due in part to the fact that terminals that unload chemicals are more sparsely distributed along the river. Further, the greater line haul savings for barge shipments of chemicals (as opposed to grain) provide an economic incentive for longer movements from the river terminal. The per ton cost of loading and unloading agricultural chemicals is about the same for both barge and rail.

The longer off-river haul and the slightly higher cost of truck transportation for chemicals (tank trailers) combine to make the cost of land transportation for agricultural chemicals about $1.00 per ton higher than

that for grain. Consequently, an average access and transfer cost of $3.80 is applied to waterborne agricultural chemical movements.

(3) **Western Coal**: Most western coal originates in the Powder River Basin located in northeastern Wyoming and eastern Montana. It moves to the Upper Mississippi River System generally by unit train at a cost of between $16.00 and $20.00 per ton. The Burlington Northern is the dominant railroad involved in these moves.

Western coal which moves via the Upper Mississippi River generally does so because all rail transportation is not available to the ultimate destination (usually a power plant). Therefore, the alternative to barge transportation would be a truck haul. Sources in the industry indicate that the additional cost of using truck transportation is in excess of $20.00 per ton.

(4) **Eastern Coal**: An overland access cost of $2.00 per ton was used for movements that do not have direct water access.

(5) **All Other Commodities**: It was assumed that there was no difference in the cost of rail and water access.

Table B-9 displays the total 1987 tonnages and average gross water transportation cost savings for each commodity group. These averages are computed over the number of movements and not weighted by the tonnage of each movement. The average rate savings per ton are related to the length of line haul and the availability of competitive alternative transport. Longer line hauls generally lead to greater water transport savings, while readily available alternative modes of transport lead to lower water transport savings.

TABLE B-9

1987 Tonnages and Average
Gross Cost Savings of Water Transport
(1989 Price Levels)

Commodity Group	Tons (thousands)	Gross Cost Savings Per Ton
Crude Petroleum	1,892	$14.93
Coal	5,980	6.35
Industrial Chemicals	590	19.78
Metallic Minerals	469	22.41
Non-Metallic Minerals	3,347	17.72
Forest Products	18	18.96
Farm Products	24,162	13.20
Agricultural Chemicals	2,410	18.50
Miscellaneous	86	18.10
Total	38,954	

LOCK CARRYING CAPACITY AND DELAY ANALYSIS

As traffic levels increase on a waterway, the increased traffic creates delays at bottlenecks on the system. Generally, these bottlenecks or constraints occur at navigation locks. Quantifying the relationship between tonnage moving through a lock and the delay at the lock is essential to the economic analysis of the value of the navigation system.

There are two distinct ways to establish the delay-tonnage relationship -- analytically or through simulation of lock operations. For this level of study, the analytical approach is more appropriate. Further, two distinct analytical techniques are employed to estimate the required lock parameters for the GEM model. The first of these techniques is an "engineered" approach which estimates the capacity at a system lock by analyzing the distribution of service times as a function of lock operating procedures and the distribution of tonnage present for processing. This technique was developed by the Rock Island District staff and is applied to estimate the capacities of Upper Mississippi River locks located in the North Central Division (Lock 22 and those upstream).

The second technique involves the direct estimation of the two required GEM model lock parameters (Capacity and Delay-at-50%-utilization) using an approach that minimizes the sum of the squared differences between observed levels of delay and estimated levels of delay using the queuing theory approximation embedded in the GEM model.

To determine the delay-tonnage relationship at a navigation lock analytically, some approximations from queuing theory may be applied. If arrivals for service (locking) follow a Poisson process (i.e,. randomly independent), then the expected wait for service (delay at lock) is given by the formula:

$$D = (U(S^2 + 1)P) / (2(1-U)), \text{ where:}$$

D = expected delay;
S = ratio of the standard deviation to the mean processing time;
U = lock utilization defined as the ration of the mean interarrival time and the mean processing time; and
P = mean processing time.

It can be seen from this formulation that as lock utilization approaches unity the expected delay at the lock grows without bound. The tonnage required to produce 100 percent utilization is defined as the "practical lock capacity."

The above demonstrates that expected delay can be related to lock utilization. It remains, however, to find the relationship between tonnage and expected delay. In order to accomplish this, a simultaneous system of equations was developed which model the relationship between tonnage and

utilization. Solving this model for a given level of tonnage allows us to find the corresponding utilization and, hence, expected delay. By solving the model over a range of tonnages, we can trace the relationship between tonnage and expected levels of delay. Further, by "backsolving" the model, we can determine the tonnage required to produce any given level of expected delay.

The navigation season was assumed to be 275 days (March through November) at all locks. Incremental capacity increases were made at lower locks to reflect the appropriate degree of nonseasonal traffic.

The system of equations required to accomplish the above tasks is sufficiently complex to warrant a computer for solution. With this in mind, the model was developed using the software package TK Solver. This software's ability to iteratively solve (and backsolve) systems of equations make it a useful tool for developing and solving the model. The following discussion describes the implementation of the model.

STEP 1 - Base year tonnage is specified for each of nine commodity groups both upbound and downbound. The model contains equations specifying tonnage growth for each of the commodity groups. For any given level of total tonnage, these growth equations are solved to yield the tonnage in each commodity group. As a by-product of this solution, the year in which this tonnage is projected to occur also is found. The growth rates used are those published in the *1988 Inland Waterway Review*.

The model, in its present form, only accommodates a constant growth rate for each commodity group. Allowing for variable growth (i.e., 2% until year 2000, 1% from 2000-2010, 2% from 2010-2020, etc.) is a model improvement that will be made for future studies.

STEP 2 - The model has, as part of its input, the proportion of upbound and downbound tonnage in each commodity group and tons per barge load by commodity. This information is readily determined from available data sources. Using these inputs, along with the tonnage by commodity group from step 1, the number of loaded barges both upbound and downbound is determined.

STEP 3 - The imbalance between upbound and downbound tonnage necessitates the movement of empty barges. Moreover, even if upbound and downbound movements were perfectly balanced, a certain percentage of the barges would still return empty as these are dedicated movements where no backhaul is possible in any navigation system.

The percentage of dedicated movements is a model input and, in conjunction with the imbalance in upbound and downbound traffic, the number of upbound and downbound empty barge movements is determined.

STEP 4 - At this point, the total number of barges traversing the lock, both upbound and downbound, is known. These numbers should be

approximately equal and, although it is not an explicit requirement of the model, this is the case.

Examination of observed data reveals that as the amount of tonnage transiting a lock increases, tow sizes also increase. From an economic perspective, this is the result of shippers and carriers, to the extent possible, taking advantage of the economies of scale available with larger tows.

Average tow sizes cannot, however, exceed limits physically imposed by the waterway and tow horsepower. To account for both these factors, the model increases average tow size linearly with tonnage until the "theoretical" maximum average tow size is achieved, at which point average tow size remains constant.

STEP 5 - Knowing both the total number of barges and average tow size permits the number of tows transiting the lock to be determined.

STEP 6 - Nearly all of the lockages taking place on the Upper Mississippi River are either double lockages, straight single lockages, knockout single lockages, or setover single lockages. The model assumes that all lockages taking place are of one of these types. The percentage of double lockages is a function of average tow size. After determining the number of double lockages, the model determines the number of straight, knockout, and setover lockages based upon historical data. Even though multi-tow lockages do not presently occur in significant numbers, this could change under congested conditions. Accounting for this type of lockage in the future is a possible model improvement.

STEP 7 - An important model input is the lockage component times. These component times are input for the various lockage types, and entry/exit types. In all, there are 21 component time inputs required for each lock modeled. These times may be determined, in the case of existing locks, from readily available data. In other cases, they may be estimated from design parameters or by comparison with similar locks. Note that, since each fly, turnback, or exchange approach corresponds to a fly, turnback, or exchange exit, the sum of exit and approach times may be treated as a single timing component.

STEP 8 - The number of lockages of each type (i.e., single, double, etc.) has already been determined. It remains to determine the proportion of lockages that will use fly, turnback, or exchange approach/exits. Since we already assume that arrivals for lockage occur randomly, it follows that the proportion of fly approach/exits is given by 1 minus utilization. If the lock utilization is less than .85, the model assumes that the lock operates using a FIFO (First-In/First-Out) policy and, hence, the proportion of turnback and exchange approach/exits are both equal to 1/2 of utilization.

At higher levels of utilization, the model compares the relative efficiency of turnback versus exchange approach/exits and assigns the appropriate

lockage policy -- either 1-up 1-down, or n-up n-down. At locks where turnback is more efficient than exchange, the model assumes a 3-up 3-down policy at 85 percent utilization. As utilization increases, so does the proportion of turnback lockages so that at 100 percent utilization a 10-up 10-down policy is implemented. At locks where exchange is more efficient than turnback, a 1-up 1-down policy is assumed at 90 percent utilization.

STEP 9 - It should be noted that the analysis implies that utilization is known. Utilization, however, cannot be known since it is dependent (among other factors) on the relative proportion of exchange/exit types. This is why the iterative capabilities of TK Solver are essential. The calculations are done using an initial seed value for utilization. The results of this calculation allow the model to iteratively adjust the utilization value. After a number of iterations, the model converges on a solution which satisfies all the equations.

STEP 10 - Having determined the total number of tows, the proportion of each lockage type, and the proportion of each approach/exit type, the model sums the lockage component times to find the total time devoted to commercial lockages. Also, the average tow processing time, needed for the expected delay calculation, can now be determined.

STEP 11 - The total time used for non-commercial lockages is a model input. At most locks, this is largely the time devoted to the lockage of pleasure craft. Historically, these types of lockages appear to be increasing at many locations in the system, however, it is not clear whether this trend will be maintained with increasing levels of commercial lockages. For this reason, it was assumed that this input would be constant through the period of analysis.

STEP 12 - The time that the lock will be unavailable for locking of any type (total time) was determined from historical data and assumed to remain constant. While this is reasonable for stalls created by weather conditions, stalls created by mishaps will increase along with increasing lock usage. The model will be modified to account for this effect in future studies.

STEP 13 - Lock utilization is determined by adding the total time the lock is used for lockages to the total time the lock is unavailable for lockages (stalls) and dividing this total by the total time in the navigation season. For the purposes of this study, it was determined that the seasonal variation in traffic was small enough so that the entire year could be considered as a single homogeneous navigation season.

STEP 14 - Delay is calculated using the queuing theory formulation previously mentioned. The ratio of the standard deviation to mean lockage time is obtained from historical data and assumed to remain constant.

The above steps are only an aid in explaining how the model works. The model will find a solution that will simultaneously satisfy all of the model conditions.

Further, although some variables in the above discussion are called input variables, the model is indifferent to which variables are input and which are output. As long as enough variables are specified to define a solution, TK Solver will find the values for the remaining variables.

The form of the delay equation used in the GEM requires capacity and expected delay at 50 percent utilization as input parameters. Lock capacity can be found by this model using 100 percent as an input value for utilization and allowing the model to solve for total tonnage. After capacity is determined, half of this value is input for tonnage and the model solves for the expected delay associated with that level of tonnage. The results of these computations for system locks upstream and including Lock 22 were displayed in table B-4.

It should be noted that since the GEM uses a simplified form of the expected delay equation there is some discrepancy between the expected delay computed in GEM and that found by this model. This difference, however, is well within the inherent uncertainty bounds of the analysis. It is neither possible, nor desirable, to account for every phenomenon which affects expected delay at a lock. The model attempts to accommodate the most fundamental parameters while allowing for future refinements. For future studies, we will examine the delay formulation within the GEM programming.

A more direct estimation of the expected delay at a lock and the traffic level at a lock relationship is used to estimate the required GEM model parameters for Locks 24 and 25. This technique finds the "best" fit between the functional form of the expected delay-tonnage formulation embedded in the GEM model and the observed historic tonnages and delays at the locks. Specifically, the sum of the squared deviations between the estimated (using the GEM function) and the observed delays is minimized using a non-linear programming technique. Observed data from the Performance Monitoring System (PMS) for 1983 through 1989 was used for the estimation of the parameters at Locks 24 and 25. The parameter estimates computed in this manner agree reasonably well with those computed using the "engineered" approach for the other 600-foot chambers in the system. The estimate of 41.7 million tons of capacity at Lock 25 does appear to be somewhat low, however. Future studies will examine the possibility of using both analytical methods to achieve greater precision in capacity estimates.

Table B-10 below displays the estimates of the lock capacities and expected delays at 50-percent utilization derived for the locks explicitly included in the GEM model. These estimates are used in the without-project system evaluations.

TABLE B-10

Lock Capacities

Lock	Capacity (millions of tons)	Delay at 50% Utilization (hours)
Upper St. Anthony Falls	16.07	0.44
Lower St. Anthony Falls	16.52	0.53
No. 1	13.82	0.59
No. 2	50.23	1.08
No. 3	39.33	1.32
No. 4	44.01	1.16
No. 5	45.04	1.12
No. 5a	46.67	1.00
No. 6	42.60	1.18
No. 7	42.43	1.22
No. 8	46.30	0.41
No. 9	48.48	1.10
No. 10	51.63	0.88
No. 11	41.80	1.24
No. 12	46.12	1.06
No. 13	48.58	0.96
No. 14	48.20	1.26
No. 15	46.30	1.58
No. 16	48.80	1.27
No. 17	45.30	1.46
No. 18	50.10	1.22
No. 19	68.90	0.66
No. 20	47.20	1.36
No. 21	48.70	1.25
No. 22	44.60	1.80
No. 24	44.10	1.43
No. 25	41.70	0.80

COSTS PER HOUR OF DELAY

Three important components are involved in estimating commodity-specific hourly delay costs at system locks. The equation below presents the three components of the cost of delay and summarizes the computation of total hourly delay costs per ton.

Barge Cost/ Ton Hour of Delay	+	Tow Cost/ Ton Hour of Delay	+	Commodity Cost/Ton Hour of Delay	=	Total Cost/ Ton Hour of Delay

The first factor affecting the cost of delay is the distribution of tow sizes and barge types employed in the movement of specific commodities. Tow size and barge type affect delay costs due to the differing capital and operating costs per ton per barge-hour of the distinct equipment.

The average number of barges per tow transiting each lock was determined from PMS data using a 3-year average (1987-1989). Hourly barge costs for covered hopper barges and tank barges were used for the appropriate commodity groups in determining average barge costs per ton. These hourly barge costs were obtained from Corps of Engineers published shallow draft vessel costs for Fiscal Year 1989.

The second major factor in estimating delay costs is the hourly cost of the towboat used to push the tows. The hourly cost of the towboat is directly related to its horsepower. Greater tow horsepower affects delay costs per hour because these larger boats cost more to own and operate.

To determine the tow horsepower component of cost, tow horsepower was regressed on tow size. This regression equation was used to estimate the horsepower requirements for typical tows used to move the different groups of commodities at the system locks.

Towboat line haul operating costs were obtained from Corps of Engineers published shallow draft vessel costs for Fiscal Year 1989. Using this information, an average tow operating cost was determined for each lock on the Upper Mississippi River for the nine commodity groupings used in this analysis.

The final component of the hourly cost of delay is commodity inventory carrying costs. These costs were estimated using the discount rate currently applicable for water resource planning (8.875 percent annually) as a proxy for the real private interest costs of inventory. The annual rate was converted to an hourly rate and applied to the average value of the commodities comprising each of the nine groupings to yield an estimate of the carrying costs. The resulting estimates of the carrying costs are all less than one-hundredth of one cent per ton per hour and, consequently, play a minor part in the total hourly cost of delay.

For each of the nine commodity groups, barge and tow cost per tow hour of delay were converted to costs per ton per hour by using average tons per tow and added to the commodity-specific inventory carrying costs. Total per hour lock and commodity-specific delay costs at all lock sites on the Upper Mississippi River are shown in table B-11.

TABLE B-11

Hourly Costs of Delay for
Commodities at System Locks
(Dollars per Kiloton)

Lock	Farm Prod	Mtls Ores	Coal	Non Mtls	Frst Prod	Ind Chem	Ag Chem	Ptrl	Misc
Up St A	218	218	217	218	219	227	227	225	219
Lo St A	219	219	218	219	219	229	229	227	219
No. 1	219	219	218	219	220	229	229	227	220
No. 2	44	45	44	44	45	52	52	51	45
No. 3	44	44	43	43	44	51	51	50	44
No. 4	42	42	42	42	43	50	50	49	43
No. 5	42	42	42	42	43	50	50	48	43
No. 5a	42	42	41	42	42	50	50	48	42
No. 6	38	38	37	35	38	46	46	44	38
No. 7	38	38	38	38	39	46	46	44	39
No. 8	36	37	36	37	37	44	44	42	37
No. 9	33	33	32	33	33	40	40	38	33
No. 10	37	37	36	37	38	45	45	43	38
No. 11	37	37	36	37	38	45	45	43	38
No. 12	38	38	37	38	38	46	46	44	38
No. 13	39	40	39	39	40	47	47	46	40
No. 14	41	41	41	41	42	49	49	48	42
No. 15	45	45	45	45	46	53	53	52	46
No. 16	40	41	40	40	41	48	48	47	41
No. 17	36	36	35	36	36	44	44	42	36
No. 18	35	36	35	35	36	43	43	42	36
No. 19	35	35	34	34	35	43	43	41	35
No. 20	35	35	34	35	35	43	43	41	35
No. 21	35	35	34	35	35	43	43	41	35
No. 22	35	35	34	35	35	43	43	41	35
No. 24	35	35	34	35	35	43	43	41	35
No. 25	35	35	34	35	35	43	43	41	35

Commodities such as industrial chemicals, petroleum products, and grain tend to move in "dedicated" tows on the Upper Mississippi River. These are tows where the barges move in the same group and have no backhaul opportunities. Delay costs are then incurred twice, once with loaded barges and once with returning empty barges. At present, the cost of empty backhauls is equally distributed among all commodities.

SECTION 3 - SYSTEM ANALYSIS RESULTS

WITHOUT-PROJECT CONDITION

One of the first steps in the formulation process is to identify the most likely condition expected to exist in the future in the absence of any improvements to the existing navigation system. The without-project condition serves as a baseline against which alternative improvements are evaluated. The increment of change between an alternative plan and the without-project condition provides the basis for evaluating the beneficial or adverse economic, environmental, and social effects of the considered plan.

It has long been recognized that any significant modification to the Nation's waterway system can have far-reaching impacts that can be either negative or positive. National Economic Development (NED) benefits of a project, a principal evaluation criteria for water resources studies, are then determined by computing the net difference of the average annual transportation costs and navigation system savings for with- and without-project conditions. Definition of the without-project condition is presented below.

The without-project condition selected for use in this study includes the following analytical assumptions:

a. Operation and maintenance of Upper Mississippi River System locks and dams will be continued through the period of economic analysis to ensure continued navigability.

b. All existing waterway projects or those under construction are to be considered in place and will be operated and maintained through the period of analysis.

c. All locks on the Upper Mississippi River Navigation System are assumed to be using the most efficient locking policies.

d. Waterway user taxes will continue in the form of the towboat fuel tax prescribed by the Water Resources Development Act of 1986, Public Law 99-662.

e. Alternative surface transportation systems (rail, truck) are assumed to have sufficient capacity to move diverted waterway traffic at current costs over the period of analysis.

f. The carrying capacities of system locks are as presented in table B-10 above.

g. Traffic demands on the system will grow at the medium growth rates.

h. Delay costs are as presented in table B-11 above.

j. Delay and congestion costs at other system constraint points not directly modeled will not change significantly.

WITHOUT-PROJECT TRANSPORTATION BENEFITS

The GEM model was run to estimate the total transportation cost savings attributable (NED benefits) to the without-project Upper Mississippi River Navigation System. The model was used to estimate the benefits to the existing system for calendar years 1987, 2000, 2010, 2020, 2030, 2040, and 2050. For intermediate years, the system transportation benefits are estimated by assuming a constant rate of change in benefits between the years explicitly modeled. Table B-12 below summarizes the results of the without-project estimations for selected years. Table B-12 shows the annual tonnages and expected levels of delay for critical system locks in the without-project condition. Annual tonnage moved on the system as well as the annual net transportation cost savings of the system over the 50-year period are also displayed in table B-12. (Note that this does not include tonnage that does not transit at least one of the modeled Upper Mississippi River System locks.) Three important results merit detailed discussion.

First, the GEM estimates of system and lock traffic for the existing 1987 conditions agree quite closely with observed data. The GEM shows 38.9 million tons of total traffic in the modeled system compared with the WCSC estimate of 39.0 million tons. Additionally, model estimated delays agree closely with PMS reported lock delays. The average net transportation cost savings of traffic using the system is $11.76 per ton.

Second, the system shows evidence of congestion as early as the year 2000. Average net water transportation cost savings have decreased to $9.33 per ton. Locks 22, 24, and 25 show significant delays with an estimated delay of over 3 days at Lock 25.

Third, both total system transportation benefits and unit transportation savings decrease markedly with increased traffic levels and congestion throughout the period of analysis. Total system benefits decrease monotonically through time from a high of $457.4 million in 1987 to a low of $202.4 million by 2050. Unit transportation benefits decrease from $11.76 per ton in 1987 to $3.86 per ton in 2050. This is the direct consequence of the increased systemic congestion caused by growing traffic demands straining the ability of the existing system to efficiently process traffic.

TABLE B-12

Without-Project Conditions
Selected Years
(Tons in Millions, Delay in Hours)

	Year							
	1987		2000		2010		2020	
	Tons	Delay	Tons	Delay	Tons	Delay	Tons	Delay
Up St. A	.8	.0	1.0	.0	1.0	.0	1.2	.0
Lo St. A.	1.4	.0	1.6	.1	1.8	.1	2.0	.1
No. 1	1.4	.1	1.6	.1	1.8	.1	2.0	.1
No. 2	9.9	.3	12.9	.4	13.5	.4	14.2	.4
No. 3	9.9	.4	12.9	.6	13.6	.7	14.3	.8
No. 4	10.4	.4	13.5	.5	14.3	.6	15.2	.6
No. 5	10.6	.3	13.7	.5	14.5	.5	15.4	.6
No. 5a	10.6	.3	13.7	.4	14.5	.5	15.4	.5
No. 6	12.0	.5	15.3	.7	15.7	.7	16.5	.7
No. 7	12.0	.5	15.3	.7	15.7	.7	16.5	.8
No. 8	12.6	.4	16.0	.6	16.4	.6	17.4	.7
No. 9	13.6	.4	17.2	.6	17.7	.6	19.0	.7
No. 10	15.2	.4	19.4	.5	19.9	.6	21.2	.6
No. 11	15.5	.7	19.4	1.1	19.9	1.1	21.2	1.3
No. 12	18.8	.7	23.6	1.1	24.1	1.2	25.3	1.3
No. 13	19.0	.6	23.7	.9	24.3	1.0	25.5	1.1
No. 14	24.3	1.3	30.3	2.1	31.0	2.3	32.3	2.6
No. 15	25.0	1.9	31.3	3.3	31.7	3.4	33.0	3.9
No. 16	26.9	1.6	33.3	2.7	33.6	2.8	34.9	3.2
No. 17	29.1	2.6	35.6	5.4	36.5	6.1	37.8	7.4
No. 18	29.8	1.8	36.5	3.3	37.5	3.6	38.4	4.0
No. 19	31.3	.5	37.4	.8	38.1	.8	38.9	.9
No. 20	32.0	2.9	38.3	5.9	38.9	6.4	39.8	7.3
No. 21	33.3	2.7	39.3	5.2	39.6	5.5	40.6	6.3
No. 22	34.2	5.9	40.1	16.0	40.5	17.6	40.9	19.7
No. 24	35.3	5.7	41.3	20.9	41.5	22.8	41.5	23.3
No. 25	35.3	4.4	41.3	76.1	41.5	155.0	41.5	206.2
Total Tons	38.9		45.7		46.7		47.8	
Total NCS	$457.4		$426.6		$380.3		$364.6	

TABLE B-12 (Cont'd)

	Year 2030		2040		2050	
	Tons	Delay	Tons	Delay	Tons	Delay
Up St. A.	1.4	.0	1.6	.0	1.8	.1
Lo St. A.	2.3	.1	2.7	.1	3.0	.1
No. 1	2.3	.1	2.7	.1	3.0	.2
No. 2	17.0	.6	17.8	.6	20.4	.7
No. 3	17.1	1.0	18.0	1.1	20.6	1.4
No. 4	18.1	.8	19.1	.9	21.9	1.2
No. 5	18.3	.8	19.4	.8	22.3	1.1
No. 5a	18.3	.6	19.4	.7	22.3	.9
No. 6	19.0	1.0	20.3	1.1	23.3	1.4
No. 7	19.0	1.0	20.3	1.1	23.3	1.5
No. 8	20.0	.8	21.4	1.0	24.6	1.3
No. 9	22.1	.9	24.1	1.1	28.1	1.5
No. 10	24.6	.8	26.4	.9	30.0	1.2
No. 11	24.6	1.8	26.4	2.1	30.0	3.1
No. 12	28.3	1.7	30.5	2.1	33.0	2.7
No. 13	28.6	1.4	30.8	1.7	33.4	2.1
No. 14	33.8	3.0	35.4	3.5	37.8	4.6
No. 15	34.8	4.8	36.6	6.0	38.5	7.8
No. 16	36.6	3.8	38.7	4.8	40.4	6.1
No. 17	39.4	9.8	41.1	14.2	43.4	33.6
No. 18	39.9	4.8	41.4	5.8	43.8	8.5
No. 19	39.7	.9	40 1	.9	42.1	1.0
No. 20	40.6	8.4	41.1	9.2	42.5	12.4
No. 21	40.5	6.2	40.3	6.0	40.9	6.5
No. 22	40.8	19.3	40.7	18.7	40.9	19.8
No. 24	41.6	23.6	41.6	23.9	41.6	24.0
No. 25	41.6	260.0	41.6	330.8	41.6	378.2
Total Tons	48.8		50.4		52.5	
Total NCS	$340.8		$278.1		$202.4	

Figure B-5 contrasts the system benefits through time with the potential benefits of the system with all congestion costs eliminated (unconstrained benefits). Note the ever-increasing divergence of existing system benefits from the potential congestion-free system benefits.

DETERMINATION OF A FEDERAL INTEREST

To evaluate potential Federal actions to relieve expected system congestion, capacity and delay at 50 percent utilization were estimated using the engineered analytical approach described above for additional 110- by 1,200-foot lock chambers at sites from Lock 11 through Lock 25.

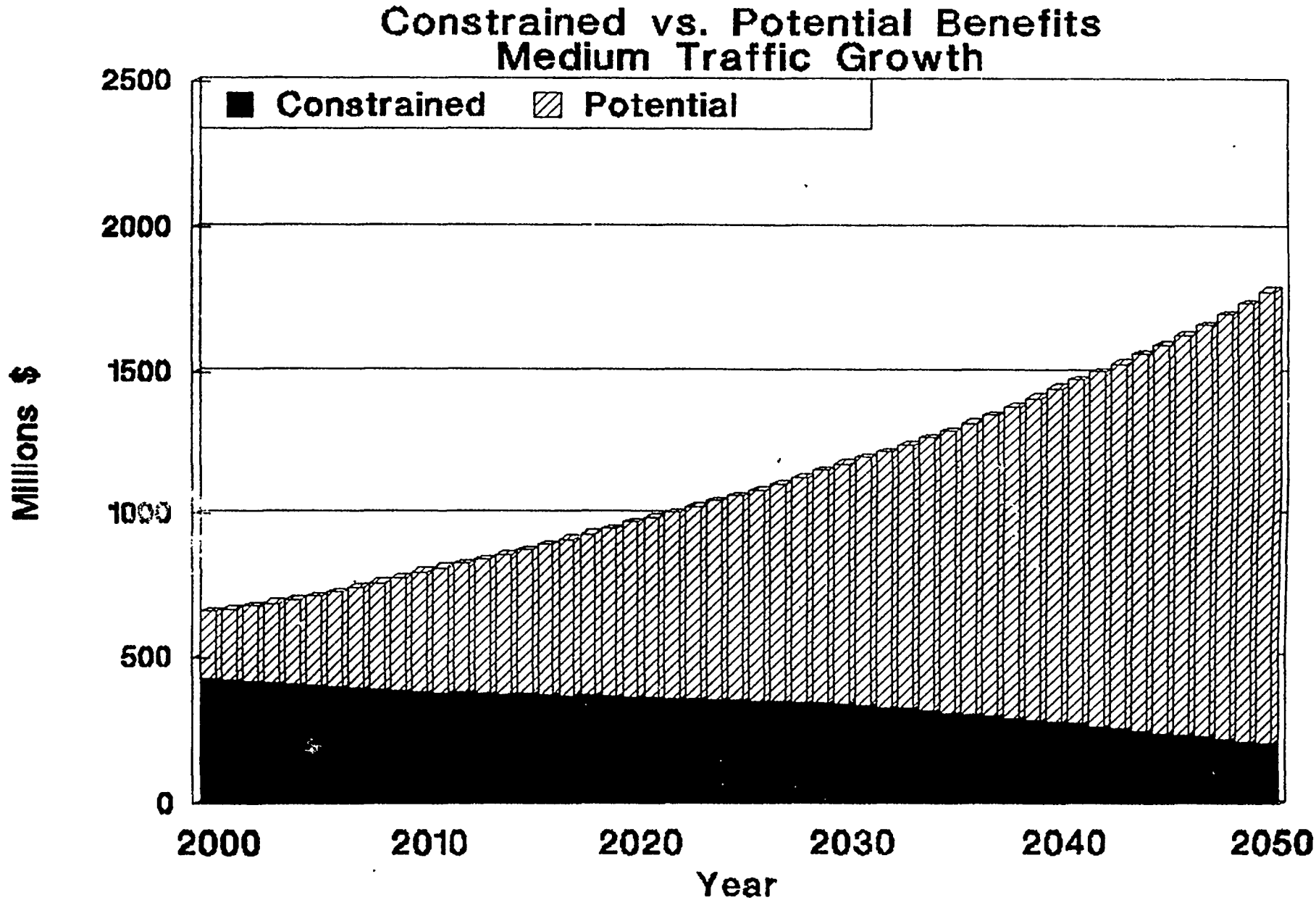
Constrained vs. Potential Benefits
Medium Traffic Growth
Constrained
Potential
Millions $
2500
2000
1500
1000
500
0
2000
2010
2020
2030
2040
2050
Year

FIGURE B-5

Then the system model was run with various combinations of the additional chambers assumed in place. Additional lock chambers were added at sites in the decade when the net incremental transportation cost savings attributable to the additional chambers first exceeded the annual costs of constructing the chambers.

Capacity and delay at 50 percent utilization used for each dual lock chamber site are displayed in table B-13. Note that capacities shown in this table account for both the capacity of the existing lock and the proposed improvement, where appropriate.

TABLE B-13

Capacity and Delay Parameters
for Locks With Additional Chambers

Lock	Capacity (millions of tons)	Delay at 50% Utilization (hours)
No. 11	143.00	0.42
No. 12	147.30	0.42
No. 13	149.80	0.42
No. 14	166.10	0.39
No. 15	147.50	0.42
No. 16	167.40	0.42
No. 17	152.00	0.50
No. 18	172.80	0.39
No. 19	110.60*	0.66
No. 20	168.10	0.36
No. 21	173.40	0.37
No. 22	150.30	0.64
No. 24	166.10	0.50
No. 25	167.70	0.50

* As there is already a 110-foot by 1,200-foot chamber at Lock 19, the addition of a 110-foot by 600-foot chamber is used for this estimate.

FIRST AND AVERAGE ANNUAL COSTS

The estimated first costs of construction and the corresponding average annual costs for the potential additional 110- by 1,200-foot chambers at existing lock sites are displayed in table B-14. The 110- by 1,200-foot lock chambers are evaluated as they represent the most costly means of achieving relief of system congestion. Consequently, if additions of these most costly measures to relieve lock congestion produce a net economic gain, then optimizing on chamber size or alternative nonstructural measures to alleviate congestion only will increase the net benefits of the system.

Average annual costs for all additional lock chambers considered were computed using an 8-7/8-percent interest rate, a 50-year project life, and October 1990 price levels. Interest during construction was calculated based on a 4-year construction period and is included in the average annual costs.

TABLE B-14

Summary of First Costs and Annual Costs
($1,000,000)

Lock	First Cost	Average Annual Cost
No. 11	380.0	39.0
No. 12	380.0	39.0
No. 13	380.0	39.0
No. 14	380.0	39.0
No. 15	380.0	39.0
No. 16	380.0	39.0
No. 17	380.0	39.0
No. 18	380.0	39.0
No. 19	380.0	39.0
No. 20	380.0	39.0
No. 21	380.0	39.0
No. 22	320.0	32.9
No. 24	370.0	38.0
No. 25	367.2	37.7

SYSTEM BENEFITS AND TIMING OF IMPLEMENTATION

The NED benefits estimated herein for each potential systemic action are entirely general navigation. Both total benefits and incremental benefits were estimated for each potential Federal action. Total benefits represent the total transportation cost savings creditable to the system of Upper Mississippi River locks with the assumed set of additional lock chambers in service, whereas the incremental benefits include only those system transportation benefits attributable to the improvements called for under each action. The incremental benefits are the appropriate values for use in the economic evaluation of potential actions.

As previously described, to establish the without-project condition, the General Equilibrium System Navigation Model (GEM) was run using the existing system inputs with 1987 traffic, and projected traffic using the medium growth rates in 2000 and in ten year increments through 2050. The results of these runs are displayed in table B-12 above.

The locks which appear to be the major system constraints in each time period (the locks with the highest delays during the period of analysis) are analyzed for alternative solutions to reduce or eliminate the delays. The alternative solutions involve the possible addition of 110- by 1,200-foot lock chambers (with the exception of Lock 19 which already has a 110- by 1,200-foot chamber in service) where warranted by systemic congestion. On the Upper Mississippi River, Locks 22 through 25 are clearly identified as being the first major constraints showing large delays by the year 2000. Removing a constraint on the system reduces the costs of delay, allowing commodities to move on the waterway at reduced total costs. When the net present value of the cost of removing the constraint(s) first becomes less than the net present value of the delay costs imposed by the constraint(s), then the constraint(s) should be relieved (lock chambers should be added) at that time to maximize the net benefits of the system. The new system with the already warranted lock chamber additions then becomes the base case for successive possible chamber additions in later years. This iterative technique is sequentially applied over the 50-year period of analysis to "optimize" the timing of supplying additional lock chambers. Table B-15 displays the results of this optimization.

TABLE B-15

Sequence of Provision of Additional Lock Chambers and Systemic Costs and Benefits
(October 1990 Price Levels)

Year	Locks With Additional Chamber	Lock Cost	Without System Benefits	With System Benefits	Project Benefits	Net Benefits
1996	22,24,25	264.3				-264.3
1997		264.3				-264.3
1998		264.3				-264.3
1999		264.3				-264.3
2000			426.6	571.6	145.0	145.0
2001			421.7	566.2	144.5	144.5
2002			416.9	560.9	144.0	144.0
2003			412.1	555.7	143.5	143.5
2004			407.4	550.5	143.0	143.0
2005			402.8	545.3	142.5	142.5
2006	17,18,20,21	380.0	398.2	540.2	142.0	-238.0
2007		380.0	393.6	535.1	141.5	-238.5
2008		380.0	389.1	530.1	141.0	-239.0
2009		380.0	384.7	525.1	140.4	-239.6
2010			380.3	728.0	347.7	347.7
2011			378.7	723.0	344.3	344.3

TABLE B-15 (Cont'd)

Year	Locks With Additional Chamber	Lock Cost	Without System Benefits	With System Benefits	Project Benefits	Net Benefits
2012			377.1	718.1	341.0	341.0
2013			375.5	713.2	337.6	337.6
2014			373.9	708.3	334.3	334.3
2015			372.4	703.4	331.1	331.1
2016	14,15,16	285.0	370.8	698.6	327.8	42.8
2017		285.0	369.2	693.8	324.6	39.6
2018		285.0	367.7	689.1	321.4	36.4
2019		285.0	366.1	684.4	318.2	33.2
2020			364.6	922.2	557.6	557.6
2021			362.1	909.9	547.7	547.7
2022			359.7	897.7	538.0	538.0
2023			357.3	885.7	528.5	528.5
2024			354.9	873.9	519.0	519.0
2025			352.5	862.3	509.8	509.8
2026	12,13,19	285.0	350.1	850.7	500.6	215.6
2027		285.0	347.8	839.4	491.6	206.6
2028		285.0	345.4	828.2	482.7	197.7
2029		285.0	343.1	817.1	474.0	189.0
2030			340.8	1,131.3	790.5	790.5
2031			333.9	1,136.6	802.6	802.6
2032			327.2	1,141.9	814.7	814.7
2033			320.6	1,147.2	826.6	826.6
2034			314.2	1,152.6	838.4	838.4
2035			307.9	1,158.0	850.1	850.1
2036	11	95.0	301.7	1,163.4	861.7	766.7
2037		95.0	295.6	1,168.8	873.2	778.2
2038		95.0	289.6	1,174.3	884.7	789.7
2039		95.0	283.8	1,179.8	896.0	801.0
2040			278.1	1,362.6	1,084.5	1,084.5
2041			269.4	1,353.1	1,083.7	1,083.7
2042			261.0	1,343.7	1,082.8	1,082.8
2043			252.8	1,334.4	1,081.6	1,081.6
2044			244.9	1,325.2	1,080.2	1,080.2
2045			237.2	1,316.0	1,078.7	1,078.7
2046			229.8	1,306.8	1,077.0	1,077.0
2047			222.6	1,297.7	1,075.1	1,075.1
2048			215.7	1,288.7	1,073.1	1,073.1
2049			208.9	1,279.8	1,070.9	1,070.9
2050			202.4	1,270.9	1,068.5	1,068.5

	Chamber Costs	Transport Benefits	Net Benefits
Net Present Value	1,637.2	2,226.6	588.9
Average Annual	146.7	199.5	52.8

Table B-15 displays the sequence of the provision of additional chambers at Upper Mississippi River System sites. The column labeled "Locks With Additional Chamber" shows the lock number(s) where an additional chamber is warranted in the year when construction on the additional chamber would begin. All chambers are assumed to require 4 years for construction. System transportation cost savings begin to accrue to the new chambers in the year following their completion.

Total annual costs for providing the indicated additional chambers, total annual system transportation benefits for the base case or without-project condition, total annual system transportation benefits with additional chambers at the indicated sites, and annual net system benefits incremental to the base case over the 50-year period of analysis are displayed in table B-15. As previously explained, system transportation benefits are the gross cost savings water transport has over rail minus the delay costs on the waterway summed for all water movements in the analysis. The net present value of the costs of the additional chambers, the transportation costs savings, and the net benefit stream are summarized. The corresponding average annual computations also are displayed.

As previously explained, incremental benefits include only those system benefits attributable to the improvements called for under each plan. They represent the difference between without-project and with-project system model runs.

The "optimal" capacity expansion plan involves the provision of 14 new lock chambers over the 50-year period of analysis at existing Locks 11 through 25. Three new chambers are needed immediately in the year 2000 at the three most downstream site, Locks 22, 24, and 25. By 2010, additional chambers are needed at Locks 17, 18, 20, and 21. In 2020, three more chambers are justified at Locks 14, 15, and 16. By 2030, new chambers at Locks 12, 13, and 19 are warranted, and in 2040 a new chamber at Lock 11 is needed. The investment in the 14 new chambers would have an average annual cost of $146.7 million, average annual transportation benefits of $199.5 million, and net average annual (NED) benefits of $52.8 million. The benefit-to-cost ratio of this investment sequence is approximately 1.4 to 1.

System transportation benefits generally grow over time with increasing traffic, then decline when delays build at other system locks or constraints. Then, as these new constraints are sequentially released, the system benefits begin to rise again until a new constraint begins causing increased levels of congestion, eroding the system transportation cost savings. Figure B-6 contrasts the annual with improvement benefit stream with both the existing unimproved system benefits stream and the potential benefit stream of a completely uncongested system.

SUMMARY

This analysis has clearly shown a near-term Federal interest in construction of additional locks on the Upper Mississippi River. Justification for additional 1,200-foot chambers at 14 of the Upper Mississippi River System locks has been demonstrated within the context of "medium" levels in system traffic growth.

SENSITIVITY ANALYSIS

PROJECTIONS OF TRAFFIC DEMANDS

Traffic growth rates have a significant impact on potential system transportation cost benefits, and, in turn, on the optimal sequencing of providing additional lock chambers. To explore the implications of different traffic growth rate assumptions on the sequencing of adding carrying capacity through the system, the "optimal" sequence of chamber additions is determined for the low and the high growth rates of the *1988 Inland Waterway Review*. The low growth rates correspond to average annual traffic growth of approximately 1.5 percent over the 50-year period of analysis, while the high growth rates are approximately 2.7 percent annually. The results of these low and high growth "optimal" chamber additions are displayed in tables B-16 and B-17, respectively.

FIGURE B-6

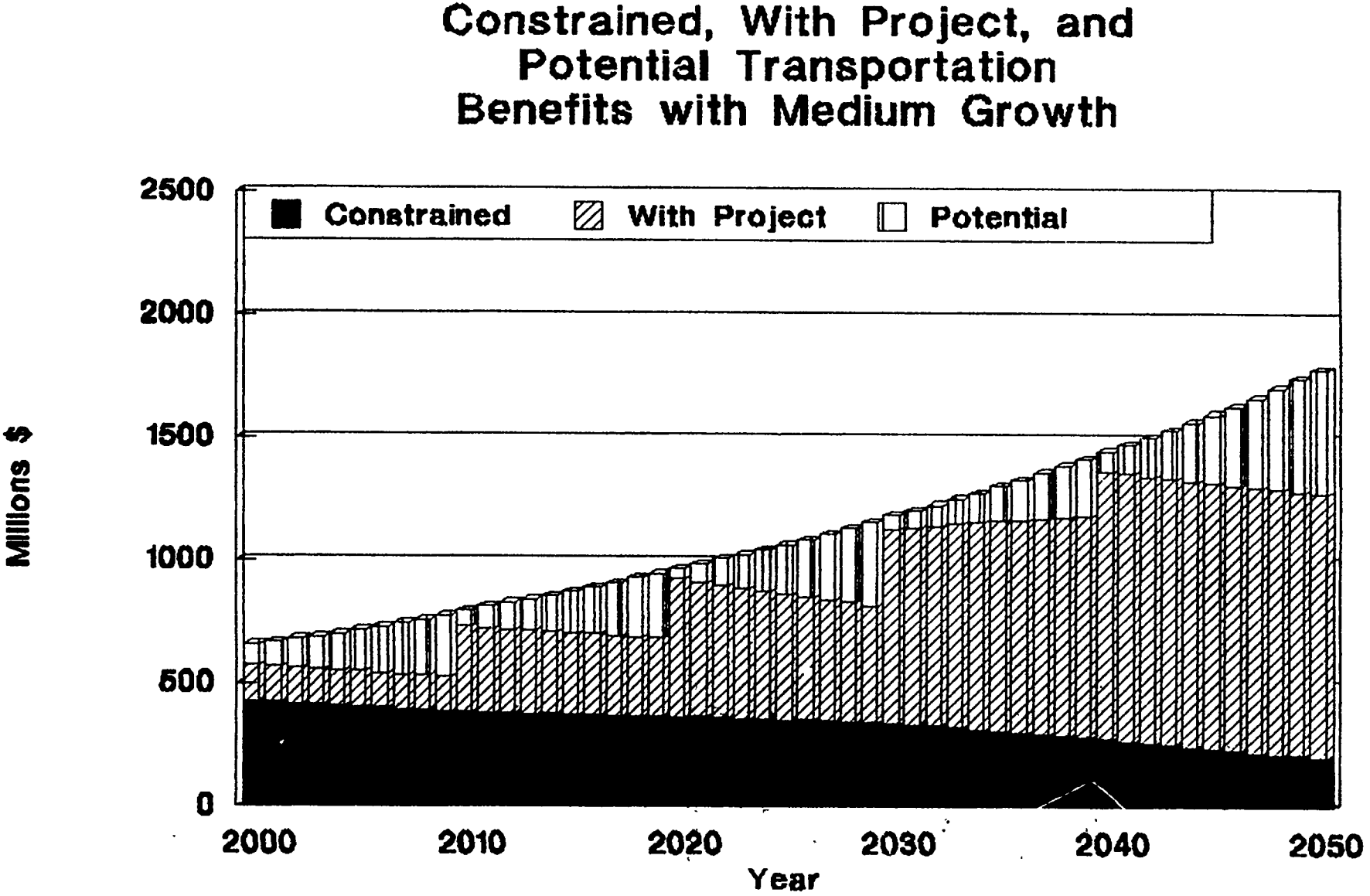
Constrained, With Project, and Potential Transportation Benefits with Medium Growth
Constrained
With Project
Potential
Millions $
2500
2000
1500
1000
500
0
2000
2010
2020
2030
2040
2050
Year

TABLE B-16

Sequence of Provision of Additional
Lock Chambers and Systemic Costs and Benefits
Low Traffic Growth
(October 1990 Price Levels)

Year	Locks With Additional Chamber	Lock Cost	Without System Benefits	With System Benefits	Project Benefits	Net Benefits
1996	22,24,25	264.3				-264.3
1997		264.3				-264.3
1998		264.3				-264.3
1999		264.3				-264.3
2000			441.5	557.0	115.5	115.5
2001			440.2	554.5	114.3	114.3
2002			439.0	552.1	113.1	113.1
2003			437.7	549.6	111.9	111.9
2004			436.5	547.2	110.7	110.7
2005			435.3	544.8	109.5	109.5
2006	20,21	190.0	434.0	542.4	108.3	-81.7
2007		190.0	432.8	539.9	107.2	-82.8
2008		190.0	431.6	537.6	106.0	-84.0
2009		190.0	430.3	535.2	104.8	-85.2
2010			429.1	629.7	200.6	200.6
2011			422.8	623.3	200.4	200.4
2012			416.7	616.9	200.2	200.2
2013			410.6	610.5	199.9	199.9
2014			404.6	604.3	199.7	199.7
2015			398.7	598.1	199.4	199.4
2016	17,18	190.0	392.9	592.0	199.1	9.1
2017		190.0	387.2	585.9	198.7	8.7
2018		190.0	381.5	579.9	198.4	8.4
2019		190.0	376.0	574.0	198.0	8.0
2020			370.5	727.5	357.0	357.0
2021			369.0	721.0	352.0	352.0
2022			367.5	714.5	347.0	347.0
2023			366.0	708.1	342.1	342.1
2024			364.5	701.7	337.2	337.2
2025			363.0	695.4	332.4	332.4
2026	14,15,16	285.0	361.5	689.1	327.6	42.6
2027		285.0	360.1	682.9	322.9	37.9
2028		285.0	358.6	676.8	318.2	33.2
2029		285.0	357.2	670.7	313.6	28.6
2030			355.7	902.7	547.0	547.0
2031			353.5	893.0	539.5	539.5
2032			351.4	883.5	532.1	532.1
2033			349.3	874.0	524.8	524.8
2034			347.1	864.7	517.5	517.5
2035			345.0	855.4	510.4	510.4

TABLE B-16 (Cont'd)

Year	Locks With Additional Chamber	Lock Cost	Without System Benefits	With System Benefits	Project Benefits	Net Benefits
2036	19	95.0	342.9	846.3	503.3	408.3
2037		95.0	340.9	837.2	496.3	401.3
2038		95.0	338.8	828.2	489.4	394.4
2039		95.0	336.7	819.4	482.6	387.6
2040			334.7	1,027.9	693.2	693.2
2041			328.7	1,027.9	699.2	699.2
2042			322.9	1,027.9	705.0	705.0
2043			317.1	1,027.9	710.8	710.8
2044			311.5	1,027.9	716.4	716.4
2045			305.9	1,027.9	722.0	722.0
2046			300.5	1,027.9	727.4	727.4
2047			295.1	1,027.9	732.8	732.8
2048			289.8	1,027.9	738.1	738.1
2049			284.7	1,027.9	743.2	743.2
2050			279.6	1,027.9	748.3	748.3

	Chamber Costs	Transport Benefits	Net Benefits
Net Present Value	1,317.6	1,487.4	169.9
Average annual	118.0	133.3	15.2

TABLE B-17

Sequence of Provision of Additional Lock Chambers
and Systemic Costs and Benefits
High Traffic Growth
(October 199 Price Levels)

Year	Locks With Additional Chamber	Lock Cost	Without System Benefits	With System Benefits	Project Benefits	Net Benefits
1996	20,21,22	454.3				-454.3
1997	24,25	454.3				-454.3
1998		454.3				-454.3
1999		454.3				-454.3
2000			433.5	634.3	200.8	200.8
2001			424.8	630.7	205.9	205.9
2002			416.3	627.2	210.9	210.9
2003			408.0	623.7	215.7	215.7
2004			399.8	620.1	220.3	220.3
2005			391.8	616.7	224.9	224.9
2006	15,16,17,18	380.0	383.9	613.2	229.2	-150.8
2007		380.0	376.3	609.7	233.5	-146.5
2008		380.0	368.7	606.3	237.6	-142.4
2009		380.0	361.3	602.9	241.6	-138.4
2010			354.1	846.6	492.5	492.5
2011			350.9	844.6	493.6	493.6
2012			347.8	842.5	494.7	494.7
2013			344.7	840.5	495.8	495.8
2014			341.6	838.5	496.9	496.9
2015			338.6	836.5	497.9	497.9
2016	12,13,14,19	380.0	335.5	834.5	498.9	118.9
2017		380.0	332.5	832.5	499.9	119.9
2018		380.0	329.6	830.5	500.9	120.9
2019		380.0	326.6	828.5	501.9	121.9
2020			323.7	1,131.7	808.0	808.0
2021			316.2	1,140.2	824.0	824.0
2022			308.9	1,148.8	839.8	839.8
2023			301.8	1,157.4	855.6	855.6
2024			294.8	1,166.1	871.3	871.3
2025			288.0	1,174.8	886.8	886.8
2026	11	95.0	281.3	1,183.6	902.3	807.3
2027		95.0	274.8	1,192.5	917.7	822.7
2028		95.0	268.5	1,201.5	933.0	838.0
2029		95.0	262.3	1,210.5	948.2	853.2
2030			256.2	1,409.0	1,152.8	1,152.8
2031			250.7	1,392.0	1,141.3	1,141.3
2032			245.3	1,375.1	1,129.8	1,129.8
2033			240.0	1,358.5	1,118.5	1,118.5
2034			234.9	1,342.1	1,107.2	1,107.2
2035			229.8	1,325.8	1,096.0	1,096.0

TABLE B-17 (Cont'd)

Year	Locks With Additional Chamber	Lock Cost	Without System Benefits	With System Benefits	Project Benefits	Net Benefits
2036			224.9	1,309.8	1,084.9	1,084.9
2037			220.1	1,294.0	1,073.9	1,073.9
2038			215.4	1,278.3	1,063.0	1,063.0
2039			210.7	1,262.9	1,052.1	1,052.1
2040			206.2	1,247.6	1,041.4	1,041.4
2041			205.4	1,226.3	1,020.9	1,020.9
2042			204.5	1,205.4	1,000.8	1,000.8
2043			203.7	1,184.8	981.1	981.1
2044			202.9	1,164.6	961.7	961.7
2045			202.1	1,144.7	942.6	942.6
2046			201.2	1,125.2	923.9	923.9
2047			200.4	1,106.0	905.5	905.5
2048			199.6	1,087.1	887.5	887.5
2049			198.8	1,068.5	869.7	869.7
2050			198.0	1,050.3	852.3	852.3

	Chamber Costs	Transport Benefits	Net Benefits
Net Present Value	2,252.8	3,260.9	1,008.2
Average Annual	201.8	292.1	90.3

Under both the low and the high growth assumptions, the lower three system locks (22, 24, and 25) all show significant congestion by the year 2000, and additional chambers are justified there at that time. With high traffic growth, Locks 20 and 21 also warrant additional chambers then. As to be expected, with low traffic growth only 11 new chambers are justified over the 50-year period, while under conditions of high traffic growth, accelerated additions of 14 new chambers are warranted (by the year 2020).

ESTIMATES OF EXISTING LOCK CAPACITIES

Without-project lock capacity estimates also impact greatly on estimated benefits and optimal sequencing. The sensitivity of the schedule of lock chamber additions to the capacity of the locks comprising the existing system is explored by assuming that the capacity at all existing chambers can be increased without cost by 25 percent. This increases systemic carrying capacity by 25 percent and will forestall the need for additional new lock chambers. Table B-18 below displays the results of increased existing capacities on the "optimal" sequence of chamber additions. The increased existing capacities delays the need for any new lock chambers

until somewhere near 2010. However, once again, Locks 22, 24, and 25 are the first system locks to warrant capacity expansions. Only 12 new chambers would be needed over the 50-year period of analysis if existing capacities could be increased without cost systemwide.

TABLE B-18

Sequence of Provision of Additional Lock Chambers
and Systemic Costs and Benefits
Existing System Capacities Increased 25 Percent
(October 1990 Price Levels)

Year	Locks With Additional Chamber	Lock Cost	Without System Benefits	With System Benefits	Project Benefits	Net Benefits
2006	22,24,25	264.3	561.3	561.3		-264.3
2007		264.3	557.1	557.1		-264.3
2008		264.3	553.0	553.0		-264.3
2009		264.3	548.9	548.9		-264.3
2010			544.8	708.4	163.6	163.6
2011			539.5	701.3	161.8	161.8
2012			534.3	694.3	160.1	160.1
2013			529.1	687.4	158.3	158.3
2014			524.0	680.5	156.6	156.6
2015			518.9	673.8	154.9	154.9
2016	17,18,20,21	380.0	513.9	667.0	153.2	-226.8
2017		380.0	508.9	660.4	151.5	-228.5
2018		380.0	503.9	653.8	149.9	-230.1
2019		380.0	499.0	647.3	148.2	-231.8
2020			494.2	894.2	400.0	400.0
2021			489.5	887.9	398.4	398.4
2022			484.9	881.6	396.7	396.7
2023			480.3	875.4	395.1	395.1
2024			475.7	869.2	393.5	393.5
2025			471.2	863.1	391.8	391.8
2026	14,15,16	285.0	466.7	857.0	390.2	105.2
2027		285.0	462.3	850.9	388.6	103.6
2028		285.0	457.9	844.9	387.0	102.0
2029		285.0	453.6	838.9	385.3	100.3
2030			449.3	1,127.6	678.3	678.3
2031			446.6	1,116.2	669.6	669.6
2032			443.8	1,104.8	661.0	661.0
2033			441.1	1,093.6	652.5	652.5
2034			438.5	1,082.5	644.0	644.0
2035			435.8	1,071.5	635.7	635.7
2036	12,19	190.0	433.1	1,060.6	627.5	437.5
2037		190.0	430.5	1,049.9	619.3	429.3
2038		190.0	427.9	1,039.2	611.3	421.3

TABLE B-18 (Cont'd)

Year	Locks With Additional Chamber	Lock Cost	Without System Benefits	With System Benefits	Project Benefits	Net Benefits
2039		190.0	425.3	1,028.6	603.4	413.4
2040		190.0	422.7	1,353.2	930.5	740.5
2041			414.3	1,353.3	939.0	939.0
2042			406.0	1,353.4	947.4	947.4
2043			397.9	1,353.5	955.6	955.6
2044			390.0	1,353.6	963.6	963.6
2045			382.2	1,353.7	971.5	971.5
2046			374.6	1,353.8	979.2	979.2
2047			367.1	1,353.9	986.8	986.8
2048			359.8	1,354.0	994.2	994.2
2049			352.6	1,354.1	1,001.5	1,001.5
2050			345.6	1.354.2	1,008.6	1,008.6

	Chamber Costs	Transport Benefits	Net Benefits
Net Present Value	689.2	1,026.3	337.1
Average Annual	61.7	91.9	30.2

SUMMARY

The sensitivity of the "optimal" number and sequence of additional lock chambers warranted on the Upper Mississippi River System to alternative rates of traffic growth and the possibility of cost ess increases to existing capacities has been explored in this section. These are the most important input variables involved in the economic evaluation of potential federal actions. While the exact number and sequence of chamber additions is sensitive to these factors, there is a Federal interest in taking some actions to relieve the expected levels of congestion under all examined assumptions.

SECTION 4 - ASSESSMENT OF RECREATION ISSUES

DISCUSSION OF POTENTIAL ALTERNATIVES

The navigation study was initiated to identify economically and environmentally feasible alternatives to improve the efficiency of the system. As part of that effort, ways to reduce conflicts between commercial and recreational users were examined. The greatest benefits are associated with the locks and dams portion of the system and related commercial navigation. Most of the alternatives proposed would directly benefit commercial navigation, such as providing 1,200-foot locks at sites that are nearing capacity, which would eliminate double lockages. However, benefits to commercial navigation would also benefit recreation. If the time required for commercial lockages were reduced, then the time between recreational lockages would be reduced. Conversely, an alternative that is recreational in nature, such as lock waiting areas or separate locking facilities for recreational craft, may benefit commercial navigation by reducing the congestion in the immediate vicinity of the lock.

A significant data gap exists for analyzing the benefits of recreational boating, especially in terms of locking through. The methodology exists to determine the benefits associated with providing marina slips, and other access points to the system. However, once the recreational boating trip begins, there is a lack of information as to how important the various trip-related activities are, how long is the "average willingness to wait" time for lockages, and typical origin-destination data. Obviously, recreational boaters are willing to wait for lockages, which could be converted into a willingness to pay based on the cost of time. A similar methodology was used in a benefit sensitivity analysis for the Lock and Dam 1 rehabilitation study. In order to fully account for all recreation-related benefits, future study efforts would need to examine the recreation data currently available, and design a data collection effort that would use existing data to the extent possible and fill the data gaps.

Most of the recreation-related alternatives proposed center on reducing the commercial-recreational traffic conflicts. These conflicts occur in the vicinity of the locks and dams, at constricted or confined areas of the main channel and main channel border, and near high use areas. There have been a number of alternatives proposed over the years by various agencies and publics that would, in part, relieve some of the congestion. These proposals have included separate facilities (locks, railways, etc.) to allow passage of recreation craft at the dams, creating separate channels at selected locations, and lock waiting areas.

A study done in the late 1970's in the St. Paul District examined a number of possible structural alternatives to accommodate the increasing recreational use of the locks and dams. However, the costs greatly outweighed the benefits to recreational navigation. These alternatives

were reexamined as part of this study effort. Again, the costs were so great that it was apparent that any recreational benefits that could be developed would be insufficient. For structural measures, such as separate locks, to be economically justified, there would need to be a combination of recreation and commercial benefits.

A related structural solution would be the use of the existing 600-foot chambers at those sites where new 1,200-foot chambers are built. It may be possible to dedicate the smaller chambers for recreational lockages during high use times. A number of safety factors would need to be considered before a decision could be made including, traffic approach and departure patterns, river currents, sight lines, and the economics of operating two chambers.

One approach to determine the economic feasibility of operating the 600-foot chambers primarily for recreational craft at those sites where 1,200-foot chambers would be considered is very similar to the methodology used to justify the additional chamber: the cost of the delay times. For recreational craft, it would be the sum of the inter-arrival time multiplied by the cost of recreational time for each occupant (generally one-half of the hourly income for adults and one-fourth of the adult income for each child).

Unfortunately, the PMS does not record arrival times for recreational craft, nor the number of people per craft. This approach would determine what the recreational boaters are currently paying to lock in terms of waiting time. It does not address the maximum they would be willing to pay. There may be additional recreational benefits associated with the locks. The locking experience itself may be one of the purposes of the trip. Additional surveys would be required to obtain this type of information.

An example of how to use this methodology would be as follows:

Assume: a typical summer weekend day with constant commercial and recreational traffic flow between 9 a.m. and 7 p.m. Each commercial lockage takes 2 hours and there is a recreational lockage of 30 craft between each commercial lockage. There is an average of two adults and two children per recreational craft. The average hourly income per adult is $10.

Therefore:

- The average waiting time per recreational craft is 1 hour.
- The average cost of time per craft is $15 per hour.
- The average cost of delay time per recreational lockage is $450.
- The day's cost of delay for recreational craft would be $2,700

Assuming a recreational season from May 1 to September 30, there are approximately 42 weekend and holiday days. Assuming that the above

scenario is typical for 75 percent of the 42 days, then the cost of delay to the recreational boater would be $85,000. This estimate does not account for the delays that would occur on week days or at times other than those chosen for this example.

The benefits of reducing delays to recreational craft would be compared to the additional costs of operating a second chamber which would have to be determined on a case-by-case basis. Also, there would be some benefits to commercial traffic in reduced delay time when the second chamber was in operation due to a reduction in any delays caused by recreational lockages and the ability of commercial craft to use the second chamber also.

A model could be developed using PMS data to estimate the average delay times for recreation. A number of site-specific criteria would have to be developed; in particular, how the average recreational arrival time would be determined. These efforts would be undertaken during the feasibility study.

One alternative that has been tried without success is establishment of dedicated recreational lockage times. The idea was to have recreational lockages at established times, say, for example, at 10 a.m., noon, 2 p.m., and 4 p.m., on the weekends and holidays. This possibility proved to be unworkable due to the randomness of craft arrivals, the cycle times for lockages, and the times required to make and break tows. It was impossible to guarantee that the locks would be available at the designated times.

One alternative that could be easily implemented is the lock waiting area. These areas would serve two basic functions: an area where recreational boaters could beach or moor their boats while waiting to lock; and, an area where recreational boating and locking information could be disseminated. This alternative could help reduce congestion immediately upstream and downstream of the lock. It would not reduce the waiting times. Conceptual plans for lock waiting areas that have been developed over the years have included sanitary facilities and picnic tables. The basic facility, as proposed in this study, would consist of a beaching area and automated signage that would inform the recreational boater of the estimated time of the next recreational craft lockage.

RECOMMENDED RECREATION ALTERNATIVES

It is recommended that, at those sites where 1,200-foot chambers are to be constructed, the existing 600-foot chambers be operated and maintained. The smaller chambers would be used primarily for recreational lockages during high recreational use periods. They also would be available for commercial lockages during other times.

In addition, lock waiting areas should be provided at Lock and Dam 3 and Lock and Dam 7. These would be minimal facilities, providing a beaching area and automated signage.

SECTION 5 - SCOPE OF STUDIES FOR UPPER MISSISSIPPI RIVER NAVIGATION FEASIBILITY STUDY

PROCEDURES

The procedures to be used in the feasibility study will be consistent with the *Principles and Guidelines for Water and Related Land Resources Planning*. All lock sites in the Upper Mississippi River System will be analyzed to determine the relative magnitude of the constraint that each poses to the efficient flow of traffic and determine the potential transportation resource cost savings that could be realized through modernization.

WORK TASKS

All Upper Mississippi River locks and critical channel constraints will be analyzed and modeled in the first feasibility study with emphasis on the major constraint identified in the reconnaissance study.

The following work tasks expend on the work completed in the reconnaissance study and make up the economic work effort for the first feasibility study on the Upper Mississippi River.

a. **Further Development and Refinement of Capacity Estimates and Delay Costs**. The TK solver program used to calculate capacity in the reconnaissance study will be reevaluated. Sensitivity tests will be conducted to determine confidence intervals around estimates. Other sensitivity tests will examine the impact of recreational traffic on system delays to commercial traffic. Alternate capacity calculations will be made using lock simulation model (LOCKSIM) and Waterway Analysis Model (WAM).

Both capacity and delays and delay costs will be evaluated on a seasonal basis and for historical and projected future conditions (i.e., changing tow size, horsepower. barge loading).

Delay costs will be reevaluated. This evaluation will include discussions with a variety of industry groups, reviewing historical and current monthly PMS/OMNI data, and using barge cost and rate data.

b **Origin-Destination Data Base**. Available origin-destination data for the most current 3 years will be obtained and changes in origins and destinations will be analyzed. The origin-destination data used in the analysis will be developed from these data and analysis. This origin-destination matrix will be reviewed with industry groups and discussed with shippers to assure the accuracy of the existing data. Seasonal changes in

origins for grain also will be analyzed. The availability of year-round navigation causes changes in the origin of grain.

c. **Rate and Cost Studies.** A statistically adequate sample of water movements will be developed. From this sample of origin destination pairs, costs for both water and alternative mode (i.e., rail, truck) will be developed using cost models for line haul portion and extensive surveys of carriers and shippers for access, loading and unloading changes. This effort will be a significant expansion of the reconnaissance study effort. Line haul costs will also be obtained through surveys to verify the cost models. A 1 percent rail waybill sample will be obtained and evaluated to verify rail cost modeling. The resulting rate/cost matrix will be reviewed with industry groups and adjusted, as necessary, to reflect actual transportation routes, costs, and modes of transport. Particular attention will be given to grain and coal to determine the basic origin and destination. Since these two commodities are general intermodal shipments, the distribution of grain origins and source of coal could be important factors in alternative rates and costs.

d. **Traffic Projections.** Traffic demand projections will be developed by commodity group for the entire Upper Mississippi River System by relating the existing traffic base to indexes of growth in the specific regions served by the waterway.

Traffic projections developed for the *Inland Waterway Review* will be reviewed with industry groups, updated, and revised, as needed, based on current trends and the latest information available and incorporated into feasibility level traffic projections. The current increase in grain shipped on the Upper Mississippi River and the changes from eastern to western coal sources makes this analysis important to accurately predicting future traffic.

e. **Navigation Model.** Determine which possible improvements to the GEM system are most appropriate for use in the Upper Mississippi River feasibility studies. Tailor the model to best incorporate the plans to be addressed, including both structural and nonstructural solutions as well as congestion fee analyses.

f. **Plans.** The first feasibility study will define the order and timing of system improvements. A full range of plans will be evaluated separately and in combination and sequenced at each lock site or constraint on the Upper Mississippi River. These plans can be categorized as major structural improvements, minor structural improvements, floating plant, and nonstructural plans and are shown in table B-19.

TABLE B-19

Alternative Solutions

Major Structural Improvements

a. 1,200-Foot Lock Replacement
b. Enlarging Lock from 600 Feet to 1,200 Feet
c. Lifts or Carriers for Recreational Craft
d. Recreational/Auxiliary Locks

Minor Structural Improvements

a. Mooring Cells
b. Extended Guidelines
c. Wind Deflectors
d. Improved Gates to Pass Ice
e. Improved Tow Haulage Equipment (Traveling Kevels)
f. Air Bubbler Systems
g. Floating Mooring Bitts
h. Modify Intake/Outlet Structures
i. Improved Lock Operating Equipment/Approaches
j. Mobile Floating Locks

Floating Plant

a. Helper Boats
b. Mandated Bow Thrusters for Larger Tows
c. Switch Boats

Nonstructural Plans

a. Lock Waiting Areas
b. N-Up/N-Down Policy
c. Mandated (Efficient) Tow Configurations
d. Recreational Lockage Hours
e. User Fees
f. Risk and Uncertainty Analysis. Multiple runs of the system model will be made to examine the sensitivity of system benefits to changes in capacity, delay, delay costs, and rates/costs. A risk analysis will be conducted.
g. Coordination and Report Preparation. The objective of this task is to prepare a draft and final report which explains the systems analysis and prioritization of improve the Upper Mississippi River System. Work conducted in completing each task will be summarized and results from model runs will be presented. The analysis will be fully coordinated within the Rock Island District and with North Central Division and higher headquarters. Coordination will be maintained with industry groups and environmental interests throughout the study process.

ENGINEERING ANALYSIS

APPENDIX C

RECONNAISSANCE REPORT
FOR
UPPER MISSISSIPPI RIVER NAVIGATION STUDY

APPENDIX C
ENGINEERING ANALYSIS

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RECONNAISSANCE REPORT
FOR
UPPER MISSISSIPPI RIVER NAVIGATION STUDY

APPENDIX C
ENGINEERING ANALYSIS

The purpose of this appendix is to provide details for the various alternatives considered in the feasibility report. Alternatives discussed included a minor structural measure (waiting areas upstream and downstream of locks for recreation craft) and major structural measures.

MAJOR STRUCTURAL MEASURES

LOCK AND DAM 20

Description

The lock and dam, which was completed in 1936, is located at river mile 343.2, with the lock located on the Missouri side of the river at the town of Canton (see figure C-1). The lock and a portion of the dam structure

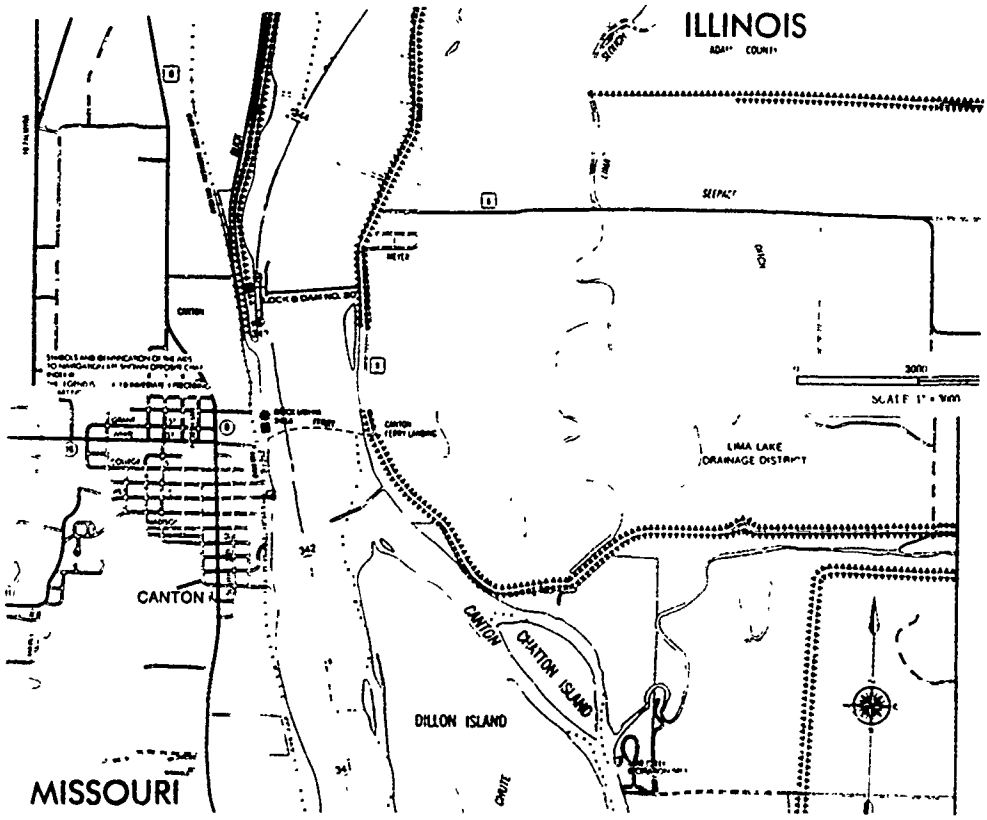

FIGURE C-1

are founded on rock, while the remaining portion of the dam is founded on sand and supported by piles. The lock has a usable chamber which is 110 feet wide and 600 feet long, with miter gates at both the upstream and down-stream ends. The lift is 10.0 feet. The upstream guidewall is 555 feet long, and the downstream guidewall is 589 feet long. Between the lock and dam is a 110-foot-wide gate bay with a pair of miter gates. A cell and beam type guard wall is located upstream of the river wall. The dam consists of 6 submergible and 34 nonsubmergible tainter gates, each 40 feet wide and 20 feet high. There are also 3 submergible roller gates which are 60 feet wide and 20 feet high.

Condition of Existing Structure

Lock and Dam 20 underwent major rehabilitation between 1986 and 1991 to extend its useful life. This rehabilitation included upgrading the lock's mechanical/electrical systems, replacing deteriorated concrete, rehabilitating the miter gates, and constructing a new central control station. Rehabilitation of the dam included placing additional scour protection above and below the dam, rehabilitating the roller and tainter gates, replacing the mechanical/electrical systems, and replacing deteriorated concrete on the dam piers. The lock and dam facility is stable, with no structural deficiencies noted. The condition of the structure and mechanical/electrical components will continue to be monitored as part of the Periodic Inspection Program.

Approach Problems

The upper approach to the lock is subjected to outdrafts that pull tows toward the dam. The outdrafts extend approach time and often result in accidents that damage the upper end of the lock. The upper approach is plagued with ice and debris blockages from the Des Moines River that restrict access to the lock. There are no mooring sites above or below the lock that allow for efficient exchange of tows and transit of the lock.

Alternative: Add 1,200-Foot Lock to the Existing Structure

Landside. The location of a 1,200-foot lock on the landside of the existing site would increase the curvature of the approach to the lock. This will increase the approach time to the lock, as well as the likelihood of navigation accidents occurring. The increase in approach curvature also will add to the already serious debris and ice collection problem that exists in the upper approach to the lock. A landside location would require extensive relocations to the adjacent railroad, oil tank farms, a major ferry landing, and portions of the city of Canton, Missouri. Construction of the lock would impact navigation traffic during the new

required channel cuts. The advantages to this location would be a reduction in cofferdam requirements, operational advantages since both locks would be adjacent to each other, and easier and less costly construction since the new lock would be built on a rock foundation.

Far Side. The location of a new 1,200-foot-lock on the far side would improve the approach curvature for downbound traffic, but would hinder upbound approaches. This location would require massive channel relocations and relocations to the town of Meyer, Illinois, a major ferry landing. The far side lock location would hamper operations since the locks would be located approximately 2,500 feet apart and would require the maintenance of two navigation channels above and below the lock.

Dam. Locating a new 1,200-foot lock in the dam could be done with only minor modifications to the existing channel. This location also would improve the approach curvature for both upbound and downbound traffic. The lock could be built with little interference to navigation. The two locks would be located a significant distance apart, which would fragment operations. This lock would require a pile foundation and cofferdam that will increase the cost of this alternative. Significant design and construction problems relating to the sheetpile cutoffs and cofferdamming exist.

Auxiliary Lock. Locating a new 1,200-foot lock in the auxiliary lock would improve upstream and downstream approach conditions. There would be no changes in operation since both locks would be adjacent to one another. The lock would be difficult to construct without interference to navigation. Significant design and construction problems exist relating to the sheetpile cutoffs and cofferdamming.

Extend Existing Lock. This alternative is impractical to construct since navigation traffic would have to be completely shut down for an extended period of time. Construction of this alternative under traffic also is completely impractical.

Alternative: Replace Existing Lock and Dam with a New Lock and Dam

Constructing a new 1,200-foot lock and dam at a remote site would be very costly and would require purchasing additional real estate for both the new facilities and new pool configuration. A new site would eliminate construction and design problems of trying to tie the sheetpile cutoffs into the existing structure.

LOCK AND DAM 21

Description

The lock and dam is located at river mile 324.9 with the lock on the Illinois shore at the city of Quincy (see figure C-2). The structures are founded on sand and supported by piles. The lock has a usable chamber 110 feet wide by 600 feet long, with miter gates at both the upstream and downstream ends. The filling system is the side port type, and the flat pool lift is 10.5 feet. There also is a 555-foot-long upstream guidewall and a 589-foot-long downstream guidewall. Between the lock and dam, there is only one gate bay with a pair of miter gates. A cell and beam type guard wall is located upstream of the river wall. The dam consists of 10 submergible tainter gates each 64 feet wide and 20 feet high. There also are 3 submergible roller gates, each 100 feet wide and 20 feet high. Connecting the gated dam section to the Missouri shore is 1,890 feet of dike, of which 1,400 feet is submergible.

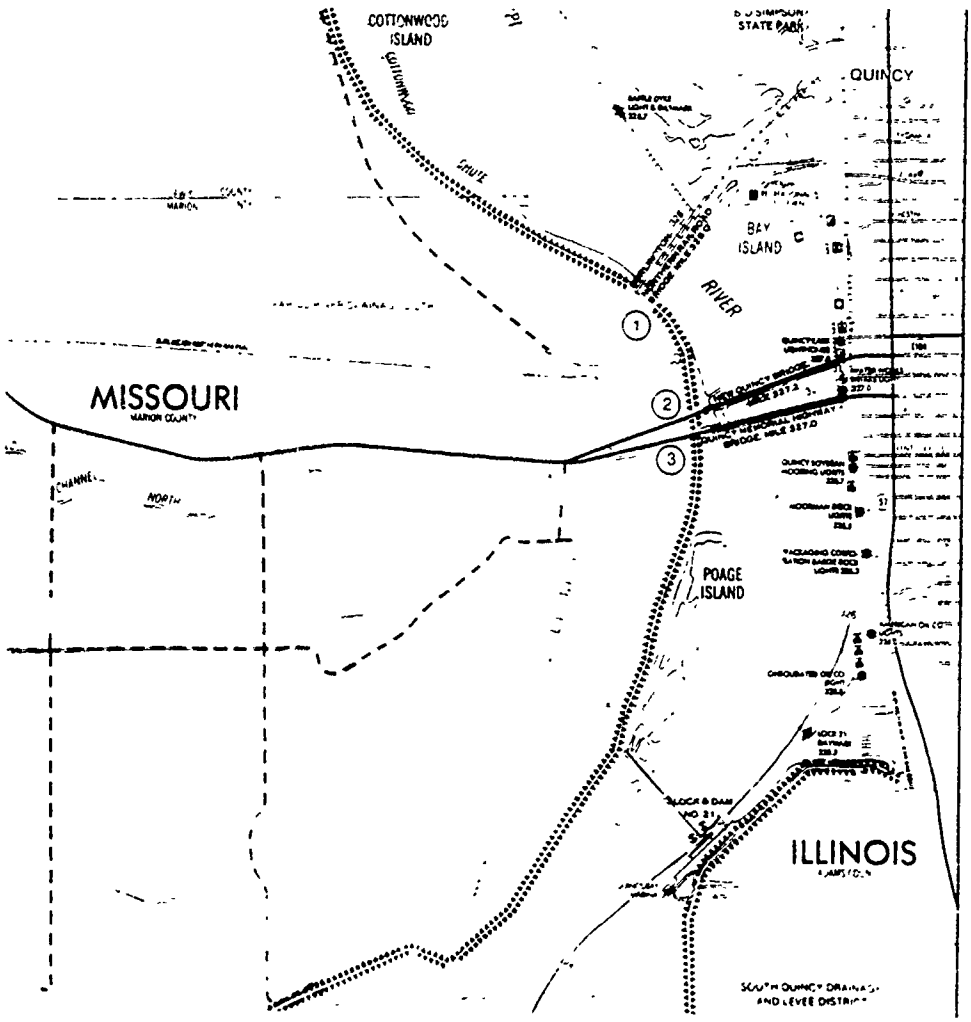

FIGURE C-2

Condition of Existing Structure

Lock and Dam 21 was rehabilitated between 1987 and 1990 to extend its useful life. This rehabilitation included upgrading the lock's mechanical/electrical systems, replacing deteriorated concrete, and rehabilitating the miter gates and tainter valves. Rehabilitation of the dam included placing additional scour protection above and below the dam, rehabilitating the roller and tainter gates, and replacing the electrical systems. The lock and dam facility is stable, with no structural deficiencies noted. The condition of the structure and mechanical/electrical components will continue to be monitored as part of the Periodic Inspection Program.

Approach Problems

The upper and lower approaches to the lock are subjected to outdrafts that pull tows toward the dam. The outdrafts extend approach time and often result in accidents that cause damage to the lock and dam. There are no mooring sites above or below the lock that allow for efficient exchange of tows and transit of the lock.

Alternative: Add 1,200-Foot Lock to the Existing Structure

Landside. The location of a 1,200-foot lock on the landside of the existing site will increase the curvature of approach to the lock. This will increase approach times to the lock as well as the likelihood of a navigation accident occurring. A landside location would require extensive relocations to the adjacent sewage treatment plant and South Quincy Drainage District levee. Construction of the lock would impact navigation traffic during the new required channel cuts. The advantages to this location would be a reduction in cofferdam requirements, and no changes in operations since both locks would be adjacent to one another. The new lock would be built on a pile foundation.

Far Side. The location of a new 1,200-foot lock on the far side would increase the approach curvature for both downbound and upbound traffic. The location would require massive channel relocations and relocation of a local flood protection levee. The far side lock location would hamper operations since the new lock and existing lock would be located about 2,600 feet apart and would require the maintenance of two navigation channels above and below the lock.

Dam. Locating a new 1,200-foot lock in the dam could be done with only minor modifications to the existing channel. This location also would improve the approach curvature for both upbound and downbound traffic. The lock could be built with little interference to navigation. Additional discharge capacity would have to be provided in the non-gated overflow

section. The two locks would be located a significant distance apart, resulting in the fragmentation of operations. This lock would require a pile foundation and cofferdam that will increase the cost of this alternative. Significant design and construction problems exist relating to the sheetpile cutoffs and cofferdamming.

Auxiliary Lock. Constructing a new 1,200-foot lock in the auxiliary lock would be difficult because its proximity to the operating lock would interfere with navigation. Also, construction problems would be encountered in trying to tie into the existing facility. Significant design and construction problems relating to the sheetpile cutoffs and cofferdamming exist.

Alternative: Extend Existing Lock

This alternative is only practical if navigation traffic can be completely shut down for an extended period. Construction of this alternative under traffic is completely impractical.

Alternative: Replace Existing Lock and Dam with a New Lock and Dam

Constructing a new 1,200-foot lock and dam at a remote site would be very costly and would require purchasing additional real estate for both the new facilities and new pool configuration. However, a new site would eliminate construction problems of trying to tie the sheetpile cutoffs into the existing structure.

LOCK AND DAM 22

Description

Lock and Dam 22 was completed in 1938. The project is located at river mile 301.2, and the lock is on the Missouri side of the river near the town of Saverton (see figure C-3). The lock is of gravity wall design founded on rock with a usable chamber 110 feet wide by 600 feet long. The filling system is the side port type, and the flat pool lift is 10.5 feet. Both the upstream and downstream lock gates are miter type. The upstream guidewall is 555 feet long, and the downstream guidewalls are 589 feet long. Between the lock and dam there is one gate bay with a pair of miter gates. The dam gates consist of 10 tainter gates and 3 roller gates. Nine tainter gates are nonsubmergible, leaving one submergible. Each of the tainter gates is 60 feet wide and 25 feet high. The roller gates are 100 feet wide and 25 feet high and are submergible. There is 2,060 feet of dike connecting the gated dam section to the Illinois shore, of which 1,600 feet is submergible.

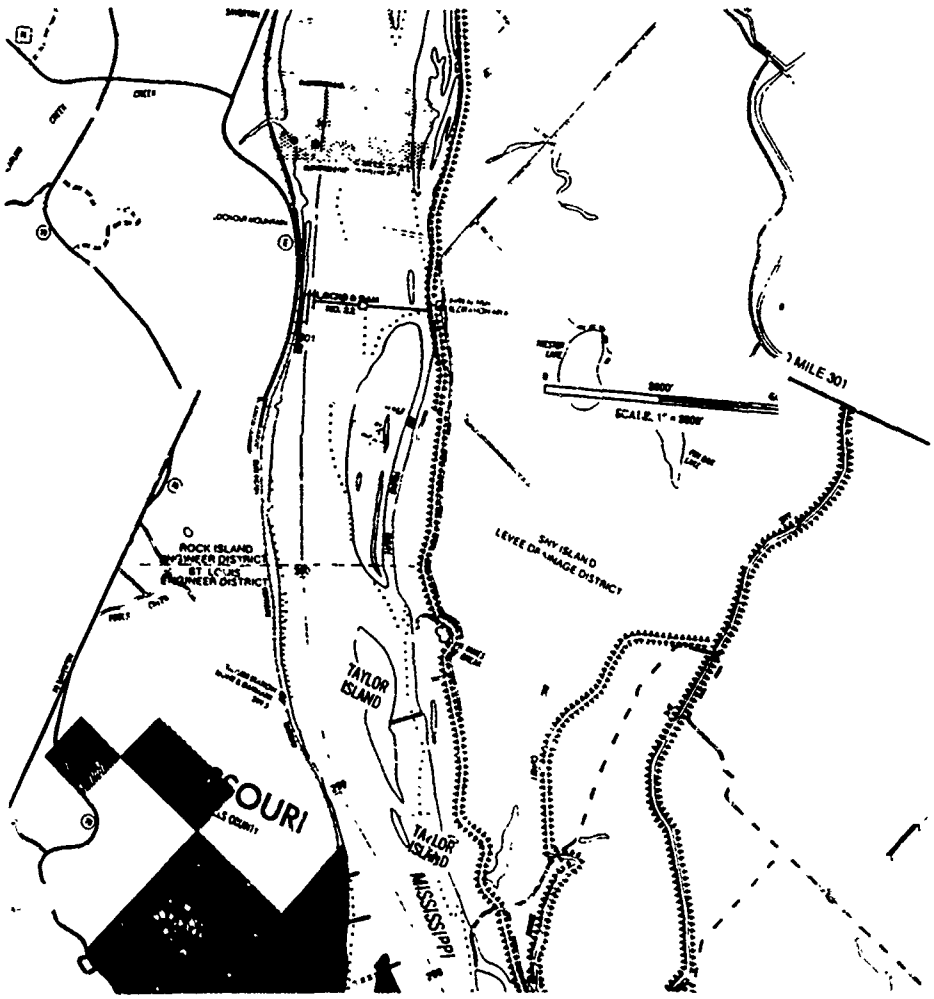

FIGURE C-3

Condition of Existing Structure

Lock and Dam 22 was rehabilitated between 1987 and 1990 to extend its useful life. This rehabilitation included upgrading the lock's mechanical/electrical systems, replacing deteriorated concrete, and rehabilitating the miter gates and tainter valves. Work on the dam included rehabilitating the roller and tainter gates and replacing the electrical systems. The lock and dam facility is stable, with no structural deficiencies noted. The condition of the structure and mechanical/electrical components will continue to be monitored as part of the Periodic Inspection Program.

Approach Problems

The upper and lower approaches to the lock are subjected to outdrafts that pull tows toward the dam. The outdrafts extend approach time and often result in accidents that cause damage to the lock and dam. There are no mooring sites above or below the lock that allow for efficient exchange of tows and transit of the lock. The downstream approach is restricted by the channel width and bend above the lock.

Alternative: Add 1,200-Foot Lock to the Existing Structure

Landside. The location of a 1,200-foot lock on the landside of the existing site will have minor impacts to the curvature of approach to the lock. A landside location would require relocations to the adjacent railroad and cabins. The new lock would require massive excavation along Lookout Mountain. Construction of the lock would impact navigation traffic during the new required channel cuts. The advantages to this location are that cofferdam requirements would be reduced and no changes in operations would be required since both locks would be adjacent to one other. The new lock would be built on a rock foundation.

Far Side. The location of a new 1,200-foot lock on the far side would increase the approach curvature for both downbound and upbound traffic. This location would require massive channel relocations and relocation of a local drainage district levee. The far side lock location would hamper operations since the new lock and existing lock would be located about 3,500 feet apart and would require the maintenance of two navigation channels above and below the lock.

Dam. Locating a new 1,200-foot lock in the dam could be done with only minor modifications to the existing channel. This location also would improve the approach curvature for both upbound and downbound traffic. The lock could be built with little interference to navigation. Additional discharge capacity would have to be provided in the non-gated overflow

section. The two locks would be located a significant distance apart, resulting in fragmentation of the operations. This lock would require a rock foundation. Significant design and construction problems relating to cofferdamming exist.

Auxiliary Lock. Locating a new 1,200-foot lock in the auxiliary lock would be very difficult to construct. The closeness to the operating lock would interfere with navigation. Also, construction problems would be encountered in trying to tie into the existing facility. Significant design and construction problems relating to the sheetpile cutoffs and cofferdamming exist.

Alternative: Extend Existing Lock

This alternative is only practical if navigation traffic can be completely shut down for an extended period of time. Construction of this alternative under traffic is completely impractical.

Alternative: Replace Existing Lock and Dam with a New Lock and Dam

Constructing a new 1,200-foot lock and dam at a remote site would be very costly and would require purchasing additional real estate for both the new facilities and new pool configuration.

LOCK AND DAM 24

Description

The lock and dam is located at river mile 273.4 adjacent to Clarksville, Missouri (see figure C-4). Construction of the lock and dam began in 1936, and project operations were initiated on March 12, 1940. The structure consists of a lock chamber 600 feet long by 110 feet wide, and 15 tainter gates 80 feet wide by 25 feet high. Adjacent to the lock is an upper gate for a dummy auxiliary lock, which was never built.

Condition of Existing Structure

The lock and dam is showing the wear and tear of 50 years of operation. The concrete exhibits distress, indicating serious deterioration. The most serious areas were patched, but these were considered small in relation to the overall extent of the deterioration. The lock gates are in need of replacement. The control system, which is the original equipment, is obsolete and replacement parts are not readily available.

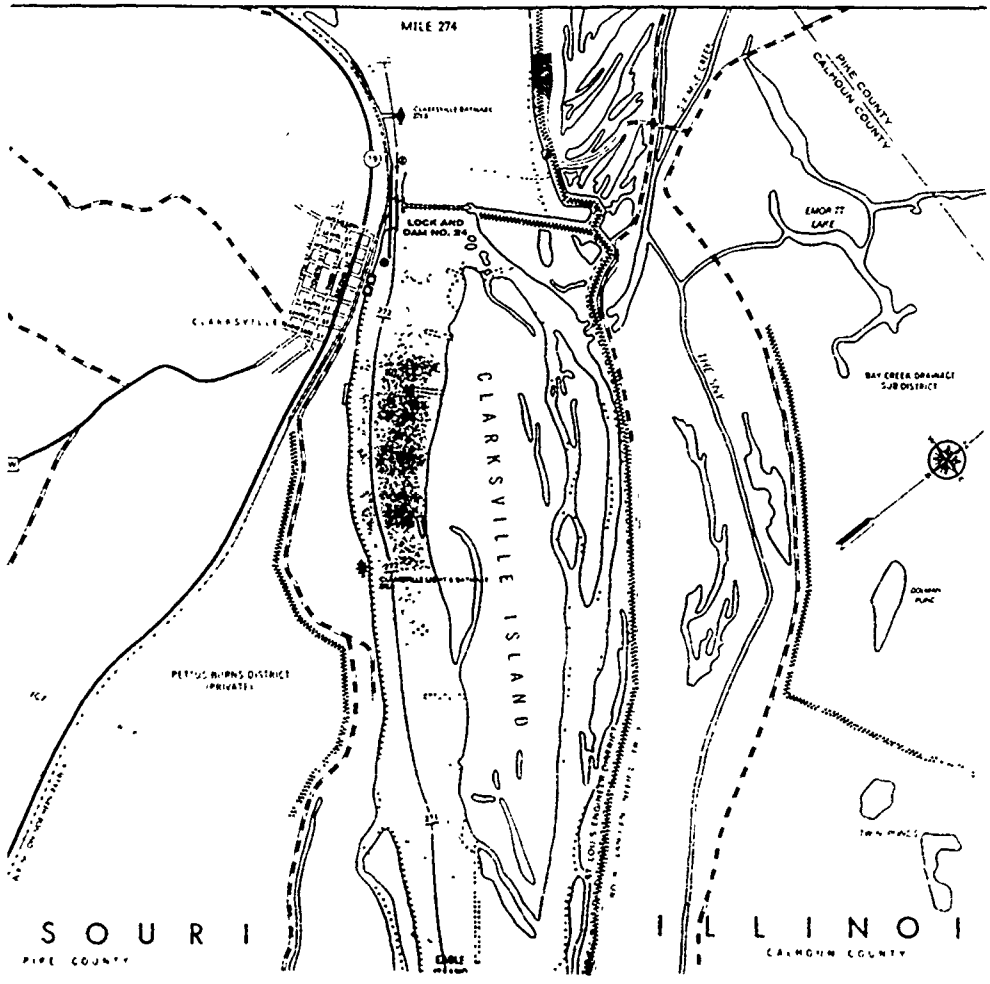

FIGURE C-4

The auxiliary lock gates have corroded to such an extent that they can no longer be relied upon to retain pool. A rock dike constructed immediately upstream of the gates to retain pool has exhibited sloughing of the upstream face and is in need of repair. The storage yard at the project exhibits serious settlement problems which are believed to be due to scour adjacent to the storage yard. Spalling of the shale lock floor has been noted on a continuing basis, due to tow prop action.

Approach Problems

Tows entering Lock 24 from the upstream direction experience approach problems due to the severe outdraft during open river conditions.

Alternative: Add 1,200-Foot Lock to the Existing Structure

Landside. Major drawbacks of the location on the Missouri side of the existing 600-foot lock were the limited space on the Missouri bank due to a highway and rail line next to a high rock bluff and the necessity to relocate several city blocks in Clarksville, Missouri.

Far Side. Access is limited on the Illinois side for construction and operation purposes. Also, for any plan which would move the main channel to the opposite side of the river, extensive channel work and river training works would be required to accommodate navigation entering and exiting the lock.

Dam. The lock would be located in the dam towards the Missouri side of the river to provide the best approach and departure conditions for navigation. Two new dam gates would be constructed between the new lock and the existing lock. The major concern would be the effects of construction vibrations and loads imposed on the existing structure due to the cofferdam, dewatering, and construction excavation.

Auxiliary Lock. Constructing a new 1,200-foot lock in the space allowed for an auxiliary lock would be difficult without interfering with navigation. The existing intermediate wall could not be used as part of the cofferdam for the new construction. Construction vibrations and cofferdam loads would be a problem on the existing structure.

Alternative: Extend Existing Lock

This alternative is not practical since it would require stopping navigation during construction.

Alternative: Replace Existing Lock and Dam with a New Lock and Dam

A new structure would be constructed in the vicinity of the existing lock and dam, operating with the same pool levels as the existing facility. This alternative would eliminate the uncertainty of construction activities on an existing structure. This alternative would eliminate the uncertainty of construction activities on an existing structure and eliminate structural problems due to deteriorating concrete.

LOCK AND DAM 25

Description

The lock and dam is located at mile 241.4 near Winfield, Missouri (see figure C-5). Construction began in 1935 and the facility went into operation in 1939. The structure has a single lock 600 feet long and 110 feet wide, and a dummy gate bay for an auxiliary lock which was never built. The dam consists of 14 tainter gates, each 60 feet wide by 25 feet high, and 3 roller gates, each 110 feet wide. Since construction, the maximum regulated pool has been elevation 434.0, and the minimum tailwater has been elevation 416.1, or a maximum differential head of 17.9 feet.

Condition

The major problem with this facility is the inability to dewater the lock without causing serious underseepage problems in the lock floor. In addition, the lock gates are in need of replacement. The lock and dam control system is obsolete, making repairs difficult.

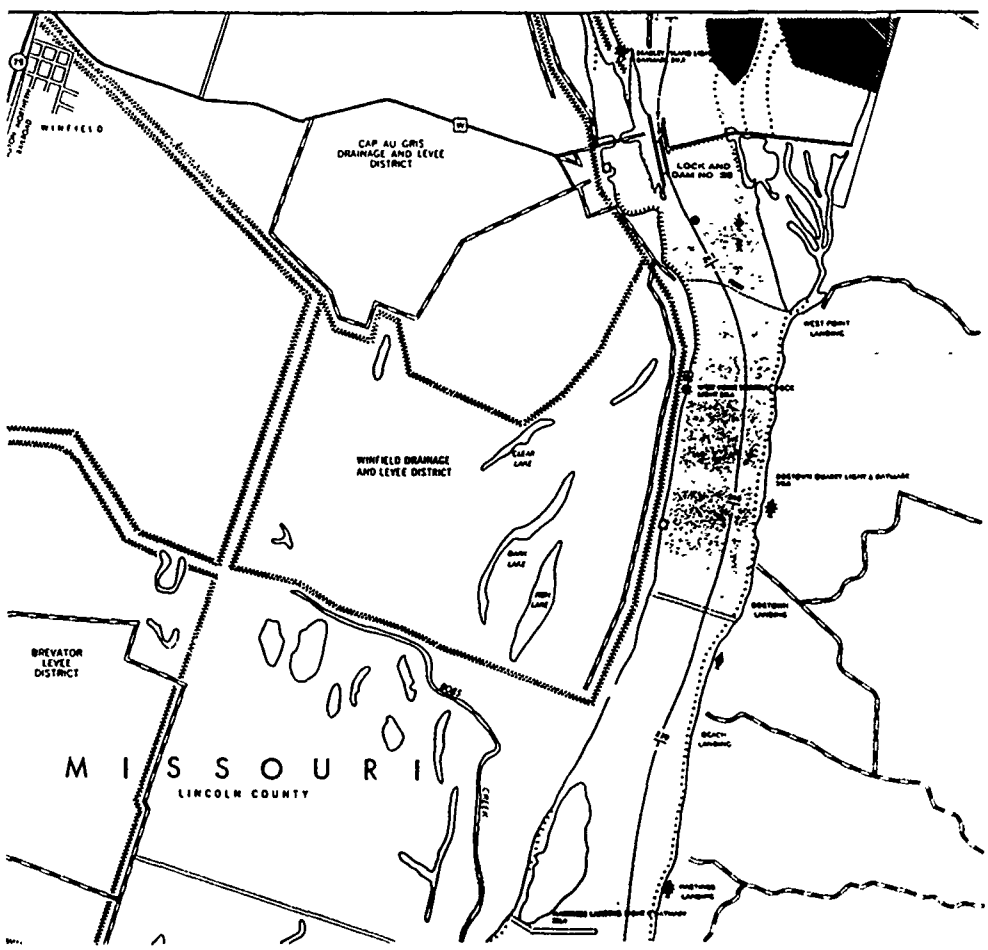

FIGURE C-5

The lock gates are in need of replacement, and the control system, which is the original equipment, is obsolete and replacement parts are not readily available. The auxiliary lock gates have corroded to such an extent that they can no longer be relied upon to retain pool. A rock dike constructed immediately upstream of the gates to retain pool has exhibited sloughing of the upstream face and seepage problems, which raise questions of the ability of the dike to retain pool. Large voids found beneath the timber pile founded dam have been grouted with low strength grout to prevent seepage and piping beneath the dam; however, the grouted voids reduce the load-carrying capacity of the pile foundation. Serious scour problems beneath the upstream guidewall, while repaired, have reduced the load-carrying capacity of the guidewall. Attempts to stop continuous movement of the downstream guidewall have been made on several occasions by grouting the foundation, tying the three moving monoliths to three stationary monoliths with post tensioning, and adding an end cell. While the movement has appeared to stop, the load-carrying capacity of the guidewall is in question. Serious settlement of the storage yard at this project is due to scour adjacent to the storage yard and a defective monolith joint which continuously loses material.

Approach Problems

Tows are able to enter the lock without any particular problem.

Alternative: Add 1,200-Foot Lock to the Existing Structure

Landside. An area exists landside of the existing lock in Sandy Slough, which would allow construction to proceed without detrimental effects on the existing structure. The new lock would be separated from the 600-foot lock by overflow monoliths. The lock would be angled from parallel with the existing lock centerline to provide better entrance conditions both upstream and downstream. The lock would be U-frame concrete monoliths and pile founded. The lift is 15 feet and a side port filling and emptying system would be utilized. Miter gates would be used upstream and downstream for the lock. No rehabilitation of the dam was included, as all repairs were considered to be accomplished under the Operations and Maintenance program. Relocation of a grain elevator and several club houses would be necessary.

Far Side. Access is limited on the Illinois side for construction and operation purposes. Also, for any plan which would move the main channel to the opposite side of the river, extensive channel work and river training works would be required to accommodate navigation entering and exiting the lock.

Dam. The lock would be located in the dam towards the Missouri side of the river to provide the best approach and departure conditions for

navigation. Two new dam gates would be constructed between the new lock and the existing lock. The major concern would be the effects of construction vibrations and loads imposed on the existing structure.

Auxiliary Lock. Locating the new 1,200-foot lock in the space allowed for an auxiliary lock would be difficult to construct without interference to navigation. The existing intermediate wall could not be used as part of the cofferdam for the new construction. Construction vibrations and cofferdam loads would be a problem on the existing structure.

Alternative: Extend Existing Lock

This alternative is impractical since it would require stopping navigation during construction.

Alternative: Replace Existing Lock and Dam with a New Lock and Dam

A new structure would be constructed in the vicinity of the existing lock and dam, operating with the same pool levels as the existing facility. It is anticipated that the additional 1,200-foot lock would be constructed in Sandy Slough on the Missouri side, approximately 250 feet west of the existing 600-foot lock.

Alternative: Construct New Lock and Dam to Replace Two Existing Locks and Dams

A new lock could be constructed in the vicinity of Lock and Dam 25 to replace both existing Locks and Dams 24 and 25. The pool at Dam 24 would be extended to the new dam, raising water levels in the 32-mile-long Pool 25 approximately 15 feet. The higher water levels would affect lands on each side of the river, inundating farmland and wildlife areas. Portions of a highway and a railroad line would either be flooded or affected by the raised water level. Portions of towns would be affected by the higher water, either from flooding or from raised groundwater seeping into basements. Pump stations and levees may be required to control water levels in some areas. The higher head would require a different type of filling and emptying system than for the other alternatives.

NONSTRUCTURAL MEASURE

LOCK WAITING AREAS

Since the mid-1970's, lock waiting areas have been considered as a measure for alleviating congestion of recreational craft at locks in the St. Paul District. They were evaluated in a report by the St. Paul, Rock Island, and St. Louis Districts entitled, *Recreational Craft Locks Study - Stage II Report, Upper Mississippi River*, dated September 1977. A subsequent report entitled, *Recreational Craft Locks Study, Design of Lockage Waiting Areas at L.S.A.F. Lock, Lock 2 & Lock 3, Upper Mississippi River*, dated January 1980, provides a more detailed design of the lock waiting area concept.

Previous conceptual plans for lock waiting areas have included sanitary facilities and picnic tables. The basic facility, as proposed in this study, would consist of a beaching area and automated signage that would inform recreational boaters of the estimated time of the next recreation craft lockage. Cost estimates were developed for sites at Locks 3 and 7.

Maintenance in the form of beach nourishment would be required on a periodic basis.

HISTORIC PROPERTIES

APPENDIX D

RECONNAISSANCE REPORT
FOR
UPPER MISSISSIPPI RIVER NAVIGATION STUDY

APPENDIX D
HISTORIC PROPERTIES

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RECONNAISSANCE REPORT
FOR
UPPER MISSISSIPPI RIVER NAVIGATION STUDY

APPENDIX D
HISTORIC PROPERTIES

Construction of the Nine-Foot Channel Navigation Project began in the 1930's and was completed in the early 1940's. Extant remains of Old Lock 19 (built between 1910 and 1913), the Old LeClaire Lock and Lateral Canal (part of the Six-Foot Navigation Project built in 1922) and Locks and Dams 1 and 2 all predate the Nine-Foot Navigation Project.

Old Lock 19, the 1910 Keokuk Power Dam, and Dam 1 are all individually listed on the National Register of Historic Places for historical, architectural, and technological significance. The State Historic Preservation Officers (SHPOs) from Illinois, Iowa, Minnesota, Missouri, and Wisconsin have agreed, along with the Rock Island and St. Paul Districts, that the entire Mississippi River Nine-Foot Channel Navigation Project is significant and eligible for listing on the National Register of Historic Places.

Significance is based upon the role of the navigation system in the economic history of the Nation, along with New Deal political history and engineering technology aspects. In recognition of this significance and to fulfill National Historic Preservation Act requirements for the ongoing major rehabilitation efforts at the Locks and Dams, the SHPOs, the Corps, and the Advisory Council on Historic Preservation (ACHP) entered into a Programmatic Memorandum of Agreement (PMOA) for treatment of the hi[illegible]ic structures during rehabilitation. A copy of the PMOA can be found [illegible] this appendix, and a detailed discussion concerning the agreement is published in the *Final Programmatic Environmental Impact Statement Major Rehabilitation Effort: Mississippi River Locks and Dams 2-22, Illinois Waterway From La Grange to Lockport Locks and Dams Iowa, Illinois, Missouri, Minnesota, and Wisconsin* (March 1989). Essentially, the PMOA states that the Corps will preserve the general overall appearance of lock and dam complexes and treat significant features with sensitivity during the rehabilitation effort. Furthermore, Historic American Engineering Record (HAER) documentation of the locks and dams have been completed and are on file with the Library of Congress.

The majority of the cultural resources data and discussion relevant to the present study is included in this appendix in the summarized results of previous archeological and geomorphological investigations conducted along the Upper Mississippi River project area. This appendix also contains the body of a report entitled *The Illinois Component of the Upper Mississippi Waterway Archaeological Database* (UMWADB) compiled by the Illinois State Museum Society under contract with the Rock Island District. The UMWADB is a compilation of existing information for archeological sites located along the Mississippi River within the State of Illinois. It contains a

60-page bibliography (cross-referenced by county) of archeological reports relevant to the Illinois portion of the study area. A component of the UMWADB is a computerized data base for the 1,400 known Illinois archeological sites in the study area. The confidential data base has been installed on Rock Island District's Geographic Information System (GIS) and will be used to facilitate evaluation of future navigation impacts. The UMWADB will be integrated with site locational data from other states and with geomorphological data, the purpose being to allow for utilization of the GIS to support potential impact assessment.

The following sections briefly summarize, by Corps District, previous investigations conducted to identify and evaluate significant historic properties within the proposed project area.

St Paul District

In 1984, the Great Lakes Archaeological Research Center, Inc., (GLARC) completed a study of the known historic and archeological record of human use of the Upper Mississippi River Valley. In this study, entitled *Literature Search and Records Review of the Upper Mississippi Basin: St. Anthony Falls to Lock and Dam 10*, GLARC gathered site-specific data from local, State, and Federal agencies and institutions in Minnesota, Iowa, and Wisconsin. They recorded more than 1,000 significant historic and archeological sites and districts and plotted them on maps.

Since GLARC's study, hundreds of new sites have been discovered. These sites have to be added to GLARC's study to define the current distribution and density of historic and archeological sites in the St. Paul District's portion of the Mississippi River Valley.

Geomorphological research conducted over the past several years has demonstrated that old archeological methods are not adequate to locate sites within the Upper Mississippi River floodplain. This is especially true if one goal is to understand the landform context in which these sites were located at the time of their occupation.

The St. Paul District has conducted detailed geomorphological studies and archeological surveys within Pools 4, 7, and 10 of the UMR. While it appears that the distribution and density of prehistoric sites in other pools is generally similar, many variables exist concerning the nature of the river's geomorphology in specific river reaches. These variables affect the ability to adequately locate sites during intensive surveys and to predict the locations of sites in other reaches. A bibliography of previous investigations conducted along the UMR within the St. Paul District is contained in this appendix.

Rock Island District

The Rock Island District manages approximately 59,784 above-water acres of fee land acquired for the Mississippi River Nine-Foot Channel Navigation project. The Mississippi River enters the Rock Island District near Guttenberg, Iowa, and exits the District 10 miles south of Hannibal, Missouri, traversing 314 river miles. Locks and Dams 11 through 22, and the associated pools, are under Rock Island District jurisdiction. Extensive island and backwater areas create roughly 25,000 miles of shoreline within the District. The USFWS, as well as a number of State and county conservation organizations, share in the management of much of this land.

A systematic Mississippi River identification program began in 1980 with the publication of the Cultural Resources Work Group Appendix to the *GREAT II Study*. This report summarized the very few archeological survey projects conducted to that date and revealed that little work had been done along the Mississippi River on Federal land. The Corps-held tracts were nearly devoid of historic properties, a condition that reflected both insufficient study and problems with site burial in a major alluvial environment.

Thus, in 1981, the Rock Island District embarked upon the so-called "pool survey" program to begin to address Section 110 and Section 106 compliance requirements of the National Historic Preservation Act. All Corps-managed recreation areas along the river have been inventoried and sites have been delineated which require impact avoidance or further evaluation. Systematic sample surveys combined with geomorphological investigations have been completed for Mississippi River Pools 11, 12, 13, 14, 16, 17, and 18. Geomorphological landform modeling also has been completed for Pools 21 and 22. Information from these studies has improved our ability, in these pools, to assess operational impacts associated with navigation, recreation area development, lock and dam rehabilitation, and timber management. This data also has enhanced our efficiency at assessing impacts to historic properties related to real estate actions, permit actions, and the Environmental Management Program (EMP) projects. The pool survey data will serve as a baseline for establishing methodology for impact evaluation on the present navigation study as well.

Three major archeological data recovery projects have been executed on Mississippi River fee land to mitigate the impacts of erosion, vandalism, and construction. These excavations have significantly increased our knowledge of the Archaic and Woodland Cultures. The detailed excavation data feed back into the inventory and evaluation process and substantially increase our ability to locate and determine site significance in other areas. It is believed that an iterative technique process involving geomorphological landscape modeling, site inventory, evaluation, and, when necessary, mitigation conducted in certain pools provides data which make future pool surveys and impact evaluations more reliable and cost-effective.

St. Louis District

Systematic pool surveys have not been completed for Mississippi River Pools 24 and 25. However, surveys conducted in the lower Illinois River Valley (Alton Pool) and farther south in the Mississippi River Valley indicate that a similar distribution and density of archeological resources can be expected in these two pools. Site-specific investigations conducted within the lower Illinois River suggest that recent alluvium masks archeological sites, making an understanding of the geomorphology of the project area imperative to the assessment of impacts.

ARCHAEOLOGICAL OVERVIEW OF THE UPPER MISSISSIPPI RIVER VALLEY, ROCK ISLAND DISTRICT

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ARCHAEOLOGICAL OVERVIEW OF THE UPPER MISSISSIPPI RIVER VALLEY, ROCK ISLAND DISTRICT

Previous Investigations

The period of navigation effects on the Upper Mississippi floodplain began in 1878, when congress authorized the creation of a 4.5ft navigation channel (Great River Environmental Action Team 1980). Landowners in the bottoms and local governments commenced construction of a system of drains and levees to restrict the floodwaters of the Mississippi River. In 1907 the channel depth was authorized at 6ft. Initially, minimum channel depths were achieved by closing chutes, bank revetment and by constricting the main channel with rock wing dams. A channel 9ft deep and 300ft wide was authorized in 1930 to extend from St. Louis to St. Paul, Minnesota by constructing 27 lock and dam structures to pool waters with periodic dredging of the main channel. The overall effects of leveeing the river and pooling its waters include maintenance of an artificially "high" water level, aggradation of the floodplain in the lower half of each pool, and bank erosion at the upper end of pools.

The earliest archaeological investigations were strictly antiquarian in interest and approach (Willey and Sabloff 1974). Local people collected artifacts that tumbled from cutbanks or floated to the surfaces of plowed fields. Artifacts were prolific in the virgin land. Most of these early collections have been lost or dispersed; others are displayed today as fragments without context. Records of the earliest excavations appeared in the publications of antiquarian scientific societies run by the Victorian age gentry of the nineteenth century. Authors of the articles represented only a few of the many people involved in mostly "weekend" digging. Some of the writers were: Gass (1880, 1881, 1883), Lindley (1876), Lynch et al (1893), McWorter (1875), Starr (1897a,b) and Thompson (1879). The Rev. Gass (1881:140-6; 183-4; 189-190; 191-2) and Frederick Starr (1897b) provided the most informative studies because of their participation in many of the Davenport Academy of Natural Science-sponsored mound excavations. Gass, for instance, reports excavating 75 mounds in the vicinity of Muscatine, most of which were conicals on benches and terraces--not the same mounds preserved today on blufftops.

The nineteenth century excavators destroyed many earthen mounds in their exuberant quest for the "Mound Builders," a myth about ancient civilized people who had been replaced by American Indians. On the positive side early excavators recorded sites and objects which have vanished or are out of context today. For instance, Starr (1897b:95) provided a description of the excavation and contents of the Toolesboro mounds (13LA29). These Havana-Hopewell mounds yielded log tombs with animal effigy pipes, copper and shell beads, obsidian, conch shell and copper axes and

awls. During the latter part of this period W. B. Nickerson, who directed the last Davenport Academy season at Albany, carried out a series of careful excavations in Jo Daviess County, including a mound on the Savanna Army Depot (Bennett 1952; 1945:66-68).

Little published archaeological work was done in the Upper Mississippi Valley during the first two decades of the twentieth century. The surveys and excavations by Cyrus Thomas and Theodore Lewis extended around the area, with only one foray into Jackson County, Iowa, by Lewis (1885 notebook 36, pg. 6). In retrospect this period of waning interest in mound digging promoted the preservation of some mounds today.

The next archeological field work in the area to appear in the literature is that of the University of Chicago under the general direction of Fay-Cooper Cole between 1926 and 1931. The project was initiated on a small scale when two graduate students began what was apparently to be a thorough survey of Illinois beginning at the northwest corner and sweeping southwest. Though most of the work in the region was in Jo Daviess County, they did work on the Savanna Proving Ground Village site with its puzzling combination of Middle Mississippian and Oneota traits (Bennett 1945; Cole 1945) and conducted limited surveys in other parts of the valley.

The beginning of archaeological scholarship in Iowa dates to the 1920s when Charles R. Keyes was appointed director of the Iowa Archaeological Survey and started publishing a prehistory of cultures in the state (McKusick 1975:44). Keyes' best chronology of Iowa cultures was published in 1927 and included four episodes relevant to the Upper Mississippi Basin: 1) Algonkian culture, 2) Hopewell, 3) Effigy Mound culture, 4) Oneota culture. He hired Ellison Orr, a retired businessman from Waukon, Iowa, to conduct a state-wide survey with some excavation. Orr ranged down the Mississippi Valley from the Upper Iowa River, recording habitation sites and mound groups and excavating in many mounds as far south as the Muscatine area (e.g., Toolesboro, the Malchow mound group (13DM4) and mounds and villages on the north side of Burlington; Keyes manuscripts at the State Historic Society of Iowa, Iowa City; Orr 1935; Tiffany 1981). His field records were compiled in 10 notebooks, with an original copy being housed at Effigy Mounds National Monument (Orr 1935) and published in the Archives of Archaeology (Orr 1963). As surveyors, Keyes and Orr added immeasurable information to Iowa's site records, because they encountered sites that have since been destroyed. As an excavator, Orr does not measure up to the caliber of other contemporaries in the United States (McKusick 1979:17). He was not trained to recognize features and strata and missed many details of mound and habitation site stratigraphy.

There was another hiatus of activity after Charles Keyes finished his work, then the modern era of intensive archaeological activities began in the 1950s. Investigations were sporadic and descriptive at first but built to a crescendo of contract archaeology by the 1980s. The increase in activity corresponded to

the advent of the Explanatory period in American Archaeology (ca. 1960-; Willey and Sabloff 1974), to a proliferation of students in anthropology departments of major universities and to the passing of the 1966 National Historic Preservation Act and subsequent regulations, which require Federal agencies to inventory and manage their historic properties. The search for explanations of prehistoric evidence led to the development of scientific field methods (e.g. flotation, systematic sample surveys, micro-analysis of artifact use-wear) and the application of human behavioral models.

Survey and recording of sites coupled with excavations started in 1958 on the Iowa side with a project by R. J. Ruppe' of the University of Iowa. Ruppe' and his students, Adrian Anderson, Dale Henning and James Scholtz, recorded many of the most significant sites in Louisa and Des Moines counties. Local individuals such as Donald Parson (Wapello) assisted the archaeologists in identifying major sites. Complete analysis of these investigations was not accomplished, although students at the University of Iowa are returning to analyze these materials at the present time. On the Illinois side, archaeological activities began with test excavations on the Putneys Landing site (11HE3; Lippincott and Herold 1965), a major Havana village and mound group (also Late Woodland) mentioned in other overviews of Hopewellian sites (cf. Struever and Houart 1972). Local collectors primarily belonging to the Quad-Cities Chapter of the Iowa Archeological Society also recorded many sites during the late 1960s and 1970s.

A major publication pertaining to the study area but not involving fieldwork was Elaine Herold's (1971) compilation of late nineteenth and early twentieth century investigations at the Albany mounds (11Cal). This study was followed by survey work and test excavations in the Albany village site, which was done in conjunction with planning for the Meredosia Levee project (Benchley and Gregg 1975; Benchley, Gregg and Dudzik 1977). In 1987, excavations were conducted at Albany mounds to evaluate and partially mitigate the damage done to a mound by vandals. This (unpublished) work was funded by the Illinois Office of Historic Preservation.

The most significant survey on the Illinois side was part of the UWM Archaeology Laboratory's reconnaissance survey of the Mississippi Valley on the Illinois side from the mouth of the Des Moines River to the Wisconsin border (Fowler 1971; Gregg 1972). Fieldwork consisted mostly of contacting landowners and local collectors, who would point out sites; then the field crew walked and recorded the sites. This investigation identified many of the largest and most prolific sites and probably tripled the number of site records.

The UWM reconnaissance survey generated several overviews of prehistoric cultures. Mark Dudzik's Masters Thesis (1974) was the most comprehensive and thoughtful because he utilized the state site records to develop settlement patterns for every prehistoric

period, then compared cultural models by other writers to his data base. Dudzik's analysis is structured around environmental variables. Another overview for all of northern Illinois (Billeck and Benchley 1982) drew general conclusions about all culture periods. The UWM site data formed the basis for site locational models which became part of a volume on Predictive Models in Illinois (Brown ed. 1981). The model for the Upper Mississippi River (Benchley et al, 1981; see also Benchley 1978) did not analyze sites according to culture period. Instead, site probabilities were calculated for four floodplain environments: bottomland prairie and timber, terrace prairie and timber. The prairie environment scored extremely high.

In 1984 the Office of the State Archaeologist of Iowa conducted survey and testing at 17 Corps recreation areas along the Mississippi River (Johnson et al. 1985). They employed bank survey, shovel-testing and one meter unit excavations to investigate the geology and archaeology of specific locations in the valley. The reader is advised to recheck all information presented in the Johnson et al. (1985) text, as it contains errors of site attributions, artifact identifications and geomorphological interpretations.

The most comprehensive survey of sites on the Iowa side was produced by the initial Great River Road project (e.g., Hotopp ed. 1977). This survey followed part of the existing right-of-way of Highway 61 and other state and county highways and roads along the Mississippi bluffline and valley floor from Ft. Madison to Dubuque. The field crew also made forays off the right-of-way to record major sites identified by landowners and collectors. Sections of the report on Muscatine, Louisa and Des Moines counties by Anton Till (Ibid.) were descriptive and provided useful information about the history of past investigations on many sites. Overall, the early Great River Road survey reports lack analysis of the collections as well as an overview of culture history developed from the new survey data, while later reports contains more sophisticated analyses.

Site excavations in Iowa in the 1970s were precipitated by an interest in Oneota culture and in salvaging site information being eroded by the Iowa River. The University of Iowa/Office of the State Archaeologist directed field schools at the McKinney Oneota site (13LA1; Slattery, Horton and Ruppert 1975), the Poison Ivy site (13LA84; Alex 1978) and at the Helen Smith site (13LA71). Some analysis of the Oneota materials was used by Tiffany (1979, 1982) in his overview of southeastern Iowa Oneota culture. The first large excavation project was at Michaels Creek, where six National Register eligible sites (13LA55, -56, -60, -140, -249, -250) were examined by Louis Berger and Associates (Fokken and Finn 1984) for a road project. Stratified Woodland and Oneota materials were encountered, and the writers expended considerable effort to model the subsistence and settlement strategies of prehistoric peoples from analysis of the site assemblages.

During the late 1970s many federal agencies, including the Corps of Engineers, began the process of indexing the known and potential cultural resources on property under their jurisdiction (viz. EO-11593, National Historic Preservation Act 1966 amended; see Eichorn 1983). Evaluations of the Upper Mississippi commenced with an extensive literature search (Petersen 1978), with formation of the Great River Environmental Action Team II (Great II) in the 1970s and with the St. Louis workshop on cultural resources sponsored by the Upper Mississippi River Basin Commission (Gramman 1981). Actual ground survey was initiated in the 1980s to develop an adequate data base for formulating management strategies. Pools 11, 12, 13, 14, 16, 17 and 18 in the Rock Island District have been surveyed, and background studies of geology and history have been done for Pool 21. Farther north in Iowa and Wisconsin, Pool 10 in the St. Paul District and Pool 11 in the Rock Island District also were surveyed. The surveys of Pools 10 and 11 by the Great Lakes Archaeological Research Center (Overstreet 1984, 1985) were done concurrently with the surface geomorphology for Pool 10 (Church 1984). Overstreet's investigations included a detailed cultural overview, survey of cutbanks in the pool and limited subsurface probing by core, shovel and remote sensing. The potential for buried sites in both pools was carefully assessed.

Overstreet built upon previous experience when he undertook the surveys in Pools 10 and 11. The earlier survey of Pool 12 by his organization (Boszhardt and Overstreet 1983) contained only descriptions of sites and two terrace levels (i.e. Pleistocene terraces, floodplain) and lacked the detailed landscape context that the later work has. Likewise, the survey report for Pool 16 (Barnhardt et al, 1983) gave similar types of information. The inclusion of a few sediment profiles from archaeological sites in Pools 16 is not helpful, even with two radiocarbon dates, when the pedogenic horizons are not described with standard soil terminology.

In 1985, sites along Sand Run Slough were brought to the attention of the COE (Smith and Barr 1985) by local collectors and the OSA. Sites 13LA30 and 13LA38 were determined eligible for nomination to the National Register, and the latter site was excavated in 1986 (Benn ed. 1987). Stratigraphic information from this report forms part of the basis for geomorphic/pedogenic evaluations in the present volume. Cultural reconstructions applying to the Middle-Late Archaic and Woodland periods in the Three Rivers region of the Upper Mississippi Valley also are presented.

The Putneys Landing site (11HE3) has been the other subject of intensive work on the Illinois side. The site was tested in the 1960s (Lippincott and Herold 1965), and portions of the village adjacent to Campbell Slough were excavated by Charles Markman (1988), Northern Illinois University, for the COE. For the latter project a
multi-disciplinary report covering every aspect of preserved materials was produced. Markman found that the village was

intensively occupied, not merely a burial camp for the nearby mounds.

The Rock Island District office continued to contract for pool wide geological and archaeological investigations in Pool 21 in 1987 (Anderson, Green and Vogel 1988). This project included fieldwork to construct a series of geomorphic maps and an archival search of the prehistoric and historic data base.

The 1987 a large-scale archaeological and geological survey in Pools 17-18 (Muscatine to Burlington) covered 4695 acres of cultivated surfaces and 50.2 miles of shoreline (Benn, Bettis and Vogel 1988). A total of 158 sites was visited or otherwise studied in some fashion. The 1988-89 survey of Pools 13-14 (Belleview to Clinton) covered 583 acres and 12 linear miles of pedestrian floodplain survey, and 72 miles of bank survey (Benn et al. 1989). A total of 58 sites was recorded and studied. Together, these pool surveys represent the most systematic, combined archaeological/geological investigation of the Mississippi Valley within the Rock Island District. This information provides the basis for the following cultural overview.

Prehistoric Cultural Overview

As surely as the landscape on the floor of the Mississippi valley has changed during the last 18,000 years, so have site distributions been affected by fluvial processes in the valley. Landscape changes affect the cultural record in two ways. First, humans choose where they will live and work because of the shape of the landscape. Therefore, prehistoric settlement patterns must be analyzed within a setting of the contemporary landscape. Second, major changes in the fluvial system can wipe out or bury the record of earlier human occupation, forcing archaeologists to consider the bias of differential site preservation in reconstructing the human past.

18,000-12,000 B.P. (Early Man period)

Evidence for cultural material that predates the lanceolate projectile point hunting traditions in the Americas is scarce and controversial. None has been found in the Midwest. For Early Man evidence to be authentic, it must have a secure stratigraphic context and dating. Context is most important because the types of non-projectile point industries thought to belong to this period, e.g. chopper/heavy flake technology or blade core/retouched flake technology, are elements of later cultural traditions as well. Essentially, locating Early Man sites is a geological issue.

Big game animals must have utilized the Mississippi Valley floor as a source of food and water, and human hunters, if present, surely preyed on these animals. However, it is doubtful that people camped permanently in the unstable floodplain, since periodic pulses of meltwater from glaciers would have inundated the

entire valley and destroyed all sites. People probably resided on the high terraces and blufftops. Since the valley was the source for blowsand and loess, the highest terraces have sand dunes and the bluffline has a substantial layer of loess predating ca. 12,500 B.P. Archaeologists might look for Early Man within the loess and beneath dunes.

Paleo-Indian/Dalton Period

The most complex processes of valley bottom formation occurred during this time span (ca. 12,500-9500 B.P.), but this is a difficult period to study geomorphologically and archaeologically. Diagnostic artifacts are sparse, and material for radiocarbon dates is hard to obtain from specified contexts.

At the end of the Wisconsinan glacial episode in the Midwest there was an overall downcutting by streams. During most of the Holocene period, valley floors underwent long periods of aggradation punctuated by partially downcutting. The sum total of Holocene geomorphic activities has been the construction of massive silt loam and sandy loam terraces over the Late Wisconsinan landscape. In Pools 17-18 the sandy and loamy Holocene terrace complex rises about 1-2m above current water levels, except where fans have accumulated to depths of 5-10m. The Late Wisconsinan floodplain "surface" lies below the current river level close to or within the permanent groundwater table.

The general consensus of archaeologists is that Paleo-Indians concentrated on game as their principal food source. They possessed a sophisticated lithic technology based on the manufacture of blade flakes, bifacial knives and weapon tips by softhammer percussion and pressure techniques (cf. Bryan ed. 1978). Their distinctive assemblage of tools--e.g. lanceolate projectile points, fluting, burinated tools, gravers, spurred end scrapers, wedges--renders their sites highly visible. The Paleo-Indian period may be roughly divided into two traditions. The first (ca. 12,500-10,500 B.P.) is characterized by lanceolate points with basal thinning flakes that evolved into more sophisticated fluting techniques, called Clovis and Folsom. The second (ca. 10,500-9500 B.P.) encompasses a wide variety of lanceolate point types which formal flutes but are finished with careful, collateral pressure flaking and an array of haft forms (e.g. Dalton, Scottsbluff, Eden, Hixton, Beaver Lake; see Wormington 1964; Goodyear 1982).

Paleo-Indian and Dalton sites in the Upper Mississippi Valley have yielded isolated points from multi-component cultural scatters. Local collectors do not seem to know of any sites which have yielded paleo-points season after collecting season, nor have recent surveys picked up scraping, graving or retouched flake tools that could be interpreted as part of a complete Paleo-Indian complex.

We must prioritize the approach to analysis of Paleo-Indian culture by realizing that the contemporary landscape is the most important variable that determined what has been preserved. On upland ridges where Paleo-Indian sites are most common, there is a blanket of loess which may hide some sites beneath the plowzone. Severe erosion has brought most of these sites to the surface, as people who collect on the bluffline have discovered. Recently, lanceolate points have been observed in the possession of landowners who find material on the highest Wisconsinan terraces. Only where eolian sand is present will sites on this terrace be buried. The Mississippi floodplain presents a completely different archaeological problem. Here, except for sand ridges the surface of late Paleo-Indian/Dalton times is either buried or destroyed by floods of meltwater. We might expect to find temporary kill/butchering sites in the floodplain, but the site excavations will be done under wet conditions.

Early Archaic Period

A long episode of floodplain aggradation began during this period. Aggradation continued into the Hypsithermal climatic episode that postdated the Early Archaic period; thus, much of the Early Archaic landscape is buried on the valley floor. Only sandy Wisconsinan terraces poke above the Holocene alluvium. These high points are where Early Archaic artifacts have been found. Elsewhere in Iowa the Gunder Member (Bettis and Littke 1987) and the Corrington (fan) Member (see also Wiant et al, 1986:106) of the De Forest Formation, and the High Terrace in the central Des Moines River Valley (Bettis and Hoyer 1986) often have a buried soil at the bottom of the fill. This soil was contemporary with the Early Archaic period. A similar alluvial fill/pedogenic context probably exists in the Mississippi Valley and could contain buried artifacts.

Recognition of the Early Archaic period (ca. 9500-8000 B.P.) is based largely on the typological evidence of projectile points, which have been dated elsewhere (Luchterhand 1970; Goodyear 1982; Brown and Vierra 1983; Stoltman 1986b). Private collections from Mississippi survey areas below Rock Island contain the point types, Thebes/Grundy and Hardin, and more careful study of these collections probably would reveal the presence of St. Charles and Kirk Cluster types. These point types are not seen as frequently north of Clinton. Bifurcate base points of the types, LeCroy and St. Albans, and side notched Graham Cave points were not noticed in private collections.

The remainder of the Early Archaic assemblage consists of bifacial knives, end and side scrapers, drills, choppers, a wide range of flake tools and grinding equipment (Brown and Vierra 1983:181; Klippel and Maddox 1977; Esarey 1987). This assemblage is a more varied and less specialized than the Paleo-Indian assemblages. Diversification of the tool inventory has been related to the subsistence patterns, which was based on seasonal

exploitation of most of the plants and animals of the oak-hickory forest and riparian biomes (Luchterhand 1970; Klippel and Maddox 1977; Stoltman 1986b). Authors recognize large, base camp ("habitation") sites as well as smaller, presumably temporary, sites for the procurement of particular resources. No distinct tool assemblages and site types of this period can be confirmed in the sites in the Upper Mississippi Valley project areas, because all of the Early Archaic points come from multi-component sites. One observation may be viable: none of the Early Archaic components seems to yield large numbers of points. Therefore, no large base camps are anticipated, unless they are buried.

Authors (e.g. Luchterhand 1970; Klippel and Maddox 1977; Springer and Harrison 1979; Esarey 1987) have been concerned with the advance of the prairie during the early half of the Holocene and what effect this had on human settlement patterns. The Archaic population shunned the upland plain in Illinois as the prairie expanded after ca. 9000 B.P. (Wright 1978; Wendland 1978; King 1981; McMillan and Klippel 1981). These archaeologists view the expansion of prairie as a constraint on the Archaic subsistence system. However, no such environmental constraint is perceived within the Mississippi River valley. At 9000 B.P. the valley was covered by oak-hickory and mesic maple forest. Most known Early Archaic sites were positioned on sand ridges adjacent to backwater sloughs and lakes, not the main channel. This is the same locational pattern of later Archaic and Woodland periods as well as the Paleo-Indian/Dalton pattern.

The relatively stable pattern of site locations just cited brings us to a general proposition: 1) given that the Upper Mississippi Valley floor is a mosaic of environmental zones, all of which are within an hour or two of walking distance, and 2) given that there are preferred locations for habitation (i.e., better drained, elevated above floods) adjacent to the most prolific backwaters, then settlements at such prime locations would be the expected pattern for all hunters and gatherers during all prehistoric periods. Major deviations from this basic settlement system would have to be a reflections of significant socio-political and economic change.

Middle Archaic Period

The Middle Archaic period dates between ca. 8000 and 4500 B.P. Point types from the early portion of this period include Helton and Rice Corner Notched types (Brown and Vierra 1983:183) and small side notched points with concave bases, such as Tama and Little Sioux (Anderson 1980; Benn and Rogers 1985:30). The remainder of the Middle Archaic period in the Midwest was dominated by side notched forms with names, but Matanzas, Godar, Raddatz and Osceola are the most common. Significant numbers of side notched points come from sites on sand rises with artifact scatters of one or more acres in extent. Fire-cracked rocks and lithic debris are very common. Private collections from these sites contain many winged

("T") drills, ground stone including grooved axes, many types of bifaces and large, unifacial scrapers. The amount and diversity of tools suggests these were base camps of long-term or multiple occupations.

Private collections from the Iowa side south of Muscatine contain a complex of side notched points (Godar, Matanzas, Raddatz) which appear to be infrequent or missing in the areas north of Clinton. Finely shaped axes, plummets, hematite and bannerstones also are rare or absent in the northern reaches. This may reflect a cultural phenomenon, not a collectors' bias, since these objects are highly prized in today's private markets. The area north of Clinton might have been in a different cultural zone than the areas to the south up to ca. 4500 B.P. Elsewhere (Benn, Bettis and Vogel 1988:145-6), it has been argued that finely made artifacts and items fashioned from exotic materials represented surplus labor value expended to satisfy social obligations ("debts"; cf, Bender 1985). Later than ca. 4500 B.P. the entire Upper Mississippi Valley was involved with the cultural tradition distinguished by the Osceola point style.

Middle Archaic sites are the earliest manifestations in the prehistoric sequence to be found in buried contexts on the valley floor. This happens because they lie in the upper half of the Holocene alluvial sequence in sandy, lateral accretion deposits above the normal water table. Buried Middle Archaic sites can have both dense and light artifact scatters suggesting dichotomous site types. Light scatters, which have not been excavated, consist of fire-cracked rocks and flakes. If these sites fail to yield diagnostic artifacts, they can only be related to a cultural system and period of time by geomorphic context or radiocarbon dates. The heavy scatters, such as the one in Sand Run West site, block C (Benn ed. 1987), are dark middens with roasting pits, trash-filled pits, masses of chipped and ground stone tools, fire-cracked rocks and organic remains of fish, mammals, nuts and seeds (including wild rice). Where this type of dense midden is in a fan sediment with more rapid accretion, the density of tools is much lower. In this case our perception of site density, therefore occupation permanence, is influenced by relative rates of sediment deposition.

Middle Archaic sites are situated along backwater sloughs and lakes. Even those along relic Mississippi channels were not contemporary with the active channel. When prairie invaded the valley floor after ca. 7500 B.P., sites sand ridges were within the prairie. A general correlation between archaeological sites and prairie on the valley floor was noticed by Benchley and others (1981:11) when they compiled survey data for the Upper Mississippi River. However, the aboriginals' occupational preference may not have been the prairie but instead the well drained alluvial soils which happened to be favored by prairie plants.

The Middle Archaic settlement pattern also includes sites on the blufftop ridges and on the broad uplands back from the river. Local collectors who roam the uplands have gathered a tremendous

quantity of grooved axes, hematite plummets, bannerstones and side notched projectile points, scrapers and lithic debris. This situation is true for both the Illinois and Iowa sides of the river. Based on simple artifact densities and types, some upland sites should be classified as base camps like sites on the valley floor. Others with axes, bannerstones, plummets and points but little else might have been mortuary sites like the Bullseye site in the Lower Illinois River valley (Hassen and Farnsworth 1987).

The other impression about Middle Archaic materials from recent survey data is that the numbers of components increased through time. Osceola points are to be found in practically every private collection. Perhaps their large size and distinctive basal configuration makes them more conspicuous when collections are merely perused by survey archaeologists. There is no doubt, however, that there are more Middle Archaic point finds than Early Archaic finds, and the Osceola type is widespread in upland and valley contexts.

Late Archaic Period

Projectile points of the Late Archaic period are very numerous in private collections. The proliferation of Late Archaic components is a fact noted by other researchers in cultural overviews of the Upper Mississippi River valley (Dudzik 1974:16; Billeck and Benchley 1982:7; McElrath et al, 1984), but it was not confirmed by initial intensive surveys in the floodplain. For instance, no Archaic sites were found in Pool 12 (Boszhardt and Overstreet 1983), and only two purported Archaic shell middens were located in Pool 16 (Barnhardt et al, 1983:53-57). Overstreet (1984:13; 1985:153) reasons that Archaic sites are deeply buried (15ft or more) in Pools 10 and 11 and will be difficult to find below the navigation water level.

The observations in the preceding paragraph would generate equivocal conclusions if the cultural data were not considered within a regional geomorphic/pedogenic context. By recognizing the Odessa stratigraphic sequence (see "Early Woodland Period"), it is possible to predict that Middle-Late Archaic materials will occur either beneath the second (buried) Woodland-bearing solum in vertical accretion deposits or at the A/B horizon interface of thick soils at the surface of horizontal accretion deposits. When these contexts were examined in Pools 17-18, two types of Late Archaic deposits were found about 1-2m below the ground surface in the northern two-thirds of the pools. One type of site (e.g. 13LA38; Benn ed. 1987) has a dense midden of artifacts, features and organic remains. Similar sites occur on the plowed surfaces of sand ridges in the bottoms. The other more common site type in buried contexts is represented by a thin scatter of fire-cracked rocks and flakes occasionally with a diagnostic artifact. These sites appear to have been temporary camps and resource procurement stations on the floodplain at the time of occupation.

The settlement pattern of large, base camp sites on well drained landforms and temporary camps on the floodplain is not a revelation. Since Caldwell (1958) theorized about the Archaic tradition, this has been the assumed settlement pattern for intensive hunting and gathering subsistence in large river valleys. Blufftop cemeteries and habitations also were part of this pattern. The proliferation of Late Archaic over Middle Archaic components in Pools 17-18, given similar adaptations and geomorphic circumstances, suggests the Late Archaic people were filling territories. Brown and Vierra (1983) and others (cf. Price and Brown ed. 1985) have described the Middle and Late Archaic periods as a time of cultural expansion and intensification. Organic data pertaining to Archaic subsistence in the Upper Mississippi Valley is not adequate to test this hypothesis, although the processing of aquatic resources, mammals, nuts, wild rice and the cultivated seed complex at the Sand Run West site lends initial confirmation (Lopinot in Benn ed. 1987; Benn and Kelly in Benn ed. 1987).

Some evidence for increasing regional and chronological variation, perhaps indicating more complex social interaction, is demonstrated in the artifacts. Styles of projectile points seem to have changed with sufficient unity so that at least three complexes may be identified. The earliest complex was transitional with the Middle Archaic period. It consisted of small to medium sized side notched points like Matanzas and Godar mixed with more of the large Osceola points. Winged T-drills and grooved axes also belong to this complex, which was dated between 4140+110 (Beta-18293) and 4270+90 B.P. (Beta-17937) at Sand Run West (13LA38). Conrad (1981) has named the Hemphill phase (ca. 4950-4250 B.P.) in west-central Illinois for a complex like this. The second complex appears to be like the Titterington phase (ca., 4200-3800 B.P.) of the Lower Illinois River valley (Cook 1976) and the Sedalia complex in northeastern Missouri (Chapman 1975:203). Diagnostic points/bifaces include Wadlow, Karnak, Sedalia, Etley/Atalissa and Nebo Hill types, with gouges, drills, heavy scrapers, axes and grinding equipment rounding out the inventory. The third, unnamed complex is identified by stemmed point types (e.g. Table Rock Stemmed, Springly, Durst Stemmed, Robbins, Tipton, Merom) and by broad side notched point types (e.g. Fort Dodge, Conrad). The first two point types have been dated early in the third millenium (Lensink ed. 1986:198; Emerson and Fortier 1986:481).

Many varieties of stemmed points typical of the period after ca. 3500 B.P. as well as Titterington-like materials occur in Pools 13-14. These preliminary findings suggest there were strong cultural relationships among Late Archaic peoples of the Mississippi valley along the entire border of eastern Iowa, thereby eliminating the north-south cultural dichotomy of the Middle Archaic period.

Price and Brown (1985:8) propose three conditions that fostered the development of complexity during the Middle and Late Archaic periods. 1) Social circumscription happened when productive units became packed in territories and opportunities for

emigration became increasingly limited. 2) Abundant resources allowed for the creation of annual surpluses. 3) Increasing population placed stress on subsistence strategies based on foraging for natural resources. The Archaic population's response to subsistence stress was to focus on a narrow range of resources, i.e., the most productive "patches," by occupying residential sites for longer periods and by developing more intensive food production systems through logistical organization (Warren and O'Brien 1982a:94; Brown and Vierra 1983:168-169). Elaborate artifacts, such as bannerstones, plummets, exotic materials, etc., indicate a response to socio-economic stress. The production of "surplus" objects was intended to fulfill obligations ("debts"; see Bender 1985) which functioned as a banking system against future stress.

Early Woodland Period

The valley floor of this period (ca. 2400-1950 B.P.) was very similar to the present day configuration (Figure 2.13). The Mississippi River meanderbelt was the same with some abandoned channels and levees along terraces still forming. Older islands were already in place. Vegetation patterns consisted of prairie cover on well drained terraces, wooded fringes along sloughs, mesic forest on the seasonally inundated floodplain, and marsh-dominated wetlands.

In the wetland zone there are regularities in the co-occurrence of paleo- and modern soil horizons and Late Archaic through Woodland period artifacts (Benn ed. 1987:238-9). These relationships are termed the Odessa sequence after a survey transect in Pool 17. Essentially, the Odessa sequence is composed of 2-3 major soil forming episodes. The surface soil, which often occurs beneath a mantle of post-settlement alluvium (PSA), contains the late Late Woodland, Oneota and Historic components (ca. 1500-100 B.P.). The Early and Middle Woodland components (ca. 2500-1500 B.P.) are found in the A horizon of the first buried soil. Late Archaic and late Middle Archaic components (ca. 5000-2500 B.P.) occur beneath the buried soil either in a second buried soil (i.e. 3A/Bb) or in sandy, lateral accretion deposits. Distribution of the third, lowest soil probably depends on the age of the landform and its proximity to the former river channel.

A complete range of Marion and Liverpool ceramics and stemmed points (e.g. Dickson, Belknap, Waubesa, Kramer, Robbins) is evident from the pool survey data below Muscatine. The Pools 17-18 sites with large surface collections yield a conjunction of stemmed points and ceramics. Unfortunately, these materials have not been excavated from sealed stratigraphic contexts. North of Clinton no Early Woodland sites have been found (Benn et al. 1989) until one reaches Pools 10 and 11.

The apparent absence of Early Woodland sites in Pools 13-14 correlates with what Fokken and Finn (1984:6-5) visualized as a decline in the Early Woodland population level in Pool 17 based on

fewer sites relative to the Late Archaic period. This appears to be a case of actual geomorphic processes influencing the cultural interpretations of archaeologists. The primary hindrance to identifying an Early Woodland assemblage is the mixing of components. Again and again the most prolific sites adjacent to backwater sloughs in Pools 17-18 were occupied throughout the Holocene period. These are the highly visible sites on sand levees familiar to most archaeologists (cf. Struever 1968). Only when slough margins in the floodplain are carefully surveyed and sites are dug deeply, does one happen onto buried Early Woodland components.

Another pattern in the settlement data is that Marion, Black Sand and Havana tradition sites have the same distribution in Pools 17-18. Evidence such as this has lulled researchers into presuming continuity between these traditions, a theory which has been bolstered by widely accepted ceramic analyses (cf. Griffin 1952). Patrick Munson (1982, 1986) disrupted this normative view by proposing that there was continuity between the Marion complex and the Havana tradition but that the Black Sand tradition was separate and peripheral to Havana. Munson saw the Black Sand tradition extending west across the prairies and north into the upper reaches of the Mississippi River Basin, while Marion was confined to the Illinois and lower-middle reaches of the Upper Mississippi River valley. Evidence from 13LA38, other Iowa sites (cf. Benn and Rogers 1985; Benn ed. 1987) and from Wisconsin (cf. Stoltman 1986a) confirms Munson's view.

Middle Woodland Period

The Havana tradition is employed to designate Middle Woodland occupation (ca. 2200-1600 B.P.) at least as far north as the Albany mounds. A complete manifestation of this tradition in all of Munson's (1986) named phases (i.e. Marion/Morton, Morton/Caldwell, Fulton, Ogden, Frazier, Weaver) is evidenced by the ceramics, lithics and Hopewellian interaction items.

When alluvial fans are cultivated major Havana components are brought to the surface. Indeed, most substantial Havana components seem to be at or near the surface in the Upper Mississippi Valley. One problematical piece of evidence, a Middle Woodland period radiocarbon date at 11MC102 in Pool 17, indicates there are buried Havana sites in the floodplain, but this site looks like a temporary camp. In general, the most significant part of the Havana settlement pattern seems to be at the ground surface. Much of it is known only to local collectors and has yet to be officially recorded, however.

Middle Woodland site patterns in the Upper Mississippi Valley have some of the aspects of Struever's (1968) original settlement model for the Lower Illinois Valley. Sites like Sand Run West (13LA38) and Putneys Landing (11HE3) were situated on backwater channels where there was ready access to aquatic and forest

resources. Such sites, termed base settlements by Struever, have evidence of permanent occupations that encompassed a wide range of task activities, including the native seed horticultural complex (Benn ed. 1987:245; Markman 1988). All of the largest Havana sites in Pools 13-14 and 17-18 qualify as base settlements on the basis of artifact content and positioning next to backwaters. The difficulty in terms of the Struever model with calling all of these sites "base settlements" is that some are in the bottoms, not at the bluff base. Struever recognized a second site type, summer agricultural camps, which were "proximal to former lake shorelines" (Struever 1968:307)--the same locations as the mid-valley, bottomland sites. However, the bottomland sites have too much material, including interaction sphere objects, to qualify as seasonal camps (see Bailey 1977). The other bottomland site type in Pools 17-18, the temporary camp/resource extraction sites, is not part of Struever's model but have been recognized in the American Bottom (Fortier, Emerson and Finney 1984). Struever's settlement model cannot be applied absolutely, perhaps because other social and political factors influenced locations for habitation.

The other half of Struever's settlement model proposed that there were regional exchange centers along major water courses where commodities passed through the interaction system. And, he named mortuary camps as the fourth settlement type, where there were temporary occupations associated with mortuary activities at mounds. Building on Gregg's (1974) initial examination of Struever's model, it is possible now to delineate a pattern of major habitation/burial sites from records in the Pools 17-18 area. Sites that have yielded large amounts of Havana pottery and lithics, burials/mounds and interaction sphere items (e.g. platform pipes, copper, galena, Hopewell vessels, marine shell) are spaced about 6-15 miles apart, depending on local topography.

If collector information, the Davenport Academy mound excavations and recent overviews (Struever and Houart 1972; Seeman 1979; Benchley, Hassen and Billeck 1979) are good indicators of Havana-Hopewell distributions, then a settlement pattern of regularly-spaced village/mound centers and habitations sites like the one discussed above is present throughout the Three Rivers region of the Upper Mississippi Basin. This writer would hesitate at imposing a hierarchy on the Havana sites within the region, as the Struever and Houart (1972) model attempted to do. Rather, the spacing of major Havana sites seems to be an expression of territorial organization.

The Albany site is one of the most important Havana tradition sites in the Upper Mississippi basin by virtue of its size (81 mounds and one or more villages) and its assemblage of interaction sphere artifacts. Seeman (1979:396) places Albany as a third order mortuary site in his measure of complexity. Judging from the site owner's large collection of exotic materials from the village site, Albany may have been a more significant stop within the exchange sphere than Seeman calculates from the mound data alone.

South of Albany there are only a few mounds that could be attributed to the Middle Woodland period, e.g., the now destroyed mound at Princeton. North of Albany several loci of activity around Thomson include mounds at 11CA11 and 11CA21 and village sites (11Ca10) that have yielded interaction sphere materials, according to local collectors. The Apple River mouth has a concentration of village sites and mounds which have been recognized as Middle Woodland sites since Bennett (1945:66) reported them. On the Iowa side there are Middle Woodland mounds at Pleasant Creek and probably at Sabula and Bellevue. If we accept the regularity of site spacing implicit in the Struever and Houart (1972) model of hierarchical settlement patterning, as derived from the pattern of interaction sphere items (see Seeman 1979), then the Middle Woodland site distribution seems to be similar in Pools 13-14 and 17-18.

Pottery types are an aspect of the Pools 13-14 sites that might be informative about the character of Middle Woodland culture in the Upper Mississippi Valley. Linn ware types are common in the assemblages from Albany and the Thomson area sites. This ware is far less common south of Muscatine, where Havana ware predominates and Pike-like and Baehr ceramics occur. We suspect, as Will Logan (1976) also did, that a major division in Middle Woodland culture types falls somewhere within or south of Jackson County, Iowa, on the Mississippi River. This would be the northern limit of the Three Rivers region.

Late Woodland Period

The valley floor landscape and activities of the rivers were the same for this period as the previous one. Late Woodland sites are distributed on all types of landforms throughout the project area. The relative density of sites appears to be determined by the intensity of survey coverage and the visibility of Woodland ceramics, which decompose rapidly in the plowzone of sandy soils. Alluvial burial of sites probably is not a significant factor in their visibility, except in forested areas where Late Woodland sherds are usually found on cutbanks. The other observation about Late Woodland sites is that most occur along sloughs and backwater lakes, and very few are on the Mississippi River channel or within the modern channelbelt. Therefore, destruction of sites by fluvial erosion probably has not occurred.

The early Late Woodland period (ca. 1600-1300 B.P.) includes the Weaver phase south of Clinton and the Allamakee phase north of Clinton (an arbitrary dividing line). Weaver ceramics tend to be plain surfaced with decorations limited to lip margins. Linn ware of the Allamakee phase has much more decoration, usually of stamped or cord impressed zoned decorations. Steuben Stemmed and corner notched points, which were carryovers from the Middle Woodland period, characterize Weaver and Allamakee assemblages. Flake tool and small core lithic technology also continued after the Havana

tradition. Interestingly, Hopewellian items like copper, galena and imported cherts (e.g. Warsaw Tabular) continued to be utilized during the both phases. Weaver and Allamakee site distributions cannot be characterized in a definitive manner. Some components occur with large Havana villages, including a possible midden "ring" at the Gast Farm site (Green et al. 1990). But, more early Late Woodland sites are scattered in the center of the bottoms, unlike Havana settlement patterns.

Cultural manifestations that followed the Weaver and Allamakee phases are unnamed, yet paradoxically their remains occur in more places in the valley than sites of all previous or later periods. Almost 120 "Woodland" sites are recorded in Pools 17-18; at least 62 sites definitely belong to the post-Weaver time period. Ceramics are the most reliable indicators of the late Late Woodland period (ca. 1300-950 B.P.). The period opened with a dramatic shift to cord-decorated ceramics. Cordage impressions cover the exterior surface in a fine textured, low-relief mat (termed cord roughening or cord marking), and rims often have geometric designs done in individual cords. In the Three Rivers region and adjacent areas of western Illinois and southeastern Iowa this pottery ware remains unnamed but occurs as two types: "cordmarked" (undecorated) and "cord-impressed" (Riggle 1981; Morgan 1986). Analogous, contemporary ceramic wares were made to the north (i.e. Madison ware, Hurley 1975; Benn 1980), west (i.e. Loseke, Benn and Rogers 1985) and southeast (i.e. Sepo, Harn 1975; White 1985:96; Bauer Branch, Green 1987).

The corded wares lasted 200-300 years, then ceramics with plain surfaces and either corded or no decorations were manufactured. In the project area the plain pottery ware probably is Minotts (Logan 1976; Benn ed. 1987:66). Farther east in Illinois it is called Maples Mills (Fowler 1955; White 1985:96). No cultural interpretations can be developed from a discussion of the typology of plain wares because too little is known about their geographic distribution and temporal range. Furthermore, this pottery's typological attributes are not yet fully described in print, including what this writer believes is a critical issue: rim form. Refinements in the technology of pottery making, which began to appear in Weaver ceramics as thinner walls and globular body forms, had the effect of making Minotts vessels more effective boiling containers (cf. Braun 1983).

Other characteristics of the late Late Woodland period included a lithic industry that emphasized small cores, triangular points and delicate, hafted flake tools (Stanley and Hoppin in Benn ed. 1987). Low earthen mounds containing domestic items, rocks and small features were constructed, and the native horticultural complex expanded to incorporate maize production (N. Asch and D. Asch 1985). Together, these Late Woodland characters suggest there was a profound shift in the allocation of labor following the Havana-Hopewell horizon in the Midwest. For instance, the lavish Havana lithic technology was reduced to an expedient flake industry of the Late Woodland period, and much less surplus labor went into

the building and furnishing of smaller mounds. Pottery production focused on the manufacture of more uniform, thin-walled vessels rather than on production of a diversified ceramic assemblage during Havana times. In addition, there was a significant expenditure of labor on the fiber technology. Most important of all changes was the increase investment in maize gardening, which developed between ca. 1350-950 B.P.

The overall trend in the changes in labor allocations was toward activities which could be accomplished by smaller sized producer units. The purported fissioning of productive units during the Late Woodland period has been described by others (e.g. Hall 1980; Kelly et al. 1984a; McConnaughy, Jackson and King 1985; N. Asch and D. Asch 1985; Benn and Rogers 1985; Markman 1986; Green 1987), and it is evident in the settlement data from Pools 13-14 and 17-18. Late Woodland people occupied all parts of the valley floor (Dudzik 1974:22; Billeck and Benchley 1982:11). The surface evidence from small, thin artifact scatters also suggests these sites were smaller.

One significant cultural boundary in the Upper Mississippi Valley is indicated by the distribution of recorded Effigy mounds, which do not extend south of Dubuque (Mallam 1976). Rumors of Effigy mounds in Pool 13 were not confirmed by the 1988 survey, although Late Woodland mound complexes were present. The Pool 13 area appears to represent the southern boundary of the Effigy Mounds tradition.

Mississippian Period

In terms of geomorphic context the landscape and site potentials are the same for the Late Woodland and Oneota/Mississippi periods. These manifestations occur in the same topsoil layer on the terraces and in the floodplain. They have the same visibility factors in terms of the effects of plowing and forest cover. The distribution of Oneota and Mississippian sites is different than Woodland, however. Sites of the later period are clustered, but it is uncertain if this is figment of survey biases or actual human preferences.

There are three cultural traditions within this period (ca. 950-350 B.P.) in the Upper Mississippi Valley. The first is represented by a collections of grit tempered, collared rims and Ramey Incised or Powell Plain-like ceramics from the surface of the Gast Farm (13LA12) in Pool 17 and from the Apple River mouth in Pool 13 (Bennett 1945; Emerson 1985). These materials relate best to the Langford tradition of northern Illinois (Brown et al, 1967; Markman 1987) and to the Aztalan site in south-central Wisconsin (Barrett 1933).

The Langford-like pottery and (Cahokia?) Mississippian vessels from 13LA12 are not isolated in eastern Iowa. The Mouse Hollow rock shelter in interior eastern Iowa (Jackson County) yielded a

few of the same kinds of rims from a mixed Woodland context (Logan 1976:79-80). If there are other unrecorded "Langford" sites to fill in the gaps between far-flung occurrences, they must await future intensive surveys. The late Late Woodland period was a time when a patchwork of structurally similar cultural manifestations, differing subtly in ceramic varieties, covered the area (cf. Braun and Plog 1982; Green 1987). These likely were independent polities ("tribes"), and they probably spawned another phase of political units during the Mississippian period. Langford was one of the Upper Mississippi groups sharing the Midwest, perhaps occupying a specific ecological niche, i.e. forested river valleys (Markman 1987a).

The Oneota tradition was another Upper Mississippian political development concentrated on the Prairie Peninsula (Gibbon 1972). The Oneota were hunters, gatherers and cultivators whose tradition is recognized by shell tempered ceramics and a flake tool lithic technology. Joseph Tiffany (1979, 1982) has provided a bibliography, ceramic analysis and overview of 22 Oneota sites in southeastern Iowa where he recognized two phases based on ceramic varieties: Burlington (1300s A.D.) and Kelley (1500s A.D.; Tiffany 1979:100).

Through catchment analysis methods Tiffany concluded that Oneota subsistence patterns were oriented toward woodland and riverine environments with four corrolaries to his reconstruction (1982:13). 1) Both upland and valley floor site locations provided immediate access to forest and river resources. 2) People may have moved seasonally between upland and valley sites. 3) Sites were positioned to maximize access to the richest natural resources. 4) Sites were clustered, and their overall placement appears to have occurred for reasons other than subsistence, e.g. "access to chert resources, view, communication, trade and defense."(Ibid) Tiffany did not attempt to analyze Oneota sites according to size, density of materials and content.

This Oneota pattern of large villages and small, seasonal sites has been found by Gibbon (1983:9) in the Blue Earth-Correctionville phase in southern Minnesota. Likewise, the pattern was found in the Moingona-Burlington phase in the Red Rock area of south-central Iowa (Rogers, Stanley and Anderson 1987) and in the central Des Moines Valley (Benn and Rogers 1985:59). Briefly, the Oneota settlement pattern was designed to dominate a huge territory but not necessarily to fill every part of that area with seasonal or permanent sites. The common pattern consisted of a cluster of large villages, perhaps occupied cyclically over hundreds of years associated with a corona of seasonal sites dispersed across the prairies and river valleys. Such a pattern is presumed to have been a material manifestation of politico-economic hegemony employed by the Oneota to dominate others (Benn 1984).

The third culture settled on the east side of the Mississippi River in discrete clusters of large villages and temporary sites. Mississippian site clusters have been recorded around New Boston in

Pools 17-18, at Clinton and at the Apple River mound in Pool 13. Since intensive surveys throughout Pools 13-14 and 17-18 failed to locate other site clusters or Oneota materials, the Middle Mississippian occupation looks like discrete groups moving their main villages. The smaller sites could have been single house places or procurement camps.

Mississippian sites at the mouth of the Apple River (Bennett 1945) apparently began with an intrusion of Cahokia-oriented people by the middle of the eleventh century A.D. (Emerson 1985). The Mississippian habitations show little influence from Oneota culture but appear to have amalgamated some influences from surrounding Late Woodland populations and from the Spoon River culture in the Illinois River valley. The settlement pattern in the Apple River locality consists of a central temple town (Mills village) and surrounding hamlets and house sites.

Oneota sites occur only on the Iowa side of the river. In the northern reaches of the valley, ceramics come from a Pleasant Creek site (13JK91) and from the Sabula locality, which probably contained at least one large Oneota site (13JK146). The few ceramics seen by this writer appear to be more similar to those from the Moigona/Burlington manifestation in southeastern Iowa rather than the Orr phase in northeastern Iowa (see Tiffany 1979; Henning 1985:52). This distribution of Oneota materials sits directly opposite the major Middle Mississippian occupation at the Apple River.

The absence of chronology for the Langford-like and Middle Oneota occupations prohibits conclusive interpretation about the circumstances of the Oneota occupation in the valley. That the Mississippi channel appears to have been a boundary between the Oneota and Mississippian sites is an intriguing issue. Considering the aggressive nature of the Oneota system and Tiffany's chronology for the Oneota phases, the Langford-like tradition at 13LA12 probably preceded the Oneota occupation. Perhaps they were repelled northward by an Oneota intrusion into southeastern Iowa sometime after 850 B.P. Moreover, it is doubtful that the Middle Mississippian enclaves on the Illinois side found coexistence with the Oneota, if that is what happened, to be comfortable. Some interaction between Oneota and Middle Mississippian groups during the sixteenth century is indicated by Cahokia-style ceramics at the Kelley site (Tiffany 1979:99), but as Markman (1987:22) stresses the interactions with the Cahokia heartland did not translate into direct influences with many groups in the upper Midwest.

Recommendations

1) Pool Surveys: In contracting for future pool surveys the COE should have the geological model and historic archival research accomplished before any of the archaeological work is initiated. This procedure would set the parameters for the archaeological investigation, which can have different problem orientations in the various Mississippi River pools. Another advantage to having the geologic and historic studies done is that the field archaeologist survey specific locations for particular types of sites. When the archaeological contract is sealed, the investigator should reconnoiter the project area before formulating the goals of the research design. The project research design would then be tailored to the specific conditions and problems within the pool.

2) Middle Woodland Period Study: From the site records review in Iowa and Illinois and from interviews with local collectors it is plain that the Upper Mississippi Valley contains an important Middle Woodland period manifestation. People of the Havana tradition participated in the pan-continental interaction sphere, and local villages were possibly linked in social and economic ways. There may be significant culture variations between the Illinois and Iowa sides of the river. Furthermore, a cultural division seems to exist between the northern and southern areas on the Iowa side. Private collections contain enough information for a detailed investigation of these research issues.

3) Historic Indian Sites: Archival research effort should focus on documenting the presence of native American Indians during the post-1828 period, then working backward in time. The key to locating the sites may be found in the papers of the fur trading firm of Farnham and Davenport; archival research will have to focus on the Davenport Papers, the Chouteau Papers, and the archives of the American Fur Company. An understanding of the physical geography and human adjustments to landscape and environmental changes over time will provide researchers with a more fine-tuned context for Historic Native American sites.

4) Early Recreation Period Sites: Many potential site locations representing early recreation on the Mississippi River (e.g., summer houses, boat docks, businesses) were noted in the archival records in Pools 13-14. Before such sites are processed piecemeal by the cultural resource management system, a theme accounting for the significance of the period of early recreational development should be developed. No such theme exists in the Iowa state plan (Henning 1985).

5) Archival Materials: Recent archival investigations of historic documents pointed out major gaps in the historic archaeological data base for the Upper Mississippi Valley. The time span for the historic period in the region runs through three centuries, and its geography is extremely diverse. The range of potential sources of

contextual and site specific archival data is extensive, but they are widely dispersed, and many of these source materials have been largely neglected by the historians working in the region. The historiography of the alluvial valley is underdeveloped, especially when compared to other regions of the United States -- indeed, CRM studies would appear to afford excellent opportunities for original research, a fact which is at the same time both heartening and yet maddening.

At the head of the list of untapped collections of archival materials pertaining to the Upper Mississippi must come the working papers and official reports generated by the United States government agencies active along the river: e.g., the correspondence and reports of officers stationed at the various military facilities on the river, deposited in the Old Military Records Division of the National Archives; the textual records of the Rock Island and St. Paul districts of the U. S. Army Corps of Engineers, the agency letterbooks of the Bureau of Indian Affairs and its War Department predecessor, and the cartographic records of the U. S. Topographical Engineers, also located in the National Archives; the unpublished files of the Works Projects Administration in the various states; and the extensive map collections of the Library of Congress. There are also several significant microfilm collections of French, Spanish, and British colonial documents relating to the Mississippi Valley held by depositories located in the United States; the foreign repositories should be thoroughly searched. Finally, a major effort should be made to locate and examine collections of documents relevant to the Upper Mississippi Valley fur trade; the principal depositories for this material would seem to be the Public Archives of Canada in Ottawa, the New York State Historical Society in Albany, the Missouri Historical Society in St. Louis, and the Newberry Library in Chicago. Other libraries, such as the Bancroft Library at the University of California and the John Carter Brown Library at Brown University, also may possess significant Upper Mississippi Valley materials among their special collections.

6) Fur Trade: There is no adequate history of the fur trade on the Upper Mississippi between the Illinois River and Prairie du Chien, nor a useful history of the Farnham-Davenport outfit of the American Fur Company. Almost all of the pool surveys completed in the Rock Island District have identified potential fur trade sites, but documentation has been based on secondary sources in almost every case. These sites have the potential to yield significant information about the frontier economy of the Upper Mississippi Valley and about Indian-European relations. Research should refine an historic context or contexts for fur trade sites and compile site specific data.

7) Historic Resource Management Plan: The Rock Island District Corps of Engineers needs to develop a comprehensive cultural resource management plan for historic archaeological sites located on lands under its jurisdiction. This plan should take the format of a series of historic contexts which correspond to major themes

in regional (i.e., Rock Island District) as well as local (i.e., pool) history. The plan should establish district-wide research and preservation priorities. The Corps may also wish to consider playing a more active role in the formulation of statewide preservation plans.

8) Modelling: Changes should be made in the approach to geomorphological modelling for archaeological surveys in pools of the Upper Mississippi River valley. The geomorphological studies in Pools 13-14, 17-18 and 21-22 were generously funded and produced a great deal of the basic information (e.g., radiocarbon dates, landform maps, soil patterns) necessary for general modelling of the valley landforms. The shift from upstream glacial influences to local processes is now well documented through radiocarbon dating and relative soil profile development on Holocene surfaces. The nature of PSA and the pre-settlement surface also are understood. Adding the data from previous studies in Pools 10, 21 and 22, it is possible now to construct general landform maps for every Upper Mississippi pool. The tools needed to do overview mapping of all pools would include good photo coverage (e.g., color infrared, black and white Soil Conservation Service) of each pool, soil survey maps, GLO and Mississippi River Commission maps and a reconnaissance of selected landforms in each pool to provide "ground truthing" for the study. It should be possible to identify Holocene fans, early, middle and late Holocene main valley surfaces, and PSA thicknesses. With overview mapping accomplished in every pool, archaeological surveys could enter individual pools with a research design geared to specific landforms and surface conditions.

Any additional geologic investigation should emphasize fine tuning previous studies by focusing on specific early Holocene problems. For instance, periods of lateral reworking or abandonment and changes in channel morphology (i.e., suspended/meandering to mixed load/braided channel types) could be addressed and better documented. This would involved additional deep coring and recovery of radiocarbon samples for dating.

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GLOSSARY

A.D.: years after the birth of Christ.
ALLUVIUM: sediment deposited by running water.
ALLUVIAL FAN: a cone-shaped landform developing where a small stream abruptly descends to a lower surface of flatter gradient; fans form where streams lack the competence (energy) to transport sediment load.
ALLUVIAL FILL: alluvium representing a lithologically distinct stratigraphic unit or period of time.
BASE CAMP: (archaeological) habitation area occupied for an extended period of time and containing evidence of many domestic activities.
B.C.: years before the birth of Christ.
BENCH: an elevated, fluvially cut surface mantled with a thin veneer of alluvium.
BLOW-SAND: sand moved by wind (eolian).
B.P.: years before present (1950).
CHANNEL SCAR: swale or groove in sediments representing a former stream or river channel.
CLAST: a rock larger than pebble size.
COLLUVIUM: material tranported primarily by gravity.
COMPONENT: (archaeological) the smallest discrete array of artifactual materials representing human activity at a site.
DECORTICATION: removal of weathered rind from the surface of lithic material (as in decortication of a chert cobble).
ESCARPMENT/SCARP: a short, steep slope usually separating inset surfaces of different age.
FIND SPOT: a cultural artifact lacking a natural (original) context.
FIRE-CRACKED ROCK (FCR): rocks showing evidence of thermal alteration in the form of splitting, spalling, color changes and crumbling.
FLAKE: the product of controlled chipping of stone, usually chert; decortication flakes = removal of cortex; interior=flakes without cortex removed from the stone core; thinning flakes=smaller biproducts from thinning an artifact; tertiary flakes=fine pressure retouch biproducts from trimming edges of artifacts.
FLUVIAL SYSTEM: the physical system through which water and sediment are transported from source areas to areas of deposition.
GULLY: a near-vertical walled channel belt entrenched in a valley floor and containing an ephemeral stream.
HEADWALL: the upvalley end of a gully, including a plunge pool and overfall.
HOLOCENE: the period of time since 10,500 B.P., encompassing adjustments of landscapes to post-glacial environments.
HORIZONTAL ACCRETION: (geological) coarse sediments deposited by the lateral movement of a stream channel.
INSET TERRACE: remnants of the former valley floor left along valley margins; formed by successive episodes of vertical and lateral erosion.
ISLAND BRAIDED STREAM PATTERN: a stream pattern composed of multiple shifting channels and relatively permanent islands.

KNICK/KNICKPOINT: a relatively sharp change in valley gradient where water collects and flows.
LEVEE: (natural) a ridge of overbank sediment on a terrace surface adjacent to the stream or former river channel.
LOESS: a wind-deposited sediment of dominately silt-sized particles; may contain significant amounts of sand-sized particles locally.
PALEOSOL: a soil that formed on a landscape and was buried by younger materials.
PEDOGENESIS: physical, chemical and biological alteration of the upper portion of a deposit resulting in development of soil horizons.
PERIOD: (archaeological) a stage of cultural development given chronological limits.
PHASE: (archaeological) a group of sites with similar contents and dating to a limited period of time (sites are assumed to have represented an interacting population).
POINT BAR: lateral accretion deposits of sand- and pebble-sized particles on the inside of a curve in a river or stream channel.
SCARP: see escarpment.
SIDEVALLEY: a much smaller valley relative to the main valley stem it empties into.
SITE: a bounded area of space containing remains of human presence; sites are accessioned by the Smithsonian Trinomial System (e.g. 13PK156, 13=Iowa; PK=Polk County; 156=site number in that county; 11=Illinois).
SOIL HORIZONS: a recognizable zone in soil where certain weathering phenomena dominate and result in a distinctive morphology.
SOLUM: the A and B soil horizons.
STRATIGRAPHY: a sequence of superimposed sediments.
TERRACE: alluvial sediments representing a former floodplain level of the fluvial system.
THALWEG: the deepest flow line in a stream channel.
TILL: nonstratified and poorly sorted loam to clay loam sediment deposited by a glacier.
TRADITION: large groups of sites (more than one phase) representing long-term continuity of artifact styles and subsistence patterns.
UNCONFORMITY: a time of non-deposition or erosion; used here to imply something is missing.
VERTICAL ACCRETION: (geological) usually finer grained sediments left by overbank (flooding) deposition.
WARE: (archaeological) a group of potteries that are similar because of the same manufacturing techniques, shapes and surface finishes.
WISCONSINAN: a geological period covering the most recent episode of glaciation in North America (ca. 70,000-10,500 B.P.).

GEOMORPHOLOGICAL OVERVIEW OF NAVIGATION POOLS 22-11 UPPER MISSISSIPPI RIVER

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SUMMARY

This report outlines the late Wisconsinan and Holocene geomorphic history of that part of the Upper Mississippi valley under the jurisdiction of the Rock Island District of the U.S. Army Corps of Engineers (COE). It encompasses the valley between Lock and Dam 22 at Saverton, Missouri and Lock and Dam 10 at Guttenberg, Iowa, a total of 314 river miles. The field work leading to development of this geomorphic history was constructed over a period of time during geological investigations in support of cultural resource management studies for the COE.

To facilitate the discussion the area encompassed by pools 22-11 is divided into four reaches where the appearance of the valley differs as a result of changing bedrock lithologies, major tributary junctions, and the vagaries of the valley's Quaternary history. The reaches are linked by a common late Wisconsinan and Holocene history that varies in detail from reach to reach as a result of parameters such as valley width, gradient, bedrock constraints, and sediment loading from major tributaries. The common history of the valley shines through reach-specific variations and provides a large-scale depositional and erosional framework that can be used as a tool in managing the resources dependent on the valley's geology.

During the late Wisconsinan (ca. 18,000-11,000 B.P.) the valley carried large volumes of water and coarse sediment from glaciers in upper parts of the basin. Several sandy and gravelly terraces originated during this interval. These terraces are differentially preserved in the valley today as a result of subsequent channel behavior. Wind reworking of the upper part of these terraces during the Holocene (ca 10,500-present) provided a depositional context that preserved extensive prehistoric cultural resources on these surfaces.

Early and middle Holocene (ca. 10,500-4,000 B.P.) deposits accumulated on the floodplain, in tributary valley sediment fans, and along the valley walls in colluvial slopes and alluvial fans. Subsequent main channel activity has varied from reach to reach and significantly influenced the potential for preservation of deposits of this age. In general, early and middle Holocene deposits are best preserved along the valley margins and in the sediment fans of large tributaries. In wide valley reaches large tracts of early and middle Holocene deposits are preserved in areas outside of the COE's jurisdiction.

Late Holocene (ca. 4,000-150 B.P.) deposits accumulated in many of the same areas as early and middle Holocene deposits, and are especially abundant in and adjacent to the modern channel area. Most island areas in the modern channel began to form in this period. Historical alluviation has buried late Holocene deposits in most areas with a variable thickness of fine-grained sediment.

Historical deposits (PSA) accumulated during approximately the last 150 years as a result of drastic changes in hydrology and sediment delivery to the Mississippi River accompanying landuse changes of the Historic period and construction of the

lock and dam system. Variable amounts of PSA have accumulated on valley surfaces depending on the position of the surfaces within a pool, relative to artificial levees and the main channel, and local landuse. The PSA sedimentation pattern has a profound effect on several aspects of resource management in the valley.

An understanding of the distribution and lithologic properties of these various age deposits is essential for several aspects of resource management in the valley, ranging from cultural resource management to the location of dredge spoil. Detailed geomorphic maps, such as those available for several of the pool areas in this part of the valley, are an essential management tool.

GEOMORPHOLOGICAL OVERVIEW OF NAVIGATION POOLS 22-11, UPPER MISSISSIPPI RIVER

E. ARTHUR BETTIS III AND JEFFREY D. ANDERSON

INTRODUCTION

During the last decade geological and geomorphological investigations have become an integral part of cultural resource assessment in the Upper Mississippi Valley. The focus of these investigations changed through time as new research questions arose and as approaches to investigating the issues changed. Today we know much more about the evolution of the valley landscape during the last 12,000 years than we did ten years ago, but there are still parts of the valley that are essentially unknown, and our knowledge of certain important periods of time is sketchy. The purpose of this report is to summarize our current understanding of the last 12,000 years of geologic history for the Mississippi Valley in the Rock Island District's jurisdiction. In order to accomplish this task it is necessary to generalize some quite specific information available in some areas and apply those generalizations to other parts of the valley where our understanding of the geologic history is rudimentary. This approach allows for easy comparison of geologic conditions from one reach of the valley to another.

This report is divided into four parts; 1) a brief summary of geological investigations conducted in support of cultural resource management in the area, 2) a discussion of the physical characteristics of the valley, division of the valley into four reaches for purposes of discussion, and a brief overview of the geologic history of the valley over the last 12,000 years, 3) discussion of the depositional history and resulting surfaces in each of the reaches in order to compare and contrast the geologic record and its influences on management of cultural and natural resources in the valley reaches, and 4) a discussion of management implications. The references following the text include those cited as well as those discussing aspects of the Quaternary geology of this part of the Mississippi Valley. The number in parentheses at the end of each reference refers to the pool area that is discussed in the reference. If no parentheses follows the reference the reference refers to the valley in general.

SUMMARY OF PREVIOUS INVESTIGATIONS

Geological investigations in support of cultural resource management in the Rock Island District's jurisdiction began in the late 1970's with brief observations made on site specific conditions in portions of pools 21 and 22 (Farnsworth, 1976, 1978). Site-specific investigations have continued to the present with increased focus on potential for buried site

materials (eg. Hajic et al., 1983; Overstreet, 1984; Bettis and Benn, 1984).

Investigations in Pool 12 in the early 1980's focused on site-specific geology, but an attempt was made to fit the site-specific information into a broader context of the valley's geologic history (Bozhardt and Overstreet, 1981; 1982). Probably the most significant aspect of these investigations, in regard to geologic influences on the archaeological record, was the discovery that postsettlement alluvium covered extensive floodplain tracts, preventing site discovery using traditional archaeological survey methods.

Church's geomorphological mapping of Pool 10 for the St. Paul District provided the first detailed look at the potential complexity of the valley's surficial deposits throughout a pool (Church, 1984; 1985). Using topographic maps, aerial photographs, literature review, and limited field inspection, Church constructed maps delineating valley landforms of varying origin and stability through time. These were further evaluated in regard to their estimated potential for containing archaeological sites. Although this study was a milestone in its own right, its utility in subsequent archaeological surveys was somewhat limited by a lack of information on either the age of most of the floodplain deposits or the distribution of postsettlement alluvium on the various landforms.

As a result of investigations in reservoir areas managed by the Rock Island District in Iowa and the Illinois Valley navigation system in the Rock Island and St. Louis Districts, it became obvious that a large portion of the potential archaeological record in valleys was buried. It was shown that using a systematic program of subsurface investigations, surficial mapping, and extensive radiocarbon dating maps could be constructed that showed the distribution of surficial and subsurface geologic deposits (eg. Anderson and Overstreet, 1986; Bettis and Hoyer, 1986; Hajic, 1987; Stanley et al., 1988). These maps formed the foundation for evaluation of the archaeological potential of various valley reaches.

These principles were applied in a geological and archaeological investigation of Pools 17 and 18 in 1987 (Benn et al., 1988). The Pool 17 and 18 investigation generated a series of maps showing the potential of the valley landscape for preserving evidence of human occupation from various culture periods. These estimates were based on an extensive, valley-wide drilling and radiocarbon dating program integrated with intensive archaeological survey in areas selected as representative of the various landscape settings in this reach of the valley. These investigations also demonstrated that the valley contains areas where detailed paleoenvironmental records spanning the period of human occupation of the Upper Midwest are preserved (Nations et al., 1989; Bettis et al., 1990).

Subsequent investigations in pools 21, 22, 13, and 14 have taken a similar approach in regard to the generation of maps and the use of subsurface investigations and radiocarbon dating

(Anderson et al., 1988; 1989; Benn et al., 1989). These investigations were also valley-wide in scope, but the pool 21 and 22 investigations were more cursory in nature and included less subsurface investigation than those in pools 13 and 14. These investigations also provided maps depicting the thickness of postsettlement alluvium in the valley. These maps are invaluable for determining appropriate methods for locating cultural resources in the valley landscape.

The advent of valley-wide geological investigations that incorporate subsurface studies and radiocarbon dating has brought about a revolution in our understanding of both the Holocene geological evolution of the valley landscape and the importance of geomorphic processes in shaping the archaeological record. What follows is an outline of our current understanding of the geological history and a discussion of how that geological template influences the management of resources in the valley.

GEOLOGICAL OVERVIEW

The Mississippi Valley between Lock and Dam 22 and Lock and Dam 10 encompasses 314 river miles (miles 301.2-615.1). In this area the river flows through a deeply entrenched valley cut into Paleozoic sedimentary rocks and overlying Quaternary deposits. The physical characteristics of the valley change dramatically along this reach as a result of changing bedrock lithologies, major tributary junctions, and the vagaries of the valley's Quaternary history. It is important to consider the Upper Mississippi as an integrated system composed of specific reaches. Parameters including valley width and gradient, bedrock constraints, sediment loading from within the reach and from major tributaries, and late glacial impacts from outside the immediate valley have strongly influenced evolution of surfaces in the valley during the Holocene.

In order to facilitate a discussion of late Quaternary history and valley surfaces we divide this stretch of the valley into four reaches where the appearance of the valley differs: Reach 1- pools 11-14 (northern two-thirds of pool 14); Reach 2- pools 15 and 16 plus lower one-third of pool 14; Reach 3-pools 17-19; and Reach 4- pools 20-22. Brief discussions of the physical characteristics of each of these reaches follow.

Reach 1 - Pools 11, 12, 13, and upper two-thirds of Pool 14

Mississippi Valley width varies through this reach ranging from about 1.5 miles in parts of Pool 11 to greater than 5 miles in some portions of Pool 14. Late Wisconsinan terraces are found discontinuously along the valley margin. Some of these such as the Osceola terrace north of Dubuque were culturally occupied but have experienced surficial instability and eolian reworking periodically during the Holocene (Overstreet, 1984). Other outwash terraces in this valley reach show a similar geomorphic history. In most areas a prominent scarp exists between the higher sandy late-glacial surfaces and the generally finer grained Holocene surfaces. Holocene surfaces of different age are

juxtaposed and complicated by major main valley tributary meander belts. The lower end of each pool inundates Holocene surfaces with the exception of valley margin deposits such as fans and footslopes.

Frequent Paleozoic bedrock exposures are seen particularly in Pools 11, 12, and 13. Fewer outcrops are seen in Pool 14 because Illinoian glaciation influenced this portion of the valley. The rocks generally dip to the south with the oldest rocks exposed in Pool 11 (Whitlow and Brown 1963, Whitlow and West 1966). Younger Silurian, Devonian and Pennsylvanian rocks occur in the southern end of the reach with generally fewer outcrop exposures (Hammer et al. 1985; Ludvigson and Bunker, 1988). Eroded remnants of Pre-Illinoian till are present on uplands in this area (Hallberg, 1980a). Roxana Silt, with the Farmdale Soil developed in its upper part, and/or Peoria Loess bury the eroded till or bedrock surface.

Reach 2 (pools 15, 16 and lower one-third of pool 14)

The Mississippi Valley in this reach is very narrow (generally less than 1.5 miles wide) and bordered by steep bluffs along both valley walls. The river likewise tends to be narrower in this reach than up- or downstream, and fewer islands are present. The gradient is relatively steep and, prior to construction of the lock and dam system, rapids were present above and below the Quad Cities. From the Quad Cities to Muscatine the valley trends essentially east-west in contrast to the general north-south trend of the valley above and below this reach. Reach 2 owes its unique character to events accompanying the diversion of the Mississippi Valley into its present course about 21,000 years ago (Anderson, 1968).

Late Wisconsinan terraces and associated benches are discontinuously present in this reach. These are separated from Holocene floodplain deposits by a prominent scarp. Holocene surfaces are preserved along the valley margins and in the floodplain and channel areas. Holocene surfaces, except those on benches, valley margins, and late Wisconsinan terraces, are inundated in the lower reaches of the pools.

Paleozoic bedrock exposed in this reach consists of Pennsylvanian sandstone and shale and underlying Devonian limestones (Ludvigson and Swett, 1987). Outcrops of the Pennsylvanian rocks are seen mostly downstream of Rock Island. The Rock River valley joins the Mississippi Valley from the east in this reach just below Lock and Dam 15. Rock Island and Moline are situated on a bedrock upland area surrounded by the Mississippi Valley on the north and west, by the Rock Valley on the south and east, and by an abandoned segment of the Rock Valley on the northeast. Eroded remnants of Pre-Illinoian and Illinoian glacial tills are found on upland areas, often beneath a mantle of Roxana and/or Peoria Loess. The Iowan Erosion Surface is developed on portions of the upland in this area (Hallberg, 1980a and b; Prior, 1976).

Reach 3- pools 17-19

The Mississippi Valley widens dramatically and returns to a north-south trend downstream of Lock and Dam 16 at Muscatine. Valley width ranges from about 10 to 6 miles from Muscatine to the mouth of the Skunk River south of Burlington. Downstream of the Skunk Valley junction the Mississippi Valley narrows to about 1 mile at the Ft. Madison gorge, widens again as it intersects a buried bedrock valley downstream of Ft. Madison, then narrows into a gorge again from Nauvoo to Keokuk. In the wide segments of this reach (above Ft. Madison) the channel pattern is island-braided and extensive riverine wetlands were common prior to extensive Historic drainage (Benn et al., 1988). Two major southeast-trending tributary valleys join the Mississippi in this reach, the Iowa-Cedar, and the Skunk. Both have constructed large sediment fans at their junction with the Mississippi Valley. Valleys joining from the Illinois side trend east-west and are smaller.

Extensive tracts of late Wisconsinan terraces are preserved in this reach. These are usually separated from Holocene surfaces by a prominent scarp or, along valley margins, are buried by alluvial fans and colluvial slopes. Much of the Holocene floodplain is levee protected along this reach. Where not levee protected the Holocene floodplain is inundated in the lower ends of the pools.

Mississippian limestone and shale crop out along the valley walls throughout this reach and are host to an array of chert resources exploited extensively by prehistoric groups (Glenister, 1987; Morrow, 1984). Pennsylvanian sandstone and shale also crop out along the valley wall along the Illinois side in the upper part of Pool 17. Pre-Illinoian and Illinoian glacial tills overlie the bedrock surface on the upland in this area (Hallberg, 1980b). The Sangamon Soil is developed in the upper part of the Illinoian-age Kellerville Till Member. Roxana Silt with the Farmdale Soil developed in its upper part buries the Sangamon Soil. Peoria Loess and associated Parkland Sand bury the Farmdale Soil and form the surficial deposits on the uplands. Parkland Sand is most commonly found on the east side of the valley and on sandy late glacial terraces in the valley.

Reach 4 - Pools 20, 21, and 22

The Mississippi Valley in this reach lies within the extended southern limits of the Southern Iowa Drift Plain physiographic region (Prior 1976, Wickham 1979). Similar to upstream, late glacial high sandy terraces are observed at isolated locations in these pools. Some late glacial surfaces are probably buried along the valley margin by hillslope alluvium/colluvium. Stratigraphic evidence of this was observed near the east valley margin in Pool 22 (Anderson et al. 1989). Compared to Reach 3, valley width narrows to about five to six miles. Evidence in this reach suggests an early to mid Holocene Mississippi River main channel meander pattern, different from what is observed upstream in Reach 3. Fine grained sediment contribution from the Des Moines river system and other major tributaries probably

accounts for a different downstream channel pattern. Older Holocene surfaces occur close to the valley margin and are often buried by late Holocene alluvium. Younger late Holocene surfaces including islands are found close to the contemporary channel margin.

Mississippian and Devonian bedrock is exposed along the valley wall and is composed of limestone, sandstone, dolomite and shale. Exploitable chert units are found in several of the formations. Pre-Illinoian tills overlie the bedrock surface on the uplands in this reach (Wickham 1979). The Loveland Silt with the Sangamon Soil developed in its upper part overlies the till surface. The Sangamon Soil is in turn buried by Roxana Silt with the Farmdale Soil developed in its upper part. Peoria Loess buries the Farmdale Soil and forms the surficial unit across most of the upland area.

Late Wisconsinan and Holocene Geologic History

Large-scale changes in valley gradient, sediment transport, and valley geomorphology accompanied the diversion of the Mississippi River from its ancient southeasterly course through the Princeton Valley to a southerly course about 21,000 years ago (Anderson, 1968). The diversion took place in the Rock Island area and formed the Port Byron and Andalusia gorges. Following the diversion late-glacial events occurring outside of the immediate valley had a tremendous influence on Mississippi Valley evolution until about 9,500 years ago. Between about 18,000 and 11,000 years ago valley train outwash from the Des Moines Lobe, Lake Michigan Lobe, Green Bay Lobe, and Superior Lobe glaciers, as well as Iowan Erosion Surface-derived alluvium, entered the Mississippi Valley via several tributary valleys. This produced a complex series of aggradational and degradational events that formed several sandy and gravelly terrace levels (Bettis, 1990; Bettis and Hallberg, 1985; Bettis and Hajic, 1990). These late glacial deposits continued to contribute coarse bed load material to the channel during the Holocene. Between about 11,000 and 9500 B.P. catastrophic drainage of glacial lakes in the upper part of the Mississippi basin produced large-scale flooding events in the valley (Clayton, 1982; Masch, 1983; Flock, 1983). These events caused valley degradation in some areas, aggradation in others, and channel pattern changes in yet other areas. Following these events, the role of local valley parameters including gradient, valley width, bedrock constraints, local fan and footslope development, and major tributary sediment/discharge contributions, as influenced by Holocene climatic and vegetation changes, strongly influenced main valley evolution (Anderson et al., 1988; Benn et al., 1988; Benn et al., 1989; Nations et al., 1989).

DEPOSITIONAL HISTORY AND RESULTING SURFACES IN THE REACHES

Reach 1- pools 11-14 (upstream two-thirds of pool 14)

This reach extends from Guttenberg, Iowa to LeClaire, Iowa. Generally, the valley varies in width from about 3 to 5 miles. Areas in the upper portion of the pools where valley widening occurs show multiple aged Wisconsinan and Holocene surfaces within the valley margins. A possible pre-Wisconsinan surface was discovered along the west valley margin in the Savanna/Sabula area (Benn et al., 1989).

The lower half to two-thirds of the pools inundate Mississippi River Holocene-age deposits, leaving highly erodible late Wisconsinan outwash terraces exposed. Remaining Holocene surfaces in the lower pools occur along the valley margin as footslope and fan deposits.

Late Wisconsinan Surfaces

Throughout this reach, late-glacial terraces are found discontinuously primarily along valley margins. At least two major late Wisconsinan and probably several minor terrace sequences are observed in this reach of the Upper Mississippi Valley. The two major Savanna Terrace sequences developed between 14,000 and 18,000 years ago while the other developed after 14,000 years ago. An example of a late-glacial sequence has been identified in Pool 11 at special use area FIA-66 Anthony's Resort at Waupeton Iowa. This surface may represent one of the last aggradational events with Superior red clay included in the deposit (Overstreet, 1985). Extensive late-glacial sequences were identified in the Savanna/Sabula study area in Pool 13. These preserved surfaces represent considerable valley adjustment to upstream discharges and sediment loadings. Approximate elevations of three late-glacial surfaces are 640, 620 and 600 feet. Downstream in Pool 14 one of the lowest late-glacial surfaces was reported just upstream of the Wapsipinicon River. Radiocarbon dated plant remains indicate that major valley incision occurred after about 9,700 to 9,500 B.P. (Benn et al, 1989).

Characteristic of these terraces is that they are coarse grained and highly susceptible to drought and loss of vegetation cover. Evidence from the Osceola Terrace (cf. Savanna Terrace) in Pool 11 shows that repeated eolian surficial reworking has occurred during the Holocene. Knowledge of the erosion potential of these surfaces is important for cultural resource managers to understand when interpreting context for an archaeological deposit.

Early to Mid Holocene Surfaces

Late Woodfordian and early Holocene erosional events removed considerable volumes of main valley alluvium. A Giddings probe profile in Pool 13 along the east valley margin showed red clay, erosional lags and no soil profile development at the contact between red clay and tributary hillslope alluvium. The indication is that high magnitude erosional events occurred during this period followed by tributary drainage and valley

margin slope development. The relative degree of valley incision during this period is thought to vary. Some areas apparently saw considerably less erosion compared to others. For example, major valley incision did not occur in the area of the Wapsipinicon whereas farther upstream in Pool 13, vertical incision of 15 feet or more was reported (Benn et al, 1989).

The result of variable degrees of late-Woodfordian/early Holocene valley incision shows a somewhat obscure distribution of early to mid Holocene surfaces. The problem in correlating early to mid Holocene surfaces is compounded by the role of tributaries and local valley morphology. Apparently, tributary influence such as sediment loadings and main channel diversion, and local valley constraints began playing a much more important role in main valley evolution. The main channel diversion and the development of large tributary fans occur throughout this reach and in other Upper Mississippi River reaches (Church 1984, Overstreet 1895, Benn et al, 1988, and Benn et al, 1989).

Early to mid Holocene main valley surfaces are mostly distributed along the upper portions of the pools. However, early to mid Holocene valley margin fan and footslope deposits can be found throughout this reach. In Pool 11 an early to mid Holocene surface occurs along the Wisconsin side of the valley adjacent to Jack Oak Slough and just south of Cassville (Overstreet 1985). Early to mid Holocene main valley surfaces occur south in Pools 13 and 14 and are similarly located along the upper portions of the pools.

These surfaces also occur where major tributaries enter the main valley. For example to the north of the Maquoketa River fan, a series of interpreted early to mid Holocene Mississippi River paleochannels show well developed Alfisols along the relict channel margin. Meanwhile, the Maquoketa River outlet into the main Mississippi River channel changed several times based on radiometric and stratigraphic data, providing a series of multiple aged Holocene surfaces. Some of the older early to mid Holocene surfaces are buried by late Holocene alluvium.

Late Holocene Surfaces

Generally more is known regarding late Holocene valley evolution and the distribution of those landscapes. In the Upper Mississippi Valley and particularly in Reach 1, evidence is widespread showing main valley aggradation (Anderson et al, 1988, Benn et al, 1988, Anderson et al, 1989, Benn et al, 1989). The distribution of late Holocene surfaces is primarily near the contemporary main channel including the islands, and along the valley margin where fan and footslope development proceeded throughout the Holocene.

Late Holocene surfaces often cap earlier surfaces especially where major tributaries enter the valley. The fan deposits produced by these tributaries often bury older Holocene surfaces with younger late Holocene alluvium. For example, profiles observed from the Maquoketa River fan in Pool 13 verify burial of older surfaces by late Holocene alluvium. Pool 11 evidence of late Holocene valley alluviation is seen from a mid channel

island at Ackerman's Cut where a large portion of a Late Woodland vessel was recovered from a weak late Holocene soil between 135 and 142cm below the surface.

Historical Alluviation

Significant historical (PSA) deposits occur throughout Reach 1. Generally, below the lock and dams minor amounts of PSA is observed. The deposits tend to thicken and become more widespread further down in the pools. The higher late Woodfordian terraces usually have little if any PSA capping the surface. The lower Holocene surfaces generally contain thicker PSA amounts. Specific areas which tend to concentrate thick PSA deposits are in the vicinity and just downstream of major tributary confluences, at the base of steep valley sideslopes and where low order tributary fans enter, in Holocene Mississippi River abandoned channels, along main channel margins and islands, and immediately upstream of the lock and dams.

Reach 2- pools 16, 15, and the lower one-third of pool 14

This reach includes the Port Byron Gorge, Rock Valley junction, and Andalusia Gorge areas. The valley is very narrow and occupied in large part by the present Mississippi channel and associated chutes in this area. Little detailed geologic work has been conducted in conjunction with cultural resource management studies in this part of the valley and therefore our understanding of the details of the late Wisconsinan and Holocene history of this reach is much more limited than in upstream and downstream reaches. Reach 2 is a key area for linking the upper part of the valley with the valley below the Quad Cities area. It is in this reach that the dramatic diversion of the Mississippi took place about 21,000 years ago. The Rock valley also enters in Reach 2. During the late Wisconsinan large volumes of outwash were carried down the Rock Valley from Lake Michigan Lobe glaciers. This outwash contributed significant coarse load to the Mississippi that probably had impacts on channel behavior. The following discussion relies on mapping in the lower one-third of Pool 14 by Anderson (in Benn et al., 1989, Vol. II), work in the Andalusia Refuge within Pool 16 (Stanley and Anderson, 1988), and scattered field observations of late Wisconsinan deposits by Bettis.

Late Wisconsinan Surfaces

Extensive sandy and gravelly late Wisconsinan deposits are present just north of this reach in the Cordova area, in the abandoned Rock Valley segment in East Moline, in the southern part of Davenport, and in the Rock and Green River valleys. Those surfaces with elevations between about 575 and 610 feet (downstream to upstream) are the Savanna Terrace. Deposits comprising this terrace accumulated before about 12,000 years ago

in a braided stream environment, and therefore have low potential for containing buried cultural material. The upper few meters of this terrace have been extensively reworked by wind, and extensive dune fields are present in some areas. Some episodes of dune activity occurred during the Holocene and buried cultural materials have been found in similar settings in other parts of the valley (Overstreet, 1984; Benn and Bettis, 1978; Markman, 1987).

A lower sandy and gravelly late Wisconsinan terrace is found in this reach between about 545 and 555 feet (maybe slightly higher in Pool 14). Deposits comprising this terrace accumulated between about 12,000 and 11,000 B.P. in a braided stream environment. Because of the depositional environment these deposits have low potential for containing in situ buried cultural materials. Wind reworked deposits that may contain buried cultural material are also present on this terrace. Several areas of bedrock bench are associated with this level and the higher Savanna Terrace level in the Rock Island and Andalusia Gorge areas.

Early and Middle Holocene Surfaces

In many cases the late Wisconsinan benches are buried by alluvial fan and colluvial slope deposits emanating from small tributary valleys along the walls of the Mississippi Valley. Alluvial fans also prograde the sandy late Wisconsinan terraces described above. Alluvial fans accumulated episodically between about 9000 and 2500 B.P. in the Upper Midwest and have been shown to have high potential for containing buried cultural materials associated with well preserved faunal, floral, and other paloenvironmental remains (Bettis et al., 1984; Benn et al., 1988; Hajic, 1987). Two radiocarbon dates collected from the upper part of an alluvial fan in the Andalusia Refuge (Pool 16) indicate that fans in this reach are the same age as regional investigations would suggest (Stanley and Anderson, 1988). These landforms are abundant and well preserved in Reach 2. Other than alluvial fans, it is not known if fine-grained Mississippi River deposits of middle Holocene age are preserved in Reach 2. Deposits of this age are known from upstream and downstream reaches where the valley is significantly wider (Benn et al., 1989; 1988).

Late Holocene Surfaces

Late Holocene deposits are present in Reach 2. Investigations in the Andalusia Refuge recognized late Holocene-age deposits, but they were rather deeply buried by PSA and water-saturated. It appears that in at least the lower half of each pool in this reach late Holocene deposits are at or below water level. In the upper reaches of these pools late Holocene deposits are above water level, but still at low elevations and subject to flooding and continuing burial by PSA. Some of the islands in this reach are probably cored with late Holocene

deposits. Investigations elsewhere in the valley suggest that thick PSA probably buries the late Holocene island deposits. Three islands in this reach are exceptions to this generalization. Rock Island is an isolated bedrock remnant that contains late Wisconsinan terrace remnants as well as a Holocene sequence on its downstream end; Campbell's Island (Pool 15) is probably a late Wisconsinan or early Holocene terrace remnant; and Credit Island (Pool 16) may be cored with early or Middle Holocene deposits.

Historical Alluviation

PSA covers the surfaces of all but the three islands mentioned above, all late Holocene valley surfaces, and the distal parts of many alluvial fans. In many areas the PSA can be greater than one meter in thickness. Several of the islands in Pool 16 are probably composed in large part of PSA.

Reach 3- pools 17-19

Reach 3 encompasses a wide valley reach that slowly narrows as it passes to the south, until it becomes a gorge from Ft. Madison to Keokuk (Pool 19). Lands under the jurisdiction of the COE usually include only a small part of the valley adjacent to the present channel in this reach. Nonetheless, this discussion will include the entire valley floor because the whole valley landscape provides the context in which the COE's holdings can be evaluated. Geologic investigations have been carried out in pools 17 and 18 in conjunction with archaeological investigations (Benn et al., 1988; Benn and Bettis, 1978; Benn et al., 1987). Geomorphic maps are available for pools 17 and 18 (Benn et al., 1988). Detailed geologic investigations have not been undertaken in Pool 19 and therefore information from Pool 18 is extrapolated to Pool 19 in this discussion.

Late Wisconsinan Surfaces

Two late Wisconsinan terraces are well preserved in Reach 3, the Savanna Terrace and a lower, younger sandy terrace known as the Kingston Terrace. The Savanna Terrace consists of sandy and gravelly Mississippi River outwash deposits that accumulated between about 18,000 and 12,000 B.P. The surface of this terrace is found between 580 and 590 feet in the upper part of Pool 17 and between 550 and 560 feet in the lower part of Pool 19. Upper parts of this terrace have been extensively wind-reworked and large dune tracts are present. Extensive remnants of this terrace are present along the Illinois side of the valley in pools 17 and 18.

The Kingston Terrace occurs at about 545 feet in the upper reaches of Pool 17 and between 525 and 535 feet in the lower reaches of Pool 19. Deposits comprising this terrace consist of sandy Mississippi River outwash. Radiocarbon dates on wood within deposits comprising this terrace in Pool 18 indicate that it accumulated between about 12,000 and 11,000 B.P. (Benn et al.,

1988). This terrace is only two to three meters higher in elevation than adjacent early and middle Holocene deposits. Upper portions of this terrace have been wind-reworked and large dune tracts are present on terrace remnants. The Kingston Terrace is most extensively preserved on the Iowa side of the valley in the Muscatine Island area.

Early Holocene Surfaces

During the early Holocene the Mississippi River occupied a series of now-abandoned paleochannels inset below the Kingston and Savanna terraces. The channel pattern appears to have been an island braided pattern similar to that of the pre-lock and dam channel in this area. Superior-source reddish brown silty clays are associated with the oldest of these paleochannels. These deposits accumulated during large glacial lake-related floods between about 11,000 and 9,500 B.P. Early Holocene surfaces are preserved in some of the older paleochannel areas, especially along the valley walls where alluvial fans prograded late Wisconsinan terraces and early Holocene riverine wetlands. Significant areas of the latter situation are present along the Iowa side of the valley south of Muscatine. Early Holocene deposits are not commonly preserved in lands under the COE's jurisdiction in pools 17 and 18 because of subsequent removal during the middle and late Holocene. These deposits may be present within lands under the COE's jurisdiction in the lower part of Reach 3 (Pool 19), especially at the junctions of the Skunk Valley and in the re-entrant on the Iowa side south of Ft. Madison.

Middle Holocene Surfaces

By about 7,000 B.P. the Mississippi River settled into a channel belt that roughly parallels the modern channel in this reach. Prominent natural levees and associated swales are present in deposits of this age. Above the Iowa Valley junction lateral channel shifting was quite extensive during the middle Holocene, probably in response to hydraulic and sediment damming by the Iowa River. Overbank deposits accumulated in early Holocene paleochannel areas during the middle Holocene. Many of these abandoned paleochannels contained extensive wetlands that persisted until artifically drained in the Historic period. Overbank sediments also accumulated on middle Holocene floodplains. Exposures and cores indicate that sedimentation was episodic with intervening periods of relative floodplain stability and soil formation. Whether these stable periods were valley-wide and produced by climatically controlled sedimentation patterns, or caused by lateral channel shifting with little or no valley-wide change in flood frequency or magnitude is not known.

Alluvial fans prograded and thickened during the middle Holocene. Deposition was episodic with intervening periods of stability and soil formation. In a few areas, such as the Odessa area, the Mississippi River shifted into the valley wall during

the middle Holocene and alluvial fans did not accumulate until later in the period.

During the middle Holocene the Iowa River shifted to the north across its sediment fan toward its present position. A system of Iowa River paleochannels is preserved south of Oakville, marking the middle Holocene meanderbelt of the Iowa Valley.

Late Holocene Surfaces

Late Holocene deposits are found in a relatively narrow belt adjacent to the modern channel, on islands in the channel, in a few abandoned channel areas such as the Odessa area in Pool 17, and where tributary valleys such as the Iowa-Cedar and Skunk join the Mississippi. These deposits consist of relatively thin overbank deposits in the Mississippi Valley deposits, but thicker in tributary deposits, with swell and swale topography that has less relief than that associated with middle Holocene-age deposits. The late Holocene deposits accumulated episodically and contain a series of relatively stable surfaces marked by soils that has been named the Odessa Sequence (Benn et al., 1988). The presence of this sequence of sediments and soils indicates that valley-wide periods of floodplain stability occurred during the late Holocene. The sedimentation pattern that produced these stable periods was probably climatically controlled. The larger islands in this reach began accumulating in the late Holocene.

Historical Alluviation

Thick increments of fine-grained PSA are present between the levees in and adjacent to the present channel area. All but the interior of the largest islands are mantled by thick PSA, and many of the smaller islands consist entirely of PSA. In levee protected areas PSA is much thinner, except immediately downstream of the Iowa (and Skunk?) valley junction and at the base of steep slopes, or where small tributary valleys emerge from the uplands and splay out onto the floodplain. The PSA consists of two increments, a lower noncalcareous increment that probably predates 1900 and a much thicker, calcareous increment that is younger and still accumulating (Anderson and Bettis, 1989).

Reach 4-Pools 20-22

This reach extends from about Keokuk, Iowa to Saverton, Missouri including Pools 20, 21, and 22. Generally, the valley narrows compared to Reach 3 and varies in width from about 4 to 6 miles. The Des Moines River is a major tributary entering the valley just south of Keokuk and is thought to have strongly influenced valley evolution during the Holocene, while other significant tributaries include the Wayconda, Fabius, North and South Rivers.

Some areas show valley widening and multiple aged Wisconsinan and Holocene surfaces. An example is the older sandy Wisconsinan terraces (Savanna Terrace) seen west of Quincy Illinois along the Missouri side of the valley. Levee construction has protected many older surfaces from erosion or pool inundation. Some of these older late Woodfordian and early Holocene surfaces occur along the Illinois side of the valley in Pools 21 and 22 (Leigh 1985, Anderson et al, 1988, 1989). Significant late Holocene island development has occurred in this reach and similar to upstream, the youngest surfaces are adjacent to the main channel.

Late Wisconsinan Surfaces

Late-glacial terraces are found discontinuously in this reach of the river primarily along valley margins. The relatively high sandy outwash terraces seen west of Quincy were not investigated however, they apparently relate to events upstream and result from late Woodfordian valley aggradation and subsequent incision. The terrace outlier at Meyer may also be related to the late-glacial sequence seen near Quincy, and further south high sandy terraces have been identified in the Fall Creek Pool 22 area. These terraces were subjected to mid Holocene drought and apparently experienced some degree of deflation.

The precise ages of these surfaces are unknown since study in this reach did not address these areas. It is believed that they may correlate to other dated late Wisconsinan surfaces (Savanna and Kingston terraces) upstream. Based upon available radiocarbon data (Leigh 1985) from Pool 22 the ages of these surfaces are older than 10,000 years.

Early to Mid Holocene Surfaces

The late Woodfordian/early Holocene erosional events removed considerable volumes of main valley alluvium. Furthermore, evidence shows lateral floodplain reworking during the early Holocene (Anderson et al, 1989). A radiocarbon date from the base of a Mississippi River abandoned channel fill indicates that lateral reworking of floodplain alluvium was occurring prior to 8400 years ago.

Additional evidence (Anderson et al, 1989) confirms Leigh's (1985) suggestion that the Illinois side of the main valley escaped Holocene reworking. This area contains the entire depositional sequence during the last 10,000 years. However, some areas generally along the Missouri side of the valley were reworked during the early to mid Holocene period. Evidence is seen in Missouri where radiocarbon dates taken from basal units are of mid Holocene age (Anderson et al, 1988, 1989) Apparently the Mississippi River maintained a meandering channel pattern during this period since numerous sinuous abandoned channels have been identified in this reach. A sinuous suspended load channel apparently responded to drier early to mid Holocene climates where transport of suspended load dominated over bedload. During this period sediment storage or modest alluviation occurred in the higher ordered tributaries to the Mississippi. The response

of the Mississippi River in this reach was: 1) reduction of overall sediment load, 2) dominant fine grained suspended sediment, 3) some lateral reworking of floodplain deposits, and 4) modest valley alluviation with the development of fans and footslopes. As a result, those areas escaping Holocene lateral reworking have a high potential for containing buried surfaces and potential archaeological sites.

Late Holocene Surfaces

Similar to the upstream reaches, generally more is known regarding late Holocene valley evolution and the distribution of those landscapes. Evidence is widespread showing main valley aggradation (Anderson et al, 1988, Benn et al, 1988, Anderson et al, 1989, Benn et al, 1989) throughout the Upper Mississippi and in particular in Reach 4. The distribution of late Holocene surfaces primarily occurs near the contemporary main channel including islands, and along the valley margin where fan and footslope development continued throughout the Holocene.

Late Holocene surfaces often cap earlier surfaces especially where side valley tributaries enter the valley. This situation occurs at many portions of Reach 4 especially along the Illinois valley margin. A radiocarbon dated profile south of Quincy shows significant late Holocene valley alluviation during the last 2500 years. Additional evidence from Long Island in Pool 21 shows about 8 feet of floodplain alluviation since about 3200 years ago. As climatic changes began during the end of the mid Holocene, the Mississippi River responded through a change in channel pattern. The increase in the frequency and magnitude of floods began mobilizing more coarse grained bedload sediment. The former suspended load meandering channel pattern was replaced with the contemporary mixed load island bar pattern. Development of islands began during the this period probably around 3500 to 4000 years ago.

Historical Alluviation

PSA deposits are widespread and occur throughout Reach 4. Levee construction has prevented PSA accumulation on protected surfaces, while unprotected areas riverward of the levees have generally thick PSA deposits. The higher late Woodfordian terraces usually have little if any PSA capping the surface. The lower Holocene surfaces generally contain thicker PSA amounts if they are not levee protected. Generally in Reach 4, there are considerable levee protected areas, such as the Sny Bottoms thick Holocene sequences exist, however, these areas are outside COE control. Those areas under COE management generally are not levee protected, are on late Holocene surfaces and have thick PSA capping the surface.

MANAGEMENT IMPLICATIONS

The distribution of the various-age surfaces and deposits discussed in the preceding section has significant implications regarding management of resources in the valley by the COE and Interior Department. The following discussion touches on four management issues; cultural resources, wetlands, erosion hazards, and dredge spoils. These issues are discussed solely from the perspective and other aspects such as vegetation and wildlife are not addressed.

Cultural Resources

Deposits dating from the entire period of human occupation of the Upper Midwest are present in lands under the Rock Island COE'S jurisdiction. These deposits are not distributed uniformly from reach to reach or within a given reach. Islands within the present channel area for the most part are made up of deposits less than 4,000 years old and therefore only have potential for containing late Archaic and younger cultural remains. Three islands in Reach 2 are exceptions. These islands contain older deposits and have potential for containing older cultural remains.

Postsettlement alluvium (PSA) usually exceeds one meter in thickness everywhere except the upper end of the pools and interiors of the largest islands. On many island margins the presettlement surface is at or beneath present water level. Significant drowning of island surfaces in all but the upper ends of the pools has occurred as a result of the construction and operation of the lock and dam system. Operation of the lock and dam system has accelerated historical alluviation in the valley.

Late Holocene deposits are most common adjacent to the modern channel, and where tributary valleys join the main valley. Extensive late Holocene deposits are associated with several of the large tributaries. Where these deposits are adjacent to the modern channel, or between the levees, they tend to be mantled with thick PSA. Late Holocene deposits are present in many of the large wetland areas in this part of the valley. In levee protected areas in reaches 3 and 4 late Holocene deposits are mantled with thinner deposits of PSA.

Early and middle Holocene deposits are also present throughout this portion of the valley. In the valley proper outcrops of these deposits are relatively rare but a few, such as that on the eastern side of the channel just below Lock and Dam 17, have been recorded. These deposits are quite extensive outside of the modern channel belt area in reaches 3 and 4. Variable amounts of PSA, depending on the location relative to the present channel, levees, and tributary valleys, can mantle these deposits. Sediment fans of the major tributary valleys also contain large tracts of early and middle Holocene deposits. These areas have not been intensively explored for their potential to contain deposits and associated cultural remains of this age.

Early and middle Holocene deposits are also found in alluvial fans and colluvial slopes along the valley margins. These areas have been shown to have high potential for containing associated cultural remains. These areas are within the COE's jurisdiction in narrow valley reaches such as Reach 2 and portions of Reach 3, as well as where the present channel approaches the valley wall such as near Dallas City, Illinois in Pool 19, and along the Missouri side of the valley in pools 20 and 21. Several COE-managed recreation areas throughout this part of the valley also contain alluvial fan and colluvial slope deposits.

Late Wisconsinan deposits are also present throughout this length of the valley. These deposits probably have low potential for containing in situ cultural remains. However, the wind-reworked upper part of these deposits have high potential for containing buried cultural remains from most of the cultural periods. Where these deposits border the channel they are very susceptible to wave attack and rapid destruction of associated cultural remains.

Wetland Impacts

Construction of the lock and dam system created large tracts of wetland in the lower reaches of many of the pools, especially in Reach 1. Accelerated alluviation coincident with the impoundments has impacted backwater sloughs and wetlands to varying degrees. Many former wetlands have experienced severe sedimentation and have been replaced by mud flats during drier parts of the year. Some of the PSA stored in these wetland areas is potentially host to various types of contaminants (Anderson and Bettis, 1989).

Erosion Hazards

Where the sandy late Wisconsinan terrace deposits crop out along the main channel and backwater sloughs they are very susceptible to erosional wave action produced by recreational activity and barge traffic. This is especially evident in portions of reaches 1 and 3. Other vulnerable deposits include alluvial fans and early to middle Holocene main valley alluvium that crops out along the main channel. These deposits are undercut by wave action and slump into the channel. An extreme case of this situation has been noted immediately downstream of Lock and Dam 17 on the Illinois side of the river where barges wait to enter the lock (Benn et al., 1988).

Dredge Spoil

Maintenance of the 9 foot navigation channel requires periodic dredging and spoil deposition. The spoils frequently occur near the main channel on islands and other low-lying Late Holocene surfaces. Throughout this part of the valley several areas have been identified where the emergent land consists entirely of PSA. Where feasible these areas should be sought out

for spoil deposition in order to avoid impacting prehistoric cultural resources.

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DRAFT

THE ILLINOIS COMPONENT OF THE UPPER MISSISSIPPI WATERWAY ARCHAEOLOGICAL DATA BASE

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Submitted to

The U.S. Army Corps of Engineers, Rock Island District

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MANAGEMENT SUMMARY

Since the mid-19th century, scientists and laymen alike have explored archaeological sites in the Mississippi River Basin. These investigations document the development of human culture. They also provide information on climate change, landscape evolution, floral and faunal ecology, and the history of the Mississippi River.

The Illinois component of the Upper Mississippi Waterway Archaeological Data Base (UMWADB) contains information on 1,501 sites. However, only a small proportion of the floodplain has been systematically surveyed. Also, most of the floodplain surveys have been done without the benefit of associated geological studies. It is apparent, given the dynamic history of the Mississippi River, that a large part of the prehistoric landscape is buried in alluvium. Thus, the existing surface is not a suitable analog for estimating site density and distribution, a fact which underscores the need for geoarchaeological studies.

Much, if not most, of what is known about archaeological resources in the Mississippi River floodplain is attributable to work sponsored by the U.S. Army Corps of Engineers. These projects have focused most closely on the river shoreline and near shoreline settings like Levee and Drainage Districts.

The Upper Mississippi Waterway Archaeological Data Base provides for the first time a comprehensive compilation of information about archaeological resources in the Mississippi River floodplain. Information from the Illinois Archaeological Survey Master Site File was converted into a Geographic Information System (GIS) format. GIS incorporates data base management and graphic software ideally suited for mapping and linking a variety of information to particular map characteristics. The UMWADB consists of several data files including: 1) a Tabular Site Location File, 2) a Tabular Site Attribute File, 3) a Graphic Site Location File, and 4) a Graphic Surveyed Areas File. In addition, it includes a bibliography of archaeological reports (Bennett 1984) and a Tabular

Public Domain Land Purchase File (Illinois State Archives 1984).

With a GIS-based UMWADB, U.S. Army Corps of Engineers archaeologists and planners can evaluate the potential impact of development on these resources. The addition of information from future geological, archaeological, and environmental studies to the UMWADB will provide a more powerful means of characterizing known resources in an area and estimating the archaeological site potential of others. Used in this way the UMWADB becomes a tool for prudent management of these unrenewable resources.

CHAPTER I

The Illinois Geographic Information System Archaeological Resource Data Base

Introduction

In 1956 professional archaeologists in Illinois formed the Illinois Archaeological Survey. Central among the Survey's constitutional mandates is the development and maintenance of a master file of archaeological sites in the state. Today the file contains information on over 28,000 sites.

In 1983 the Illinois Department of Mines and Minerals (IDMM) implemented the U.S. Department of the Interior, Office of Surface Mining Lands Unsuitable for Mining Program (LUMP). LUMP establishes a petition process by which private citizens may request IDMM to determine the suitability of mining a particular property. IDMM contracted the Illinois Department of Energy and Natural Resources (IDENR) to create a data base of information to evaluate the potential impact of mining in coal-bearing areas of the state, and assist the public in preparing petitions.

Five IDENR Divisions, the State's Geological, Natural History, and Water surveys, the Illinois State Museum, and the Office of Research and Planning, submitted a proposal to IDMM to develop a computer-based LUMP information system. IDENR proposed a state-of-the-art Geographic Information System (GIS). GIS is a powerful means of acquiring, storing, manipulating, and presenting graphic and content information that have a geographic or spatial component. After reviewing several proposals, IDENR chose the GIS system developed by Environmental Systems Research Institute (ESRI).

ESRI's GIS incorporates data base management and graphics software ideally suited for mapping and linking a variety of information to particular map characteristics. It is a hybrid of two software packages: ARC, a proprietary software of ESRI, and INFO, developed and marketed by Henco. ARC enables the GIS

to process graphic information. Graphic data are input by digitizing, a process that transforms cartographic data in the form of points, lines, and polygons, into digital images. INFO, a data base management software, enables the GIS to store, retrieve, and manipulate data about digital images as well as establish independent data files. Together these programs provide a powerful means of managing information. The IDENR GIS is now known as the Illinois Geographic Information System (IGIS).

The Illinois State Museum is responsible for the development and maintenance of a cultural resource data base for LUMP. Since 1984, Museum staff have converted information from the IAS files into a GIS format. Several files are now functional. They include information on site locations, cultural and physiographic attributes of sites, and a limited coverage of surveyed areas. Through LUMP, Museum staff also compiled a bibliography of research reports (Bennett 1984). Originally produced in a word processing format, the bibliography is being converted into a more powerful cross-referenced information source. Integration of bibliography information into a GIS format is planned.

These files facilitate both cultural resource management and archaeological research missions. Thus, copies of the files are now accessible to the Illinois Historic Preservation Agency (IHPA), the IAS, and several archaeological programs in Illinois. The request from the U.S. Army Corps of Engineers, Rock Island District is in keeping with the need to prudently manage cultural resources in the Mississippi River basin.

The Mississippi River has a rich record of human history spanning over 10,000 years, and has long been a focus of archaeological research. Since the late 19th century, scientists and laymen alike have explored Native American, French Colonial, and now, early American sites. The IAS files include information on 1,501 sites in the Mississippi River valley, including island, floodplain, terrace, and bluffbase settings (see Appendix D).

The Illinois component of the Upper Mississippi Waterway Archaeological Data Base (UMWADB) is a compilation of our current knowledge of archaeological sites in the Mississippi River valley bordering Illinois. In addition, it

includes a compilation of the Land Purchase record compiled by the Illinois State Archives. The remainder of this report discusses the following topics:

1) GIS-based archaeology files;

2) data base compilation;

3) data base limitations; and

4) recommendations for file updates and refinements.

CHAPTER II

Development of the Illinois Component of the Upper Mississippi Waterway Archaeological Data Base

Introduction

The Upper Mississippi Waterway Archaeological Data Base (UMWADB) is a subset of the IGIS version of the Illinois Archaeological Survey (IAS) site file. Their organization and information content are identical.

Illinois Archaeological Survey Site File

Information on archaeological sites is forwarded to the IAS by archaeologists throughout the state. The IAS site file consists of site record forms, which include sketch maps of site location (see Appendix A for an example).

Information quality is evaluated by IAS staff who review all forms and maps, checking to make sure legal descriptions and UTM coordinates match site locations. U.S.G.S. topographic sheets, originally 15 minute series, but now exclusively 7.5 minute series sheets, serve as base maps for master site location maps. IAS staff transfer site location information from forms and sketch maps to the master sheets. Initially, site locations were recorded as points. More recently, however, they are recorded as polygons to illustrate the spatial extent of the site.

Duplicate copies of the full set of site record forms are curated in the IAS offices at the University of Illinois, Urbana, and by Southern Illinois University, Carbondale; the Illinois State Museum; and in the near future, the Illinois Historic Preservation Agency. A number of universities and archaeological organizations have subsets of the file.

UMWADB Architecture

The type of information needed for cultural resource assessments, the number

of sites in the site file, and the need for expedient access to site information strongly influenced the architecture of the GIS archaeology data base. In the context of the LUMP program, it was imperative to have a comprehensive listing of sites in coal-bearing areas available as quickly as possible. To meet these needs, the archaeological data base was designed with several components, here listed in order of development. They include:

1) a Tabular Site Location File;
2) a Digitized Site Location Map File;
3) a Site Attribute File; and
4) a Digitized Surveyed Areas Map File.

Currently under development are files on cemeteries, and the locations of National Register and Illinois Register sites.

In addition, a bibliography of reports, articles, monographs, and books on Illinois archaeology (Bennett 1984) was compiled for LUMP. Although not currently organized in a GIS format, plans to do so are being developed. A GIS-based listing of land purchases compiled from the Illinois State Archives is also included.

Information in the GIS site location and attribute files are linked by index numbers. A unique number, based on the FIPS county code and IAS site number, is assigned to each site. Thus information about a site, regardless of format, may be cross-referenced.

File Organization

The architecture of the UMWADB mirrors the LUMP data base. To build the UMWADB, subsets of information were extracted from each LUMP file. A description of the organization of each file, how it was compiled, and its limitations follows.

Site Location File (Tabular)

Completed IAS site record forms (Appendix A) contain information on site

location. Museum staff transferred information from site record forms to standard 80-column computer data sheets. Using a commercial PC-based data base software, DBase II and DBase III+ (Ashton-Tate Inc. 1985), site location information was transferred to computer files. The D-Base files were then transferred to the GIS data base management software INFO. The Site Location File includes the following information:

Variable
County
Site Type Code
Illinois State Museum Site Number
Site Type Code
Illinois Archaeological Survey Site Number
Site Name
Legal Descriptions in Quarter Section
Alignment/Orientation of Quarter-Section Template
U.S.G.S. Topographic Sheet Reference
Topographic Sheet Scale
Easting U.T.M. Coordinate
Northing U.T.M. Coordinate
County FIPS Number
Site Index Number

Site Attribute File (Tabular)

This file contains administrative, environmental, and cultural information about each site in the data base. This information was obtained from the IAS site record form. The contents of this file are listed below:

Variable
County
IAS Site Number
Cultural Affiliation [1]
Site Extent
Physiographic Setting
Drainage
Field Conditions at Time of Survey
Multiple Visits?
Pottery Present
Projectile Point Present
Surveyor
Date of Form
Collection - Institution Where Artifacts are Curated
Index number

[1] Codes for this variable and those that follow are presented in Appendix B.

Digitized Site Location File (Graphic)

This file is a graphic version of site location. The graphic file was created by digitizing the location of sites plotted on the IAS master maps (Appendix A). Digitizing converts the map features into digital images. Traditionally, site locations were noted as points. Today, where possible, polygons are used to illustrate the spatial extent of a site. The digitized data are in the form of an ARC/INFO point coverage recorded in the Lambert Coordinate system. UMWADB maps are plotted at 1:24,000 scale. These include site locations annotated with IAS numbers; surveyed areas, demarcated with thick red lines; sections lines; the name of the U.S.G.S. 7.5 minute topographic sheet; and a border signifying the extent of the topographic sheet coverage.

Surveyed Areas Map (Graphic)

The State Historic Preservation Office, now part of the Illinois Historic Preservation Agency (IHPA), has maintained records on the location of archaeological site surveys for approximately 15 years. This information is recorded on U.S.G.S. topographic sheets. The map information reflects the location of archaeological reconnaissance projects conducted under the auspices of historic preservation laws. The implementation of more rigorous reconnaissance and recording procedures during the last decade has provided systematic information on surveyed areas. Museum staff digitized these maps to create this coverage. Although not a comprehensive coverage, it provides the best, accessible information on the subject.

Quality Assurance, Quality Control

Quality Assurance

The Illinois State Museum is not responsible for the quality of information recorded in the IAS site file or the IHPA surveyed area maps. The GIS data base is a duplicate of the IAS file. Museum staff simply transferred information from site record forms and maps to computer files. There are, however, two exceptions to this statement. Descriptive terms used to describe landform setting are particularly diverse and often inconsistent. We developed a simplified classification system consisting of general landform terms. A similar system was developed to record field conditions at the time of survey. Reclassification of these data are the only deviations from information found on IAS site record forms. Questions about specific site information should be directed to the individual who recorded it (see the Site Attribute File for this information).

Quality Control

Museum staff implemented a series of quality control procedures to insure the accuracy of the data transfer process. Tabular data files are compared with original site record forms. When errors have been discovered, museum staff

consult with IAS staff to determine, if possible, the source of the error. In some instances, the error can be attributed to the data translation process, in others, the original data are incorrect. The data quality control process is ongoing. File users are urged to note errors and forward them to the museum for correction.

Graphic file coverages are evaluated by comparing site maps with expected legal location. Particularly noteworthy are errors caused by the transfer of information from 15 minute to 7.5 minute maps. Minor mislocations are magnified by the difference in map scale. Review of the map file is also ongoing.

Limitations

Unregistered Information

By far the most serious limitation of the IAS files is the potential amount of unrecorded information. As information is discovered by Museum, IAS, and IHPA staff it is added to the site data base. Once this information becomes available, a revised file will be forwarded to the Rock Island Corps.

Historical Archaeological Sites

Only recently have Illinois archaeologists systematically recorded historical archaeological sites. A truly comprehensive record of historical sites will require 1) field work and 2) research of plat maps, county histories, and atlases. Plat map information can be digitized to provide locations for potential historical archaeological sites and architectural sites. Development of such a data base is in the conceptual stage. Pilot studies have been conducted to evaluate feasibility.

Verification

A noteworthy portion of sites in the Mississippi River valley were recorded more than a decade ago. In some areas development may have impacted these sites. GIS coverages of infrastructure, mined-out areas, metropolitan areas, and other

maps of modern development can provide a means of evaluating the current status of sites in developing areas. Ultimately, however, field verification is necessary to evaluate site status.

Bibliography and Land Purchase Data

A Bibliography of Illinois Archaeology (Bennett 1984)

This bibliography systematically lists citations of papers, articles, and monographs on Illinois archaeology through 1982, more recent citations are currently being added. It is not presently integrated with the GIS archaeological resources files. Organized originally in a word processing format, the bibliography has been transferred to a proprietary software of the Museum. Through this software, known as Alexis (Aeria 1989), the bibliography is cross-referenced by county. Efforts are underway to expand the cross-reference codes to inc ude more detailed information such as drainage basin, cultural affiliation, and the subject of the report. If a research report refers to a site or sites, this information is also being encoded. In the future this information will be linked to the GIS format.

Compilation of UMWADB bibliography was a two-step process. First references were compiled for all counties bordering the river. This was done with the Alexis-based files. At the current time there is no means of separating Mississippi River valley references from those pertaining to other physiographic settings. As a result, there is duplication in references on a county by county basis, particularly where projects encompassed several counties.

Next, the IHPA surveyed areas map was examined. Each surveyed area is denoted with a record number which refers to a specific project. Project files were examined to accumulate a list of report titles. Much of the work done in the Mississippi River valley since 1982 is unpublished. The results of most reconnaissance projects are recorded on standard IHPA archaeological short report forms (ASSR). Reference to these projects is included in the bibliography on a county by county basis. As is the case with all of the files, the bibliography

file will be updated.

Land Purchase File - Erich Schroeder

In 1975 the Illinois State Archives began a long-term project to computerize the Illinois land records (Kremm 1975). The project was finished in 1984, resulting in a file of more than 500,000 records of land entries (Illinois State Archives 1984). Each record consists of:

Variable

The Date of the Transaction

Name of the Purchaser

Number of Acres

Price Per Acre

Total Price

Legal Description of the Land Parcel (principle meridian, township, range, section, and fractional description)

County or State of Purchaser (if available)

Type of Transaction

In general, the pattern of land entries reflects the spatial patterns of frontier development and settlement. Sometimes the reflection is direct, for example the procurement of adjacent land parcels by members of an extended family of settlers (Schroeder 1988; Faragher 1986). Sometimes the reflection is less direct, for example land grants to veterans or companies, or purchases by speculators (Rezab 1980; Conzen 1988; Stover 1975). Also, the patterns of land entries can reflect the changing legal and economic environment (Hart 1974:77-61; Schroeder 1989). However, there can also be cases in which the land records do

not reflect the frontier settlement patterns; for example, it is not possible to identify "squatters" by using this data set (Wagner 1989).

To summarize briefly, before the 1840s the land entries follow environmental factors, particularly the prairie-timber boundary and small river drainages. In the floodplain of the Illinois River, the earliest land entries are usually at the base of the bluffs, often well away from the river. There is also a trend towards purchases in the vicinity of communities, reflecting the higher perceived value of the lands in that situation.

Description of the data set

This data set was produced by using the GIS to clip out all the sections that are shown on any of the USGS 7.5 minute quadrangle maps that border the Mississippi River. The legal locations of these sections were then used to make a subset of the INFO file that contains the land records. In cases where a section is only partially located on one of the USGS maps, all of the parcels in that section are included in the file.

Limitations

There are some limitations of this data set. The most important is that it does not represent the final version produced by the Illinois State Archives. The tape received by the Illinois State Museum is an interim version, and is therefore missing several data sets. In particular there are no records of the 1818-1819 land grants to veterans in the Military tract. This means that there is a great deal of missing data on the east side of the Mississippi River in the counties from Calhoun, in the south, to JoDaviess, in the north. We are currently working with the Archives to incorporate this information.

Another group of land transactions that is missing from this file are those resulting from the Swamp Land Act of 1850. This act donated swamps or inundated lands to the counties for the purpose of draining or reclaiming. Records for these transactions are stored at the respective county courthouses, and the information from most of the counties is not included in the Archive's file

(Gaynon 1975; Schroeder 1989).

UMWADB Use

The GIS format enables one to search the archaeological site data files, list and cross-tabulate site characteristics, and illustrate site location and distribution based on specified parameters. A typical application may involve determining if any known sites are located in a specified area. A search of the Site Location File using INFO commands will provide a listing of sites in the area in question. Using the index number to cross-tabulate, one can access the Site Attribute File to obtain more detailed information on the antiquity, extent, and physiographic setting of the site or to obtain administrative information about who conducted the work and where artifacts and records are curated. Using ARC commands, a map of the site and its relationship to other sites may be generated. As other graphic coverages -- such as water bodies, distribution of pre-settlement vegetation, or geoenvironmental context -- are added to the system, one can use INFO to gather more detailed information on site setting. Thus, the UMWADB is a foundation of information on which one can build a more detailed and sophisticated data base.

Summary

The UMWADB is a compilation of information from the IAS site files, published and unpublished reports on archaeological research, and Land Purchase records. It contains a variety of information on the site locations and their physiographic setting. Also included is administrative information identifying the source of data and the location of artifact and record curation. The bibliography of reports, articles, and books is organized by county. The Land Purchase data were obtained for U.S.G.S. topographic sheets which map the course of the Mississippi River.

These data were compiled in a Geographic Information System format which

includes tabular and graphic components. The UMWADB consists of several files including:

1) a Tabular Site Location File;

2) a Digitized Site Location Map File;

3) a Site Attribute File;

4) a Digitized Surveyed Areas Map File; and

5) a Tabular Public Domain Land Purchases.

All of the archaeological site files are cross-referenced by an index number. Thus, one can search the Site Location File using specified parameters. If sites are identified, the Site Attribute and Site Location Maps may be consulted. The bibliography and Land Purchase records are currently independent of the GIS format. These files can be used to develop preliminary interpretations of the character and distribution of archaeological resources in the Mississippi River valley.

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Advisory
Council On
Historic
Preservation

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PROGRAMMATIC AGREEMENT
LOCKS AND DAMS 3 THROUGH 22, UPPER MISSISSIPPI RIVER

WHEREAS, the U.S. Army Corps of Engineers, Rock Island and St. Paul Districts, (Corps) proposes to administer a program to rehabilitate the locks and dams under their jurisdiction on the Mississippi River (locks and dams 3 through 22); and,

WHEREAS, the Corps has determined that the program may have an effect upon properties included in or eligible for inclusion in the National Register of Historic Places and has consulted with the Advisory Council on Historic Preservation (Council) and the State Historic Preservation Officers (SHPO) of Missouri, Illinois, Iowa, Wisconsin, and Minnesota pursuant to Section 800.13 of the regulations (36 CFR Part 800) implementing Section 106 of the National Historic Preservation Act (16 U.S.C 470f),

NOW THEREFORE Corps, the Council, and the SHPOs agree that the program shall be administered in accordance with the following stipulations to satisfy the agency's Section 106 responsibilities for all individual undertakings of the program.

Stipulations

The Corps will ensure that the following measures are carried out.

1. In implementing this Agreement and in carrying out all work on the locks and dams, the Corps will seek to ensure that the overall historic character and appearance of the lock and dam system is preserved and restored.

2. Actions which do not affect potentially significant features of the locks and dams, as identified in table 12 (attached) of Major Rehabilitation Program, Mississippi River Locks and Dams 11 through 22 (Rock Island District) and Major Rehabilitation Program, Mississippi River Locks and Dams 3 through 10 (St. Paul District) will be carried out as proposed.

3. Actions which may affect significant features, as identified in table 12, will be carried out as follows:

A. Where the Corps determines that work will be in accordance with the "Secretary of the Interior's Standards for Rehabilitation," the actions will be carried out. The Corps will maintain records of all work performed, which shall be open to inspection by the relevant SHPO, upon request, to verify that the "Standards" are being interpreted in a manner consistent with the policies of the SHPO.

B. Where the Corps determines that work will not be in accordance with the "Secretary of the Interior's Standards for Rehabilitation", or where any guidewall extension; addition of lock structure; or removal, relocation or major alteration of control stations are proposed, the Corps will consult with the relevant SHPO to determine an acceptable treatment. Where the Corps and the SHPO reach agreement, the Corps may proceed in accordance with the agreed upon treatment. Where the Corps and the SHPO cannot reach agreement, the Corps will notify the Council to obtain help in resolving the disagreement and may request the comments of the Council in accordance with 36 CFR Section 800.5(e)(6).

4. The Corps shall ensure that a record is made of locks and dams 3 through 22. The Corps shall request the National Park Service (Historic American Engineering Record) to determine appropriate documentation for the locks and dams. Prior to conducting any rehabilitation, the Corps shall ensure that documentation specified by the National Park Service is completed. Copies of the documentation of the locks and dams within each State's jurisdiction shall be provided to the relevant SHPO. Copies of the documentation of the locks and dams within each Corps district shall be maintained in each district office of the Corps.

5. Rehabilitation work anticipated, but not yet planned, including work at locks and dams 11, 14, and 19 (only the c. 1913 portion or lock and dam complex 19), will be reviewed by the Corps, the relevant SHPO, and the Council at the time planning begins. If the Corps, the SHPO, and the Council agree, such work may be carried out in accordance with the terms of this Agreement.

6. Nothing in this Agreement is intended to prevent the Corps, the SHPOs, or the Council from consulting more frequently or informally concerning any questions that may arise or on the progress of any projects falling under this Agreement.

7. Any of the signatories to this Agreement may request a reconsiderations of its terms or revoke the Agreement upon written notice to the other signatories. In the event the Agreement is revoked or for other reasons is not implemented, the Corps will follow the procedures set out in 36 CFR Part 800 to obtain the Council's comments on individual undertakings of the program.

Execution of this Programmatic Agreement and carrying out its terms evidences that the Corps has satisfied its Section 106 responsibilities for all individual undertakings of the program.

(date) 30 June 87

Chairman
Advisory Council on Historic
Preservation

(date) 24 June 1987

District Engineer
Rock Island District
Corps of Engineers

(date) 12 June 87

District Engineer
St. Paul District
Corps of Engineers

(date) July 1987

Illinois State Historic
Preservation Officer

(date) 7/24/87

Iowa State Historic
Preservation Officer

(date) 8/5/87

Minnesota State Historic
Preservation Officer

(date) Aug. 21 1987
Missouri State Historic
Preservation Officer

(date) Aug 31, 1987
Wisconsin State Historic
Preservation Officer

TABLE 12

Impact Summary for Major Rehabilitation Actions
(see also table 11)

Action	Affect to Significant Res.	Affect to Potential NRHP Element	Adverse Effect Criteria	No Adverse Effects	Compliance w/Sec'y Interior's Standards	Beneficial Effects
Lockwalls, Guidewalls Walking Surfaces	Yes	Yes	Potentially 1 and 3 for guidewall extensions	All actions except guidewall extensions	Concrete and armor replacement will essentially match existing conditions; guidewall extension will match those already in place at some locations and will appear clearly different from original lock walls	Except guidewall extension, required upkeep of structures
Main Lock Miter Gates	Yes	Yes	None apply	All actions	Cleaning and painting essentially as existing	Required maintenance
Lock Dewatering System	No	No	None apply	No effect	Straight forward inspection and repair as existing/original	Required maintenance
Emergency/Auxiliary Lock Miter Gates	No	No	None apply	No effect	Straight forward inspection and repair as existing/original	Required maintenance
Main Lock Miter Gate Machinery	Yes	Yes	None apply	New machinery on lockwall will be a minor intrusion	New machinery on top of lock wall will only be about 3 ft. high and visually unobtrusive; replacement parts for 50-yr.-old equipment cannot be obtained	Required maintenance and removal of machinery from flood susceptible site
Lock Tainter Valve Machinery	Yes	Yes	None apply	New machinery on lockwall will be a minor intrusion	New machinery on top of lock wall will only be about 3 ft. high and visually unobtrusive; replacement parts for 50-yr.-old equipment cannot be obtained	Required maintenance and removal of machinery from flood susceptible site
Main Lock Outlet	No	No	None apply	No effect	Not required	Required resolution of safety hazard
Lock Electrical Equipment	No	No	None apply	No effect	Not required; replacement parts unavailable for 50-yr.-old equipment; unobtrusive alteration	Required maintenance to improve operation
Dam Structure	Yes	one at L/D 15 and L/D 17	None apply	All actions	Repair, no overall appearance or function changes	Required maintenance

TABLE 12 (Cont'd)

Action	Affect to Significant Res.	Affect to Potential HMMP Element	Adverse Effect Criteria	No Adverse Effects	Compliance w/Sec'y Interior's Standards	Beneficial Effects
Roller Gates	Yes	Yes	None apply	All actions	Cleaning, painting and wiring plans conform	Routine maintenance
Tainter Gates	Yes	Yes	None apply	All actions	Cleaning, painting, wiring, chain work conform	Routine maintenance
Service Bridge	No	No	None apply	No Effect	Full compliance	Routine maintenance
Piezometers	No	No	None apply	No Effect	Full compliance	Routine maintenance
Emergency Bulkheads	No	No	None apply	No Effect	Full compliance	Routine maintenance
Scour Protection	No	No	None apply	No Effect	Full compliance	Routine maintenance
Storage Yard Tracks	No	No	None apply	No Effect	Full compliance	Routine maintenance
Overflow Section	No	No	None apply	No Effect	Full compliance	Routine maintenance
Storage Yard Embankment	No	No	None apply	No Effect	Full compliance	Routine maintenance
Non-Overflow Section	No	No	None apply	No Effect	Full compliance	Routine maintenance
Abutments	No	No	None apply	No Effect	Full compliance	Routine maintenance
Davenport Seawall/ Storm Sewer	No	No	None apply	No Effect	Full compliance	Routine maintenance
Powerhouse Generator	Yes	Yes	Criteria 1 could apply for roofs and windows	All actions	Normal user repairs; roofs and windows could be designed to comply and preserve appearance, profile, and configuration	Routine maintenance
Maintenance Storage Shed	No	No	None apply	No Effect	Normal user repairs; roofs and windows could be designed to comply and preserve appearance, profile, and configuration including doors	Routine maintenance
Lock Control Stand Enclosures	Yes	Yes	Criteria 1 and 3 for new enclosures could apply	All actions	New enclosures can be designed to blend in with overall concrete matrix and be an improvement over the existing metal ones	Routine maintenance

November 27, 1990
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Upper Mississippi River

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TYPE

PUBLIC INVOLVEMENT

APPENDIX E

RECONNAISSANCE REPORT
FOR
UPPER MISSISSIPPI RIVER NAVIGATION STUDY

APPENDIX E
PUBLIC INVOLVEMENT

The purpose of the Upper Mississippi River Navigation Reconnaissance Study Public Involvement Program is to ensure that the study takes into consideration the needs, concerns, and general welfare of the public. "The public" is defined as all potentially affected individuals, organizations, businesses, and navigation industries; communities; and local, regional, State, and Federal agencies.

The objectives of the public involvement program are twofold: first, to provide the public with information about the study and to educate the public regarding system navigation; and second, to provide a mechanism for making the public's desires, needs, and concerns known to the study team.

The above objectives were pursued through newsletters, press releases, public meetings and workshops, and letter correspondence. These efforts required development of a comprehensive mailing list representing approximately 1,700 public, private, and individual interests in the Upper Mississippi River navigation system. Distribution of public coordination documents is made to all parties on the mailing list, which is updated periodically to include new public interests as they are known.

Public coordination for the reconnaissance study began with the distribution of a Public Notice on February 24, 1989. The notice announced that navigation reconnaissance studies for the Illinois Waterway and the Upper Mississippi River would be undertaken by the Corps of Engineers in Fiscal Year 1990. The notice, which is included in this appendix on page E-23, also solicited public comments.

A Plan of Study (POS) for the two river systems was distributed on August 7, 1989. The POS summarized the objectives of the navigation studies and explained the Corps of Engineers' planning process and the history of navigation on the two waterways. The POS also described existing riverine resources and navigation trends and forecasts. A copy of the POS is on file at the Corps of Engineers' Rock Island District office.

A Notice of Initiation for the Upper Mississippi River Navigation Study was distributed on April 3, 1990. The notice provided information about the study area, discussed the objectives of the study, requested public views and comments, and stated various means by which the public could be included in the Corps of Engineers' decision-making process. Together, this information comprised the study's first newsletter. A copy of this newsletter is included in this appendix on page E-25.

On May 30, 1990, a letter was sent to environmental interests and agencies inviting them to attend an environmental coordination meeting on June 19, 1990. (A copy of this letter is included in this appendix on page E-29.) The purpose of the meeting was to establish and maintain communication between the Corps of Engineers, Federal and State agencies, and interested groups and individuals. The meeting also served as a forum for the exchange of environmental ideas, concerns, and comments regarding the Upper Mississippi River Navigation Reconnaissance Study.

Approximately 25 Corps of Engineers and agency representatives attended the environmental coordination meeting. Representatives from the Rock Island District explained the study authorization and detailed the need for the study, including assessment of economic, environmental, and engineering considerations. Attendees were encouraged to make statements, express their opinions, and interact with the Corps of Engineers representatives and other attendees by the use of an informal meeting format. A certified court stenographer prepared a transcript of the meeting, which is on file at the Corps of Engineers' Rock Island District office. Input from this meeting is incorporated in the public input summary of this appendix.

A notice announcing three public workshops to be held on October 9-11, 1990, was mailed to all interests on the Upper Mississippi River Navigation Study mailing list on September 4, 1990. The study's second newsletter was distributed on September 17, 1990. This newsletter provided more detailed information on the October 1990 public workshops, as well as information regarding the reconnaissance study components: economic, recreational boating, environmental, and cultural resources assessments. Comments from interested individuals were encouraged. A copy of the workshop announcement and the second newsletter are included in this appendix beginning on page E-31.

On October 9-11, 1990, the Corps of Engineers sponsored three public workshops in St. Louis, Missouri; Davenport, Iowa; and South St. Paul, Minnesota, respectively. The twofold purpose of the workshops was to: provide the attendees with information regarding study progress and direction and provide a forum for interested individuals and agency representatives to share and discuss their ideas and concerns with each other and the study team.

The workshops were well attended, with over 100 individuals participating in total (22 in St. Louis, Missouri; 54 in Davenport, Iowa; and 34 in South St. Paul, Minnesota). Participants represented commercial, environmental, recreational, industrial, economic development, and related interests.

Each workshop had a similar structure. The workshops opened with welcomes, introductions, and brief study updates. Next, the audience divided into small discussion groups, each group focusing on a specific interest or concern (e.g., environment, recreation). Following the small group discussions, the audience reconvened as a whole and a summary of each small group's discussion was presented. The meeting concluded with a question

and answer session. Certified court stenographers prepared transcripts of each workshop. These transcripts are on file at the Corps of Engineers' Rock Island District office. Input from the workshops is incorporated in the summary of public input in this appendix.

The third newsletter for the Upper Mississippi River Navigation Reconnaissance Study was distributed to the study's mailing list on November 29, 1990. This newsletter contained a study update, which included an economic analysis update and progress on the environmental evaluation. The results of the three October 1990 public workshops were summarized in the newsletter. Information also was discussed regarding how the issues and concerns that were identified during the workshops, or provided in written correspondence, comment sheets, or telephone conversations with the Corps of Engineers, would be used during the plan formulation process of any subsequent feasibility studies. Again, comments concerning the study were encouraged. A copy of the third newsletter is included in this appendix beginning on page E-39.

Public involvement activities for this study have generated a number of letter inquiries. Correspondence from agencies for which coordination is required by Federal law or the National Environmental Protection Act is included in Appendix F - Pertinent Correspondence.

All public input and comments were systematically handled using a modification of the Codinvolve content analysis method. This technique, which was initially developed by the U.S. Department of the Interior, ensures consistent, objective, and thorough coding, summarizing, and storing of all public input. A summary of public input is included in this appendix beginning on page E-4.

A Notice of Study Completion will be distributed at the conclusion of the reconnaissance study. The notice will be issued by the Commander of the Corps of Engineers' North Central Division. It will summarize the reconnaissance study's findings, conclusions, and recommendations, and also will inform the public on how to request a copy of the Final Upper Mississippi River Navigation Reconnaissance Study Report.

UPPER MISSISSIPPI RIVER NAVIGATION RECONNAISSANCE STUDY
COMMENTS/QUESTIONS/STATEMENTS

SUPPORT STUDIES

1 Study is needed.

2 Support studies.

3 Expedite studies.

4 Support system-wide approach or analysis of Illinois Waterway and Mississippi River.

5 Very interested in study outcome and recommendations.

INFORMATION/HELP

1 Coordinate with and inform public and agencies of pending studies and results.

2 Explain the Corps' 3-point management approach.

3 Agencies and the public will work and coordinate with Corps.

4 Request copy of POS, report, minutes, or related navigation study document(s), put on mailing list, correct address. Distribute written from public workshops to public.

5 What is the status of the Plan of Study?

6 Public and agencies would welcome Corps assistance in preserving Illinois Waterway habitat and recreation.

7 Hold public meetings as soon as possible.

8 Coordinate with State Departments of Transportation directly, rather than through Upper Mississippi River Basin Association.

9 Local communities and leaders exemplify concern and dedication to the waterways through organizations (e.g., Illinois River Coalition).

10 Commend the Corps for its early coordination.

11 Corps should use its knowledge and resources to take a leadership role in coordinating local resources.

12 A direct answer from the Corps is negligible.

13 Hold public meetings or workshops up and down the Mississippi River - not just in major cities.

14 Upper Mississippi River Waterway Association has boating safety fliers and a safety video for public viewing.

15 Are the Corps' public workshops/meetings open to anyone?

16 Corps should host a meeting for different interest groups to get to know each other -- just for open discussion among participants.

17 Disliked the fact that interest groups at 10 Oct 90 Rock Island workshop were segregated rather than integrated. (The 9 and 11 Oct 90 workshops in St. Louis, Missouri, and St. Paul, Minnesota, respectively, also used segregated interest groups.)

18 Some of the public is unrepresented because they have no specific concern relative to the study -- they have just an overall interest. How do they fit in? How are they heard?

19 What was the consensus of the 9 Oct 90 public workshop in St. Louis, Missouri?

GENERAL COMMENTS

1 No comments.

2 Reconnaissance study should interrelate with other studies, issues, activities, and projects.

3 How will the navigation reconnaissance studies be better than those from the 1970's Master Plan (Berger Study)?

4 Address coordination and planning process requirements and methods.

5 Address the study schedule; it must allow reasonable time to complete required coordination and studies.

6 Will the Districts' plans incorporate the system-wide approach for the entire study? Use the system-wide approach for reconnaissance studies -- study the Upper Mississippi River System as a whole; do not separate the Illinois Waterway and Upper Mississippi River.

7 There are 138 terminals located on the Illinois River System.

8 Who would undertake the proposed studies?

9 Question of balancing transportation modes is missing from analysis: rail vs. highway vs. river transportation. Is the Corps of Engineers the best judge of investments by transportation mode?

10 Provide greater detail in reconnaissance reports about methods and assumptions discussed in 1988 Inland Waterway Review article. Address differences between current and past projections/forecasts.

11 Recreational use, environmental responsibility, and safe use by commercial freight should be the Corps' objectives for the waterways; legislation at the Federal level is needed if these are not within the Corps' current mission. The navigation, ecological, recreational, and economic facets of waterways are important and should be properly represented in the studies.

12 Corps broke commitments to drainage districts when building navigation and flood control structures.

13 Will lobby for support and completion of Muscatine Island project.

14 Bureaucracy has overburdened itself with paperwork, resulting in inefficiency.

15 Nearly all drainage districts are members of Upper Mississippi River Flood Control Assocation.

16 What is status of the ongoing Illinois Waterway Navigation Reconnaissance Study?

17 How will the Corps address problems identified by the public during this study?

18 Plan of Study adequately addresses navigation and environmental concerns.

19 How will the system-wide economic analysis be completed?

20 Corps should take a leadership role to balance river interests. All interests on the river should be able to work together to live together regarding river values and uses. The public needs to learn about each others' interests and concerns.

21 Rivers and river transportation helped to develop the entire U.S.

22 Recreation and the environment are important, but the Upper Mississippi River is most important to local economies.

23 The Corps cannot experiment with Upper Mississippi River navigation like a laboratory animal, but must complete research to predict how the system will react to increasing navigation. The Corps must determine the environmental costs and how to avoid and minimize any potential adverse impacts before expanding navigation traffic.

24 The three-year study time schedule is insufficient given the detailed environmental studies needed.

25 What is the difference between the 2nd Lock Plan of Study (POS) and the Upper Mississippi River Navigation Reconnaissance Study?

26 Is the Upper Mississippi River navigation study an environmental study?

27 The Corps should make industry well aware that environmental factors must be considered during the Corps' study.

28 Reduce the lead-in time from start of studies to completion of projects.

29 Don't overlook existing flood control projects and their role in the navigation system when assessing system needs.

30 Levee modifications are needed near Quincy, Illinois.

31 Consider special, non-commercial interests and desires during studies and project implementation.

32 How does the navigation study interact with legislation designating the Mississippi River a National Scenic River? What authority would the National Scenic Riverways Commission have over navigation activities?

33 Identify the positive and negative economic and environmental impacts associated with the current navigation system and planned developments.

34 Define the law enforcement authority on Federal waters.

35 How can large capital investments in new lock facilities be justified? Explain the justification in laymen terminology.

36 What are the long-range implications of the navigation system and its potential improvements? Impacts to communities, citizens, economies?

37 Should citizens talk to congressional representatives about involving the Corps in other modes of commodity transportation? (Sarcasm intended)

38 Navigation and environmental issues are confusing to common citizens.

39 Congress needs to get the Mississippi River navigation and environmental issues up on the table for logical discussion, especially regarding their economic implications.

40 Corps study process provides only reactions by interest groups, not real problem identification and study involvement or direction from the public.

41 Inform the public of the interrelationship between different transportation modes and the importance of commercial navigation.

42 Corps should work more closely with river towns to help them with economic development.

43 How does the flood insurance program affect long-range development?

44 What is the relationship between the Fish and Wildlife Service and the Corps of Engineers?

45 The Corps doesn't meet its own permit standards and requirements.

MONEY AND FUNDING

1 How will projects be financed? Will the Inland Waterway Trust Fund be impacted? Perform cost allocation analysis before increasing the use fee. All beneficiaries should pay accordingly, including recreational boaters.

2 Address how capital investment recommendations will be formulated for three Districts.

3 What is the status of FY90 funding?

4 What is the $200,000 for Navigation Study on Illinois Waterway in FY90 Appropriations about?

5 State of Illinois' role in studies likely to be minor, since there is 100% Federal funding for the studies.

6 Define who would fund environmental restoration and enhancement measures.

7 Assure adequate operation and maintenance funding for the navigation system.

8 What is the probability of State or local user fees or taxes being charged for use of Federal waterways?

9 What is the potential for additional fees for Coast Guard activities?

NAVIGATION CONCERNS AND COMMENTS

1 Maintain viability and reliability of navigation system, including maintenance and upgrading of the locks and dams. Assess 50-year-old and older facilities. Plan far enough ahead to allow for substantial traffic growth. Bring the navigation system up to 21st century standards for commercial and recreation craft.

2 Improve navigation system. The structural modernization of both the Upper Mississippi and Illinois Waterways has been neglected. The present river system will be inadequate by 1995. Many of the locks on the waterways are 50 years or older, constructed when tonnage was far less than today. The locks need improvement, particularly those which perform the greatest number of lockages. Make the locking process more efficient. Use auxiliary locks more. Lengthen guidewalls. Eliminate double lockages. Provide 1,200-foot locks to take a 15-barge tow in one pass. Make larger lock replacements to allow several tows at one time to transit. Make structured improvements to lock approach areas, especially for L/D 15, 16, 17, 18, and 22. Provide more tie-off areas at the locks. Provide year-round commercial navigation facilities.

3 Corps is responsible for a channel for all river traffic and should emphasize channel maintenance.

4 Navigation facilities will require more repair-related downtime as they reach the end of their useful lives (50 years).

5 Solve approach and other traffic improvements before undertaking major improvements. Priority should be given to those structures on the system which may create bottlenecks on the river.

6 Delays have increased considerably and congestion is a major factor. Delays and stoppages are inconvenient and increase costs for consumers. How will delays be addressed? Reduce delays caused by maintenance activities. Address delays at L/D 17.

7 Concerned about increasingly prohibitive restrictions placed on dock locations and State intrusion in control of Federal waters. Maintain fair consideration for fleeting areas in urban locations. Need approved fleeting areas.

8 Obsolescence of structures nationwide contributes to higher transportation costs through slower transit times, and higher incidence of downtime due to more frequent maintenance and rehabilitation.

9 Estimate rehabilitation and capacity needs for the next 50 years, given the lead time required for construction and rehabilitation to begin.

10 Is scheduling (lockages) an issue?

11 The following comments pertain to Dresden Island: The lower cells are used by tows clearing the bridge in order to set them up for exchange once a downbound tow clears the lock. The nearby railroad bridge hampers traffic. A downbound double blocks the chamber entrance when it moves to couple its first half; the bye-time is wasted time for use of the chamber. With an upbound 9-barge double or a configuration that allows passage of pleasure boats, some time is saved by exchanging the tow during the tow bye-time. The upper approach is in good shape, with 4 cells above the lock used by waiting tows. Wall extensions and additional haulage are needed. An increase in commercial and recreation craft could increase the bottleneck and maintenance needs at Dresden Island. The lower left cells below the lower guidewall at Dresden Island fill with silt at present traffic levels and the two upper cells would be useless at increased traffic levels.

12 If over 60 percent of capacity is used, then at least 30 to 40 percent of capacity is still available.

13 What constraints are eliminated when analyzing unconstrained demand? agricultural land base; drought; physical dimensions of the river; highways as competitors; and highways as a mode to move grain to waterways?

14 Navigation improvements would increase capacity to accommodate traffic demands.

15 Prevent navigation problems and delays experienced in 1988 and 1989 -- if not a new lock, find an alternative more acceptable than traffic disruption. Minimize construction related delays. Address delays caused by sharp river bends.

16 Interested in developing a port facility in Clarke County, Missouri. Address the need for a port facility in northeastern Missouri.

17 Reduce ice flows into lower Mississippi River when Upper Mississippi River is closed in winter. Ice delays on the lower Mississippi River make barges miss export vessels.

18 Slow speed of lockage adds excess costs to tow operation -- speed up lockages.

19 Will lockage delays move upstream as a result of new Lock 26?

20 Can St. Louis to Cairo sections of river be kept open with continued low water conditions? Maintain adequate water flows below the Missouri River.

21 Will there be enough barge fleeting in Clinton to meet needs if barge loading increases 50 percent?

22 Address delays, especially those that could be alleviated by better Corps management at individual locks.

23 Does Corps plan to increase channel depth?

24 Demands on the river are increasing tremendously for both commercial and recreation craft.

25 Need adequate mooring cells above and below locks. Tows should be allowed to moor to trees.

26 Corps should more closely monitor small dock and boat landing locations near locks and sharp bends in the river -- safety is a problem due to the dangerous mix of recreation and commercial traffic and low visibility.

27 St. Paul Corps should dredge deeper and wider to provide and assure better and safer handling of tows.

28 Corps and the Coast Guard must resolve their debate and prohibit the use of single-hulled commercial vessels on the waterways (for environmental safety).

29 Assuming navigation system improvements are warranted despite environmental concerns, the Corps should first examine current navigation practices before undertaking structural changes; tow and barge design changes that could prevent oil spills and speed the locking process, tributary sediment measures to keep silt out of the system, and better planning and management of barge fleeting areas should all be considered as a first alternative.

30 Alleviating one bottleneck will just create another one, and so on ad absurdum!

31 Reduce the average processing times at Locks 15, 16, 17, 18, and 22.

32 Did the issue identification of a lock and dam downstream of St. Louis mention any specific location? Investigate a lock below St. Louis.

33 Examine potential benefits from modifying pool regulation and lock operating procedures at all locks.

34 Is dike construction necessary in the St. Louis Harbor?

35 Concerned about reduced flows from the Missouri River and potential impacts on navigation.

36 Improve communication between the Corps and industry.

37 When traffic is heavy and delayed, locks should promote self-help programs with towboats helping each other to speed the lockage process.

38 Need the user-fee to balance between competing modes.

39 Store water for use during low water. Maintain adequate water levels to facilitate maximum barge loading during low water.

40 Increase capacity from L/D 25 through L/D 14 as a system.

41 If commercial and recreation users will benefit from navigation system improvements, they should all be required to ensure their activities don't negatively impact the river system.

42 Add 1,200-foot lock chambers in addition to existing 600-foot chambers at all locks.

43 Need a consistent (accurate) lock data computer-link between St. Louis, Rock Island, and St. Paul Districts of the Corps of Engineers.

44 Establish and enforce a maximum threshold of boating activities.

45 Spill restrictions are overly prohibitive.

46 Use technology for more efficient traffic management.

47 How would the Corps establish a 12-foot channel? By raising the dams or by dredging?

48 Open side chutes near Andalusia, Illinois, to reduce commercial and recreation congestion.

49 Concerned about increased congestion caused by riverboat gambling.

50 Corps should require inspections of ALL navigation equipment.

51 Determine optimum traffic levels to maintain multiple uses on the river and possibly establish traffic restrictions in appropriate areas, as needed.

52 Provide lighted channel markers.

53 Are there or can there be size restrictions for commercial craft?

54 Require use of double-hull barges.

COMMODITY/PRODUCT SHIPMENTS AND DATA

1 Need improved cargo data and forecasts, particularly for hazardous commodities.

2 Illinois Waterway has become a focus of opportunity for Great Lakes ports, with the decline in direct overseas vessel traffic. (Marketing efforts are examining potential for increased cross-lake-river U.S. Canadian trade following the recent signing of the U.S./Canadian Bi-lateral Trade Agreement.) Maritime activity on Illinois Waterway will likely increase.

3 Five separate businesses wrote stating their reliance on the waterways for shipment and receipt of goods and commodities. One of these specifically stated it anticipated increased shipments of stone and gravel up the Illinois Waterway.

4 Any improvements to the Illinois Waterway's infrastructure could enhance grain traffic.

5 The Chicago Board of Trade's future market depends on deliverable grain at Chicago, which moves downward through the Illinois Waterway.

6 U.S. Department of Agriculture, Office of Transportation, monitors weekly volumes of agricultural products transported by barge along the Mississippi River and its major tributaries (PMS data), in cooperation with the Corps. One of its monitoring sites is LaGrange.

7 The waterway system makes exports more price competitive by moving commodities (coal, grain, petroleum) in large volumes at a low unit cost.

8 Illinois Waterway corn shipments are estimated to average 30 percent of all corn exported from the Mississippi River ports from 1979-1989. Illinois Waterway soybean shipments are estimated to average 18 percent of all soybeans exported from New Orleans from 1979-1989. Corn growers are the largest single beneficiary on the waterways.

9 Involve the grain and barge carrier industry in a timely fashion when repairs or maintenance are contemplated, to minimize adverse impacts to all areas of the grain marketing channel. Need increased capacity to meet further export demands.

10 Biotechnology progress will lead to increases in yields and crop production and new corn products will increase demand.

11 It is difficult to perceive continuing traffic growth, since production of agricultural products is likely to decrease. Plan of Study ignores the shrinking agricultural land base when it forecasts expanding agricultural production.

12 Skeptical about projections that Midwest coal production will increase.

13 There is little interchange of commodities between Minnesota and the Illinois Waterway.

14 Navigation is vital to Midwest and entire Nation. Water transportation enhances the country's ability to compete in an international market place and assists in the balance of trade. The Illinois Waterway is an essential part of Illinois commercial navigation and must be able to efficiently handle current and future traffic levels. Illinois Waterway significantly contributes to the economic well-being of Illinois, particularly the agricultural interests. Make improvements necessary to handle future commerce demands. Economic development goes hand in hand with navigation. Increased traffic projections point out the importance of maintaining the efficiency and low cost of the system (continue maintenance and reduce delays).

15 How will navigation improvements impact agricultural resources?

16 Concerned that existing rail system and carriers would be unable to handle increased grain shipments.

17 Provide sensitivity analysis on grain, coal, and other commodity projections.

18 Are most grain terminals south of St. Paul? Does most upbound Mississippi River traffic travel to St. Paul as the primary destination?

19 Restrict barges carrying hazardous materials to single lockages only.

FISH, WILDLIFE, AND CULTURAL RESOURCES

1 Corps must be open and honest with the environmental community in order to alleviate concerns regarding navigation reconnaissances studies. Must implement the Environmental Management Program in full to maintain credibility with the environmental community. Hope to avoid the confrontational history of the 2nd Lock POS and avoid and mitigate issues.

2 How will the system-wide environmental assessment be completed?

3 How will study address National Environmental Policy Act requirements?

4 Support thorough reconnaissance study with long-term scientific study of navigation problems and the environmental effects from existing and proposed system improvements. Environmental consequences of increased commercial traffic are unknown. Address environmental concerns, including cumulative effects and possible perturbations

of riverine ecosystems resulting from increased traffic, and recreation. Increase the efficiency in an environmentally safe manner.

5 Plan of Study should equally address future environmental and navigation needs.

6 Use a system-wide approach in order to address cumulative impacts. Analyze the river as an environmental system, not on a site-specific basis.

7 Identify and implement measures to protect the environment and reduce and mitigate existing and traffic related environmental impacts, protect fish and wildlife habitat/environment, and to enhance the environment. Corps must mitigate environmental impacts created by its navigation activities, as is consistent with all other Federal programs. Past promises of mitigation and restoration (e.g., Master Plan measures) must be kept as a precondition to any future improvements. EMP funding should be extended and restored to equal 2nd Lock funding levels (2nd Lock costs increased; therefore, EMP funding should be increased). Fund 2nd lock environmental studies and mitigation. Implement avoid-and-minimize measures immediately. Complete and implement 2nd Lock POS before or concurrent with any additional navigation work.

8 There are two national and several State Wildlife Refuges on the Illinois Waterway. The Illinois Waterway is important for migratory fowl and birds, including the Great Blue Heron.

9 Prepare a comprehensive system-wide Environmental Impact Statement to address all recommendations developed in the reconnaissance report.

10 Navigation effects tasks of the Long-Term Resource Monitoring Program are being revised into testable hypotheses.

11 Implement the St. Louis Plan of Study, including avoid-and-minimize measures. St. Louis Plan and LTRM data are necessary for continued planning for capital improvement measures.

12 The Environmental Management Program has study elements which examine navigation impacts on the environment. The Corps has broken faith with the environmental community by drastically reducing EMP funding, while rehabilitation and navigation funding were unaffected.

13 An examination of past and future commodity movements could provide a base for environmental considerations and future planning needs, such as potential for hazardous spills and cleanup.

14 Use a balanced approach to improve transportation efficiency without degradation of the environment.

15 Commend Corps for environmental efforts, but much more needs to be done. Look beyond the river corridor into watershed land uses in order to achieve environmental objectives.

16 Corps has shown it has changed its focus to being more concerned with environment, as exemplified by permit process.

17 Continue using the team approach to identify issues and develop the Environmental Impact Statement.

18 Environmentalists should pay for all the mitigation they propose for projects.

19 Does the Corps plan to convert agricultural lands to wetlands? How will this affect tax revenues?

20 Is F&W performing an environmental study of fleeting impacts for the Corps?

21 Very interested in Illinois Waterway ecosystem.

22 Enhance wildlife habitat (especially refuges).

23 Prohibit barges mooring to trees and other structures not designed for this use. Eliminate all barge fleeting given the negative environmental impacts which result.

24 Method for prioritizing inland navigation improvements should include natural resource and environmental information.

25 Upper Mississippi River is a dual-purpose Federal project: commercial navigation and environmental resource.

26 Towboats should be allowed to moor to trees on Fish and Wildlife lands. When tied off properly, little, if any, damage is done.

27 Commercial and environmental communities must open dialogue for development on the river to continue. The Biologist on Board program (Fish and Wildlife and EPA biologists ride on tows and talk with crews) helps promote this communication and understanding. Biologists learn that industry employees also love the river and the environment.

28 The navigation studies and resulting projects could increase winter navigation and enhance hydropower development opportunities, both of which may negatively impact fish and wildlife resources.

29 Define the maximum system capacity for commercial and recreation craft relative to maintaining environmental systems.

30 Environmental goals need to be more clearly defined for commercial interests.

31 Lock and Dam structural modifications should consider restoration of free fish passage through facilities.

32 Commercial interests should care about the well-being of the river system and influence their customers to reduce environmental impacts.

33 How will unavoidable impacts be compensated for?

34 Adjust water regulation procedures to more closely approximate natural flow conditions.

35 Define the agency who has authority/mandate to supervise actual environmental disasters.

36 What are the environmental impacts of the new Campbell's Island bridge?

37 More Federal money should be spent on environmental studies and mitigation.

RECREATION AND CULTURAL RESOURCES

1 Will Illinois Waterway improvements impact on recreational and cultural aspects of the I&M Canal National Heritage Corridor? The first priority of the study should be to preserve the natural heritage of the river.

2 Recreation and commercial boaters vie for the same water areas, making it increasingly difficult and dangerous for water-oriented recreational activities to take place. The number of recreation craft continues to increase.

3 Peoria Lake is widely utilized for personal recreation and community activities.

4 Existing and planned marinas near Morris, Moose Island, Bonnel Bend and the Dupage-Des Plaines intersection, Big Bend, and Three Rivers will generate much recreation traffic which will have to be dealt with.

5 Recreation traffic projections should utilize data from the Environmental Management Program's Study on the Economic Value of Recreation on the Upper Mississippi River System.

6 Economic impact from recreation boaters is important.

7 Raise the river 1 to 1.5 feet over the next 4 to 5 years to keep it viable for recreation boaters and to help the environment.

8 The Illinois Waterway, and particularly Peoria Lake, is a major water-based recreation/conservation area.

9 Plan of Study adequately addresses cultural resources.

10 Archaeological resources are non-renewable and will be lost by mid-21st century.

11 Protect tribal trust resources.

12 Commercial boats give up turns to lock for recreation boats.

13 Need additional public use and access areas.

14 Commercial boats aid recreation boaters in distress.

15 Majority of cultural sites are on private property.

16 Concerned about safety on the Upper Mississippi River. The Upper Mississippi Waterway Association requests Corps assistance with safety programs for recreation boaters. Provide waiting areas at locks for recreation boaters as a safety measure.

17 Construct separate recreation locks for heavily congested locks with high recreation traffic. The original plans for the Upper Mississippi River locks included auxiliary locks at a later date; these are needed now. While not economically feasible in the 1970s study by the Corps, circumstances have changed; safety, not cost, should be the governing factor at this time. What price does the Corps place on the lives of a boatload of people?

18 Design considerations must consider the physical requirements of recreational traffic.

19 Concerned about increasing recreation traffic and impacts to riparian wildlife when boaters recreate on shore.

20 Set wake/speed limits for commercial and recreation craft. Establish a Federal licensing program and set minimum education requirements in boating safety for a commercial and recreational boat operating license.

21 If recreation lockages are facilitated, larger recreation craft may dominate recreation use of the river.

22 May need to limit recreation craft in order to conserve natural resources.

23 Increase use of dredged material for beach nourishment.

24 Improving recreation lockages may increase congestion throughout the system.

25 Use auxiliary locks for recreation craft, especially at L/D 2 and 3.

26 Is there a Master Plan for recreation dock facilities?

27 Identify recreation boating hazards (e.g., wing dams).

28 Concerned about wakes and traffic impacts on small recreation craft.

29 Provide technical and financial assistance for recreation facility development.

30 Provide breakwaters on Mississippi River to protect recreation craft.

31 Concerned about recreation and commercial craft competition for lockages.

SEDIMENTATION AND WATER QUALITY

1 Sedimentation and ice buildups cause maintenance problems on the Upper Mississippi River System for both environmental and navigation concerns. Land use practices cost the U.S. millions of dollars for maintenance of the navigation system and the environment.

2 Will the Plan of Study or Reconnaissance Reports address Illinois Waterway siltation?

3 Concerned about shoreline erosion. Protect soil along the waterways and prevent upland erosion.

4 Dresden Island causes currents to swirl around it, bringing in more silt. Determine effects of increasing traffic on the bottom topography near Dresden Island and its rate of change.

5 Illinois River Soil Conservation Task Force is addressing erosion problems to help eliminate sedimentation. It has pilot test-projects, including revegetation, revetments along with tire structures, and gabion baskets for gullies. Results from these test projects won't be fully realized for 2 years.

6 Without sediment control, we will continue to spend tax monies to dredge. Study the impact of soil erosion on channel maintenance.

7 All rivers have sediment problems, including Upper Mississippi River.

8 Are the waterways receiving waste effluents from surrounding communities, industries, or farms? What is the Corps' responsibility to regulate

this? Disposal of sanitary waste should be more strictly regulated and more disposal facilities should be provided.

9 Commercial users do not cause all pollution, erosion, wakes, or other water problems.

10 Shoreline erosion is causing levee deterioration along Mississippi.

11 U.S. Government owns land under levees and riverward banks and should maintain bank stabilization as part of navigation system -- not the responsibility of drainage districts. Corps should be responsible for planning and construction of erosion control projects on the river.

12 Corps hauls riprap for island stabilization, jetty repairs, etc -- for navigation and flood control levees a "stitch in time could save nine."

13 Concerned about secondary impacts of silt on tributaries and methods to prevent these impacts and recycle the sediment.

14 Siltation is gradually cutting Harper's Ferry, Iowa, off from the main channel -- we must plan and act soon (with Corps assistance).

15 City of New Boston, Illinois, wants to apply for funding or a grant to dredge Sturgeon Bay.

16 Put Bay Island Pump Station back in river instead of in Bell Pocket in Sturgeon Bay. Why was pump station ever moved from the river?

17 Deptn of shallow areas (too shallow to sail over) in Peoria Lake did not change significantly between 1972 and 1982.

18 Estimated losses of top soil near Illinois Waterway were significantly greater than the deposits (loss of depth) on the river bottom in Peoria Lake, 1972-1982.

19 Silt is deposited on Illinois Waterway bottom only when Mississippi River backs up Illinois Waterway above Peoria Lock and Dam and stops the flow. Suspended silt stays in suspension as long as water is moving.

20 Density of bottom silt decreases as soluble materials dissolve into water. Once this silt is resuspended, it stays suspended until it is carried by current to the Mississippi Delta.

21 Some areas on Illinois Waterway could be reclaimed for recreation by using tug propeller turbulence during high water periods to suspend sediment. These areas include the lower part of Upper Peoria Lake.

22 Review and possibly revise existing Corps policy for dredged material removal and placement. Can we make better use of this material?

23 Placement of dredged material creating problems at New Boston, for example. New Boston Ferry landing so silted in ferry can no longer operate.

24 Concerned about backwater siltation and recreation impacts.

25 New Boston Bay silted in due to pump situation -- needs dredging fast.

26 Increased river traffic will increase water and air pollution.

POOL LEVELS

1 Why is fluctuation of Pool 15 less severe than for other pools? Is this because of the new computer at the Rock Island District Corps? Is the Pool 15 fluctuation kept lower because of the commercial enterprises that use it?

2 Is the water let into a navigation pool released at the same rate? If so, why does the sink level (pool elevation) fluctuate so drastically within just 24 hours?

3 Pool 16 (Andalusia, IL) has dropped as much as 2.7 feet in 24 hours, and that never happened before the Rock Island District got the computer to monitor and control the water levels. The lockmasters did a much better job regulating the pools than the computers.

4 The stage at L/D 15 was 3.4 feet on July 29, 1990, and 7.5 feet on July 31, 1990.

5 Has the Corps changed the pool stage in Pool 15? If not, why do residents need docks four times as long? If something is not done, the side channel will be reduced to a creek between East Moline, Illinois, and Campbell's Island.

6 Corps is not doing a good job maintaining pool elevations.

7 Concerned about drastic fluctuations in water levels. The pool elevation fluctuates midway between the dams, not just at the tailwater areas.

8 Public would like to see a demonstration of how the computer at the Rock Island District regulates the water levels. Can the presentation be videotaped?

9 Why does the water fluctuation have to be so severe when it occurs?

10 It's good that the Corps knows how much water enters the pool. But apparently the problem is that the Corps doesn't know how much water is going out through the dam. If the same amount of water goes out of L/D 11 as comes in to L/D 10, then the pool ought to stay flat, and it doesn't.

11 The Corps says it manages the water levels to 1/10th foot. But then why is the pool 9.7 feet one day and 8.39 feet the next? If you let out the water as it enters, the pool would stay level.

12 Why can't the Corps hold back water at dams during high flows? Corps raises rolled dams during high water because it can't hold water back, and then opens the roller gates during low flow to maintain the water levels? Explain this process?

13 Why doesn't Pool 15 fluctuate like Pool 16? Both are downstream of a dam, but Pool 15 never seems troublesome for boating, for example. If the water is going to fluctuate, shouldn't it do so in every pool?

14 The rapid fluctuation of water levels is a problem for boating, fishing, fish spawning, waterfowl, whatever. We must work to stop the rapid changes by better anticipating water levels and needs.

15 The public needs to understand how the Corps' computer and 15-minute satellite interpretations work and how they can be used to avoid the drastic pool fluctuations.

16 How were pool levels maintained and monitored before installation of the computer and satellite equipment? Was it up to the lockmasters? Did it take longer for the changes to be monitored and adjustments made to the pool level?

17 How would a 12-foot channel affect pool fluctuations?

18 Which dam or pool determines whatever water must be passed through the system?

19 Has operation of the hydroelectric plant on the Wisconsin River changed during the past 4 or 5 years, affected pool fluctuations?

20 If the Corps is not deepening the channel to 12 feet, why did it dredge at Campbell's Island the last few years?

21 A local utility company was required to ensure that its pipe was 14 feet below the water level. Wasn't that because of the 12-foot channel?

22 Has the Corps considered the environmental impacts of pool fluctuations?

23 Concerned about increased boat ramp maintenance which is required as a result of pool fluctuations.

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

REPLY TO ATTENTION OF

February 24, 1989

Planning Division

UPPER MISSISSIPPI RIVER AND ILLINOIS WATERWAY
NAVIGATION STUDIES

Two navigation reconnaissance studies are to be undertaken by the Corps of Engineers in Fiscal Year 1990. The studies encompass the Upper Mississippi River and the Illinois Waterway. These studies will involve system-wide economic and environmental data. Any future facility studies within St. Paul, St. Louis, and Rock Island Districts will be accomplished by those Districts (see enclosed map).

The studies reflect a three-point management approach that has evolved over several years regarding navigation responsibilities on the Upper Mississippi River and Illinois Waterway Systems.

Routine operations and maintenance activities, including the addition of safety features, constitute the foundation, and first management point, upon which our navigation mission is based. Routine repairs and maintenance activities keep system components safe and operational.

The second point involves our major maintenance program which began about 1975 and is expected to continue through the late 1990's. The primary purpose of this effort is to keep the existing navigation system, and its component parts, structurally sound and operational for up to 50 years. By definition, the work done under this management point is of a substantially larger scale than routine operation and maintenance (O&M).

The third and final point in the management approach is planning for the future. The proposed navigation studies respond to Corps' responsibilities to formulate a strategic approach for sound capital investment planning related to our Nation's inland waterways' infrastructure. These studies begin the process of establishing prioritized, waterway specific, capital investment recommendations, including efficiency measures, required to handle future traffic.

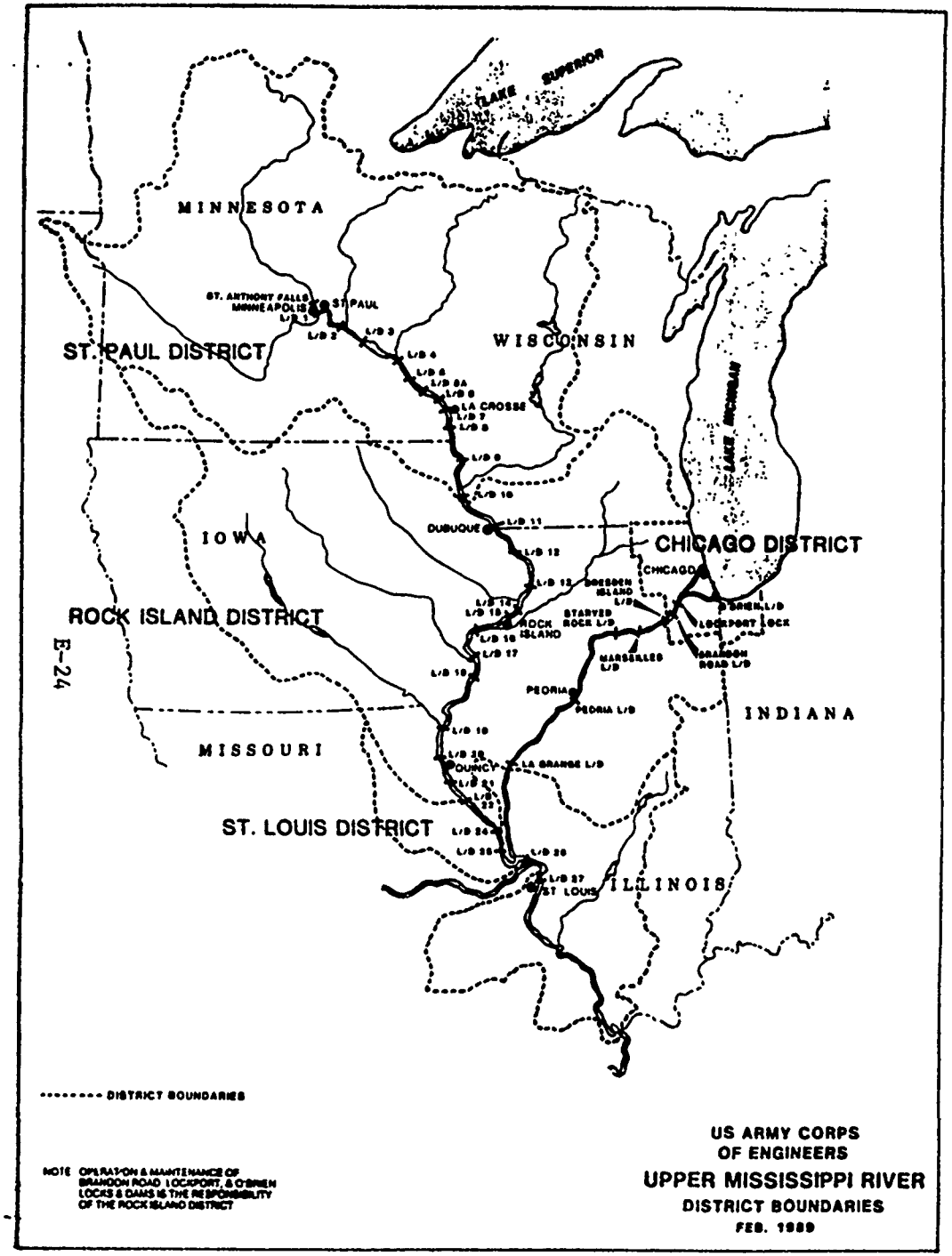
At the reconnaissance level for each study, we propose to examine information related to the existing condition (e.g., engineering, economics, environmental, and social parameters) and to determine what navigation and environmental problems and opportunities require more detailed study. As an integral part of the formulation process, we will conduct environmental studies which will identify enhancement measures. This will be done in coordination with environmental enhancement measures broader in scope, such as the Upper Mississippi River System - Environmental Management Program (UMRS-EMP). Specific capital investment recommendations would be deferred until completion of any follow-on feasibility studies, and be based on rigorous economic analysis. Potential economically justified solutions which are identified at the reconnaissance level will be conceptual in nature.

More details concerning the purpose and content of the two reconnaissance studies will be forthcoming in a "Plan of Study" (POS) scheduled for release later this fiscal year. A preliminary table of contents for the POS is included with this notice for your information. If you should have any questions or require any additional information, please call Mr. Mark Schroeder or Mr. Nelson Cordoba of our General Investigations and Special Studies Branch, project managers for the Mississippi River and Illinois Waterway studies, respectively, at 309/788-6361, or you may write to the following address:

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

Neil A. Smart
Colonel, U.S. Army
District Engineer

Enclosures


LAKE SUPERIOR
MINNESOTA
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ST. PAUL DISTRICT
IOWA
CHICAGO DISTRICT
ROCK ISLAND DISTRICT
INDIANA
MISSOURI
ST. LOUIS DISTRICT
ILLINOIS
DISTRICT BOUNDARIES
NOTE OPERATION & MAINTENANCE OF BRANDON ROAD LOCKPORT, & O'BRIEN LOCKS & DAMS IS THE RESPONSIBILITY OF THE ROCK ISLAND DISTRICT
US ARMY CORPS OF ENGINEERS
UPPER MISSISSIPPI RIVER
DISTRICT BOUNDARIES
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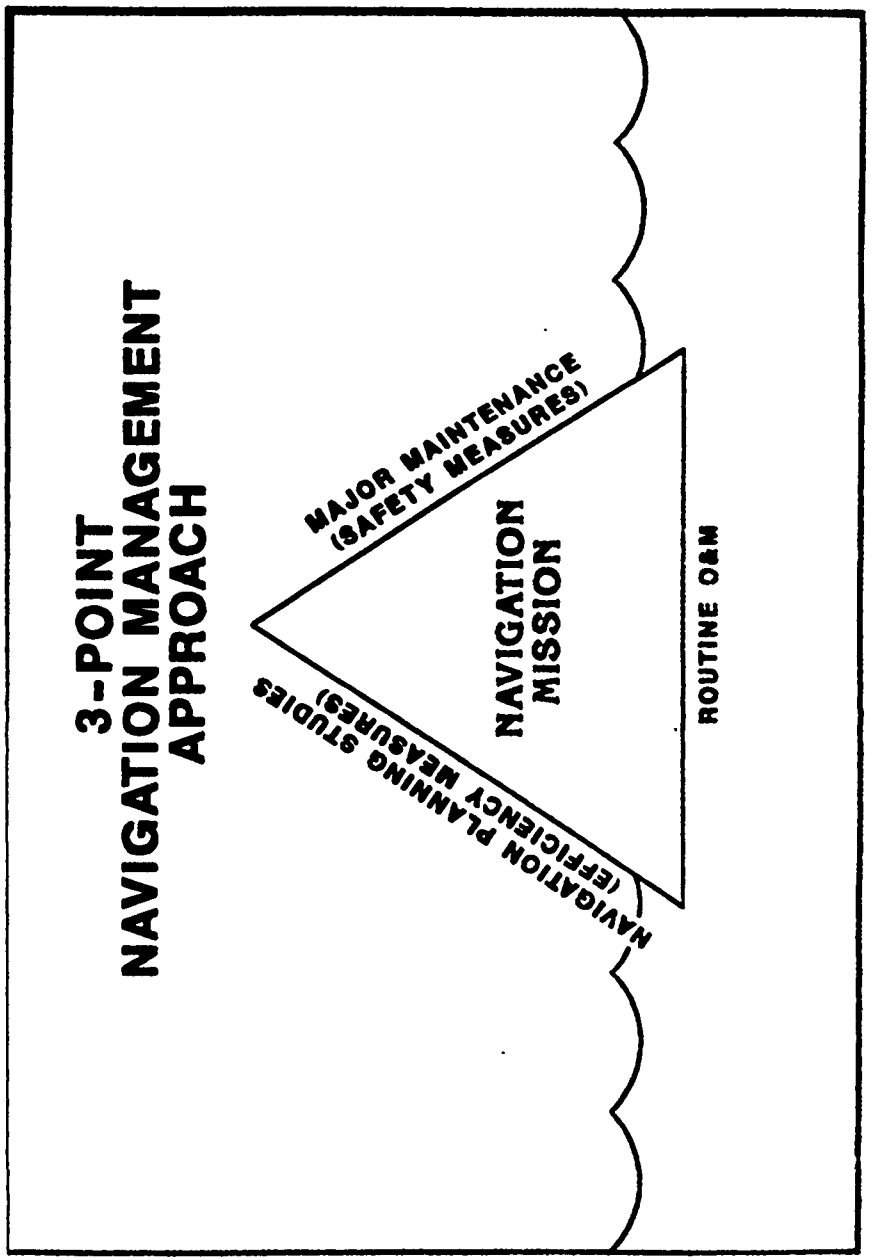
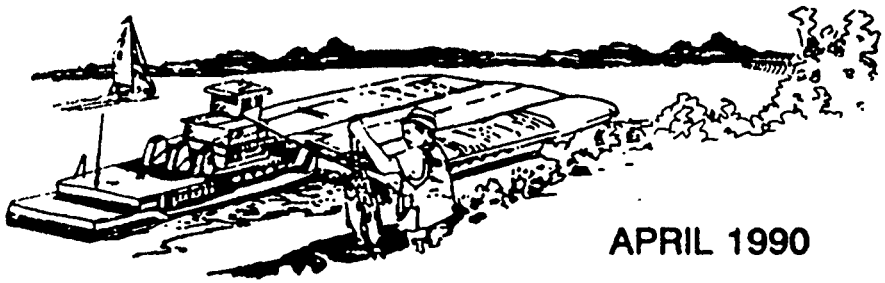

3-POINT
NAVIGATION MANAGEMENT
APPROACH
MAJOR MAINTENANCE
(SAFETY MEASURES)
NAVIGATION
MISSION
NAVIGATION PLANNING STUDIES
(EFFICIENCY MEASURES)
ROUTINE O&M



APRIL 1990

Upper Mississippi River Navigation Study

NOTICE OF INITIATION

The Congress of the United States has appropriated funds for the U.S. Army Corps of Engineers to initiate a reconnaissance study for the Upper Mississippi River navigation system. The study is authorized by Section 216 of the Flood Control Act of 1970 (Public Law 91-611).

The reconnaissance study will be initiated in April 1990 and the Notice of Completion will be released to the public in September 1991.

The study will be jointly performed by the St. Paul, Rock Island, and St. Louis Districts of the Corps of Engineers. These Corps Districts are jointly responsible for operating and maintaining the Upper Mississippi River Navigation System. The study team includes representatives from each of the three Corps Districts.

DESCRIPTION OF STUDY AREA

The Upper Mississippi River System is authorized for commercial navigation and as a fish and wildlife refuge. The study area includes 613 miles of the Upper Mississippi River, extending from St. Anthony Falls above Minneapolis, Minnesota, to Lock and Dam 25 near St. Louis, Missouri.

This study will not address concerns or issues related to the Illinois Waterway System. A separate navigation study for the Illinois Waterway System was initiated in November 1989.

RECONNAISSANCE STUDY

The reconnaissance study will determine the Federal interest in performing detailed feasibility studies for the Upper Mississippi River based on engineering, economic, and environmental criteria. The reconnaissance report will provide a prioritized schedule for any recommended feasibility studies.

AFTER THE RECONNAISSANCE STUDY

If further studies are recommended in the reconnaissance study, St. Paul, Rock Island, and St. Louis Districts would each conduct any site-specific feasibility studies within their individual Districts. These studies would be based on a common economic analysis and System Environmental Impact Statement. The three Corps Districts would continue to fully coordinate their recommendations during the feasibility studies.

PUBLIC INVOLVEMENT

Your Help is Needed

Your concerns, questions, and opinions are of vital importance to the success of this study as we identify issues which need to be addressed.

For our planning process to be effective, it is important that you identify any navigation-related problems and concerns for the Upper Mississippi River System.

Ways to Provide Input

There are several ways you can make your viewpoint known to the Corps of Engineers:

This newsletter includes a prepaid, preaddressed mailer. You can simply indicate your concerns, write your comments, and detach and mail the form.

You can contact the study team either by letter, telephone, or personal visit. The name, address, and phone number of the primary point of contact is listed on the following page.

Meetings will be held with interested agencies, groups, and individuals. At these meetings, the Corps of Engineers will describe and discuss the study and the planning process. The meetings will allow participants to express their concerns and exchange information directly with the study personnel and other meeting participants.

To request a meeting about the Upper Mississippi River

Navigation Study, contact Dan Johnson, study manager, at the address or telephone number provided below:

District Engineer
US Army Engineer District, Rock Island
ATTN: CENCR-PD-W
ClockTowerBldg-PO Box 2004
Rock Island, IL 61204-2004

309/788-6361, Ext. 6392

You have the opportunity to use one or all of these ways to express to the Corps of Engineers your concerns and viewpoint on the Upper Mississippi River Navigation Study. Why not start by filling out and returning the comment sheet provided with this newsletter!

MORE ABOUT OUR STUDY

Some of the questions you may have pertaining to the Upper Mississippi River Navigation Study are answered below. We encourage you to send us your questions and comments and, if space permits, we may print them in future editions of this newsletter. For your convenience, a prepaid comment sheet is provided with this newsletter.

1. What is the objective of this study?

This reconnaissance study will examine the Upper Mississippi River to determine the location and extent of navigation problems. The study will identify navigation and environmental problems and opportunities which merit more detailed study. Finally, it will recommend and prioritize feasibility studies based on identified problems and needs.

2. Why is a reconnaissance study of the Upper Mississippi River navigation system needed at this time?

Delays for commercial lockages on the Upper Mississippi River are resulting in increased transportation costs to the Midwest economy. Since traffic growth on the Upper Mississippi River is projected to increase between 1.7 and 3.1 percent annually, the resulting expectation is further increases in delay times and related costs.

3. Protection of the environment is extremely important. How will the Corps address environmental concerns in the reconnaissance study?

Coordination with other agencies and input from private organizations and the public will be pursued to help identify major environmental issues and concerns, including: natural resources; endangered species; cultural resources; water quality; wildlife refuges; recreation; and social and economic effects. Should feasibility studies be recommended, documentation required by the National Environmental Policy Act will be addressed during the feasibility phase. Coordination and environmental data gathering would be pursued in greater detail during feasibility studies.

4. How does the Corps intend to include the public in its decision-making process?

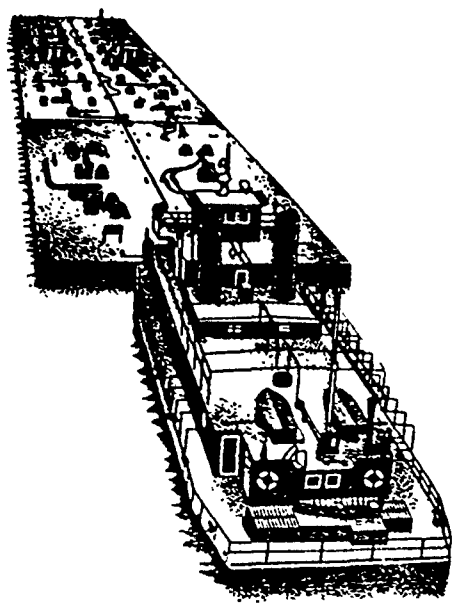
The Corps is providing this study initiation notice and newsletter to solicit your questions and ideas at the beginning of our study effort. We also plan to hold face-to-face meetings with interested parties (for example, environmental communities, navigation interests, Federal and State agencies, and any other interested groups) during the study process for the purpose of idea and information exchange.

5. How can I make a difference?

Get involved. Your comments and suggestions are a valuable part of our study process. The attached prepaid form is provided for your convenience as a means of providing any comments, suggestions, or questions you may have. Please attach an additional sheet if necessary. We look forward to hearing from you!

Attend our scoping meetings and provide your input.

Let your State and Federal representatives know how you feel.



UPPER MISSISSIPPI RIVER NAVIGATION SYSTEM COMMENT SHEET

Name _____

Address _____

City _____ State _____ ZIP _____

(Please provide your comments in the space below)

_____

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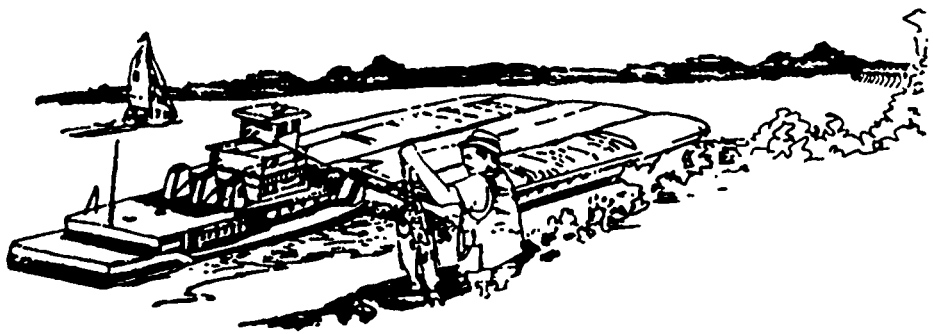

(Detach this sheet, fold here, and return to addressee)

Please indicate your responses by checking the appropriate answer. If more than one answer is appropriate, please rank your responses in order of decreasing importance (for example: 1 = most important).

My primary area of concern is:

___ Navigation
___ Environmental
___ Recreation
___ Fish & Wildlife
___ Economic Development
___ Other (specify)

_____

I represent:

___ Commercial/Industry
___ Federal/State/Local Govt
___ Regional/Local Planning
___ Private Interest Group
___ Self
___ Other (specify)

_____

US Army Corps of Engineers

Privacy Act Statement

In accordance with the Privacy Act of 1974 (Authority: Paragraph 11, ER 1105-2-502), routine uses of the information obtained from this form include compiling official mailing lists for future informational publications and recording additional views and public participation in studies. Disclosure of information is voluntary.

UPPER MISSISSIPPI RIVER
NAVIGATION STUDY

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Rock Island, Illinois 61204-9907

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CHICAGO
ROCK ISLAND
ILLINOIS RIVER
MISSISSIPPI RIVER
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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

May 30, 1990

Planning Division

SEE DISTRIBUTION LIST

The U.S. Army Corps of Engineers has initiated a Reconnaissance Study to identify the needs of the Upper Mississippi River Navigation System. An integral part of the study is to identify environmental issues and concerns.

As part of our study initiation, we are holding an environmental coordination meeting at the Holiday Inn in Moline, Illinois, on June 19, 1990. This meeting will be hosted by the St. Paul, Rock Island, and St. Louis Districts of the Corps of Engineers, who are collectively managing the Reconnaisasance Study. The purpose of the meeting is to initiate contact with environmental interests and to exchange information about the Upper Mississippi River Navigation System. The particulars of the meeting are given on the enclosed information sheet. Also enclosed is our tentative agenda.

We encourage you to attend and to participate in our meeting. If you plan to attend the meeting, please refer to the attendance instructions on the enclosed information sheet. If you are unable to attend the meeting but would like to request information or provide comments, please call Mr. Bob Vanderjack of Rock Island District's Environmental Analysis Branch at 309/788-6361, Ext. 6385, or write to the following address:

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

Our mailing list for this notice is enclosed. Please bring this meeting invitation to the attention of any environmental groups you know of who did not receive an invitation.

Sincerely,

Dudley M. Hanson, P.E.
Chief, Planning Division

Enclosures

Copies Furnished:

Division Engineer
U.S. Army Engineer Division,
North Central
ATTN: Planning Division (Curt Meeder)
536 South Clark Street
Chicago, Illinois 60605-1592 (w/enclosures)

District Engineer
U.S. Army Engineer District, St. Paul
ATTN: Planning Division (Jeff McGrath)
1421 USPO & Custom House
180 East Kellogg Boulevard
St. Paul, Minnesota 55101-1479 (w/enclosures)

Division Engineer
U.S. Army Engineer Division,
Lower Mississippi Valley
ATTN: Planning Division (William Arnold)
P.O. Box 80
Vicksburg, Mississippi 39181-0080 (w/enclosures)

District Engineer
U.S. Army Engineer District, St. Louis
ATTN: Planning Division (Dave Leake)
210 Tucker Boulevard N.
St. Louis, Missouri 63101-1986 (w/enclosures)

UPPER MISSISSIPPI RIVER NAVIGATION STUDY
ENVIRONMENTAL "INITIAL CONTACT/INFORMATION EXCHANGE" MEETING

TENTATIVE AGENDA

I. Opening Remarks by Corps of Engineers

II. Study Authority

III. Federal Planning Process; Reconnaissance Study and Feasibility Study

IV. Reconnaissance Study Schedule

V. Reconnaissance Study Scope

VI. Current and Projected Navigation Problems

VII. Possible and Probable Solutions that Could Be Proposed During Our Reconnaissance Study

VIII. Environmental Coordination and Documentation During the Reconnaissance Phase and the Feasibility Phase

IX. Simultaneous Efforts and Potential Interactions (Illinois Waterway Navigation Study; Second Lock POS; LTRM)

X. Questions

XI. Statements or Concerns from Attendees

XII. Closing Remarks by Corps of Engineers

UPPER MISSISSIPPI RIVER NAVIGATION STUDY
ENVIRONMENTAL "INITIAL CONTACT/INFORMATION EXCHANGE" MEETING

INFORMATION SHEET

Where:

Holiday Inn of Moline (located 1/2 mile northeast of the Quad City Airport in Moline, Illinois)

When:

June 19, 1990 - 1 p.m. to 4 p.m.

Accommodations:

A block of 20 single rooms has been reserved at the Holiday Inn of Moline (309/762-8811) for June 19, 1990. Please make your reservation prior to June 4, 1990, to reserve a room. The Government rate is $46.75 + 9% tax.

Attendance:

Please call one of the following people listed below by June 8, 1990, if you plan to attend the meeting. Your reservation is not a requirement to attend our meeting; however, it will assist us in arranging for an appropriate meeting room and for proper seating.

1. Bob Vanderjack, Environmental Analysis Branch, Rock Island District, 309/788-6361, Ext. 6385

2. Nelson Cordoba, Waterway Systems Branch, Rock Island District, 309/788-6361, Ext. 6399

3. Sue Simmons, Economic and Social Analysis Branch, Rock Island District, 309/788-6361, Ext. 6573

US Army Corps of Engineers

UPPER MISSISSIPPI RIVER NAVIGATION STUDY PUBLIC WORKSHOPS

★ ★ ★ ★ ★ PURPOSE ★ ★ ★ ★ ★

The U.S. Army Corps of Engineers is conducting a reconnaissance study to determine the location and extent of navigation and environmental problems, needs, and opportunities on the Upper Mississippi River and to determine if there is a Federal interest in future navigation improvements. The study is being jointly managed by the St. Paul, Rock Island, and St. Louis Districts of the Corps of Engineers, who are responsible for operating and maintaining the Upper Mississippi River navigation system.

The Corps of Engineers will hold three public workshops in October 1990 to discuss progress on the Upper Mississippi River Navigation Study and to solicit input for our future study process.

All persons interested in the study are encouraged to attend one of the workshops.

You will receive a newsletter in mid-September which will discuss study progress to date and will provide more information on the workshops.

★ ★ ★ ★ ★ WHEN/WHERE ★ ★ ★ ★ ★

Tuesday, October 9, 1990 - 7 p.m.
Union Station Hyatt Hotel
Fleur de Lis Room A
18th and Market Streets
St. Louis, Missouri

Wednesday, October 10, 1990 - 7 p.m.
Blackhawk Hotel
Gold Room East
200 East 3rd Street
Davenport, Iowa

Thursday, October 11, 1990 - 7 p.m.
Drover's Inn
River/Concord Rooms
701 South Concord Street
South St. Paul, Minnesota

★ ★ ★ ★ ★ FOR MORE INFORMATION ★ ★ ★ ★ ★

Contact: District Engineer
U.S. Army Engineer District, St. Louis
ATTN: Planning Division
210 Tucker Boulevard North
St. Louis, Missouri 63101-1986

Or Call: Mr. David E. Leake, Study Manager
314/263-5015

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

Or Call: Mr. Nelson J. Cordoba, Study Manager
309/788-6361, Ext. 6399

Contact: District Engineer
U.S. Army Engineer District, St. Paul
ATTN: Planning Division
1421 USPO and Custom House
180 East Kellogg Boulevard
St. Paul, Minnesota 55101-1479

Or Call: Mr. Jeffrey L. McGrath, Study Manager
612/220-0256

UPPER MISSISSIPPI RIVER NAVIGATION STUDY UPDATE

US Army Corps of Engineers

VOL I, No. 2 September 1990

This newsletter is the second issue for the Upper Mississippi River Navigation Reconnaissance Study. The purpose of this newsletter is to provide you updated information about the study, inform you of upcoming public workshops, and solicit your comments, concerns, and suggestions.

The first issue of the newsletter, distributed in April 1990, explained that the St. Paul, Rock Island, and St. Louis Districts of the U.S. Army Corps of Engineers (Corps) had begun a joint 18-month reconnaissance phase study of the Upper Mississippi River. A map of the study area is provided on page 11 of this newsletter.

As we explained in the first issue, the Upper Mississippi River is vital for transporting goods that are either produced or consumed in the Upper Midwest region.

For example, in 1988, 82 million tons of commodities valued at $15 billion were transported on the Upper Mississippi River.

PUBLIC WORKSHOPS SCHEDULED

The U.S. Army Corps of Engineers will hold three public workshops to discuss study progress and to solicit input for our future study progress.

All interested persons are invited to attend one of the following workshops:

October 9, 7 p.m. - St. Louis
October 10, 7 p.m. - Rock Island
October 11, 7 p.m. - St. Paul

For further information about the workshops, see page 7 of this newsletter.

Forecasts for the Upper Mississippi River indicate an increase in tonnage over the next 2 decades, as shown in Figure 1.

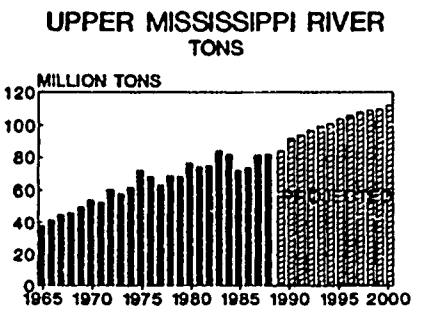
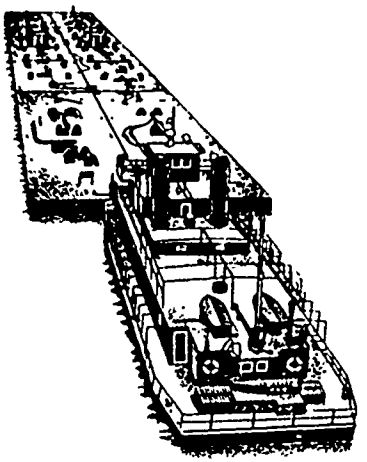


Figure 1

The Upper Mississippi River navigation system is an efficient way to transport bulk commodities. One 15-barge tow (which moves 22,500 tons) transports the equivalent of 870 semi-trailers. Consequently, waterborne transportation provides lower costs to producers, which result in lower consumer prices for food products, electricity, gasoline, and a variety of other products.



RECONNAISSANCE STUDY

The purpose of the reconnaissance study is to identify issues, concerns, and opportunities related to the Upper Mississippi River in order to determine the Federal interest in constructing navigation improvements. If a Federal interest in improvements is identified, the District Engineer will recommend that a feasibility study be initiated.

The decision to complete more detailed studies will be based on a consideration of engineering, economic, and environmental concerns and constraints. To be considered a feasible alternative, an improvement measure must have benefits greater than costs, and adverse environmental impacts must be avoided or minimized.

FEASIBILITY STUDIES

The results of the reconnaissance study will be announced by the North Central Division Engineer in his Notice of Study Completion, which will be distributed to the public in the early fall of 1991.

Should the Corps proceed to the feasibility study phase, the Corps would more fully examine potential nonstructural and structural alternatives and identify a preferred alternative. The preferred alternative would maximize the benefits to system users and the United States as a whole, while fully considering environmental, economic, and engineering goals and constraints.

RECONNAISSANCE STUDY COMPONENTS

The reconnaissance study will address a variety of navigation-related concerns, including economic and commercial, environmental, and recreational interests. A brief description of these study components is provided for your information.

Economic Assessment

The economic assessment for the reconnaissance study is being completed on a system-wide basis, using the General Equilibrium Model (GEM). The GEM computer program interprets the interrelationship between locks in the system and the manner in which modifications at one lock affect the efficiency of the system as a whole. Data used for the analysis include lock capacity, lockage delays and costs, and origin and destination of waterway shipments.

Various structural and nonstructural improvements on the waterway are being evaluated. Potential improvements to the navigation system are being defined and their economic impacts are being assessed.

Recreational Boating Assessment

During the past decade, recreational boating on the Upper Mississippi River has increased. The number of recreational craft using the locks on the Upper Mississippi River has increased approximately 75 percent from 1979 to 1989. Figure 2 shows this dramatic increase.

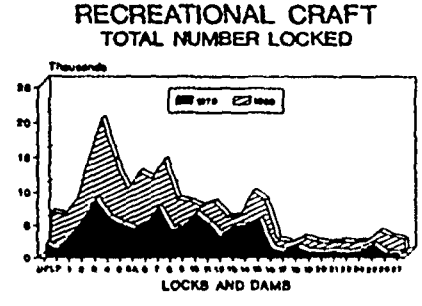


Figure 2

Boaters and commercial interests are becoming increasingly concerned about congestion in the navigation channel and at the locks. As the number of marina facilities within the Upper Mississippi River grows, the potential for traffic congestion will increase, expecially at the locks.

How will the increase in use of the locks affect commercial and recreational navigation? The reconnaissance study will consider this and similar questions during the issue identification process. One of the Corps of Engineers goals as a river resource manager is to create a situation where all users can realize the most benefits possible. The reconnaissance study and any future feasibility studies will address safety, congestion, and other recreation concerns as related to the multiple uses of the Upper Mississippi River.

Environmental Assessment

The environmental assessment for the reconnaissance study will attempt to identify opportunities for environmental enhancement and restoration. Awareness of these opportunities contributes to a balanced view of the navigational and environmental needs of the river system. The river's natural resource value is accentuated by the presence of two extensive wildlife refuges. These refuges provide important habitat for migratory waterfowl. The extensive use of the river corridor by migratory waterfowl adds international significance to the value of this resource.

Any proposed navigation improvement will be evaluated for its site-specific impacts as well as system-wide impacts. Site-specific impacts would include any direct or peripheral construction impacts. System-wide impacts might result from changes in traffic.

Assessment and evaluation of system-wide impacts present a great evaluation challenge. Considerable interagency effort and time are being expended to develop appropriate evaluation methodologies to assess these potential impacts.

A Planning Aid Letter has been requested from the U.S. Fish and Wildlife Service to assist in the Corps planning effort. The Corps is currently compiling information to assist the Fish and Wildlife Service in developing its Planning Aid Letter.

E-35

Cultural Resources Assessment

Portions of the Upper Mississippi River Navigation System are listed on or determined eligible for the National Register of Historic Places. Any proposed improvements to the lock and dam complexes will consider the effect to these significant structures. Both system-wide and site-specific impacts to significant archeological resources also will be evaluated.

ENVIRONMENTAL "INFORMATION EXCHANGE" MEETING

As part of the Corps of Engineers effort to identify major issues and concerns, an environmentally oriented "information exchange" meeting was held on June 19, 1990, at the Holiday Inn, Moline, Illinois. Approximately 25 people interested in the management of the Upper Mississippi River attended the meeting.

The Corps study team opened the meeting by explaining the purpose and structure of the reconnaissance study, and how it might interact with other concurrent efforts. The four major areas of discussion were: (1) the status of the Plan of Study (i.e., the plan of study to evaluate the effects of navigation) that resulted from the Second Lock at Lock and Dam 26 (Replacement) Environmental Impact Statement process; (2) concern about the amount of time likely to be allotted for the Upper Mississippi River Navigation Study feasibility phase; (3) progress in implementing the "Avoid and Minimize (A&M) Measures," which are the preferred ways to mitigate for any resultant project impacts; and, (4) how non-navigation related environmental concerns might be addressed by the study.

CORPS SPONSORS PUBLIC WORKSHOPS

Only through the cooperative efforts of all interested parties, public and private, government agencies, and commercial and environmental interests can the Upper Mississippi River's resources be managed in the best interest of all.

For this reason, the U.S. Army Corps of Engineers is sponsoring three public workshops in October 1990.

The workshops will provide you with information regarding study progress and direction and give you the opportunity to share and discuss your ideas or concerns with the study team. A question and answer session will be included at the end of the workshops.

Who Should Attend?

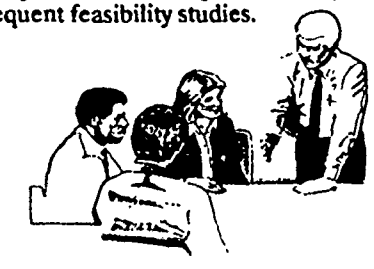
We encourage all interested persons to attend a workshop. This includes individuals with civic, business, environmental, or recreational interests, as well as representatives from Federal and non-Federal agencies, and the general public.

Why Should You Participate?

- Your views and opinions are important to the Corps of Engineers and to the success of this reconnaissance and any future studies. Don't assume that someone else will represent your interests.

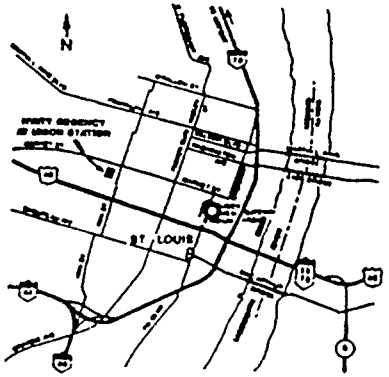
- Meet others with similar interests and along with study personnel help identify and summarize ideas and issues.

- Input from these workshops will be discussed in the Reconnaissance Study Report and will be considered during the plan formulation process of any subsequent feasibility studies.

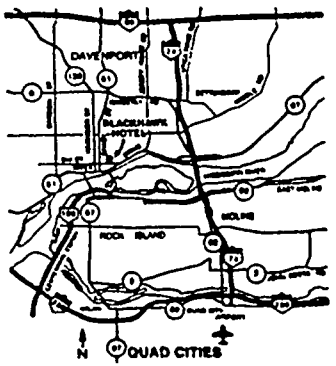


Workshop Information

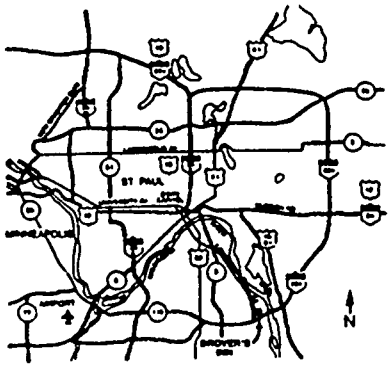
The dates and locations of the workshops are listed below. All workshops begin at 7 p.m.



Tuesday, October 9, 1990
Union Station Hyatt Hotel
Fleur-de-Lis Room A
16th and Market Streets
St. Louis, Missouri
314/231-1234



Wednesday, October 10, 1990
Blackhawk Hotel
Gold Room East
200 East 3rd Street
Davenport, Iowa
319/323-2711



Thursday, October 11, 1990
Drover's Inn
River/Concord Rooms
701 South Concord Street
South St. Paul, Minnesota
612/455-3600

OTHER WAYS TO PROVIDE STUDY INPUT

As we mentioned in our first Upper Mississippi River Navigation Study newsletter, there are several ways in which you can provide input to the study: contact the study team by letter, telephone, or a personal visit; request a meeting with the study team; or use the postage-paid, pre-addressed mailer included with each newsletter.

Mr. Nelson J. Cordoba has been appointed to the position of Upper Mississippi River Navigation Study Manager.

You may contact Mr. Cordoba at the following address or telephone number:

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

309/788-6361, Ext. 6399

QUESTIONS AND ANSWERS

Q. Who would undertake any proposed feasibility studies?

A. The three Corps of Engineers Districts involved with this study would complete their own feasibility studies for projects located within their physical jurisdictions.

Q. How would these studies be financed?

A. These studies would be 100 percent federally funded.

Q. How would potential improvement measures be financed?

A. The cost of implementing an improvement measure would be divided between the Federal Government and the Inland Waterways Trust Fund. Commercial users of the navigation system pay a special fuel tax which is deposited into the Trust Fund. Money from this fund would be used to pay for 50 percent of any improvement measure that was implemented, with the Federal Government paying the remaining 50 percent.

UPPER MISSISSIPPI RIVER NAVIGATION STUDY COMMENT SHEET

Name _____
Address _____
City _____ State _____ ZIP _____

(Please provide your comments in the space below)

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_____

(Detach this sheet, fold here, and return to addressee)

Please check the appropriate category below.

I represent:

____ Towing Industry
____ Other Business or Industry
____ Federal Government
____ State Government
____ County Government
____ City Government
____ Regional/Local Planning
____ Private Interest Group
____ Self
____ Other (specify)
_____

Privacy Act Statement

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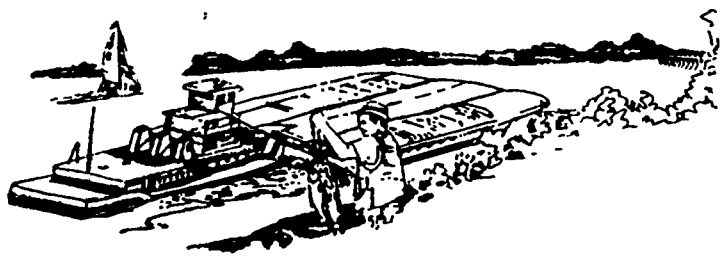

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NAVIGATION STUDY

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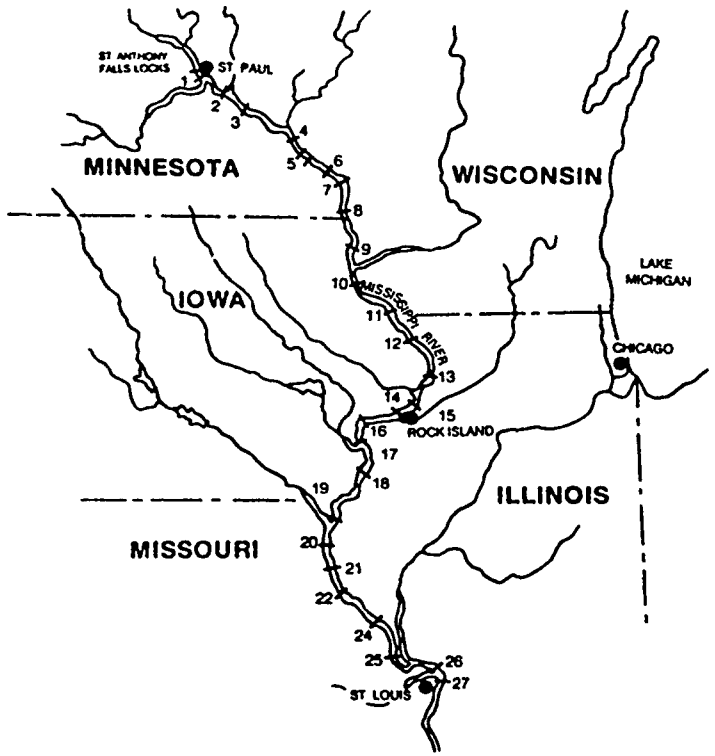
Rock Island, Illinois 61204-9907



UPPER MISSISSIPPI RIVER SYSTEM

UPPER MISSISSIPPI RIVER
NAVIGATION STUDY

DEPARTMENT OF THE ARMY
US ARMY ENGINEER DISTRICT ROCK ISLAND
ATTN CENCR-PD-W
CLOCK TOWER BUILDING - PO BOX 2004
ROCK ISLAND ILLINOIS 61204-2004

OFFICIAL BUSINESS

UPPER MISSISSIPPI RIVER NAVIGATION STUDY UPDATE

US Army Corps of Engineers

VOL I, No. 3 November 1990

This is the third Upper Mississippi River Navigation Study newsletter. The purpose of this newsletter is threefold: to provide a study update, to summarize our October 1990 public workshops, and to solicit your input to the study process.

E-39

STUDY UPDATE

As we discussed in our April and September 1990 newsletters, the St. Paul, Rock Island, and St. Louis Districts of the U.S. Army Corps of Engineers began an 18-month joint reconnaissance study of the Upper Mississippi River Navigation System in April 1990.

The purpose of this reconnaissance study is to identify issues, concerns, and opportunities related to the Upper Mississippi River navigation system, identify potential measures to address these concerns, and determine the Federal interest in additional efforts.

The reconnaissance study will determine if there is at least one potential cost-effective alternative to address a specific navigation concern(s). If a cost-effective alternative is identified, the reconnaissance study will recommend that more detailed feasibility studies be completed.

The decision to complete more detailed studies will be based on a consideration of engineering, economic, and environmental concerns, constraints, and opportunities. To be considered a feasible alternative, an improvement measure must be cost-effective, with resultant benefits outweighing implementation costs.

The decision to proceed with feasibility studies would be announced by the North Central Division Engineer in his Notice of Study Completion, which will be distributed to the public in the early fall of 1991.

During the feasibility study phase, the Corps of Engineers would more fully examine the wide range of potential non-structural and structural improvements and recommend a plan for remedying the problem(s). The selected plan would maximize the benefits to system users and the United States as a whole, while fully considering environmental (including social), economic, and engineering goals, constraints, and opportunities.

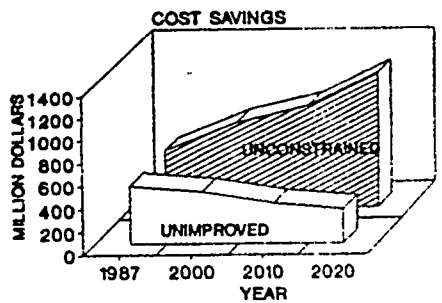
Economic Analysis Update

The Corps of Engineers is continuing its economic assessment of the potential need to improve the navigation system from a commercial and a recreational standpoint.

At this point in the reconnaissance study, two commercial traffic scenarios have been evaluated: unimproved and unconstrained. The unimproved condition assumes existing conditions, including traffic delays, and projects traffic demand. The unconstrained condition assumes that navigation system improvements are made to meet demand and eliminate traffic delays.

Our preliminary economic analysis indicates that the most pressing need for lock capacity increases begins near the year 2000 at Locks and Dams 25, 24, and 22. Further capacity increases may also be warranted over the next 50 years extending north to Lock and Dam 11.

The Corps of Engineers' preliminary assessment of transportation costs for those commodities now shipped on the river indicates that nearly $1 billion annually in potential cost savings would be lost under existing conditions (with no navigation system improvements).



Costs for other modes of transportation also would be expected to increase, as those commodities which could not be transported on the river would create higher demands on rail, truck, and pipeline.

Regarding congestion problems with recreational boating, existing traffic levels may warrant improvements at some locks and dams. These features would be included with those downstream addressing the lock capacity ssue in developing a system-wide package of navigation improvements.

The detailed economic analysis which would be performed in the feasibility phase will examine a wide variety of scenarios in order to determine the economic impacts and recreational benefits associated with various types and magnitudes of navigation system improvements.

Environmental Evaluation

A Planning Aid Meeting for the Upper Mississippi River Navigation Study was held at the U.S. Fish and Wildlife Service Field Office in Rock Island, Illinois, on September 26 and 27, 1990. Attendees included representatives of the five Upper Mississippi River States (Illinois, Iowa, Missouri, Minnesota, and Wisconsin), the U.S. Environmental Protection Agency, and the U.S. Army Corps of Engineers.

Discussion focused on the Upper Mississippi River Navigation Study, the Plan of Study for the 2nd Lock at Lock and Dam 26(R), and the Long-Term Resource Monitoring Program Navigation Effects Studies.

Also discussed at length were the "enhancement opportunity recommendations" that the U.S. Fish and Wildlife Service has been asked to provide as part of its planning assistance. Enhancement opportunities are those opportunities that a civil works project presents to conserve fish and wildlife resources or restore them to modern historic levels of environmental value. Much of the discussion centered on identifying and integrating the natural resource management goals of the Upper Mississippi River States into a comprehensive package of river enhancement recommendations.

SUMMARY OF PUBLIC WORKSHOPS

On October 9, 10, and 11, 1990, the Corps of Engineers sponsored three public workshops for the Upper Mississippi River Navigation Reconnaissance Study. These workshops were held in St. Louis, Missouri, Davenport, Iowa, and South St. Paul, Minnesota, respectively.

The workshops had a twofold purpose: to summarize study progress and to provide a forum for interested publics to share and discuss ideas and concerns among themselves and with Corps of Engineers representatives.

Who Attended the Workshops?

More than 100 people attended the three workshops (22 in St. Louis, 54 in Davenport, and 34 in South St. Paul). Those attending represented commercial, industrial, environmental, recreational, economic development, and related interests.

Workshop Format

The workshops began with opening remarks, introductions, and an overview of the reconnaissance study purpose and background.

Audience members then divided into small discussion groups according to their primary interest: commercial/economic, recreation, or environmental. Each discussion group focused on the following statement: "The Corps of Engineers is interested in learning about any concerns or issues that you may have regarding improving the Upper Mississippi River for navigation and environmental purposes. By upgrading and improving we mean anything that will make the system more efficient through reducing delays and congestion on the system."

The interest groups, which were aided by a facilitator, voiced issues, concerns, and questions regarding the statement. Their input was recorded on paper and hung on the wall for easy viewing. Issues continued to be recorded until each person in the group had stated all of his/her concerns. Once all issues

were recorded, the group members voted on the importance of each issue raised.

After the voting, the audience reconvened as a whole and a representative from each interest group shared the results of its discussion and issue prioritization.

The workshops ended with a more detailed study update, followed by a general question and answer session between the audience and the Corps of Engineers.

Interest Group Results

The interest group participants raised several issues and questions. The text below compares the similarities and differences between a few selected issues.

We want to stress that the issues are not listed in priority order and do not reflect all statements recorded. If you would like a total list of the statements, concerns, or questions expressed by each interest group, please contact the study manager at the address given on page 6.

Commercial interests represented at the St. Louis and Davenport workshops tended to focus on the issue of larger (1,200-foot) locks to accommodate 15-barge tows. They also were concerned with maintaining water levels for maximum barge loading during droughts. Commercial interests represented at the South St. Paul workshop raised issues regarding the long-term maintenance and replacement of the lock and dam system, as well as issues concerning the funding for improvements.

The recreation group in Davenport also was concerned about water levels. Here the emphasis was on how pool fluctuations affected access to the backwaters. This group also discussed siltation caused by commercial navigation and its effects on recreation and the environment. The recreation group in South St. Paul was concerned about wake/speed limitations. They also focused on licensing and educational programs for recreationists, within the context of promoting boater safety. There was no recreation group at the St. Louis workshop.

The environmental interests represented at all three workshops were most concerned about the effects of navigation, both commercial and recreational, on the river ecology. They also focused on the need for adequate research to document effects of traffic on the ecosystem. The environmental group in Davenport centered on problems associated with pool fluctuations and site-specific sedimentation problems. The South St. Paul group asked that the Corps of Engineers look beyond the river corridor into land uses of the watershed when developing environmental goals and objectives. The St. Louis group was concerned about harmful environmental impacts resulting from improving and operating the locks and dams.

How Will the Concerns Voiced at the Workshops Be Used?

The results of the workshops will be used to guide the completion of the Upper Mississippi River Navigation Reconnaissance Study, and will be presented in the study report. The issues and concerns identified during the workshops, or provided in written correspondence, comment sheets, or telephone conversations with the Corps of Engineers, will be used during the plan formulation process of any subsequent feasibility studies. These issues and concerns also will help the study team to address public concerns as alternatives are developed.

WAYS TO PROVIDE STUDY INPUT

We would like to thank those of you who attended one of the October workshops and/or have provided your comments to us during this reconnaissance study. We encourage your continued input.

As we discussed in our first two Upper Mississippi River Navigation Study newsletters, there are several ways in which you can provide input to our study: contact the study team by letter, telephone, or a personal visit; request a meeting with the study team; attend meetings or workshops sponsored by the Corps of Engineers; or use the postage-paid, pre-addressed mailer included with each newsletter.

You can contact Mr. Nelson J. Cordoba, the Upper Mississippi River Navigation Study Manager, at the following address and telephone number:

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

309/788-6361, Ext. 6399

UPPER MISSISSIPPI RIVER SYSTEM

7

UPPER MISSISSIPPI RIVER
NAVIGATION STUDY

DEPARTMENT OF THE ARMY
US ARMY ENGINEER DISTRICT ROCK ISLAND
ATTN: CENCR-PD-W
CLOCK TOWER BUILDING - PO BOX 2004
ROCK ISLAND ILLINOIS 61204-2004

OFFICIAL BUSINESS

UPPER MISSISSIPPI RIVER NAVIGATION STUDY COMMENT SHEET

Name _____
Address _____
City _____ State _____ ZIP _____

(Please provide your comments in the space below)

_____

_____

_____

_____

_____

_____

_____

(Detach this sheet, fold here, and return to addressee)

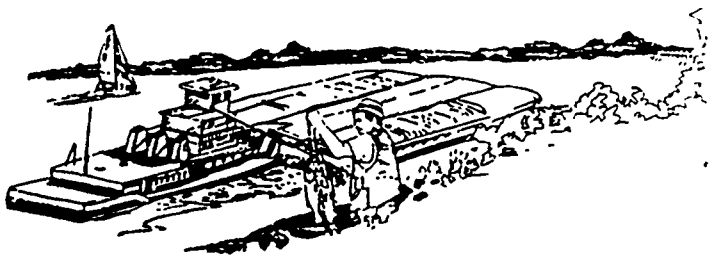
Please check the appropriate category below.

I represent:

____ Towing Industry
____ Other Business or Industry
____ Federal Government
____ State Government
____ County Government
____ City Government
____ Regional/Local Planning
____ Private Interest Group
____ Self
____ Other (specify)
_____

Privacy Act Statement

In accordance with the Privacy Act of 1974 (Authority: Paragraph 11, ER 1105-2-502), routine uses of the information obtained from this form include compiling official mailing lists for future informational publications and recording additional views and public participation in studies. Disclosure of information is voluntary.



UPPER MISSISSIPPI RIVER
NAVIGATION STUDY

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District Engineer
US Army Engineer District, Rock Island
ATTN: CENCR-PD-W
Clock Tower Building - P O Box 2004
Rock Island, Illinois 61204-9907

APPENDIX F

PERTINENT CORRESPONDENCE

RECONNAISSANCE REPORT
FOR
UPPER MISSISSIPPI RIVER NAVIGATION STUDY

APPENDIX F
PERTINENT CORRESPONDENCE

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State of Illinois
DEPARTMENT OF AGRICULTURE
Division of Natural Resources
State Fairgrounds, P.O. Box 19281, Springfield, IL 62794-9281, 217/782-6297

Bureau of Farmland Protection

Bureau of Soil Conservation

March 8, 1989

Colonel Neil A. Smart
District Engineer
US Army District, Rock Island
ATTN: Planning Division
Clock Tower Building - P.O. Box 2004
Rock Island, Illinois 61204-2004

Re: Upper Mississippi River and
Illinois Waterway Navigation Studies

Dear Colonel Smart:

The Illinois Department of Agriculture has received official notice of two navigation studies to be undertaken by the Corps of Engineers in FY 1990. The studies will encompass the Upper Mississippi River and the Illinois Waterway. These studies reflect a three-point management approach that has evolved over several years regarding navigation responsibilities on the Upper Mississippi River and Illinois Waterway Systems.

The Department takes this opportunity to remind the Corps that the IDOA should be kept abreast of all pending studies and results. Potential agricultural impacts of any navigation problems and resulting projects require written notification of the IDOA in accordance with the Federal Farmland Protection Policy Act and Illinois' Farmland Preservation Act. Resulting impact comments and the completion of the USDA - Soil Conservation Service's AD-1006 form, along with the completion of Illinois' Site Assessment factors, should be included within the Corps' project findings. We trust that the upcoming Plan of Study will address potential impacts to agricultural resources under the category of Natural Resources.

Should you have any questions or comments in regard to the completion of AD-1006 or our Department's agricultural impact comments, please do not hesitate to contact our office.

Sincerely,

Teresa J. Savko

Teresa J. Savko
Bureau of Farmland Protection

TJS:mdg

J. L. SHIELY CO. *QUALITY COMMERCIAL AGGREGATES*

1101 Snelling Avenue North
St Paul, Minnesota 55108
Phone (612) 646-8601

March 9, 1989

Neil A. Smart, Colonel
U. S. Army District Engineer
Department of the Army
Rock Island District, Corps of Engineers
Clock Tower Building - P. O. Box 2004
Rock Island, Illinois 61204-2004

RE: **Upper Mississippi River and Illinois Waterway Navigation Studies**

Dear Colonel Smart:

We received your correspondence regarding the above subject. We are very interested in hearing more about your 3 point management approach as it affects us directly, both as a supplier of construction aggregates, such as Rip Rap for erosion control and we are users of the river to move our products to market.

Please keep us on your mailing list for any future mailings on this subject.

Sincerely,

Michael McCormick
Aggregate Sales Manager

MPM.mlv

MISSOURI DEPARTMENT OF CONSERVATION

MAILING ADDRESS:
P.O. Box 180
Jefferson City, Missouri 65102-0180

STREET LOCATION:
2901 West Truman Boulevard
Jefferson City, Missouri

Telephone: 314/751-4115
JERRY J. PRESLEY, Director

March 13, 1989

Colonel Neil A. Smart
District Engineer
Rock Island District, Corps of Engineers
Clock Tower Building
P. O. Box 2004
Rock Island, Illinois 61204-2004

Attn: Planning Division

Dear Colonel Smart:

Thank you for the notice announcing that two navigation reconnaissance studies will be undertaken by the Corps of Engineers in Fiscal Year 1990. We understand the studies will address the economic and environmental impact of the Corps of Engineers' Upper Mississippi River system management responsibilities, including routine operation and maintenance activities, the major rehabilitation program and planning for future capital investment.

Mr. William H. Dieffenbach and/or Mr. Norman P. Stucky will coordinate Department involvement in this effort. Further information on this matter should be directed to one of them at the above address.

Sincerely,

Dan F. Dickneite

DAN F. DICKNEITE
ENVIRONMENTAL ADMINISTRATOR

COMMISSION

JEFF CHURAN, Chillicothe
JAY HENGES, Earth City
JOHN POWELL, Rolla
RICHARD REED, East Prairie

Domtar Industries Inc.
SIFTO® Salt Division

4825 N. Scott St., Suite 400
Schiller Park, IL 60176
(312) 671-0680

March 15, 1989

Colonel Neil A. Smart
District Engineer
Dept. of the Army
Rock Island District
U. S. Army Corps of Engineers
Clock Tower Building
P.O. Box 2004
Rock Island, Illinois 61204-2004

RE: UPPER MISSISSIPPI RIVER AND ILLINOIS WATERWAY NAVIGATION STUDIES

Dear Sir:

Thank you for your recent directive of February 24, 1989 regarding navigation planning studies, major maintenance and routine operation and maintenance for the navigation mission for the Upper Mississippi and Illinois Waterways.

Domtar Industries Inc./Sifto Salt Division has a mine located on an island on the West Canal at Cote Blanche, LA and so is tied 100% to barge navigation for movement on the Inland Waterways. A lot of our highway salt winds up on the Illinois and Upper Mississippi Rivers for deicing purposes on highways. We applaud your studies and are obviously very interested in not only the maintenance of the Lock and Dam system but also the upgrading of that Lock and Dam system as we move toward the 21st Century.

Please keep us abreast of studies and public hearings and be assured of our support for commercial navigation of the Inland Waterway System.

Sincerely,

DOMTAR INDUSTRIES INC.
SIFTO SALT DIVISION

John H. Nikolai
Distribution Manager

JHN:er

cc: C. T. Burdic
Mr. Dave Marshall
Vice President of Marketing
Alter Barge Line Inc.
P.O. Box 3310
Davenport, IA 52808

Mr. J. Kroskey
American Commercial Barge Line
Director, Dry Bulk Sales
P.O. Box 610
Jeffersonville, IN 47130

Mr. Robert Gardner
Vice President-Gen. Mgr.
ContiCarriers & Terminals
Suite 2600
222 S. Riverside Plaza
Chicago, IL 60606

United States Department of the Interior
FISH AND WILDLIFE SERVICE
ROCK ISLAND FIELD OFFICE (ES)
1830 Second Avenue, Second Floor
Rock Island, Illinois 61201
IN REPLY REFER TO
COM: 309/793-5800
FTS: 386-5800

March 27, 1989

Colonel Neil A. Smart
District Engineer
U.S. Army Engineer District
Rock Island
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61204-2004

Dear Colonel Smart:

This is in response to your public notice for the proposed Upper Mississippi River and Illinois Waterway Navigation Studies dated February 1989. We commend your early coordination and systemwide approach to the proposed reconnaissance studies.

We recommend that you address the following in the proposed Reconnaissance Plan of Study:

a. How capital investment recommendations will be formulated for all three Corps Districts on the Upper Mississippi River System;

b. How system-wide ecological and economic analyses will be completed;

c. Coordination requirements and the process for accomplishing these requirements including use of existing work groups;

d. National Environmental Policy Act procedures to be taken; and,

e. Future planning process requirements and tentative schedules.

We remain concerned that the environmental consequences of increasing commercial navigation traffic are still largely unknown. Much of the information proposed for collection by the St. Louis District Plan of Study and the Long Term Resource Monitoring Program is necessary for you to make an informed decision relative to continued planning for any capital

improvement measures. In addition, little has been proposed to address the cumulative effects of increasing tow traffic and the possible limit to perturbations on the riverine ecosystem.

As with our coordination on the Major Rehabilitation Program, the questions at hand are very complex. We will continue to work with you to identify planning requirements and to seek mutually acceptable conclusions and recommendations. We anticipate being able to negotiate a Fish and Wildlife Coordination Act transfer fund agreement at the conclusion of the Reconnaissance Plan of Study review period.

Sincerely,

Richard C. Nelson
Field Supervisor

cc: ILDOC
MODOC
IADNR
WIDNR
MNDNR
USEPA
SLD
SPD

STATE OF ILLINOIS

OFFICE OF THE GOVERNOR

SPRINGFIELD 62706

JAMES R THOMPSON
GOVERNOR

SAI# 89-03-10-47

SUBJECT: Upper Mississippi River and Illinois Waterway Navigation Studies - Environmental Assessment

TO: Department of the Army
Rock Island District, Corps of Engineers
Atten: Neal A. Smart
Clock Tower Building
P.O. Box 2004
Rock Island, Illinois 61204-2004

The Illinois State Clearinghouse has reviewed the reference subject pursuant to the National Environmental Policy Act of 1969. State agencies which are authorized to develop and enforce environmental standards have been given the opportunity to comment on this subject. At this time no comments have been received.

Illinois State Clearinghouse

April 10, 1989

CC: Roger Barcus
I.D.O.T.
Division of Aeronautics
One Langhorne Drive
Capital Airport
Springfield, Illinois 62706

STATE OF MINNESOTA
DEPARTMENT OF NATURAL RESOURCES
(612) 345-3331
PHONE NO.
Mississippi River System Management Team
Route 2, Box 230
Lake City, MN 55041-9015
FILE NO.

Celebrate MINNESOTA 1990

April 14, 1989

Colonel Neil A. Smart
District Engineer
U.S. Army Engineer District, Rock Island
ATTN: Planning Division
Clock Tower Building, P.O. Box 2004
Rock Island, IL 61204-2004

Dear Colonel Smart,

We have reviewed the 24 February 1989 Public Notice for the proposed Upper Mississippi River and Illinois Waterway Navigation Studies and have a few comments for your consideration.

We are encouraged by the District's effort to notify the public of the proposed studies early in the planning process. We also believe it is essential to involve the resource agencies in all the Upper Mississippi River System states throughout the study process. Details of anticipated interagency coordination should be included in the Plan of Study scheduled for release later this fiscal year. The POS should also include a tentative schedule for implementation of the proposed studies.

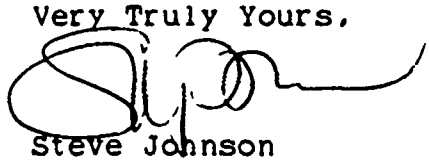
We encourage the District to design a POS which will identify the environmental needs of the future as well as the navigation needs. Maintaining and improving the environmental integrity of the UMRS is as important as providing for the needs of navigation. A balanced approach on the part of the Corps should also include recognizing the common source of our maintenance problems on the UMRS, sedimentation. Any future-oriented planning process must recognize that land use practices in the UMRS watershed are costing the public millions of dollars in maintenance both for navigation and the environment.

The public notice indicates system-wide economic and environmental data will be included in the study. It is not clear, however, whether the District plans to incorporate the system-wide approach for the entire study. Due to concerns with cumulative impacts of navigation-related changes in the system, it is imperative the reconnaissance study considers the UMRS as a whole, not just the Rock Island District. The POS should address the proposed extent of system wide analysis.

AN EQUAL OPPORTUNITY EMPLOYER

Please call me if you have any questions regarding these comments.

Very Truly Yours,



Steve Johnson
Mississippi River Coordinator

cc: Larry Gates
Jack Skrypek

GROWMARK

P O BOX 2500 • BLOOMINGTON IL 61702 2500 • (309) 557 6000

May 2, 1989

Dear Senator _____:

GROWMARK as a regional farmer cooperative serving the farmers in Illinois, Iowa, and Wisconsin is very dependent on the upper Mississippi and Illinois river systems for movement of grain and fertilizer products. The Army Corps of Engineers estimates that 75-80 percent of all tonnage moved on these waterways is agricultural products.

In recent years the delays at Lock and Dam 22 near Hannibal, MO have increased by a considerable amount. Some predict that the present river system will be very inadequate by 1995.

GROWMARK supports the U.S. Army Engineer District at Rock Island to conduct a study on the Mississippi River and Illinois Waterway Navigation Systems to determine what improvements are needed in the future to meet increasing barge transportation needs.

GROWMARK will greatly appreciate your assistance in getting the Corps funded to conduct this study during FY 1990 under Section 216 of the Flood Control Act of 1970.

Sincerely,

GROWMARK, Inc.

James F. Eberwine
Director of Traffic

JFE:jdw

bcc: Chip Smith, Corps of Engineers

MAILING LIST

The Honorable Paul Simon
United States Senator
462 Dirksen Bldg.
Washington, DC 20510

The Honorable Alan J. Dixon
United States Senator
331 Hart Bldg.
Washington, DC 20510

The Honorable Tom Harkin
United States Senator
316 Hart Bldg.
Washington, DC 20510

The Honorable Charles E. Grassley
United States Senator
135 Hart Bldg.
Washington, DC 20510

The Honorable Herbert Kohl
United States Senator
708 Hart Bldg.
Washington, DC 20510

The Honorable Robert W. Kasten
United States Senator
110 Hart Bldg.
Washington, DC 20510

TRANSPORTATION RESEARCH &
ANALYSIS CENTER, INC
JAMES G CREW
5703 LOCUST STRE
KANSAS CITY, MO 641
(816) 363-8471

May 4, 1989

District Engineer
US Army Engineers District, Rock Island
ATTN: Planning Division
Clock Tower Building
PO Box 2004
Rock Island, IL 61204-2004

RE: Navigation Reconnaissance Studies-Upper Mississippi River and Illinois Waterway

I would like to obtain a copy of the POS and any additional background information you might be able to provide regarding the above referenced propsed studies.

Sincerely;

James G. Crew
President

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES
File Ref: 1650 - 2
Carroll D. Besadny
Secretary
BOX 7921
MADISON, WISCONSIN 53707

May 10, 1989

Colonel Neil A. Smart
District Engineer
U. S. Army Engineer District, Rock Island
Clock Tower Building, P. O. Box 2004
Rock Island, Illinois 61204-2004

Dear Colonel Smart,

I am responding to your public notice for the proposed Upper Mississippi River and Illinois Waterway Navigation Studies. The Wisconsin Department of Natural Resources has the following comments on your proposed studies:

1. We appreciate the inclusion of environmental parameters in the proposed reconnaissance studies. Study justification should reference the Water Resources Development Act of 1986 (P.L. 99-662), which requires study coordination with transportation and environmental concerns. This might best be accomplished by Rock Island District's participation and funding in the Melvin Price Lock and Dam (MPL&D) studies as recommended by the MPL&D Plan of Study.

2. The reconnaissance study should be done for the entire UMRS, and not segmented by Corps of Engineer districts or separated into the UMR and Illinois River.

3. The proposed reconnaissance studies should not only seek to identify environmental enhancement measures, but should also seek measures to reduce existing environmental impacts from current transportation levels.

4. There should be a comprehensive system wide EIS to address all of the recommendations developed in the reconnaissance study.

Thank you for the opportunity to comment on your proposed studies.

Sincerely,

Michael T. Neuman

Michael T. Neuman, Acting Director
Bureau of Environmental Analysis and Review

cc: James Lissack - WD
James Huntoon - SD
Fish and Wildlife Service - Rock Island

Sverdrup
CORPORATION

June 17, 1989

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

Gentlemen:

Subject: Navigation Studies Illinois Waterway and Upper Mississippi River

In reading the Inland Rivers, Ports and Terminals Newsletter of June 1989, my attention is called to the proposed studies to be undertaken by the Rock Island District on navigation on the Upper Mississippi River and the Illinois Waterway. The article indicates that a plan of study is scheduled for release later this year. I hereby request to be notified when this plan of study is released.

Very truly yours,

SVERDRUP CORPORATION

Ronald N. Zimmer

Ronald N. Zimmer, Manager
Waterways Projects

ALTER BARGE LINE, INC.

2333 ROCKINGHAM ROAD P.O BOX 3310 DAVENPORT, IOWA 52808

TEL. (319) 383-0512

TLX (EASY LINK) 62-942-194

JOHN R. McKENZIE
PRESIDENT

July 11, 1989

The Honorable Tom Harkin
U.S. Senate
Washington, D.C. 20510

Dear Senator Harkin:

We understand that there may be a reduction in funding for the general investigation appropriation concerning the Upper Mississippi and Illinois Rivers. This investigation was to deal with condition and possible need for modifying, revising, and new construction of the lock and dam systems on both rivers. This investigation is of vital importance to everyone in the Midwest because of the amount of agricultural and non agricultural products and goods that move on the Upper Mississippi River System. The locks are getting old and in most cases are being utilized to capacity and, therefore, it is important that we know what kind of a lock and dam system will be needed in the future.

Please do everything possible to see that this important appropriation is not reduced to the point of making the study ineffective. This would be very shortsighted.

Please keep us posted as this appropriation proceeds.

Thank you for your help.

Sincerely,

ALTER BARGE LINE, INC.

John R. McKenzie

JRM/lsp

MAYOR
699-6714

CLERK'S OFFICE
699-6714

VILLAGE OF CREVE COEUR
101 NORTH THORNCREST AVENUE
CREVE COEUR, ILLINOIS - 61611

AUGUST 10, 1989

DISTRICT ENGINEER
U.S. ARMY ENGINEER DISTRICT, ROCK ISLAND
ATTN: PLANNING DIVISION (NELSON CORDOBA)
CLOCK TOWER BUILDING , P.O. BOX 2004
ROCK ISLAND, ILLINOIS 61204-2004

GENTLEMEN:

THE VILLAGE OF CREVE COEUR WOULD LIKE VERY MUCH TO RECEIVE YOUR PLAN OF STUDY, NAVIGATION RECONNAISSANCE STUDIES UPPER MISSISSIPPI RIVER AND ILLINOIS WATERWAY. I WOULD LIKE TO THANK YOU IN ADVANCE FOR THIS INFORMATION.

SINCERELY,

Pat Barnes

PAT BARNES
VILLAGE CLERK

SOUTHWESTERN ILLINOIS PLANNING COMMISSION

Carl Upchurch
PRESIDENT

Jack Lampen
VICE-PRESIDENT

Ray Buescher
SECRETARY

Gene Brombolich
TREASURER

EXECUTIVE COMMITTEE

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Leonard Ernsting
Lester Holcomb

Bond County
Frank Thompson
Harvey LeBegue

Clinton County
Dennis Rickhoff
Jack Lampen

Washington County
Lester Campbell
Ray Buescher

203 West Main Street
Collinsville Illinois 62234
(618) 344-4250

August 11, 1989

District Engineer
U.S. Army Engineer District, Rock Island
Attn: Planning Division (Nelson Cordoba)
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61204-2004

Dear Sir:

Please forward to the Southwestern Illinois Metropolitan and Regional Planning Commission a copy of the Plan of Study for the Illinois Waterway.

Thank you.

Yours very truly,

Robert L. Pinkerton
Executive Director

RLP:bd

Robert L. Pinkerton
EXECUTIVE DIRECTOR

American Commercial Barge Line Company

Box 610, Jeffersonville, Indiana 47131-0610
Area Code (812) 288-0100

August 14, 1989

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

Attention: Mr. Nelson Cordoba, Planning Division

Dear Mr. Cordoba:

Please send me a copy of the Corps' Navigation Reconnaissance Plan of Study for the Upper Mississippi River and the Illinois Waterway.

Yours very truly,

Charles F. Lehman

CFL:bjs

a unit of CSX corporation

ILLINOIS DEPARTMENT OF AGRICULTURE

DIVISION OF MARKETING
Illinois State Fairgrounds
P.O. Box 19281
Springfield, IL 62794-9281
217/782-6675

August 15, 1989

District Engineer
U. S. Army Engineer District, Rock Island
Attn: Planning Division (Nelson Cordoba)
Clock Tower Building, P. O. Box 2004
Rock Island, Illinois 61204-2004

Dear Mr. Cordoba:

Please furnish this office with two (2) copies of the plan of study for the upper Mississippi and Illinois Waterway Reconnaissance Studies.

Thanks.

Sincerely,

L. M. Rife
Transportation Specialist

LMR:sr

State Historical Society of Iowa

The Historical Division of the Department of Cultural Affairs

August 17, 1989

Mr. Dudley M. Hanson, P.E.
Chief, Planning Division
Rock Island District Corps of Engineers
Clock Tower Building
P.O. Box 2004
Rock Island, IL 61204-2004

RE: COE - PLAN OF STUDY - NAVIGATION RECONNAISSANCE STUDIES - UPPER MISSISSIPPI RIVER AND ILLINOIS WATERWAY

Dear Mr. Hanson:

We have reviewed the Plan of Study for this project and look forward to working with you on the reconnaissance studies.

Thank you for the opportunity to comment on the POS.

Sincerely,

Kay Simpson
Review and Compliance Program
Bureau of Historic Preservation

☐ 402 Iowa Avenue
Iowa City, Iowa 52240
(319) 335-3916

☑ Capitol Complex
Des Moines, Iowa 50319
(515) 281-5111

☐ Montauk
Box 372
Clermont, Iowa 52135
(319) 423-7173

PAUL SIMON
ILLINOIS

COMMITTEES:
LABOR AND HUMAN RESOURCES
JUDICIARY
FOREIGN RELATIONS
BUDGET

United States Senate

WASHINGTON, DC 20510

August 17, 1989

Mr. John R. McKenzie, President
Alter Barge Line, Inc.
2333 Rockingham Road
P.O. Box 3310
Davenport, Iowa

Dear Mr. McKenzie:

Thank you for your recent letter concerning appropriations for general investigation of the Upper Mississippi and Illinois Rivers.

It is clear that this is an important project because of the amount of products that are shipped on the Upper Mississippi River System. Please be assured that I am supportive of this investigation and hope that the necessary funding will be included in the final appropriations bill.

Again, thank you for taking time to write on this important matter. It really helps us when we are able to point to the kind of support that exists for something like this.

My best wishes.

Cordially,

Paul Simon
U.S. Senator

PS/rer

230 S. Dearborn
Kluczynski Bldg., 38th Floor
Chicago, IL 60604
312/353-4952

3 West Old Capitol Plaza
Suite 1
Springfield, IL 62701
217/492-4960

8787 State St.
Suite 212
East St. Louis, IL 62203
618/398-7707

250 West Cherry
Room 115-B
Carbondale, IL 62901
618/457-3653

STATE OF ILLINOIS

OFFICE OF THE GOVERNOR

SPRINGFIELD 62706

JAMES R THOMPSON
GOVERNOR

August 18, 1989

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

SAI#: 89-08-18-26
REGIONAL# 00
TITLE: Navigation Reconnaissance Studies Upper Mississippi River and Illinois Waterway - Environmental Assessment
DEPT.: Department of the Army

The Illinois State Clearinghouse has received a "Notice of Intent" for the above project.

The review of your proposal has begun as required by law. You should receive additional correspondence on this project within 30 days. Please refer to the SAI number in future correspondence on this proposal. For further information call (217)782-1671.

Cheryl Bradley
Illinois State Clearinghouse
Room 107 Stratton Building
Springfield, Illinois 62706

Illinois Historic Preservation Agency

Old State Capitol • Springfield, Illinois 62701 • (217) 782-4836

217/785-4997

STATEWIDE
Plan of Study
Upper Mississippi River and Illinois Waterway

IHPA LOG #89080801

August 22, 1989

Mr. Dudley M. Hanson, P.E.
Chief, Planning Division
District Engineer
U.S. Army Engineer District, Rock Island
Attention: Planning Division
Clock Tower Building - Post Office Box 2004
Rock Island, Illinois 61204-2004

Gentlemen:

Thank you for requesting comments from our office concerning the possible effects of the project referenced above 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".

Thank you for the opportunity to comment on the Plan of Study for Upper Mississippi River and Illinois Waterway Navigation Studies. Our staff has reviewed this document and have determined that adequate consideration was given to cultural resources in the planning stages of this project.

If you have any further questions, please contact Joyce A. Williams, Staff Archaeologist, Illinois Historic Preservation Agency, Old State Capitol, Springfield, Illinois 62701, 217/785-1279.

Sincerely,

Theodore Hild

Theodore W. Hild
Deputy State Historic
Preservation Officer

TWH:JAW:bv

cc: CoE-St. Paul
CoE-St. Louis

MISSOURI DEPARTMENT OF CONSERVATION

MAILING ADDRESS
P.O. Box 180
Jefferson City, Missouri 65102-0180

STREET LOCATION
2901 West Truman Boulevard
Jefferson City, Missouri

Telephone: 314/751-4115
JERRY J. PRESLEY, Director

August 22, 1989

Mr. Nelson Cordoba
Planning Division
Rock Island District, Corps of Engineers
Clock Tower Building
P. O. Box 2004
Rock Island, Illinois 61204-2004

Dear Mr. Cordoba:

We appreciate receiving a copy of the "Plan of Study for Upper Mississippi River and Illinois Waterway Navigation Studies" dated August 1989. As the state fish and wildlife agency we would be most interested in participating in this study effort.

Review of the Plan of Study raised several questions or comments as follows:

- Page 11. Forecasts of "ever expanding" agricultural production for ultimate waterway movement ignore the fact that the land base for agricultural production is shrinking due to farm programs, urbanization, etc. It's difficult to perceive a continuing upward spiral for traffic growth if production is reduced. We are also somewhat skepical about predictions that midwestern coal production will continue to grow.

- Page 22-23 - Existing Conditions. The question of balancing transportation modes, water, rail, highway and air seems to be missing. We wonder if the Corps of Engineers is the best judge of investments in waterways as opposed to rail, highways, etc.

- Page 24. If the locks and dams are used to "over 60 percent" it would appear that 30-40 percent capacity still remains. Is one of the issues scheduling and efficient utilization?

- Page 26. A list of constraints eliminated in analyzing for "unconstrained demand" would be enlightening. Did constraints include land base for agricultural production, drought, physical dimensions of the river, highway systems as competitors and as movers of grain to waterway terminals?

COMMISSION

JERRY P. COMBS, Kennett
ANDY DALTON, Springfield
JAY HENGES, St. Louis
JOHN POWELL, Rolla

The opportunity to offer these brief comments is appreciated. If you wish to discuss our involvement in this study, please contact William H. Dieffenbach of my staff.

Sincerely,

Dan F. Dickneite

DAN F. DICKNEITE
ENVIRONMENTAL ADMINISTRATOR

cc: U. S. Fish and Wildlife Service
Rock Island, Illinois

John Ashcroft
Governor

James R. Moody
Commissioner

State of Missouri
OFFICE OF ADMINISTRATION
Post Office Box 809
Jefferson City
65102

Stan Perovich
Director
Division of General Services

August 30, 1989

Dudley M. Hanson, P.E.
Chief, Planning Division
Rock Island District
U.S. Department of the Army
Corps of Engineers
Clock Tower Building
P. O. Box 2004
Rock Island, Illinois 61204-2004

Dear Mr. Hanson:

Subject: 89080031 - Plan of Study for Upper Mississippi River and Illinois Waterway Navigation Studies

The Missouri Federal Assistance Clearinghouse, in cooperation with state and local agencies interested or possibly affected, has completed the review on the above project application.

None of the agencies involved in the review had comments or recommendations to offer at this time. This concludes the Clearinghouse's review.

A copy of this letter is to be attached to the application as evidence of compliance with the State Clearinghouse requirements.

Sincerely,

Lois Pohl, Coordinator
Missouri Clearinghouse

LP:cm

Illinois Department of Conservation
life and land together

LINCOLN TOWER PLAZA • 524 SOUTH SECOND STREET • SPRINGFIELD 62701-1787
CHICAGO OFFICE • ROOM 4-300 • 100 WEST RANDOLPH 60601
MARK FRECH, DIRECTOR - KATHY SELCKE, ASSISTANT DIRECTOR

September 7, 1989

Mr. Dudley M. Hanson, P. E.
Chief, Planning Division
U. S. Army Corps of Engineers
Rock Island District
Clock Tower Building, P O Box 2004
Rock Island, IL 61204-2004

Dear Mr. Hanson:

Thank you for your letter of August 7, 1989 and the Plan of Study (POS) for Navigation Reconnaissance Studies on the Upper Mississippi River and Illinois Waterways.

My staff and I look forward to working with the Rock Island and St. Louis Corps Districts during the course of the studies. We are pleased to note that commercial navigation and environmental concerns will receive equal consideration during the planning process.

Sincerely

Mark Frech

Mark Frech
Director

MF:RWL:bg

cc: U. S. Fish & Wildlife Service, Rock Island
Colonel James Corbin, St. Louis Corps District

STATE OF ILLINOIS

OFFICE OF THE GOVERNOR

SPRINGFIELD 62706

JAMES R THOMPSON
GOVERNOR

SAI# 89-08-18-26

SUBJECT: Navigation Reconnaissance Studies Upper Mississippi River and Illinois Waterway - Environmental Assessment

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

The Illinois State Clearinghouse has reviewed the reference subject pursuant to the National Environmental Policy Act of 1969. State agencies which are authorized to develop and enforce environmental standards have been given the opportunity to comment on this subject. At this time no comments have been received.

Illinois State Clearinghouse

September 18, 1989

CC: Roger Barcus
I.D.O.T.
Division of Aeronautics
One Langhorne Drive
Capital Airport
Springfield, Illinois 62706

United States Department of the Interior

FISH AND WILDLIFE SERVICE
ROCK ISLAND FIELD OFFICE (ES)
1830 Second Avenue, Second Floor
Rock Island, Illinois 61201

IN REPLY REFER TO:
COM: 309/793-5800
FTS: 386-5800

October 11, 1989

Colonel John R. Brown
District Engineer
U.S. Army Engineer District
Rock Island
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61204-2004

Dear Colonel Brown:

We have reviewed the Plan of Study for Navigation Reconnaissance Studies on the Upper Mississippi River and Illinois Waterway. The plan describes the objectives and content of the future reconnaissance studies and how they will be accomplished in cooperation among the three Corps districts. We have the following comments:

Page 6, Natural Resources. The Illinois River is an important migratory link in the Mississippi Flyway. Each year thousands of waterfowl and other migratory birds use the remaining wetlands of the Illinois River for feeding and nesting. In addition some species such as the great blue heron nest in the river's corridor. Two National Wildlife Refuges are located on the Illinois River, the Chautauqua National Wildlife refuge near Havana and a portion of the Mark Twian National Wildlife Refuge at the river's juncture with the Mississippi River. In addition, the Illinois Department of Conservation manages several wildlife areas along the Illinois River.

Page 20, UMRS-EMP The navigation effects Tasks of the Long Term Resource Monitoring Program currently are being revised into testable hypotheses.

Page 24-27, Projected Traffic The Reconnaisance Studies should provide greater detail on the methods and assumptions of the 1988 Inland Waterway Review. Differences from past projections should also be addressed. Projections of recreation traffic should take advantage, to the extent possible, data being collected for the Environmental Management Program recreation economics study.

Page 31, Environmental Coordination We strongly urge you to continue the team approach used for the St. Louis District Plan of Study. The team can assist you in identifying significant issues and development of a comprehensive environmental impact statement (EIS). In addition, we anticipate that we will be providing you a planning aid letter in accordance with the Fish and Wildlife Coordination Act (FWCA).

In conclusion, I'd like to reiterate some concerns expressed in my letter of March 27, 1989. Much of the information necessary for you to make an informed decision on the environmental impacts of any recommendations in the Reconnaissance Studies is still largely unavailable. This only emphasizes the urgency in initiating the St. Louis District Plan of Study. Once these studies have been accomplished, additional scoping will be necessary to address the cumulative effects of increasing tow traffic and the possible limit to perturbations on the riverine ecosystem.

We are interested in meeting with your staff as soon as possible to define FWCA requirements and future transfer funding needs. Please contact Gail Carmody of my staff to arrange a suitable meeting time.

Sincerely,

Richard C. Nelson
Field Supervisor

cc: Col. Corbin, St. Louis District
Col. Baldwin, St. Paul District
MNDNR (Skrypek, Davis)
WIDNR (Neuman, Kennedy)
ILDOC (Lutz, Sallee, Atwood)
IADNR (Szcodronski, Schonhoff)
MODOC (Dieffenbach, Stucky)
USEPA (Bronoski, Chicago)
USFWS (AE/FP, EMTC, SPFO, MISO)

GC:hw

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES
Carroll D. Besadny
Secretary

Box 7921
Madison, Wisconsin 53707

November 22, 1989 IN REPLY REFER TO: 1650 - 2

Colonel John R. Brown
District Engineer
U. S. Army Engineer District
Clock Tower Building, P. O. Box 2004
Rock Island, Illinois 61204

SUBJECT: Plan of Study for Navigation Reconnaissance Studies on the Upper Mississippi River and Illinois Waterway

Dear Colonel Brown::

We have reviewed your Plan of Study for Navigation Reconnaissance Studies on the Upper Mississippi River and Illinois River and have the following comments:

The Plan of Study provides the necessary emphasis on giving equal consideration to environmental as well as navigation concerns during the planning process (Introduction, p.1). However, we note that the alternatives to be evaluated in the reconnaissance studies (p.27) consist only of navigation system improvements. Equal consideration should be given to evaluating alternative environmental improvements during the planning process, consistent with the objectives in Public Law 91-611.

The Plan of Study recommends a systems approach (p. 29), as opposed to a site-specific approach, which should enable a better understanding of the economic, social and environmental impacts of increased navigation traffic on the Upper Mississippi River System. We support the systems level approach.

The Plan of Study recognizes there is insufficient information to assess the environmental impacts of increased navigation on the Mississippi River (pgs. 19 & 29). Navigation improvements evaluated in the reconnaissance studies will undoubtedly increase the capacity of the Upper Mississippi River System to accommodate increased navigation. This only emphasizes the urgency in initiating the St. Louis District Plan of Study. Once these studies have been accomplished, additional scoping will be necessary to address the cumulative effects of increasing tow traffic and the possible limit to perturbations on the Upper Mississippi River ecosystem. The cumulative effects of any avoid and minimize measures adopted in conjunction with the St. Louis District Second Lock Program and the Corps of Engineers Lock and Dam Major Rehabilitation will also need to be factored into this analysis, should there be any such measures adopted or

recognized.

As indicated in the Plan of Study, the environmental aspects of the navigation studies should be coordinated with interested groups, the public, the U. S. Environmental Protection Agency, the U.S. Fish and Wildlife Service and the five States bordering the Upper Mississippi River.

I am also asking that you send me 5 copies of any system EIS related documents or site-specific EIS's on projects affecting Wisconsin so that we can carry out our environmental impact document review responsibilities pursuant to the national and Wisconsin environmental policy acts.

Sincerely,

Kathryn A. Curtner, Director
Bureau of Environmental Analysis and Review

KAC:MN

cc: Hal Meier - SD
Craig Thompson - La Crosse
Dave Kennedy - La Crosse
Bob Roden - WZ/6
Richard Nelson, U. S. Fish and Wildlife Service, Rock Island
Col. Corbin, St. Louis District Corps of Engineers
Col. Baldwin, St. Paul District Corps of Engineers
MNDNR (Davis)
ILDOC (Atwood)
IADNR (Schonhoff)
MODOC (Stucky)
USEPA (Bronoski)

OJT
ORBA-JOHNSON TRANSSHIPMENT CO.
P. O. Box 768
Keokuk, Iowa 52632
(319) 463-7162

December 12, 1989

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

Dear Sirs:

We have been asked by Mr. Paul Soyke if we support further navigation studies on the upper Mississippi and Illinois waterways.

As a transshipment terminal at UMR 371, we are very interested in the viability and reliability of our waterway systems.

Even at current use levels, it is apparent that congestion on the waterways is becoming a major factor in this geographic area.

Delays and stoppages are not just inconveniences but are costs that affect the ultimate consumer in terms of food and utilities, just to name two of many.

Studies that result in more efficient and beneficial use of the waterways are vital to the economic and environmental development of the waterways systems.

I appreciate the opportunity to express my opinion on issues having a major impact on our society.

Sincerely,

W. Breen Turley
General Manager

Minnesota Department of Transportation
Transportation Building, St. Paul, MN 55155

Celebrate MINNESOTA 1990

612 296-1609

December 15, 1989

Dudley Hanson, Chief
Planning Division
Rock Island District, U.S. Army COE
Clocktower Building
Rock Island, Illinois 61201

Dear Mr. Hanson:

The Ports and Waterways Section of the Minnesota Department of Transportation (Mn/DOT) has taken advantage of the opportunity to review the Corps proposals for navigation studies on the Upper Mississippi and the Illinois River. We feel that the studies will answer many questions and provide a strong base for planning on the rivers.

Mn/DOT supports the proposed study program which will investigate the rivers separately. Since there is very little interchange of commodity movement between our part of the Upper Mississippi and the Illinois we think that our needs require the individual analysis.

Thank you for the opportunity to comment on the proposal. We look forward to the completion of the studies. If we can provide assistance please call.

Sincerely,

M. William Newstrand, Director
Ports and Waterways

An Equal Opportunity Employer

National Waterways Conference, Inc., 1130 17th Street, N.W., Washington, D.C. 20036-4676

January 3, 1990

Col. John R. Brown
District Engineer
Army Engineer District, Rock Island
P.O. Box 2004
Rock Island, Illinois 61204

Dear Col. Brown:

The FY 1990 Energy and Water Development Appropriations Act contains funds for navigation studies on the Upper Mississippi Waterway and also on the Illinois Waterway. Both of these waterways are, as you know, vital shipping arteries, particularly in the movement of grain and other agricultural products.

Over the last few decades, the structural modernization of both the Upper Mississippi Waterway and the Illinois Waterway has unfortunately been neglected. The recently funded navigation studies are long overdue, and I can tell you that there is a great deal of support among the waterway shipper and carrier industries in a thorough study of needed improvements. We are most hopeful that these studies can be expedited in every way possible.

Sincerely yours,

Harry N. Cook
President

HNC/djg

CHAIRMAN OF THE BOARD
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Harry N Cook
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Washington D C
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W Richard Christensen
Ashland Petroleum Company
Ashland Kentucky
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Pine Bluff-Jefferson County
Port Authority
Pine Bluff Arkansas
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Barge Line Company
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Tennessee-Tombigbee Waterway
Development Authority
Columbus Mississippi
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The Waterways Journal
St Louis Missouri
TREASURER
Donald C. McCrory
Memphis and Shelby County
Port Commission
Memphis Tennessee

Dedicated to a greater understanding of the widespread public benefits of the American waterways system

Telephone
(202) 296-4415
Facsimile
(202) 835-3861

MID-AMERICA TRANSPORTATION COMPANY

50 JEROME LANE

FAIRVIEW HEIGHTS, ILLINOIS 62208

TEL. 618-397-8310 TWX 910-756-2344

January 8, 1990

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

Dear Col. Brown:

Mid-America Transportation Company is a St. Louis based barge line which operates dry bulk barges and towboats on the Mississippi River and tributaries. On behalf of this Company we support both the concept and the initiation of the Reconnaissance Study for the Illinois and Upper Mississippi Waterway Navigation System.

If we can be of any help on this, please don't hesitate to contact us.

Sincerely,

MID-AMERICA TRANSPORTATION COMPANY

J. A. Tinkey,
President

JAT:cmc

Illinois Department of Conservation
life and land together

LINCOLN TOWER PLAZA • 524 SOUTH SECOND STREET • SPRINGFIELD 62701-1787
CHICAGO OFFICE • ROOM 4-300 • 100 WEST RANDOLPH 60601
MARK FRECH, DIRECTOR - KATHY SELCKE, ASSISTANT DIRECTOR

Mr. Dudley M. Hanson, P.E.
Chief, Planning Division
Rock Island District, Corps of Engineers
Clock Tower Building - P.O. Box 2004
Rock Island, IL 61204-2004

Dear Mr. Hanson:

Thank you for you March 29, 1990 letter regarding the Corps initiation of a Navigation Improvement Reconnaissance Study on the Illinois Waterway and Upper Mississippi River to determine if Federal involvement is warranted.

I have designated Mr. Richard W. Lutz, Supervisor Impact Analysis Section, Division of Planning as the Point of Contact (POC) for the Illinois Waterway and Upper Mississippi River Reconnaissance Studies. Mr. Lutz will involve other interested Department staff as necessary.

This designation is not meant to change the daily contact that normally occurs between Corps and Department field staff but will provide the Corps one person through whom requests for information, comments or questions can be channeled in a more expeditious manner.

Thank you for the opportunity to comment.

Sincerely,

Mark Frech

Mark Frech
Director

RWL:ts

CARGO CARRIERS

A Division of
Cargill Marine & Terminal, Inc.
Foot of Davis Street
Box 147
East Carondelet, IL 62240-0147
618/286-4801
Fax: 618/286-3338

May 2, 1990

District Engineer
U.S. Army Engineer District
Rock Island
Clock Tower Building
P. O. Box 2004
Rock Island, IL 61204-9907

Attention: CENCR-PD-W

Dear Sir:

Please mail copies of the Upper Mississippi River Navigation Study to any of the attached addresses that are not on your mailing list.

Sincerely,

Everett Johnson II
Everett Johnson
Chairman, RIAC

EJ/lb

Attachments

Captain Billy Martin
Wisconsin Barge Line
1655 Des Peres Road
St. Louis, MO 63131

Mr. Bill Robertson
e Valley Line Company
120 S. Central Avenue
St. Louis, MO 63105

Mr. Jerry Tinkey
Mid-America Transp. Co.
50 Jerome Lane
Fairview Heights, IL 62208

Everett Johnson
Route 3, Box 178
Gordonville, MO 63752

Mr. John Martin
Alter Barge Line
P. O. Box 157
Alton, IL 62002

Mr. Scott Puettmann
American Barge & Towing Co.
12400 Olive Blvd.
Suite 430
St. Louis, MO 63141

Captain Buck Lay
B & H Towing Co.
P. O. Box 2635
Paducah, KY 42001

Mr. Chuck Norman
Norman Bros. Inc.
P. O. Box 100
Alton, IL 62002

Captain Greg Menke
Ohio River Company
P. O. Box 327
Wyatt, MO 63882

Mr. Harry Brewick
TPC Transportation Co.
5100 Oakland Avenue
St. Louis, MO 63110

ptain Daniel E. Brock
ingram Barge Company
P. O. Box 2756
Paducah, KY 42001

Mr. Rick Sadtler
Bunge Corporation
P. O. Box 28500
St. Louis, MO 63146

Captain Tommy Seals
American Comm. Barge Line
730 E. Davis Street
St. Louis, MO 63111

Capt. Mike Rushing
Rushing Marine Corp.
2 N. Lorimier
Cape Girardeau, MO 63701-7304

Mr. Jim Farley
Conti-Carriers & Terminals
222 S. Riverside Plaza
Suite 2600
Chicago, IL 60606

Mr. Floyd Goodman
Peavey Barge Lines
111 E. Fourth Street
Alton, IL 62002

Mr. Delbert Knoy
Delman Marine Inc.
P. O. Box 369
Pekin, IL 61555

Mr. Ed Senn
Material Service Corp.
P. O. Box 158
Lockport, IL 60441

Mr. Jack L. Wershbale
Dravo Mechling Corp.
P. O. Box 52189
New Orleans, LA 70152-2189

Mr. Jim Call
American Rivers Transp. Co.
P. O. Box 656
Ama, LA 70031

Captain Dave Dewey
Western KY Navigation, Inc.
5059 Reidland Road
Paducah, KY 42003

Marine Superintendent
Conti-Carriers & Terminal
P. O. Box 5030
Cahokia, IL 62206

Captain Larry Jamison
CGB Marine Services
P. O. Box 1916
Naples, IL 62669

Mr. Harry Waddington
Marine Eqpt. Management
11042 Manchester
St. Louis, MO 63122

Mr. Donald Huffman
Huffman Towing Co.
10 S. Brentwood Blvd.
Suite 306
St. Louis, MO 63105

Mr. Timothy Powers
Consolidated Grain & Barg
5100 Oakland Avenue
Suite 101
St. Louis, MO 63101

Capt. Gary Crader
Apex Towing Company
P. O. Box 11533
8182 Maryland
St. Louis, MO 63105

Mr. Bruce Hancock
Riverway Company
7703 Normandy Road
Room 110
Minneapolis, MN 55435

Mr. Bill Boyd
Reidy Terminal/ARTCO
P. O. Box 2856
4528 So. Broadway
St. Louis, MO 63111

Captain Leo Steger
Missouri Barge Line
102 N. Main Street
Cape Girardeau, MO 63701

Capt. Kenneth Stiltz
Iowa Marine Repair Corp.
P. O. Box 732
Morris, IL 60450

Mr. Bruce Sheehan
R.B. Miller & Assoc., Inc.
7980 Clayton Road
St. Louis, MO 63117

Captain Buddy Compton
Orgulf Transportation Co.
[illegible]0 Virginia Avenue
... Louis, MO 63111

Mr. Robert Goodwin
Fabick Marine
Foot of Gratiot Street
St. Louis, MO 63102

Mr. Brad Stone
Riverway Co. - Operations Dept.
P. O. Box 166
East Carondelet, IL 62240

CPT Billy Martin
Wisconsin Barge Line
1655 Des Peres Road
St. Louis, MO 63131

Mr. Jerry Tinkey
Mid-America Transportation Co.
50 Jerome Lane
Fairview Heights, IL 62208

Mr. John Martin
Alter Barge Line
P.O. Box 157
Alton, IL 62002

Mr. Scott Puettmann
American Barge & Towing Co.
12400 Olive Blvd.
Suite 430
St. Louis, MO 63141

CPT Greg Menke
Ohio River Company
P.O. Box 327
Wyatt, MO 63882

Mr. Harry Brewick
TPC Transportation Co.
5100 Oakland Avenue
St. Louis, MO 63110

CPT Daniel E. Brock
Ingram Barge Co.
P.O. Box 2756
Paducah, KY 42001

Mr. Rick Sadtler
Bunge Corp.
P.O. Box 28500
St. Louis, MO 63146

CPT Mike Rushing
Rushing Marine Corp.
2 N. Lorimier
Cape Girardeau, MO 63701-7304

Mr. Floyd Goodman
Peavey Barge Lines
111 E. Fourth St.
Alton, IL 62002

Mr. Delbert Knoy
Delmar Marine Inc
P.O. Box 369
Pekin, IL 61555

Mr. Jack Weshbale
Dravo Mechling Corp.
P.O. Box 52189
New Orleans, LA 70152-2189

Mr. Donald Huffman
Huffman Towing Co.
10 S. Brentwood Blvd. - Suite 306
St. Louis, MO 63105

Mr. Timothy Powers
Consolidated Grain & Barge
5100 Oakland Ave.-Suite 101
St. Louis, MO 63101

CPT Gary Crader
Apex Towing Co.
P.O. Box 11533
8182 Maryland
St. Louis, MO 63105

Mr. Bill Boyd
Reidy Terminal/ARTCO
P.O. Box 2856
4528 So. Broadway
St. Louis, MO 63111

CPT Kenneth Stiltz
Iowa Marine Repair Corp.
P.O. Box 732
Morris, IL 60450

CPT Buddy Compton
Orgulf Transportation Co.
7200 Virginia Ave.
St. Louis, MO 63111

Mr. Robert Goodwin
Fabrick Marine
Foot of Grat' Street
St. Louis, 63102

Mr. Brad Stone
Riverway Co. - Operations Dept.
P.O. Box 166
East Carondelet, IL 62240

United States Department of the Interior

Fish and Wildlife Service
Rock Island Field Office (ES)
1830 Second Avenue, Second Floor
Rock Island, Illinois 61201

COM: 309/793-5800
FTS: 782-5800

TAKE PRIDE IN AMERICA

In Reply Refer to:

June 28, 1990

Colonel John R. Brown
District Engineer
U.S. Army Engineer District
Rock Island
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61204-2004

Dear Colonel Brown:

We recently noticed that the Upper Mississippi River and Illinois River Navigation Studies will be discussed at the next meeting of the Inland Waterways Users Board (IWUB). We ask that you consider this meeting an opportunity to foster new relationships between the industry and the environmental community by briefing the Board on the environmental planning requirements that will be necessary for future feasibility studies.

We note that the proposed Methodology for Prioritizing Inland Navigation Investments does not include any natural resource or environmental information. We believe that this provides a skewed picture to the industry and may bias priorities. This bias needs to be avoided on the Upper Mississippi River System which has a dual federal purpose.

One of our recommendations for the Navigation Studies Reconnaissance Reports will be for completion of the proposed St. Louis District Plan of Study. It appears that the majority of the plan can be completed in 5-7 years. Implementation should be before or concurrent with feasibility planning. It is our hope that the plan can be completed in a timely manner and that a repeat of the confrontational history on this issue can be avoided.

We ask that you immediately assess the need for the St. Louis District Plan of Study in completing the proposed navigation feasibility planning. Please also consider accelerating the Plan of Study implementation process, thereby avoiding any future

costs of delay. If you would like to discuss these ideas further or would like any assistance in briefing the IWUB, please let me know.

Sincerely,

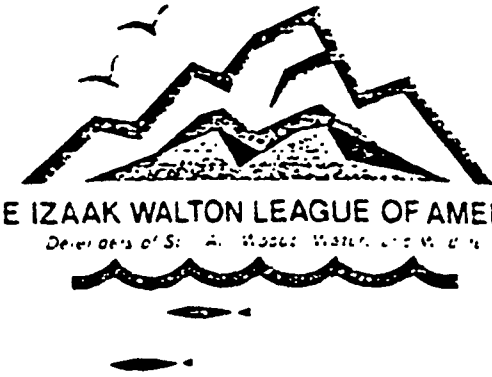
Gerald Bade

for Richard C. Nelson
Field Supervisor

cc: Division Engineers (Gen. Patin, Gen. Williams)
District Engineers (Col. Corbin, Col. Baldwin)
U.S. EPA (Regional Administrators)
Izaak Walton League

GC:sjg

July 23, 1990



Lt. Gen. Henry Hatch, Chief
U.S. Army Corps of Engineers
200 Massachusetts Ave. N.W.
Washington, D.C. 20314-1000

Dear General ~~Hatch~~ Hank,

I am sorry that I missed you during your recent visit to the Upper Mississippi -- your visit coincided with the IWLA National Convention in Syracuse, New York.

As we enter the environmental decade of the 90's, we are at a crucial juncture on the management of the Upper Mississippi River. As you know, Congress has designated this as a multi-purpose resource - a nationally significant ecosystem as well as a nationally significant waterway. Now is the time that we must get all parties to sit down together up front, and set a reasonable planning schedule to fulfill the intent of Congress on the management of this great national resource.

Navigation studies now being prepared by your district propose extensive improvements to the navigation capacity of the Upper Mississippi and Illinois Rivers. These projects will have significant environmental impacts, and analyses of the impacts must occur before any of these improvements can be built. As we have seen in the past year and a half regarding improvements of Locks and Dam 26, the conservation community and the Corps can work together. We must try to avoid the confrontational history of the past as your new projects and alternatives are developed.

We fear that the Corps may be starting out in the wrong direction. Ramrodding navigational studies, without letting industry know clearly and up front that environmental factors will be considered at every step of the way, is not appropriate. There are those within your agency that seem to believe that if they are able to build up enough steam, they will be able to roll over environmental concerns. This is a mistake. Environmental concerns have never been more important with the American public, and those of us in the conservation community have never had more resources to call on with which to fight environmental battles.

The Corps has already broken the faith with the conservation community with regards to funding the Environmental Management Program. During the first three years this essential project, only one-half of the $58 million authorized for the project has been requested and appropriated. This program was supposed to be kept "on equal fiscal footing" with navigation projects. Funds for navigation improvements at Locks and Dam 26, for major rehabilitation of existing locks and dams, and for operation and maintenance, have been fully funded or not cut to anywhere near this extent. Full implementation of this program is at the heart of Corps credibility for future projects.

National Office 1401 Wilson Blvd., Level B, Arlington, Virginia 22209 • Phone 703-528-1818
Regional Office 2117 Stout Street, Minneapolis, Minnesota 55454 • Phone 612-334-2950

I encourage you to convene a meeting of all parties, and to lay out a reasonable planning schedule for consideration of the environmental impacts of the entire range of navigations improvements that are being considered. There is no reason why we cannot work together. I encourage you to make sure that the environmental planning work is done up front, so that we do not find ourselves in a position of fighting over projects when the controversy could have been resolved years before.

Sincerely,

Paul W. Hansen
Director
Midwest Regional Office, IWLA

cc: Jim Gritman, Rick Nelson, USFWS
Lt. Gen. Jude Patin, Col. Jim Corbin, Col. Roger Baldwin,
Col. John Brown
Ten UMR Senators: IL, WI, MN, MO, IA
IWLA UMR Directors

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

October 17, 1990

Planning Division (11-2-240a)

SEE DISTRIBUTION LIST

The Rock Island District of the U.S. Army Corps of Engineers is currently conducting a reconnaissance study to determine future navigation improvements on the Upper Mississippi River which may warrant Federal involvement in their planning and construction.

We are enclosing a list of alternatives being considered at this time. Assessment of the various alternatives at the reconnaissance phase is broad and general in nature. The purpose of the reconnaissance study is to determine if any alternatives are economically feasible and can, therefore, be recommended for additional detailed study in the feasibility phase.

A system-wide Environmental Impact Statement (EIS) will be prepared during the feasibility phase to determine the effects of any recommended improvements to the Upper Mississippi River System. The EIS will include an assessment of impacts to historic properties.

At this time, we request that your agency indicate the types of studies which may be required to determine impacts to significant historic properties pursuant to the National Historic Preservation Act. We also request a listing of any structures or sites, on or immediately adjacent to the Mississippi River, which are listed on or determined to be eligible for the National Register of Historic Places.

Portions of the Upper Mississippi River Navigation System have been listed on or determined eligible for listing on the National Register of Historic Places. A Programmatic Memorandum of Agreement (PMOA) for Locks and Dams 3 through 22, Upper Mississippi River, was executed with your office in 1987 to guide rehabilitation efforts at the locks and dams. Historic American Engineering Record (HAER) documentation was completed as part of this agreement. The PMOA can be used as a baseline for evaluating future impacts to the locks and dams during the feasibility phase of the navigation study.

The Rock Island, St. Louis, and St. Paul Districts of the Corps of Engineers are compiling existing archeological resource information for the Mississippi River corridor, which will be summarized in the reconnaissance study report and used as a baseline for estimating future study requirements for the feasibility phase.

This letter is being provided to the State Historic Preservation Officers (SHPO) in Iowa, Illinois, Missouri, Wisconsin, and Minnesota. It is also provided as preliminary documentation to the Advisory Council on Historic Preservation.

We request SHPO comments on this project within 30 days so that they can be fully integrated into the first draft of the reconnaissance report. If you have any questions concerning this study, please call District Archeologist Mr. Kenneth Barr of our Environmental Analysis Branch at 309/788-6361, Ext. 6349, or you may write to the following address:

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

Sincerely,

ORIGINAL SIGNED BY
PATRICK T. BURKE, P.E.

Dudley M. Hanson, P.E.
Chief, Planning Division

Enclosures

Copies Furnished:

Commander
U.S. Army Engineer District, St. Paul
ATTN: CENCS-PD-E
1421 USPO & Custom House
180 East Kellogg Boulevard
St. Paul, Minnesota 55101-1479 (w/enclosures)

Commander
U.S. Army Engineer District, St. Louis
ATTN: CELMS-PD-E
210 Tucker Boulevard North
St. Louis, Missouri 63101-1986 (w/enclosures)

DISTRIBUTION LIST

Iowa:
Mr. David Crosson
State Historic Preservation Officer
State Historical Society of Iowa
Capitol Complex
Des Moines, Iowa 50319

Illinois:
Mr. Michael Devine
State Historic Preservation Officer
Illinois Historic Preservation Agency
Old State Capitol
Springfield, Illinois 62701

Missouri:
Dr. Frederick A. Brunner, PhD
State Historic Preservation Officer
State Department of Natural Resources
1915 Southridge Drive
P.O. Box 176
Jefferson City, Missouri 65102

Wisconsin:
Mr. Jeff Dean
State Historic Preservation Officer
Historic Preservation Division
State Historical Society of Wisconsin
816 State Street
Madison, Wisconsin 53706

Minnesota:
Dr. Nina Archabal
State Historic Prservation Officer
Director, Minnesota Historical Society
690 Cedar Street
St. Paul, Minnesota 55101

Mr. Don L. Klima
Director, Eastern Office of Project Review
Advisory Council on Historic Preservation
The Old Post Office Building
1100 Pennsylvania Avenue, NW., #809
Washington, DC 20004

September 26, 1990
Vanderjack/PD-E/6385

UPPER MISSISSIPPI RIVER NAVIGATION
RECONNAISSANCE PHASE STUDY
(ALTERNATIVES)

1. Preliminary evaluations of historic and current traffic on the UMRS indicate major navigation constraints on the system. Based on future traffic projections the constraints (delays) at several of the system's locks will only get worse. In order to evaluate elimination of constraints this reconnaissance study will primarily evaluate an alternative of new 1200-foot x 110-foot lock chambers at Locks and Dams No. 20, 21, 22, 24 and 25 to relieve the most severe constraints on the system. The evaluation of such an alternative will determine the engineering, environmental and economic viability, thereby establishing if a Federal interest exists and if further and more detailed studies (feasibility) are needed.

2. If feasibility studies are recommended as a result of this Reconnaissance Report, these studies would begin with a formulation of potential navigation improvements at specific lock sites and the respective pool. Therefore, this Reconnaissance Report will only include identification and brief discussions of structural and non-structural navigation improvements. Attached please find a listing of these potential improvements.

September 26, 1990
Vanderjack/PD-E/6385

MISSISSIPPI RIVER NAVIGATION STUDIES
RECONNAISSANCE PHASE

IMPROVEMENT MEASURES DISCUSSED IN THE RECONNAISSANCE REPORT THAT MAY BE CONSIDERED IN A FEASIBILITY STUDY

Major Structural Improvements:

A. Replacement of locks (600' x 110') and dams at two separate sites by a new lock (1200' x 110') and dam, e.g. LD 24 & 25.
B. New 1200' x 110' lock at existing site, (e.g. LD 20 - LD 25):
   * Lock may be adjacent to existing chamber riverward or landward.
   * Lock may be located somewhere in dam.
C. Extend existing 600' x 110' chamber to a 1200' x 110' chamber.
D. Extend lock chambers smaller than 600' x 110' to at least those dimensions.
E. Waiting areas upstream and downstream of locks for recreational crafts.
F. Completion of the auxiliary chambers at existing locks.
G. Mobile floating dock.
H. Small scale steel or concrete locks.
I. A variety of lifts, carriers and railways for moving recreational craft.

Other Structural and Nonstructural Improvements:

A. Extended guidewalls.
B. Mooring cells.
C. Powered traveling kevels/mooring bits.
D. Helper boats.
E. Additional waiting or passing areas.
F. Approach and channel improvements.
G. Intense dredging program.
H. Traffic management and control systems improvements.

THE STATE HISTORICAL SOCIETY OF WISCONSIN

H. Nicholas Muller III, Director

816 State Street
Madison, Wisconsin 53706
608 262-3266

October 31, 1990

Mr. Dudley M. Hanson, P.E.
Chief, Planning Division, DOA
Rock Island District, Corps of Engineers
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61204-2004

SHSW: 90-0300
RE: Upper Mississippi River Navigation Study

Dear Mr. Hanson:

Thank you for your letter of October 17, 1990 regarding possible navigational improvements on the Upper Mississippi River.

As requested, I am enclosing a current listing of properties included in the National Register of Historic Places in Wisconsin.

The effects of a project such as this on cultural resources would be difficult to predict but they should be directly related to the levels of projected traffic increase on the Upper Mississippi. Based on my understanding of this project, effects on cultural resources could come from the following types of activities.

1) Erosion and other effects caused by increased commercial traffic;
2) Direct and indirect effects of new construction projects;
3) Effects on submerged resources caused by the need for increased dredging; and
4) Effects on upland areas caused by need for additional dredge disposal sites.

If I can provide you with any further information or if you have any questions on this, please contact me at (608)262-3417.

Sincerely,

Richard W. Dexter
Chief, Compliance Section
DIVISION OF HISTORIC PRESERVATION

RWD:da/HANSON.LTR
Enclosure
cc: Valerie de Carlo, ACHP

STATE OF MINNESOTA
DEPARTMENT OF NATURAL RESOURCES

DNR INFORMATION
(612) 296-6157

500 LAFAYETTE ROAD • ST. PAUL, MINNESOTA • 55155-40

November 14, 1990

Colonel Baldwin
St. Paul District, Army Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101-1479

Re: Navigational Reconnaissance Study

Dear Colonel Baldwin:

At the October 11, 1990 Navigation Reconnaissance Study Workshop the Corps of Engineers invited participants to submit written comments for consideration in the drafting of the proposed Navigation Reconnaissance Study Report. The Minnesota Department of Natural Resources (DNR) is providing the following comments in response to your invitation.

It is increasingly evident to DNR employees working with Mississippi River issues that the Corps of Engineers has an "environmental mission", and in recent years, the Corps has moved to a more holistic approach to the management of the Upper Mississippi River Navigation System. We believe that with this holistic approach many of the long term problems and issues confronting the Mississippi River can be satisfactorily resolved.

With the expansion of the Corps' management goals and a 50 year planning horizon for the Navigation Reconnaissance Study, the DNR believes it is appropriate for the Corps to consider the following types of issues in the evaluation of future needs of the Upper Mississippi River System.

This list of issues is not meant to be comprehensive but is intended to illustrate the breadth of thinking that the Corps should be considering for the Navigation Reconnaissance Study. Many of the following ideas may seem futuristic with only a remote possibility of ever coming to fruition. However, many technical innovations thought impossible 50 years ago are widely accepted today, including the widespread use of computers and biogenetic engineering. The Navigation Reconnaissance Study offers a rare opportunity to help determine the future for one of our most valuable natural resource entities. With this opportunity, however, also comes a very real responsibility to assess all the options and alternatives for public good and the good of the environment.

Over the next fifty years, maintenance of the nine foot channel will become increasingly costly due to the continued

AN EQUAL OPPORTUNITY EMPLOYER

input of sediments into the navigation pools from the uplands. Non-point sources of sediment are primarily associated with agricultural activities. Since the agricultural industry is a first order beneficiary of the lock and dam system and is also the largest contributor of sediments, it only seems equitable that the agricultural industry be required to use best management practices to reduce the operation and maintenance costs for the navigation system and protect the integrity of the river's aquatic ecosystem.

Currently, agricultural activities are exempt from Corps of Engineers Clean Water Act 404 authority. The Corps of Engineers could petition Congress for additional 404 authority to expand its permitting activities to include agricultural lands that have the potential to contribute sediment to the navigable waters of the nation. For example, those lands identified by the Soil Conservation Service as highly erodible land could be required to receive a permit from the Corps of Engineers to farm the land. The permit could only be issued once a Soil Conservation Service best management practices plan is approved and in place on the farm.

We recommend that the Study investigate the point at which it is uneconomical and/or physically impossible to maintain the channel. It has been documented in Pool 19 that flood frequencies are increasing because less storage is available in the reservoir. The cost benefit analysis for the Navigation Reconnaissance Study should include the increasing cost of flood damage and protection over time.

We also suggest that the Study attempt to determine the cost of maintaining a viable self-sustaining riverine aquatic ecosystem that will be both politically and publicly acceptable.

At some time, the DNR believes that the Corps must determine when it is no longer feasible or appropriate to continue to enhance and enlarge facilities to accommodate future commercial and recreational use of the riverway. The above suggestions for inclusion in the Study should assist the Corps in deciding when that point might occur and what alternatives exist.

The Corps may not be aware that the Cousteau Society commissioned ecologist H.T. Odum to complete an ecosystem analysis of the Mississippi River. Odum was able to quantify variables and natural resources by using a common unit of measure "Emergy" for his system wide analysis. An Emergy budget was used to assess the current management of the river and may be helpful in the assessment of other management strategies. This document may be helpful in the cost benefit analysis for the Navigation Reconnaissance Report.

To estimate how great the need for commercial navigation may be in the future, it may be useful to examine federal and state farm programs which do and which will continue to influence agricultural production. The federal government

farm program includes the Conservation Reserve Program (CRP) which removes marginal lands from crop production and the Swampbuster/Sodbuster provisions which reduce the number of new tillable acres available to farmers. At the state level, the Reinvest in Minnesota Program (RIM) has removed many acres of marginal lands from crop production. Funding for the RIM program may increase dramatically if some of the state lottery money is earmarked for the program. There is a push by both federal and state governments to change the present farming methods to a more sustainable and less chemically dependent way of farming. With all these governmental programs that may reduce crop production, and the social movement away from non-sustainable agricultural techniques which artificially raised crop production during the "Green Revolution" at a great cost to the environment, transportation needs could be expected to decrease rather than increase. In addition, the continuing crises in oil producing nations, gradual depletion of world oil reserves, mounting environmental concerns over the use of fossil fuels and higher fuel taxes may raise fuel prices to a level that will make the current mechanized and chemically (petroleum-derived) dependent farming methods uneconomical in the future and lower crop production.

It is our understanding that, based on barge industry projections, the Corps expects transportation needs of the system to increase markedly due to an increase in crop production attributable to developments in plant genetics and bioengineering. We are curious if these projections have been independently verified and how these projections relate to the changes in farm practices discussed above. At the present time, we do not understand the Corps conclusion that the demand for barge transportation for crops will dramatically increase over the next fifty years. We believe this issue should be more thoroughly explored in the Study.

If crop production predictions are verified, more information should be provided concerning the share of the projected increase in grain transportation that will be handled by barges. The Study should also indicate what share of the increase will go to other current and future transportation methods.

There may be other transportation methods that could be employed that would be more efficient and more environmentally benign for moving grains. For example, pneumatic pipelines might be feasible, especially if such developments received the federal public works support now afforded the lock and dam system. The same may be true for existing transportation methods such as trucks and trains. Recent developments in super conductance which provide near frictionless tracks for magnetic levitation (maglev) trains might result in a reduction in train transportation energy costs while increasing transport speed.

Energy developments may also influence projections involving commodity transport. Large regionally located fusion power plants or local solar photovoltaic and/or wind powerplants

could displace coal as the dominant electrical energy source and reduce shipping needs. World-wide social and political changes could also influence grain transportation needs. With the ever evolving new world order and economic development, previous importers of grain may become self sufficient or competitors in the export grain market. Within the United States, there is a small but developing grass roots social and political movement that supports bioregionalism. In a societal structure based on bioregionalism, most trading occurs intra-regionally within an established bioregion and the need for large transportation systems are reduced. These issues deserve attention during the development of the Navigation Reconnaissance Study.

The issues and possible future scenarios we have identified may not be probable but are possible, as possible as the development of super-producing plants by geneticists and bioengineers which we understand the Corps believes will contribute to increases in barge traffic. The Navigation Reconnaissance Study must look at all foreseeable future paths of development which may influence the need for structural and non-structural improvements on the Upper Mississippi River Navigation System and the billions of dollars these improvements may cost. The DNR believes it is in the national interest to pursue only long-term infrastructure development plans that are sustainable and environmentally sound.

Thank you for the opportunity to comment on the Navigation Reconnaissance Study. We look forward to our next opportunity to provide comments on the Navigation Reconnaissance Study and possible Feasibility Studies, systemic Environmental Impact Statements, and site specific Environmental Impact Statements associated with any future navigation system improvements.

Sincerely,

Thomas W. Balcom

Thomas W. Balcom, Supervisor
Natural Resources Planning and Review Services

c. Steve Johnson
Doug Norris
Jack Emblom
Mike Davis
Scot Johnson
Robert Welford--U.S. Fish and Wildlife Service

DEERE & COMPANY

JOHN DEERE ROAD MOLINE ILLINOIS 61265 8098 U S A

JOHN S GAULT
Director Production Engineering

21 November 1990

Mr. Dudley M. Hanson, P.E.
Chief, Planning Division
Dept. of the Army, Rock Island District
Corps of Engineers, Clock Tower Bldg.
P.O. Box 2004
Rock Island, IL 61204-2004

Dear Mr. Hanson:

Your letter of 8 November 1990 to Mr. Bill Zessar has been referred to me for comment and reply. While Deere & Company will not have a representative present at the Reconnaissance Resolution Conference on 28 November 1990, we would like to provide our input via this letter.

Currently, Deere & Company operating units (factories) only directly use the Illinois Waterway for transportation of coal for use in our powerhouses. Indirectly, the Waterway provides an economical source of transportation for bulk commodities, such as corn, soybeans and portable fuels. This indirect benefit to Deere & Company is a direct benefit to many of our customers and assists them in being competitive in the world commodity markets. As a result, we support continued maintenance of the infrastructure of the Illinois Waterway and its contiguous waterways. Obviously, the same comments apply to the Mississippi River and its navigational infrastructure.

We would appreciate the opportunity to receive future mailings regarding Midwest navigation systems administered by the Corps of Engineers. Please send correspondence to:

John S. Gault
Director, Production Engineering
Deere & Company
John Deere Road
Moline, IL 61265-8098

JOHN S. GAULT

JSG\A.431

c: Gerry Saylor
Bill Zessar

JOHN ASHCROFT
Governor

G TRACY MEHAN III
Director

STATE OF MISSOURI
DEPARTMENT OF NATURAL RESOURCES

Division of Energy
Division of Environmental Quality
Division of Geology and Land Survey
Division of Management Services
Divisionof Parks, Recreation,
and Historic Preservation

DIVISION OF PARKS, RECREATION, AND HISTORIC PRESERVATION
P.O. Box 176
Jefferson City, MO 65102
314-751-2479

November 26, 1990

Mr. Dudley M. Hansen
Chief, Planning Division
Department of the Army
Rock Island District, Corps of Engineers
P.O. Box 2004
Rock Island, Illinois 61204-2004

RE: Proposed Navigation Improvements (COE), Upper Mississippi River, Missouri

Dear Mr. Hansen:

In response to your letter dated 17 October 1990 concerning the above referenced project, our records indicate that a substantial portion of the proposed project area has never been professionally surveyed for archaeological, histo· .cal, or architectural resources. Since the National Historic Preservation Act (P.L. 89-665, as amended), the Advisory Council on Historic Preservation's regulation 36CFR Part 800, and Executive Order 11593 of 13 May 1971 require identification and evaluation of such cultural resources, it is recommended that such a survey be conducted of all areas not previously evaluated prior to final formulization of project plans or any disruptive activities.

We would appreciate two (2) copies of the cultural resource survey when it is finished so we may complete the review and comment process.

If I can be of further assistance, please write or call 314/751-7860.

Sincerely,

HISTORIC PRESERVATION PROGRAM

Michael S. Weichman
Senior Archaeologist

/mc

c: Kenneth Barr

Printed on recycled paper

Advisory Council On Historic Preservation

The Old Post Office Building
1100 Pennsylvania Avenue, NW, #809
Washington, DC 20004

DEC 12 1990

District Engineer
U.S. Army Engineer District, Rock Island
ATTN: Planning Division - Mr. Kenneth Barr
Clock Tower Building - P.O. Box 2004
Rock Island, Illinois 61204-2004

RE: Future Navigation Improvements
Upper Mississippi River
Iowa, Illinois, Missouri, Wisconsin, and Minnesota

Dear Mr. Barr:

Thank you for the notification of the reconnaisance study for the referenced project.

The scope of the proposed project leads us to believe that Council participation in consultation is appropriate. Accordingly, we would appreciate the opportunity to review relevant project documentation when it becomes available.

The notification included a request for SHPO comments. Please forward to us a copy of these.

If we can provide assistance, please contact Valerie DeCarlo at (202) 786-0505.

Sincerely,

Don L. Klima
Director, Eastern Office
of Project Review

MINNESOTA HISTORICAL SOCIETY
FOUNDED IN 1849 [illegible] St. Paul MN 55111 • (612) 726-1171

December 19, 1990

Dudley M. Hanson
Department of the Army
Rock Island District, Corps of Engineers
Clock Tower Building - P. O. Box 2004
Rock Island, Illinois 61204-2004

Dear Mr. Hanson:

Re: Navigation improvements/survey of lock & dam work on
Upper Mississippi River
MHS Referral File Number: 91-0179

Thank you for consulting this office in regard to the above-referenced matter. It would be little more than speculation for us to comment on what the possible effects on historical properties might be from the various improvement measures. For you information I have included copies of The National Register of Historic Places, Minnesota Checklist, and a printout of known archaeological sites in the counties bordering the Mississippi.

If you have questions regarding this matter, please contact me at the address and telephone number on the letterhead.

Sincerely,

Ted Lofstrom

Ted Lofstrom
Review and Compliance Officer
State Historic Preservation Office

TL:dmb

Enclosures: Checklist, printout of archaeological sites

Illinois Historic
Preservation Agency
Old State Capitol Springfield, Illinois 62701 (217) 782-4836
Suite 4-900 State of Illinois Center 100 W Randolph Chicago, IL 60601 (312) 814-1409

217/785-4997

REGIONAL
Upper Mississippi River Reconnaissance Study

December 31, 1990

Mr. Dudley M. Hanson, P.E.
Chief, Planning Division
District Engineer
U.S. Army Engineer District, Rock Island
Attention: Planning Division
Clock Tower Building - Post Office Box 2004
Rock Island, Illinois 61204-2004

Gentlemen:

Thank you for requesting comments from our office concerning the possible effects of the project referenced above 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 Agency would like to see several issues addressed in the reconnaissance study. It is our understanding that one of the alternatives being considered is the construction of new lock chambers at five locks and dams. It is our concern that Phase I archaeological reconnaissance studies be implemented at those facilities within the State of Illinois.

In addition, the increased commercial traffic on the river will have an impact on the rate of erosion along the banks thus endangering archaeological remains. Riverbank surveys along the river have previously identified numerous archaeological sites. These will have to be identified, evaluated, and protected from additional destruction.

Both of the above issues shold be considered when studies are initiated to address the impact of the navigational improvements on the Upper Mississippi River.

If you have any further questions, please contact Joyce A. Williams, Staff Archaeologist, Illinois Historic Preservation Agency, Old State Capitol, Springfield, Illinois 62701, 217/785-1279.

Sincerely,

Theodore W. Hild
Deputy State Historic
Preservation Officer

TWH:JAW:bb0999A/54

cc: Ken Barr

* U.S. Government Printing Office - 746-036/80001