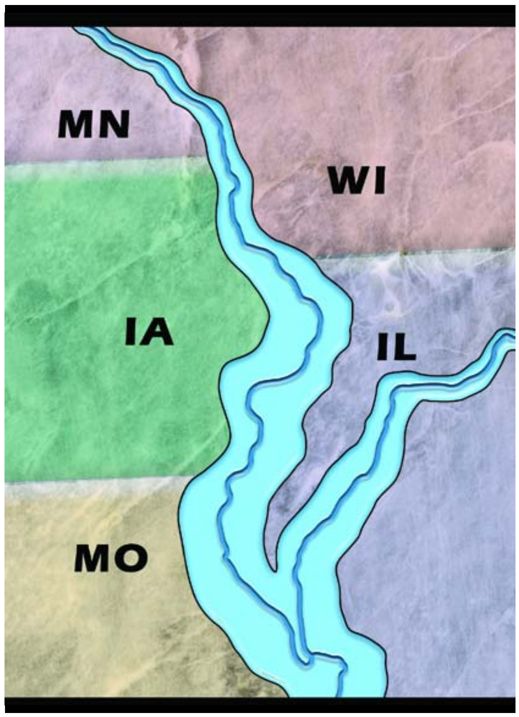
UPPER MISSISSIPPI RIVER COMPREHENSIVE PLAN



APPENDIX A

ENVIRONMENTAL PLANNING AND ANALYSIS

Prepared by the
U.S. Army Corps of Engineers
Rock Island, St. Louis, and St. Paul Districts

March 2008

UPPER MISSISSIPPI RIVER COMPREHENSIVE PLAN

APPENDIX A
ENVIRONMENTAL PLANNING AND ANALYSIS

CONTENTS

TABLES

UPPER MISSISSIPPI RIVER COMPREHENSIVE PLAN

APPENDIX A
ENVIRONMENTAL PLANNING AND ANALYSIS

I. INTRODUCTION

A. Purpose and Scope

The purpose of this appendix is to describe the environmental planning and analysis process as it relates to the Upper Mississippi River Comprehensive Plan (UMRCP) Study.

Planning for this project was conducted using the 1983 Economic and Environmental Principles and Guidelines (P&G) for Water and Related Land Resources Implementation Studies. Under P&G, the objective of Federal water and related resource planning is to "contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements."

B. Study Area

The study authorization (Section 459 of the Water Resources Development Act of 1999) defines the study area as including the Upper Mississippi and Illinois River basins, from Cairo, Illinois, to the headwaters of the Mississippi River. This 118 million-acre region is referred to herein as the UMRS. This system includes 1,100 river miles, with total river floodplain acreage of 2.7 million acres. The distribution of leveed floodplain as a proportion of total floodplain area is approximately:

3 percent north of Pool 13
50 percent from Pool 14 through Pool 26
80 percent downstream of St. Louis, and
60 percent of the lower 160 miles of the Illinois River.

Four UMRCP study reaches were established based on factors of economics and hydraulics. They are:

Reach 1 - extending from the Upper Mississippi River (UMR) Head of Navigation, approximate river mile (RM) 870 to Locks and Dam (L&D) 13, RM 522

Reach 2 - extending on the Mississippi River from L&D 13 to L&D 19, RM 364

Reach 3 - extending from L&D 19 to the Mississippi River open river at Cairo (RM 0), and

Reach 4 - including the Illinois River

C. UMRCP Study Goals and Objectives

The overall goal of the UMRCP study has been "to develop a comprehensive FDR plan supportive of the evolving long-term UMRS goal for economic and environmental sustainability." Specific study objectives include: minimizing health and safety risks, reducing the damages and costs associated with flooding, and identifying environmental opportunities.

It is the intent of this appendix to incorporate habitat, nutrients, and sediments management considerations into a holistic framework that has flood damage reduction as its primary focus. It explores UMRS environmental restoration opportunities that can be effectively coupled with flood damage reduction (FDR) actions. These opportunities strive to consider both the human and the natural environment, and also consider regional long-term data collection, trends analysis, and adaptive management.

D. Environmental Study Constraints

Environmental planning and analysis was based almost entirely on existing data sources. For example, the identification of floodplain biological problems and needs were derived primarily from the UMRS-EMP Long-Term Resource Monitoring Program (LTRMP) and Habitat Needs Assessment (HNA) reports. In instances where there was an absence of actual data, projections relied heavily upon professional judgment.

Another important constraint was that Sec 459 did not provide an authority for co-equal National Economic Development (NED) [Flood Damage Reduction (FDR)] and National Ecosystem Restoration (NER) Federal objectives; rather, the legislation provided for a single-purpose FDR project, with secondary purposes (including environmental) that must be tied to FDR.

E. Definitions

A description of environmental terms of relevance to the UMRCP discussion is included in Environmental Chapter 1 of the supplemental CD. Included are such terms as adaptive management, decision support system, ecosystem, geographic information system, integrated river management, mitigation, models, restoration, and sustainability.

F. Environmental Sustainability Planning Process

1. Environmental Requirements. A detailed description of these requirements, along with Corps Planning Guidance Documents can be found in Environmental Chapter 1 of the supplemental CD.

2. Environmental Operating Principles. In 2002, USACE published a doctrine referred to as the *Environmental Operating Principles and Implementation Guidance* (EOP). The EOP describes ways in which the Corps' missions must be integrated with natural laws, values, and sound environmental practices. This doctrine of seven principles is intended to result in an organizational culture change over time (Corps, 2002a). These principles are: (1) strive towards environmental sustainability, (2) consider program ecosystem impacts, (3) seek a balance/synergy between development and the ecosystem, (4) accept corporate responsibility/accountability for environmental actions, (5) mitigate cumulative impacts and conduct systemic studies, (6) utilize a comprehensive approach, and (7) utilize a collaborative approach.

To the extent consistent with Sec 459, the Corps has applied the EOP during the UMRCP planning process.

3. Historic Perspective on River Management Studies. Comprehensive basin planning has undergone a significant conceptual change during the past 40 years. Initially, it was characterized by a single-resource, single-agency, and non-public interactive focus. Over time a general trend has evolved towards multi-resource considerations, increased interagency collaboration, and an increased recognition of the need for public education and involvement. The tools for managing a river's resources have become increasingly more sophisticated, as reflected by the recent development of the flood flow frequency study and the EMP programs: habitat rehabilitation projects, Long-Term Resource Monitoring Program (LTRMP) and Habitat Needs Assessment (HNA). Key prior studies reflecting the evolving nature of UMRS management are summarized in chronological order in Environmental Chapter 1, Table 4 of the supplemental CD. Some of the more significant studies of the past two decades are described below:

The *Comprehensive Master Plan for the Management of the Upper Mississippi River System* was completed in 1982. This was a truly comprehensive effort from all vantage points: geographic scope, resources considered, degree of collaboration, and degree of public involvement. The study led to Congressional authorization of a 600-foot second lock at L&D 26(R), and it spawned the UMRS-Environmental Management Program (EMP) that today is conducted as a continuing authority program. The effective organizational structure of the Master Plan was subsequently adopted—with minor modifications—for use under the UMRS-EMP.

Sharing the Challenge: Floodplain Management into the 21st Century, often referred to as “the Galloway report,” was released in 1994. As a reaction to the Midwest’s flood of 1993, the U.S. Secretary of Agriculture established a review committee to take a fresh look at Federal floodplain management policies. That committee issued a comprehensive and thorough documentation of flood-related problems and solutions. Among its many recommendations was a call for Environmental Quality (EQ) and NED as co-equal objectives, as well as support for collaborative efforts and cost-sharing in floodplain management at all levels of government. The Corps’ 1995 Report to Congress, entitled *Floodplain Management Assessment* (FPMA,) was conducted in collaboration with four Federal agencies and seven flood-affected states. The report applied the Corps’ planning process to study alternative plans of change in flood insurance, floodplain regulation, flood hazard mitigation, disaster assistance, wetlands restoration, and agricultural support policies. The FPMA report reinforced the findings of the Galloway Report in areas where the Corps is uniquely qualified. A by-product of this effort was the development of the first UMRS systemic hydraulic computer model of floodplain storage parameters. The assessment validated the view that structural flood control measures have limitations, and floodplains are best managed through a combination of structural and non-structural measures that recognize the inherent risk of occupying flood hazard areas.

The *Report to Congress - An Evaluation of the Upper Mississippi River System Environmental Management Program* was completed in 1997. The intent of this report was to provide documentation on the first phase of the program's three major elements: Habitat Rehabilitation and Enhancement Projects (HREPs), Long Term Resources Monitoring (LTRM) and the Computer Inventory and Analysis (CIA). The LTRM and the CIA are jointly referred to as the Long Term Resources Monitoring Program (LTRMP). The program is a state-of-the-art example of ecosystem management theory transformed into reality. Both the HREP and the LTRMP components were well coordinated and yielded highly beneficial results. By 1997, the HREP's had restored, enhanced, and/or protected 97,000 acres of habitat. The first phase of the LTRMP had done much to provide decision makers with the information (computer assisted data gathering, interpretation, and results dissemination) needed to maintain the UMRS as a viable multi-use large river ecosystem. The EMP during this phase was unprecedented in its level of inter-agency collaboration. Congress concurred by establishing the cost-shared EMP as a continuing authority program with periodic status updates.

Published in 1998, a background report to the Report to Congress was released, entitled the *Ecological Status and Trends of the Upper Mississippi River System*. The objective of the report was to compare river health criteria with measured observations and to convey this comparison via gauges that reflect stable, declining, or improving conditions. The trends analysis effort emphasized the need to document environmental trends and to monitor the ecological health as input to river management decisions.

As an EMP phase 2 initiative, a report was released in 2000 entitled *Upper Mississippi River System Habitat Needs Assessment*. Its purpose was to provide the first generation habitat needs assessment (HNA) for the UMRS, with the intent of helping to guide the development of future HREPs. The document serves as a state-of-the-art tool for assessing habitat resource needs on a systemic basis. The tool goes a good distance towards addressing the cumulative effects of HREP projects and other river related activities.

The *UMR-IWW System Navigation Feasibility Study* was initiated in April 1993 to address the potential economic losses to the nation for significant traffic delays at locks on the commercial navigation system between years 2000 and 2050. In 2001, the study was restructured to address the ongoing cumulative effects of navigation, as well as the ecosystem restoration needs, with a goal of attaining an environmentally-sustainable navigation system, in addition to insuring an efficient transportation system for the future. The primary opportunities examined were to reduce or eliminate commercial traffic delays and improve the national and regional economic conditions while restoring, protecting, and enhancing the environment. The goal of the feasibility study was to outline an integrated plan to ensure the UMRS continues to be a nationally treasured ecological resource as well as an efficient national transportation system as designated by Congress in the 1986 Water Resources Development Act (PL 99-662). The draft feasibility study report was released in April 2004. This was the first UMRS systemic study to address the issue of environmental sustainability. Approximately 400 individual actions were identified through the Navigation Study and reviewed for their potential to address Upper Mississippi River-Illinois Waterway (UMR-IWW) environmental objectives. This list of actions was then grouped into 12 overarching categories of restoration measures (USACE 2004, Table A-9), and per project costs and ecological benefits were estimated (USACE 2004).

In spite of prior achievements, a continuing authorization vehicle for a UMRS basin-wide multi-resource river master planning framework—with provisions for periodic updates—still does not exist.

4. Current River Management Perspective. The river management approach that seems to be garnering the most support these days is one that uses an ecosystem-based process that embraces the concepts of both integrated management and adaptive management. The approach is briefly mentioned here, but the reader is referred to Section V. E of this appendix for specific details.

Integrated management on the UMRS involves the application of an interactive, scientific process to collaboratively manage water and floodplain resources. An integrated approach recognizes the complex interactions among the multiple, and often conflicting and competing, uses of the river and associated floodplain (i.e. navigation, agriculture, recreation, and ecological interests). An integrated management approach requires an open management process that includes partners and stakeholders during the planning, decision-making and implementation stages. It requires the application of an interactive, adaptive, and flexible science-based approach to management and decision-making among agencies and entities that have authority in river and floodplain management. This can include multiple Federal agencies, state agencies, and, potentially, county governments and municipalities. Adaptive management, simply stated, is an interactive approach to decision making involving a cycle of planning, implementation, monitoring, research, and subsequent re-examination of decisions, and plans and priorities based on new information.

5. Environmental Planning Assumptions. Key environmental assumptions inherent to the planning of the environmental portion of the UMRCP Study are listed below (see also Chapter 1, *Environmental Planning,* of the CD).

- The UMRCP (per Sec 459) is a single-purpose FDR study. It gives equal consideration, but not equal purpose, to environmental resources.
- The environmental analysis is to be conducted at a generalized programmatic level of detail.
- The primary source of environmental information (per Sec 459) is to be existing data.
- The UMR-IWW System Navigation Feasibility Study is to be used as the basic source of river ecosystem restoration objectives and management actions.
- Due to the broad geographic scope of the study, the environmental benefits analysis is to be based on habitat acres, not habitat units.
- The planning process is to be conducted consistent with ER 1105-2-100.
- The planning process is to be accomplished through interagency collaboration.
- Developing a methodology to integrate Benefit-Cost Ratio considerations both economic and environmental is beyond the scope of the UMRCP study.

6. Six Planning Steps. Consistent with P&G, the environmental planning process consisted of six-basic steps: (1) identify problems and opportunities, (2) inventory and forecast future conditions, (3) formulate alternative plans, (4) evaluate alternative plans, (5) compare alternative plans, and (6) select a recommended plan. The following sections further describe the environmental planning process as it was applied to the UMRCP study.

II. INVENTORY AND FORECAST OF FLOODPLAIN ENVIRONMENTAL CONDITIONS

A. Introduction

Environmental Chapter 1, Attachment B of the supplemental CD provides a qualitative summary of past, present and future (without project) conditions for each of the Upper Mississippi River System's significant floodplain environmental resources. Much of the background information for Attachment B was derived from the UMRS-EMP Long-Term Resource Monitoring Program's Trends Analysis Report (1998).

Consistent with the Navigation Study, the UMRCP has assumed that the baseline environmental project condition (over the next 50 years) is similar to that of the existing resource conditions. In acknowledgement of the fact that many river managers believe that the river will continue to degrade somewhat over time, this assumption may slightly overstate the future without project condition. However, in view of the lack of precise predictive data, and the generalized programmatic nature of the UMRCP study, such a simplifying assumption does not seem unreasonable.

The following is a brief overview of the baseline biological, water quality and sediment resource conditions of the UMRS.

B. Baseline Conditions

1. Biological Resources (Land Cover). Baseline land cover conditions for the UMRCP study area were based on an interpretation of color infrared aerial photography of the UMR floodplain obtained in the year 2000 by the EMP Long-Term Resource Monitoring Program (LTRMP). For the purposes of this study, land cover classes delineated by the LTRMP were consolidated into five basic cover type categories (table A-1):

- water — open water areas
- nonforest — all cover types dominated by non-woody, uncultivated vegetation (e.g., submergent and rooted floating plant beds, deep and shallow marsh, wet meadow, grassland, scrub-shrub), as well as sand bars or mud flats
- forest — all areas dominated by trees
- agriculture — encompasses all cultivated lands
- developed — lands include urban and residential areas, farmsteads and industrial sites

Table A-1. Relationship Between LTRMP Cover Classes and UMRCP Cover Type Categories

LTRMP Cover Classes	UMRCP Cover Type
Open Water (OW)	Water
Submersed Aquatic Bed (SAB)	Nonforest
Floating-Leaved Aquatic Bed (FLAB)	Nonforest
Sand-Mud (SM)	Nonforest
Semi-Permanent Flooded Emergent Perennial (SPFEP)	Nonforest
Semi-Permanent Flooded Emergent Annual (SPFEA)	Nonforest
Seasonally Flooded Emergent Perennial (SFEP)	Nonforest
Seasonally Flooded Emergent Annual (SFEA)	Nonforest
Wet Meadow (WM)	Nonforest
Grassland (G)	Nonforest
Scrub-Shrub (SS)	Nonforest
Salix Community (SC)	Forest
Populus Community (PC)	Forest
Wet Floodplain Forest (WFF)	Forest
Mesic Bottomland Hardwood Forest (MBHF)	Forest
Agriculture (A)	Agriculture
Developed (D)	Developed
No Coverage (NC)	No Coverage

Cover type acreages were determined for both leveed and unleveed areas of the floodplain. Leveed area acreages (table A-2) were compiled by individual levee district, while unleveed acreages (table A-3) were summed for each pool. Acreages by cover type were summed separately by pool and reach for leveed and unleveed areas, and then combined for grand total acreages by pool and reach (table A-4).

Table A-2. Leveed Acreages by Land Cover (5 Classes) in UMRCP Study Area

	Water	Nonforest	Forest	Agriculture	Developed	No Coverage	TOTAL
Reach 1							
Leveed 2	0	51	24	0	266	0	342
Leveed 4	20	18	14	0	133	0	185
Leveed 5	0	1	2	33	46	0	82
Leveed 5A	0	0	0	0	0	0	0
Leveed 6	550	1,085	675	34	3,588	0	5,932
Leveed 7	0	0	0	0	0	0	0
Leveed 8	3	40	14	0	1,345	0	1,402
Leveed 9	0	0	0	0	2	0	2
Leveed 10	0	0	0	0	7	0	7
Leveed 11	19	21	27	0	404	0	471
Leveed 12	53	54	4	0	973	0	1,084
Leveed 13	952	4,534	1,170	1,484	155	0	8,295
Reach 2							
Leveed 14	300	2,241	1,586	12,826	3,316	0	20,269
Leveed 15	12	97	181	16	1,903	0	2,209
Leveed 16	145	412	473	474	1,964	0	3,468
Leveed 17	1,049	4,102	4,446	44,953	4,956	0	59,506
Leveed 18	617	2,668	1,485	42,125	1,459	0	48,354
Leveed 19	737	2,266	1,855	27,631	1,247	0	33,736
Reach 3							
Leveed 20	743	2,457	1,867	51,821	539	0	57,427
Leveed 21	1,029	2,325	626	34,279	1,019	0	39,279
Leveed 22	1,214	4,264	2,215	57,481	1,571	0	66,745
Leveed 24	719	4,661	4,366	55,736	836	0	66,319
Leveed 25	761	5,761	4,160	40,167	597	0	51,445
Leveed 26	444	3,261	1,583	28,671	1,705	0	35,664
Leveed Op1	5,551	21,809	20,698	195,362	51,508	0	294,928
Leveed Op2	1,208	7,082	6,645	39,289	1,954	0	56,178
Reach 4							
Leveed Peoria	140	289	444	2,635	1,488	0	4,996
Leveed LaGrange	2,830	9,382	6,923	98,186	3,766	0	121,087
Leveed Alton	1,226	6,208	3,890	119,971	2,214	0	133,509
Reach Totals							
Leveed Rch1	1,597	5,804	1,930	1,551	6,919	0	17,802
Leveed Rch2	2,860	11,786	10,026	128,025	14,845	0	167,542
Leveed Rch3	11,669	51,619	42,161	502,806	59,729	0	667,985
Leveed Rch4	4,196	15,879	11,257	220,792	7,468	0	259,592
All Leveed	**20,323**	**85,088**	**65,374**	**853,174**	**88,961**	**0**	**1,112,921**

Table A-3. Unleveed Acreages by Land Cover (5 Classes) in UMRCP Study Area

	Water	Nonforest	Forest	Agriculture	Developed	No Coverage	TOTAL
Reach 1							
Unleveed 2	9,185	3,939	5,276	724	4,493	0	23,618
Unleveed 4	32,754	10,839	14,361	5,329	6,545	0	69,828
Unleveed 5	8,593	8,620	5,625	5,589	1,574	0	30,001
Unleveed 5a	3,424	5,459	5,713	1,477	617	0	16,690
Unleveed 6	5,871	6,514	4,868	658	1,496	88	19,495
Unleveed 7	7,202	12,007	8,639	6,947	6,686	0	41,481
Unleveed 8	16,609	12,646	6,653	148	9,547	0	45,603
Unleveed 9	18,497	19,705	12,448	930	577	0	52,157
Unleveed 10	13,698	9,387	10,511	2,391	3,918	0	39,905
Unleveed 11	18,194	4,925	6,965	1,636	1,321	0	33,041
Unleveed 12	9,924	3,943	5,059	318	1,693	0	20,937
Unleveed 13	19,646	17,967	18,037	21,095	4,223	0	80,968
Reach 2							
Unleveed 14	10,020	4,048	9,360	16,664	6,753	0	46,845
Unleveed 15	3,588	283	538	341	4,099	0	8,849
Unleveed 16	12,113	3,447	7,080	2,558	6,126	0	31,324
Unleveed 17	6,987	1,821	5,533	8,791	536	0	23,668
Unleveed 18	14,461	6,930	19,139	37,395	3,239	0	81,164
Unleveed 19	28,307	6,121	13,992	29,832	6,813	0	85,065
Reach 3							
Unleveed 20	8,140	3,356	5,963	8,654	721	0	26,834
Unleveed 21	7,882	1,680	8,572	2,669	709	0	21,512
Unleveed 22	8,402	2,232	7,044	2,955	373	0	21,005
Unleveed 24	10,755	3,658	8,303	1,204	323	0	24,242
Unleveed 25	15,388	3,635	13,428	5,699	575	0	38,724
Unleveed 26	23,057	8,744	22,244	47,963	5,681	0	107,689
Unleveed Open 1	35,970	16,884	38,115	23,509	4,039	0	118,517
Unleveed Open 2	25,807	14,550	36,319	122,688	5,366	0	204,730
Reach 4							
Unleveed Peoria	33,399	12,198	27,745	40,736	14,152	0	128,230
Unleveed LaGrange	25,223	19,522	38,055	23,687	3,809	0	110,296
Unleveed Alton	13,934	9,901	18,378	19,577	1,393	0	63,183
Reach Totals							
Unleveed Reach 1	163,597	115,951	104,155	47,242	42,690	88	473,724
Unleveed Reach 2	75,476	22,650	55,642	95,581	27,566	0	276,915
Unleveed Reach 3	135,400	54,738	139,987	215,341	17,787	0	563,253
Unleveed Reach 4	72,556	41,621	84,178	84,000	19,354	0	301,709
All Unleveed	**447,029**	**234,961**	**383,962**	**442,164**	**107,397**	**88**	**1,615,601**

Table A-4. Total Leveed Acreages by Land Cover (5 Classes) in UMRCP Study Area

	Water	Nonforest	Forest	Agriculture	Developed	No Coverage	TOTAL
Reach 1							
All Pool 2	9,185	3,990	5,301	724	4,759	0	23,960
All Pool 4	32,774	10,857	14,375	5,329	6,678	0	70,013
All Pool 5	8,593	8,621	5,627	5,622	1,620	0	30,083
All Pool 5A	3,424	5,459	5,713	1,477	617	0	16,690
All Pool 6	6,421	7,599	5,543	692	5,084	88	25,427
All Pool 7	7,202	12,007	8,639	6,947	6,686	0	41,481
All Pool 8	16,612	12,686	6,667	148	10,892	0	47,005
All Pool 9	18,497	19,705	12,448	930	579	0	52,159
All Pool 10	13,698	9,387	10,511	2,391	3,925	0	39,912
All Pool 11	18,213	4,946	6,992	1,636	1,725	0	33,512
All Pool 12	9,977	3,997	5,063	318	2,666	0	22,021
All Pool 13	20,598	22,501	19,207	22,579	4,378	0	89,263
Reach 2							
All Pool 14	10,320	6,289	10,946	29,490	10,069	0	67,114
All Pool 15	3,600	381	719	356	6,002	0	11,058
All Pool 16	12,258	3,859	7,553	3,032	8,090	0	34,792
All Pool 17	8,036	5,923	9,979	53,744	5,492	0	83,174
All Pool 18	15,078	9,598	20,624	79,520	4,698	0	129,518
All Pool 19	29,044	8,387	15,847	57,463	8,060	0	118,801
Reach 3							
All Pool 20	8,883	5,813	7,830	60,475	1,260	0	84,261
All Pool 21	8,911	4,005	9,198	36,948	1,728	0	60,791
All Pool 22	9,615	6,496	9,259	60,436	1,944	0	87,750
All Pool 24	11,474	8,319	12,669	56,940	1,159	0	90,561
All Pool 25	16,148	9,395	17,588	45,866	1,172	0	90,169
All Pool 26	23,501	12,005	23,827	76,634	7,386	0	143,353
All Open 1	41,521	38,693	58,813	218,871	55,547	0	413,445
All Open 2	27,015	21,632	42,964	161,977	7,320	0	260,908
Reach 4							
All Peoria	33,539	12,487	28,189	43,371	15,640	0	133,226
All LaGrange	28,053	28,904	44,978	121,873	7,575	0	231,383
All Alton	15,160	16,109	22,268	139,548	3,607	0	196,692
Reach Totals							
All Reach 1	165,194	121,755	106,086	48,793	49,609	88	491,526
All Reach 2	78,336	34,437	65,668	223,605	42,411	0	444,457
All Reach 3	147,069	106,358	182,148	718,147	77,516	0	1,231,238
All Reach 4	76,752	57,500	95,435	304,792	26,822	0	561,301
All Total	**467,352**	**320,050**	**449,337**	**1,295,337**	**196,358**	**88**	**2,728,522**

The supplemental CD Environmental Chapter 1, Attachment F provides a general habitat characterization and prioritization of the Drainage and Levee District (D&LD) areas within the UMRS floodplain. This assessment was conducted using acreage data from the Navigation Study Geographic Information Systems (GIS), hydrologic data from the Flood Flow Frequency study, computer programming, and a scaling-weighting methodology.

2. Threatened and Endangered Species

Federal Species. The Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq) provides for the conservation of threatened and endangered (T&E) species and the ecosystems on which those species rely. A Federal agency must coordinate its proposed actions with the U.S. Fish and Wildlife Service (USFWS) and assess for potential impacts. Where necessary, a Federal agency would develop measures to minimize those impacts if a proposed action could affect threatened or endangered species or their habitat. This would likely be performed through a formal, detailed consultation process. Environmental Chapter 3 of the supplemental CD provides a more detailed description of the Federal T&E topic.

Given the reconnaissance nature of this study, and the fact that specific project construction is not being recommended at this time, full coordination of potential ESA issues was not performed with the USFWS. Consultations with the USFWS, as well as a more detailed evaluation of potential impacts of systemic FDR on T&E species, would need to be undertaken as part of future site-specific feasibility studies. Such a consultation would ensure compliance with Section 7 of the ESA and any applicable State statues concerning the protection of listed species.

The species discussed here (table A-5) are based on those identified for the aforementioned coordination during the Navigation Study. This list is likely representative of the federally-listed species within the study area. The exception may be at the extreme southern extent of the UMRCP project area, which is downstream of the area considered by the Navigation Study. Future coordination with the USFWS would confirm if any additional species would need to be included for this area.

Table A-5. Species Within the UMRS Floodplain Listed as Threatened or Endangered Under the ESA

Common Name	Scientific Name	Federal Status
Decurrent false aster	*Boltonia decurrens*	Threatened
Higgins' eye pearly mussel	*Lampsilis higginsii*	Endangered
Pink mucket pearly mussel	*Lampsilis abrupta*	Endangered (Extirpated)
Winged mapleleaf	*Quadrula fragosa*	Endangered
pocketbook mussel	*Potamilus capax*	Endangered (Extirpated)
Scaleshell mussel	*Leptodea leptodon*	Endangered (Extirpated)
Pallid sturgeon	*Scaphirhynchus albus*	Endangered
Bald eagle	*Haliaeetus leucocephalus*	Threatened
Interior least tern	*Sterna antillarum*	Endangered
Indiana bat	*Myotis sodalis*	Endangered

Decurrent false aster (*Boltonia decurrens*). The decurrent false aster is a federally-listed threatened floodplain species that occurs along a 400 km section of the lower Illinois River and nearby parts of the Mississippi River. *B. decurrens* is an early successional species that requires either natural or human disturbance to create and maintain suitable habitat. Its natural habitat was wet prairies, shallow marshes, and shores of open rivers, creeks, and lakes. In the past, the annual flood/drought cycle of the Illinois River provided the natural disturbance required by this species. The USFWS indicates that the species can be considered to occur anywhere in the Illinois River floodplain downstream of La Salle County, Illinois, and the Mississippi River in Jersey, Madison and St. Clair Counties, Illinois, and St. Charles County, Missouri. It occupies disturbed alluvial soils in the floodplains of these rivers. No critical habitat is listed for this species. Annual spring flooding created open, high-light habitat and reduced competition by killing other less flood-tolerant, early successional species. Field observations indicate that in "weedy" areas without disturbance, the species is eliminated by competition within three to five years.

Higgins' eye pearly mussel (*Lampsilis higginsii*). The Higgins eye pearly mussel was listed as an endangered species by the USFWS on June 14, 1976 (Federal Register, 41 FR 24064). The major reason for the listing of *L. higginsii* was the decrease in both the abundance and range of the species. As stated in the original and the 2003 draft revision to the recovery plan, *L. higginsii* was never abundant, and Coker (1919, as cited in USACE 2004) indicated the species was becoming increasingly rare around the turn of the century. The fact that there were few records of live specimens from the early 1900s until the enactment of the Endangered Species Act in 1973 was a major factor in its listing in 1976. A variety of factors have been listed as affecting *L. higginsii* over time including commercial harvest; impoundment from the project; channel maintenance dredging and disposal activities; changes in water quality from municipal; industrial and agricultural sources; unavailability of appropriate glochidial hosts; exotic species; and disease. There are 10 Essential Habitat Areas identified for Higgins eye pearlymussel:

- the St. Croix River near Interstate
- the St. Croix River at Hudson, WI (RMs 16.2 - 17.6)
- the St. Croix River at Prescott, WI (RMs 0 - 0.2)
- the WI River near Muscoda, WI (Orion)
- the UMR at Whiskey Rock, at Ferryville, WI, Pool 9 (RMs 655.8 - 658.4)
- the UMR at Harpers Slough, Pool 10 (RMs 639.0 - 641.4)
- the UMR Main and East Channel at Prairie du Chien, WI, and Marquette, IA, Pool 10 (RMs 633.4 - 637)
- the UMR at McMillan Island, Pool 10 (RMs 616.4 - 619.1)
- the UMR at Cordova, IL, Pool 14 (RMs 503.0 - 505.5)
- the UMR at Sylvan Slough, Quad Cities, IL, Pool 15 (RMs 485.5 - 486.0)

Winged mapleleaf (*Quadrula fragosa*). The winged mapleleaf is an endangered mussel species of the central United States, federally-listed in 1991. The USFWS acknowledges uncertainty with the taxonomic designation of the winged mapleleaf within its 1997 Recovery Plan; however it believed the winged mapleleaf met the ESA definition of *species* and thus was appropriate for its protection. Studies conducted since 1991 have stated that *Q. fragosa* should be considered a separate species and is genetically distinct from the similar species *Q. quadrula*. In the UMRS, the winged mapleleaf is found only in the St. Croix River.

Pallid sturgeon (*Scaphirhynchus albus.).* Pallid sturgeon, like shovelnose sturgeon, inhabits comparatively large flowing rivers, but pallid sturgeon occur over a narrower range of conditions. In general they prefer greater turbidity, finer substrates, and deeper, wider channels. In addition, they are more likely than shovelnose sturgeon to occur in sinuous reaches and near long-established islands and alluvial bars. The endangered pallid sturgeon (*Scaphirhynchus albus)* occurs in the Missouri River and the Mississippi River downstream from the mouth of the Missouri. The species formerly occurred in the Mississippi River at least as far upstream as Grafton, Illinois. A pallid sturgeon was captured in the tail-water of Melvin Price Locks and Dam in 2000. The USFWS listed four reasons for the decline of the pallid sturgeon: (1) habitat loss, (2) commercial harvest, (3) pollution/contaminants, and (4) hybridization with the shovelnose sturgeon.

Bald eagle (*Haliaeetus leucocephalus).* Now occurring again throughout most of the United States, the bald eagle was first listed as a Federally-endangered species in 1967. In 1995 the eagle was reclassified as threatened in all 48 conterminous states, and in 1999 the USFWS proposed to delist the bald eagle as Federally-endangered in the 48 conterminous states; that proposal remains pending. Meanwhile, the bald eagle also occurs in Alaska and Canada—where it is not at risk and is not protected under the Endangered Species Act—and in small numbers in northern Mexico.

Interior least tern (*Sterna antillarum).* The interior least tern is a federally-listed endangered breeding migratory bird species that occurs in the Missouri River, Arkansas River, Mississippi and Ohio Rivers, Red River, and Rio Grande River systems. The Mississippi Valley Division prepared a Biological Assessment to evaluate the effects of the Regulating Works Feature of the Mississippi River between the Ohio and Missouri Rivers and the Channel Improvement Feature of the Mississippi River and Tributary Project (USACE 1999b, as cited in USACE 2004). That Biological Assessment and the USFWS's Biological Opinion for Operation and Maintenance (O&M) of the 9-foot Navigation Project contain extensive reviews of the life history of the least tern that are hereby incorporated by reference. On the Mississippi River ,the least tern is most abundant on the Lower Mississippi River, below Cairo, Illinois. In the Middle Mississippi River, the species is known to occur between St. Louis and the mouth of the Ohio River. Within this segment of river they are known to nest on Marquette Island (RM 50.5), Bumgard Island (RM 30), and Brown's Bar (RM 23) (Jones 2003, as cited in USACE 2004).

In addition, the St. Louis District recently constructed a least tern nesting island in Pool 26, just above Melvin Price Locks and Dam that is showing promise as a nesting site. The wintering area of the interior least tern is unknown; however, it is believed to be in Central and/or South America (USFWS 1990, as cited in USACE 2004). No critical habitat is listed for this species. The only Mississippi River essential habitat occurs downstream of the proposed project (from Hwy 146 Bridge, Missouri and Illinois, to Vicksburg, Mississippi).

Indiana bat (*Myotis sodalis).* The Indiana bat is an endangered mammal species that has been found in 27 states throughout much of the eastern United States. The USFWS issued a "will likely adversely affect" Biological Opinion for Indiana bats to the Corps for continued O&M of the 9-foot Navigation Channel Project on the Upper Mississippi River in 2000. However, while the project may affect individuals, the impacts will be offset by management actions proposed by the Corps or will be negligible, and will not rise to the level of incidental take (i.e., harm and harassment). Indiana bats are associated with the major cavernous limestone (karsts) regions of the Midwestern and eastern United States. Indiana bats winter in caves or mines that satisfy their highly specific needs for cold (but not freezing) temperatures during hibernation. The fact that Indiana bats congregate and form large aggregations in only a small percentage of known caves suggests that very few caves meet their requirements. Exclusion of Indiana bats from hibernacula by blockage of entrances, gates that do not allow for bat flight or proper air flow, and human disturbance of hibernating bats have been major documented causes of Indiana bat declines.

State Species. States along the UMRS have a number of species identified that fall within their own state classification of endangered or threatened (table A-6). The Navigation Study has recently identified state-listed species that potentially occur within the floodplains of the Mississippi and Illinois Rivers. For full description of this compilation, please see USACE (2004). See Environmental Chapter 4 of the supplemental CD for more detail on state-listed species.

Table A-6. Numbers of Species Listed Threatened and Endangered Species in Each State

	State Studied				
Listed Species	**Wisconsin**	**Minnesota**	**Iowa**	**Illinois**	**Missouri**
Fish	21	21	15	31	52
mussels	18	30	14	27	24
invertebrates	24	49	15	25	62
Mammals	2	15	7	8	11
Birds	26	28	7	34	29
Reptiles/amphibians	10	14	19	22	28
Plants	128	276	147	331	374

3. Water Quality. The Upper Mississippi River Conservation Committee (UMRCC) developed a water quality assessment of the UMR from Anoka, Minnesota (just upstream of the Twin Cities) to the Ohio River. Data were compiled from Federal, State, and local agencies that conducted monitoring on the river over the past two decades (1980-1999). Summer water quality data were provided by six agencies and included more than 5,800 records for the 20-year period. Temporal and spatial (longitudinal) evaluation of 11 water quality parameters was conducted by plotting the entire summer data set by river mile over four, 5-year intervals.

Several of the evaluated parameters exhibited distinct longitudinal profiles and changes over time that appeared to overshadow any potential field or laboratory biases. Nonpoint source inputs from tributary streams, major point source discharges, and river flows were the dominant factors influencing observed longitudinal water quality patterns. In the upper portions of the study reach, wastewater discharges from metropolitan areas have a strong influence on water quality. In the lower study reaches, nonpoint source pollution from large agricultural watersheds, including the Missouri River, contributes to high nutrient and suspended solids concentrations.

Fish contaminant data were compiled from six agencies and one industrial source and included the river reach from Anoka, Minnesota, to Memphis, Tennessee. Most of these data were confined to three separate reaches or areas: Pools 2 through 10, Pool 15, and the open river reach. Carp were the most frequently sampled species due to their suitability for assessing contamination of polychlorinated biphenyls (PCBs) and chlordane. An evaluation of mercury contamination was limited to samples from channel catfish, walleye, and white bass, which typically exhibited higher mercury concentration. Median PCB concentrations in samples were greatest in the upper reach of the UMR, with the highest levels reported in the Pool 2 to 4 reach in the early 1980s. Fish tissue PCB concentrations have decreased noticeably river-wide from the early 1980s to the 1990s. These reduced PCB concentrations likely reflect use restrictions, reduced point source contributions, and reduced nonpoint source inputs associated with soil or sediment cleanup activities. In contrast to PCBs, median chlordane concentrations were highest in carp samples from the lower reaches of the UMR. Chlordane concentrations appear to be decreasing with time, likely as a result of use restrictions and decreased inputs. A systemic assessment of mercury contamination in UMR fish was more difficult due to fewer samples, but as with other assessed contaminants, available data appear to exhibit a declining trend from the l980s to the 1990s.

Measurable reductions in total and un-ionized ammonia nitrogen concentrations and increases in dissolved oxygen (DO) in the 1990s below the Twin Cities have been attributed to point source pollution abatement activities implemented in the 1980s, as well as to more recent widespread infestations of zebra mussels. Nitrate-nitrogen concentrations throughout the river increased to higher levels in the 1990s, compared to concentrations observed during 1985-1989. Environmental Chapter 6 of the supplemental CD provides a more detailed overview of nutrients in the UMR basin.

Elevations within the UMRS drainage basin range from 300 feet above sea level (at Cairo, Illinois) to 1,950 feet above sea level (at Timms Hill, Wisconsin). The average river slope is 0.5 feet per mile. The predominant landform in the basin is flat to irregular plains that are composed of a thick layer of silt (from 3 to 300 feet thick). These plains have been highly modified for crop production, but are highly susceptible to the effects of water induced erosion. Average annual sediment yields are generally many times greater for the southern portion of the basin than the northern portion (USACE, 1969). Small bluff drainage areas in the southern area can have sediment yields several times greater than the regional average. The major source of sediments is sheet erosion, with streambed and bank erosion contributing lesser amounts. As noted on the supplemental CD, Environmental Chapter 7—which is an attempt to modernize the findings of *Appendix G, Fluvial Sediment* of the 1969 Upper Mississippi River Comprehensive Basin Study—provides a more detailed overview of sedimentation in the UMR basin.

III. IDENTIFICATION OF ENVIRONMENTAL PROBLEMS/NEEDS AND OPPORTUNITIES

A. Introduction

Information reviewed by the environmental team for this section, include prior study reports, the minutes of the UMRCP collaboration team (CT) meetings, and the public scoping meetings.

B. Environmental Degradation Overview

Since the early 1800s, the Upper Mississippi River ecosystem has been drastically affected by landscape alterations. These alterations included land use changes (i.e. urban development, agriculture, forestry, and mining); navigation improvements (i.e. locks and dams, dikes, revetments, and dredging); and flood damage reduction improvements (levees, floodwalls, and reservoirs).

Likewise, the Illinois River ecosystem has suffered a series of landscape alterations: Lake Michigan water diversion, floodplain drainage, water pollution, commercial navigation, and accelerated sedimentation. The environmental resource implications of this degradation are more fully described below.

1. Habitat Loss. Based on the findings of the HNA study, six habitat related problems have been identified with relevance to the UMRS floodplain:

River/Floodplain Connectivity. Connectivity between the river and floodplain is important to the functioning of a healthy river ecosystem. Extreme floods rework alluvial deposits on the floodplain, thereby creating new habitats. Floods may have short-term adverse biological impacts, but the long-term effect is generally beneficial. A flood is the major way that exchanges of nutrients, organic matter, and organisms take place between the main channel and lateral floodplain areas. Thus, levees prevent some environmental damages, but they also break an important link of floodplain ecosystem components.

The sequestering of the floodplain with extensive levee protected areas (in both urban and farm areas) has contributed to a less natural floodplain hydrology, and as a physical barrier to fish movement. Fish species are dependent on seasonally flooded areas for successful reproduction, and many require unobstructed routes to sheltered deep-water areas for over wintering.

Fragmentation. Natural habitats are well connected south of Minneapolis to Clinton, IA due to an abundance of public lands. Along the Mississippi River south of Rock Island, IL and along the lower Illinois River these habitats are fragmented due to the more limited extent of public lands and to the presence of an extensive flood protection system (with large-scale conversion of natural habitat to farmland and urban uses). In other reaches, the riparian forest is fairly contiguous, that is, in a narrow band along the longitudinal gradient of the rivers.

Lost Diversity. *Habitat diversity* is defined as a measure of the different types of habitats, their size, and their relative abundance in a defined area. Like habitat fragmentation, habitat diversity has been greatly diminished by the flood protection system. The existing land cover diversity is highest along Minnesota, Wisconsin, and the northern parts of Illinois and Iowa. Pools 1 to 4, 14 to 19, and the Illinois River have moderate diversity, while Pools 1 and 15 are highly urbanized. Pool 18 and Alton Pool are highly agricultural and have incomplete data, while the highly agricultural Pool 20 and southward area has the lowest diversity scores.

Grasslands Loss. Historically, there has been a loss of grassland cover from Iowa to southern Illinois. The amount of this conversion and fragmentation represents the most significant change in many parts of the UMRS. Where farms and development are next to grassland patches, grassland patch connectivity has been highly reduced, and connectivity to other natural habitats has been reduced.

Marsh Loss. Because river marshes were not well mapped in the past, and because, by nature they tend to be fragmented, marsh fragmentation is difficult to assess. Present day marsh communities are less abundant in southern reaches, where few backwaters exist, turbidity is high, and sediment quality is poor. Marsh habitats are more abundant, and widely distributed in northern river reaches.

Forest Loss. Forest is an important component of the floodplain for many species of amphibians, reptiles, birds, and mammals. However, the distribution and species composition of today's forests is different than in the past. In the northern-pooled reach, trees are now more even-aged and lower in species diversity due to water impoundment and development displaced floodplain forests; however, these remaining forests do have a species composition similar to the past. In the southern-pooled reach—the lower Illinois River and the open river south to the Kaskaskia River—open forests and grassland-oak savannas joining dense riparian forests and grasslands were eliminated, but riparian forests remain largely intact. In the open river south of the Kaskaskia River, the floodplain was once almost completely forested, but was later cleared and leveed for crop production.

Resource managers agree that the habitat of the UMRS is currently degraded and may be expected to get worse. The factors responsible for the degradation also suggest some promising directions for ecological restoration. The navigation workshops (described in the next section) identifies the types of ecosystem need emphasis required to achieve broad UMRS restoration objectives. It should be noted that the Navigation Study data also subsumed the data obtained by the 2000 UMRS-EMP Habitat Needs Assessment (HNA) study.

Future information needed to better characterize the river's habitats include: systemic topographic and bathymetric data, substrate type characterization, habitat spatial structure metrics, floodplain inundation models, floodplain geomorphic classification and survey, surveys of existing floodplain plant communities, confirmation/validation of species habitat models, refinement of life history information, refinement of species habitat models, and analysis of seasonal habitat availability.

2. Water Quality Problems. The UMRS water quality has improved in response to a mandated treatment of domestic sewage (USACE, 1998). However, the river still receives a mixture of contaminants from agricultural, industrial, municipal, and residential sources. For example, heavy metals accumulated in riverbed sediments could be a long-term problem for aquatic life, especially in sites downstream of metropolitan areas.

Watershed nutrients and sediments are water quality problems specifically called out in the Sec 459 legislation, and for that reason this report focuses its discussion on those two aspects. The nutrients topic is fully addressed in Environmental Chapter 6, and the sediments topic is addressed in Environmental Chapter 7 of the supplemental CD.

Several factors have contributed to today's significant increase in UMRS nutrients loading. First, the expansion of agriculture resulted in a loss of 26 million acres of wetlands (along with its natural capacity for denitrification) prior to the 1980s. Second, there has been a substantial increase in the application of nitrogen fertilizer to crop fields. Finally, the use of drainage tiles has accelerated the drainage of nitrogen fertilizer containing groundwater from the system.

Nutrients loading has the potential to degrade water quality and aquatic life along the river system per se. Most UMRS states have significant river miles impaired by high nutrient concentrations. Impaired waters are those not fully supporting one or more resource uses, including swimming, fish consumption, aquatic life, and/or drinking water.

In addition, UMRS nutrients loading may be a potential contributing factor to hypoxia in the Gulf of Mexico. There is now a preponderance of scientific evidence (based on sediment records) that shows that low DO levels in the Gulf are primarily the result of excess nutrients from the Mississippi River system in combination with stratification. Studies have shown that fish preys are now less plentiful in hypoxic bottom waters, and there is evidence of a decline in the brown shrimp catch.

The specific linkage between flood control and nutrient control is that floodwaters carry suspended clay and carbon sediment particles, to which nutrients adhere. Upon deposition, these sediment-adsorbed nutrients can be released, causing an excess increase in primary producers, and symptoms of eutrophication (algal blooms, changes in biological oxygen demand, hypoxia, and anoxia).

With or without consideration of the Gulf hypoxia issue, the UMRCP study considers UMRS nutrients loading to be sufficiently important to warrant further consideration.

In addition to basic compliance with Federal environmental laws dealing with water quality, the UMRCP study provides an opportunity to explore FDR compatible methods, such as wetlands restoration, for nitrogen load reduction by denitrification and nitrogen.

Sedimentation is a major socio-economic problem in the UMRS. It has caused portions of the floodplain to fill, thereby decreasing channel conveyance and increasing flooding. It has also caused maintenance problems in reservoirs; blockage of inflow/outflow pipes for water supply facilities and power plants; blockage of the entrances to harbors and marinas; the filling of drainage ditches; increased cost of water treatment; and has aesthetic and structural damages (including erosion at bridges). Sediment can also be a major physical or chemical pollutant. High levels of turbidity can limit the penetration of sunlight into the water column, thereby limiting the growth of plants. Gravel beds covered with fine sediment could also impact upon fish spawning. Metals tend to be highly attracted to ionic exchange sites that are associated with fine clay particles. Iron and manganese coatings commonly found on clay also attract these pollutants. Many of the persistent, bio-accumulating and toxic organic contaminants are strongly associated with sediment.

Federal and state agencies have been reporting for years that decreasing budgets have greatly reduced the amount of sediment monitoring being conducted in the basin. The U.S. Geological Survey (USGS)“sediment program” hasn’t changed significantly in magnitude since the late 1990s. Funding has usually been directed at ongoing sediment problems for only short-term analysis. It has been 20 years since major sediment monitoring of UMRS tributaries was performed. If funding is not reestablished, there will be a large historical data gap that is statistically difficult to overcome.

The 1993 flood showed the value of installing flood-prevention measures and land-treatment practices on watershed agricultural lands. Natural Resource Conservation Service (NRCS) projects prevented many millions of dollars in damages during this flood event, with crop losses less in areas with upland watershed treatment.

An opportunity exists to resample older surveyed sites (e.g. previously surveyed reservoir sites) to determine if sediment transport characteristics have changed and to assess its implications (e.g. on river bed load transport). This would increase the knowledge base and improve future management decisions. In the future, there is a need to employ the use of new remote sensing technologies to measure sediment. As proposed by several national task force committees, there is a need for maintaining and increasing the existing river/stream gage network. To reduce sediments into the UMRS, efforts are needed to reduce overall flow from the watershed, and to restore lower tributary channels so that they transport less sediment to the mouth. Identifying critical reaches, and stabilizing flows, is critical if sediment reduction is to be achieved. Since a large portion of the material can be attributed to bank erosion, measures that restore channel sinuosity and width by means of stabilization, dike contraction, or grade control may be a cost-effective way of reducing UMRS sediment contributions.

IV. UMRS GOALS AND OBJECTIVES

A. UMRCC Ecosystem Management Goals

In 1994, the UMRCC adopted the following ecosystem management goals for use on the UMRS.

(1) maintain viable populations of native species *in situ*
(2) represent all native ecosystem types across their natural range of variation
(3) restore and maintain evolutionary and ecological processes
(4) integrate human use and occupancy within these constraints

In 2000, the UMRCC expanded their list of goals to include:

(1) improve water quality for all uses
(2) reduce erosion and sediment impacts
(3) restore natural floodplain
(4) restore natural hydrology
(5) increase backwater connectivity with main channel
(6) increase side channel, island, shoal, and sand bar habitat
(7) minimize or eliminate dredging impacts
(8) sever pathways for exotic species introductions/dispersal
(9) improve native fish passage at dams

B. UMR-IWW System Navigation Study Ecosystem Management Objectives.

Via workshops, the Navigation Study pursued a collaborative review and refinement of a database of regionally explicit ecosystem objectives. This effort built upon previous objective setting exercises performed under the EMP Habitat Needs Assessment, Pool Plans, UMRCC Reports, USFWS Comprehensive Conservation Plans, Cumulative Effects Study, and related study efforts to develop specific, quantitative, local-to-regional scale environmental objectives for the UMR-IWW. This objective setting exercise resulted in over 2,500 spatially explicit objectives for the condition of the river ecosystem (table A-7). Collectively, these objectives define a desired future condition for the UMRS ecosystem. Subsequent report discussions look at avenues for addressing that desired condition with respect to the floodplain area, and the relationship between this and other complex floodplain and water resource efforts. A more detailed discussion of these issues is contained within Environmental Chapter 2 of the supplemental CD.

The UMRCP has adopted these desired future conditions for its planning effort as well. In addition, CD Environmental Chapter 1 provides a quantification of the reach objectives to the level of the HNA reaches and the navigation pools.

Table A-7. Summary—Number of Environmental Objectives by UMRCP Study Reach

	Study River Reach (Number of Environmental Objectives Identified)				
Objective	**1**	**2**	**3**	**4**	**UMRS Total**
Water Clarity	188	40	79	51	358
Backwater Depth	203	43	81	56	383
Water Level	23	6	5	0	34
Connectivity	71	18	75	27	191
Aquatic Areas	85	40	167	43	335
Terrestrial Areas	317	27	51	54	449
Land Cover/Use	395	54	149	78	676
Plants	0	0	0	3	3
Fish	2	3	1	0	6
Birds	0	0	0	1	1
Other	21	12	69	29	131
Total	**1,305**	**243**	**677**	**342**	**2,567**

V. ENVIRONMENTAL ALTERNATIVES FORMULATION AND EVALUATION

A. Environmental Measures Identification

The same general categories of environmental measures used in the Navigation Study were also applied to the UMRCP study (table A-8). The identification of a more detailed subset of measures was determined by reviewing a number of informational sources, including: the FPMA Report; Galloway Report; National Oceanic & Atmospheric Administration Report; Delft Hydraulics Report; Corps Hydraulics and Hydrology Reports; UMR-IWW System Navigation Study Report; and the EMP and Environmental CAP project reports. Table A-8 includes a sampling of the many types of improvement measures that can be applied to the river's ecosystem. For a more in-depth description of potential environmental measures, the reader is referred to the supplemental CD, Environmental Chapter 1, Attachment C.

B. Environmental Measures Compatible with Flood Damage Reduction (FDR) Measures

No direct evaluation was made of the pros and cons to the various environmental measures per se. The team felt that all of the identified measures could have an appropriate place on the system depending on the nature of site-specific conditions. It was felt that collectively these measures represent a "tool-box" of procedures for future systemic ecosystem restoration. However, early on in the study there was an interest in assessing the environmental utility of the then identified FDR measures for subsequent plans development.

Each FDR measure was rated against various environmental evaluation criteria using a scaling-weighting methodology. That procedure is further described in the CD, Environmental Chapter 1, Attachment D. Based on the total scores, the measures were ranked into one of three priority categories for future study. On this basis, the highest priority FDR measures were determined to be:

- new flood control reservoirs
- small watershed ponds and detentions
- vegetation management to reduce energy loss
- controlled overtopping of levees/structures
- alternative agriculture/flood tolerant crops
- reduced damages via acquisition/buyouts

However, subsequent hydraulics and economics screenings showed only the controlled overtopping option to have merit from an FDR standpoint. Somewhat later in the study, ring levees and highway raises were also judged to have enough economic/hydraulic/environmental merit for inclusion within the plan formulation framework.

C. Systemic Floodplain Ecosystem Restoration Project Opportunities

1. Number of Projects. The UMRCP study conceptually adopted the reach-specific ecosystem management actions (measures) developed by the Navigation Study. However, the primary focus of the UMRCP study has been on the protected floodplain, while that of the Navigation Study has been on the river and its immediate unprotected floodplain. Per the process described in the following paragraphs a determination was made of the general magnitude of the floodplain ecosystem project opportunities applicable to the UMRCP study.

The Navigation Study identified approximately 2,567 site-specific environmental objectives for the UMRS via the workshops process (table A-7). Subsequently, a list of 1,450 environmental project opportunities (table A-9) were identified (referred to as the virtual reference) to address those environmental objectives. Of the 1,450 project opportunities, 1,007 (table A-10) were selected for inclusion in the Navigation Feasibility Study's recommended Ecosystem Restoration Plan (Plan D).

Table A-8. Ecosystem Management Actions

Measure Category	Category Definition	Sample Measures
SC Connectivity	Various methods used to ensure the continued habitat connection and function between the river and its secondary channels	• Secondary Channel Structures • Partial Closures • Channel Dredging
Island Protection	Various methods used to control the detrimental effects resulting from island bank erosion	• Chevron dikes • Riprap
Dike Modification	Modifications to channel regulating structures to enhance habitat diversity	• Notched dikes • Bullnose dikes (around islands) • Log piles • Gravel bars
Island Area	Any means by which new island areas can be created	• Seed islands • Chevron islands • Barrier Islands • Low Islands
Fish Passage	Any means by which fish are permitted to circumvent existing barriers to movement	• Fish ladder • Modified dam gate operation • Riffle-pool by-pass
WLM—Pool	Modifications for water level management on a large scale	• Environmental Pool Management (EPM)
WLM—BW	Modifications for water level management on a small localized scale.	• Water control structures (levees, gated CMPs, pumps, ditches)
FP Connectivity	Modifications directed at restoring the biological relationships between a river and its adjacent floodplain	• Levee removal • Gated structure at levee • Channel Dredging • Backwater Dredging
Topographic Diversity	Modification of the existing ground surface elevations to improve habitat diversity.	• Dredged Material Management Plans • Confined Dredge Material Placement & Tree Plantings • Behind Levee Dredge Material Placement
Depth	Modifications directed at improving water depth diversity	• Dredging • Potholes excavation
Shore Protection	Various methods used to control detrimental effects resulting from bank erosion	• Riprap • Offshore revetments • Biotechnical techniques
Dam Point Control	Modified water level regulation at the navigation dams to provide improved conditions for fish spawning and overwintering habitat and for migratory waterfowl habitat above and beyond that possible utilizing EFM alone.	• Modified Water Control Plan • Dam Gates Automation • Additional Lands Acquisition
FP Immediate Projects	Ecosystem restoration projects in an advanced stage of planning awaiting implementation and funding authority for implementation	• Spunky Bottoms Project • Emiquon Project • Hennepin Project

Table A-9. Summary - Number of Ecosystem Restoration Project Opportunities Identified within UMRS (= Virtual Reference)

	Study River Reach (Number Environmental Objectives Identified)				
Measure	**1**	**2**	**3**	**4**	**UMRS Total**
SC Connectivity	35	20	131	39	225
Island Protection	131	1	10	15	157
Dike Modification	10	6	55	3	74
Island Area	146	6	16	4	172
Fish Passage	14	6	8	5	33
WLM - Pool	14	6	6	0	26
WLM - BW	8	0	1	1	10
FP Connectivity	44	8	31	15	98
Topographic Diversity	16	8	8	0	32
Depth	203	43	81	56	383
Shore Protection	70	31	73	60	234
Dam Point Control	0	1	2	0	3
FP Immediate Projects	0	0	0	3	3
Total	**691**	**136**	**422**	**201**	**1,450**

Table A-10. Summary - Number of Ecosystem Restoration Project Opportunities Addressed by Navigation Study

	Study River Reach (Number Environmental Objectives Identified)				
Measure	**1**	**2**	**3**	**4**	**UMRS Total**
SC Connectivity	31	19	63	34	147
Island Protection	131	1	10	15	157
Dike Modification	9	6	46	3	64
Island Area	65	6	16	4	91
Fish Passage	6	2	5	0	13
WLM—Pool	6	3	3	0	12
WLM—BW	5	0	1	1	7
FP Connectivity	21	6	6	4	37
Topographic Diversity	16	8	8	0	32
Depth	82	31	48	46	207
Shore Protection	70	31	73	60	234
Dam Point Control	0	1	2	0	3
FP Immediate Projects	0	0	0	3	3
Total	**442**	**114**	**281**	**170**	**1,007**

Approximately 443 (1,450-1,007) environmental opportunities were not being addressed by the Navigation Study (table A-11), and of these—approximately 240—are UMRCP floodplain related (table A-12). Generally speaking, the Rock Island and St. Louis Districts regarded each D&LD as representing one environmental project opportunity.

Table A-11. Summary - Number of Ecosystem Restoration Project Opportunities Not Addressed by the Navigation Study

	Study River Reach (Number Environmental Objectives Identified)				
Measure	**1**	**2**	**3**	**4**	**UMRS Total**
SC Connectivity	4	1	68	5	78
Island Protection	0	0	0	0	0
Dike Modification	1	0	9	0	10
Island Area	81	0	0	0	81
Fish Passage	8	4	3	5	20
WLM—Pool	8	3	3	0	14
WLM—BW	3	0	0	0	3
FP Connectivity	23	2	25	11	61
Topographic Diversity	0	0	0	0	0
Depth	121	12	33	10	176
Shore Protection	0	0	0	0	0
Dam Point Control	0	0	0	0	0
FP Immediate Projects	0	0	0	0	0
Total	**249**	**22**	**141**	**31**	**443**

Table 12. Summary - Number of Ecosystem Restoration Project Opportunities Not Addressed by the Navigation Study

	Study River Reach (Number of Environmental Objectives Identified)				
Measure	**1**	**2**	**3**	**4**	**UMRS Total**
WLM—BW	3	0	0	0	3
FP Connectivity	23	2	25	11	61
Depth	121	12	33	10	176
Total	**147**	**14**	**58**	**21**	**240**

2. Acres of Projects. Table A-13 indicates that the average number of acres per Navigation Study-identified floodplain ecosystem restoration (ER) project is 1,295 acres. Accordingly, the total acres for the 239 Navigation Study-identified floodplain project opportunities is of a magnitude of about 309,500 acres. The 309,500 acres can be viewed as representing the 100 percent floodplain ecosystem sustainability level for the UMRS. Table A-13 also displays the 100 percent sustainability level for each individual UMRCP reach. Thetable A-13 acreages will subsequently serve as a point of reference for determining the relative ER performance of the various FDR study plans.

Table A-13. Determination of 100 Percent Environmental Sustainability Level

	UMRCP Study Reach				
Factor	**1**	**2**	**3**	**4**	**UMRS Total**
Unaddressed Floodplain Opportunities Related to UMRCP FDR Study	147	14	58	21	240
Average Acres of Influence Per ER Project Opportunity	1,295	1,295	1,295	1,295	1,295
Total Acres of Influence—All ER Project Opportunities Combined (= 100% Floodplain Sustainability)	190,365	18,130	75,110	25,900	309,505

D. ER Project Opportunities Compatible with FDR Plans

Since FDR is the primary study driver, it was deemed necessary to take a closer look at each alternative FDR plan to further discriminate the potential for ER project opportunities. Also considered was the type of habitat management strategy that might be applied at a given floodplain site; this could ultimately impact the number of manageable habitat acres.

1. FDR Plans. The UMRCP main report provides a description of the systemic FDR alternative plans. The FDR plans range from the purely non-structural to the purely structural, with many plans reflecting a combination of those two elements.

2. Habitat Management Strategies. Four different options for floodplain ecosystem management were evaluated against each of the FDR alternative plans. These options are described in table A-14.

Table A-14. Description of Ecosystem Restoration Options

Option	Description
1 No Action	No additional expenditure of Federal funds via the UMRCP for the management of UMRS floodplain habitat development.
2 Conservation Easements Acquired in Conjunction with Plan Flowage Easements	Under this option, a payment for residual property rights on FDR flowage easement lands would be offered to landowners (on a voluntary basis) as conservation easements for future fish and wildlife management purposes. The conservation easement cost would be equivalent to the difference between fee simple acquisition costs and the costs of flowage easements. This option would encourage enhanced Federal funding to support the management of existing state and Federal conservation programs (e.g. the CRP, CREP, WRP, EMP programs, etc.). It is assumed that the eligible locations could be approximated by determining those leveed areas that would have less than a 100-yr level of flood protection (with a UMRCP project in place), and those sites that would require flowage easements. The acreage opportunities available would be directly proportional to the amount of landowner interest in the program. Lands under conservation easements would be enhanced using a wide variety of available habitat improvement methods. For example, fisheries management might include backwater channel dredging, the incorporation of woody debris, or the placement of rock and gravel within aquatic areas to serve as aquatic habitat structures. Wildlife management might include the placement of bird nesting structures, the protection of special habitat areas, the enhancement of habitat corridors, the planting of prairie vegetation, the planting of trees on dredged disposal material sites, the creation of a mix of successional stages, exotic species control, and water level management.
3 Buyouts	Under this option, lands included as FDR buyouts would meet two key criteria: (1) the cost of levee improvements for a given D&LD would have to exceed the value of the land protected, and (2) leveed areas must be less than 10% urbanized. The same site development measures described for Option 2 would be applied here as well. Areas of high physical diversity and areas in close vicinity to existing Federal refuges and state management areas would receive a high priority for future study. Federal and state conservation agencies would manage the lands similar to the Corps' current General Plan lands leased out to the agencies under a cooperative agreement. This option addresses a more literal interpretation of the WRDA '99 language that states "FDR and floodplain management by means of…habitat management…"
4 Conservation Easements on Lands adjacent to Levees Construction	This measure is similar to Option 2. However, since no flowage easements would be involved, obtaining conservation interests landward of the levees would be tantamount to the cost of a fee simple acquisition. Areas of high physical diversity, and areas in close vicinity to existing Federal refuges and state management areas would receive a high priority for future study.

3. ER Locational Opportunities. To better define the location of FDR related opportunities, the following procedure was used: For each study plan, the hydraulics group established an effective configuration of FDR features. Based on the tentative assumption that these systemic plans were cost justified for implementation, compatible plan-specific ER project location opportunities were identified.

Under a given plan, an ER opportunity was based on an affirmative response to the questions in table A-15. CD Chapter 2 lays out this process and its outcome in more detail. Not all management options were applicable to all FDR plans: table A-16 shows the relationship between the management options and the FDR plans.

It is important to note that the site locations portrayed in CD Environmental Chapter 2 are for general planning purposes only. This approach represents an order of magnitude for a given plan's ER potential and is not intended to be an actual selection of specific sites for ecosystem projects. To achieve that degree of specificity would require the future development and testing of a UMRS region-wide Ecosystem Functions Model (EFM) for sites evaluation and prioritization.

Table A-15. Questions Applied to Determine Ecosystem Restoration Locational Opportunities

Option	Question [1]
1	• No applicable questions
2	• With a project in place, will the location have less than a 100-Yr level of protection? (Y/N) • Does the location require flowage easements? (Y/N)
3	• Does the cost of levee improvements at the location exceed the value of the lands protected? (Y/N) • Is the land use at the location less than 10 percent urban ? (Y/N)
4	• With a project in place, will the location have less than a 100-Yr level of protection? (Y/N) • Would the location be without flowage easements? (Y/N) • Would there be a levee raise at the location ? (Y/N)

[1] An affirmative response to all option criteria yields an ER locational opportunity for a given alternative plan

Table 16. Plans Quantified for Specific Types of Impacts

Plan	Mitigation	Secondary Development	ER Opportunities	Nutrients	Sediments
No Action	Y	Y	Y	Y	Y
A	N	N	N	N	N
B	Y	Y	Y	Y	Y
C	N	N	N	N	N
D	Y	Y	Y	Y	Y
E	Y	Y	Y	Y	Y
F	Y	N	N	N	N
G	N	N	N	N	N
H	Y	Y	Y	Y	Y
I	N	Y	Y	Y	N
J	N	Y	Y	Y	Y
K	N	N	N	N	N
L	N	N	N	N	N

E. Other Management Considerations

1. Adaptive Approach. A central part of the ecosystem management recommendations from the Navigation Study is the concept of adaptive management. Some have suggested that this approach might also have potential application to the UMRCP. Because so many systemic components are intrinsically linked, this approach assumes that the implementation of any ecosystem restoration alternative needs to be done in the context of a comprehensive and integrated plan for river management.

It further assumes that making decisions to address and resolve a complex assortment of ecological needs and objectives within the UMRS should be conducted in the context of a long-term commitment to a policy of adaptive management. Adaptive management being a process that seeks to aggressively use management intervention as a tool to strategically probe the functioning of an ecosystem. In that context, management measures are designed to test key hypotheses about the structure and functioning of the ecosystem. This approach is very different from a typical "informed trial-and-error" method which uses the best available knowledge to generate a risk-averse, "best guess" management strategy, which is then changed as new information modifies the "best guess." Adaptive management identifies uncertainties, and then establishes methodologies to test hypotheses concerning those uncertainties. It uses management actions as tools to not only change the system, but as tools to learn about the system.

There are several elements both scientific and social that are vital components of adaptive management:

- Management is linked to appropriate temporal and spatial scales.
- Management retains a focus on statistical power and controls.
- Use of computer models to achieve ecological consensus.
- Use embodied ecological consensus to evaluate strategic alternatives.
- Communicate alternatives to stakeholders for negotiation of a selection.

The success of an adaptive management approach would require an open management process that seeks to include partners and stakeholders during the planning and implementation stages. Consequently, adaptive management must be a social as well as a scientific process. It must focus on the development of new institutions and institutional strategies just as much as it must focus upon scientific hypotheses and experimental frameworks. Adaptive management attempts to use a scientific approach, accompanied by collegial hypotheses testing to build understanding, but this process also aims to enhance institutional flexibility and encourage the formation of the new institutions that are required to use this understanding on a day-to-day basis.

One of the important benefits of adaptive management is the development of an iterative and flexible approach to management and decision-making. This iterative approach emphasizes the fact that management actions can be viewed as experimental manipulations of the system of interest. The results of the manipulations can be monitored and future management decisions can be informed by the outcomes of previous decisions. Another important benefit lies in the opportunity for scientists and managers to collaborate in the design of novel and imaginative solutions to the challenges of managing complex and incompletely understood ecological systems. Alternative management actions can be stated as hypotheses and addressed from the perspectives of rigorous experimental design and decision analysis. The probable (possible) outcomes of management alternatives and the values of such outcomes can be estimated in relation to management goals and objectives. The adaptive approach recognizes that uncertainty is unavoidable in managing large-scale ecological systems. Importantly, uncertainty can be analyzed and exploited to identify key gaps in information and understanding. The results of such analyses of uncertainty can be used to efficiently allocate limited management resources to new research or monitoring programs.

2. Institutional Arrangements for Adaptive Management. Integration of Federal river management activities is essential to achieve a sustainable system. A number of institutions currently are involved in management of the UMR, including Federal and State agencies, non-governmental organizations, and the public. A conceptual model of institutional arrangements is currently under development as a potential transitional stage of the Navigation Study (USACE 2005). Although not final, this model provides an idea of what new institutional arrangements might be possible in the future.

The conceptual model of institutional arrangements is based on the framework necessary to support integrated, adaptive management. The framework comprises the River Managers Teams (RMTs), the River Managers Council (RMC), and a Science Panel. In addition, a Federal Principals Group at the national level, a Regional Principals Group of Federal agencies at the regional level, and the Upper Mississippi River Basin Association (UMRBA) provide oversight on UMRS activities.

The draft concept calls for an RMC, comprised of 19 member organizations, with a total of 26 representatives. The RMC would provide a means for government agencies and other stakeholders to work together in managing the UMRS at the system level, including agreement on vision, goals, and objectives for integrated adaptive river management. A Communications Panel would help in the implementation of a communication strategy, and with the solicitation of public input on river management issues. This Panel would be a sub-group under the RMC.

Such a concept would call for the Environmental Management Program Coordinating Committee (EMPCC) to transition to the RMC. The scope of EMPCC would expand to support integrated management. This would require the RMC to operate at a more systemic level than that at which the EMPCC is currently operating.

The RMTs would be the existing River Resources Forum (RRF), River Resources Coordinating Team (RRCT), and River Resources Action Team (RRAT) aligned with the St. Paul, Rock Island, and St. Louis Corps Districts, respectively. The RMT would provide a means for government agencies and other stakeholders to work together in managing operation, maintenance, and restoration of the UMRS at the reach and specific project levels.

The Science Panel would provide scientific expertise in support of adaptive management of the UMRS to the RMC and RMTs. The panel would not be a decision-making body and is not intended to provide independent technical review.

Outcomes of both the RMC and the RMTs would need to be syntheses of positions concerning integrated, adaptive management of the UMRS, which would provide all members and other stakeholders a better sense of how to manage their programs and initiatives toward achievement of the shared vision, goals, and objectives of the UMRS, while meeting their program and mission responsibilities.

3. Integration of the UMRCP into an Adaptive Management Approach. The above described arrangements are based largely on discussions from the aforementioned Navigation Study. Such an effort would develop some form of adaptive management. It has been suggested that the UMRCP could somehow be included somehow within this global, UMRS adaptive management approach. This inclusion could provide both environmental benefits, as well as economic benefits. The adaptive management approach provides stakeholders with the flexibility to improve, monitor, and adjust the collection of individually authorized flood control projects to perform as one river-wide flood damage reduction system, without compromising evolving economic and ecological sustainability goals. If successfully implemented, adaptive management should provide consensus on a structured process toward long-range goals, rather than a plan of fixed strategies based solely on the knowledge available at the time a planning or decision document was prepared.

F. Environmental Impacts Evaluations

1. General Evaluation. A general assessment of the environmental impacts of the alternative study plans using scaled values is provided by the table A-17 matrix. The supporting rationale for the matrix can be found in CD Chapter 1.

This assessment discusses the general systemic effects of various alternative systemic plans for flood damage reduction (FDR) upon social, economic and environmental resources within the UMRS. These systemic effects are being addressed from a broad, general perspective. Such an approach is appropriate given the programmatic level of study, and the fact that, at this time, none of the evaluated systemic plans has an identified Federal interest. Should any alternative be recommended for further consideration, a much more detailed impact assessment would be warranted, in accordance with the provisions of the National Environmental Policy Act (NEPA) and other applicable environmental statutes.

The effects of systemic plans A through L were assessed through a scoring process within a matrix. Alternative plans were listed against a range of social, economic and environmental resources of concern within the UMRS. The potential effects of each alternative for a given resource were used to populate the matrix. For this exercise, the magnitude of the effect was estimated as the change between the future with and without plan condition. Effects were scored on the following scale:

+3	major beneficial environmental impacts might be expected
+2	moderate beneficial environmental impacts might be expected
+1	minor beneficial environmental impacts might be expected
0	no appreciable environmental impacts might be expected
-1	minor adverse environmental impacts might be expected
-2	moderate adverse environmental impacts might be expected
-3	major adverse environmental impacts might be expected

Table A-17. Magnitude of Probable Environmental Impacts Associated with Implementation of Alternative Plans

	Social Effects										**Economic Effects**										**Environmental Effects**											
Plan	**Noise Levels**	**Aesthetic Values**	**Recreational Opportunities**	**Public Health and Safety**	**Transportation**	**Community Cohesion**	**Community Growth and Development**	**Business and Home Relocations**	**Existing/Potential Land Use**	**Controversy**	**Property Values**	**Tax Revenues**	**Public Facilities and Services**	**Regional Growth**	**Employment**	**Business Activity**	**Farmland/Food Supply**	**Commercial Navigation**	**Energy Needs and Resources**	**Flooding**	**Air Quality**	**Terrestrial Habitat**	**Wetlands**	**Aquatic Habitat**	**Habitat Diversity and Interspersion**	**Biological Productivity**	**Quality of Surface Water**	**Water Supply**	**Groundwater**	**Soils**	**Threatened or Endangered Species**	**Architectural/Archaeological Values**
NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A	0	-2	0	+1	+3	+1	+3	+2	+3	-3	+2	+2	+1	+2	+1	+2	+1	0	0	+1	0	-2	-2	0	0	-2	-1	0	-2	-3	-1	0
B	0	-1	0	+2	+3	+1	+1	+1	+2	-3	+2	+2	+1	+2	+1	+2	+1	0	0	+1	0	-1	-1	0	0	-1	-1	0	-2	-3	-1	-1
C	0	-1	0	+2	+2	+1	+1	+1	+2	-2	+2	+2	+1	+2	+1	+2	+1	0	0	+1	0	-1	-1	0	0	-1	0	0	0	-2	0	-1
D	0	-1	0	+2	+1	+1	+1	+1	+2	-1	+2	+2	+1	+2	+1	+2	+1	0	0	+1	0	-1	-1	0	0	-1	0	0	0	-1	0	-1
E	0	-1	0	+2	0	+1	+1	+1	+1	-1	+2	+2	+1	+1	+1	+1	+1	0	0	+1	0	-1	-1	0	0	-1	0	0	0	-1	0	-1
F	0	-1	0	+2	+2	+1	+1	+1	+1	0	+2	+2	+1	+1	+1	+1	+1	0	0	+1	0	-1	-1	0	0	-1	0	0	0	0	0	-1
G	0	-1	0	+2	+3	+1	+1	+1	+3	-3	+2	+2	+1	+2	+1	+2	+1	0	0	+1	0	-1	-1	0	0	-1	-1	0	-2	-3	-1	-1
H	0	0	+1	+2	+2	0	+1	-2	0	-2	+2	+2	+1	+2	+1	+2	+1	0	0	+1	0	+1	+1	+1	+1	+1	+1	0	+1	+1	+1	-1
I	0	+1	0	+2	0	-2	-3	-2	-2	-2	-3	-3	-2	-3	-3	-3	0	0	-1	+1	0	+1	+1	0	0	+1	+1	0	0	+1	0	-2
J	0	+2	+1	+3	0	0	-3	-3	-3	-3	-2	-2	-2	-3	-3	-3	-1	0	-1	+1	0	+3	+3	+2	+2	+3	+2	0	+2	+3	+2	-1
K	0	0	0	+2	+3	0	0	0	0	0	+2	+2	+1	+2	+1	+2	+1	0	0	+1	0	0	0	+1	0	0	+1	0	0	0	0	0
L	0	0	0	+1	+2	0	0	0	0	0	+1	+1	+1	+1	+1	+1	+1	0	0	+1	0	0	0	0	0	0	0	0	0	0	0	0

RATINGS CODE:

+3 Major beneficial environmental impacts likely
+2 Moderate beneficial
+1 Minor beneficial
0 Not appreciable

1 Minor adverse
2 Moderate adverse
3 Major adverse

The level of effect was largely determined by professional judgment following review of the proposed alternative and likely resulting effects. For discussion of economic resources, much of the impact discussion is based on the Regional Economic Development analysis prepared by the Tennessee Valley Authority (TVA) for the UMR-IWW Navigation Study. However, it should be noted that this discussion of economic effects is general in nature, and does not in any way supercede the more detailed economic analyses performed to evaluate FDR economic effectiveness. For this discussion please see the Main Report, Section 2.

In general, these assessments of potential effects are highly speculative and greatly dependent on site-specific conditions. The effort here is only a first attempt at identifying potential impact areas that might be of concern should any alternatives be considered for further study. Further review and documentation of site-specific conditions and potential impacts would be required for any future project. Rationale for the effects score associated with each resource category is summarized below.

For Social Resources, the majority of alternatives would have some form of beneficial effect except I and J, which would frequently have adverse social effects. However, several alternatives also have a wide range of social effects, with major beneficial effects as well major adverse effects to certain social resource issues. Almost all alternatives could be controversial, either due to associated costs, resulting potential benefits, and/or potential effects to flood heights or environmental resources.

For Economic Resources, the majority of alternatives would most frequently have some form of beneficial effects that range from 0 to +3. It should be noted that many of these adverse and beneficial effects are minor and/or locally based. Economic benefit-to-cost value of systemic FDR is quite low, and no alternative was found to have a Federal interest. See the Main Report, Section 2 for a detailed discussion of the economic analysis performed to evaluate FDR alternatives. As with Social Resources, alternatives I and J would frequently have adverse economic effects. However, these two alternatives also would have a minor beneficial effect on flooding.

For Environmental Resources, disturbance mechanisms resulting from implementation of systemic FDR measures that have the potential to adversely affect floodplain biota (including any threatened or endangered species within the project footprint). Potential impacts include, but are not limited to, dredging for construction materials and it's associated impacts, direct burial of biota during construction, vegetative clearing, changes in soil and drainage characteristics, fragmentation of habitat, reduced floodplain connectivity, and changes in river hydraulic and flow patterns. Secondary impacts from improved FDR measures also may result and could be significant. These secondary impacts may be more difficult to predict, but would need to be fully considered within any future site-specific FDR analysis.

Potential impacts to the Higgins'eye pearlymussel include dredging and direct burial, sediment resuspension during construction; with long-term impacts potentially occurring through alteration of current and flow patterns. However, since most construction would likely occur downstream of existing Higgins' eye populations, and because levee footprints would usually not occur within aquatic areas, the likelihood of substantial adverse impacts to Higgins eye would be low.

Potential impacts to the pallid sturgeon include dredging entrainment and sediment resuspension; with long-term impacts potentially occurring through reduction of lateral connectivity and alteration of current and flow patterns. However, most levee creation/expansion would not occur immediately within aquatic areas, so the likelihood of substantial adverse impacts to pallid sturgeon through construction activities, alternations in flow patterns or reduced connectivity would probably be low.

Potential construction impacts to the Indiana bat include displacement or disruption of normal feeding, resting or reproductive activities. Long-term impacts could include permanent changes in land cover, separation, fragmentation or reduction of habitats. Some forest clearing may be necessary should many of these alternatives be considered further. Therefore, impacts to the Indiana bat may be possible, and any future project would need careful coordination with the USFWS to ensure compliance with ESA.

Potential construction impacts to the bald eagle include displacement or disruption of normal feeding, resting or reproductive activities. Long-term impacts could include permanent changes in land cover, separation, fragmentation or reduction of habitats. Some forest clearing may be necessary should many of these alternatives be considered further. Therefore, impacts to bald eagles may be possible, and any future project would need careful coordination with the USFWS to ensure compliance with ESA.

Potential construction impacts to interior least tern include displacement or disruption of normal feeding, resting or reproductive activities. Long-term impacts could include permanent changes to habitat as a result of altered hydraulic conditions, though these may be limited. Impacts would probably be limited to more floodplain areas, with less influence on river islands that are important tern habitat.

Potential construction impacts to decurrent false aster include covering of existing communities. Implementation of FDR measures also could influence the microhabitat conditions such as soil, elevation and moisture conditions important to the species. It also could affect disturbance mechanisms, such as flooding, that are important for this species. Several FDR measures can, themselves, create disturbance. It is uncertain how this anthropogenic disturbance may have short- or long-term effects (either adversely or beneficially) on decurrent false aster. Any future project would need careful review to identify potential effects. This would include thorough coordination with the USFWS to ensure compliance with ESA.

For systemic environmental effects, alternatives A through H would most frequently have some form of adverse effect to environmental resources. These impacts would typically be footprint impacts from levee expansion and could impact various floodplain terrestrial and wetland habitat. Aquatic habitat would probably be less affected. In general, most adverse effects related to construction would likely be minor in nature, relative to future-without project conditions. Only alternatives A, B, C and G would be anticipated to have any adverse environmental impacts categorized as either moderate or major. However, any potential for moderate or major adverse effects would need to be considered further for all alternatives within any detailed, feasibility-level planning effort for the identified alternatives. Furthermore, because environmental impacts can be highly site-specific any future individual project would need to further review its potential contribution to either adverse or beneficial effects.

In contrast to the adverse environmental impacts noted above, alternatives H and especially I would frequently have beneficial environmental effects to various aquatic, terrestrial and wetland habitats. These benefits would be due to floodplain restoration that could potentially occur within areas of where levees have been removed and/or structures have been removed from the floodplain. Lastly, alternatives K and L would likely have few beneficial or adverse effects to environmental resources.

2. Mitigation. Of necessity, the current study investigation has been conducted at a conceptual level of detail. Because no systemic FDR plan with a potential Federal interest was identified during the planning process, a detailed assessment of potential NER benefits and costs necessary to achieve those benefits was not conducted. Accordingly, at this preliminary level of planning, the variability with respect to potential environmental impacts and mitigation requirements is primarily that inherent in the overall impact differences associated with the various alternative FDR plans.

To obtain a gross indication of the magnitude of mitigation required for direct (construction-related) impacts under each systemic alternative, the environmental team determined the total footprint of each plan using the engineering design figures generated for those plans. Using GIS, a rough estimate was made of the existing habitat types affected by each alternative plan. Next, the total impacted acreage of open water, non-forested, and forested habitat for each plan was then multiplied against a generic mitigation cost per restored floodplain acre. This general approach to the mitigation analysis was presented at the April 23, 2004 CT meeting, with no major objections expressed.

Table A-18 summarizes the acreage and cost related impacts of implementing alternative Plans B, D, E, F and H.

3. Secondary Development. By far, the most significant potential impact of the FDR systemic plans relates to induced secondary development. This is especially true in areas with minimal existing flood protection. Adverse effects of increased development include: water pollution from storm runoff, increased urban flooding from increased permeable surfaces, increased damages from floods overtopping levees, and a demand for even more structural measures. In recognition of this problem, Executive Order 11988 discourages Federal actions that act as an inducement to future floodplain development--unless there is no reasonable alternative. While the Corps does not require compensatory mitigation for unavoidable secondary development effects; the minimization of such effects is an important planning priority.

The approach to the assessment of secondary development was to document the amount of plan lands that would be at or above a 100-year level of protection with a project plan in place (i.e. likely to be within the regulated floodplain) and available for potential development. In addition (as supplemental information), Environmental Chapter 5 looks at the proximity of those lands relative to two potential specific development catalysts—existing river highway bridge crossings, and existing major urban areas.

The results of the secondary development analysis for Plans B, C, D, E, H, I and J are displayed in table A-19.

4. Ecosystem Restoration Opportunities. Similar to the mitigation discussion, the environmental team determined that the use of an incremental cost analysis was inappropriate for a general assessment of habitat restoration opportunities. Alternatively, and similar to what was done in the Navigation Study, restoration opportunities were quantified using the river reach counts for potential ER project opportunities and the potential area of influence for such opportunities.

Table A-18. Mitigation Costs [1]

	Total Impacted Acreage					Cost Per Acre Multiplier	First Costs ($ Thousands)				
Plan	**R1**	**R2**	**R3**	**R4**	**UMRS**		**R1**	**R2**	**R3**	**R4**	**UMRS**
Permanent Easements											
No Action	0	0	0	9	0	5,600	0	0	0	0	0
B	1	323	1,300	1,097	2,721	5,600	6	1,809	7,280	6,143	15,238
D	1	67	1,206	481	1,755	5,600	6	375	6,754	2,694	9,829
E	1	15	840	489	1,345	5,600	6	84	4,704	2,738	7,532
H	1	259	724	256	1,240	5,600	6	1,450	4,054	1,434	6,944

[1] The costs reported here assume that all habitat types impacted would be mitigated. A more detailed (feasibility-level) analysis would document a lower cost figure by computing the costs for impacted native habitat types only.

Table A-19. Secondary Development Potential by Alternative Plan

		Potential Secondary Development Lands **					Potential Secondary Development Lands**		
Plan	**Reach**	**Future w/out Systemic Plan**	**Future w/ Systemic Plan**	**Net Change**	**Plan**	**Reach**	**Future w/out Systemic Plan**	**Future w/ Systemic Plan**	**Net Change**
No Action	R1	562	562	0	**E**	R1	562		
	R2	81,898	81,898	0	No Buyouts	R2	81,898	82,011	-113
	R3	297,085	297,085	0		R3	297,085	297,981	896
	R4	66,798	66,798	0		R4	66,798	66,950	152
	UMRS	446,343	446,343	0		UMRS	446,343	447,504	935
B	R1	562	562	0	**E**	R1	562	562	0
No Buyouts	R2	81,898	143,466	61,568	w/ Buyouts	R2	81,898	82,011	-113
	R3	297,085	486,252	189,167		R3	297,085	297,981	896
	R4	66,798	136,100	69,302		R4	66,798	62,594	4,204
	UMRS	446,343	766,380	320,037		UMRS	446,343	443,148	4,987
B	R1	562	562	0	**H**	R1	562	562	0
w/ Buyouts	R2	81,898	138,458	56,560	Buyouts	R2	81,898	138,458	56,560
	R3	297,085	458,228	161,143		R3	297,085	458,228	161,143
	R4	66,798	64,870	-1,928		R4	66,798	64,870	-1,928
	UMRS	446,343	662,118	215,775		UMRS	446,343	662,118	215,775
D	R1	562	562	0	**I**	R1	562	562	0
No Buyouts	R2	81,898	81,898	0	Buyouts	R2	81,898	80,446	-1,452
	R3	297,085	297,981	896		R3	297,085	292,084	-5,001
	R4	66,798	66,950	152		R4	66,798	64,455	-2,343
	UMRS	446,343	447,391	1048		UMRS	446,343	174,547	-8,776
D	R1	562	562	0	**NS-2**	R1	562	562	0
With Buyouts	R2	81,898	81,898	0	Buyouts	R2	81,898	32,613	-49,285
	R3	297,085	297,981	896		R3	297,085	75,630	-221,455
	R4	66,798	59,681	-7117		R4	66,798	3,210	-63,588
	UMRS	446,343	440,122	-6221		UMRS	446,343	112,015	-334,328

While technically possible to calculate Year 25 and Year 50 ecosystem restoration needs (in addition to baseline needs), for the following reasons this was not considered to be a productive course of action. First, the habitat of the protected floodplain (the primary focus of the UMRCP study) has already been extensively altered for agriculture and will likely change little over the next 50 years. Second, the current investigation is operating at a very gross level of detail, and the funding/effort devoted to refining temporal changes would not likely alter the broad level conclusions/recommendations made by the UMRCP study. Accordingly, for the purposes of this analysis, the future habitat condition without a project was assumed to be essentially the same as that of the existing baseline habitat condition.

The environmental team did not make an estimate of O&M costs. While such an O&M determination is required for reach-specific feasibility analyses, insufficient information on specific O&M requirements exists to develop a meaningful quantification at the programmatic level. In addition, the annual O&M costs for an ER project are typically minor when compared to the annualized construction costs. For example, the Swan Lake EMP project's estimated annual O&M costs were less than 10 percent of the annualized construction costs for that project.

The potential ER managed acres, percent sustainability level achieved, and ER first costs for Plans B, D, E, H, I and J are displayed in table A-20.

5. Nutrients Reduction. The Wetlands Initiative estimated that 38 percent of the lands within the 100-year flood zone represent existing or drained wetlands. The nutrients analysis multiplied that percentage by the number of acres of potential ER managed lands (within levees) under each alternative plan to approximate the potential number of acres of wetland nutrients reduction opportunities.

The potential acres suitable for wetland restoration on the UMRS are displayed in table A-21.

6. Sediments Reduction. The method used in this analysis was to determine the number of tributary feeders entering each of the floodplain D&LDs identified as ER opportunities for each alternative plan in subsection c above. These represent an order of magnitude for the treatment of sedimentation problems affecting the floodplain.

The results of the tributaries analysis are presented in table A-22.

Table A-20. Ecosystem Opportunities - Managed Acres, Sustainability Achieved and First Costs

	PLAN B														
	Potential ER Managed Acres [1]					Percent Sustainability Achieved [1]					ER Total First Costs (Millions)				
	R1	R2	R3	R4	T	R1	R2	R3	R4	T	R1	R2	R3	R4	T
1 No Action	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 Conservation Easements in Conjunction with Plan Flowage Easements	0	0	42,687	396	43,083	0	0	57	2	14	0	0	217	2	219
3 Buyouts	0	5,008	44,441	125,553	175,002	0	28	60	485	57	0	13	116	326	455
4 Conservation Easements on Lands Adjacent to Levee Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	PLAN D														
	Potential ER Managed Acres [1]					Percent Sustainability Achieved [1]					ER Total First Costs (Millions)				
	R1	R2	R3	R4	T	R1	R2	R3	R4	T	R1	R2	R3	R4	T
1 No Action	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 Conservation Easements in Conjunction with Plan Flowage Easements	0	15,392	69,057	47,546	131,995	0	85	92	184	43	0	78	352	242	672
3 Buyouts	0	0	36,139	94503	130,642	0	0	48	364	42	0	0	94	246	340
4 Conservation Easements on Lands Adjacent to Levee Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	PLAN E														
	Potential ER Managed Acres [1]					Percent Sustainability Achieved [1]					ER Total First Costs (Millions)				
	R1	R2	R3	R4	T	R1	R2	R3	R4	T	R1	R2	R3	R4	T
1 No Action	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 Conservation Easements in Conjunction with Plan Flowage Easements	0	3,672	31,117	30,776	65,565	0	20	41	119	21	0	19	159	157	334
3 Buyouts	0	0	42,023	91,866	133,889	0	0	56	355	43	0	0	109	239	348
4 Conservation Easements on Lands Adjacent to Levee Construction	0	2,108	0	1,067	3,175	0	12	0	4	1	0	13	0	7	20

Option 1 Assumes no major land use conversion to native habitat types in the absence of a UMRCP systemic program.
Option 2 Since participation is voluntary under this option, the area of influence would likely be low. It is assumed that most farmers would want to continue their agricultural pursuits except on the most marginal of lands within a given D&LD. Achieving a regional goal of 25% native habitat coverage is here assumed to be an ambitious but potentially achievable goal.
Option 3 Since participation under this option is mandatory, a nearly 100% conversion to native habitat types is assumed as an achievable goal.
Option 4 The area of influence would be similar to that of Option 2, i.e. a maximum of 25% land conversion

[1] Sustainability Level Achieved = Potential ER Managed Acres divided by total reach acres needed (Table 7, row g values) to achieve 100 % sustainability times 100.

Table A-20 (continued). Ecosystem Opportunities - Managed Acres, Sustainability Achieved and First Costs

	PLAN H														
	Potential ER Managed Acres [1]					Percent Sustainability Achieved [1]					ER Total First Costs (Millions)				
	R1	R2	R3	R4	T	R1	R2	R3	R4	T	R1	R2	R3	R4	T
1 No Action	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 Conservation Easements in Conjunction with Plan Flowage Easements	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3 Buyouts	0	5,008	44,441	125,553	175,002	0	28	60	485	57	0	13	116	326	455
4 Conservation Easements on Lands Adjacent to Levee Construction	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

	PLAN I														
	Potential ER Managed Acres [1]					Percent Sustainability Achieved [1]					ER Total First Costs (Millions)				
	R1	R2	R3	R4	T	R1	R2	R3	R4	T	R1	R2	R3	R4	T
1 No Action	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 Conservation Easements in Conjunction with Plan Flowage Easements	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3 Buyouts	0	1,452	5,999	2,340	9,791	0	8	8	9	3	0	4	16	6	25
4 Conservation Easements on Lands Adjacent to Levee Construction	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

	PLAN J														
	Potential ER Managed Acres [1]					Percent Sustainability Achieved [1]					ER Total First Costs (Millions)				
	R1	R2	R3	R4	T	R1	R2	R3	R4	T	R1	R2	R3	R4	T
1 No Action	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 Conservation Easements in Conjunction with Plan Flowage Easements	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3 Buyouts	0	113,401	511,172	183,370	807,943	0	625	681	708	261	0	295	1329	477	261
4 Conservation Easements on Lands Adjacent to Levee Construction	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Option 1 Assumes no major land use conversion to native habitat types in the absence of a UMRCP systemic program.
Option 2 Since participation is voluntary under this option, the area of influence would likely be low. It is assumed that most farmers would want to continue their agricultural pursuits except on the most marginal of lands within a given D&LD. Achieving a regional goal of 25% native habitat coverage is here assumed to be an ambitious but potentially achievable goal.
Option 3 Since participation under this option is mandatory, a nearly 100% conversion to native habitat types is assumed as an achievable goal.
Option 4 The area of influence would be similar to that of Option 2, i.e. a maximum of 25% land conversion

[1] Sustainability Level Achieved = Potential ER Managed Acres divided by total reach acres needed (Table 7, row g values) to achieve 100 % sustainability times 100.

Table A-21. Wetlands Nutrients Reduction Opportunities Afforded by UMRCP FDR Plans [1]

		Floodplain Nutrients Farming Potential by River Reach (Acres)				
FDR Plan	**Option**	**1**	**2**	**3**	**4**	**Total**
NA		0	0	0	0	0
B	2	0	0	16,221	150	16,372
	3	0	1,903	16,888	47,710	66,501
	4	0	0	0	0	0
D	2	0	5,849	26,242	18,067	50,158
	3	0	0	11,824	35,911	49,644
	4	0	0	0	0	0
E	2	0	1,395	11,824	11,695	24,915
	3	0	0	15,969	34,909	50,612
	4	0	801	0	405	1,207
H	2	N/A	N/A	N/A	N/A	N/A
	3	0	552	16,888	47,710	66,501
	4	N/A	N/A	N/A	N/A	N/A
I	2	N/A	N/A	N/A	N/A	N/A
	3	0	552	2,280	889	3,721
	4	N/A	N/A	N/A	N/A	N/A
J	2	N/A	N/A	N/A	N/A	N/A
	3	0	43,092	194,245	69,681	307,018
	4	N/A	N/A	N/A	N/A	N/A

[1] The Wetlands Initiative estimated that 38% of lands that it sampled from the 100-year flood zone represent existing or drained wetlands. The above analysis has applied that percentage to the acres of ER managed lands opportunities to approximate the potential acres of wetlands restoration opportunities on the UMRCP floodplain.

Table A-22. Sediments Reduction Opportunities Afforded by UMRCP FDR Plans

		Floodplain Sediments Reduction Opportunities (Number of Tributary Feeders)				
FDR Plan	**Option**	**1**	**2**	**3**	**4**	**Total**
No Action	1	0	0	0	0	0
B	2	0	0	38	0	38
	3	0	5	42	77	124
	4	0	0	0	0	0
D	2	0	8	89	109	206
	3	0	0	27	64	91
	4	0	0	0	0	0
E	2	0	1	53	81	135
	3	0	0	35	67	102
	4	0	1	0	3	4
H	3	0	5	45	91	141
J	3	0	14	161	111	286

VI. PLANS COMPARISON

A. General Comparison

In general, the structural and critical infrastructure plans scored high on socio-economic factors at the regional economic development (RED) level, while the non-structural plans (involving buyouts) were highly negative in their impacts. Plan A scored the highest on socio-economics, but was flawed from an NED and hydraulics standpoint. Environmentally, Plan J scored the highest and Plan A the lowest. Combining both socio-economic and environmental effects, Plan H scored the highest and Plan J the lowest.

B. Specific Comparisons

1. Plans Quantified for Environmental Impacts. Plans B, D, E, H, I, and J were quantified for environmental impacts.

Mitigation. As expected, the acres and costs fell out proportional to the amount of structural features implementation. Systemically, the mitigation acres and costs from highest to lowest were as noted in table A-18:

Plan B	2,721 acres at $15.2 million
Plan D	1.755 acres at $9.8 million
Plan E	1,345 acres at $7.5 million
Plan H	1,240 acres at $6.9 million

Secondary Development. Based on the table A-19 quantification, the plans can be ranked from lowest to highest in potential for secondary development as follows:

Plan J	-334,328 acres
Plan I	-8,776 acres
Plan D	-6,221 to 1,048 acres
No Action Plan	0 acres
Plan E	+935 to 4,987 acres
Plan H	+215,775 acres
Plan B	+215,775 to 320,037 acres

It should be noted that the quantification of Plan D is somewhat problematic. Plan D raises levees to an elevation close to, but just shy of, the regulated 100-year floodplain. This condition would tend to encourage development with neither insurance nor building elevations being required, even as the possibility of a catastrophic flood increases. Plan E would have a similar effect as Plan D; however, because of Plan E's lower, less attractive level of flood protection (50-year), it would not induce development to a somewhat lesser extent.

ER Opportunities. Based on the table A-20 quantification, the plans can be ranked from highest to lowest, in terms of potential for environmental opportunities, as follows:

Plan J	+807,943 managed acres
Plan H	+175,002 acres
Plan B	up to 175,002 acres
Plan E	up to +133,889 acres
Plan D	up to +131,995 acres
Plan I, Option 3	+9,791 acres
No Action Plan	0 acres

From an environmental standpoint, the Option 3 buyouts provide the most cost-effective means of managing habitat ($2,600/acre), followed by Option 2 ($5,100/acre) and then Option 4 ($6,100).

Nutrients Reduction. Based on the table A-21 quantification, the plans can be ranked from highest to lowest potential for nutrients reduction (NR) opportunities as follows:

Plan J	+307,018 acres
Plan H	+66,501 acres
Plan D	up to +50,158
Plan B	up to +66,501 acres
Plan E	up to 50,612 acres
Plan I	+3,721 acres
No Action Plan	0 acres

Sediments Reduction. Based on the table A-22 quantification, the plans can be ranked from highest to lowest potential for sediments reduction opportunities reflected by the number of tributary feeders as follows:

Plan J	286 tributary feeders
Plan D	up to 206 tributary feeders
Plan H	141 tributary feeders
Plan E	up to 135 tributary feeders
Plan B	up to 124 tributary feeders

2. Plans Not Quantified for Environmental Impacts. For various reasons, Plans A, C, F, G, K and L were not directly quantified for environmental impacts. However, to an extent, the potential magnitude of impacts from these plans can be deduced.

Plan A (Confined, 0.2 percent chance annual (500-year) protection), the most structural of the flood damage reduction plans, would likely have adverse environmental effects surpassing those of Plan B (Unconfined, 0.2 percent chance annual (500-year) protection). It would thus be the least desirable plan from an environmental standpoint.

Plan C (with 200-year agricultural protection) would likely be intermediate in its environmental effects between Plans B (including 0.2 percent chance annual (500-year) agricultural protection) and Plan D (including 100-year agricultural protection), but closer to Plan D effects than Plan B effects.

Plan F with no additional agricultural protection and its urban containment approach is judged to have environmental effects very similar to the No Action Plan (with no net effects).

Plan G would have effects similar to Plan B, but slightly more adverse due to its higher allowable flood stage rise and reduced requirements for real estate acquisitions.

Plans K and L, from a systemic perspective, would entail only minor changes in the environment, with effects not vastly different from those of the No Action Plan.

VII. ENVIRONMENTAL CONCLUSIONS

The environmental team reached the following programmatic level environmental conclusions:

A. Resource Problems

1. Habitat. Major habitat problems exist on the UMRS, including a historic loss of river/floodplain habitat connectivity; habitat fragmentation; lost habitat diversity; and habitat conversion from grasslands, marsh and forest to urban or agricultural land uses.

2. Sediments. Sedimentation is a major problem on the UMRS. It results from a combination of sheet and rill erosion on agricultural lands and channel degradation and/or bank erosion. It has resulted in severe maintenance problems at reservoirs, water facilities, power plants, harbors, drainage ditches, navigation channel, and bridge openings. Fine-grain sediment carried by surface runoff can fill in backwater areas, increase turbidity, carry excessive nutrients into the river ecosystem, and bring in pesticides and other toxic chemicals.

3. Nutrients. The historic loss of millions of acres of wetlands, and its nitrogen reduction capacity, the increased application of nitrogen fertilizer to crop fields, and the installation of drainage tiles has contributed to a substantial increase in nutrients loading on the UMRS. Most states have miles of river impaired by high levels of nutrients. Thus, certain areas are not supporting some types of resource use (e.g. swimming, fishing, and aquatic life).

B. Systemic FDR Plans

1. Environmental Desirability. The systemic FDR alternative plans were found to vary in the extent to which they addressed identified environmental problems. In general, the more non-structural a plan was, the less mitigation it required, the less likely it was to induce development, and the more likely it was to provide substantial environmental restoration opportunities.

2. No Justified Ecosystem Restoration Projects. Significant systemic ER project opportunities do exist within the UMRS floodplain; however, at this time there does not appear to be cost-justified systemic FDR plans that would support the inclusion of ER projects. Recommending ER projects independent of FDR is not feasible as the UMRCP—unlike the UMR-IWW Navigation Feasibility Study—lacks a dual FDR/ER authorization.

3. Existing Contribution of Habitat Management Areas. It should be noted that the UMRS has many thousands of acres of existing leveed fish and wildlife management areas that currently can overtop during major flood events, and thus provide a valuable FDR function to the river system.

C. FDR Follow-On Studies

1. NEPA Compliance. Protection of the Quincy bridge approach, and reconstruction of existing FDR systems, has been proposed as two potential FDR follow-on studies. If approved for further study, a site-specific feasibility level investigation with integrated NEPA documentation would be required for any economically viable alternatives that emerge. This compliance would need to give full consideration to stakeholder concerns, fish and wildlife habitat needs, endangered species, clean water, prime farmland, cultural resources, and cumulative effects. Depending on how the economic assumptions are formulated, the reconstruction concept could have mitigation requirements ranging from none to considerable. If mitigation were to be incorporated, mitigation banking would be a useful implementation tool to consider. Mitigation bank areas might also be able to double as sites for pilot projects used to test out innovative approaches to environmental management.

2. State-of-the-Art Improvements . Our current understanding of the mechanisms affecting the environmental health and management of the river is incomplete. Due to the current state-of-the-science, the initial years of any future proposed floodplain ecosystem restoration program should emphasis research and monitoring over that of construction. Following are some of the primary data gaps:

- **Geographic Information System (GIS) Based Modeling.** GIS-based computer modeling is needed for the UMRS to better analyze ecosystem responses to physical changes. An enhanced GIS would allow for the visualization of baseline resource conditions for identifying future restoration sites, and to help evaluate and rank project alternatives. For example, the new GIS based Hydraulic Engineering Center (HEC)—Ecosystem Functions Model (EFM) may be of utility in better predicting ecosystem response to changes in flow regime.

- **Habitat Needs Assessment.** A second generation of HNA is needed to factor in both the quantity and quality of habitat into future habitat management decisions. The regionalization of habitat units could contribute to the more efficient development of future restoration projects.

- **Sediments.** Insufficient long-term sediment monitoring has taken place in the UMRS during the past two decades. There is a need to resample previously sampled sites to determine if sediment transport characteristics have changed, as well as a need to resurvey old reservoir locations to increase our knowledge base, and to improve future sediment management decisions. New survey methods using remote sensing technologies could greatly reduce the costs of future sediment surveys. In the future, stream data collection at existing stream gage locations needs to include sediment measurements in addition to water information.

- **Nutrients.** Local nutrient effects and there control are relatively unstudied. However, some preliminary studies suggest that the filtration capacity of created wetlands could be a valuable management tool.

3. Integrated River Management. FDR concerns should be incorporated into an adaptive management process for the UMRS that brings floodplain stakeholders into broader river management planning. FDR measures and floodplain agro-systems are inseparable elements of the overall UMRS. The following are specific considerations for such a management system.

- **Documentation.** The documentation vehicle for integrated river management could be the development of a permanent Integrated Management Plan (IMP), which could include navigation, FDR, environmental, and recreational considerations. The IMP would be a "living document", one that receives periodic updates, and takes advantage of state-of-the-art planning and Monitoring/Modeling/ Research (MMR) innovations.

- **Decision Support System.** The regional IMP effort could be founded on an interagency web-based Decision Support System (DSS) allowing access to basin (or sub-basin) level databases and models for system-wide assessments. A useful starting point could be the application of the Corps' System-wide Modeling, Assessment, and Restoration Techniques (SMART) Program. This DSS could allow watershed mission needs to be more fully addressed, could increase the effectiveness of partnering with Federal, state and local entities, and could help encourage sustainable management. SMART could become the primary planning tool for future site-specific FDR planning activities. This regional effort would need to fully recognize the jurisdictional authorities, missions, and project implementation limitations of each of the Federal and state agencies contributing to the effort.

- **IMP Related Studies.** Various models could be employed to enhance our understanding of the resources of the UMRS, and to help with the future prioritization and assessment of restoration project site locations. These include HEC hydraulics models such as the River Analysis System (RAS), Reservoir System Simulation (ResSim), and the Ecosystem Function Model (EFM). From a habitat perspective, a regional application of the Habitat Evaluation Procedures (HEP), Wildlife Habitat Appraisal Guide (WHAG), Aquatic Habitat Appraisal Guide (AHAG) and Hydrogeomorphic (HGM) model would be of great utility. The integration and improvement of a combined economics/environmental incremental cost analysis model into the IMP could improve the decision making process.

- **Institutional Arrangement.** Any future ecosystem restoration efforts should capitalize on existing institutional mechanisms for its implementation. Two obvious candidates are the present institutional structure of the EMP, and that of the Navigation and Ecosystem Sustainability Program. (NESP). For example, a basin-wide public environmental awareness program could be served by the similar programs established under the EMP or NESP.

- **Adaptive Management.** The adaptive management approach to IMP preparation should include an iterative approach to decision making involving a cycle of planning, implementation, monitoring, research, and subsequent reexamination of decisions, plans and priorities, based on new information.

- **Research Support.** Funding support for the development of a UMRS regional IMP (based at MVR) and a regional database (based at UMESC) could be beneficial. Continued Federal funding in support of state level DSS and IMP initiatives would also be of help, as well as the continued funding of ERDC and HEC in the R&D portion of SMART. Also beneficial would be funding for continued IWR R&D of a combined economics/environmental project evaluation/justifications model as an interface for use with SMART.

- **Pilot Projects.** To encourage management innovation within the UMRS, it could be instructive to select sub-basins for establishment as pilot planning projects. The environmental component, including habitat, could be planned, designed, constructed, monitored, reassessed, and modified, as appropriate, under the purview of the EMP or the Navigation Study. The performance of these projects could be reported within periodic "Reports to Congress." The program could include the states and larger non-governmental organization groups as potential project sponsors. The pilot projects could be cost-shared at the typical environmental restoration project rate of 65 percent Federal and 35 percent non-Federal. Using a strategy of adaptive management, and assuming the pilot projects prove successful, additional increments of project could be proposed to Congress for implementation via the "Reports to Congress."

- **Continued Support to Environmental Programs.** The continuation of funding support to UMRS Federal habitat management programs could provide positive benefits. These programs include the:

  Conservation Reserve Program (CRP)
  Conservation Reserve Enhancement Program (CREP)
  Forestry Incentives Program (FIP)
  Environmental Quality Incentives Program (EQIP)
  Wildlife Habitat Incentives Program (WHIP)
  Wetlands Reserve Program (WRP)
  UMRS Environmental Management Program (EMP)
  UMR-IWW Navigation Study Ecosystem Restoration Program
  Section 1135 Program
  Section 206 Programs

- **Continued Support to FEMA Programs.** Continued funding support to FEMA programs that discourage floodplain development would have an environmentally positive effect. Programs such as the National Flood Insurance Program Community Rating System (an incentives program to reduce insurance costs when communities implement mitigation measures beyond the minimum participation requirements), and the Flood Mitigation Assistance Program (a buyout program) should be encouraged.

VIII. GENERAL REFERENCES

Birkland, T.A., R.J. Burby, D. Conrad, H. Cortner and W.K. Michener. 2003. *River Ecology and Flood Hazard Mitigation.* ASCE. Natural Hazards Review. Vol 4, No. 1, pp 46-54.

Block, W. M., A. B. Franklin, J.P. Ward Jr., J. L. Ganey, and G.C. White. 2001. *Design and implementation of monitoring studies to evaluate the success of ecological restoration on wildlife.* Rest. Ecol. Vol 9, No. 3 pp 293-303.

British Columbia Ministry of Forests. 2003. *An introductory guide to adaptive management.* http://www.for.gov.bc.ca/hfp/amhome/INTROGD/

Committee on Environment and Natural Resources (CENR). 2000. *Integrated Assessment of Hypoxia in the Northern Gulf of Mexico.* Prepared by the National Science and Technology Council—Committee on Environment and Natural Resources. 58 pp.

DeHaan, H.C., ,N.M. McVay, C.H. Theiling and R.S. Soileau. 2003. *Upper Mississippi River – Illinois Waterway System Environmental Objectives Planning Workshops.* Upper Mississippi River – Illinois Waterway System Navigation Feasibility Study. U.S. Army Corps of Engineers, Rock Island District. ENV Report 50. June 2003.

Delft Hydraulics. 1997. *A Balanced Management for the Upper Mississippi, Illinois and Missouri Rivers—A Provocative Outsider's View.* Prepared for Upper Mississippi, Illinois and Missouri Rivers Association.

Demissie, M., Y. Guo, H. Knapp, and N. Bhowmik, 1999. *The Illinois River Decision* Support System (ILRDSS). Prepared by Illinois State Water Survey, Champaign, Illinois. 50 pp.

Holling, C. S. editor. 1978. *Adaptive environmental assessment and management.* John Wiley & Sons, London, England.

Interagency Ecosystem Management Task Force. 1995. *The Ecosystem Approach: Healthy Ecosystems and Sustainable Economies.* 3 Volumes.

Interagency Floodplain Management Review Committee. 1994. *Sharing the Challenge: Floodplain Management into the 21st Century.* Main Report & Appendixes.

James, W.F., W.B. Richardson, D.M. Soballe, and D.B. Wilcox. 2003. *Water Level Manipulation for Managing and Improving Aquatic Habitat in the UMR: Effects of Dewatering on Sediment Nutrients and Physical Characteristics.*

Kelley, T.R. and E. Huddleston, 2001. *Monitoring of Spunky Bottoms Restored Wetland in Southern Illinois for Biotic and Abiotic Pollution Indicators.* Transactions of the Illinois State Academy of Science. Vol. 94, #2, pp. 69-78.

Kessler, W. B., H. Salwasser, C. W. Cartwright, Jr., and J.S. Caplan. 1992. *New perspectives for sustainable natural resources management.* Ecol. App. 2(3), pp 221-225.

Mitsch, W. J. 2001. *Reducing Nitrogen Loading to the Gulf of Mexico from the Mississippi River Basin: Strategies to Counter a Persistent Ecological Problem*. Bioscience. May 2001.

Mississippi River/Gulf of Mexico Watershed Nutrient Task Force (WNTF). 2001. *Action Plan for Reducing, Mitigating, and Controlling Hypoxia in the Northern Gulf of Mexico.* 31 pp.

Ogden, J. C. 2000. *An adaptive assessment strategy for the Comprehensive Everglades Restoration Plan. RECOVER Adaptive Assessment Team.* South Florida Water Management District, West Palm Beach FL. 6 pp.

Sather, J.H. 1992. *Intensive Studies of Wetland Functions: 1990-1991 Research Summary of the Des Plaines River Wetlands Demonstration Project.* Wetlands Research, Inc. Technical Paper No. 2. 11 pp.

Shewhart, W. 1939. *Statistical method from the viewpoint of quality control.* U.S. Department of Agriculture, Washington D.C.

TWI, 2002. *Nitrogen Farming: Using Wetlands to Remove Nitrogen from our Nation's Waters.* Proceedings of Four Workshops Sponsored by McKnight Foundation. 20 pp.

TWI, 2004. *Reducing Flood Damages in the Upper Mississippi River Basin—An Ecological Alternative.* Funded by McKnight Foundation. 8 pp.

Upper Mississippi River Basin Association (UMRBA). 1983. *Recreation in the Upper Mississippi River System: An Overview of Facility Needs.*

Upper Mississippi River Basin Commission (UMRBC). 1980. *The Upper Mississippi River Main Stem Level B Study.*

Upper Mississippi River Basin Commission (UMRBC). 1982. *Comprehensive Master Plan for the Management of the Upper Mississippi River System.* Main Report and Technical Reports.

Upper Mississippi River Conservation Committee (UMRCC). 2000. *A River that Works and a Working River.*

U.S. Army Corps of Engineers (USACE). 1961. *Basin Plan for Upper Mississippi River Basin*

U.S. Army Corps of Engineers (USACE). 1972. *Upper Mississippi River Comprehensive Basin Study. Prepared under supervision of Upper Mississippi River Comprehensive Basin Study Coordinating Committee.* Main Report & Appendixes.

U.S. Army Corps of Engineers (USACE). 1974 -1975. *Final Environmental Impact Statement—Nine-foot navigation channel operations and maintenance.* St. Paul, Rock Island, and St. Louis Corps Districts.

U.S. Army Corps of Engineers (USACE). 1976. *Final Environmental Statement, Lock and Dam No. 26 (Replacement)*. St. Louis District.

U.S. Army Corps of Engineers (USACE). 1977. *Recreational Craft Locks Study, Stage II Report—Upper Mississippi River (Draft).* St. Paul District.

U.S. Army Corps of Engineers (USACE). 1980. *Mississippi River Year-Round Navigation Study, Stage II, Final Feasibility Study.* North Central and Lower Mississippi Valley Divisions.

U.S. Army Corps of Engineers (USACE). 1981-1982. GREAT I, II & III. *Great River Resource Management Study—Mississippi River.* Main Reports and Appendices.

U.S. Army Corps of Engineers (USACE). 1982. *Mississippi River Navigation System Adequate Mooring Facilities for Watercraft.* St. Louis District.

U.S. Army Corps of Engineers (USACE). 1983. *Upper Mississippi River Land Use Allocation Plan, Master Plan for Public Use Development and Resource Management Part I and II.*

U.S. Army Corps of Engineers (USACE). 1984. *Defense Use of Civil Works Navigation Projects (Phase I). Institute of Water Resources.* Report 84-DR-2.

U.S. Army Corps of Engineers (USACE). 1986. *Final Report for the Mississippi River, Coon Rapids Dam to the Ohio River*. Rock Island and St. Paul Districts.

U.S. Army Corps of Engineers (USACE). 1988. *Final Environmental Impact Statement—Second Lock at Locks and Dam No. 26 (Replacement) Mississippi River, Alton, Illinois and Missouri.* Main Report & Appendixes.

U.S. Army Corps of Engineers (USACE). 1989. *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.*

U.S. Army Corps of Engineers (USACE). 1991. *Reconnaissance Report for Upper Mississippi River Navigation Study. Rock Island District.* Main Report & Appendixes.

U.S. Army Corps of Engineers (USACE). 1995. *FPMA—FloodPlain Management Assessment of the Upper Mississippi and Lower Missouri Rivers and their Tributaries.* Main Report and Appendixes.

U.S. Army Corps of Engineers (USACE). 1996-Present. *Melvin Price Locks and Dam, Design Memorandum No. 24, Avoid and Minimize Measures—Progress Report.*

U.S. Army Corps of Engineers (USACE). 1997. R*eport to Congress—An Evaluation of the Upper Mississippi River System Environmental Management Program.* Rock Island District. Main Report & Appendixes.

U.S. Army Corps of Engineers (USACE). 1997. *Dredged Material Management Plan, Preliminary Assessment. St. Louis District.* Mississippi and Illinois Rivers

U.S. Army Corps of Engineers (USACE). 1997. *Upper Mississippi River System—Report to Congress—Long Term Resources Monitoring.*

U.S. Army Corps of Engineers (USACE). 1998. *Upper Mississippi River System—Ecological Status and Trends of the Upper Mississippi River System.*

U.S. Army Corps of Engineers (USACE). 1999. *Design Memorandum No. 3, Rivers Project Master Plan for Mississippi, Illinois, Missouri and Kaskaskia Rivers, Illinois and Missouri.* St. Louis Corps District. Main Report and Plates.

U.S. Army Corps of Engineers (USACE). 2000. Habitat Needs Assessment—*Upper Mississippi River System Environmental Management Program. Summary Report, Query Tool User's Manual, Public Involvement Report,* Appendixes.

U.S. Army Corps of Engineers (USACE). 2000. *Habitat Needs Assessment for the Upper Mississippi River System: Technical Report.* U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin. Contract report prepared for U.S. Army Corps of Engineers, St. Louis District, St. Louis, Missouri. 248 pp. + Appendices A to AA.

U.S. Army Corps of Engineers (USACE). 2000. *Final report of the Dredged Material Management Plan Process Action Team,* U.S. Army Corps of Engineers, Rock Island District. Unpubl.

U.S. Army Corps of Engineers (USACE). 2002. *U.S. Army Corps of Engineers. Interim Report for the Restructured Upper Mississippi River – Illinois Waterway System Navigation Feasibility Study.* Rock Island District, USACE. July 2002.

U.S. Army Corps of Engineers (USACE). 2004. *Draft UMR-IWW System Navigation Feasibility Study: An Integrated Plan for Navigation and the Environment. Alternative Formulation Briefing Pre-conference Report.* January 2004.

U.S. Army Corps of Engineers (USACE). 2004. *Alternative Formulation Briefing Pre-conference Report for the UMR-IWW System Navigation Feasibility Study, 6 February 2004.* U.S. Army Corps of Engineers, Rock Island District, Rock Island, Illinois.

U.S. Army Corps of Engineers (USACE). 2004. *FINAL - UMR-IWW System Navigation Feasibility Study, Integrated Feasibility Report and PEIS.* Rock Island District, Corps of Engineers. September 2004.

U.S. Department of Commerce (USDOC). 1994. *Natural Disaster Survey Report. The Great Flood of 1993.*

U.S. Geological Survey (USGS). 1999. *Ecological status and trends of the Upper Mississippi River System 1998: A report of the Long Term Resource Monitoring Program.* U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin. April 1999. LTRMP 99-T001. 236 pp.

West. 2000. *Upper Mississippi River and Illinois Waterway Cumulative Effects Study: Volume 1, Geomorphic Assessment*, and *Volume 2, Ecological Assessment.* Prepared by WEST consultants for Rock Island District, U.S. Army Corps of Engineers. June 2000.