

Upper Mississippi River Comprehensive Plan

MAIN REPORT



US Army Corps
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ILLINOIS

FINAL REPORT

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MAIN REPORT

EXECUTIVE SUMMARY

Background

The Flood of 1993 provided a vivid demonstration of the vulnerabilities of the existing flood control systems on the Upper Mississippi River System (UMRS). Forty-seven deaths were attributed to the Flood of 1993, and assessments of the economic damages range from \$15 to 20 billion including more than \$2.9 billion in damages along the Mississippi River and its floodplain. The social disruption was beyond measure, with more than 70,000 homes damaged or destroyed and approximately 74,000 persons evacuated from flooded areas. In-place flood risk management facilities built by the U.S. Army Corps of Engineers prevented an estimated \$19 billion in potential additional damages. While the size and impact of the Flood of 1993 was unprecedented in recent history, floods of equal or greater magnitude will likely occur in the future, and the region will likely again be exposed to the destructive potential of the Mississippi and Illinois Rivers.

The flood damage reduction facilities (Federal and non-federal) of the Upper Mississippi River System were not constructed in accordance with any overall systemic plan. These facilities have varying structural integrity, and provide varying levels of flood risk reduction for similar land uses. Not since 1981 (with the termination of the Upper Mississippi River Basin Commission) has there been an overall active planning authority for Upper Mississippi River System resources management. The Mississippi River Commission (MRC) has statutory authority for the general improvement of the river from the Head of Passes to its headwaters near Lake Itasca. The MRC started a process of listening, inspecting, and partnering in the Upper Mississippi Basin in 1997, but in its current capacity the Commission does not have the funded authority to implement plans of improvement in the basin as it does with the comprehensive Mississippi River & Tributaries (MR&T) project below Cape Girardeau, MO.

The Flood of 1993 awakened renewed interest in developing a systemic approach to flood damage reduction on the Upper Mississippi River System. In authorizing this study, Congress recognized the need for a planning effort that develops a floodplain management plan in which there may be a Corps of Engineers interest.

The Upper Mississippi and Illinois River floodplains have extensive existing flood control projects consisting of levees and floodwalls and large tributary reservoirs. Many of the levee systems were originally built privately between 1880 and 1920 and upgraded later. The average age of all the systems, when the last major construction upgrade occurred, is just over 46 years. The average year of the last construction upgrade of the agriculture systems on the Upper Mississippi and Illinois Rivers was 1940, making the agriculture systems upgrade, on average, over 65 years old. The various systems level of protection is from less than 2 percent (50-year) up to the 0.2 percent (500-year) annual chance protection. In addition, there are numerous environmental areas, managed by Federal, state or local governments. Today, most components of this system were federally constructed or improved, and were planned and built incrementally (rather than systemically) under various authorities. There are separable areas of the floodplain which have non-federal projects, not meeting USACE design and construction standards. About three quarters of the existing urban systems exist at the 0.2 percent (500-year) annual chance level of protection.

The Importance of the Upper Mississippi River Basin

The study area of the Upper Mississippi River Comprehensive Plan (Comprehensive Plan) is the Upper Mississippi River Basin drainage area above Cairo, IL, at the confluence of the Mississippi and Ohio Rivers exclusive of the Missouri River Basin, and encompasses approximately 185,000 square miles.

The Upper Mississippi River System (UMRS) and associated environments have a rich record of human history spanning over 12,000 years that is increasingly being documented as one of the most archeologically and historically significant regions in the country. The abundant and diverse ecological resources found along the UMRS have attracted and sustained human populations for thousands of years, providing food, water, shelter, and transportation. In modern times, the Upper Mississippi River System has assumed a significant role in the development and prosperity of the Midwestern economy and way of life. The presence of the rivers provides many benefits to the States and counties along the river corridor. Benefits are derived from the employment and income generated from transportation of goods, recreation, hydropower production, and water supply for municipalities, commercial, industrial and domestic use. Some of these benefits are:

- Commercial and recreational fishery.
- About half of the 30 million residents of the watershed rely on the water from the UMR and its tributaries for municipal and industrial water supplies.
- It provides for over \$6.6 billion dollars in revenue annually from some 12,000,000 visitor-days of use by people that hunt, fish, boat, sightsee or otherwise visit the river, its magnificent bluffs and communities (Black et al. 1999).
- Recreation and tourism employ 143,000 people in the corridor.
- It provides the important benefit of over 1,191 river miles of diverse natural, rural and urban open space for human exploration, experiential education, spiritual renewal and aesthetic enjoyment.

The primary impact area of the study lies within the 78 counties bordering the Upper Mississippi River and Illinois Waterway. Together, these counties contain nearly 5 percent of the nation's population, with total population in 2000 of nearly 13.4 million.

Further, the importance of the entire Mississippi River Basin to the Nation is demonstrated by the fact that Congress established the Mississippi River Commission (MRC) in 1879, over 125 years ago. The Mississippi River Commission's stated purpose by the Forth-Sixth Congress is "for the improvement of said river from the Head of Passes near its mouth to its headwaters." The President appoints seven members, with the advice and consent of the United States Senate.

The Comprehensive Plan

The authority for and purpose of the Upper Mississippi River Comprehensive Plan (Comprehensive Plan) is contained in Section 459 of the Water Resources Development Act of 1999, which states in part that: *"The Secretary shall develop a plan to address water resource and related land resource problems and opportunities in the upper Mississippi and Illinois River basins, from Cairo, Illinois, to the headwaters of the Mississippi River, in the interest of systemic flood damage reduction...."*

Due to the very large study area, the watershed encompasses about 185,000 square miles and about 1,025 river miles, and in consideration of fiscal and time constraints, it was determined that the scope

would be limited to the Mississippi and Illinois Rivers floodplain and not be a comprehensive watershed analysis. Further, while the discharges of the tributaries including the Missouri River Basin were included in the flood frequency analysis for the Comprehensive Plan, no tributaries, except the Illinois River were studied or analyzed. This current analysis was performed to about a reconnaissance phase level, also known as Section 905(b) analysis. Any recommendation for authorization would typically require more detailed analysis in a later phase.

The Comprehensive Plan followed the Corps of Engineers six planning steps used in the formulation of alternative plans.

1. Identify Problems and Opportunities. The specific problems and opportunities are identified, and the causes of the problems discussed and documented. Planning goals are set, objectives established, and constraints identified.

2. Inventory and Forecast Resource Conditions. This step characterizes and assesses conditions as they currently exist and forecasts the most probable without-project condition (or no action alternative) over the period of analysis. This assessment gives the basis by which to compare various alternative plans and their likely impacts.

3. Formulate Alternative Plans. Alternative plans are developed in a systematic manner to ensure that reasonable alternatives are evaluated.

4. Evaluate Alternative Plans. The evaluation of each alternative consists of measuring or estimating the economic benefits, costs, environmental impacts, and social effects of each plan, and determining the difference between the without-project and with-project conditions.

5. Compare Alternative Plans. Alternative plans are compared, focusing on the differences among the plans identified in the evaluation phase and public comment. As part of the evaluations, the best plans are identified based upon those plans that provide the greatest economic benefits for the least cost.

6. Select Recommended Plan. A recommended plan is selected based upon the comparison of alternative plans. If no alternative which can be implemented is identified, the recommended plan is the No Action alternative.

In the execution of the Comprehensive Plan, coordination with various other Federal, state, local and non-governmental agencies and groups occurred through the Collaboration Team created in 2002. The coordination occurred through team meetings, teleconference calls, and electronic transmission of documents.

The objectives developed from considering the problems, opportunities, and the authorizing language include:

- minimize the threat to health and safety resulting from flooding by using structural and non-structural flood damage reduction measures;
- reduce damages and costs associated with flooding;
- identify opportunities to support environmental sustainability/restoration goals of the Upper Mississippi and Illinois River floodplains as part of any systemic flood damage reduction plan;
- seek opportunities to address, in concert with flood damage reduction measures, other floodplain specific problems, needs and opportunities to include:
 - continued maintenance of the navigation project and related commercial infrastructure;
 - reduction of nutrient input and sedimentation into the rivers;
 - improved habitat management;

- o bank caving and erosion reduction;
- o improved recreation opportunities; and
- identify and recommend appropriate follow-on studies.

The Comprehensive Plan used recently updated frequency water surface profiles from the Upper Mississippi, Missouri and Illinois River Flow Frequency Study (Flow Frequency Study) for frequency floods between the 50 percent (2-year) chance annual event and 0.2 percent (500-year) chance annual event. This is the first time since the Flood of 1993 that an updated frequency analysis is being used on a systemic basis.

The Upper Mississippi River Comprehensive Plan investigated systemic flood risk management plans for the floodplain of the Upper Mississippi and Illinois Rivers. In developing the plans, both structural and nonstructural flood damage reduction alternatives were considered. Work accomplished within the Comprehensive Plan was an effort involving a Collaboration Team consisting of the Corps of Engineers Rock Island, St. Louis, and St. Paul Districts, a number of other Federal and state agencies, and attendance and participation by non-governmental organizations. In total, fourteen alternatives were considered, and eight alternative plans were evaluated in detail ranging from floodplain buyouts, non-structural plans, to structural alternative plans including various increases in the level of protection

The evaluation of alternative plans is accomplished using the four accounts established in the Corps' Principles and Guidelines to facilitate the evaluation and display of effects of alternative plans (ER 1105-2-100):

- The National Economic Development (NED) account displays changes in the economic value of the national output of goods and services.
- The Environmental Quality (EQ) account displays non-monetary effects on ecological, cultural, and aesthetic resources including the positive and adverse effects of ecosystem restoration plans.
- The Regional Economic Development (RED) account displays changes in the distribution of regional economic activity (e.g., income and employment).
- The Other Social Effects (OSE) account displays plan effects on social aspects such as community impacts, health and safety, displacement, energy conservation, and others.

The Corps seven Environmental Operating Principles, published in 2002, and the Chief of Engineers' 12 Actions for Change, which were issued in August 2006, were considered as alternative plans were developed and formulated.

Alternative plan evaluation using the NED and EQ accounts is required. The hydraulic analyses of the alternative plans formulated utilizes the existing numerical hydraulic (UNET) models developed for the Flow Frequency Study along with a new, stochastically-generated, 1,000 years of tributary inflows. The alternative plans were evaluated using traditional expected value (damage and flood probability) analysis. Current stage frequency profiles were used to provide elevations for floods with varying probability. Alternative plans were evaluated from an ecosystem and environmental opportunities aspect in the five following major categories: mitigation; secondary development; ecosystem restoration; nutrients; and sediments. The environmental evaluation presented results in acres.

Regional Economic Development (RED) evaluation was accomplished in detail for three alternative plans. For the Upper Mississippi River Comprehensive Plan, RED benefits were computed by the Tennessee Valley Authority (TVA) for three alternatives. The TVA estimated that every dollar spent on comprehensive flood risk management reduction would generate as much as \$5.00 in increased gross regional product. Projected employment was also evaluated.

A series of four public meetings was held to present the Comprehensive Plan results. The public meetings were held the last week of June 2006, about a month after the draft Comprehensive Plan Report was released to the public. There was generally significant support for a reduction in flood risk in the UMRS. Though some questioned the need and advisability of such a potential large expenditure. Plan G, proposed by the Upper Mississippi, Illinois, and Missouri Rivers Association (UMIMRA), a member of the Collaboration Team, was strongly supported at the three public meetings held north of St. Louis, MO. Attendees at the fourth and last public meeting held at Chester, IL, located on the Mississippi River south of St. Louis, MO, opposed Plan G. Plan G, in addition to a high level of protection, required a 10,000 acre storage area located in the floodplain of Monroe County, IL, which is located just south of St. Louis. The storage area in Monroe County, IL was a major area of concern. The storage area would probably require purchase of the 10,000 acres, which local residents strongly opposed. Written correspondence in response to the public meetings including letters, emails, calls and petitions, was about evenly split, supporting and opposing Plan G. Over the months following the public meetings, a series of meetings was held with publics and representatives of the drainage and levee districts south of St. Louis, MO. In direct response to the meetings held and input received during this period, Plans B and G were the further refined and Plan M, was formulated.

To complete alternative plan evaluation, the Comprehensive Plan obtained assistance from the Corps of Engineers Engineer Research and Development Center (ERDC), located in Vicksburg, MS, in applying the new Risk Informed Decision Framework (RIDF) methodology that draws from current practice in the fields of multi-criteria decision analysis (MCDA) and risk and uncertainty analysis. Plan H, with Plan D very close behind, and to a slightly lesser extent Plan M, emerged as the high-scoring alternative plan using the RIDF methodology.

CONCLUSIONS

General Overview.

The need for a comprehensive, systemic plan for flood risk reduction and floodplain management along the Upper Mississippi and Illinois Rivers has been recognized by numerous stakeholders and in numerous documents and forums including the post-1993 flood reports and the regional summit meetings of the mid-1990's. This recognition ultimately led to the authorization of the Upper Mississippi River Comprehensive Plan (Comprehensive Plan) in the Water Resources Development Act (WRDA) of 1999 (Section 459), which states in part that, *"The Secretary shall develop a plan to address water resource and related land resource problems and opportunities in the upper Mississippi and Illinois River basins, from Cairo, Illinois, to the headwaters of the Mississippi River, in the interest of systemic flood damage reduction "*

The study investigated opportunities to develop and implement a systemic approach that reduces cumulative flood risk costs and annual flood damages, while simultaneously providing long term improvements to other system values and uses (ecological, economic, recreation, transportation, etc.).

A number of Corps studies completed since the Flood of 1993, provided the foundation for evaluation of a comprehensive systemic plan for flood risk reduction.

The Upper Mississippi River Comprehensive Plan provides a possible framework to go forward with flood risk reduction by interested Federal, state and local interests. In total, eight alternatives were evaluated in detail ranging from reconnection of the floodplain through buyouts to various levels of increases in the level of protection, up to a systemic 500-year level of protection.

Two significant events occurred during the period of preparation of the draft report in 2005 that served to refine the study approach and analysis. First, two severe hurricanes, Katrina and Rita, hit the southern United States. The hurricane experience, in addition to the lessons of the Flood of 1993, resulted in a reexamination of approaches to flood risk management and flood mitigation, changing some perspectives and increasing the emphasis on risk informed decision making rather than relying on more narrowly defined economic decision criteria. Secondly, during the development of the report, the Corps of Engineers issued several engineering circulars, emphasizing collaborative approaches to planning and reaffirming the assessment of plans based on all four accounts: NED, EQ, RED and OSE.

The lessons learned from the 1993 Flood and Hurricanes Katrina and Rita were incorporated into the UMR Comprehensive Plan, including the recognition that flood risk management is a shared Federal, state and local responsibility and any future improvements will need support from all interests. To assist in providing a framework for complex decision making, the project team and stakeholders utilized a Risked Informed Decision Framework (RIDF). RIDF is a planning tool which incorporates risk and uncertainty information into the decision process. One outcome of the process highlighted the importance of public health and safety. Prior to implementing RIDF, while Other Social Effects were considered, the analysis focused on net NED benefits in the selection process. However as indicated above, both the 1993 Flood and Hurricanes Katrina and Rita demonstrated that using the NED results as the primary decision tool does not adequately address public health and safety, especially in the event of infrequent floods.

Evaluation of the project alternatives revealed very low National Economic Development benefits and high RED (state and local) benefits. In addition the impacts of the OSE and EQ accounts were considered as part of the evaluation. To meet the legislative requirement to develop a systemic plan for flood protection, it is clear that a collaborative partnership of Federal, state and local interests is necessary. The Corps can bring technical expertise (hydraulic, hydrologic, economic, environmental, and engineering) to such a collaborative partnership as well as coordination with existing Corps programs (Upper Mississippi River And Illinois Waterway System Navigation Environmental Sustainability Program (NESP); the Environmental Management Program (EMP); Illinois River Basin Restoration, Sec. 519 (Illinois 519)); and other environmental programs to help prioritize and locate environmental projects that benefit the Upper Mississippi River System.

As the Comprehensive Plan was limited to the Mississippi and Illinois River floodplain, about 4,000 square miles, rather than the entire watershed, there exists the possibility of performing watershed analysis on major tributaries in the future.

Conclusions

Systemic Flood Risk Management.

The existing flood risk management systems currently prevent 95-97% of the potential average annual flood damages on the system. However, the Flood of 1993 and Hurricanes Katrina and Rita have clearly shown that even low residual risk may not meet the Nation's expectations with regard to public health and safety. If there would be an overtopping of a levee or floodwall, a catastrophic loss could result.

None of the comprehensive, systemic flood damage reduction plans that were evaluated had net positive NED benefits. For the eight plans evaluated, benefit-to-cost ratios (BCR) were below 0.1.

Initial analysis indicated NED benefit-to-cost ratios of greater than one for a project addressing critical transportation facilities (e.g. bridge approaches, etc.).

Environmental Quality (EQ) opportunities exist within the Upper Mississippi River floodplain. Coordination between other Corps programs (NESP, EMP and Illinois 519) and the Comprehensive Plan could encourage wetland and conservation in areas that would also result in flood risk reduction. Existing conservation areas located in the Upper Mississippi and Illinois Rivers floodplain may be impacted by the rise in water surface profiles if a systemic flood risk management plan is implemented.

Implementation of a large, systemic flood risk reduction plan would result in significant regional economic benefits. The Tennessee Valley Authority estimated that every dollar spent on comprehensive flood risk reduction (i.e., 500-year level of risk reduction for urban areas and 100-year or greater level of risk reduction for agricultural areas - Plans A, B, D, G, H or M) would generate as much as \$5 in increased gross regional product. Also, employment could increase by more than 20,000 jobs annually in the five-state Upper Mississippi Valley Region resulting from upgraded levee protection provided by the full implementation of a comprehensive flood risk reduction plan.

Other Social Effects (OSE) benefits for public health and safety and displacement would occur if a systemic alternative plan were implemented.

From a stakeholder view, the results of applying the Risked Informed Decision Framework (RIDF) indicated a preference for a comprehensive plan with a high level of risk reduction for the entire Upper Mississippi River System.

Plans B, G, H and M are all similar in providing a high level of flood risk reduction. Plan H includes a cost comparison. For Plan H, the construction cost of increasing the system height, typically raising a levee, is compared to the cost of acquisition of the district, and the cost effective option, either the levee raise or acquisition, then becomes a part of Plan H for that site. Any district could choose not to be a part of the plan and then the district would stay "as is" or find other resources to improve the existing level of protection. Of the existing flood damage reduction systems, 37 systems should be further evaluated using a cost comparison methodology.

A Regional or National oversight group (e.g., the Mississippi River Commission or an interstate group) would provide assistance to the states and local drainage and levee districts to implement a comprehensive flood risk management plan. This oversight would provide a regular review of the

water resources problems, needs and opportunities in a collaborative framework working with other Federal, state and local agencies and non-governmental organizations, stakeholders, and the interested public. This oversight group would be the catalyst to address the problems and needs collaboratively. The Corps could assist by bringing its leadership and expertise in technical areas (e.g., hydrology and hydraulics, economic and environmental analysis, and engineering) to bear in addressing the changing problems, needs, and opportunities of the region. The Corps could also help coordinate environmental programs, including NESP, EMP, and Illinois 519, to provide greater priority for projects benefiting flood risk reduction, navigation, bank caving, and erosion, watershed nutrient and sediment management, recreation needs, and other purposes.

Reconstruction.

The Upper Mississippi River Comprehensive Plan recognized the importance and benefit of the existing flood damage reduction systems in place. Due to the average age of the last major construction upgrade, over 45 years, and condition, the existing flood risk reduction systems need to be evaluated to determine the feasibility of reconstruction. Reconstruction could insure that the systems continue to provide the billions of dollars in benefits for the foreseeable future. The average year of last construction upgrade of the agriculture systems on the Upper Mississippi and Illinois Rivers was 1940, making the last system major construction upgrade, on average, over 65 years old.

The reconstruction effort would focus on a feasibility phase level of evaluation of the system components including pump stations, gates, closures, and supporting infrastructure. Further, reconstruction would address, if necessary, the current frequency water surface profiles and the height of the existing protection systems to determine if the systems have to be raised to maintain the authorized level of protection.

Critical Infrastructure – Transportation.

Preliminary analysis of costs and benefits for the protection of one location crossing the Mississippi River indicates that the protection may be economically justified from an NED account evaluation, the traditional Corps evaluation account. A systemic analysis of the Upper Mississippi and Illinois Rivers for critical transportation infrastructure (e.g. bridge approaches, railroad infrastructure, etc.) using all four evaluation accounts may indicate that protection of the transportation infrastructure is worthwhile at several locations to insure that the transportation system continues to function during a significant flood event. The result of this analysis may indicate where priority plan implementation could occur to reduce the flood risk to critical transportation systems. During the Flood of 1993, major east west transportation arteries (roads and railroads) were severed causing significant delays and major rerouting of goods and individuals. In many cases the rerouting was in excess of 100 miles. If a flood similar to the Flood of 1993 were to occur today, the container traffic disruption from the west coast to the major distribution center in the Chicago area would have national ramifications. The reduction of flood risk for this critical transportation infrastructure would fit within the total system plan.

Systemic Hydrologic Analysis of the Upper Mississippi River System.

The UMR Comprehensive Plan successfully developed a set of tools capable of analyzing the hydraulic, economic and environmental effects of systemic flood damage reduction alternatives.

The hydrologic body of knowledge of the Upper Mississippi and Illinois Rivers has dramatically increased as a direct result of the previously completed Flow Frequency Study and the Comprehensive

Plan. The systemic modeling is a useable product for the future if maintained. It allows the determination of system-wide hydrologic impacts from actual and proposed changes. This modeling has the potential to substantially change the way this river system is managed.

Specific findings of the hydraulic analysis of alternatives include:

- The levees above Lock and Dam 19 at Keokuk, Iowa (study reaches 1 and 2) can be systemically raised without causing more than a one-foot increase in the 1 percent annual chance (100-year) flood profile anywhere within reaches 1 and 2.
- Likewise, the levees on the Illinois River (reach 4), river mile 0.0 to 160.0, can be raised without causing more than one foot of rise in the 1 percent annual chance (100-year) flood profile.
- Several flood risk reduction measures (levee setbacks, realignments, and removal of bridge obstructions) have only a very localized reduction of water surface profiles.
- Any raises to levees immediately above the confluence of the Missouri and Mississippi Rivers, or south of St. Louis on the Mississippi River, where limited non-leveed floodplain exists, would increase flood heights more than one (1) foot. The existing levee alignment in these areas will not allow significant flood risk reduction improvements.

Emergency Action Scenarios.

Members of the Collaboration Team expressed the need for an evaluation of Emergency Action Scenarios for the Upper Mississippi River System to be included as part of the Upper Mississippi River Comprehensive Plan. The evaluation of a series of Emergency Action Scenarios, temporary raising of levees during a flood emergency of up to three feet, was conducted to develop a better understanding of the hydraulic and economic impacts of emergency actions such as flood fighting. Hydrologic analysis of a series of scenarios concluded that:

- There is no induced rise in frequency stage in Reaches 1 and 2 for any of the scenarios. This implies that induced damages are not a concern when determining emergency response priorities within these reaches.
- There is no induced rise in frequency stage anywhere along the length of the Mississippi River or Illinois River (Reaches 1-4) caused by increasing the level of protection of only urban and industrial areas.
- Induced damages could be a concern at some locations for systemic agricultural levee raises in Reaches 3 and 4.

Potential Follow-on Studies

The Comprehensive Plan efforts pointed to the need for several follow on studies. The first three follow-on studies are specifically recommended in the next section. The fourth study would assist in identifying the expected flood risk throughout the Upper Mississippi River System in a useable and understandable way to the general public, a key factor in reducing flood risk.

1. Cost shared feasibility phase reconstruction analysis should be undertaken. This reconstruction analysis would be accomplished on individual flood risk management systems to evaluate whether rehabilitation on the aging infrastructure is needed and justified to assure that the existing system provides benefits in the future. This reconstruction analysis and FEMA Flood Insurance Rate Map development are two immediate examples using the results of the hydrologic modeling in Follow-on Study No. 3.

2. A systemic analysis of critical transportation systems should be performed to determine the feasibility of protecting river approaches for land based systems, highways and railroads.
3. The hydrologic modeling for the Upper Mississippi River System should be maintained and updated as changes occur and new data is available. This would make the modeling and its results available to all Federal, state and local agencies in the future and would allow new tools to be incorporated as available. Existing information used to evaluate project benefits is, on the average, over 30 years old. Updating this information would provide decision-makers and the public with better quality data upon which to manage the system on a long-term basis. Also, The Flood Flow Frequency (FFF) study did not complete the GIS mapping of the Illinois River from Mile 42.0 to 90.0, and this should be completed.
4. Development of a methodology to clearly convey the flood risk for the Upper Mississippi River System should be undertaken using a combination of technology tools, such as a geographic information system (GIS), and a series of river gages, so the public can relate a specific location to the expected flood risk.
5. To close data gaps in our understanding of the river system, investments should be made in GIS-based computer modeling, a second generation Habitat Needs Assessment, long-term sediment monitoring, and pilot Projects for evaluating wetlands creation using existing agricultural drainage districts as a potential management tool for nutrients control and reduction.
6. As the Comprehensive Plan was limited to the Mississippi and Illinois River floodplain, about 4,000 square miles, rather than the entire watershed (185,000 square miles), there exists the possibility of performing watershed analysis on individual tributaries in the future as interest and funding allows.

RECOMMENDATIONS

This Upper Mississippi River Comprehensive Plan is prepared in response to the Congressional directive contained in Section 459 of the Water Resources Development Act of 1999. While this report presents a Comprehensive Flood Risk Management Plan in response to Congressional direction, additional authority to implement the Comprehensive Plan is not being recommended nor requested at this time based upon the NED evaluation of alternative plans. Specifically, the congressional language required the development of a comprehensive plan for systemic flood damage reduction in the upper Mississippi and Illinois River basins. While none of the plans evaluated were feasible based on net National Economic Development (NED) benefits, decision makers may desire information beyond NED to ensure that their decision meets the needs of the Nation. Therefore, in an effort to be responsive to the congressional directive, the best performing of the plans evaluated was identified based upon consideration of the four evaluation accounts, NED, EQ, RED and OSE, using both traditional economic analysis and risk informed decision framework analysis techniques.

Plan H, while not economically feasible when evaluated by NED guidelines, has been identified as the best performing plan of those alternative plans evaluated. Plan H includes a cost effectiveness consideration. For Plan H, the construction cost of increasing the system height, typically raising a levee, is compared to the cost of acquisition of the district, and the cost effective option then becomes a part of Plan H for that site. Any district could choose not to be a part of the plan and then the district would stay “as is” or find other resources to improve the existing level of protection. However, it should be noted that Plan H has not been thoroughly vetted with the public and stakeholders. In addition, the following factors should be considered by decision makers.

- a. Implementation of Plan H would provide a significant increase in the level of risk reduction for the Upper Mississippi River System (UMRS).
- b. There is likely to be limited Federal interest, based upon current guidance, in plan implementation by Federal agencies.
- c. Regional or national oversight (e.g., the Mississippi River Commission) would be required to ensure the plan functions as a system over the implementation and operation phases of the project and project priorities are established to reflect the changing systemic needs.
- d. The States of Illinois, Iowa, and Missouri need to agree on the plan and plan implementation to insure the plan is acceptable. The Corps could provide facilitation and technical support to this effort.
- e. If Plan H were implemented as a comprehensive, systemic flood risk reduction plan for the Upper Mississippi and Illinois Rivers, significant additional technical analysis in all areas would be required before final plan design and implementation could be initiated to insure all potential impacts are adequately addressed.

Continued collaboration between Federal agencies, state agencies, and stakeholders, may establish a comprehensive approach to flood risk reduction and floodplain management leading to consensus building for the UMRS. This would then allow other Federal and non-Federal agencies to bring to bear their authorities and capabilities toward implementation.

Reconstruction.

It is recommended that a study authorization be established to address reconstruction needs for the Upper Mississippi and Illinois Rivers drainage and levee districts. The cost shared feasibility phase reconstruction analysis would then be accomplished on individual flood risk management reduction systems to evaluate whether rehabilitation of the aging infrastructure (e.g. pumps, gates, closures, etc.) is needed and justified to ensure that the systems provide their intended benefits into the future.

Critical Transportation Analysis.

It is recommended that a regional feasibility study be conducted to evaluate higher levels of risk reduction for approaches to bridges crossing the Upper Mississippi and Illinois Rivers. This critical transportation feasibility study would include an analysis of all the Upper Mississippi and Illinois Rivers bridges/approaches to insure. The analysis could evaluate all four accounts (NED, EQ, RED, and OSE). Initial analysis indicates that there may be several locations justified for follow-on implementation.