

Inland Navigation System Planning: The Upper Mississippi River—Illinois Waterway

Committee to Review the Upper Mississippi River-Illinois Waterway
Navigation System Feasibility Study

Water Science and Technology Board
Division on Earth and Life Studies

Transportation Research Board

National Research Council

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Executive Summary

In 1988, the U.S. Army Corps of Engineers began an investigation of the benefits and costs of extending several locks on the lower portion of the Upper Mississippi River–Illinois Waterway (UMR–IWW) in order to relieve increasing waterway congestion, particularly for grain moving to New Orleans for export. With passage of the Flood Control Act of 1936, Congress required that the Corps conduct a benefit-cost analysis as part of its water resources project planning; Congress will fund water resources projects only if a project’s benefits exceed its costs. As economic analysis generally, and benefit-cost analysis in particular, has become more sophisticated, and as environmental and social considerations and analysis have become more important, Corps planning studies have grown in size and complexity. The difficulty in commensurating market and nonmarket costs and benefits also presents the Corps with a significant challenge. The Corps’ analysis of the UMR–IWW has extended over a decade, has cost roughly \$50 million, and has involved consultations with other federal agencies, state conservation agencies, and local citizens. The analysis has included many consultants and has produced dozens of reports.

In February 2000, the U.S. Department of Defense (DOD) requested that the National Academies review the Corps’ final feasibility report. After discussions and negotiations with DOD, in April 2000 the National Academies launched this review and appointed an expert committee to carry it out. The committee, appointed under the joint auspices of the Academies’ Water Science and Technology Board (WSTB) and Transportation Research Board (TRB), conducted its study in accordance with the following statement of task:

This study will focus on the U.S. Army Corps of Engineers’ economic analysis regarding proposed improvements, including economic assumptions, methods, and forecasts regarding barge transportation demand on the Upper Mississippi River–Illinois Waterway. The Corps must also consider larger water resources project planning issues, such as formal U.S. federal water resource planning guidelines, possible environmental impacts, and the costs of navigation improvements. Thus, while the committee will focus on the Corps’ economic analysis, they will also comment upon the extent to which these larger issues are being appropriately considered in the navigation system feasibility study.

In September 2000, the Corps reported that completion of its feasibility study would be delayed. As the committee was contractually obligated to finish its study in February 2001, it was clear that a final Corps study would not be available for the committee's review. Nonetheless, the National Academies and DOD agreed that an interim report would be useful. The committee's report thus focuses on a July 2000 draft of the feasibility study, on a draft environmental impact statement, and on numerous studies and reports that the Corps presented to the committee as key supporting documentation in the draft report.

The committee is mindful of its original assignment to examine the Corps' final report. As the Corps has yet to finish its feasibility study, the assessment and recommendations in Chapter 4 do *not* critique the Corps' final report, but rather comment upon a draft of the final report and relevant supporting documents provided by the Corps. Because the Corps decided that more analysis was required before it could produce a final feasibility report, the Corps may have already changed some of the plans the committee describes and analyzes in Chapter 4. The committee thus presents its report with the hope that it will prove useful to the Corps as it continues the analysis and preparation of the final feasibility report.

The prospective lock extensions on the lower UMR-IWW are highly controversial, as was made clear by the high level of participation and passion displayed by proponents and opponents during the committee's meetings and public comment sessions in Washington, D.C. and St. Louis in June and August 2000, respectively. It is not easy to pursue this difficult analysis of the UMR-IWW in such a highly charged atmosphere.

The Corps attempted to build the first comprehensive model of grain use and exports from the area surrounding the river system, and attempted to build a model of the environmental effects of extending the locks and increasing barge traffic. These two studies are exceedingly difficult, and the committee commends the Corps for undertaking them and making important advances. The committee also offers recommendations on how the final feasibility study could be improved over the draft reviewed in this report.

The committee's recommendations for improving navigation system planning on the Upper Mississippi and Illinois system are divided into four areas: economics, inland waterway and water resources system planning, the environment, and engineering. The Corps itself may not be able to unilaterally implement all of the committee's recommendations. The Corps operates at the behest of the U.S. Congress, and the committee recognizes the roles of Congress in granting enabling authorities and appropriations for Corps water resources studies and projects. In addition, the federal Office of Management and Budget (OMB) establishes fiscal priorities for water resources projects. The Corps' discretion to carry out certain studies and projects is thus not always matched by the funds to do so.

The Corps is, however, granted a certain degree of latitude in various authorizations and in its feasibility studies. The committee thus primarily directs recommendations that can be implemented within the Corps' discretion to the Corps of Engineers. Recommendations beyond the Corps' discretion to enact are directed to the U.S. Congress.

Some of the committee's recommendations will require sustained and significant resources in order to be implemented, requiring Congressional appropriations. The Department of Defense's request for a rapid evaluation of the draft study meant that some potentially useful aspects of the committee's review could not be accomplished in such a short time frame. The DOD agreed that the committee should not be asked to estimate the resources required to imple-

ment the committee's recommendations. Nonetheless, the committee was cognizant of the limited nature of available funds. We discussed how limited resources should be managed to provide the most valuable information to the public, Corps, and Congress to inform their decisions concerning river and waterway management decisions and policies.

ECONOMICS

Spatial Equilibrium Model and ESSENCE

The Corps developed a theoretical spatial equilibrium model for the UMR–IWW feasibility study to help forecast future levels of barge traffic across the entire navigation system. This system model represents a major advance over previous economics models used by the Corps to forecast barge traffic. The committee recommends that this spatial equilibrium model be used as a foundation for the feasibility study. The Corps also developed the ESSENCE model, which calculates equilibrium values for barge traffic and waterway congestion and calculates changes in barge shipping costs that are consistent with waterway traffic forecasts and with past delay patterns at locks. The ESSENCE model does not, however, adequately use the most important concepts of the spatial equilibrium model that were advocated in the draft feasibility study.

Despite advances represented in the spatial equilibrium model and the ESSENCE model, many of the assumptions and data used as input to these models are flawed. The committee found that forecasts of future global grain demand did not adequately account for global or domestic supply and demand factors. In some instances, simple linear extrapolations were used in constructing demand forecasts, a practice unlikely to produce satisfactory results. The committee also found that assumptions regarding the sensitivity and variability of barge shipping rates were not empirically sound.

As a result of flawed assumptions and data, the current (September 2000) results of the spatial equilibrium model and the ESSENCE model should not be used in the feasibility study. The problem lies not in the theoretical motivation behind these models, but in their implementation and data used as input. To correct these problems, the Corps should: (1) obtain a satisfactory database of grain and other relevant freight shipments by barge and alternative modes which includes quantity, origin and destination, and price are included, (2) revise the ESSENCE model, eliminating assumptions that shipment costs are proportional to distance and that agricultural yields are uniform, (3) estimate demand and supply sensitivities to price from studies of current data, and assure that model parameters reflect these price sensitivities, and (4) include spatial equilibrium concepts in its ESSENCE model.

Managing Congestion

The locks and dams on the UMR–IWW system are presently not being used efficiently. Shippers and tow operators bear needlessly high costs because there is no traffic management system for the waterway. Shipments are delayed and costs are driven up by tows that sometimes

must wait many hours to pass through a lock, while at other times, locks sit idle. If barge traffic was distributed more evenly, congestion would decrease and shipping costs would fall. Rather than waiting for a decade for relief from the congestion by extending the locks, shippers and towboat operators could enjoy immediate improvements through better traffic management.

The committee noted that only a narrow range of alternatives for addressing waterway congestion on the UMR–IWW was assessed in the feasibility study. Several relatively inexpensive, nonstructural options exist for reducing UMR–IWW traffic congestion, including better scheduling, tradable lockage permits, and congestion fees. Furthermore, it is not clear how the benefits of lock extensions can be evaluated adequately without first managing waterway traffic more efficiently on the existing system. **Congress should instruct the Corps to explore fully these nonstructural options for improving traffic management as the baseline condition for the National Economic Development alternative and environmental evaluation of any proposal for lock extensions. A comprehensive review and assessment of the benefits and costs of nonstructural options for improving traffic management should be conducted. The benefits and costs of lock extensions should not be calculated until nonstructural measures for waterway traffic management have been carefully assessed.**

INLAND WATERWAY AND WATER RESOURCES SYSTEM PLANNING

Integrated Systems Planning

The committee found that the feasibility study lacks a comprehensive assessment of how changes in navigation might affect economic, environmental, and social systems. For example, the study does not describe the relations between the river's environmental resources and the substantial economies (tourism and recreation) that depend on those resources. Environmental effects of changes in barge traffic have economic implications, but these are not considered in the feasibility study.

A thorough analysis that supports informed decisions must address environmental impacts with the same comprehensiveness and sophistication that is now expected for the evaluation of the National Economic Development alternative. **The Corps should aim toward a more comprehensive and integrated assessment of the navigation system's effects on the environment in the UMR– IWW.**

The Corps has conducted many environmental investigations as part of the feasibility study. However, it is not clear how these environmental studies are incorporated into the decision regarding lock extensions on the Upper Mississippi. **The Corps should clarify the nature of the relations between environmental studies and the decision-making process regarding proposed lock extensions.**

Independent Review

The feasibility study is exceedingly complex, spanning more than a decade and costing over \$50 million. The ability to adequately conduct such an extensive study would test the capabilities of most federal agencies. The Corps' study is too important to not receive an independ-

ent judgment on the merits of the various approaches and a careful scrutiny of the analysis. The feasibility study would benefit from a second opinion from an independent, expert, and interdisciplinary body from outside the Corps of Engineers and Department of Defense. **Congress should thus direct the Corps to have the waterway system management and lock extension feasibility study reviewed by an interdisciplinary group of experts^{3/4}including environmental and social scientists^{3/4}from outside the Corps of Engineers.**

U.S. Federal *Principles and Guidelines*

The water resources project planning framework and criteria contained in the *Principles and Guidelines* are generally satisfactory and offer the Corps adequate flexibility to undertake comprehensive water resources and navigation system investigations. Corps of Engineers Headquarters has issued clarifying guidance that allows for such planning to proceed. For example, Corps district offices now have instructions to incorporate public values, especially in terms of serving both environmental and National Economic Development objectives, when defining planning problems and opportunities and formulating alternative plans. In addition, the Corps is expected to utilize modern analytical techniques such as system transportation modeling. However, for reasons not clear to this committee, this comprehensive planning framework is not reflected in the draft feasibility study. **The Secretary of the Army should ensure that the environmental consequences of proposed construction and operating practices be analyzed along with the National Economic Development account. Furthermore, environmental improvements—not just the mitigation of incremental environmental damages—should be examined as part of the navigation feasibility study.**

ENVIRONMENT

Environmental concerns have become increasingly important in the last three decades. Large-scale infrastructure changes last a long time, long enough for human and social perceptions and preferences to change significantly. Environmental groups and some government agencies have criticized the feasibility study, charging that it has not treated environmental issues and resources adequately. In the committee's judgment, environmental concerns are likely to become even more important in the future. Environmental concerns have become a core issue in the operation of inland waterway systems and should be treated as such in planning studies. The Corps should recognize the central importance of environmental issues and adapt its planning, engineering design, operations, and analysis accordingly.

Effects of the Navigation System on the Environment

The construction of dozens of locks and dams on the Upper Mississippi and Illinois rivers, the creation of a series of huge navigation pools, wing dams and other river-training structures, and barge traffic have had numerous and complex environmental effects. Although there has been some systematic research into the environmental effects of human and social activities

on the Upper Mississippi River (the federal Environmental Management Program being a good example), the understanding of the complex ecosystem dynamics in the UMR–IWW system is limited in many areas. The committee found that despite numerous environmental assessments conducted as part of the feasibility study, characterization of the current environmental system is insufficient, as it is in the early stages of scientific validation. The combination of past construction and continuing operations and maintenance continue to affect the river’s environmental systems. Gaps in current scientific understanding make it very difficult to accurately understand how additional changes will affect the river. Environmental studies on systemwide effects, cumulative effects, and site-specific effects are needed. **Systemwide research should be conducted on the following topics in the UMR–IWW: (1) cumulative effects of the existing navigation system on river ecology, (2) environmental effects of recent navigation system improvements, (3) cumulative effects of increased towboat passage, and (4) site-specific effects of future construction activities on the UMR–IWW.**

Congress should provide the resources for this research, but the responsibility for conducting this research not be shouldered by the Corps alone; relevant federal and state agencies should participate with the Corps in this research. Since the late 1980s, the Corps has participated in a federal, multi-agency environmental research program in the Upper Mississippi River—the Environmental Management Program (EMP). The EMP, with support of its participating agencies, has gathered much fundamental data on environmental changes in the Upper Mississippi basin. **Congress should continue to provide support for EMP-based research on the links between the navigation system and river ecology. The EMP research effort should be enhanced to improve assessment of the current navigation system's cumulative effects on the environment, and broadened to include studies of the impacts of barge traffic on river ecology.**

Adaptive Management

Adaptive management is a planning approach that strives to meet environmental, economic, and social objectives while keeping management policies flexible and adjustable. An adaptive management approach would be useful to the Corps in addressing and responding to the great environmental and economic uncertainties that attend UMR–IWW system planning. Components of an adaptive management strategy would include ecosystem monitoring, adjusting management policies in light of new information, recognizing the values of ecosystem resiliency, variability, and diversity, recognizing the limits of the river’s resources, and seeking to avoid irreversible decisions. **The Corps should seek the authority and funding from Congress necessary to conduct its navigation feasibility study based on the principles of adaptive management that have been articulated in the natural resources management literature.**

Adaptive Mitigation Strategy

The draft feasibility study describes a strategy for mitigating the environmental effects of incremental increases in barge traffic from lock extensions and from the site-specific impacts of construction. The draft study explains a strategy for monitoring the results of mitigation activities, and subsequent adjustments to those mitigation activities, described as an “adaptive mitigation” strategy. The steps in this approach are reasonable. But on a broader scale, this adaptive mitigation strategy is insufficient. The environmental effects of additional barge traffic and construction are not known with a reasonable degree of precision. Consequently, the extent to which these effects might be mitigated, and the associated costs, are also not known. The Corps’ approach to considering environmental resources only after locks have been extended is inadequate. In this approach, the environment is treated as a planning constraint rather than as a resource on par with waterway infrastructure investments. Moreover, the process by which adaptive mitigation measures would be identified, implemented, evaluated, and consequently adjusted, is not described. This process should include relevant federal and state agencies, as well as representation of the public. **The Corps’ adaptive mitigation strategy is inconsistent with the principles of adaptive management articulated in the natural resources management literature.**

ENGINEERING

If the UMR–IWW locks are extended, the costs of rehabilitating the existing, aging locks, would be greatly reduced. The Corps estimates that the savings through these reduced rehabilitation costs would be considerable. The committee reviewed the basis for these savings and their magnitude. The committee finds the Corps’ modeling approach to be sensible, however, benefits should be recalculated based upon new waterway traffic demand forecasts.

During the feasibility study, the Corps revised the contingency estimates for the costs of extending the locks. The committee recognizes the Corps’ expertise in designing and building structures such as locks and dams. The Corps proposes a novel method for lock extension. Although the Corps has not used the method, it has been used extensively. As the Corps gains experience with this method in modifying the first few locks, they should be able to estimate future costs more accurately and to find means to lower costs. However, many factors have escalated lock and dam costs in the past and it seems prudent to expect that construction costs might increase significantly due to a variety of factors. **A 25 percent cost contingency is likely to be too low, particularly since recent experience with Lock 26 suggests that major escalation of costs can occur.**