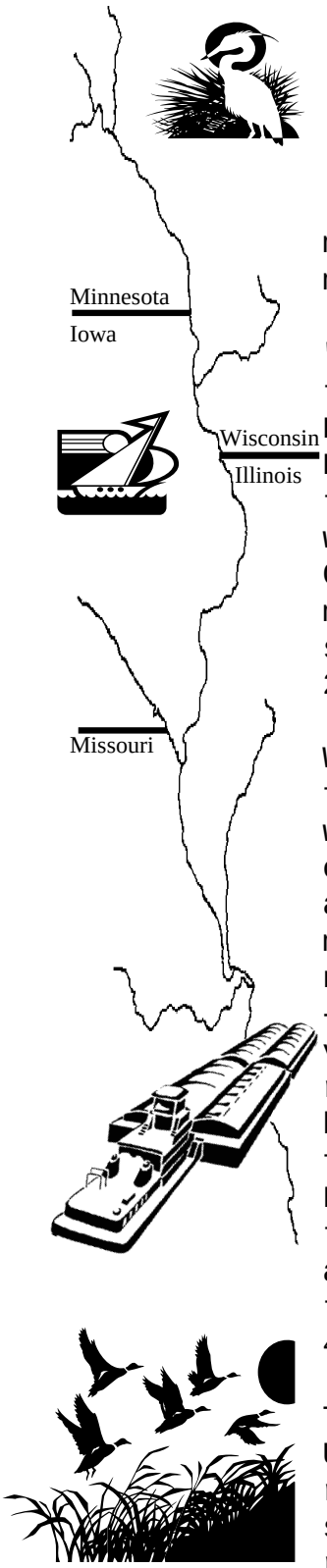
US Army Corps of Engineers

Upper Mississippi River - Illinois Waterway System Navigation Study

UMR-IWW System Navigation Study Newsletter April 1997 Vol. 4 No.2



Computer Simulation Model Demonstrated

From the computer screen, you can see the tiny towboats heading upstream. Within a minute or so, they are moving more slowly, and lines start to form at the miniature models of three locks and dams.

"The picture simulates the reality of current traffic along the Upper Mississippi River," says Dr. Don Sweeney, technical manager of the Economics Work Group and creator of the new traffic simulation model. But the model, which was demonstrated at the Feb. 18 meeting of the Governors' Liaison Committee (GLC), is even more useful when specifications are changed to show what happens when traffic is increased by 25 percent.

With more towboats on the system, congestion forms more quickly on the computer screen, with delays reaching more than a day at a lock, compared to an average of three-to-seven hours a tow in 1995. When a time savings of 20 minutes is applied per towboat – the preliminary estimated savings of a small-scale measure – the images change again, and the back-ups are visibly reduced. When the computer is told to reduce the average lockage time by about an hour to 40 minutes per double-lockage, traffic flows freely on the model with few delays. Forty minutes is a rough estimate of the average time a lockage would take after construction of a new 1,200-foot lock. The existing average time for a double lockage is about 1 hour and 40 minutes.

The simulation of actual traffic patterns along Upper Mississippi locks 25, 24 and 22 accurately reflects the workings of the entire river system, said Jeff Mammorstein, an operations research analyst who demonstrated the model for the Governors' Liaison Committee and Economics Coordinating Committee. The model illustrates the "cold start," he said, when traffic begins after the spring thaw and towboats start to move up-river. It then shows how traffic pulses through the system, eventually working its way downstream.

The model now is used in the St. Louis District for the "Lock 24 Major Rehabilitation Study" to illustrate what happens to the output of the entire river system if a single lock chamber is unusable or working at less than peak efficiency, Sweeney said. It will be applied to the Navigation Study efforts to help calculate the effects of any proposed measures for reducing traffic delays.

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Navigation and Construction Industries Come Together For Workshop

As part of the ongoing effort to determine the best way to reduce delays to commercial river traffic, the Engineering Work Group went straight to the people who'd be most able to answer questions related to potential improvements at lock and dam sites.

An "expert elicitation" meeting was held February 4 and 5 in St. Louis as a part of the Engineering Work Group's efforts to further narrow the number of large-scale and small-scale measures now under consideration. Expert elicitation is a recognized methodology to gather information from individuals with expertise in areas where historical record is not available to help make accurate estimates.

Representatives from navigation and construction industries meet in St. Louis.

In a meeting coordinated by the Sverdrup Corp., an engineering firm, the work group solicited comments on a variety of construction-related scenarios from members of the transportation and construction industries as well as operations, engineering and construction personnel from the Corps of Engineers.

"I think the greatest value (of the meeting) was the fact the information was developed as a partnership between the construction industry, the Corps of Engineers and the navigation industry," said Denny Lundberg, member of the Engineering Work Group.

"Determining the impacts of construction to navigation was put together not just by one of the individuals but as a whole partnership."

The study team is now screening potential methods for reducing congestion at the system's lock and dam sites. Remaining options include extending the existing 600-foot lock to 1,200 feet, completing or extending an auxiliary lock adjacent to the existing one, or building a new lock in the existing dam. Three alternative lock designs spanning a range of performance levels and life expectancy are being considered. The group also is looking at several small-scale alternatives, many of which require no construction.

There is little difference among the remaining large-scale measures under consideration in terms of construction costs, Lundberg said. The expert elicitation meeting was held to help define the costs associated with impacts to navigation and potential safety hazards.

Environmental impacts are being examined concurrently by the Environmental Work Group. The environmental impacts will be brought together with engineering performance and cost data as part of further plan formulation efforts.

Costs Explored

"There's a real cost if tows can't get through during construction of a new lock," Lundberg said. There also are potential dangers if towboats are forced to maneuver around long-term construction at dams.

"Much of the activities discussed were ways to minimize risk," Lundberg said. "This could be a pretty high-risk venture for the construction industry."

For the February meeting, the Sverdrup Corp.

invited representatives from four construction companies and four navigation companies, including three tow boat captains. Several Corps of Engineers employees also participated. During the two-day session, the experts were given an overview of the entire Navigation Study, then questioned on potential impacts and/or estimated durations of individual tasks needed to complete a given construction project.

They were asked, for example, how long it would take to drive pilings, excavate materials and place so many yards of rock for a particular construction job, Lundberg said.

Information also was solicited on issues like how long it would take for a tow boat to get from "point A to point B" if a switchboat was provided to help pull an unpowered cut from a lock, and how much time would be lost maneuvering through construction-related obstacles.

Methods were used to account for the participant's relative level of expertise on each question and for a variety of construction conditions.

The findings have been forwarded to the Economics Work Group to define costs associated with impacts to navigation.

"Hopefully, we'll be able to use this as an additional screening tool," Lundberg said. "If the magnitude of impact to navigation of a particular (construction) measure is very, very high, that measure is going to drop out."

On the other hand, it is possible that a specific alternative could emerge as so attractive that it would become the likely team recommendation, Lundberg said.

Much of the information gained in the meeting, however, will be saved and used for consideration during the design phase if the study results indicate improvements are needed. ❍

COMPUTER MODEL

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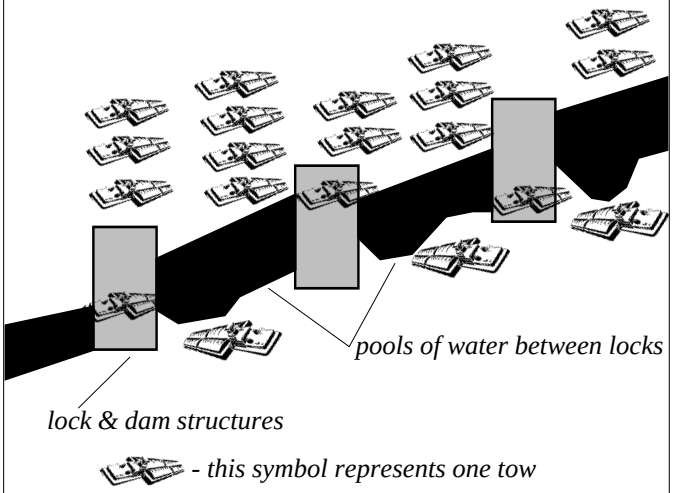
Although the display model simulates traffic flows at three locks, the actual model used by the Navigation Study team includes all 37 locks on the system and accounts for both the Upper Mississippi River and Illinois Waterway.

What the model will be able to show is whether a savings of even 20 minutes per lockage can make a difference at various congestion levels. The display model indicates that in some situations putting a small-scale measure in place provides noticeable relief.



This diagram illustrates the computer simulation model that assesses commodity movement and traffic delays on the Upper Mississippi River System. Tows on the top and in the lock and dam structures are traveling upbound and the tows on the bottom of the diagram are traveling downbound, typically loaded with commodities. The tows stacked on top of each other at the locks represent the lines that form while waiting to lock through.

"You still get some congestion, but nowhere near what you get in the without-project condition (without making any navigation improvements to the current system)," Sweeney told the governors representatives from the five participating states. "Clearly the small-scale measures buy you something." The larger construction measures, on the other hand, provide even greater benefits but involve more up-front costs, he said. ❍

Freshwater Mussels Studied

Drs. Drew Miller and Barry S. Payne, of the U.S. Army Engineer Waterways Experiment Station (WES), have been conducting a series of studies to evaluate the environmental effects of commercial navigation traffic on freshwater mussels.

Freshwater mussels (also referred to as clams, naiads, or unionids) spend their entire adult life partially or wholly buried in mud, sand or gravel in permanent bodies of water. Found on every continent except Antarctica, freshwater mussels are most diverse in eastern North America, where they number nearly 300 species. Their large shells make mussels the most conspicuous mollusks in the waters of the Midwest.

The mollusks serve as a good indicator of the health of freshwater aquatic systems. More than 40 types can be found in the Upper Mississippi River system, including three listed on the federal endangered species list: the higgins eye pearly mussel; the fat pocketbook pearly mussel; and the winged mapleleaf.

Freshwater mussels were chosen as a significant Upper Mississippi River resource because they are both an important biological resource as well as an economic resource. Young mussels are an important food source for a number of species of fish, muskrats, minks, otters, and some birds.

Freshwater mussel (narrow papershell) typically found in the Mississippi.

In the late 1800s and early 1900s, enormous numbers of freshwater mussels were harvested to make pearl buttons for clothing, and button-making was a multi-million dollar industry. By 1912, nearly 200 factories were operating in towns such as Muscatine and Keokuk, Iowa and Peoria and Beardstown, Ill. The pearl-button industry collapsed with the invention and widespread use of plastics in the 1940s and1950s, and some freshwater mussel populations subsequently recovered.

Today, a few species are collected commercially and sold to the Japanese. The shells are used to produce nuclei for starting cultured pearls.

As part of the Navigation Study, the effects of increased water velocities and suspended sediment on the physiology and general condition of the mussels have been evaluated in the laboratory. Changes in basic physiology have been monitored by looking at such factors as filtration rate, oxygen consumption and nitrogen excretion. General conditions have been measured by evaluating changes in tissue weight. Preliminary analysis of data indicate that increased traffic levels associated with navigation improvements will not significantly affect mussels.

Initial Laboratory Results

In a field study being conducted near Prairie du Chien, Wis., mussels were collected from two locations, one with a high level and one with a low level of commercial navigation traffic. A preliminary analysis of data indicates the reproductive potential has not been impacted in the high traffic area.

In another field study, mussels were fitted with monitors which indicate when they open and close their shells. The object of this study is to see how mussels respond to navigation traffic. Do they shut their shells and stop feeding or is there no response? Data are still being analyzed, but some early results show they feed by day and stop at night. In addition, they appear to briefly stop feeding when small recreational boats pass over a mussel bed. The analysis of towboat impact on feeding has not yet been completed.

Dr. Miller has teamed up with Dr. Steve Maynord of the Hydraulics Laboratory at WES to look at the physical forces required to scour a mussel bed. This work is currently underway. An artificial mussel bed was built in an artificial stream and velocity was gradually increased to determine when the bed would erode.

"As a result of conducting all of these studies we have not seen dramatic biological effects caused by passage of commercial vessels," said Dr. Miller, who has been evaluating the effects of navigation traffic on mussels for the last 15 years. ❍

Regional Economic Analysis Model Developed

How would changes to the navigation system impact the economics of the five study area states?

That will be examined for representatives of the states of Minnesota, Illinois, Iowa, Wisconsin and Missouri as part of a "Regional Economic Development Analysis" portion of the Navigation Study.

The model will evaluate the income and employment benefits resulting from the regional distribution of the three primary benefit categories: transportation savings, water compelled rates and construction. Water-compelled rates are the degree to which water transportation availability moderates the cost of other transportation such as rail. When the analysis is complete, it will provide valuable information to states about how project benefits are spread throughout the region, said Dennis Robinson, an analyst with the Institute for Water Resources who will conduct the study. However, national benefits rather than regional benefits will be used in determining the federal interest of any project.

Robinson gave a presentation to the Economics Coordinating Committee Feb. 18, illustrating the impact of a hypothetical $100 million construction project along the Illinois Waterway.

Robinson created the project as an example and used the multi-regional input-output model being developed for the analysis to give the committee members an idea of the kind of information they'll have access to when final study recommendations are determined. In order to simplify the example, he analyzed just the construction benefits. If a construction project costing in the range of $100 million with a one-year construction season actually were built, it would generate $203 million in goods and services and $66.9 million in wages and would create 2,250 jobs in a single year, Robinson said. Just looking at the construction impacts significantly understated the total regional benefits expected from all three categories; however, it does demonstrate the type of information that will be generated by the analysis as part of the Navigation Study.

Regional Benefits

Based on the assumptions used in the example, just over half of the benefits would be gained in the state of Illinois (where the hypothetical project is based), about 20 percent in the eastern United States, 15 percent in the western United States, 4 percent in the lower Mississippi Valley, 2.5 percent in Wisconsin and between 1 and 1.7 percent in the other study states. However, the model is sensitive to the assumptions made regarding the type of improvements made, materials used, and total labor costs. Actual information on these variables will not be known until later in the study.

> *The model will evaluate regional benefits from transportation savings, water compelled rates and construction.*
>
> - Dennis Robinson, an analyst with the Institute for Water Resources.

The next step in this analysis is to continue the updating and refinement of the model to account for study specific information. Once the model is complete, a training session will be provided to allow Study Team and Economics Coordinating Committee members to get hands-on experience using the model.

A Note: On April 1, the Corps of Engineers announced a restructuring that has placed the three study districts under a single division for the first time. The St. Paul, Rock Island and St. Louis districts are now part of the Mississippi Valley Division based in Vicksburg, Mississippi. The division also includes the Memphis, New Orleans and Vicksburg districts.

Traffic Forecast Adopted

Association Members Voice Concerns

A draft report showing a steady increase in river traffic on the Upper Mississippi between 2000 and 2050 was accepted as complete by study team members and the Division Engineer on April 4.

In written comments submitted to the Corps of Engineers, several representatives of the grain and transportation industries said the numbers were too conservative. But consultants stood by traffic projections, which estimate a 63 percent increase in barge traffic over the next 50 years.

"Upon considering the comments, we believe the assumptions we made were valid," said Donald Frahm, vice president of Sparks Companies, Inc., which did the grain-related projections for the Jack Faucett and Associates traffic forecast report. While many of the estimated 100 comments submitted to study contractors will lead to clarifications in the text of the forecast, the numbers will not change, Frahm said at a February presentation to the Economics Coordinating Committee in Chicago.

The forecast predicts an average growth rate of 2 percent per year on the Upper Mississippi River during the remainder of the 1990s, then a slightly lower increase of 1.5 percent a year between 2000 and 2005 and an approximate 1 percent growth rate during the remainder of the study period. The Illinois Waterway is expected to see a similar trend.

Grain Traffic Debated

The largest increase is projected to come in the volume of grain carried on the river. Grain, prepared animal feed and agricultural chemicals are forecast to move from half of total river traffic in 1988 to two-thirds of total traffic in 2050. Tonnage of corn carried on the river is predicted to increase from 27 million tons in the early 1990s to 46 million tons in 2010, 58 million tons in 2030 and approximately 72 million tons in 2050.

The amount of U.S.-produced grain needed to meet world demand in coming decades is likely to be higher than that, according to some groups representing the grain and barge industries. United Grain Council President Kenneth Hobbie says the estimated 1 percent increase in feed grain projected over the 50-year study period doesn't take into account the fact that China recently became an importer of U.S. corn. The grain council expects an increase of 2.5 percent a year for at least the next 10 years, he wrote.

"Without an aggressive approach to waterway improvement, you will be crippling the competitive position of the U.S. as the pre-eminent supplier of feed grains to the world," he wrote in a letter urging forecast revisions.

The study methodology, which determined future export numbers by estimating land production capabilities then subtracting what the U.S. market is expected to consume, was questioned by Bill Hudson, who submitted several pages of comments on behalf of the National Corn Growers Association. Hudson said exports are the "driver" of future grain needs, rather than a market for the residuals or leftovers of production.

"History assures us that the future volume of corn exports will have a rising trend," Hudson wrote. "However, history assures us even more so that there will be significant volatility around such trends. The smooth trend given in the JFA report is the least likely outcome."

To come up with the navigation study forecasts, consultants used a standard accounting formula which was explained by Chris Holleyman, a representative of Jack Faucett and Associates. While he said the grain-related section of the forecast was based on a continuation of the linear growth trend seen in grain over the past 25 years, it also takes into account several other factors.

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TRAFFIC *continued from page 6*

Many Factors Considered In Forecast

The forecast already includes factors such as the 1996 "Freedom to Farm" Bill, which allows farmers to plant as much grain as they want and whatever type of grain they want, as well as expected future variations of this legislation. It also assumes continued strong economic growth in major consuming areas of the world and that U.S. production will increase to meet the demand, according to the written responses to comments provided by Jack Faucett and Associates, the authors of the forecast.

Frahm said his personal bias was to show a faster pace of growth due to current or pending technological advances like fertilization and global positioning -- another suggestion made by several interest groups who commented on the study. But he said he could find no "objective" basis for doing so. And regardless of future world demand, he added, the U.S. only has a limited amount of land for growing crops.

"We've changed significantly in the way we till ground, the way we manage weeds and insects," Frahm told the Economics Coordinating Committee. "All these things were subject to the technical advances of the last 25 years... We couldn't find alternatives that would improve statistically or logically upon the last 25 years."

In conclusion, Paul Bertels, an economist for the U.S. Department of Agriculture and a member of the Economics Coordinating Committee, said he believes the contractors did an outstanding job overall.

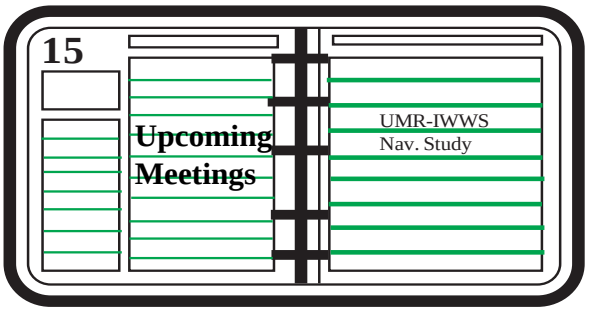
"Trying to forecast out 50 years what'll happen is a somewhat ludicrous thing to try given the increasing uncertainties in projecting that far into the future, but overall, using the methodology employed, the numbers seem reasonable."

He suggested, however, that contractors add a section to the forecast that explores how grain markets fluctuate. The appearance that export growth will occur in a straight-line trend does not reflect what will actually happen, he said.

In asking for final comments on the forecast from the Economics Coordinating Committee, Dr. Don Sweeney indicated that acceptance of the forecast will allow the study team to move ahead in narrowing the options under consideration by the Navigation Study. The study team will take into account the "risk and uncertainty" of the forecast and factor in the possibility the numbers could be higher or lower than the forecast in any year. However, the numbers are key in determining the need for and timing of potential navigation improvements.

"These are not hard numbers, they're probabilities," Sweeney told the committee. "What they mean is our job to figure out, with your help. . . Short of modeling the whole world, they're not bad."

Upcoming Meetings



Economics Coordinating Committee
May 20 - Renaissance St. Louis Hotel-Airport
9801 Natural Bridge Road
St. Louis, MO
10 a.m. - 3 p.m.

Governors' Liaison Committee
May 20 - Renaissance St. Louis Hotel-Airport
9801 Natural Bridge Road
St. Louis, MO
3:30 p.m. - 6:30 p.m.

Navigation Environmental Coordination Committee
September - Holiday Inn
Moline, Ill.

Small-Scale Measures: An In-Depth Look

Small-scale measures for reducing delays to commercial navigation are being given increased attention as the Navigation Study moves forward. Here we continue a closer look at them by focusing on two related measures that are among the 16 being examined by the study team. The January issue discussed the use of powered traveling kevels, extended guidewalls and helper boats.

ADJACENT MOORINGS are structures that provide a waiting area where tows can tie-off near a lock. Adjacent moorings can help improve lock efficiency in two distinct ways.

First of all, they are useful when a channel is so narrow that tows can't pass each other easily, requiring them to wait several miles from the lock when another tow is going through the lockage process. A tow heading downstream at Lock and Dam 22, for example, may have to wait four miles upstream of the lock as a tow heading upstream clears the channel and passes by before it can get into the channel to make the approach into the lock. The mooring facility could provide a spot next to the lock where tows could safely wait.

The second, and potentially more significant benefit would involve the use of a mooring facility in conjunction with the switch boat measure described here in more detail.

The options for moorings types include spud barges, moored barges, Delong piers, timber pile clumps, mooring cells, or in some cases a waiting tow.

A **SWITCH BOAT** would make use of a mooring facility after removing an unpowered cut of barges from the lock chamber during what is called a double-lockage process. A double lockage occurs when a 1,200-foot tow goes through the existing 600-foot lock by sending half (a cut) of its barges through the lock without the towboat. The boat then would go through the lock with the remaining barges and reconnect them with the others outside the lock.

A switch boat would pull the unpowered barges to the remote mooring facility to wait for the towboat, out of the approach path to the lock. This would make the lock available sooner for the next tow waiting in either direction. This saves time over the current procedure where tows remake while still partially in the chamber.

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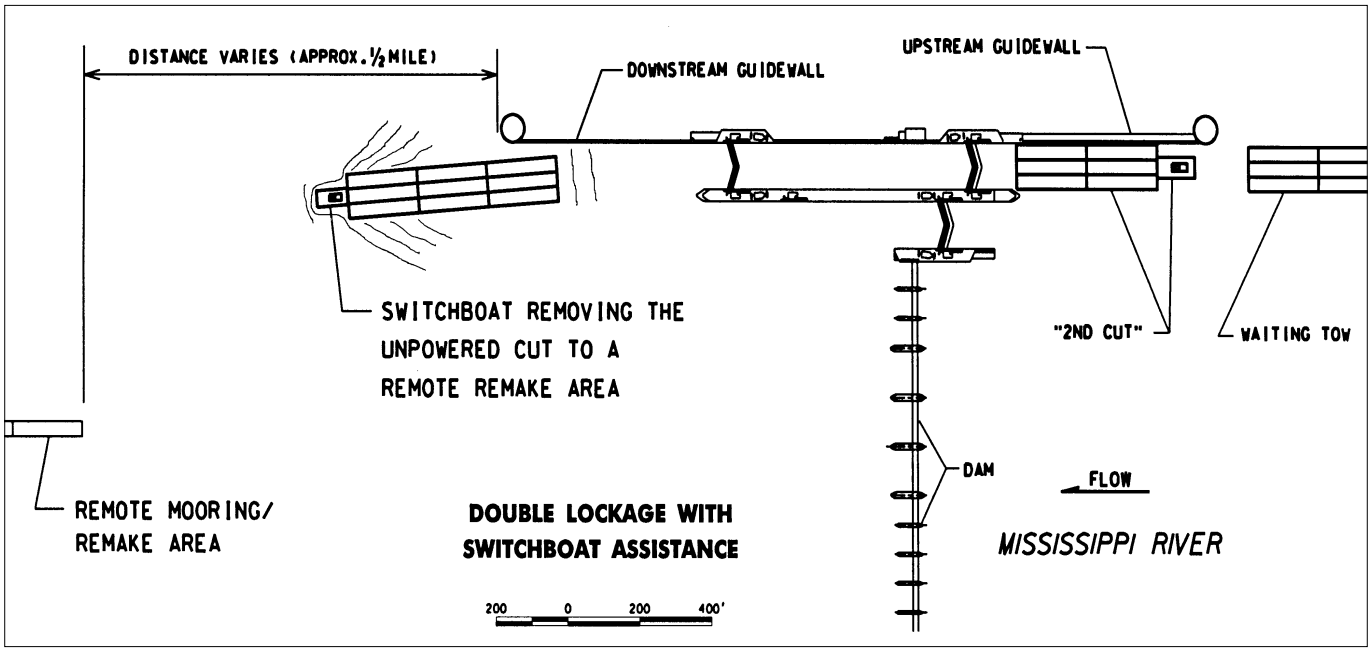

Illustration of a switch boat and mooring facility in use.

SWITCH BOATS *continued from page 8*

Switch boats, which have approximately 1,200 horsepower, also can save time by helping tows approach the locks during dangerous flow conditions and by moving ice and debris out of the way.

In most cases, the use of switch boats requires construction of two mooring facilities -- one above and one below the lock.

Unlike helper boats, which pull unpowered barges along an existing or extended guidewall and only out of the way of tows heading the same direction, the switch boat clears the way for lockages in either direction.

Preliminary figures show that using a switch boat to moor an unpowered cut to a mooring facility would save an estimated 15 to 30 minutes per double-lockage. That includes an estimated 5-to-10 minute saving from pulling out the unpowered cut, and 10 to 20 minutes of savings by keeping the unpowered barges from blocking the lock chamber during its remake.

Switch boats also can reduce the basic lockage time for downbound double lockages because they allow water to be released at a faster rate during lock chamber emptyings.

Under current procedures, an unpowered cut is pulled out of the chamber and tied off along the existing guidewall directly below the lock chamber. Because the full force of emptying the chamber when locking the second cut could break the lines holding the tow, water is released at a slower rate. If a switch boat were used to pull the first cut to a mooring facility away from the lock, the water could be released at a faster rate. ❍

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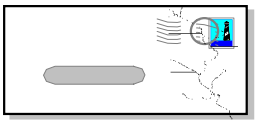

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If we do not receive a response, we will continue sending you a newsletter at the current address on our data base. ❍

In Brief...

❍ The GLC was given an update by project manager Mark Gmitro on the revisions being made to the Project Study Plan. The revisions were made to account for approved changes to the study that had previously been made and coordinated, additional efforts required by Corps headquarters, and the balancing of cost estimates both higher and lower than original projections.

Items already approved but not yet recorded in the study plan include expansion of fish, plant and math model studies as well as the inclusion of a cumulative impact study, a Regional Economic Development Study, and additional environmental decision points and engineering funding.

❍ The Economics Work Group provided scopes of work on the "Emissions and Fuel Use" and "Accidents and Hazardous Spills" studies to members of the study team for review. The Emissions and Fuel Use study will compare rates for water, rail and truck transportation. The Accidents and Hazardous Spills effort will focus on rail and truck modes for comparison with data which already has been collected on waterways.

Questions?

❍ For general study information, call Mark Gmitro project manager, at 309/794-5279 or write to the address below, ATTN: CEMVR-PP-M or visit our home page at: **http://ncrsun7.ncr.usace.army.mil/nav_study.html.**

❍ For information on Public Involvement meetings, call the toll-free telephone number, 800/USA(872)-8822. Meeting announcements will be in the Public Involvement menu. Or call Kevin Bluhm, public involvement coordinator, at 612/290-5247, or write to the address below, ATTN: CEMVR-PD-C/Bluhm.

❍ To be added to the mailing list for future newsletters, study updates, and meeting announcements, write to the address below, ATTN: CEMVR-PD-C, or call the toll-free telephone number and leave your information in the Public Involvement menu.

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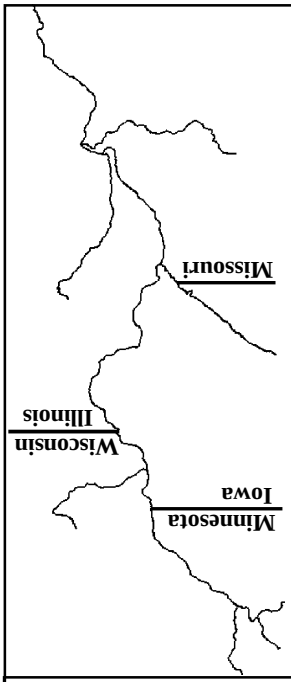
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