Old Man River

"On March 30, 1938, Dam No. 3 was completed and accepted for the United States by Colonel Fleming. On May 13, 1938, Dam No. 9 was likewise accepted…. Although many small improvements remain to be prosecuted before the work is complete, the obtaining of the Nine-Foot Channel in the entire St. Paul District constitutes a milestone in the progress of the great undertaking. It was thought, therefore, that a review of the project in so far as it applies to this stretch of the river is in order." (L.E. Wood, Junior Engineer, "A Nine Foot Depth in the St. Paul District below St. Anthony Falls!" Old Man River, Vol. 5 No. 5, May 1938)

Many years have passed since Junior Engineer Wood wrote these words. The "great undertaking" he referred to was the construction of the Mississippi River Nine-Foot Channel Locks and Dams Project. During the 1930's, the United States Army, Corps of Engineers, built 24 locks and dams between Red Wing, Minnesota, and St. Louis, Missouri, and modified 3 existing locks and dams in an effort to secure a reliable, efficient, and cost-effective navigation route for the Midwest. Three Corps Districts each worked on a segment of the project. The St. Paul District built Locks and Dams 3-9, Rock Island District 10-22, and St. Louis District 23-26. Fifty years ago, the St. Paul District finished its part of the undertaking. (Rock Island completed its locks and dams one year later and St. Louis finished two years later.) Just as Junior Engineer Wood thought half a century ago, we think that a review of the project as it applies to the St. Paul District is in order.

Joseph Briggs
Colonel, Corps of Engineers District Engineers
District Engineer

The Demand for Improvement: Men of Vision /td>

Wing dams on the Upper Mississippi River

Congress authorized the Corps of Engineers to construct the Mississippi River locks and dams because of the rapid growth of population, agriculture, and industry in the Upper Midwest after 1900. By 1920, railroads could not handle all the goods produced and demanded by Midwesterners and often charged monopoly rates. The Mississippi River, once the principal artery of commerce in the Midwest, was inadequate for modern shipping needs in its natural condition. And as shipping costs increased, the growing numbers of Midwest businessmen and farmers demanded a cheap and efficient transportation system. Without such a system, they believed, their region could not compete in either national or international markets. For this reason, they argued, the Midwest would stagnate; its booming cities would become prairie towns again, and its economy would not mature.

Since the mid-19th century, the Corps had improved the Mississippi River for navigation through dredging, snagging and clearing, and channel constriction. The latter procedure began with the authorization of the 4 1/2-foot channel in 1878 and continued with the 6-foot channel in 1907. Channel depth was based on the low-water year of 1864; ideally, if another year as dry as 1864 occurred, there would be at least 4 1/2 or 6

feet of water for navigation. The Corps constricted the river with wing dams and the closing of side channels. Together, these measures forced the river down a narrower passage, allowing it to cut through sand and debris in the main channel. The Corps also completed Lock and Dam No. 1 in the Twin Cities, in 1917, and Lock and Dam No. 2 at Hastings, Minnesota, in 1930, because wing dams were inadequate in these areas. The 4 1/2- and 6-foot channels sufficed for rafting lumber and for the shallow draft packets, tows, and barges of the late 19th and early 20th centuries, but could not meet the demands of modern business and agriculture.

Commercial use of the Upper Mississippi River declined after 1892 as the timber industry --- its primary user --- exhausted the region's forests. In 1892 lumbermen shipped a record 5,113,913 tons of logs and lumber on the river between St. Paul and the mouth of the Missouri River. By 1916, the total for all goods shipped on this reach of the Mississippi River fell below 1 million tons annually and did not recover until the 1940s.

Steamer and log raft near Alma, Wisconsin

Other factors aggravated the Midwest's transportation problem. With the completion of the Panama Canal in 1914, goods could be shipped more cheaply between the East and West Coasts than from the Midwest to either coast. The Midwest had, in effect, moved economically farther from the coasts than the coasts were from each other. As a result, Midwest businesses could not compete as easily with businesses on the seaboards. Some Midwesterners believed that since the Federal Government had built the Panama Canal, it should compensate them with a 9-foot channel on the Upper Mississippi River.

In the early 1920s, the costs of shipping in the Midwest increased further. The Interstate Commerce Commission, in the Indiana Rate Case of 1922, determined that the Mississippi River was not an effective transportation route and ruled that railroad rates should no longer be set against the lower waterway rates. When freight rates rose again, several important Minneapolis businesses moved to a region with lower transportation costs.

Rising transportation rates struck Midwest farmers hard. American agriculture had been in a depression for most of the 1920s. With higher freight rates, the purchasing power of farmers decreased and their crops became less competitive, strapping them even further.

While shipping on the Upper Mississippi River declined, traffic on the lower river increased. New towboats and barges, with drafts of eight and one-half feet, could haul two to four times as much cargo as freight trains. These new developments in shipping on the lower river demonstrated the promise of a deep channel on the upper river, but the new towboats and barges could not operate on the shallower Upper Mississippi River. Goods had to be transferred to smaller towboats and barges, increasing shipping costs greatly. This breaking of bulk, as rivermen called it, discouraged use of the Upper Mississippi River.

Because of this limited and costly transportation network, many Midwesterners feared that their region would stagnate or decline. Not only would businesses decide not to locate in the Midwest, those already there would leave.


President Hoover
Courtesy of MN Historical Society

As a result, businessmen, civic leaders, politicians, and farmers joined to fight for the 9-foot channel project. The principal champions of the project were Secretary of Commerce and later President Herbert Hoover, Minnesota Senator Henrik Shipstead, and businessmen such as retired Colonel George C. Lambert, S.S. Thorpe, C.C. Webber, and A.C. Wiprud. Secretary Hoover believed that improving America's inland waterways would solve the farm crisis and better integrate the nation's economy. More than any other advocate he made the 9-foot channel a national issue.

Senator Henrik Shipstead led the fight for the project in Congress, not only for its authorization but for its funding after the stock market crash of 1929. And Lambert, Thorpe, Webber, Wiprud and others, working for the Upper Mississippi and St. Croix Improvement Commission, the Upper Mississippi Waterway Association, and the Minneapolis Real Estate Board, mobilized businessmen and farmers from New Orleans to Minneapolis in support of the project. By 1927, they had succeeded in getting a survey for die feasibility of a 9-foot channel on the Upper Mississippi River, and by 1930, Congress had authorized the construction of 24 locks and dams from Red Wing, Minnesota, to near St. Louis, Missouri.


FDR at Lock and Dam
No. 5, Aug. 8, 1934

The Great Depression, however, threatened to postpone construction. Hoover, now President, withdrew his support for the project because he did not believe in deficit spending, and he approved only small expenditures for the project. Fortunately for the Midwest, his successor, Franklin Roosevelt, not only recognized the project's commercial importance, but he saw it as an opportunity to put thousands of unemployed citizens to work. And in contrast to Hoover, Roosevelt accepted deficit spending as a way to improve the economy. In 1933, he signed the National Industrial Recovery Act, providing $51,000,000 for the project through the Public Works Administration, $33,500,000 of which became available immediately. Now that the Corps had money for the project, it had to work out the details of building such a massive undertaking.

The Project

The Mississippi River posed unique problems for the Corps of Engineers. While the Corps had completed a 9-foot channel project on the Ohio River in 1929, the Mississippi River required a different approach. In response to the problems encountered on the Upper Mississippi River, the Corps developed many innovative and precedent-setting solutions. As the project advanced, the Engineers incorporated experiences learned along the way. Consequently, the locks and dams embody a history of dam engineering technology.


Tainter gate construction

Special Conditions on the Mississippi River

According to a Corps survey completed in 1931, the Upper Mississippi River presented some "unusual" design problems. The floodplain varied from 1/2 to 2 miles across at the proposed lock and dam sites. Because of this wide floodplain, the Mississippi River had relatively low flood stages. At the upper end of the project, the maximum flood stage was about 18 feet, and at the lower end it reached 21 feet. In contrast, the, Ohio River ranged 69 feet from low to high water. Railroads, farms, and some small towns encroached upon the Mississippi River floodplain or the lands just above it. In addition, ice ---12 to 24 inches thick --- formed in the river during the winter. When the ice broke up in the spring, it gouged the riverbanks and most obstacles in its path. Finally, the Upper Mississippi Wild Life and Fish Refuge lay between Lake Pepin and Rock Island. A high dam would have inundated wetlands and other wildlife areas only seasonally flooded before. Because of these conditions, the Corps carefully evaluated the type of lock and dam system to use on the Mississippi River.

Selecting a Lock and Dam System

After intensive surveys on the Upper Mississippi River and an extensive inspection of dams in Europe and the United States, the Corps of Engineers decided to build a lowcrest, non-navigable dam. High, fixed dams would have flooded the railroads, farmlands, and buildings in or just above the floodplain. And navigable dams --- dams that allowed open river navigation during high stages --- such as the Chanoine wicket dams of the Ohio River, could not be used on the Mississippi River because of the short duration of high stages. While low crest dams were more expensive, they were more dependable, easier to maintain and repair, safer to operate, and sustained an operational channel better than navigable dams.

The selected dam contained a number of elements: dikes, spillways, and both Tainter and roller gates. Each type of gate had been used in dams before, but general dam engineering practice discouraged the use of both types in one dam. By incorporating both gates into their dams on the Mississippi River, the Corps established a precedent in dam engineering.

Roller gate construction

Invented by Wisconsin lumberman Theodore Parker and patented by Jeremiah B. Tainter in 1886, Tainter gates became the principal component of the dam. The Corps chose these gates for the main part of the dam because they were cheaper than roller gates and still offered dependable operation. Tainter gates, however, were ineffective for spans greater than 35 feet, and some channel openings had to be wider than this to accommodate the passage of ice and debris. Also, Tainter gates were difficult to maneuver during cold weather because ice often formed on them. Roller gates solved both the problems of length and icing.

Swedish engineer M. Karstanjen invented the roller gate about 1900, and the Krupp and M.A.N companies, in Germany, patented it. The gates are large cylinders with toothed ends that mesh with an inclined track set into the piers at the ends of the gate. Large, electrically operated gears on top of the piers raise and lower the gate. While roller gates had not been used extensively in the United States, Scandinavian countries had used them for many years under severe ice conditions. Roller gates offered the greatest assurance of operation in freezing weather with a span of 80 feet or more between the supporting piers.


Lock construction

"In general," the Engineers concluded, "the dam will be composed mainly of Tainter gates, with a sufficient number of roller gates to pass running ice and drift, and to provide ample capacity for the greatest flow likely to occur during the winter months." To ensure the greatest economy in design, construction, and operation, the Engineers recommended that gate size be standardized. Consequently, all the New Deal era Tainter gates in the St. Paul District are 35 feet wide, and all the roller gates, except Nos. 4 and 5, are 80 feet wide. The roller gates at dams 4 and 5 are only 60 feet wide because they were the first two built in the District, before the mid-1930s when advances in roller gate technology allowed for wider gates.

The Corps patterned the Mississippi River locks after those on the Ohio River. All of the New Deal locks are 110 feet wide by 600 feet long, and the lock chamber fills through the opening of Tainter gate valves in the lock walls. The use of these gates as valves was characterized as "somewhat unusual."

Unusual, unique, and innovative are terms that characterize the 9-foot channel project on the Upper Mississippi River. To deal with the unusual conditions on the river, the Corps built models of most of the project's elements. According to Martin Nelson, chief of the Corps hydraulic laboratory at the University of Iowa, Iowa City, during the planning and construction of the 9-foot channel, the Corps built models to study the feasibility and operational limitations of roller and tainter gates, and to gather information on the "hydraulic loadings on which to base the structural design…." They also fabricated small scale models to examine how to improve the hydraulic systems for the locks. And, Nelson reported, the Corps undertook model experiments on "such problems as the feasibility of discharging water over protected sand dams; the effect of percolation through sand foundations on the conditions of failure; determination of coefficients of discharge of weirs, gates, orifices, tubes, etc." The use of model studies was a new development in the 1930s, and, Nelson claimed, "Confidence in this tool of engineering has been greatly aided in this country by the attitude of the Corps of Engineers which has used it as a means of solving some of the most complex problems involved in river flow."

Despite the great amount of time spent in research and testing, the St. Paul District completed its portion of the 9-foot channel project in only 7 years. The quickness and soundness with which the Corps of Engineers constructed the project demonstrated its feasibility from an engineering perspective. The chief test remained: Would navigation increase to justify the great expenditure of public funds?

Commercial Navigation: The Vision Realized

During one of America's worst depressions, Congress provided the Corps of Engineers with over $170 million to build the Mississippi River 9-foot channel project. While the project created jobs for thousands of men and women, not even its proponents justified it solely as a make-work project. Its validation depended upon the development of commercial navigation on the Upper Mississippi River.

Commercial traffic on the river began increasing even before the St. Paul District had completed its reach of the 9-foot channel project. Old Man River, a District newsletter, reported that river traffic for 1937 had expanded 100 percent over 1936 and increased even more in 1938. While World War II stalled the Mississippi River's commercial development, navigation on the river soared after 1945. Within 5 years of the wars end, shipping on the river more than doubled from 4 1/2 million tons to 11 million tons. By 1960, it had more than doubled again to over 27 million tons. Today, barges carry nearly 80 million tons of goods annually on the Upper Mississippi River.

Energy commodities --- petroleum products, coal, and coke --- spurred the revival of river commerce. Grain shipping increased slowly, however. Not until the mid-1950s did grain comprise a significant portion of the commodities transported on the river.

Today, agricultural products account for nearly one-half of all goods shipped on the Upper Mississippi River.

Proponents of the 9-foot channel project based their projections for the Mississippi River's commercial expansion upon towboats of up to 2,000 h.p. and tows of some 14,000 tons. Now, towboats of up to 5,000 h.p. and tows carrying more than 22,000 tons operate on the Upper Mississippi River. The variety of barges has increased as greatly as their capacity. Open barges carry coal, tank barges haul petroleum, and covered barges transport grain and other perishable cargoes. Some barges have foot-thick linings of specially treated balsa wood for carrying liquid methane gas at minus 258 degrees Fahrenheit, and other barges transport molten sulfur at temperatures of 300 to 350 degrees. Specialized barges also haul carbon black, anhydrous ammonia, and cement. The variety of barges indicates the diversity of goods shipped on the Upper Mississippi River today.

The Mississippi River 9-foot channel works as those who had envisioned it predicted. Both farmers and urban consumers benefit from the project. Bulk shipping of energy products has reduced the costs of consumer products and of manufacturing goods. The cost of shipping agricultural products also has fallen with the river as a dependable means of transport. Because of the 9-foot channel, the Midwest has a cheap and reliable transportation route providing both an outlet for its products and an inlet for the goods it needs.

The Corps has continued to improve the Upper Mississippi River for navigation since the New Deal. In 1948, the St. Paul District replaced the 500-foot long lock at Lock and Dam No. 2 with the standard 600-foot lock. In 1937, Congress authorized extending the 9-foot channel above St. Anthony Falls, in Minneapolis, Minnesota. This 4.6-mile expansion of the project called for constructing two additional locks and dams: one at the upper falls and one at the lower falls. World War II, problems with flowage rights, and utility and bridge alterations delayed construction of the St. Anthony Falls project until 1950. The St. Paul District completed the Lower St. Anthony Falls project in 1959 and upper lock and dam in 1963. Because of severe structural problems, the St. Paul District reconstructed the locks at Locks and Dam No. 1 between 1979 and 1983.

The Future

The Corps of Engineers has begun a major rehabilitation effort for most of the 9-foot channel locks and darns. Under this project the St. Paul District will spend approximately $170,000,000 over the next 15 years to repair and upgrade the 50-year old structures. This effort will insure at least fifty more years of navigation on the Upper Mississippi River.

The 9-foot channel project is part of the country's 25,500 miles of navigable inland waterways. The Mississippi River and its tributaries account for approximately 9,000 miles of this system and constitutes its largest segment. Together, our waterways integrate the regions of the United States into an economically productive whole.

The Environment

National and local conservation groups feared that the 9-foot channel project would destroy the fish and wildlife habitat of the Upper Mississippi River valley. Clearly, the 9-foot navigation channel has changed the environment of the river and its floodplain dramatically. What was a large, free-flowing river with numerous side channels and extensive floodplain forests is now a series of reservoirs separated by small stretches of the old riverine habitat. However, the navigation project has created an environment that is richly diverse and productive for natural resources.

Today, the U.S. Fish and Wildlife Service manages two national wildlife refuges on the Upper Mississippi River. Congress formed the Upper Mississippi River Wildlife and Fish Refuge and the Mark Twain National Wildlife Refuge from lands obtained by the Corps of Engineers for the 9-foot channel and from U.S. Fish and Wildlife Service property. Over 200,000 acres of water, islands and marshes, extending 560 miles southward along the river bottoms from Wabasha, Minnesota, to St. Louis, Missouri, comprise these two refuges. The States of the Upper Mississippi River also manage wildlife and fish refuges.

During the last 15 years, the Corps has worked closely with the Fish and Wildlife Service and State agencies to ensure that Corps projects address both natural resource interests and navigation concerns. An excellent example of this cooperation is the Weaver Bottoms project. Hay meadows and bottomland forests covered Weaver Bottoms before the Corps completed the 9-footchannel. With the raising of pool 5, this area became a 4,000-acre backwater and one of the most important fish and wildlife habitats on the Upper Mississippi River.

Weaver Bottoms

By the 1960s, however, Weaver Bottoms was silting in. Water flowing from the main channel of the Mississippi River entered the bottoms from side channels, depositing sand and sediment. To arrest this deterioration, to provide long-term dredged material disposal sites, and to reduce dredging requirements in the main channel, the Corps, in cooperation with the Fish and Wildlife Service, has closed off the side channels and has started building islands of dredged material in the bottoms. The islands will reduce wave action in the bottoms, improving water clarity and encouraging aquatic plant growth. Thus, the Weaver Bottoms project will preserve an important wildlife refuge while maintaining the 9-foot navigation channel.

The Corps is also working to preserve and record prehistoric and historic sites affected by the 9-foot channel project. Humans have lived in the Upper Mississippi River Valley for 10,000 to 12,000 years. In a 1982 study for the St. Paul District, researchers identified more than 1,000 historically and architecturally significant sites and recorded over 1,400 prehistoric archeological components in the District's portion of

the valley alone. Some of these sites, ranging from ancient Indian villages to the locks and dams themselves, are now on the National Register of Historic Places.

Recreation

The chain of lakes or pools created by the 9-foot navigation channel provides opportunities for a variety of recreation activities including sightseeing, fishing, and hunting. Each year, millions of visitors enjoy the natural resources of the Upper Mississippi River; in 1987, they logged more than 19,000,000 visitor hours in the St. Paul District.

Over 130 years ago, tourists from the East boarded steamboats in St. Louis and ascended the Mississippi River to St. Paul. They came to see the "untamed West," with Indian villages along the banks of the river, to enjoy the river's pristine landscape and high bluffs, and to view St. Anthony Falls. So many Easterners took part in these excursions that they became known as the "fashionable tour." Today, the fashionable tour is a ride on paddleboats such as the Mississippi or Delta Queen or an excursion in a small pleasure craft.

Boating is one of the most popular summer activities on the Upper Mississippi River. Some recreationists enjoy brief outings on the river while others sail down to the Gulf of Mexico. A number of small-boat harbors, built by the Corps and turned over to local interests, facilitate boating on the river.

Recreational use of the Upper Mississippi River valley is not limited to the waterway. The Great River Road, a continuous system of highways that parallels the river, allows tourists to follow the routes of early explorers, have a picnic lunch at a scenic viewpoint, visit prehistoric Indian village sites, explore historic trading posts and forts, and spend a pleasant evening in a modern campground.

Fishing on the river