US Army Corps
of Engineers ®
St Paul District

MINNESOTA RIVER BASIN RECONNAISSANCE STUDY

Section 905(b) Analysis
(WRDA of 1986)

Minnesota, South Dakota,
North Dakota, and Iowa

December 2004

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MINNESOTA RIVER BASIN RECONNAISSANCE STUDY
Section 905(b) (Water Resources Development Act of 1986) Analysis

Minnesota, South Dakota, North Dakota, and Iowa

1 STUDY AUTHORITY

This Section 905(b), Water Resources Development Act of 1986 (WRDA 1986), Analysis is authorized by a Resolution of the Committee on Public Works of the U.S. House of Representatives, May 10, 1962. The resolution reads as follows:

> "Resolved by the Committee on Public Works of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors be, and is hereby, requested to review the report of the Chief of Engineers on the Minnesota River, Minnesota, published as House Document 230, 74th Congress, First Session and other pertinent reports, with a view to determining the advisability of further improvements in the Minnesota River Basin for navigation, flood control, recreation, low flow augmentation, and other related water and land resources."

Funds were appropriated in Fiscal Year 2003 to initiate this reconnaissance study.

2 STUDY PURPOSE

The purpose of this reconnaissance study is to evaluate the potential for Federal interest in implementing solutions to flooding, navigation, low flow augmentation, recreation, ecosystem restoration, and other related water resource problems and opportunities in the Minnesota River Basin (MRB) in Minnesota, South Dakota, North Dakota, and Iowa. If Federal interest is demonstrated, the reconnaissance phase will include development of one or more Project Management Plans (PMPs) and negotiation of one or more Feasibility Cost Sharing Agreements (FCSAs) with non-Federal partners for the next phase of study.

This reconnaissance study has resulted in the finding of Federal interest in and potential solutions to several existing water resources problems that warrant feasibility studies. The purpose of this Section 905(b) Analysis is to document the basis for this finding and to define the scope of the feasibility studies.

This reconnaissance investigation has been conducted in close coordination with many agencies active in land and water resources management in the MRB, including the U.S. Fish and Wildlife Service (USFWS); Natural Resources Conservation Service (USDA); U.S. Geological Survey (USGS); U.S. Environmental Protection Agency (EPA); Minnesota Department of Natural Resources (DNR); Minnesota Pollution Control Agency (MPCA); Minnesota Board of Water and Soil Resources (BWSR); University of Minnesota; Minnesota State University at Mankato; City of Mankato, Minnesota; MRB Joint Powers Board; Metropolitan Council of the Twin

Cities; local watershed districts; Clean Up the River Environment (CURE); Ducks Unlimited; and The Nature Conservancy. These agencies are committed to a Basin-wide watershed framework to address water resources problems and needs in the MRB.

3 LOCATION, CONGRESSIONAL DISTRICTS

3.1 LOCATION

The study area is the entire MRB. The Minnesota River originates in Big Stone Lake on the Minnesota-South Dakota border and flows 335 miles south and east to join the Mississippi River in Minneapolis/St. Paul, Minnesota. The river drains 16,770 square miles, of which 14,840 are in Minnesota, 1,610 are in South Dakota, and the remainders are in North Dakota and Iowa. Figure 1 illustrates the study area.

Figure 1. Minnesota River Basin (MRB) Location Map.

3.2 CONGRESSIONAL DISTRICTS

The study area includes six Congressional Districts:

Minnesota
District 1: Rep. Gil Gutknecht (R) Rochester
District 2: Rep. John Kline (R) Lakeville
District 7: Rep. Collin Peterson (D) Detroit Lakes

South Dakota:
At Large: Rep. Stephanie Herseth (D)

North Dakota:
At Large: Rep. Earl Pomeroy (D)

Iowa:
District 4: Rep. Tom Latham (R) Alexander

4 PRIOR STUDIES, REPORTS, AND EXISTING WATER PROJECTS

4.1 EXISTING CORPS OF ENGINEERS PROJECTS

The St. Paul District operates and maintains three existing projects in the MRB.

Highway 75 Dam. The Corps of Engineers operates and maintains the Highway 75 Dam near Odessa, Minnesota, for the U.S. Fish and Wildlife Service in accordance with a 1975 cooperative agreement between the two agencies. The dam is integral to the Big Stone National Wildlife Refuge. The dam was constructed as part of the Big Stone Lake and Whetstone River project completed in 1987.

Lac qui Parle Flood Control Project. The Lac qui Parle Flood Control and Water Conservation Project is located on the Minnesota and Chippewa Rivers upstream of Montevideo, Minnesota. It consists of the Lac qui Parle Dam, the Marsh Lake Dam, and the Chippewa River Diversion including the Watson Sag weir and levee. The project was authorized by the Flood Control Act of 1936, Public Law 74-738 and was partially constructed by the Works Progress Administration. The Corps of Engineers completed construction between 1941 and 1951. Operation of the project was transferred from the State of Minnesota to the Corps of Engineers in 1950. The Lac qui Parle Dam creates the Lac qui Parle flood control reservoir. The Chippewa Diversion reduces downstream flows at Montevideo, Minnesota, by diverting a portion of the Chippewa River floodwaters into the Lac qui Parle reservoir through the Watson Sag. Marsh Lake Dam is a fixed-crest dam constructed to hold a conservation pool in the upper portion of the Lac qui Parle reservoir. The Minnesota DNR's Lac qui Parle Wildlife Management Area surrounds Lac qui Parle Lake and Marsh Lake.

Minnesota River Nine-foot Navigation Channel. The original navigation project on the Minnesota River was authorized in 1867 and provided for the removal of snags and boulders

from the mouth to river mile 237. Further authorization was obtained in 1892 to maintain a channel 4 feet deep up to Shakopee, Minnesota (mile 25.6). The Corps of Engineers' 1935 report (House Document 230, 74th Congress, First Session) noted that no commercial traffic had been recorded since 1920 and recommended no navigation improvements at that time. The River and Harbor Act of 1958, Public Law 85-500, authorized constructing a channel 9 feet deep and 100 feet wide from the mouth in St. Paul to Savage, Minnesota, 14.7 miles upstream. The Lower Minnesota River Watershed District was created to act as the non-Federal sponsor for the navigation project. Construction of the 9-foot channel was completed between 1966 and 1968. The Corps of Engineers maintains the 9-foot channel with dredging operations using dredged material disposal sites provided by the sponsor.

4.2 CORPS OF ENGINEERS CONSTRUCTED PROJECTS

The Corps of Engineers participated in the construction of the following projects in the MRB, where local interests own, operate, and maintain the projects.

Section 14, Emergency Streambank Protection:

- Minnesota River, Belgrade Township; Nicollet County, MN
- Sterling Center, Maple River; Blue Earth County, MN
- Mankato Township, Le Sueur River; Mankato Township, MN
- Le Sueur River, CSAH 28; Blue Earth County, MN
- Minnesota River at Le Sueur, MN
- Minnesota River at Shakopee; City of Shakopee, MN
- State Highway 7 Bridge, Pomme de Terre River, Appleton; City of Appleton, MN

Section 205, Small Flood Control:

- Minnesota River at Henderson; City of Henderson, MN
- Redwood River below Marshall, MN

Specifically Authorized Projects:

- Big Stone Lake and Whetstone River Flood Control; Upper Minnesota River Watershed District
- Mankato and North Mankato Flood Control; Cities of Mankato and North Mankato, MN
- Chaska Flood Control; City of Chaska, MN
- Marshall Flood Control; City of Marshall, MN

Upper Mississippi River System Environmental Management Program:

- Rice Lake Habitat Project; Minnesota DNR

4.3 OTHER WATER RESOURCES PROJECTS

Many other locally owned and operated water resources projects are in the MRB. The extensive artificial drainage network was constructed to drain land for agricultural use and for road drainage. Landowners have drained many wetlands, constructed ditches, and installed thousands of miles of underground drainage tile. Townships and counties have constructed thousands of

miles of road ditches, and many bridges and culverts that connect with the agricultural drainage system. County drainage districts constructed hundreds of miles of legal "judicial" drainage ditches and channelized hundreds of miles of streams. The U.S. Soil Conservation Service (now the Natural Resources Conservation Service), local watershed districts, and landowners have constructed many smaller flood control impoundments. Hydropower dams were constructed at Granite Falls on the Minnesota River and at Rapidan Dam on the Blue Earth River. These hydropower facilities are now locally owned.

4.4 RECENT EMERGENCY ACTIONS

In the last decade, the Corps of Engineers provided emergency assistance during the major flood events of 1993, 1997, and 2001. Flooding occurs in many communities in the MRB during major flood events. During the floods of 1997 and 2001, the St. Paul District provided emergency assistance to the cities of Browns Valley, Odessa, Dawson, Appleton, Montevideo, Granite Falls, Redwood Falls, New Ulm, St. Peter, and Carver, Minnesota.

In April 2002, the Corps of Engineers assisted Blue Earth County with emergency foundation repairs at the Rapidan Dam on the Blue Earth River near the city of Mankato, Minnesota.

4.5 ONGOING CORPS OF ENGINEERS STUDIES

In addition to this reconnaissance study, the St. Paul District is currently conducting the following studies for specific projects in the MRB.

Section 14, Emergency Streambank Protection:

- Chippewa River at Big Bend Lutheran Church, Chippewa County, MN

Section 205, Small Flood Control:

- Lac qui Parle River at Dawson, MN
- Chippewa River at Montevideo, MN
- Granite Falls, MN (Minnesota River)
- Minnesota River at Jordan, MN

Upper Mississippi River System Environmental Management Program:

- Long Meadow Lake, Minnesota Valley National Wildlife Refuge, Bloomington, MN

4.6 PREVIOUS CORPS OF ENGINEERS PLANNING STUDIES

The Corps of Engineers has conducted a number of planning studies in the MRB under various authorities.

Lac qui Parle Reservoir Operating Plan Evaluation (ROPE). A planning process was conducted in 1994 to evaluate the effectiveness of the reservoir regulation plan for the Lac qui Parle project and to evaluate alternative changes to the regulation plan. This work was funded with Operation and Maintenance funds for the existing project. A number of modifications to the historic reservoir regulation plan were implemented to increase flood protection benefits, improve

wetland and aquatic habitat conditions, and improve conditions for recreational use of the reservoir. The primary modification to the reservoir regulation plan was to change the flood control regulation schedule for the project. The historically practiced late winter drawdown of the reservoir was found to be ineffective in reducing downstream flooding and was discontinued. The changes in the reservoir regulation plan were incorporated into the project's Water Control Manual.

Minnesota River 9-Foot Navigation Channel Project. A dredged material management plan was prepared for the navigation channel from Interstate Highway 35W (river mile 7) upstream. This plan was developed with Operation and Maintenance funds for the existing project. The plan addresses long-term management of dredging and dredged material placement sites for public and private dredging activities in the upper portion of the navigable channel.

Section 22, Planning Assistance to States. The Section 22 program is a continuing authority that allows the Corps of Engineers to assist States and federally recognized Indian Tribes with planning for the development, use, and conservation of water and related land resources. Study costs are shared equally between the Corps of Engineers and the non-Federal sponsor. Two recent efforts have been accomplished under the Section 22 program.

- Hydraulic and hydrologic modeling, 2000 – 2003: The Minnesota DNR sponsored efforts to update hydraulic and hydrologic models of the Minnesota River and tributaries. Models were created for the main stem from its mouth to Carver, and from New Ulm to Big Stone Lake. Portions of the Cottonwood, Redwood, Yellow Medicine, Lac qui Parle, and Yellow Bank River basins were also modeled. This work will be used to update floodplain mapping for Federal Emergency Management Agency flood insurance studies.

- Wetland delineation, 2001 – 2004: The Minnesota Board of Water and Soil Resources sponsored a pilot study to develop methods of delineating drained depressional wetlands. The Corps of Engineers worked with the U.S. Fish and Wildlife Service on the study. The study determined that aerial photo interpretation was the most reliable technique for that purpose. The Minnesota Pollution Control Agency is currently sponsoring a subsequent study to delineate the wetlands in portions of the Minnesota River and Red River of the North basins. The products of this study will include wetland delineations on aerial photographs and digital data produced from scanned and geo-rectified photos. The information will facilitate decisions related to watershed planning, prioritizing wetland restorations for wildlife habitat, water quality and floodwater attenuation benefits, and identification of potential wetland mitigation sites.

The "639 Study", Public Law 87-639. The Corps of Engineers and the USDA Soil Conservation Service (now Natural Resources Conservation Service) conducted the Upper Minnesota River Subbasins Study (639 Study) from 1978 through 1989. The study area included the Yellow Bank, Lac qui Parle, Yellow Medicine, Redwood, and Cottonwood River basins. Public Law 87-639 authorized the Corps of Engineers and the USDA to conduct joint investigations and surveys in accordance with existing authorities to make recommendations for "the installation of

the works of improvement needed for flood prevention or the conservation, development, utilization, and disposal of water, and for flood control and allied purposes." The objective of the study was to develop an overall plan to reduce flood damages and soil erosion within the study area. With the exception of two small projects in the Lac qui Parle watershed, no flood damage reduction measures were found to be feasible. Several erosion reduction measures were recommended under Soil Conservation Service authorities.

4.7 STUDIES BY OTHER STAKEHOLDERS

Many stakeholders have conducted land and water resources assessments and planning efforts in the MRB, especially since 1992 when Minnesota Governor Arne Carlson set a goal for making the river "fishable and swimmable" by 2002. Stakeholders including the Minnesota River Citizens Advisory Committee, Minnesota River Joint Powers Board, Minnesota Pollution Control Agency, Minnesota DNR, Board of Water and Soil Resources, Minnesota Environmental Quality Board, Metropolitan Council of the Twin Cities, University of Minnesota, Minnesota State University at Mankato, U.S. Geological Survey, The Nature Conservancy, and various other agencies, counties, and watershed districts responsible for water resource management have published numerous reports and plans, including the Minnesota River Assessment Project Report (Minnesota Pollution Control Agency 1994). Several groups in the basin have formed Clean Water Partnerships and undertaken water quality monitoring efforts. Minnesota State University at Mankato has developed a geospatial data center, sharing spatial data and reports about the MRB (see: http://mrbdc.mnsu.edu/reports/report.html).

The University of Minnesota has conducted extensive research on agriculture and water quality management in the MRB (see: http://www.soils.umn.edu/research/mn-river/index.html). Projects by the Center for Integrated Natural Resources and Agricultural Management (CINRAM), involving the departments of Agronomy and Plant Genetics, Forest Resources, and Applied Economics, are focusing on "Improving water quality and enhancing hydrologic stability of the Minnesota River through agroforestry and other perennial cropping systems."

The U.S. Geological Survey has conducted many water resources investigations in the MRB (see: http://wwwmn.cr.usgs.gov/umis/).

The Nature Conservancy identified areas of freshwater biodiversity significance in the MRB and priorities for conservation (The Nature Conservancy 2003).

These previous studies and reports by others provide a wealth of information for water resources planning in the MRB.

5 PLAN FORMULATION

The six planning steps in the Water Resources Council's Principles and Guidelines focus Federal water resources planning efforts leading to plans recommended for authorization. The six planning steps are: 1) specify problems and opportunities, 2) inventory and forecast conditions, 3) formulate alternative plans, 4) evaluate effects of alternative plans, 5) compare alternative plans, and 6) select recommended plan. In reconnaissance studies, the planning steps defining

problems and opportunities and inventory and forecast of future conditions are emphasized. Initial formulation and evaluation of alternative plans is done in the reconnaissance phase, to be iteratively refined in subsequent feasibility studies. The following sections describe the results of the initial planning steps conducted during this reconnaissance study. This information will be refined in future iterations of the planning steps that will be accomplished during the feasibility phase.

Plan formulation for this reconnaissance study was conducted in coordination with MRB stakeholders. Existing conditions were described and water resources problems were identified. Planning objectives and constraints were specified. Opportunities to address water resources problems were identified. Selected potential solutions were evaluated to illustrate Federal interest. Discussions were held with potential non-Federal sponsors to determine their interest in participating in feasibility phase investigations.

5.1 WATER RESOURCES PROBLEMS IN THE MINNESOTA RIVER BASIN

5.1.1 PRE-SETTLEMENT CONDITIONS

The Glacial River Warren created the Minnesota River valley between 9,000 and 12,000 years ago. Moraine and ice dam failure resulted in the catastrophic flooding that drained Glacial Lake Agassiz. Glacial River Warren was much larger than the present-day Minnesota River, and it carved a valley up to 5 miles wide and 250 feet deep. Today, many tributaries enter the Minnesota River valley in waterfalls, rapids, or gorges because of the elevation difference between the adjoining upland areas and the valley floor.

Before European settlement in the mid-1800s, Ojibwa and Dakota Native Americans occupied the MRB. They were subsistence hunters, fishermen, and farmers. Their populations had already been decimated by disease from earlier European contacts. The tallgrass prairie ecosystem supported abundant bison, elk, and deer that in turn supported the spiritual and nutritional needs of the Native Americans.

Most of the MRB consisted of prairie with many scattered wetlands and shallow lakes. Many of these wetland and lake basins were isolated, and were not connected to the rivers by surface water flow. Wetland areas stored rain and snowmelt until the water evaporated, soaked into the ground, or overflowed into the stream network. The prairie vegetation held the soil in place. Prairie soils were highly permeable and absorptive of water. Trees grew in the river valleys and provided woodland habitat, and the prairie grasslands and wetlands supported large populations of diverse wildlife species including waterfowl, shorebirds, fur-bearing mammals, bison, elk, and deer. The eastern portion of the MRB was deciduous hardwood forest. Terrestrial productivity was very high, with no human intervention other than occasional fires set by Native Americans. The Minnesota River and its tributaries ran clear during periods of lower flow. Aquatic plants grew in the river channels. Accumulations of woody debris occurred in the river channels and provided habitat for macroinvertebrates and fish. Migratory fish such as northern pike, walleye, sauger, smallmouth bass, lake sturgeon, paddlefish, and channel catfish made annual movements for spawning, foraging, and travel to winter habitats. Native mussels and fingernail clams were abundant in the Minnesota River and in the larger tributaries. The natural hydrologic regime was

buffered by the prairie and forest vegetation, permeable soils, and extensive wetlands and lakes. Flow of the Minnesota River and its tributaries changed gradually in response to snowmelt and precipitation events. Groundwater base flow of the rivers was substantial, providing sustained low flow and cool water during summer. Water quality was good, with sufficient water clarity to allow aquatic plant growth, and enough dissolved oxygen to support a diverse river biota.

5.1.2 LAND USE CHANGES AND ECOSYSTEM RESPONSES

European settlement led to an unprecedented effort to till the wet prairie and drain wetlands. Today, in the historic prairies and savanna areas of Minnesota, less than 10 percent of the original wetlands and less than 1 percent of the native prairie and savanna by area still exist. An extensive artificial drainage network was developed, first with open ditches and channelized streams, and more recently with underground drain tile.

Urban development, wetland drainage, development of the artificial drainage network, and conversion of grassland to row crop agriculture greatly modified the natural hydrologic regime. Water from snowmelt and precipitation events flows quickly through the artificial stream drainage network, shortening the time for water to reach the Minnesota River. These modifications, along with a wetter recent climate, have resulted in increased frequency and magnitude of flooding in the MRB.

The combination of urban development, artificial drainage, and removal of the natural prairie and riparian vegetation has made much of the basin's land susceptible to erosion, and the frequency and intensity of flooding have increased. This has led to increased sediment loads entering the river and increased streambank erosion. Wetland drainage and conversion of the land to urban and agricultural uses have significantly decreased the diversity of wildlife populations in the basin and increased nutrients and other pollutants in runoff. The consequences have included significant and sustained declines in migratory bird populations and water quality degradation in lakes, tributaries to the Minnesota River, the Minnesota River main stem, the Mississippi River, and the Gulf of Mexico.

5.1.3 EXISTING CONDITIONS

5.1.3.1 General Description

Southwest Tributary Area. The Lac qui Parle, Yellow Medicine, Redwood, and Cottonwood Rivers in the southwestern portion of the basin begin on top of a plateau known as the Coteau des Prairies. The edge of the Coteau is an escarpment about 6 miles wide and ranging from about 500 to 800 feet above the surrounding terrain. These rivers originate in the poorly drained land atop the plateau and flow rapidly to the northeast down the escarpment to the plains, where they flatten out and meander to the northeast toward the Minnesota River. The areas at the base of the escarpment are subject to flash floods that cause water to cross over between river basins, and the water coming off the Coteau is high in sediment. There are three distinct reaches in these streams: the relatively clear headwaters; the turbid, slow meandering, and extensively ditched reaches of the lowland plains; and the rocky gorges entering the Minnesota River valley.

Northern Tributary Area. The Pomme de Terre and Chippewa Rivers in the northern part of the basin begin in the lakes and ponds between the cities of Willmar, Alexandria, and Fergus Falls. Small lakes and marshes above the town of Morris characterize the Pomme de Terre River, but below Morris it becomes more turbid with eroding, muddy banks. The Chippewa River watershed also contains several lakes and wetlands, although significant portions have been channelized, resulting in a reduction of wetland areas. Hawk Creek also flows into the MRB from the north, and it drains the area south and east of the Chippewa River. This watershed has been significantly altered by channelization for agricultural drainage. Over half of the wetlands in the channelized reaches of the watershed have been drained.

South-Central Tributary Area. The Blue Earth River and its two major tributaries, the Watonwan and Le Sueur Rivers, drain the south-central portion of Minnesota. These streams are deep ravines with steep riverbank hillsides cut into the surrounding plains. All of the downstream reaches in this watershed have cut through glacial drift to expose sedimentary bedrock; some of the gorges are 200 feet deep. The Watonwan River has shallower channels and more ditching than the Blue Earth and Le Sueur Rivers.

Middle and Lower Minnesota River Watersheds. The Middle and Lower Minnesota River watersheds contain several small creeks and rivers that feed directly into the Minnesota River main stem. Most of the urbanized land within the MRB lies within the Lower Minnesota River watershed between the cities of Chaska and St. Paul. Much of this area is characterized by urban developments, including paved roads and parking lots, building roofs, and storm sewers, that have significantly altered the natural environment and drainage conditions of the watershed.

General Geographical Differences. Three major factors have been cited for differences in the runoff and pollutant load characteristics between the different watersheds in the MRB (Mulla 1997). First, the mean annual precipitation increases from 22 inches in the west to more than 31 inches in the eastern portions of the basin. That results in mean annual runoff depths of less than 2 inches in the west and 8 inches in the east. Second, the eastern portion of the basin has a steeper landscape, which in conjunction with the wetter climate results in more erodible soils. Finally, about 60 percent of the basin's population lives in the eastern portion of the basin in the four counties nearest to the Twin Cities metropolitan area and the two counties nearest to the city of Mankato.

5.1.3.2 Modified Hydrologic Regime

The hydrology of the MRB has changed dramatically since European settlement began in the mid-1800s. The pre-settlement landscape consisted of prairie with numerous lakes and wetlands. Upstream reaches of the tributaries were often typified by poorly defined channels connecting a linearly arranged series of wet prairie meadows. Many depressions had no outlet streams and contributed virtually no surface water runoff. In many historic prairie pothole region stream watersheds, less than 20 percent of overall watershed area contributed to stream flow because of abundant depressional wetland storage. The region’s geologically young age and this depressional storage explain the relative lack of natural drainage networks. Hence, rivers in the prairie pothole region tend to be weakly incised, with low gradient and channel capacity.

The region's soils developed on glacial till and loess, and tend to be clay rich with limited infiltration potential. Depressional wetlands are the primary source of recharge of shallow aquifers in many areas. Nevertheless, more than 90 percent of runoff trapped in prairie potholes is typically lost to evapotranspiration (ET). Annual potential ET exceeds precipitation in most years, which explains why most prairie wetlands undergo a wet-dry cycle each year.

The USDA Natural Resources Inventory for 1992 showed nearly 70 percent of the land area in the basin was cultivated cropland, primarily for corn and soybean production. Construction of artificial drainage projects in these areas began in the 1880s and continues today. More than 80 percent of the original prairie wetlands in the MRB have been drained or filled for agricultural or urban development (Figures 2 and 3). Natural streams were channelized, surface ditches were constructed, and subsurface tile networks were installed to improve agricultural drainage. Transportation networks and urban development covered nearly 5 percent of the land in 1992. This development replaced naturally vegetated areas with paved roads, parking lots, storm sewers, and buildings, reducing the areas available for infiltration and increasing runoff.

The hydrologic effects of these land use changes are complex, and interactions between the various changes are not fully understood. Peak flows in extreme flood events appear to be affected very little by the constructed drainage systems. Artificial drainage has generally decreased the time of concentration and increased the average annual flow, causing more frequent bank-full conditions and destabilizing streambanks.

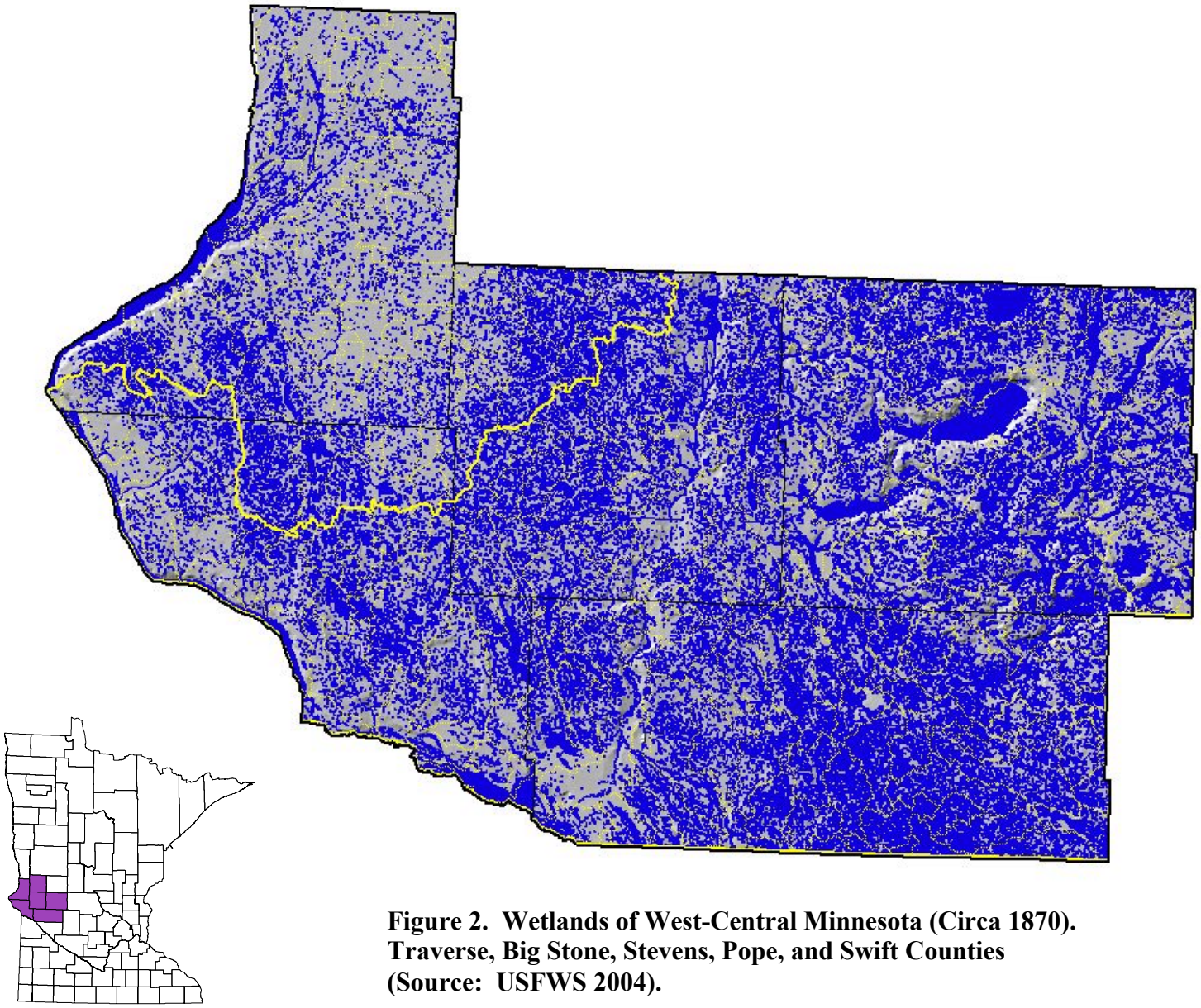


Figure 2. Wetlands of West-Central Minnesota (Circa 1870). Traverse, Big Stone, Stevens, Pope, and Swift Counties (Source: USFWS 2004).

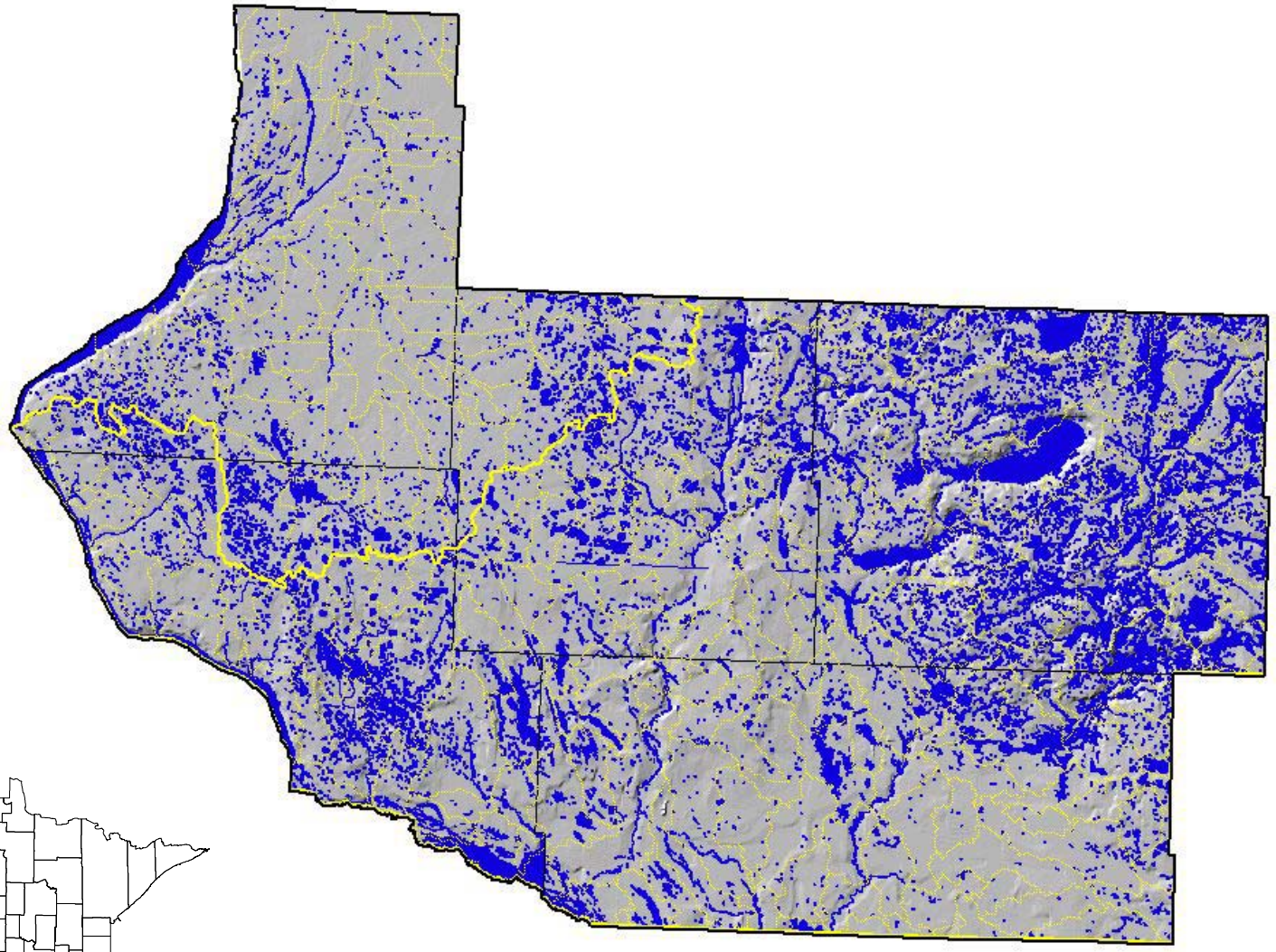


Figure 3. Wetlands of West-Central Minnesota (Circa 2000). Traverse, Big Stone, Stevens, Pope, and Swift Counties (Source: USFWS 2004).

5.1.3.3 Erosion and Sedimentation

The combination of artificial drainage and removal of the natural prairie and riparian vegetation has made much of the basin's land susceptible to erosion. More frequent bank-full conditions have caused increased bank erosion in tributary channels. Recent studies at the University of Minnesota estimated that bank collapse and erosion was the source of between 23 and 56 percent of the sediment transported by the Blue Earth River between April 2000 and April 2001 (Thoma et al. 2003). Agricultural tillage practices and surface intakes to subsurface tile networks have led to significant loss of topsoil.

Sediment must be dredged frequently from the navigation channel and private slips in the lower 15 miles of the Minnesota River. The Minnesota River contributes the majority of sediment and nutrients to the Mississippi River upstream of Lake Pepin, approximately 50 miles downstream of Minneapolis/St. Paul (Figure 4). Sediment core studies have shown that Minnesota River sediments are primarily responsible for Lake Pepin filling in at a rate 10 times faster than the rate prior to European settlement (Engstrom and Almendinger 2000).

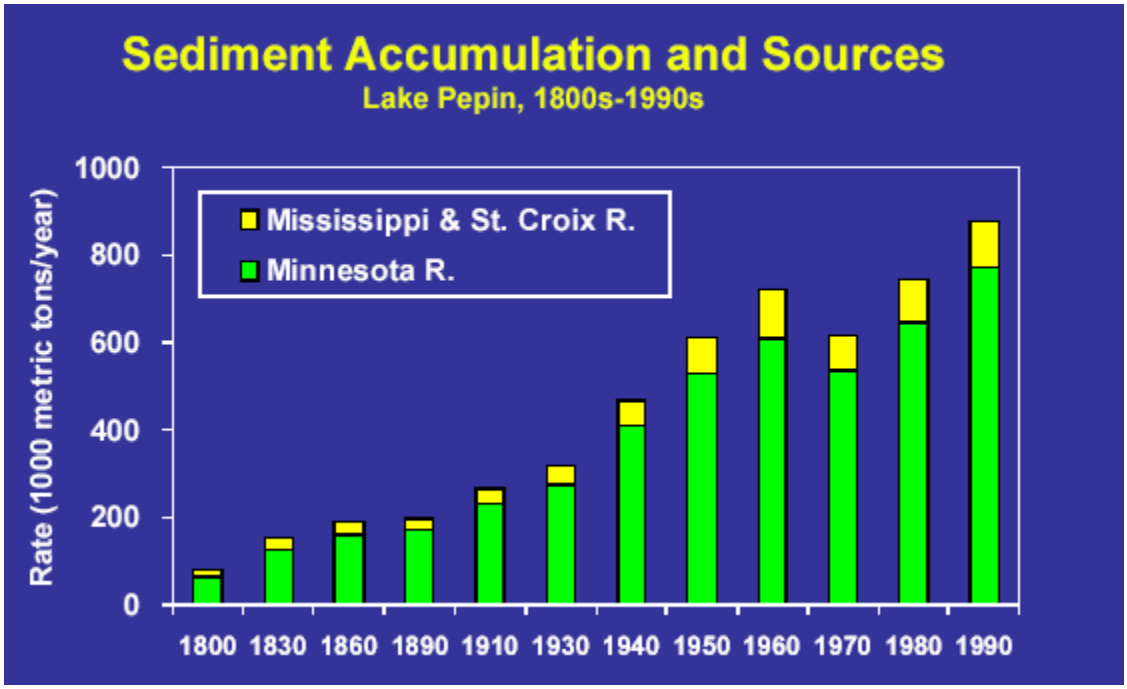


Figure 4. Lake Pepin Sediment Accumulation and Sources (Engstrom and Almendinger 2000).

5.1.3.4 Habitat Loss

Conversion of the land to urban and agricultural uses and drainage of wetlands have significantly decreased the diversity and abundance of wildlife populations. Most of the Minnesota River watershed lies in the prairie pothole region of North America. This gently rolling landscape was created by the advance and retreat of late Pleistocene glaciers that left millions of wetlands ranging from shallow and temporary to deep and semi-permanent. Wetlands in the region once numbered more than 100 per square mile, covering more than 20 percent of the landscape in

some areas. Prairie potholes are small depressional wetlands, and more than 80 percent of them are smaller than 2 acres in size. Anthropogenic activities such as drainage and tillage have dramatically changed this landscape. Today, across most of the Minnesota River watershed, wetlands remain in less than 20 percent of their historic abundance by number, and 50 percent of their historic area. In the headwaters area of the Minnesota River watershed, over 87 percent of historic wetlands have been drained and converted to agriculture. Ongoing erosion and sedimentation continue to threaten those wetlands that remain. Small, shallow wetlands have been the most severely affected. In many townships, every historic wetland has been drained, and no depressional storage or other normal wetland function remains.

Row crop agricultural use now covers about 70 percent of the basin. Less than 1 percent of the area of native prairie vegetation remains. The loss of wetland and prairie habitat has had many ecological ramifications, including the direct loss of habitat for many groups of fauna such as waterfowl, shorebirds, furbearers, large mammals, amphibians, reptiles, and insects. Also, the diverse wetland and prairie plants on which these animals depend were lost and replaced with agricultural crops.

Wetlands of the prairie pothole region are among the most important for North American migratory birds. Historically, the prairie pothole region accounted for 50 to 80 percent of annual continental duck populations. Wetland density, particularly the density of small, shallow wetlands, is nearly the sole factor determining the distribution of breeding waterfowl across the region. Unlike wetlands in other parts of the north-central United States and Canada, prairie potholes are highly productive by virtue of their dynamic hydrology, i.e., seasonal inundation followed by dry periods characterized by organic decomposition and rapid nutrient release, and the germination of seed-producing annual plants.

The MRB wetlands were probably of comparable importance to populations of many other waterbirds whose breeding range included the mid-continent of North America. Thirty-six species of shorebirds occur in the prairie pothole region, and 13 of those species breed there; the rest are spring and fall migrants. Many shorebird species have experienced population declines, likely due to habitat loss, and more specifically due to the loss of wetlands. Loss of wetlands in the prairie pothole region is the greatest threat to shorebirds migrating through the mid-continent (Skagen 1997). Loss of migration habitat contributes to the decline of shorebird populations because migration is energetically expensive and requires habitat for feeding and rest.

The tallgrass prairie ecosystem, which includes the prairie pothole region of western and central Minnesota, is the most endangered ecosystem in North America, with less than 1 percent by area of native tallgrass prairie remaining. Most of these native remnants occur in small isolated tracts, which limits their function for wildlife, although they are important reservoirs of floristic diversity. Several State and Federal endangered species are dependent on this ecosystem in Minnesota. Grassland bird populations have declined at a faster rate than any other group of birds in North America over the past 50 years. Recent programs such as the Conservation Reserve Program have helped to reduce, but have not checked, this decline.

Riverine habitat and connectivity have been fragmented throughout the basin. Prior to European settlement, the MRB was a large and connected aquatic habitat. Migratory fish had access to

habitats throughout the Minnesota River main stem and tributaries. The river and its tributaries provided a diversity of habitats, including pools, riffles, rock and rubble beds, and woody debris. The smaller streams provided important spawning and nursery areas. Diverse populations of aquatic species were able to access the appropriate habitats needed during their different life stages. In the past 150 years, numerous dams, water control structures, gradient control structures, and culverts have created barriers to fish movement and reduced access to high-gradient habitats. Riparian vegetation has been replaced with crops. Many of the smaller streams have been channelized, and the spawning habitat has been drained. Increased sediment loads and degraded water quality have also contributed to degradation of riverine habitat. Rock and gravel habitats in tributaries and the Minnesota River have become covered with silt, limiting production of filter-feeding macroinvertebrates and spawning habitat for many fish species.

Two Corps of Engineers projects contribute to connectivity problems in the upper MRB: the Lac qui Parle flood control project and the Big Stone/Whetstone project. The Lac qui Parle Dam, Marsh Lake Dam, Chippewa Diversion, Highway 75 Dam, and Big Stone Lake Dam hinder fish migration. These projects also included diverting the Pomme de Terre and Whetstone Rivers from their natural channels.

5.1.3.5 Water Quality

Conversion of the land to urban and agricultural uses has contributed to significant water quality problems in the MRB. The Minnesota River is currently one of the most polluted rivers in Minnesota, and one of the larger contributors of nitrogen to the Mississippi River, which results in hypoxia in the Gulf of Mexico. Figure 5 shows the confluence of the Minnesota River and the Mississippi River, illustrating the contrast in water quality between the two streams.

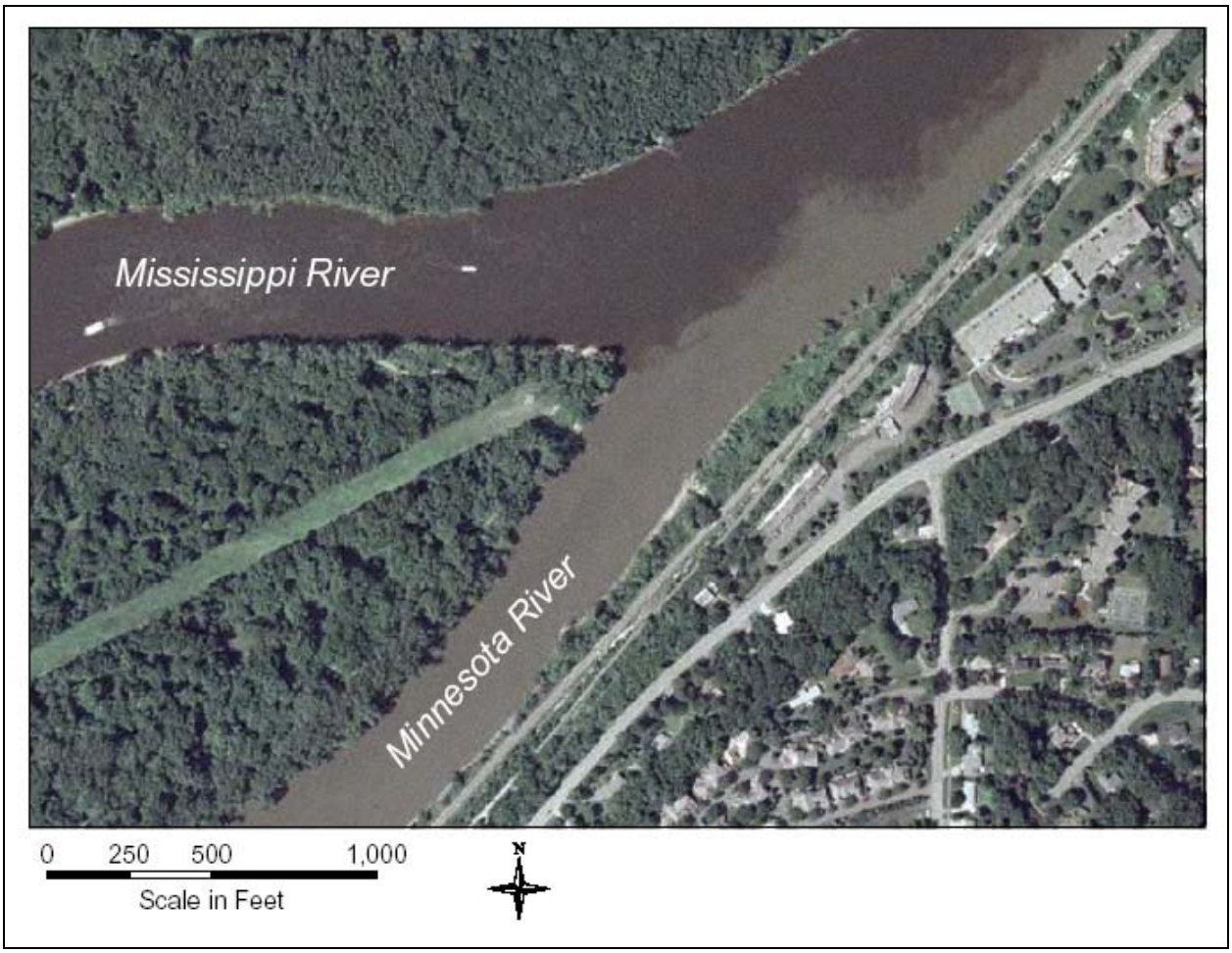


Figure 5. Confluence of the Minnesota and Mississippi Rivers in St. Paul, Minnesota.

The increased pollutants in runoff degrade water quality and aquatic habitat downstream. Runoff from snowmelt and rainfall washes soil, pathogens, and nutrients into storm sewers, drain tiles, and ditches. Pollutants come from a variety of sources including runoff and erosion from agricultural fields, streambanks and stream channel scouring, city streets, construction sites, feedlots, and effluent from wastewater treatment plants and septic systems. The pollutants eventually end up in the tributaries and are transferred downstream.

The Minnesota Pollution Control Agency's 2002 Clean Water Act Section 303d List of Impaired Waters for the MRB includes 29 rivers and creeks that are impaired for one or more of the following pollutants: low dissolved oxygen, impaired biota, mercury, fecal coliform, turbidity, excess ammonia, chloride, polychlorinated biphenyls (PCBs), and eutrophication. There are also 81 lakes listed with one or more of the following impairments: excess nutrients and mercury or PCBs in the water column and/or fish tissue. Altogether, 320 river reaches and lakes in this basin are listed as impaired.

Suspended solids are the sediment and organic matter that are transported by moving water and create turbidity. The solids block sunlight and hinder photosynthesis of aquatic plants. This further reduces the dissolved oxygen in the stream. Much of the sediment consists of fine clay

and silt particles that do not settle out of the water easily and are thus transported long distances. Toxic substances and phosphorus attach to suspended sediment and travel with it. The particles move with the water until it reaches a calm area, such as a reservoir, where they settle to the bottom and smother aquatic habitat. Minnesota River reservoirs are shallow and turbid from algae and wind-driven wave sediment resuspension. Suspended solids reduce the river's usefulness for most recreational uses, drinking water supplies, and industrial use.

Three watersheds, the Blue Earth, Le Sueur, and Lower Minnesota (Figure 1), control most of the total suspended solids (TSS) load in the Minnesota River. These watersheds drain about one-quarter of the MRB, but generate about two-thirds of the suspended solids load at the mouth of the Minnesota River (Mulla 1997).

Nutrients, such as phosphorus and nitrogen, are needed for plant growth. They are routinely applied in excess to fertilize agricultural row crops and urban lawns. Excessive levels of phosphorus in water encourage undesirable algae growth in fresh water lakes, rivers, and reservoirs. The free-floating algae block sunlight and inhibit the growth of rooted aquatic plants, thus reducing habitat quality and diversity of aquatic life in the river. As the algae dies and decays, dissolved oxygen is removed from the water. Low dissolved oxygen harms fish and other aquatic life. Low dissolved oxygen is a persistent problem in the lower reaches of the river during summer low-flow periods, especially in the navigation channel reach. The combined effects of slack water from the navigation pool and resuspension of fine sediments by towboats is suspected to contribute to this problem.

About 64 percent of the total phosphorus load at the mouth of the Minnesota River comes from the Blue Earth, Le Sueur, and Lower Minnesota River watersheds (Mulla 1997). The other nine watersheds drain about three-quarters of the basin and generate about one-third of the phosphorus load.

High levels of nitrate-nitrogen in drinking water can be harmful, especially to infants and livestock. Nitrogen is the limiting nutrient for algal growth in oceans, and has been implicated in the hypoxia problem in the Gulf of Mexico. About 63 percent of the nitrate-nitrogen load at the mouth of the Minnesota River comes from the Blue Earth, Le Sueur, and Watonwan River watersheds (Mulla 1997). The Lower Minnesota, Middle Minnesota, and Cottonwood River watersheds generate another 31 percent of the nitrate-nitrogen load.

The artificial drainage network, especially underground tile drains, has a profound effect on sediment and nutrient loading to the Minnesota River. The following is part of an abstract of a seminar on a paired (surface inlet and subsurface inlet) drain tile system monitoring project, by Magdalene (2004).

> *Three [University of Minnesota] research stations in the MRB monitored paired surface-subsurface drainage discharges, and automatic samplers collected water samples during peak events. Samples were analyzed for sediment and for dissolved ionic concentrations, including nitrate- and nitrite-nitrogen and total phosphorus. Drainage responded to recharge events (heavy rainfall and snowmelt) within minutes to hours, and dye traces indicated macropores provided direct connection of the soil*

surface to subsurface drainage. Peak sediment concentrations in runoff preceded peak discharges, in a non-linear hysteresis pattern. Normalized storm hydrographs revealed consistent water quality-discharge relationships, enabling model estimation of unsampled peak events and total annual loads. Surface runoff into tile inlets carried 10 percent of the water, 75 percent of the sediment, 28 percent of the phosphorus and 4 percent of the nitrogen, while subsurface runoff carried 90 percent of the water, 25 percent of the sediment, 72 percent of the phosphorus and 96 percent of the nitrogen in annual combined surface-subsurface flow. Peak events were important to annual loading: 62 percent of the water and 71 percent of the sediment loading occurred in the first 24 hours of discharge response; 82-97 percent of annual sediment yield in annual combined flow was derived from loading during peak events. Moldboard tillage at one station increased peak spring runoff from 3,000 to 80,000 mg/l sediment concentrations, producing seven times greater annual sediment loads than with conservation methods employed by the landowners. Basin-wide, artificial drainage accounted for a significant portion of sediment loading at the mouth of Minnesota River.

Bacteria, viruses, and other pathogens can cause disease in humans and wildlife. Recreational activities such as swimming and boating are not safe when high levels of bacteria exist. High levels of bacteria often indicate that other types of contamination are also present. Other pollutants include pesticides, industrial chemicals, oil and grease, paints, and litter. All of these affect the riverine environment and water quality in the MRB.

In addition to degrading the main stem Minnesota River, loadings of sediment, nitrogen, and phosphorus degrade conditions in the Mississippi River and the Gulf of Mexico. The Minnesota River contributes most of the sediment that is filling Lake Pepin on the Mississippi River (Figures 4 and 5). Phosphorus loading from the Minnesota River contributes to dense nuisance blue-green algae blooms in Pool 2 and in Lake Pepin. Nitrogen loading from the Minnesota River is substantial, and it contributes to hypoxia in the Gulf of Mexico.

5.1.3.6 Interbasin Transfer of Biota – Lake Traverse Project

The Red River of the North and the Minnesota River were once part of Glacial River Warren that drained Glacial Lake Agassiz after the last Wisconsin glacial age. Consequently, there was movement of aquatic biota between the present-day Hudson's Bay and Mississippi River Basins at that time. Since the last glaciation, the land elevation rebounded, and today the Red River of the North flows north. The headwaters of both the Minnesota River and the Red River of the North are at the continental divide at Browns Valley, Minnesota. The low divide (elevation 983.9 feet 1912 MSL) has historically allowed surface water connection between the Little Minnesota River and Lake Traverse during relatively frequent high water periods (approximately a 10 percent exceedence frequency). Steamboats navigated over the continental divide by this route during floods in the late 1800s. Transfer of water and invasive species from one basin to another is a concern, because the introduction of non-indigenous invasive species into a watershed can cause ecological and economic damage. Invasive species including zebra mussels and Asian carp have spread into the Mississippi River Basin, but they have not yet crossed the continental divide. In order to prevent biota transfer between the basins, the International Joint Commission has

recommended eliminating the hydraulic connection between Lake Traverse and the Minnesota River.

The Flood Control Act of 22 June 1936, Public Law 74-738, authorized the Lake Traverse flood control project for construction, citing flood control and water conservation as project purposes. Following completion of the project, Congress assigned other authorized purposes to include recreation, fish and wildlife, water supply, and water quality. The Lake Traverse flood control project includes three box culverts under South Dakota Highway 10 northwest of the city of Browns Valley, Minnesota. These culverts were installed in 1945 to allow Little Minnesota River floodwaters to continue to pass into Lake Traverse as they did naturally prior to construction of the project. Removing or blocking the culverts would eliminate the hydraulic connection between the two basins. However, it would also force higher flood flows through Browns Valley and into Big Stone Lake than would have occurred naturally. It has been estimated that it would cost approximately $1.5 million to divert Little Minnesota River flows around Browns Valley.

The hydraulic connection between these basins is just one possible source of biota transfer. Other sources could include inadvertent transfers by fishermen and boaters with bait, boats, and trailers used in both basins.

Studies are needed to determine alternatives and impacts related to eliminating inter-basin biota transfer at Lake Traverse. This 905(b) analysis does not recommend a cost-shared feasibility study at this time, because no willing potential non-Federal sponsors were identified during the reconnaissance study.

5.1.3.7 Flooding

Flood damages can occur in many communities in the MRB during major flood events. During the floods of 1997 and 2001, the St. Paul District provided emergency assistance to the cities of Odessa, Dawson, Appleton, Montevideo, Granite Falls, Redwood Falls, New Ulm, St. Peter, and Carver, Minnesota. These efforts prevented more than $17 million in damages in 1997, and $6.8 million in 2001. The Lac qui Parle flood control project prevented more than $11 million in damages in 2001. The cities of Jordan and Browns Valley, Minnesota, also have histories of flood damages.

The cities of Marshall, Mankato, Henderson, and Chaska, Minnesota, have federally constructed flood damage reduction projects in place. The Big Stone Lake and Whetstone River flood control project and the Lac qui Parle flood control project provide flood damage reduction benefits in the upper portion of the basin. Studies are under way in Dawson, Montevideo, Granite Falls, and Jordan, Minnesota. Agricultural flooding and flood damage to rural infrastructure are common. Estimated requirements in the MRB for the Federal Emergency Management Agency's public assistance program after the 2001 flood were over $7.5 million, including $4 million for damages to roads and bridges. The "639 Study," completed in 1989, looked at the southwest tributary area along the Coteau des Prairies. That study concluded that, from a Federal perspective at that time, there were few potentially feasible flood damage reduction projects in the study area.

It is likely that most future urban flood damage reduction studies in the MRB could be pursued under the Corps of Engineers' Section 205 Small Flood Control Project authority. Future planning efforts should consider multi-purpose projects to provide flood damage reduction benefits in connection with other justified project purposes such as ecosystem restoration.

5.1.4 EXPECTED FUTURE CONDITIONS

Degradation of the structure and function of the MRB's aquatic ecosystems will continue without focused restoration efforts that address soil erosion, agricultural drainage and runoff, wetland restoration, riparian and aquatic habitat degradation, streambank erosion, sedimentation, and growing water quality problems. Chronic stresses will continue to tax species diversity and abundance. The lack of a comprehensive basin-wide plan for management and preservation of water and related land resources would limit the effectiveness of efforts to foster better land management, aquatic ecosystem restoration, and water quality improvements in the MRB. Continued soil erosion and stream channel erosion threaten the sustainability of agricultural land use. Continued losses of nitrogen and phosphorus from agricultural areas represent economic losses to landowners and contribute to eutrophication of rivers, reservoirs, and the Gulf of Mexico downstream.

5.2 PROBLEMS AND OPPORTUNITIES

A number of problems and opportunities have been identified during the course of scoping the reconnaissance study. Input was received through coordination with a wide range of stakeholders including Federal, State, and local agencies; non-profit organizations; and the general public throughout the MRB. Many of the physical problems are interrelated. Most of the problems require a combination of management actions to be applied in concert and at appropriate scales to be effective. Opportunities exist for application of management actions that would address multiple problems.

There is a significant opportunity to collaboratively plan and implement management actions through Federal (Corps of Engineers, USDA, EPA, USGS), State (DNR, BWSR, MPCA), local (Metropolitan Council, counties, watershed districts, landowners), and non-profit (The Nature Conservancy, Ducks Unlimited, CURE) programs. The Mid-West Natural Resources Group provides a forum for interagency coordination and collaboration. During this reconnaissance study, relationships among agencies and stakeholders have developed that provide an opportunity to work together. Without coordinated action, that opportunity will fade as time passes.

There is a need to improve the effectiveness and efficiency of the many government and non-profit programs that exist to address the problems identified in this study. Ongoing advancements in computer modeling technology offer the opportunity to improve our understanding of the MRB watershed as a system. This knowledge would facilitate better overall watershed management and application of remedial programs.

The physical, chemical, and ecological problems and related opportunities include the following. State and Federal (USDA, Corps of Engineers) programs are available to conduct ecosystem restoration, water quality and watershed management.

- Significant loss of original prairie, riparian, wetland, lake, and river habitats.

Opportunities: Restore native prairie, riparian corridors, wetlands, lakes, and rivers.

- An extensive, aging, and still-expanding artificial drainage network.

Opportunities: Modify the artificial drainage network to attain a more natural hydrologic regime and maintain agricultural production and income. Modify the drainage network and regulate drainage activities to protect river channels, reduce flooding, and improve water quality.

- Modified hydrologic regime.

Opportunities: Increase infiltration on the landscape through conservation tillage, increase perennial vegetation cover, restore wetland areas, restore channelized tributaries, modify the artificial drainage network, modify the design and operation of Minnesota River main stem dams, and implement best management practices in urban development.

- Erosion of agricultural land and riparian areas (threatens infrastructure and affects water quality).

Opportunities: Reduce soil erosion from agricultural land through a combination of best management practices. Increase perennial vegetation cover on the landscape by growing alternative crops. Restore riparian areas with native woody and herbaceous vegetation. Restore channelized tributary channels; stabilize eroding tributary channels.

- Unstable and eroding stream channels.

Opportunities: Modify the artificial drainage network; restore wetland areas to attain a more natural hydrologic regime. Restore channelized tributary channels; stabilize eroding tributary channels.

- High sediment loadings to tributaries and the Minnesota River, affecting river habitat conditions, water quality, and navigation.

Opportunities: Reduce soil erosion from agricultural land through a combination of best management practices. Increase perennial vegetation cover on the landscape by growing alternative crops. Restore riparian areas with native woody and herbaceous vegetation. Restore channelized tributary channels; stabilize eroding tributary channels. Modify regulation of main stem reservoirs to reestablish aquatic vegetation to reduce sediment resuspension.

- Flooding (both urban and agricultural areas).

Opportunities: Increase infiltration on the landscape through conservation tillage, increase perennial vegetation cover, restore wetland areas, restore channelized tributaries, modify the artificial drainage network, modify the design and operation of Minnesota River main stem dams, and implement best management practices in urban development.

- Degraded aquatic habitat and biological communities in the Minnesota River and tributaries.

Opportunities: Apply watershed best management practices, restore wetland areas, reduce loadings of sediment and nutrients, restore channelized tributaries, modify the hydrologic regime toward more natural conditions, and modify the design and operation of Minnesota River main stem dams.

- Loss of river habitat connectivity for fish migration.

Opportunities: Remove dams or construct fishways.

- Impaired water quality in rivers throughout the basin.

Opportunities: Modify the artificial drainage network to attain a more natural hydrologic regime. Incorporate water detention and other best management practices in urban landscape design and storm water systems. Reduce soil erosion from agricultural land through a combination of best management practices. Reduce fertilizer application to that needed by crops. Increase perennial vegetation cover on the landscape by growing alternative crops. Restore riparian areas with native woody and herbaceous vegetation. Restore wetlands. Restore channelized tributary channels and stabilize eroding tributary channels. Improve residential and municipal waste treatment to reduce nutrient loading to the river system.

- Reduced recreational opportunities due to intensive agricultural practices, degraded aquatic habitat, and impaired water quality.

Opportunities: Restore wildlife populations through increasing perennial vegetative cover, restoring native prairie, and riparian buffer strips. Restore wetland, tributary streams, and main stem Minnesota River aquatic habitats. Improve water quality conditions as described above. These measures could improve the aesthetic appearance of the landscape; increase fish and wildlife populations; increase fishing, hunting, and wildlife viewing opportunities; and improve the tourism-related economy.

5.3 NATIONAL OBJECTIVES

The national or Federal objective of water and related land resources planning is to contribute to National Economic Development (NED) consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the Nation.

The Corps of Engineers has added a second national objective for Ecosystem Restoration in response to legislation and Administration policy. This objective is to contribute to the Nation's ecosystems through ecosystem restoration, with contributions measured by changes in the output of ecosystem goods and services of value to human society.

5.4 PLANNING OBJECTIVES

The national objectives of National Economic Development and National Ecosystem Restoration are general statements. The water and related land resource problems and opportunities identified in this study are stated as specific planning objectives to provide focus for the formulation of alternatives. These planning objectives reflect the problems and opportunities and represent desired future conditions.

The planning objectives for land and water resources in the MRB are as follows:

1. A more natural hydrologic regime
2. Reduced soil erosion from upland areas
3. Stabilized stream channels
4. Reduced sediment loading to the Minnesota River
5. Reduced economic damages from flooding
6. Restored prairie, wetland, and river ecosystems
7. Quantified hydrologic effects and economics of urban and agricultural drainage, to provide for more informed design and regulation of drainage activities
8. Reduced sediment and nutrient loadings; improved water quality throughout the Basin
9. A sustainable agricultural economy

5.5 PLANNING CONSTRAINTS

Planning constraints are temporary or permanent limits imposed on the scope of the planning process and choice of solutions. Planning constraints include ecological, economic, engineering, legal, and administrative constraints. Some are states of nature; some are based on the design of built structures. Legislation or rule making imposes other constraints. The human-imposed constraints are possible to change. Planning constraints identified in this study are as follows:

1. The planning process must be consistent with all applicable Federal, State, and local laws, regulations, and policy.

2. The scope and products of this reconnaissance study are prescribed by the resolution of the Committee on Public Works of the U.S. House of Representatives, May 10, 1962, that authorizes the study.

3. Funding and time for the reconnaissance study are limited.

4. Planning will be limited to water and related land resources in the MRB.

5. The existing population, land use, communities, and economy of the MRB impose constraints.

6. The existing built water resources projects in the MRB, including the artificial drainage network, dams, reservoirs, and flood protection projects.

7. The climate, geology, soils, and native biota of the MRB.

5.6 ALTERNATIVES

During the reconnaissance phase, alternatives were identified and assessed at a relatively low level of detail, limited to descriptions of conceptual measures for achieving study objectives. The study evaluated the likelihood that more detailed plans could be formulated that would qualify for Federal assistance with implementation and maintain local support. Alternative plans consisted of combinations of management actions or measures that address one or more of the planning objectives. As described in the Problems and Opportunities section above, a wide variety of management measures needs to be applied in combination, in appropriate sequence, and at appropriate locations and scales to meet the planning objectives for future conditions in the MRB.

Table 1 lists a variety of alternative management measures available for implementation in the MRB to manage and restore watersheds, water quality, and aquatic ecosystems. Alternative measures include no action, nonstructural and structural solutions. The relative effectiveness of a set of example management measures in attaining the planning objectives was subjectively estimated (Table 1).

Table 1. Planning Objectives, Example Alternative Management Measures, and Their Relative Effectiveness for the MRB.
(3 = highly effective, 0 = not effective).

Planning Objectives

Alternative Management Measures	Restore Hydrologic Regime	Reduce Soil Erosion	Stabilize Stream Channels	Reduce Sediment Loading to MN River	Reduce Flooding Damages	Restore Native Prairie	Restore Wetlands	Restore Aquatic Ecosystems	Reduce Nutrient Loadings to Rivers	Improve Water Quality Conditions	Sustainable Farm Economy
Best Land Management Practices (BMPs)											
Non-Structural BMPs	**Relative Effectiveness in Meeting Objectives 3 = High**										
Contour farming	2	3	1	3	1	0	0	1	2	2	3
Contour strip cropping	2	3	1	3	1	0	0	1	2	2	3
Field borders	1	2	1	1	1	1	0	1	1	1	1
Filter strips	2	2	1	2	1	0	0	1	1	1	1
Conservation tillage	1	3	1	2	1	0	0	1	2	2	3
Conservation cropping sequence	1	2	1	2	1	0	0	1	2	2	3
Perennial cover crops	3	3	2	3	3	0	0	2	3	3	3
Nutrient management	0	0	0	0	0	0	0	1	3	3	3
Feedlot management	0	0	0	0	0	0	0	1	3	3	3
Structural Land Management BMPs											
Terraces	2	3	1	2	1	0	0	1	2	1	3
Water and sediment control basins	2	0	2	2	1	0	0	2	2	2	1
Diversions	2	0	2	2	1	0	0	2	2	2	1
Grade stabilization structures	0	2	2	1	0	0	0	0	1	1	1
Grassed waterways	1	2	1	2	0	0	0	1	2	2	1
Agricultural Drainage System BMPs											
Riser pipe or filtered surface inlets	0	0	0	1	0	0	0	0	2	2	1
Vegetated ditches	0	1	2	2	0	0	0	0	2	2	0
Water and sediment control basins	1	0	1	2	1	0	0	1	2	2	0
Structural Modifications to the Drainage Network											
Wetland restorations	3	0	2	3	3	2	3	3	3	3	3
Lake restorations	3	0	2	3	3	2	3	3	3	3	3
Restore channelized streams	3	0	3	3	2	0	0	3	2	2	1
Stabilize eroding stream and river banks	0	0	3	3	0	0	0	3	3	3	1
Urban runoff detention systems	1	2	1	2	2	0	0	2	2	2	0
Urban rain gardens	1	1	1	1	1	0	0	1	1	1	0
Other Measures											
Restore native prairie	3	3	2	3	2	3	1	2	3	3	3
Upgrade residential septic systems	0	0	0	0	0	0	0	1	1	1	1
Upgrade municipal wastewater systems	0	0	0	0	0	0	0	2	3	3	0
Reduce urban fertilizer application	0	0	0	0	0	0	0	1	2	1	0
Construction site sediment management	0	2	1	1	0	0	0	1	1	1	0
Remove dams on rivers	3	0	2	0	0	0	0	3	0	3	0
Construct fishways at dams	0	0	0	0	0	0	0	3	0	0	0
Restore aquatic habitat with woody debris	0	0	3	0	0	0	0	3	0	0	0
Restore riparian zones with native vegetation	1	2	2	3	1	3	2	3	3	3	3
Perennial flood-tolerant crops in floodplains	0	1	0	0	3	0	0	1	0	1	3
Restore aquatic vegetation in main stem reservoirs	0	0	0	0	0	0	3	3	0	3	0

River basin scale watershed, water quality, and aquatic ecosystem management and restoration require a variety of management measures implemented at different scales of time and space. Table 1 is a partial list and provides only an indication of the potential effectiveness of different management measures in meeting the planning objectives. Various stakeholders are applying all the management measures listed in the MRB under a number of ongoing programs. However, quantitative information about the effectiveness of different combinations of management measures and the appropriate scales of application to meet the planning objectives is needed to determine optimal investments.

Through public meetings, interagency discussions, and consultation with stakeholders, we identified a number of alternative plans. We then conducted a preliminary screening to identify a set of plans that would meet the following criteria:

1) Contribute to meeting the planning objectives.
2) Federal (Corps of Engineers) interest likely.
3) Interested non-Federal cost share sponsor(s).
4) Appropriate for this specifically authorized study (rather than another Corps of Engineers program).

The following three alternative plans met those criteria:

1) Integrated watershed, water quality, and ecosystem restoration analysis.
2) Blue Earth River aquatic ecosystem restoration.
3) Marsh Lake Dam aquatic ecosystem restoration.

5.6.1 INTEGRATED WATERSHED, WATER QUALITY, AND ECOSYSTEM RESTORATION ANALYSIS

Decision-makers involved in management of the MRB must consider the effects of the management measures on the ecosystem and the human economy. Decision support tools are needed to estimate the effects of management actions on agricultural production and income, and to estimate the increase in ecosystem goods and services that may result from watershed management, aquatic ecosystem restoration, and water quality improvements.

The many agencies and organizations engaged in watershed management and river restoration in the MRB need quantitative predictive tools to use in planning and decision-making. We propose to link the Corps of Engineers technical expertise with Minnesota State agencies and the University of Minnesota. A series of hydraulic, water quality, geographic information system (GIS), and decision support models can contribute to more informed watershed, water quality, and aquatic ecosystem management and restoration in the MRB.

The following is an initial description of a proposed effort of integrated watershed, water quality, and aquatic ecosystem restoration planning for the MRB.

5.6.1.1 Study Objectives

The primary objective is to prepare a plan for watershed, aquatic ecosystem, and water quality management and restoration in the MRB. Identification of effective management and restoration actions will be assisted by a decision support system (DSS). The DSS will consist of a family of process-based simulation models, GIS, agricultural and ecological economics valuation models, plan formulation, alternatives analysis, and evaluation models. Because water flow is the central process, this modeling effort will emphasize the hydrology and other material mobilization, transport, and fate processes in the MRB.

The DSS will enable examination of existing conditions, forecasting of future conditions, and simulation of alternatives that would be ecologically sustaining and socially desired. The DSS will address watershed, water quality, and ecosystem restoration needs at the small watershed, major watershed, tributary river, and main stem Minnesota River reach levels of spatial scale. The DSS will enable forecasting future conditions. The primary purpose of the DSS will be to assist in the selection, design, implementation, monitoring, and evaluation of watershed, water quality, and ecosystem management and restoration measures. The DSS will assist decision-makers and the public in identifying optimal investments and the long-term requirements to meet planning objectives in the MRB.

5.6.1.2 Planning Framework

Development of a watershed management plan for the MRB will be based on a standard planning process of assessing existing conditions, forecasting future conditions, and identifying desired future conditions based on planning objectives. The system needs will be identified through comparison between forecasted future conditions and desired future conditions. Simulations of different alternative management and restoration plans (combinations of measures) will be done using the DSS to evaluate effectiveness. Ecological and agricultural economics models will be used to identify optimal combinations of management and restoration measures to achieve planning objectives to approach sustainability of ecosystems and the agricultural economy. Results of this modeling and planning effort will be synthesized into a GIS-linked DSS that decision-makers can use to allocate investments in watershed, water quality, and ecosystem restoration in the MRB. The watershed management plan will identify the most effective combination of management measures to attain the plan objectives.

5.6.1.3 Technical Team

We propose that an interagency technical team be formed with expertise in hydrology, geomorphology, limnology, ecology, agriculture, economics, planning, and modeling. The non-Federal participants would be from the Minnesota Pollution Control Agency (MPCA), the Minnesota Department of Natural Resources (DNR), the Minnesota Board of Water and Soil Resources (BWSR), the Metropolitan Council of the Twin Cities, Minnesota State University – Mankato, and the University of Minnesota. Federal participants would include the Corps of Engineers, the Natural Resources Conservation Service (NRCS), the U.S. Fish and Wildlife Service (USFWS), the U.S. Geological Survey (USGS), and the U.S. Environmental Protection Agency (EPA). We propose that the U.S. Army Engineer Research and Development Center (ERDC) Environmental Laboratory scientists actively participate in the Technical Team in conjunction with the ERDC System-Wide Assessment, Modeling and Restoration Technologies (SMART) program. The Technical Team would collaborate on the details of the modeling and DSS development. The non-Federal participants would be the lead people representing their respective agencies for in-kind cost-share work. Subteams consisting of people with special expertise would be formed as needed to deal with process- and task-specific technical matters.

5.6.1.4 Small Watershed Modeling

Spatially explicit, process-based hydraulic models using the Corps of Engineers Gridded Surface Subsurface Hydrologic Analysis (GSSHA) program will be developed for six selected smaller (~23,000-acre) watersheds. The watersheds will be selected to geomorphically represent different parts of the MRB, and for availability of environmental data needed for modeling. The models will simulate surface and groundwater flow and subsurface drainage. The small watershed models will be calibrated using contemporary monitoring data. Stakeholders at all levels will assist in selecting the representative small watersheds to model and to provide the full set of available environmental data needed for the modeling work. We propose that the University of Minnesota, the Metropolitan Council of the Twin Cities Environmental Services, and the MPCA work closely with the Corps of Engineers in providing input on physical processes for the modeling effort and in conducting monitoring needed to provide data for model calibration.

The GSSHA models will be used to generate a set of annual hydrographs, representing existing conditions in typical dry, normal, and wet years, selected from the hydrologic record. Soil and Water Assessment Tool (SWAT) models of urban subwatersheds provided by the Metropolitan Council Environmental Services will be incorporated into the small watershed modeling effort.

5.6.1.5 Simulate Existing Materials Transport Processes

The GSSHA models will be adapted and linked to process-based models of sediment erosion, nitrogen (N) and phosphorus (P) mobilization, and transport. The GSSHA models will be used to simulate annual loading rates of TSS, total nitrogen (TN), and total phosphorus (TP).

5.6.1.6 Simulate the Natural Hydrologic Regime

The GSSHA models will be modified to simulate a set of natural (without agricultural drainage, storm water systems, road ditches, dams, with prairie vegetation, etc.) hydrographs for typical dry, normal, and wet years.

5.6.1.7 Simulate Natural Materials Transport Processes

The GSSHA models will be adapted and linked to process-based models of sediment erosion, N and P mobilization, and transport for natural conditions (prairie vegetation, no agriculture, no artificial drainage system, etc.). The GSSHA models will be used to simulate annual loading rates of TSS, TN, and TP.

5.6.1.8 Assess the Effects of Hydrologic Alteration and Land Use

The simulated annual hydrographs will be examined and compared using selected indicators of hydrologic alteration (Richter et al. 1996). Simulated annual yield curves of sediment, N, and P for existing and natural conditions will be compared.

5.6.1.9 Scaling to Major Watersheds

Hydrologic characteristics of the smaller watersheds will be selected for scaling to the major watersheds in the MRB. GSSHA models of a selected set of four to six major MRB watersheds will be developed at lower levels of spatial resolution. The GSSHA major watershed models will incorporate the available Hydrologic Simulation Program Fortran (HSPF) models to simulate TSS, N, and P loadings to the Minnesota River. The annual hydrographs and loading rate curves will be simulated for existing conditions using the same set of typical dry, normal, and wet hydrologic conditions.

5.6.1.10 Simulate Minnesota River Water Quality

Output from the major watershed models and a hydrologic model (HEC-RAS) will be used as input to CEQUAL river and reservoir water quality models. The main stem river model system will extend from Big Stone Lake to the confluence with the Mississippi River. The focus of attention will be in Big Stone Lake, Marsh Lake, Lac qui Parle, and the lower Minnesota River from Shakopee to the Mississippi River. The annual progression of existing conditions (TSS, Secchi transparency, N, P, Chlorophyll a, Biochemical Oxygen Demand (BOD), Dissolved Oxygen (DO)) will be simulated for typical dry, normal, and wet hydrologic conditions.

For the lower Minnesota River, a model system incorporating NAVEFF and NAVSED (hydraulic effects of commercial navigation traffic) models will be used to simulate the effects of commercial navigation traffic on water quality in the lower Minnesota River.

5.6.1.11 Simulate Future Conditions

The Technical Team would make a series of assumptions about future land use, urban development, climate, geomorphic processes, the agricultural drainage system, and watershed management in the MRB. These assumptions would be used as input variables in the model system to simulate future (year 2055) conditions. The small watershed, large watershed, and river water quality model systems would be used to simulate future (without project) conditions of system hydrology, loading rates, and Minnesota River water quality conditions. These simulations would be used to generate a description of future conditions for typical dry, normal, and wet hydrologic conditions.

5.6.1.12 Identify Ecologically Realistic Target Future Conditions; Identify System Needs

The Technical Team would examine the simulated future conditions, consider goals for watershed and water quality conditions, and develop a set of target future conditions. The Team would identify system needs (e.g., changes in the hydrologic regime, wetland, lake, reservoir and river restoration, sediment and nutrient loading rates, and river water quality conditions) that would be required to meet the target future conditions.

5.6.1.13 Select Management Measures to Simulate

The Technical Team would identify a set of best management practices for watershed management, land cover changes, modifications to the agricultural drainage system, wetland restorations, tributary channel restoration, reservoir water level management, navigation traffic restrictions, and other measures appropriate to the MRB.

5.6.1.14 Simulate Effects of Management Measures Applied at Different Spatial Scales

The Technical Team would simulate the effects of watershed and tributary river management actions in the six selected small-scale watersheds using GSSHA and the linked sediment and nutrient transport models. Rules for the spatial effects by number, geographic location, and area (as appropriate) of application of the management measures on the annual hydrograph and yield curves would be developed. Using the larger watershed and the river and reservoir water quality models, effects of combinations of management actions on conditions in the Minnesota River would be simulated.

5.6.1.15 Simulate Economic Effects of Management Actions

The Technical Team would select appropriate modeling approaches to simulate the effects of management measures on the economy. Effects of management measures on crop acreages, alternative crops, crop yields, and agricultural income would be simulated. Economic effects of applying urban best management practices would also be assessed. Rules for the spatial effects by number, geographic location, and area (as appropriate) of application of the management measures on the local, regional, and national economy would be developed.

5.6.1.16 Simulate Ecological Benefits of Management Actions

The Technical Team would select a set of ecosystem goods and services that would be affected by watershed management, aquatic ecosystem, and water quality restoration. The model system would be used to simulate the effects of management measures on the production of ecosystem goods and services. Rules for the spatial effects by number, geographic location, and area (as appropriate) of application of management measures on the production of ecosystem goods and services would be developed. Monetary valuation of selected ecosystem goods and services would be estimated by applying accepted valuation methodologies and information from ecological economics literature sources.

5.6.1.17 Develop a Decision Support System

A decision support system (DSS) would be developed, using the results of the model system, to enable decision-making about investments in watershed management, aquatic ecosystem restoration, and water quality management measures in the MRB. The DSS would be linked to the Basin GIS to enable visualization of the spatial arrangement of management measures. The DSS would incorporate incremental analysis techniques to identify the best value sequence of management measures to apply within each major watershed to achieve target future conditions.

5.6.1.18 Deliver DSS, Technology Transfer

The DSS would be made available to planners, resource managers, and decision-makers throughout the MRB via the Internet. The MRB watershed management and ecosystem restoration Internet site would include findings of the study, a synthesis of the modeling results, instructions for use of the DSS, and the Watershed Management Plan. The Internet site would be designed to enable tracking implementation of management and restoration measures and system response as revealed by monitoring.

5.6.1.19 Watershed Management Plan

The Watershed Management Plan would document the planning process and development of the DSS. The DSS would be used to identify the combination of management measures needed to attain the planning objectives. The type, geographic distribution, estimated cost, sequence of implementation, and implementing agency for the management measures would be described in the Watershed Management Plan for the MRB.

5.6.2 BLUE EARTH RIVER AQUATIC ECOSYSTEM RESTORATION

5.6.2.1 General Description

The Blue Earth River watershed is drained by the Blue Earth River and its major tributaries – the East, West, and Middle Branches of the Blue Earth River; the Watonwan River; Elm Creek; and Center Creek. Other smaller streams, public and private artificial drainage systems, lakes, and wetlands complete the drainage network.

5.6.2.2 Problem Description

The Blue Earth River ecosystem has been degraded by land use changes in the watershed that have altered the hydrologic and sediment transport regimes and by impoundment. Extensive artificial drainage made up of public and private ditch and tile systems facilitates the movement of water throughout the watershed. Approximately 86 percent of wetlands once present in the watershed have been lost through drainage. The remaining lakes and wetlands constitute about 2 percent of the watershed. Predominant land use within the watershed is agriculture, which includes row crops and feedlot operations. Much of the land in the watershed is highly erodible, and the intensive agricultural land use and steep slopes in the lower reaches of the watershed result in considerable bank erosion along stream channels and high suspended sediment concentrations in the river. The Blue Earth River is a major contributor of sediment to the Minnesota River.

Water quality monitoring has revealed high concentrations of suspended sediment, phosphorus, turbidity, nitrate-nitrogen, and ammonia, and high counts of fecal coliform bacteria.

The Rapidan Dam is located on the Blue Earth River approximately 12 miles upstream of Mankato in Blue Earth County, Minnesota. The reservoir extends approximately 4.3 miles

upstream, filling a steep U-shaped valley carved in sandstone bedrock. The dam is an Ambursen type concrete structure 414 feet long and 90 feet high. Figure 6 shows the dam.

Figure 6. Rapidan Dam.

The dam was built in 1910 and served as an electric power generating facility for Northern States Power Company until the dam was severely damaged during the 1965 flood. The dam also supported a county highway bridge, and Blue Earth County acquired the dam in 1970. A new bridge was constructed upstream of the dam in the 1980s. Under an agreement with the county, Rapidan Redevelopment, Ltd., redeveloped the dam in 1984 to resume producing hydroelectric power. The Blue Earth River provides significant recreational opportunities. Canoeing, kayaking, and fishing are popular activities both upstream and downstream of the dam.

In the winter of 2002, a substantial scour hole was discovered under the foundation of the dam. The St. Paul District, Corps of Engineers provided emergency assistance in April 2002 to repair the foundation. The county performed additional repairs to the downstream apron in the fall of 2003.

The Rapidan Dam blocks fish movements between the Minnesota and lower Blue Earth Rivers and the 2,400-square-mile drainage area above the dam, which is approximately 14 percent of the entire MRB. This area includes approximately 210 miles of the Blue Earth River and Watonwan River main stem channels, nearly 1,000 miles of smaller perennial tributaries, and over 1,000 miles of intermittent streams.

Rapidan Dam is a major barrier to fish movements in the MRB. Records of fisheries surveys of the Minnesota River and Blue Earth River system since the 1960s (Jack Engblom and Bobbi Chapman, Minnesota Department of Natural Resources, personal communication 2004) include 25 migratory fish species (Table 2). Migratory species in Table 2 were identified on the basis of fish mark-recapture studies in the Upper Mississippi River System and life history information

from fisheries literature (Wilcox et al. 2004). The State-listed threatened paddlefish and special concern blue sucker occur in the Minnesota River but not in the Blue Earth River or the Watonwan River above Rapidan Dam. Of the 25 migratory fish species reported from the Minnesota River, nine do not occur above Rapidan Dam, including shovelnose sturgeon, American eel, goldeye, mooneye, smallmouth buffalo, river redhorse, flathead catfish, white bass, smallmouth bass, and largemouth bass. An additional 13 non-migratory fish species have been reported from the Minnesota River but not from the Blue Earth River drainage above Rapidan Dam.

Table 2. Fish Species of the Minnesota, Blue Earth, and Watonwan Rivers.

Fish Species	Migratory	Minnesota River and Blue Earth River Below Rapidan Dam	Blue Earth River and Watonwan River Above Rapidan Dam
shovelnose sturgeon	X	X	
shortnose gar		X	
bowfin		X	
American eel	X	X	
gizzard shad		X	
goldeye	X	X	
mooneye	X	X	
northern pike	X	X	X
carp		X	X
brassy minnow		X	X
emerald shiner		X	X
common shiner		X	X
bigmouth shiner		X	
spottail shiner		X	X
spotfin shiner		X	X
sand shiner		X	X
river shiner		X	X
mimic shiner			X
pugnose shiner		X	
blacknose shiner		X	
redfin shiner		X	
rosyface shiner		X	
bluntnose minnow		X	X
fathead minnow		X	X
blacknose dace			X
silver chub		X	
creek chub		X	X
quillback	X	X	X
river carpsucker	X	X	X
highfin carpsucker	X	X	X

Table 2 (continued). Fish Species of the Minnesota, Blue Earth, and Watonwan Rivers.

Fish Species	Migratory	Minnesota River and Blue Earth River Below Rapidan Dam	Blue Earth River and Watonwan River Above Rapidan Dam
central stoneroller		X	X
white sucker	X	X	X
blue sucker	X	X	
northern hogsucker	X	X	X
smallmouth buffalo	X	X	
bigmouth buffalo	X	X	X
silver redhorse	X	X	X
golden redhorse	X	X	X
river redhorse	X	X	
shorthead redhorse	X	X	X
brook stickleback			X
black bullhead		X	X
brown bullhead		X	
yellow bullhead		X	X
channel catfish	X	X	X
stonecat		X	X
tadpole madtom			X
flathead catfish	X	X	
white bass	X	X	
rock bass		X	
smallmouth bass	X	X	
largemouth bass	X	X	
white crappie		X	X
black crappie		X	X
bluegill		X	
hybrid sunfish		X	
green sunfish		X	X
orangespotted sunfish		X	X
yellow perch			X
johnny darter		X	X
blackside darter			X
slenderhead darter		X	X
fantail darter			X
Iowa darter			X
logperch		X	
sauger	X	X	X
walleye	X	X	X
freshwater drum	X	X	X

The reservoir behind Rapidan Dam is almost entirely filled with sediment and presently provides low quality aquatic habitat and limited recreational opportunities. The shallow impoundment increases river water temperature during the summer, degrading habitat conditions for aquatic life in the river downstream.

Rapidan Dam is deteriorating and will require major rehabilitation or removal. Dam failure was averted by emergency short-term measures in 2002, and more permanent repairs would be needed to stabilize the dam for long-term safety. Although Rapidan Dam is not a high-hazard dam, failure would cause extensive adverse environmental damage in the Blue Earth and Minnesota Rivers. Debris flows from the dam would damage 7 miles of river gorge and county park. Hundreds of thousands of cubic yards of sediment from the reservoir would cover Blue Earth and Minnesota River floodplains for miles downriver. Extensive areas in the Blue Earth and Minnesota Rivers would be scoured, and extensive silt deposits would kill aquatic life. Cleanup following a major dam failure would be costly.

The Blue Earth River is a popular river for canoeing and kayaking. The Rapidan Dam imposes a barrier to whitewater recreation on the Blue Earth River in what would otherwise be more than 10 miles of scenic canyon with canoeable rapids.

5.6.2.3 Benefits of Blue Earth River Ecosystem Restoration

Naturalizing the hydrologic regime of the Blue Earth River through wetland restorations and modification of the artificial drainage network would improve habitat conditions in the Blue Earth River and its tributaries, and would reduce streambank erosion. Streambank stabilization efforts would greatly reduce sediment yield and improve habitat conditions.
The Blue Earth River presently supports a popular sportfishery for channel catfish and walleye. Approximately 22,730 angler hours of effort on the Blue Earth and Watonwan Rivers were estimated in a 1985 creel survey. This sportfishery presently provides at least $400,000 of economic value to the regional economy each year (estimate based on a 10-percent inflation update from 2001 to present, and economic value information for Minnesota in American Sportfishing Association 2001). Improved habitat conditions in the Blue Earth River would increase sportfishing opportunity and regional economic benefits.

Removing Rapidan Dam would avoid the possibility of a major dam failure with associated cleanup costs.

A free-flowing Blue Earth River would provide improved whitewater recreational boating opportunities through the former reservoir area. Whitewater recreation is one of the fastest-growing sports in the country, and the Class 1 and 2 rapids in the lower Blue Earth River and the scenic beauty of the canyon will probably receive increased use in the future. Without the reservoir, a free-flowing Blue Earth River would maintain lower summer water temperatures and higher dissolved oxygen levels, providing improved habitat conditions for aquatic life.
Removing the dam would allow fish migration up the Blue Earth River that has been blocked for nearly a century. Nine species of native migratory fish that occur in the Minnesota River would be able to migrate into the Blue Earth and Watonwan Rivers. An additional 13 non-migratory species occur below Rapidan Dam and could become established in the upper Blue Earth River if

they were able to pass the dam site. These fish species would be able to access more extensive and suitable spawning, nursery, foraging, and wintering habitats. Fish populations in the approximately 1,200 miles of perennial streams in the Blue Earth and Watonwan River watersheds and in the Minnesota River would increase in abundance, along with sportfishing opportunities. The increased fishing opportunities could result in a significant economic benefit to the regional economy.

Both the Minnesota Department of Natural Resources and the Minnesota Pollution Control Agency have indicated that removing the dam is their preferred option, on the condition that it is feasible to accomplish the work in an environmentally and socially acceptable way.

5.6.2.4 Impacts of Dam Removal

There are potential negative impacts associated with dam removal, however. The dam is an active hydroelectric generating facility, and dam removal would decrease the amount of renewable energy production in the area and curtail a revenue source for Blue Earth County. The dam is potentially eligible to the National Register of Historic Places, so any plans to alter the structure must include appropriate mitigation measures. The dam has created areas of wetland habitat that did not exist prior to its construction, and dam removal would eliminate these reservoir wetland areas. Dam removal would also eliminate flat water boating and fishing opportunities associated with the reservoir. As a barrier to fish movement, the dam also presents a barrier to the invasion of exotic species currently moving up the Mississippi River, such as bighead carp and other Asian carp species.

The reservoir is nearly full of sediment, and all of the inflowing sediment now passes downstream. Chemical analyses of a core sample of the sediment indicate that contaminant levels are generally low, but total phosphorus and total Kjeldahl nitrogen are high enough to be potential concerns. Impacts from releases of sediment to biota downstream must be considered in designing a dam removal project. Increased suspended sediment and nutrient concentrations could negatively affect water quality and aquatic life in the Blue Earth and Minnesota Rivers during dam removal.

5.6.2.5 Conceptual Plans and Estimates for Rapidan Dam Removal

A preliminary plan for removing the dam is described in Barr Engineering (2000). The plan involved a five-phase lowering of the sill over a 5- to 10-year period and removal of 1.9 million cubic yards of sediment. As the sediments in the reservoir were dewatered, they would be excavated with conventional land-based equipment, moved, and regraded within the river valley to create a new floodplain. Significant volumes of sediment would be allowed to pass downstream during each dewatering phase. Channel stabilization would begin upstream and progress toward the dam with each dewatering phase. The restored river would be designed to match natural conditions upstream and downstream of the reservoir. Under this plan, the restored reach would be approximately 2.3 miles long. The project would also involve reconstructing bridge piers for the county bridge immediately upstream of the dam.

The project would not require acquisition of any real estate interests or real estate costs. We have assumed that access would be obtained from public access areas and that all dredging/disposal and removal of the dam would be on State- or county-owned land. If project plans are changed or other alternatives are identified during the feasibility stage that invalidate these assumptions, we would identify the real estate interests and costs necessary to support these changes or alternatives.

The total cost for the conceptual plan (including design, construction, and contingencies) was estimated in the February 2000 report at $12 to $20 million, depending on several pending legal and environmental concerns.

For the reconnaissance study, the Corps of Engineers considered the preliminary planning estimate and prepared a revised estimate. The revised estimate assumed that much of the sediment would need to be hydraulically dredged, resulting in significantly higher unit costs. Structural demolition costs were also increased slightly based on Corps of Engineers experience with dams in the St. Paul District. It was assumed that much of the dam structure would be disposed of on-site, and some of the material could be placed downstream of the dam where the channel bottom has eroded. The dredged material would be disposed of within the existing reservoir limits but outside of the floodplain of the reestablished channel following dam removal. The revised cost estimate was $31 million, including a $6 million contingency.

The Corps of Engineers also investigated case histories of dam removals looking for trends that could be used for cost estimating. No clear trends emerged from the investigation. We found few projects similar in size and scope to the Rapidan Dam, and unit costs varied considerably from case to case.

Both of the preliminary estimates were based on a nearly complete removal of the existing structure. Subsequent conceptual plans have suggested that a partial dam removal with additional fill and armoring downstream would reduce dredging quantities, sediment transport, and potential structural problems during the project. Significant questions remain regarding how the sediment would behave during and after dewatering, how the Ambursen (hollow concrete) dam could be safely deconstructed, and what would be required to stabilize the restored channel reach. All of these issues need to be explored in more detail before accurate estimates can be prepared.

On the basis of the discussion above, construction costs for dam removal and channel restoration are estimated to be in the range of $20 to $30 million.

Blue Earth County has also considered rehabilitating the dam to allow continued hydroelectric power generation (Barr 2002). The preliminary estimate for rehabilitation in that report was approximately $8.5 million. Rehabilitation of the dam would maintain the current pool and its associated wetlands, as well as the income generated from selling the electric power. However, additional information about the structure's foundation is needed to make an accurate assessment of the costs, risks, and benefits of rehabilitation.

The feasibility study would consider several alternatives, including removing the dam, rehabilitating the dam, and providing fish passage around the dam. The study would develop all the information needed to determine what is in the best interest of Blue Earth County, the surrounding region, and the State and Federal governments from economic, environmental, and engineering standpoints.

5.6.3 MARSH LAKE AQUATIC ECOSYSTEM RESTORATION

5.6.3.1 General Description

Marsh Lake is located on the Minnesota River between Swift and Lac qui Parle Counties near Appleton, Minnesota. The Marsh Lake Dam is currently owned and maintained by the Corps of Engineers as part of the Lac qui Parle flood control project. The fixed-crest dam was constructed to hold a conservation pool in the upper portion of the Lac qui Parle reservoir. The Works Progress Administration constructed the dam and rerouted the Pomme de Terre River into the reservoir between 1936 and 1939. The reservoir was first filled in the spring of 1939, creating Marsh Lake. The Corps of Engineers improved the dam between 1941 and 1951 as part of the Lac qui Parle flood control project. The project was operated by the State of Minnesota until 1950, when operation and maintenance responsibilities were transferred to the Corps of Engineers. During flood events, the Marsh Lake Dam is inundated by the Lac qui Parle pool, and it serves no significant flood control purpose.

Figure 7 illustrates the Marsh Lake project area.

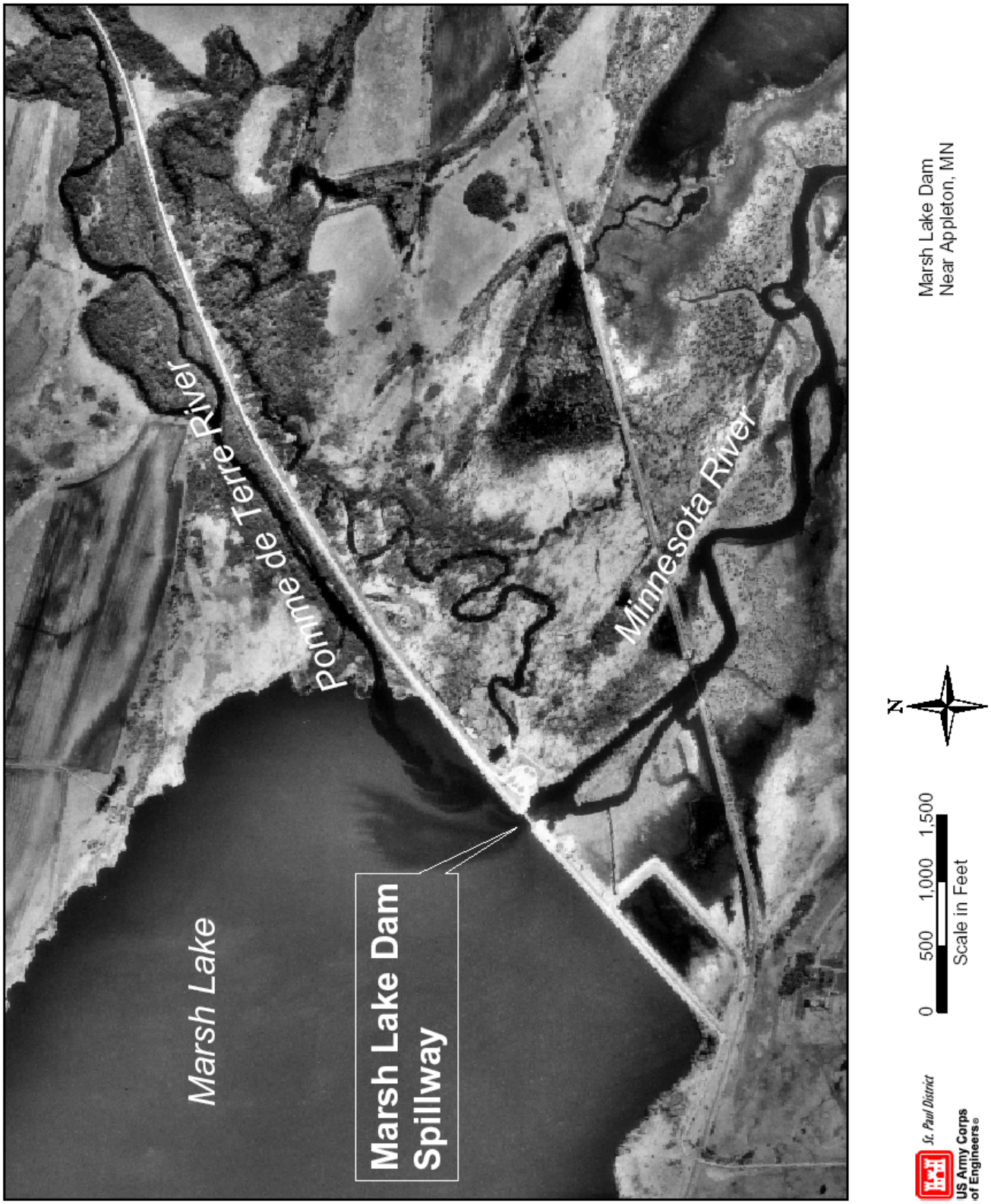


Figure 7. Marsh Lake Project Area.

Marsh Lake lies within the Lac qui Parle Wildlife Management Area, managed by the Minnesota DNR. The adjacent Big Stone National Wildlife Refuge is upstream. In the fall, as many as 150,000 Canada geese use the management area at one time. The migratory Canada geese are mostly from the Eastern Prairie Population, which nests near the southwestern shore of Hudson's Bay and traditionally winters on and near the Swan Lake National Wildlife Refuge in Missouri. Approximately 70 to 80 percent of this Canada goose population uses the management area during migration. Marsh Lake is also home to Minnesota's largest breeding colony of American white pelican. According to DNR fish surveys, there are 27 fish species in Marsh Lake, but the primary game fish are northern pike and walleye.

The earth-fill dam is 11,800 feet long with an average top elevation of 950.0 feet. The service spillway is a concrete fixed-crest overflow section 112 feet wide with a crest elevation of 937.6 feet. A grouted riprap emergency spillway immediately southwest of the service spillway is 90 feet wide with a crest elevation of 940.0 feet. The dam also has a 2-foot-square low flow outlet conduit. Unlike the Lac qui Parle Dam downstream, the Marsh Lake Dam cannot be operated to manage the elevation of Marsh Lake.

5.6.3.2 Problem Description

Creation of the reservoir in 1939 increased reservoir fish and wildlife habitat and created new colonial waterbird habitat. However, it also disrupted natural river functions and processes, affecting sediment movement and floodplain function, blocking fish movement, and reducing lotic (riverine) and floodplain habitats. Natural flooding and drying cycles were disrupted, reducing emergent aquatic plants and associated fish and wildlife habitats found in the area prior to the impoundment.

Marsh Lake has been subject to long-term degradation. Rapid delivery of water, sediment, and nutrients into the system, due to land use changes in the watershed, leads to larger and faster rises in lake elevation and degraded water quality. The sedimentation rate over the last 60 years has been estimated at approximately 60 acre-feet (97,000 cubic yards) per year. After spring runoff, water levels remain relatively stable due to the dam's fixed-crest design. The water quality in Marsh Lake is poor. The lake is very shallow, with more than 3,000 of its 5,000 acres less than 3 feet deep. Wind and wave action resuspends sediments that have accumulated in the reservoir. The suspended sediment blocks sunlight and hinders the growth of aquatic plants, which affects the quality of fish and wildlife habitat. Much of the resuspended material passes downstream where it affects water quality and promotes algal growth in Lac qui Parle. Carp thrive in the lake, uprooting vegetation and further hindering its growth and degrading the habitat for other fish and wildlife. The lake has developed into a shallow, turbid basin, and its habitat quality has declined.

5.6.3.3 Potential Solutions

A study by the U.S. Army Corps of Engineers Waterways Experiment Station found that aquatic vegetation was beneficial in reducing sediment resuspension in Marsh Lake (James and Barko 1995). That study recommended using reservoir drawdown to consolidate sediment and facilitate seed germination, constructing islands to reduce wind fetch, and transplanting

macrophytes to promote increased abundance of emergent/wetland plants. The St. Paul District has recently had ecologically effective results with summer drawdowns at the Lake Traverse flood control project (Mud Lake) and at Pool 8 on the Mississippi River.

The Minnesota DNR conducted planning and public involvement activities from 2000 through 2003 to consider possible modifications at the Marsh Lake Dam within the DNR's Lac qui Parle Wildlife Management Area. A full range of alternatives was evaluated, including no action, removing the dam, changing the elevation of the fixed-crest outlet, and providing a variable crest outlet structure. In July 2003, the DNR proposed modifying the fixed-crest weir and emergency spillway to allow more natural water level fluctuations in the reservoir (see DNR letter dated July 11, 2003, in the attached letters of intent). A variable crest outlet structure would be constructed to allow for periodic drawdowns to consolidate sediments and facilitate germination of aquatic vegetation. The existing primary outlet would be notched to increase variability of the water surface during typical summer flow conditions. The DNR conceptual plan also calls for building fish passage structures (rock riffles) downstream of the dam and restoring the Pomme de Terre River to its 1938 channel and floodplain. A management plan would be developed for the project to establish criteria for initiating drawdowns, monitoring vegetation and wildlife conditions, and coordinating operations with the other Minnesota River dams in the vicinity. Schematic profiles of the existing dam and proposed modifications are shown on Figure 8.

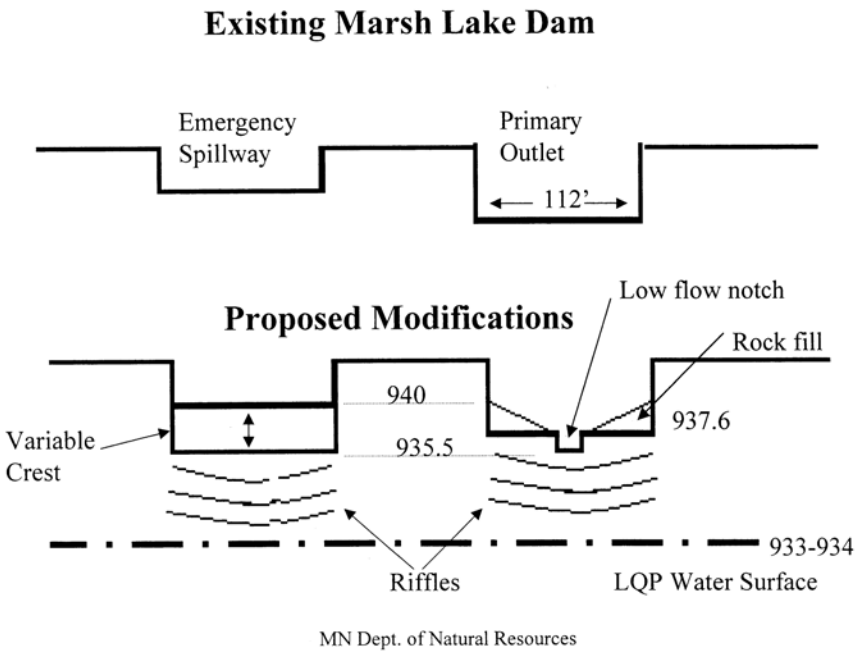


Figure 8. Marsh Lake Dam Profiles.

The conceptual plan carefully balances a number of potentially competing natural resource and recreational values associated with Marsh Lake and the Minnesota River. The maximum targeted drawdown is to an elevation of 936.0. That elevation preserves the Marsh Lake pool at approximately the level experienced during the 1988 drought. At that level, islands used by colonial waterbirds are still isolated from the mainland. The proposed project would give

resource managers the flexibility to adaptively manage the reservoir to improve conditions for aquatic plants, wildlife, and fish. It would also return the hydraulics of the outlet to a more natural condition in the majority of years when no active drawdowns are employed.

Constructing islands and transplanting aquatic vegetation may also be considered, although they are not described in the Minnesota DNR proposal. The St. Paul District has had success with these techniques in Mud Lake at the nearby Lake Traverse Project and on the Mississippi River, and their application to Marsh Lake may be appropriate.

5.6.3.4 Cost Estimates

A preliminary construction cost estimate for the features described in the DNR proposal is as follows:

Notch existing spillway	$11,000
Construct new variable crest outlet structure	$1,350,000
Construct rock riffles	$600,000
Reroute Pomme de Terre River	$750,000
TOTAL	$2,711,000

These estimates are based on similar projects in the St. Paul District. No detailed quantities were generated as part of the conceptual plan, and this estimate should be considered very preliminary. Additional costs for island construction and other potential features are not included in this estimate, but could significantly increase the cost of the project.

The total construction cost for all potential features would likely be in the $2 to $5 million range.

The estimate assumes that there is public access to the dam and that the proposed project would not require acquisition of additional real estate interests or estates, because all of the work proposed would be done on either State or Federal land. A permit may be required from the State. Because the area is dedicated as a wildlife area and the project is intended to improve habitat quality, there would be no diminution in value to the property and it would not be eligible for lands, easements, rights-of-way, relocations, and disposal areas (LERRDs) credit. During the feasibility stage, if these assumptions are found to be incorrect or if the project is modified, we will determine the appropriate real estate interests, their costs, and eligibility for LERRDs credit.

5.7 PRELIMINARY EVALUATION OF ALTERNATIVES

5.7.1 RESOURCE SIGNIFICANCE

Resources of the MRB are ecologically, economically, and culturally significant. The soils and agriculture in the Basin produce internationally significant amounts of grain, soybeans, dairy products, beef, and turkeys. Agriculture in the MRB produces a majority of the agricultural income to the State.

Numerous Federal, State, and local designations of unique resources demonstrate the significance of resources in the MRB. There is widespread technical recognition that the MRB provides essential habitat for many migratory bird species in the central flyway of North America. The prairie pothole region is an internationally significant area for migratory waterbirds, as recognized by Canada, the United States, and Mexico in the North American Waterfowl Management Plan. In the North American Wetlands Conservation Act of 1989, Congress recognized wetlands in the MRB as a federally significant resource. Public recognition of the significance of wetlands in the MRB is evidenced by the millions of dollars of 50 percent non-Federal matching of North American Wetlands Conservation Act (NAWCA) grants for wetland restoration that have already been invested in the MRB.

Federally listed threatened and endangered species are institutionally recognized significant resources that occur in the MRB. These include the bald eagle (threatened) and the prairie bush clover (threatened). A much longer list of threatened, endangered, and special concern species that occur in the MRB is recognized as significant by the State of Minnesota.

Federally recognized significant resource areas in the MRB include the Lac qui Parle and Minnesota Valley National Wildlife Refuge.

Congress recognized the significance of the Gulf of Mexico hypoxia phenomenon, its effect on marine fisheries, and connection with nitrogen loading from the Mississippi River Basin in Public Law 105-383. Congress provided institutional recognition of the significance of the MRB. The Upper Mississippi River Environmental Management Plan was authorized by Section 403 of the Fiscal Year 2000 Water Resources Development Act (WRDA), Public Law 106-541 to conduct watershed and basin scale modeling, assessment, and research as part of broader concerns for sediment and nutrient problems within the Upper Mississippi River Basin.

State-recognized significant resource areas include the following State parks:

- Big Stone Lake State Park and Environmental Education Center
- Upper Sioux Agency State Park
- Camden State Park
- Lac qui Parle State Park
- Minnesota Valley State Park
- Minnesota Valley State Trail
- Fort Snelling State Park

In addition to the State parks and trails, there are over 30 State scientific and natural areas in the MRB.

The Nature Conservancy has identified conservation priorities for freshwater biodiversity in the Upper Mississippi River Basin, including the MRB (The Nature Conservancy 2003 Appendix 13, Priority Areas Maps and Descriptions, Minnesota River, pages 24-27). These areas include portions of the Minnesota River main stem, much of the upper Minnesota River valley, and the Chippewa River.

5.7.2 PRELIMINARY ESTIMATE OF PROJECT COSTS

Table 3 contains preliminary estimates of construction, operation, and maintenance costs for the two representative ecosystem restoration projects (Alternatives 2 and 3). The details, assumptions, and supporting information for these estimates are contained in the preceding descriptions of each alternative. Study costs for all three studies are described in Paragraph 10, Feasibility Phase Cost Estimate.

Table 3. Preliminary Project Cost Estimates.

Project/Example Site	Range of Construction Cost	Annual O+M Cost	Study Cost
Rapidan Dam Removal, River Restoration	$20 to $30 million	$10,000	$1,491,000
Marsh Lake Dam Modification, Water Level Management	$2 to $5 million	$5,000	$766,000
Integrated Watershed, Water Quality, Ecosystem Restoration Analysis	N/A	N/A	$5,663,500

These projects are only representative examples of the types of projects that could be implemented in the MRB and do not constitute all of the potential construction opportunities. Additional opportunities will be identified during the course of the feasibility studies, particularly as part of the integrated watershed management, water quality, and ecosystem restoration analysis (Alternative 1).

5.7.3 PRELIMINARY ESTIMATE OF PROJECT BENEFITS

Ecosystem restoration projects are defined as high priority outputs in the Administration's budget policy. Ecosystem restoration outputs are increases in ecosystem goods and services of value to human society. The integrated watershed, water quality, and ecosystem restoration analysis and the ecosystem restoration projects described above represent a holistic approach to system-wide restoration of degraded hydrologic regime, water quality, and aquatic, wetland, and riparian habitats within the MRB. These actions would result in significant benefits to ecosystems of unique local, regional, and national importance. The restoration projects would help offset degradation and loss of aquatic and wetland habitats in the MRB. They would improve the hydrologic regime, water quality, vegetation, fish, and wildlife biodiversity. These restoration projects would also provide fish and wildlife habitat on-site and produce systemic improvements to the basin ecosystem.

5.7.3.1 Integrated Watershed, Water Quality Management, and Ecosystem Restoration Analysis

Significant public and private investments in management of land and water resources in the MRB will be made in the coming decades, numbering in the billions of dollars. The integrated

analysis would lead to more informed, cost-effective, and ecologically effective decision-making for watershed management, water quality management, and aquatic ecosystem restoration in the MRB. It would facilitate more sustainable urban development and agricultural practices. The analysis may identify a variety of potential projects under Corps of Engineers and other Federal agency authorities. A wide range of non-Federal sponsors, stakeholders, and other Federal agencies have expressed support for this proposal, and it offers an opportunity to guide implementation of several existing government programs to maximize their benefits. The integrated analysis would contribute to increased ecosystem goods and services through natural resources management and sustainability of agriculture in the MRB. These benefits would include more sustainable agriculture and rural communities in the MRB, reduced flooding damages, improved water quality, improved human health, increased distribution and abundance of wildlife, and increased recreational opportunities.

5.7.3.2 Blue Earth River Aquatic Ecosystem Restoration

Removal of Rapidan Dam and restoration of the Blue Earth River channel would restore habitat connectivity for a number of migratory fish species between the Minnesota River and approximately 1,200 miles of perennial streams in the Blue Earth River and Watonwan River basins. It would reconnect 14 percent of the MRB that has been isolated from the main stem Minnesota River for nearly a century. The State-listed threatened paddlefish and the special concern blue sucker have been returning to the Minnesota River and could make use of the higher-gradient parts of the Blue Earth River system for spawning. Nine species of native migratory fish that occur in the Minnesota River would be able to migrate into the Blue Earth and Watonwan Rivers. An additional 13 non-migratory species occur below Rapidan Dam and could become established in the upper Blue Earth River if they were able to pass the dam site. These fish species would be able to access more extensive and suitable spawning, nursery, foraging, and wintering habitats. Fish populations in the approximately 1,200 miles of perennial streams in the Blue Earth and Watonwan River watersheds and in the Minnesota River would increase in abundance, along with sportfishing opportunities.

The Blue Earth River presently supports a popular sportfishery for channel catfish and walleye. Approximately 22,730 angler hours of effort on the Blue Earth and Watonwan Rivers were estimated in a 1985 creel survey. This sportfishery presently provides at least $400,000 of economic value to the regional economy each year (estimate based on a 10-percent inflation update from 2001 to present, and economic value information for Minnesota in American Sportfishing Association 2001). Rapidan Dam removal would probably increase the abundance of fish and increase sportfishing opportunity in the Blue Earth, Watonwan, and Minnesota Rivers, resulting in a significant economic benefit to the regional economy.

A free-flowing Blue Earth River would provide improved whitewater recreational boating opportunities through the former reservoir area. Whitewater recreation is one of the fastest-growing sports in the country, and the Class 1 and 2 rapids in the lower Blue Earth River and the scenic beauty of the canyon will probably receive increased use in the future. Increased whitewater recreation, and visitation for hiking and wildlife viewing would provide economic benefits to the region.

5.7.3.3 Marsh Lake Aquatic Ecosystem Restoration

The Marsh Lake project could restore over 3,000 acres of emergent aquatic vegetation and about 2,000 acres of submersed aquatic vegetation, greatly improving wetland and shallow aquatic habitat in an existing reservoir. A restored Marsh Lake would provide habitat and nesting for many bird species and migration habitat for thousands of migratory waterbirds. The Minnesota River valley is a major bird migration corridor in mid-continent. In addition to contributing to the abundance of wildlife, restored Marsh Lake habitat would increase hunting and wildlife viewing opportunity in the Lac qui Parle Wildlife Management Area. In addition to the Minnesota DNR and the U.S. Fish and Wildlife Service, Ducks Unlimited Inc. recognizes the value of restoring Marsh Lake to improve fall migration habitat for waterfowl as part of its Living Lakes Initiative (see attached letter of support).

Aquatic and wetland habitat restoration in Marsh Lake would provide high quality spawning habitat for northern pike, increase forage fish production, and contribute to the regionally significant Lac qui Parle sportfishery.

Restoring the lower reach of the Pomme de Terre River to its former channel and floodplain would improve aquatic and floodplain habitat conditions in Lac qui Parle State Park, increasing opportunities for sportfishing and wildlife viewing. Migratory fish such as northern pike, walleye, channel catfish, and shorthead redhorse in Lac qui Parle would gain improved access to the Pomme de Terre River watershed with more than 750 miles of streams. Removing the Pomme de Terre River flows from Marsh Lake would reduce over-wintering habitat for non-native carp and improve the northern pike/carp balance in the system.

6 FEDERAL INTEREST

6.1 GENERAL

Ecosystem restoration is a high priority mission for the Corps of Engineers, and a basin-wide approach to water resources management is Corps of Engineers policy. The Corps of Engineers objective in ecosystem restoration planning is to contribute to National Ecosystem Restoration (NER) by increasing the net quantity and/or quality of desired ecosystem resources (Engineer Regulation (ER) 1105-2-100). The objective of ecosystem restoration is to restore degraded ecosystem structure, function, and dynamic processes to a less degraded, more natural condition. Ecosystem restoration efforts will involve a comprehensive examination of the problems contributing to the system degradation and the development of alternative means for their solution (ER 1165-2-501). The intent of restoration is to partially or fully reestablish the attributes of a naturalistic, functioning, and self-regulating system. Both the Blue Earth River and the Marsh Lake projects would provide significant aquatic ecosystem restoration benefits. The preliminary analysis conducted during the reconnaissance phase indicates that the benefits of proposed restoration outputs would exceed project costs.

6.2 INTEGRATED WATERSHED, WATER QUALITY MANAGEMENT, AND ECOSYSTEM RESTORATION ANALYSIS

This reconnaissance study proposes an integrated watershed, water quality management, and ecosystem restoration analysis in order to evaluate the MRB as a dynamic system. A better understanding of how hydrologic changes and land use affect water quality and the ecosystem is needed in order to target appropriate measures to correct the problems found in the MRB. The study will develop tools that can be used to identify structural measures that may be recommended for Federal implementation and to recommend nonstructural measures to be implemented by State and local governments.

Corps of Engineers regulations require that we take a broad perspective in planning for civil works projects. ER 1105-2-100 (22 April 2000) states that:

> *Civil works planning should incorporate a watershed perspective, whether that planning involves a project feasibility study or a more comprehensive watershed study. Such planning should be accomplished within the context of an understanding and appreciation of the impacts of considered actions on other natural and human resources in the watershed. In carrying out planning activities, we should encourage the active participation of all interested groups and use of the full spectrum of technical disciplines in activities and decision-making. We also should take into account: the interconnectedness of water and land resources (a systems approach); the dynamic nature of the economy and the environment; and the variability of social interests over time. Specifically, civil works planning should consider the sustainability of future watershed resources, specifically taking into account environmental quality, economic development and social well-being.*

Other Federal, State, and local groups contacted during the reconnaissance investigation strongly support development of an integrated analysis for watershed, water quality, and ecosystem management and restoration. They considered it an integral complement to their ongoing MRB initiatives. The integrated watershed, water quality, and ecosystem analysis will provide for informed implementation of structural and nonstructural management measures throughout the Basin, along with a powerful tool to perform incremental analysis of costs and benefits. The preliminary analysis indicates that the ecological and economic benefits of proposed efforts will exceed project costs, that the proposed measures are technologically feasible, and that they can be accomplished in a cost effective and efficient manner. Potential sponsors are able and willing to participate as non-Federal partners in cost-shared feasibility studies.

The presence of four federally constructed impoundments on the river's main stem and a Corps of Engineers navigation pool and channel in the lower 15 miles of the river also support a Federal interest in the proposed study. Operation and navigation activities in these reaches contribute to water quality and ecosystem problems, and additional research and modeling is necessary to evaluate these impacts and potential solutions.

6.3 BLUE EARTH RIVER AQUATIC ECOSYSTEM RESTORATION

Federal interest in the Blue Earth River is based on the potential benefits of aquatic ecosystem restoration. A combination of wetland restorations and modifications to the artificial drainage network would naturalize the hydrologic regime, producing both ecosystem and flood damage reduction benefits. Streambank stabilization efforts in the Blue Earth River and its tributaries would reduce sediment yield, improving water quality conditions in the Minnesota River and possibly reducing dredging requirements in the Lower Minnesota River. Although the removal of the Rapidan Dam would have temporary adverse environmental effects on the Blue Earth and Minnesota Rivers due to sediment mobilization and transport, the long-term net effect would be a restoration of the Blue Earth River and connected Minnesota River ecosystem. Rehabilitation of the dam for continued hydroelectric power generation must be considered as an alternative in order to quantify the potential economic trade-offs involved. Current Corps of Engineers policies would not support Federal participation in implementing a hydropower dam rehabilitation project. The Corps of Engineers can contribute to ecosystem restoration activities in connection with dam removal, but dam removal costs may be the responsibility of the dam's owner. Specific cost sharing arrangements for implementation would be developed during the feasibility study.

6.4 MARSH LAKE AQUATIC ECOSYSTEM RESTORATION

Federal interest in Marsh Lake is based not only on the expected environmental benefits, but also on the Corps of Engineers' existing stewardship responsibilities at the site. Significant ecosystem benefits and no adverse environmental impacts are anticipated from the implementation of the proposed modifications at Marsh Lake. The dam is part of a federally authorized project, the Lac qui Parle flood control project. Standing authority of Section 216 of the Flood Control Act of 1970 authorizes studies to review the operation of completed Federal projects and recommend project modifications "when found advisable due to significantly changed physical or economic conditions... and for improving the quality of the environment in the overall public interest." The St. Paul District and the Minnesota DNR both want to improve environmental conditions within the Lac qui Parle Wildlife Management Area, which contains Marsh Lake. The Corps of Engineers must be involved in plans to change the existing federally operated and maintained structures.

7 PRELIMINARY FINANCIAL ANALYSIS

Non-Federal sponsors will be required to provide 50 percent of the cost of the feasibility phase. Letters of intent from several potential sponsors are listed in Table 4 and are included as Attachment 1.

Table 4. Organizations Submitting Letters of Intent.

Organization	Integrated Watershed Analysis	Blue Earth River Restoration	Marsh Lake
Blue Earth County		X	
MN Department of Natural Resources (DNR)	X		X
MN Pollution Control Agency (MPCA)	X		
Metropolitan Council	X		
The Nature Conservancy	X		
University of Minnesota	X		

The letters state each sponsor's willingness to pursue the feasibility study and to share in its cost. Letters of support from other potential partners are also included as Attachment 2.

The integrated watershed, water quality management, and ecosystem restoration analysis will involve many State and local agencies, as well as non-profit organizations that could contribute both cash and in-kind services. We anticipate that most of the non-Federal partners will enter into third-party agreements in order to support a small number of official study sponsors. Given the wide variety of potential funding partners, it appears that there will be sufficient funding capacity to support the non-Federal cost share. Specific expectations will be developed in the Project Management Plan for the study.

Blue Earth County intends to sponsor the Blue Earth River feasibility study. The county's 2004 budget was over $56 million, and the county has successfully served as a sponsor on other Corps of Engineers projects in the past. The Minnesota DNR has also offered to seek State funding to assist the county with this study.

The Minnesota DNR intends to sponsor the Marsh Lake feasibility study. The DNR is pursuing funding through the Minnesota State Legislature to support the non-Federal share, and DNR staff will likely provide in-kind services as well.

8 SUMMARY OF FEASIBILITY STUDY ASSUMPTIONS

Feasibility Phase Assumptions: The following critical assumptions will provide a basis for the feasibility study.

1. Project Management Plans and Feasibility Cost Sharing Agreements will be executed for two feasibility studies for the Blue Earth River and Marsh Lake ecosystem restoration projects described in this report. The decision documents will be integrated Feasibility Reports and National Environmental Policy Act (NEPA) compliance documents prepared by the St. Paul District. The priorities and schedules of the proposed feasibility studies will be determined in consultation with the potential non-Federal sponsors during the development of the Project Management Plans.

2. One Project Management Plan and Feasibility Cost Sharing Agreement will be executed for a watershed study addressing integrated basin-scale analyses as described for the Integrated Watershed, Water Quality Management, and Ecosystem Restoration Analysis. The products of this integrated watershed analysis would provide the scientific and economic basis for decision-making for implementation of both structural and nonstructural measures. Most of the nonstructural management measures can probably be implemented by the non-Federal sponsors or other Federal partners.

3. Identification of a Federal interest in additional water resources projects is likely during the course of the three initial studies. We anticipate that supplements to this 905(b) Analysis would be required to support specific recommendations for additional feasibility studies in the future, as non-Federal interest arises.

4. The Blue Earth River Ecosystem Restoration feasibility study would be conducted in two phases. The first phase would look at an array of alternatives in enough detail to accurately estimate construction costs and evaluate economic trade-offs. The alternative array would include both dam removal and dam rehabilitation for continued hydroelectric power generation. The second phase would complete detailed design and NEPA documentation for a selected plan with demonstrated Federal interest. Significant field data and design will be required in Phase 1 to assess foundation conditions, likely sediment behavior during and after construction, and potential environmental impacts of sediment release. An alternative selection decision will be made after Phase 1 and before detailed scoping for Phase 2. The non-Federal sponsor and the Corps of Engineers will decide after Phase 1 whether continuing the study into Phase 2 is in our mutual interests. Under current Corps of Engineers policy, it is unlikely that a Federal interest can be demonstrated for rehabilitating the dam.

9 FEASIBILITY PHASE MILESTONES

The Blue Earth River and Marsh Lake Aquatic Ecosystem Restoration feasibility studies are scheduled to take 2 years, subject to availability of funds. The potential non-Federal sponsors' fiscal years typically run from 1 July through 30 June, and current budgets have already been passed. Both Federal and non-Federal funding would need to be obtained before the studies could be initiated. The milestone schedules for the Blue Earth River and Marsh Lake studies are shown in Table 5. These schedules are generic as to starting date, but they identify the significant milestones.

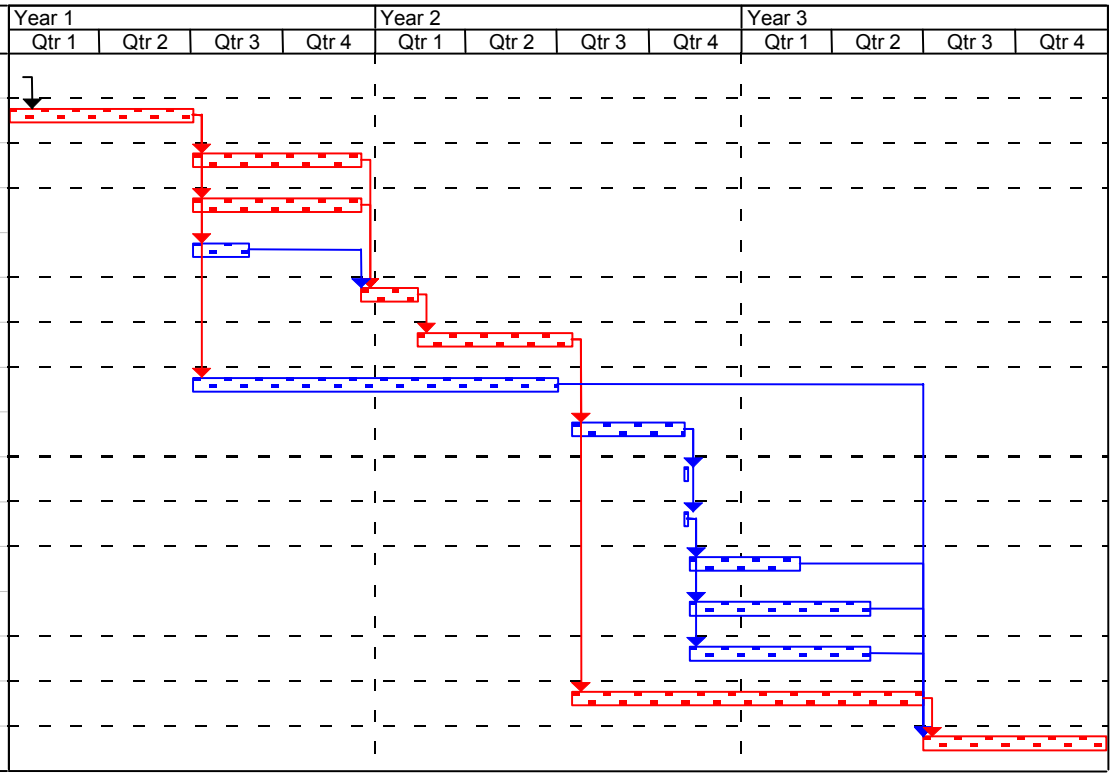
Table 5. Blue Earth River and Marsh Lake Feasibility Milestone Schedules.

Feasibility Phase Milestones	Blue Earth River	Marsh Lake
PHASE 1		
Notice of Intent/Notice of Initiation of Feasibility Study	Jan (year 1)	Jan (year 1)
EA/EIS Scoping Meeting – Public Workshop	Jan (year 1)	Jan (year 1)
ITR Initial Meeting and Site Visit	May (year 1)	May (year 1)
Field Investigations Complete	July (year 1)	July (year 1)
In Progress Review Meeting	Sep (year 1)	Sep (year 1)
Alternative Designs Complete	Oct (year 1)	Oct (year 1)
ITR Review of draft alternative formulation report	Nov (year 1)	Nov (year 1)
Alternative Formulation and Evaluation Complete	Dec (year 1)	Dec (year 1)
Decision Point: Continue to Phase 2?	Dec (year 1)	Dec (year 1)
PHASE 2		
Alternative Formulation Report Complete	Jan (year 2)	Jan (year 2)
Alternative Formulation Briefing	Feb (year 2)	Feb (year 2)
ITR Team review AFB issues and conduct VE study	Feb (year 2)	Feb (year 2)
Prepare Draft Feasibility Report (DFR) and Draft EA/EIS	Mar (year 2)	Mar (year 2)
DFR and Draft EA/EIS review/comment/revision	May (year 2)	May (year 2)
Transmit DFR and DEA/DEIS to Division and HQ and mail to public	Jul (year 2)	Jul (year 2)
Comment and Response Period	Sep (year 2)	Sep (year 2)
Prepare Final Feasibility Report (FFR) and Final EA/EIS	Nov (year 2)	Nov (year 2)
ITR Team review final product	Nov (year 2)	Nov (year 2)
Transmit FFR and FEA/FEIS to Division and HQ	Dec (year 2)	Dec (year 2)
Division Commander's public notice	Dec (year 2)	Dec (year 2)

The Integrated Watershed, Water Quality Management, and Ecosystem Restoration Analysis is proposed to take 3 years. Independent Technical Review will be conducted at appropriate points throughout the study as intermediate products are developed. A proposed schedule of major activities is shown on Figure 9.

Figure 9. Milestone Schedule for the Integrated Watershed, Water Quality Management, and Ecosystem Restoration Analysis.

ID	Task Name	Duration
1	Start Project	0 days
2	Small Watershed Modeling	26 wks
3	Simulate Existing Materials Transport Processes	24 wks
4	Simulate Natural Hydrologic Cycle	24 wks
5	Simulate Natural Materials Transport Processes	8 wks
6	Assess Effects of Hydrologic Alteration and Land Use	8 wks
7	Scaling to Major Watersheds	22 wks
8	Simulate Minnesota River Water Quality	52 wks
9	Simulate Future Conditions	16 wks
10	Identify Ecologically Realistic Target Future Conditions	3 days
11	Select Management Measures to Simulate	3 days
12	Simulate Hydrologic Effects of Management Measures	16 wks
13	Simulate Economic Effects of Management Actions	26 wks
14	Simulate Ecological Benefits of Management Actions	26 wks
15	Develop Decision Support System	50 wks
16	Deliver Decision Support System, Tech Transfer	26 wks



10 FEASIBILITY PHASE COST ESTIMATE

The estimated feasibility phase costs are shown in Tables 6a, 6b, and 6c. These costs are based on initial cost estimates for feasibility study tasks including planning, public involvement, environmental assessment, engineering surveys and design, study management, and plan formulation. Detailed cost estimates will be developed in consultation with cost-share sponsors in developing the Project Management Plans (PMPs) and the Feasibility Cost Sharing Agreements (FCSAs) with the non-Federal partners.

Table 6a. Integrated Watershed, Water Quality, and Ecosystem Restoration Analysis Costs.

	Activity	Cost
1	Project Management Team	$482
2	Technical and Modeling Team	$662
3	Small Watershed Modeling	$378
4	Simulate Existing Materials Transport Processes	$479
5	Simulate the Natural Hydrologic Regime	$126
6	Simulate Natural Materials Transport Processes	$112
7	Assess the Effects of Hydrologic Alteration and Land Use	$68
8	Scaling to Major Watersheds	$300
9	Simulate Minnesota River Water Quality	$1,116
10	Simulate Future Conditions	$142
11	Identify Ecologically Realistic Target Future Conditions	$16
12	Select Management Measures to Simulate	$13
13	Simulate Effects at Different Spatial Scales	$272
14	Simulate Economic Effects of Management Actions	$209
15	Simulate Ecological Benefits of Management Actions	$209
16	Develop DSS	$792
17	Deliver DSS, Technology Transfer	$288
	TOTAL	$5,664

Assumptions:

1. All costs are in thousands of dollars.
2. This estimate includes substantial in-kind services from several non-Federal partners in addition to cash contributions.
3. Work of other Federal agencies is included in this estimate. Assume that the Corps of Engineers would obtain funding and distribute it to other Federal agencies as needed to support the study.

Table 6b. Blue Earth River Ecosystem Restoration Feasibility Study Costs.

	Task Description	Phase 1 Estimate	Phase 1 Contingency	Phase 2 Estimate	Study Total	Notes:
A	Public Involvement	20	2	15	37	Public meetings, newsletters, etc.
B	Institutional Studies	10	2		12	Lease agreements, historical information, etc.
C	Social Studies	5	1		6	Recreation, etc.
D	Cultural Studies	10	2		12	National Register Issues, archaeology
E	Environmental Studies	75	50	25	150	Environmental design and NEPA process
F	Fish and Wildlife	10	2		12	Coordination Act Requirements
G	Economic Studies	20	5		25	Evaluate financial trade-offs of all alternatives
H	Surveying and Mapping	40	20		60	Stream cross sections
J	Hydrology and Hydraulics	300	100	100	500	Hydraulic analysis and design for dam removal, and Risk Analysis for dam rehabilitation
K	Foundations and Materials	150	30	50	230	Investigate abutments and foundation (6 borings) plus borings for testing of sediments
M	Designs and Cost Estimates	100	50	100	250	Structural and layout issues, construction cost estimates
N	Real Estate Studies	15	2	15	32	Project site, adjacent landowners, disposal areas
P	Study Management	30	5	30	65	Administration, cost tracking, coordination
Q	Plan Formulation	40	5	5	50	Developing, comparing and assessing alternatives
R	Report Preparation	20	5	25	50	Prepare draft and final reports of findings
	Column Totals	**845**	**281**	**365**	**1491**	
	SUBTOTAL BY PHASE	**$1,126,000**		**$365,000**	**$1,491,000**	

Assumptions:

1. Two year study
2. Phase 1 = planning up to selection of preferred plan
3. Phase 2 = detailed design of selected plan, determine baseline cost estimate, submit report for Congressional approval.
4. Assume selected plan = dam removal

Table 6c. Marsh Lake Dam Ecosystem Restoration Feasibility Study Costs.

	Task Description	Phase 1 Estimate	Phase 1 Contingency	Phase 2 Estimate	Study Total	Notes:
A	Public Involvement	10	2	10	22	Public meetings, newsletters, etc.
B	Institutional Studies	5	2		7	Project history, intergovernmental relations
C	Social Studies	5	1		6	Recreation, etc.
D	Cultural Studies	10	2		12	Cultural resources survey, coordination
E	Environmental Studies	30	20	20	70	Environmental design and NEPA process
F	Fish and Wildlife	5	2		7	Coordination Act Requirements
G	Economic Studies	10	5		15	Document and compare costs of alternatives
H	Surveying and Mapping	40	20		60	Dam area topography, bathymetry
J	Hydrology and Hydraulics	40	40	40	120	Hydraulic analysis and design for dam modifications
K	Foundations and Materials	30	30	30	90	Geotechnical design
M	Designs and Cost Estimates	50	50	75	175	Structural and layout issues, construction cost estimates
N	Real Estate Studies	10	2	15	27	Project site, borrow and disposal areas
P	Study Management	30	5	30	65	Administration, cost tracking, coordination
Q	Plan Formulation	30	5	5	40	Developing, comparing and assessing alternatives
R	Report Preparation	20	5	25	50	Prepare draft and final reports of findings
	Column Totals	**325**	**191**	**250**	**766**	
	SUBTOTAL BY PHASE	**$516,000**		**$250,000**	**$766,000**	

Assumptions:

1. Two year study
2. Phase 1 = planning up to selection of preferred plan
3. Phase 2 = detailed design of selected plan, determine baseline cost estimate, submit report for Congressional approval.

11 POTENTIAL ISSUES AFFECTING INITIATION OF FEASIBILITY PHASE

The partners have indicated their willingness and capability to fulfill their commitments under the potential Feasibility Cost Sharing Agreements (FCSAs). Discussions with the partners indicate no issues that would preclude their signing FCSAs. Discussions are currently under way with the partners to determine the most advantageous approach for budgeting and scheduling purposes. More detailed discussions will be continued during the development of the Project Management Plans.

It must be noted that the Integrated Watershed, Water Quality Management, and Ecosystem Restoration Analysis promises to be a complicated interagency effort. Significant coordination will be required in the remaining Reconnaissance Phase to draft an acceptable project management plan and develop cost-sharing arrangements.

12 VIEWS OF OTHER RESOURCE AGENCIES

The Minnesota River Reconnaissance Study included extensive coordination with local, State, and Federal agencies throughout the Basin. The implementation of a comprehensive watershed-based approach to ecosystem restoration, watershed, water quality management, and recreation improvement in the MRB has received strong widespread support, as evidenced by the attached letters of intent and letters of support from Sponsors. The Minnesota DNR intends to sponsor the Marsh Lake Dam study and has also pledged to pursue funding to assist Blue Earth County in sponsoring the Blue Earth River study. No agency opposition has been raised to any of the proposed studies.

13 RECOMMENDATIONS

We recommend that this 905(b) Analysis Report be approved as a basis for proceeding with the following studies in the Minnesota River Basin:

1) Integrated watershed, water quality management, and ecosystem restoration analysis, leading to the development of a basin scale watershed management plan
2) Blue Earth River aquatic ecosystem restoration feasibility study
3) Marsh Lake aquatic ecosystem restoration feasibility study

The integrated watershed, water quality management, and ecosystem restoration analysis would facilitate better watershed management and identify specific opportunities for the Corps of Engineers and other stakeholders. The study would integrate the efforts of a wide range of agencies currently working independently, leading to more cost-effective use of existing government programs.

The Blue Earth River study could lead to restoration of habitat and connectivity between the Minnesota River and 1,200 miles of perennial tributary streams that have been isolated from the main stem for nearly a century. Reconnecting this ecosystem would benefit at least 22 species of native fish and increase associated recreational opportunities throughout the Blue Earth River basin.

The Marsh Lake study would identify measures to restore over 5,000 acres of wetland habitat within an existing Corps of Engineers reservoir and reconnect Lac qui Parle to more than 750 miles of streams.

Remaining tasks in the reconnaissance phase include developing Project Management Plans and finalizing Feasibility Cost Sharing Agreements with the non-Federal sponsors. The feasibility phase of the studies would begin under the authority of the General Investigations program upon execution of cost sharing agreements and receipt of Federal and non-Federal funds.

We also recommend that this report serve as the basis for future feasibility studies not specifically described herein. Supplemental 905(b) analyses would be developed as opportunities arise in connection with the three identified studies.

There are sufficient indications that cost-effective engineering solutions to watershed, water quality management, and ecosystem degradation problems in the Minnesota River Basin can be formulated that will result in project benefits in excess of project costs. These potential solutions are consistent with Army and budgetary policies, and the projects meet criteria for Federal participation in project implementation.

Michael F. Pfenning

MICHAEL F. PFENNING
COL, EN
Commander

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ATTACHMENT 1

SPONSOR LETTERS OF INTENT

Organization	Integrated Watershed Analysis	Blue Earth River Restoration	Marsh Lake
Blue Earth County		X	
Minnesota Department of Natural Resources	X		X
Minnesota Pollution Control Agency	X		
Metropolitan Council	X		
The Nature Conservancy	X		
University of Minnesota	X		

BLUE EARTH COUNTY

COMMISSIONERS

District 1 - Colleen Landkamer District 2 - Tom McLaughlin District 3 - Katy Wortel
District 4 - Al Bennett District 5 - Kip Bruender

www.co.blue-earth.mn.us

July 13, 2004

District Engineer
U.S. Army Engineer District, St. Paul
190 Fifth Street East
St. Paul, MN 55101-1638

Dear Sir:

Blue Earth County, hereafter called the "sponsor", has reviewed the draft Minnesota River 905(b) Reconnaissance Report and is interested in participating as a non-federal sponsor in a Corps of Engineers' feasibility phase study addressing both removal and rehabilitation options for the Rapidan Dam in Blue Earth County. We understand that the feasibility study costs will be shared between the Corps and the non-federal sponsor on a 50/50 basis, and all or part of the non-federal cost-share can be provided as cash or in-kind services.

We understand that the Corps will initiate the feasibility phase of study when funds are appropriated by the Congress and allocated to the St. Paul District; a Feasibility cost Sharing Agreement has been executed between the Corps and the sponsor; and any initially required sponsor contribution has been provided.

We also understand that this letter constitutes an expression of intent and does not represent either a financial or contractual obligation on the part of the sponsor or the Federal government.

Sincerely,

Colleen Landkamer, Chair
Blue Earth County Board of Commissioners

CL/kll

h:\word\atf\2004\corps feasibility req

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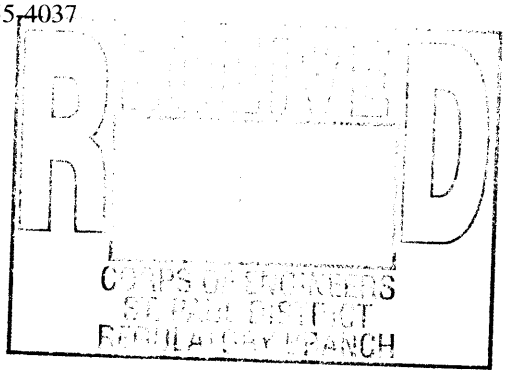
Minnesota Department of Natural Resources

OFFICE OF THE COMMISSIONER

500 Lafayette Road

St. Paul, Minnesota 55155-4037

August 10, 2004



District Engineer
U.S. Army Engineer District, St. Paul
190 Fifth Street East
St. Paul, MN 55101-1638

Dear Sir:

The Minnesota Department of Natural Resources, hereafter called the "sponsor", has reviewed the draft Minnesota River 905(b) Reconnaissance Report and is interested in participating as a non-federal sponsor in a Corps of Engineers' feasibility phase study for the Marsh Lake Dam Modification/Water Level Management Project to address sedimentation and nutrient loading and habitat decline in Marsh Lake through modification of the existing fixed crest weir and construction of a spillway to allow more natural water level fluctuations in this reservoir on the Upper Minnesota River near Appleton, Minnesota in Lac qui Parle and Swift Counties. The DNR is also interested in participating as a non-federal sponsor in the Corps of Engineers' feasibility phase study concerning an Integrated Watershed, Water Quality, Ecosystem Restoration Analysis for the Minnesota River Watershed in Southern Minnesota. The DNR believes that this modeling and planning effort will be a critical tool to assist resource management agencies and local decision makers in targeting approaches and resources in ways that effect a positive change in water quality and restoration of the Minnesota River ecosystem. We understand that these feasibility study costs will be shared between the Corps and the non-federal sponsor on a 50/50 basis, and all or part of the non-federal cost-share can be provided as cash or in-kind services.

We understand that the Corps will initiate the feasibility phase of the studies when funds are appropriated by the Congress and allocated to the St. Paul District; a Feasibility Cost Sharing Agreement has been executed between the Corps and the sponsor; and any initially required sponsor contribution has been provided.

We also understand that this letter constitutes an expression of intent and does not represent either a financial or contractual obligation on the part of the sponsor or the Federal government.

Sincerely,

Mark Holsten
Deputy Commissioner

Minnesota Department of Natural Resources

500 Lafayette Road
St. Paul, Minnesota 55155-40__

July 11, 2003

Mr. Craig Evans, P.E.
U.S. Army Corps of Engineers
190 East Fifth Street
Saint Paul, Minnesota 55101-1638

Dear Mr. Evans:

This letter is to formally convey to the U.S. Army Corps of Engineers (USACE) the framework decision that has been agreed upon by the Minnesota Department of Natural Resources' (DNR) Divisions of Ecological Services, Fisheries, and Wildlife regarding the Marsh Lake Dam modification that will result in definite improvements to Marsh Lake's biological values. We are proposing that both the primary spillway and the emergency spillway be modified. We are also proposing that the Pomme de Terre River be restored to its pre-1938 channel. The attached Agreement in Principal outlines those proposed modifications. It also provides particular terms and constraints regarding the management of the facility.

There are several additional steps that the DNR needs to take, these include: communication with the public regarding our framework decision, development of a more detailed management plan, continue to evaluate other potentially interesting restoration strategies, and then determine and pursue the most appropriate means of funding for this project.

It has been our approach all along that once we can identify and agree upon the strategies that will have the greatest benefit for the resource and resource users, we will focus on financing and implementation. We recognize that the Marsh Lake dam is owned and managed by the USACE, and so we plan to work closely with the USACE to determine how best to pursue the funding and implementation. As a first step, the DNR would like to see the Marsh Lake dam modifications included in the Minnesota River Basin Reconnaissance study.

Sincerely,

TIMOTHY P. BREMICKER, Director
Division of Wildlife
DNR Building – 500 Lafayette Road
Saint Paul, Minnesota 55155-4007
(651) 297-4960

TPB/KV/jls; Attachment
c Bradley M. Moore, Assistant Commissioner for Operations
Ron Payer, Director, Division of Fisheries
Lee Pfannmuller, Director, Division of Ecological Services
Cheryl Heide, Regional Director, New Ulm

Agreement in Principle

Preamble

Marsh Lake is a 5,000 acre, shallow impoundment on the upper Minnesota River. It is located at the borders of Big Stone, Lac qui Parle and Swift Counties. Because of the nature of the existing fixed crest the basin is not subject to the dynamic variation in water levels that healthy wetland systems require. This facility is part of the US Army Corps of Engineers Lac qui Parle Flood Control Project. However, its origins predate the flood control project as a WPA water conservation project. The USACE has notified the Department of Natural Resources that the facility provides no flood control benefit. The USACE has requested the Minnesota DNR recommend appropriate modifications to the facility in order to enhance ecological and recreational values of the basin and the Minnesota River. A work group of six DNR staff have been working on developing a set of recommendations to the USACE since January 2001. This framework carefully balances a number of potentially competing natural resource and recreational values associated with Marsh Lake and the Minnesota River. We, the undersigned Senior Managers, agree in principle to the below described framework to improve and enhance Marsh Lake.

Modifications to the Marsh Lake Dam

The Marsh Lake Dam is an earthen berm 11,800 feet long, with a primary spillway 112 feet wide set at a run out elevation of 937.6 feet. It also has a 90 foot wide emergency spillway with a run out elevation of 940 feet. The DNR would propose to the USACE the following modifications to the Marsh Lake Dam.

Primary Outlet: The primary spillway would be modified to maintain a water surface elevation of 938.3 feet or higher 70% of the time in August, and 937.6 feet or higher 70% of the time in September and October, excluding years in which a draw down is completed. A design, based on returning the Pomme de Terre River to its 1938 channel, would incorporate both a low flow notch cut into the spillway and a narrowing of the spillway above the current run out elevation. The low flow notch would be approximately 2 feet wide with a bottom elevation of 935.5 feet. In addition, the spillway would be narrowed from 112 feet to approximately 30 feet between the elevations of 937.6 to 938.3. The spillway would then widen back out to 112 feet above the 938.3 feet elevation. A fish passage structure consisting of rock riffles would also be constructed at the outlet.

Emergency Spillway: The emergency spillway would be replaced with a variable crest structure. The structure's final dimensions will be set to pass a May Q70 flow at a draw down elevation of 936. A fish passage structure consisting of rock riffles would also be constructed at this outlet. The structure will continue to function as an emergency spillway at water surface elevations above 940 feet.

Pomme de Terre River: The Pomme de Terre River will be restored to its 1938 Channel and flood plain. As a result, the Pomme de Terre will flow directly into the Minnesota River/Lac qui

Parle Lake downstream of the Marsh Lake dam. During some flood events, a portion of the Pomme de Terre's flow may spill over into Marsh Lake.

Management Plan

The above modifications are contingent upon a management plan being developed that includes the following core points.

- The maximum targeted drawdown will be to an elevation of 936.
- Clear triggers and constraints will be established that govern when a draw down will be attempted including: vegetation, sufficient year classes of northern pike present, and sufficiently small snow pack to predict a reasonable probability of success.
- When active drawdowns are conducted, the basin will remain in drawdown condition through the fall and winter. Refill will be accomplished during spring floods. However, refill or partial refill in the fall could be accomplished if precipitation results in a spike in the Minnesota River's flow, such that a "normal" discharge hydrograph can be maintained while raising pool levels.
- Consecutive attempts at drawdowns over a multiple year period will not be made.
- Fish passage will be available at one or both of the outlets 100% of the time.
- A monitoring program will be developed which includes: vegetation, fish populations, waterfowl populations, and flows.
- In the event of unanticipated water levels or vegetative responses, appropriate modifications could be made to the primary spillway or the management plan.

Agreement

While additional detailed management plans and construction designs will needed to be developed, we agree in principal to the above described framework for modifying and managing the Marsh Lake Dam

Tim Bremicker, Director — Date 6/12/2003
Division of Wildlife

Ron Payer, Director — Date 6/12/03
Division of Fisheries

Cheryl Heide, Regional Director — Date 6/11/03
Southern Region

Lee Pfannmuller, Director — Date 6/12/03
Division of Ecological Services

Minnesota Pollution Control Agency

July 26, 2004

Lieutenant Colonel Thomas E. O'Hara
District Engineer
U.S. Army Engineer District, St. Paul
190 Fifth Street East
St. Paul, MN 55101-1638

Dear Lieutenant Colonel O'Hara:

The Minnesota Pollution Control Agency has reviewed the draft Minnesota River 905(b) Reconnaissance Report and is interested in participating as a non-federal sponsor in the United States Army Corps of Engineers' (COE) Feasibility Phase Study (Study) titled Integrated Watershed, Water Quality, and Ecosystem Restoration in the Minnesota River Basin. We understand that the Study costs will be shared between the COE and the non-federal sponsor on a 50/50 basis, and all or part of the non-federal cost-share can be provided as cash or in-kind services.

We feel it is important to take the next step to scope out the project objectives, costs, and other details. The hydrologic emphasis of the Study will be important to assist the Minnesota River Basin Community in solving water quality problems.

We understand that the COE will initiate the Study when funds are appropriated by the Congress and allocated to the St. Paul District. A Feasibility Cost Sharing Agreement has been executed between the COE and the sponsor, and any initially required sponsor contribution has been provided.

We also understand that this letter constitutes an expression of intent and does not represent either a financial or contractual obligation on the part of the sponsor or the federal government.

Sincerely,

Leo Raudys
Division Director
Regional Environmental Management Division

LR/LG:kt

520 Lafayette Rd. N.; Saint Paul, MN 55155-4194; (651) 296-6300 (Voice); (651) 282-5332 (TTY); www.pca.state.mn.us
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Metropolitan Council
Building communities that work

Environmental Services

July 22, 2004

District Engineer
U.S. Army Engineer District, St. Paul
190 Fifth Street East
St. Paul, MN 55101-1638

Dear Sir:

The Metropolitan Council has reviewed the Corps of Engineer's draft report on the Minnesota River Basin Reconnaissance Study and is interested in participating as a non-federal sponsor in a Corps of Engineers' feasibility study addressing degraded water quality in the Minnesota River Basin. The stated objective of the study is to prepare a decision support system to assist in watershed, aquatic-ecosystem, and water-quality management and restoration in the Minnesota River Basin.

The Council's interest in the feasibility study is expressed with the following understandings:

- The costs of the feasibility study will be shared between the Corps and non-federal sponsors on a 50/50 basis, and all or part of the non-federal cost-share can be provided as cash or in-kind services.

- The Corps will initiate the feasibility phase of study when

  - Funds are appropriated by the Congress and allocated to the St. Paul District,
  - A Feasibility Cost Sharing Agreement has been executed between the Corps and the Metropolitan Council, and
  - Any initially required sponsor contribution has been provided.

Finally, we understand that this letter constitutes an expression of intent and does not represent either a financial or contractual obligation on the part of the Federal government or the Metropolitan Council.

The Metropolitan Council is the regional planning agency serving the seven-county metropolitan area of Minneapolis and St. Paul, Minnesota. The Council provides essential services to the region, which include wastewater services, water-quality monitoring, and water-resource management. The Minnesota River flows through the southwestern portion of the metropolitan area and merges with the Mississippi River in the heart of the Twin Cities. The lower Minnesota River is among the most impaired river reaches in the State of Minnesota, and the river's pollutant loads negatively impact the Mississippi River in the metropolitan area and other downstream locations. For these reasons, the Metropolitan Council has a strong interest in improving the water quality of the Minnesota River.

We look forward to participating with the Corps and other sponsors in this important study and developing new tools for managing the Minnesota River Basin. The Council's liaison to this study is Cathy Larson, who can be reached at 651/602-1275 or cathy.larson@metc.state.mn.us.

Sincerely,

William Moore
General Manager
Environmental Services Division

Cc: Keith Buttleman, Marcel Jouseau, Cathy Larson

The Nature Conservancy

SAVING THE LAST GREAT PLACES ON EARTH

August 10, 2004

District Engineer
U.S. Army Engineer District, St. Paul
190 Fifth Street East
St. Paul, MN 55101-1638

Dear Sir:

The Nature Conservancy in Minnesota, hereafter called the "sponsor", has reviewed the draft Minnesota River 905(b) Reconnaissance Report and is interested in participating as a non-federal sponsor in a Corps of Engineers' feasibility phase study addressing Integrated Watershed, Water Quality and Ecosystem Restoration in the Minnesota River watershed.

We understand that the feasibility study costs will be shared between the Corps and the non-federal sponsor on a 50/50 basis, and all or part of the non-federal cost-share can be provided as cash or in-kind services. The Nature Conservancy can help provide in-kind services, in the form of scientific expertise, by Dr. Phil Gerla and Dr. Meredith Cornett to the project. We can help add to the 50% cost-share to the project, but cannot provide all the match needed.

We understand that the Corps will initiate the feasibility phase of study when funds are appropriated by the Congress and allocated to the St. Paul District; a Feasibility Cost Sharing Agreement has been executed between the Corps and the sponsor; and any initially required sponsor contribution has been provided.

We also understand that this letter constitutes an expression of intent and does not represent either a financial or contractual obligation on the part of the sponsor or the Federal government.

Sincerely,

THE NATURE CONSERVANCY IN MINNESOTA

Tom Landwehr
Assistant State Director for Conservation
612-331-0705
tlandwehr@tnc.org

cc: Meredith Cornett
Phil Gerla

UNIVERSITY OF MINNESOTA

Twin Cities Campus

Center for Integrated Natural Resources and Agricultural Management
Department of Forest Resources
College of Natural Resources
College of Agricultural, Food, and Environmental Sciences

115 Green Hall
1530 Cleveland Avenue North
St. Paul, MN 55108-1027
Office: 612-624-7418
Fax: 612-625-5212
Internet: CINRAM@forestry.umn.edu

10 August 2004

District Engineer
U.S. Army Engineer District, St. Paul
190 Fifth street East
St. Paul, MN 55101-1638

Dear Sir:

The Center for Integrated Natural Resources and Agricultural Management (CINRAM), University of Minnesota, hereafter referred to as the "sponsor", has reviewed the draft Minnesota River 905(b) Reconnaissance Report and is interested in participating as a non-federal sponsor in a Corps of Engineers' feasibility phase study addressing mitigating agricultural non-point source pollution in small catchments near Waseca, Minnesota in the Elm Creek watershed, Martin County, Minnesota. We understand that the feasibility study costs will be shared between the Corps and the non-federal sponsor on a 50/50 basis, and all or part of the non-federal cost-share can be provided as cash or in-kind services.

We understand that the Corps will initiate the feasibility phases of the study when funds are appropriated by the Congress and allocated to the St. Paul District; a Feasibility Cost Sharing Agreement has been executed between the Corps and the sponsor; and any initially required sponsor contribution has been provided.

We also understand that this letter constitutes an expression of intent and does not represent either a financial or contractual obligation on the part of the sponsor or the Federal government.

Kenneth N. Brooks
Professor and Co-Director
of CINRAM

Donald Wyse
Professor and Co-Director
of CINRAM

Dean Current
Program Director
of CINRAM

ATTACHMENT 2

LETTERS OF SUPPORT

Organization	Integrated Watershed Analysis	Marsh Lake
Clean up the River Environment (CURE)	X	
Ducks Unlimited	X	X
Natural Resources Conservation Service	X	
U.S. Fish and Wildlife Service	X	
U.S. Geological Survey	X	

August 12, 2004

Mr. Craig Evans
Minnesota River Basin Reconnaissance Study
US Army Corps of Engineers Centre
190 Fifth Street East
St. Paul, MN 55101-1638

Dear Mr. Evans:

We want to congratulate you on an excellent "Minnesota River Basin Reconnaissance Study Report." It fully explains the current poor conditions of our watershed and leads to a potential solution for our problems in the future. It is absolutely necessary that the Integrated Watershed, Water Quality, and Ecosystem Restoration Analysis be conducted if we expect to achieve clean water in our lifetimes along with all the other potential societal benefits associated with restoration of the Minnesota River Watershed.

Following are a few suggested changes and/or additions for the Report:

- In the first paragraph of 5.1.3.3. Habitat Loss (on page 13), we suggest that your add a statement which indicates that current soil erosion and resulting sedimentation represents the number one threat to existing wetlands remaining in the intensively cultivated regions of the watershed.
- In the first paragraph on page 16, nitrate-nitrogen comparisons might be more understandable if related to flows originating from the various tributaries in each sub-watershed/region of the Minnesota River Basin.
- Also on page 16, there is a need to explain why subsurface runoff carried 25 percent of the sediment but contained 72 percent of the phosphorus. This seems contradictory to the last sentence on page 15.
- On pages 18 and 19, we believe restoration of wetlands should be listed in each bullet statement based on data presented in Table 1 on page 22.

Thank you for the opportunity to review this comprehensive Reconnaissance Report. We look forward to working with you and the Corps during the Feasibility Study Phase for the Integrated Watershed, Water Quality, and Ecosystem Restoration Analysis. CURE will continue to raise public awareness about the absolute need for this comprehensive/holistic study and will help provide public forums for the Corps and its partners to maximize citizen input during the process.

Sincerely,

Marta Coursey
Executive Director

Dick Kroger
Conservation Ag Advisor

cc: Various Envionmental Groups

114 South First Street West • Montevideo, MN 56265

office (320) 269-2984 • fax (320) 269-5624 • cure@info-link.net • www.curemnriver.org

DUCKS UNLIMITED

Jon P. Schneider
Manager - Minnesota Conservation Programs
311 EAST LAKE GENEVA ROAD, ALEXANDRIA, MN 56308 • (320) 762-9916 • FAX (320) 759-1567 • jschneider@ducks.org

27 August 2004

Mr. Craig O. Evans
Project Manager, Minnesota River Basin Reconnaissance Study
USACE, St. Paul District
190 East Fifth Street
St. Paul, MN 55101-1638

Dear Mr. Evans:

On behalf of Ducks Unlimited, I am pleased to review and comment on the draft Minnesota River Reconnaissance Report and provide this letter of support for the continuation of this Study under Section 905(b) of the Water Resources Development Act of 1986. The report appears to adequately address the degraded status of wetland, lake, and riverine resources in the Minnesota River Basin. This portion of Minnesota is of great concern to DU, as our focus here and throughout the state is on improving water quality in, and the waterfowl migration habitat value of, shallow lakes under our new "Living Lakes Initiative" (summary enclosed). Shallow lakes (defined by Minnesota DNR as wetlands > 50 acres with a maximum depth of 15 feet or less) represent the cornerstone of Minnesota's remaining wetland resource base in the prairie-agricultural portion of the state, yet most have been badly degraded by adjacent agricultural land use, landscape drainage, and proliferation of undesirable fish species including exotic carp that have infested otherwise isolated wetland basins and allowed to over-winter due to increased flows and water levels resulting from wetland loss and drainage, as well as conversion of native prairie for row crops. The hydrologic alterations continue today, with an estimated 20,000 miles of pattern tiling being installed in Minnesota farm fields each year. The hydrologic effects of subsurface pattern tiling and ramifications for existing wetlands and streams is one area that could be expanded upon in your Reconnaissance Study and should be addressed in any future Corps restoration feasibility studies.

The ramifications of degraded shallow lakes and wetlands in prairie Minnesota on waterfowl are becoming well documented. Biological indicators including declining body mass of spring migrating lesser scaup, degraded water quality, reduced wild rice distribution, and reduced duck use of staging wetlands during migration suggest that the shallow lakes have crossed a critical threshold and require timely and focused conservation action. In response to reduced migrating duck use of Minnesota's wetlands, the Minnesota DNR has initiated a Fall Duck Use Plan and expanded its shallow lake program. Through our new Living Lakes Initiative, DU is working with DNR and other agency and private partners to protect, restore, and enhance shallow lakes across Minnesota to provide waterfowl with the necessary food and habitat resources as they travel this migratory pathway. Enhancing and actively managing existing shallow lakes to maximize their productivity along with restoring wetlands upstream of shallow lakes are two critical components of this Initiative. Reversing declines in continental populations of lesser scaup may well hinge upon the improvement of shallow lakes and large wetlands in Minnesota and Iowa used by lesser scaup as they pass through in spring on their way north to breed, and working with partners such as the Corps will be critical to our success in helping this and other migratory species.

With that in mind, DU is pleased to see at least two potential shallow lake related alternatives identified in the Reconnaissance Study. In the short-term, replacement of Marsh Lake's fixed-crest dam with a variable crest structure allowing water level manipulations and active water level management is paramount. Marsh Lake is one of Minnesota's most important shallow lake wetlands complexes for ducks and non-game birds alike. Unfortunately, it's poor water quality and degraded stands of submerged aquatic plants are largely the result of years of stable water levels combined with infestations of rough fish (especially exotic carp) and heavy nutrient loads from the Pomme de Terre River. Natural water level fluctuations in shallow lakes normally keep fish populations in check, consolidate sediments, and allow wetland plants to become established and thrive, however this has not been possible in Marsh Lake. Relocating the structure so that the Pomme de Terre River enters the Minnesota River downstream of Marsh Lake will help, but the real key here is the need for a variable crest structure to allow Corps and DNR field staff to actively manage water levels and simulate natural droughts via manual drawdowns of water levels in Marsh Lake. Corps feasibility funding for section 5.7.3.1 "Marsh Lake Water Level Management and Vegetation Restoration" of the Study is critical to making this a reality, and you have DU's full support of that component.

DU is also very supportive of section 5.7.3.3 "Integrated Watershed, Water Quality Management and Ecosystem Restoration Analysis." The Minnesota River Basin contains numerous shallow lakes of critical import to migrating ducks, including Swan Lake in the southeast and Lake Christina in the northwest. These and other shallow lakes can be managed, but the real key to their full restoration is improvement in their watersheds and restoration of surrounding wetland complexes. Many other shallow lakes have been drained within the Minnesota River Basin, and their restoration would be of significant benefit. To that end, DU has actively assisted and funded the U.S. Fish & Wildlife Service's Restorable Wetland Inventory and we encourage the Corps to fully use that resource, collaborate with the Service, and assist the Service in completing inventories for other counties within the Minnesota River Basin. DU is very willing to participate in any integrated feasibility analysis that is funded for the Minnesota River Basin, and you have DU's full support of that component of your Study.

I hope you find these comments and our support useful as you submit your Reconnaissance Study and seek feasibility funding for the components mentioned above. Thank you for the opportunity to review the draft and provide comments, and I look forward to providing further assistance in the future.

Sincerely,

Jon Schneider, Manager
Minnesota Conservation Programs

Copies: Mr. John Guenther, Director of Fish & Wildlife – Minnesota DNR
Ms. Marta Coursey, Executive Director – Clean Up The River Environment (CURE)
Dr. Steve Adair, Director of Conservation - CO/WY/NE/MN/IA - DU
Dr. Roger Pederson, Manager of MN/IA Conservation Policy and Farm Bill Programs - DU

PM-B

United States Department of Agriculture

NRCS
Natural Resources Conservation Service
375 Jackson Street, Suite 600
St. Paul, MN 55101-1854
Phone: 651-602-7900 Fax: 651-602-7914

August 9, 2004

District Engineer
U.S. Army Engineer District, St. Paul
190 Fifth Street East
St. Paul, MN 55101-1638

Dear Sir:

USDA, Natural Resources Conservation Service has reviewed the draft Minnesota River 905(b) Reconnaissance Report and supports Corps of Engineers' feasibility phase studies. The Natural Resources Conservation Service has had significant involvement in planning in the Minnesota River Basin in the past, and has many conservation efforts underway in the basin currently. Although we are unable to serve as an official non-federal sponsor, we intend to participate in the study.

We are particularly interested in the Integrated Watershed Analyses proposal. To the extent that this proposal will facilitate a better understanding of conservation activities in the upper watershed and their impact on the Minnesota River System, there is a great deal to be gained for our conservation efforts in the Basin. We would also look to the study to promote interagency cooperation and further collaborative attainment of our common missions.

We understand that the Corps will initiate the feasibility phase of the study when funds are appropriated by the Congress and allocated to the St. Paul District; a Feasibility Cost Sharing Agreement has been executed between the Corps and the sponsor; and any initially required sponsor contribution has been provided.

We also understand that this letter constitutes an expression of intent and does not represent either a financial or contractual obligation on our part, the part of the sponsor or the Federal government.

Sincerely,

William Hunt

WILLIAM HUNT
State Conservationist

cc:
John Beckwith, Water Resources Staff Leader, NRCS, St. Paul, MN

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Bishop Henry Whipple Federal Building
1 Federal Drive
Fort Snelling, MN 55111-4056

IN REPLY REFER TO:

FWS/RFS-3

AUG 1 1 2004

Mr. Craig O. Evans
Project Manager
USACE, St. Paul District
190 East Fifth Street
St. Paul, Minnesota 55101-1638

Dear Mr. Evans:

The U.S. Fish and Wildlife Service (Service) is dedicated to the restoration and preservation of a national network of lands and waters for the conservation and management of fish, wildlife, and plant resources for the benefit of present and future generations. Partnerships with other federal, state, or local agencies and conservation organizations will further the advancement of a healthy ecosystem and accomplish many more projects on a landscape scale.

The Service's National Wildlife Refuge System is well established at fifteen field stations across Minnesota where staffs are working with various partners in this on-going effort to preserve, restore, and manage wildlife habitat on public and private lands. Six of these field stations manage National Wildlife Refuges, Waterfowl Production Areas, and Conservation Easements within the Minnesota River Basin. These field stations also provide technical and financial assistance to private landowners to restore wetland and grassland habitat on their property through the Service's Partners for Fish and Wildlife private lands program.

Consequently, the U.S. Fish and Wildlife Service supports the U.S. Army Corps of Engineer's (ACOE) project proposal for the Minnesota River Basin Integrated Watershed, Water Quality, and Aquatic Ecosystem Analysis. This proposed project, a result of the ACOE's Minnesota River Watershed Reconnaissance Study, can provide a holistic approach to watershed scale conservation activities to improve water quality, control flood waters and restore wildlife habitat in areas where the most benefit will be derived. Through this analysis, the establishment of a decision support system based on current data and applicable models will provide local land managers and planners with important tools to prioritize projects that can address several concerns.

Although the Service cannot commit funds to this proposal at this time, we will attempt to provide as much technical support as possible through the Minnesota Private Lands Office, Habitat and Population Evaluation Team (HAPET) Office, or other agency resources.

If you have any questions, or if we can be of further assistance, please contact Sheldon Myerchin, State Coordinator, Minnesota Private Lands Office, at 320/253-4682.

Sincerely,

Jim Leach
Refuge Supervisor, Area 3

United States Department of the Interior
U. S. GEOLOGICAL SURVEY
Water Resources Discipline
Minnesota District
2280 Woodale Dr.
Mounds View, MN 55112
763-783-3100

August 23, 2004

District Engineer
U. S. Army Engineer District, St. Paul
190 East 5th Street
St. Paul, MN 55101-1638

Dear Sir,

The U.S. Geological Survey has reviewed the draft Minnesota River 905(b) Reconnaissance Report and supports the Corps of Engineers' feasibility phase studies addressing the water resource and water quality issues in the Minnesota River Basin, southwestern Minnesota. Although we are unable to serve as an official non-federal sponsor, we intend to participate in the study and could provide as much as 50/50 match dollars of financial support to the State or local sponsor.

This study is important to the U.S. Geological Survey because it addresses the priority water resources issues and problems facing the State in regard to effects of land use on water quality, water availability and is a primary element of our District Science Plan.

We understand that the Corps will initiate the feasibility phase of study when funds are appropriated by the Congress and allocated to the St. Paul District; a Feasibility Cost Sharing Agreement has been executed between the Corps and the sponsor; and any initially required sponsor contribution has been provided.

We also understand that this letter constitutes an expression of intent and does not represent either a financial or contractual obligation on our part or the part of the sponsor or the Federal government.

Sincerely,

Jeffrey D. Stoner
District Chief
U.S. Geological Survey,
Water Resources Discipline, Minnesota