Minnesota Pollution Control Agency

Minnesota River Basin

Upper Minnesota River Watershed

Physiography And Description

As the last glaciers in the southern Minnesota area retreated northward above the continental divide at Browns Valley and into the Red River Valley, vast Lake Agassiz - headwaters of the glacial River Warren - was formed. The River Warren, flowing to the southeast, began cutting and shaping the Minnesota Valley to its present form. Eventually, the retreating ice margin uncovered lower outlets, and lake Agassiz, now draining to the north, was reduced to such a low elevation that River Warren ceased to flow. In its place, the Minnesota River became established.

The 2020 square mile, Upper Minnesota River Watershed, is one of the 13 major watersheds of the Minnesota River Basin. Situated within the Northern Glaciated Plains Ecoregion, the watershed can further be divided into three geomorphic settings: the headwaters flowing off the Coteau des Prairies, the lower basin-situated within the Blue Earth Till Plain, and the Minnesota River Valley-carved by the glacial River Warren.

The portion of the watershed within the Blue Earth Till Plain is represented by nearly level to gently sloping lands, ranging from 0-6% in steepness. Soils are predominantly loamy, with landscapes having a complex mixture of well and poorly drained soils. Drainage of depressional areas is often poor, and tile drainage is common. Water erosion potential is moderate on much of the land within this geomorphic setting.

The Coteau des Prairies or Highland of the Prairies, so named by French explorers, is a morainal plateau that occupies the headwaters of the Upper Minnesota River and several other rivers. In addition to being an impressive topographic barrier, the Coteau acts as an important drainage divide. Its well drained southwestern side sheds water into the Big Sioux River, while waters on the northeastern side flow into the Des Moines and Minnesota Rivers. The Coteau is characterized by landscapes with long northeast facing slopes which are undulating to rolling (2-18%). Soils are predominantly loamy and well drained.

Tributaries draining the Coteau and entering the Upper Minnesota River from South Dakota include the Little Minnesota River - headwaters of Big Stone Lake and the Whetstone River. Alluvial deposits at the mouth of the Whetstone River formed a natural dam and originally impounding Big Stone Lake. In 1973 a diversion was completed that directed flows of the Whetstone River directly into Big Stone Lake. Further modifications were made in the late 1980's with the completion of the Big Stone/Whetstone River Control Structure. This structure can redirect up to 1460 cubic feet per second (cfs) of flow from the Whetstone directly into the Minnesota River, bypassing the deposition of unwanted sediments and nutrients into Big Stone Lake during high flow periods.

Below Ortonville, the Minnesota is a small but distinct river. It flows for fifteen miles, passing through the Big Stone-Whetstone Reservoir (constructed during the 1970's) and further down receives the waters of the Yellow Bank River whose headwaters are also in South Dakota. The Upper Minnesota then meets Marsh Lake and Lac Qui Parle (meaning the Lake Which Talks). Both Marsh and Lac Qui Parle lakes are natural impoundments, dammed by alluvial fans of sediment deposited at the mouths of two major tributaries, the Pomme De Terre and Lac Qui Parle rivers respectively. The Pomme De Terre River comes down from the hills of the lake country to the north. The Lac Qui Parle River originates in the Coteau des Prairies, flows northeast through the prairies of the southwest, then confluences with the Minnesota River by Watson. Although they are natural reservoirs, the lakes were subject to some natural fluctuation; thus dams were built at the outlets for greater water control. The outlet of the Upper Minnesota River Watershed is below the Lac Qui Parle Reservoir, 288 miles upstream from the mouth of the Minnesota River.

Counties within the watershed include sections of Big Stone, Chippewa, Lac Qui Parle, Swift and Traverse.

Geology and Land Use

Cretaceous rock and glacial drift overly crystalline Precambrian bedrock within the watershed. Till deposits vary in depth from over 300 feet deep within the Bigstone Moraine to exposed bedrock along the Minnesota River.

Land use within the watershed is primarily agricultural, with 76% of the available acres utilized for production of grain crops, mainly corn and soybeans. Of these acres, approximately 15% have been tiled to improved drainage. The majority of the crop-lands (82%) are classified as moderately productive. As of 1994, roughly eight percent of the agricultural acres within the Upper Minnesota River Watershed were classified as grasslands enrolled in the Conservation Reserve Program (CRP), a voluntary federal program that offers annual rental payments to farmers in exchange for planting areas of grass and trees on lands subject to erosion. Approximately thirty nine percent of the lands draining into the Upper Minnesota River have a high water erosion potential and twenty six percent have the potential for significant wind erosion. Water erosion potential is highest on lands draining the Coteau region.

Climate

The climate along the Upper Minnesota is continental, with cold dry winters and warm wet summers. Average monthly temperatures recorded at Montevideo range from 11.60 F in Jan., to 73.30 F in July. An average of twenty two to twenty four inches of precipitation annually fall within the watershed with two thirds of this precipitation normally falling in the five months from May through September. The effect of low average precipitation combined with evaporation from the four headwater reservoirs results in this region having the lowest annual average runoff (1"-2") in the Minnesota River Basin.

Water Quality

Ground Water

Ground water in the watershed is from three principal aquifers: near surface sand and gravel aquifers, buried sand and gravel aquifers, and aquifers within Cretaceous deposits. Hard water, commonly high in iron is found within the sand and gravel aquifers. The Cretaceous aquifers contain relatively soft water, low in iron but high in chloride, sulfate, sodium, and boron.

Surface Water

During the summer of 1767, Jonathan Carver, an English-colonial and one of the most noted chroniclers of early America, described the upper river as, "A most delightful country, abounding with all the necessaries of life that grow spontaneously. Wild rice grows here in great abundance; and every part is filled with trees bending under their loads of fruit, such as plums, grapes and apples." Even as recent as 1966, a report by the United States Geological Survey stated that surface waters of the Big Stone Lake sub-watershed, although hard were generally of good quality.

Today, pollution of surface waters in the Minnesota River's major watersheds is a moderate to severe problem. Constituents of concern often include: suspended sediments, excess nutrients (primarily nitrogen and phosphorus), pesticides, pathogens, and biochemical oxygen demand. High concentrations and loads of suspended sediments and nutrients can often be linked to artificial drainage patterns (ditches, tile, etc.) and wetland reductions. Alone or in combination, these landscape alterations have effectively increased the hydraulic efficiency and magnitude of storm and snowmelt runoff events. Estimates vary, but about 80 percent of the wetlands in the Minnesota River Basin have been drained and converted to other uses. High nutrient levels in lakes and streams often result from over-land runoff across erodible soils. Eroded soils and the runoff which transport these particles often carry pesticides and excess nutrients to receiving waters. Increased discharges and elevated flood peaks also erode streambanks, destroy shoreline vegetation and deposit sediment on floodplains, in streams, and in downstream receiving waters. Sediment in water often leads to impaired habitat for aquatic life, decreased photosynthetic activity, and reduced recreational quality. Excessive levels of nutrients often promote eutrophication; defined as nutrient rich oxygen poor water. Elevated nutrient levels often promote abundant algal populations which in turn can cause large diurnal fluctuations in dissolved oxygen concentrations (photosynthesis being responsible for daytime highs, respiration for nighttime lows). In addition, algal decomposition is often a major factor responsible for high biochemical oxygen demand (BOD) levels. BOD is the amount of oxygen consumed-biologically and chemically-over a five day period. The BOD test reflects the effect of easily decomposed organic materials on oxygen depletion. Other sources of organic materials include eroded organic materials associated with sediment or manure, and discharges from faulty wastewater treatment plants, and faulty septic systems. The presence of water-borne pathogens is often characterized by determining the population of fecal coliform in water quality monitoring samples. Fecal coliform are a subset of bacterial populations, and generally arise from the fecal excrement of humans, livestock, and water fowl. Common sources of fecal coliform include feedlots, faulty wastewater treatment plants, and faulty septic systems.

Of particular concern in this watershed is the sedimentation and accelerated eutrophication of the recreational lakes of the lower watershed. A study done during early 1982 to assess the trophic status of Big Stone Lake concluded, the lake had reached an extreme trophic status called "hypereutrophy," the most severe form of cultural lake aging or eutrophication. As a result of this study, the Big Stone Lake Restoration Project was developed. Implementation of the project began in 1985 with the overall objective being to maintain or increase the recreational potential and lifespan of Big Stone Lake by altering the trophic status from hypereutrophic to eutrophic. The objective was to be attained through the management of land uses within the watershed and Big Stone Lake itself. Activities included the management of; lake levels, feedlots, grazing, croplands, wetlands, and the Whetstone River. Public input and involvement was an important component in the development of project goals and management activities. Although significant reductions in nutrient concentrations within the lake have not yet been quantified, recent observation by lake users suggests algal bloom frequencies have been declining as a result of the clean up efforts.

Table 4.06 **Upper Minnesota River** **Mean Total Phosphorus Concentrations**		
		Mean Annual TP

		Concentration (mg/l)
Upper Minnesota River Upper Minnesota River Northern Great Plans Ecoregion Minnesota River Basin	annual summer only annual annual	NA NA 0.2189 0.251

Table 4.07 Water Quality Characteristics Upper Minnesota River Phosphorus and Total Suspended Sediment	
Upper Minnesota River Mean Annual Flow	661 cfsc
Minnesota River Mean Annual Flow	4,266 cfs
Total Phosphorus	
Estimated TP Load (March - Aug)	56.9 tons
% of MN R Basin TP Load[a]	4.82%
Total Suspended Sediment	
Estimated TSS Load (March - Aug)[b]	9,837 tons
% of MN R Basin TSS Load[a]	2.08%

Results from the Minnesota River Assessment Project (MRAP), published in 1994, concluded that concentrations and loads of suspended sediments recorded at the watershed outflow at Lac Qui Parle were considerably less than those recorded at other points along the Minnesota River mainstem. Settling of sediments in the headwater reservoirs was sited as the likely cause. The median total phosphorus concentration at the Lac Qui Parle outflow was computed to be 0.26 mg/L during the study period, slightly above the median value of 0.22 mg/L for all water samples collected at mainstem sites. Increased nitrate concentrations during periods of increasing stream discharge was common to all sites sampled during the MRAP study. However, the effect was less pronounced in the headwater source region. Nitrate concentrations were elevated during runoff from the Minnesota River at Montevideo, but did not exceed 3 mg/L, well below the federal maximum drinking water standard of 10 mg/L.

Water quality treatment benefits, with the possible exception of phosphorus concentrations, are most certainly derived by waters flowing through the series of lakes and reservoirs. However, intensive studies such as those done at the restored Steen Wetland located on Meadowbrook Creek in Big Stone County (Baskfield 1995, Jacobson 1994) demonstrate that significant reductions in concentrations and loads of suspended sediments and nutrients can be acquired higher up in the watershed. Attacking the problem closer to the source(s) increases the quality of waters discharged into downstream lakes and/or reservoirs, increasing their environmental and recreational potential.

Among the nutrients, phosphorus is a pollutant of major concern to the water quality of the Minnesota River and its tributaries. Any strategy to restore the Minnesota River will require each major watershed to take part in reducing phosphorus loadings to the main stem. Eventually, through basin management, a basinwide phosphorus loading reduction goal can be established. Through a collaborative process involving local, state and federal government, in addition to watershed residents and other stakeholders, this whole-basin load-reduction goal can be allocated among the 13 major watersheds. Within each major watershed, in turn, the total watershed load-reduction goal can be further allocated among point and nonpoint sources.

In preparation for this process, several kinds of information on phosphorus pollution sources, concentrations and loads have been collected. This includes an estimate of phosphorus loads from point sources within the major watershed (Table 4.08), together with watershed specific monitoring data on recent phosphorus concentrations, flows, total phosphorus load estimates, ecoregion specific phosphorus values, and basin wide ecoregion weighted phosphorus values (Table 4.06, 4.07).

As mentioned, Livestock feedlots are a major potential source of several pollutants: phosphorus, nitrogen, and pathogens in particular. Considerable progress has been made through the state feedlot program in recent years. Attached is a map (figure 4.03) of feedlots in the Chippewa River Watershed that have received certificates of compliance, often referred to as feedlot permits *(coming soon)*.

Table 4.08: Point Source Estimates of Phosphorus Loads for the Upper Minnesota River (1996)

7020001	Minnesota River Watershed				
NPDES# (National Pollutant Discharge Elimination Number)	Permittee	Ave. Annual Flow (MGD)	Type of Discharge Facility	Total Phos. Conc. (mg/l)	Total Phos. Load (lbs/yr)
MN0022144	WATSON	0.0201	POTW*	4.00	244
MN0022161	ODESSA	0.0315	POTW-pond	2.00	191
MN0050369	BELLINGHAM	0.0266	POTW-pond	2.00	162
MN0020753	MILAN	0.0047	POTW-pond	2.00	29
MN0023078	CLINTON	0.0013	POTW-pond	2.00	8
MN0051152	ORTONVILLE	0.383	POTW-pond	2.00	2,328
MN0043567	ORTONVILLE WTP	0.011	water	1.00	33
				Total	2,995

* - Public Owned Treatment Works

Recreation

The lakes, swamps, reservoirs, and streams within the Upper Minnesota River Watershed are suited for wildlife habitat, limited water sports, recreational areas, and hunting lands. Although both classified as hypereutrophic water bodies, Big Stone Lake and Lac Qui Parle have exceptional fisheries, being primarily managed for walleyes, northern pike, perch and panfish. The Minnesota Department of Natural Resources stocks Big Stone Lake with black crappies, walleyes, northern pike and sunfish. Lac Qui Parle is stocked with walleyes biennially. As with most lakes in this ecoregion rough fish populations are also in abundance. The sport fishery within the Upper Minnesota River is predominated by channel catfish, although walleyes, smallmouth bass, northern pike, and panfish are also taken. Channel catfish, northern pike, crappies, and smallmouth bass have been stocked by the state since 1962. Fish populations in the Upper Minnesota River however, are dominated by species considered rough fish: sheepshead, buffalo, quillback, suckers, redhorse, and carp.

The valley bottoms provide a rich diverse habitat for many species of wildlife-large and small game animals, song birds, waterfowl, and fur-bearers. Marsh and Lac Qui Parle lakes are incorporated into some of the largest and most important wildlife management areas and public hunting grounds in the state, and are stopovers for great concentrations of migrating waterfowl in spring and fall. Brushy, wooded hills bordering the river bottoms with agricultural fields, swamps, and wetlands, provide both food and cover.

There are several state parks located within the Upper Minnesota River watershed, including; Big Stone Lake State Park, with three separate units along the headwater lake; Lac Qui Parle State Park, at the lower end of Lac Qui Parle Lake, site of an early fur trading post, church, school, and mission serving the Dakota.

References

General

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More Information

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