Minnesota Pollution Control Agency

Minnesota River Basin

Chippewa River Watershed

Physiography And Description

Beginning it's journey in the high, clear, fertile, headwater lakes of central Minnesota, the Chippewa River flows 130 miles southwest, to its mouth in the Minnesota River at Montevideo. The 2085 square mile Chippewa River Watershed is one of the largest major watersheds of the Minnesota River. Lying between the Pomme De Terre River to the west, and Hawk Creek to the east, the Chippewa River and it's major tributaries drain sections of several counties including: Chippewa, Douglas, Grant, Kandiyohi, Otter Tail, Pope, Stevens, and Swift.

Geomorphology of the Chippewa River Watershed includes a complex mixture of moraines, and till, lacustrine, and outwash plains. The eastern half of the Chippewa River Watershed, extending from approximately Evansville in the north to just below the town of DeGraff in the south, lies within the North Central Hardwood Forest Ecoregion. More specifically, with the exception of a long, narrow section of the Belgrade-Glenwood outwash plain along the east-central edge of the basin, the eastern half of the watershed falls within the geomorphic setting of the Alexandria Moraine Complex. This morainal complex is composed of well drained, loamy, silty, sandy and mucky soils with moderate to steep sloping landscapes (6-45%), producing a large potential for sediment delivery to streams. As such, water erosion potential within this section of the watershed is classified as moderate to high. The section of the watershed situated in the Belgrade-Glenwood outwash plain, lying east of the line from Glenwood in the north to Lake Johanna in the south, is characterized by nearly level to gently sloping (2-6%), well drained landscapes with sandy-loamy soils of moderate water and wind erosion potential.

Lands in the western half of the Chippewa River Watershed fall within the Northern Glaciated Plains Ecoregion, primarily within three geomorphic settings, the Big Stone Moraine on the far western edge, the Appleton-Clontarf Outwash Plain along the lower Chippewa River, and the Benson Lacustrine Plain within the south-central section of the watershed. Landscapes within the Big Stone moraine are characterized as rolling (6-12 %), with well drained, silty and loamy soils. Water erosion potential within the moraine is generally classified as moderate. Lands within the Appleton-Clontarf outwash are characterized as being nearly level to gently sloping (2-6%), poorly drained, and extensively tiled. Water and wind erosion potentials are classified as moderate for this region. The Benson Lacustrine Plain is also nearly level (0-2%), poorly drained and extensively tiled. Soil textures in the lacustrine plain range from silty clay to silt loam, water erosion potentials are high for lands adjacent to streams and much of the plain has the potential for significant wind erosion.

Geology and Land Use

The oldest and deepest rocks in the Chippewa River Watershed are Precambrian in age. These hard, relatively impermeable, crystalline rocks are of igneous and metamorphic origins. Overlying the Precambrian rocks in the southern part of the watershed are shales and sandstones of the Cretaceous age. Covering these deposits and extending over the entire watershed, lay deposits of glacial drift, including: till, clay, silt, sand, and gravel. With the exception of bedrock outcrops along the river, drift deposits within the watershed generally range in depth from over 500 feet in the headwaters area to less than 100 feet near the Chippewa's mouth.

Land use within the Chippewa River Watershed is primarily agricultural, accounting for approximately 68% of the available acres. Corn and soybeans are grown on approximately 66% of cropped lands; small grains, hay, and grasslands enrolled in the Conservation Reserve Program (CRP) make up the majority of the balance. Early 1996 estimates were that 10.5% of the agricultural acres within the watershed were enrolled in the CRP program, 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. Crop lands are generally classified as moderately productive (68%), although nearly 25% are ranked as low production acres.

1996 figures estimated there were roughly a million cattle and three million hogs in the Minnesota River Basin. Of the cattle, approximately 30% occur in the southwestern portion of the Minnesota River Basin and an additional 30% in the southeastern portion. Approximately half of the hogs are raised in the southeastern section of the basin with an additional 25% in the southwestern section.

Climate

The climate within the Chippewa River Watershed is continental, with cold dry winters and warm wet summers. Average monthly temperatures at Benson range from 10.10 F in Jan., to 72.500 F in July. An average of twenty five to twenty eight inches of precipitation annually fall within the watershed with two thirds of this precipitation normally falling in the five months from May through September. Average annual runoff is estimated to be between two to four inches.

Water Quality

Ground Water

According to the publication, Water Resources of the Chippewa River Watershed published by the United States Geological Survey, ground water is available almost anywhere within the watershed, principally from glacial drift, but to a limited extent from Cretaceous and Precambrian rocks. Buried lenses of sand and gravel yield small quantities of water throughout the entire watershed. Outwash and ice-contact sand and gravel deposits commonly yield greater quantities and receive more rapid recharge than buried sand and gravel deposits. Cretaceous deposits, present only in the southern part of the watershed, and Precambrian rocks, present throughout the watershed, have the lowest rate of recharge and yield little water. Ground water movement within the glacial drift is mainly across the watershed from northeast to southwest, depth to water is quite variable (near surface to over 100 feet). Wells in the moraine more commonly yield "hard" bicarbonate type waters and those in the till plains the "softer" sulfate type. Many wells within the watershed, with the exception of those in the Benson area, are also high in iron, often exceeding 3 parts per million (ppm). Water containing more than .3 ppm iron is considered unsatisfactory for many uses.

Surface Water

Originating in northeast Douglas County, the Chippewa River winds its way to the south at an average gradient of 4.5 feet per mile. Gathering flows from several major tributaries including the Little Chippewa River, East Branch Chippewa, and Shakopee Creek, the Chippewa River joins the Minnesota River at Montevideo, approximately two hundred and seventy one miles upstream from the mouth of the Minnesota River. Together, the Chippewa's tributaries contribute nearly half the flow of the main stem, and their combined drainage comprises approximately half of the total watershed. Drainage patterns within the Benson Lacustrine Plain--particularly along Shakopee Creek--have been severely altered through the years with the elimination of numerous wetlands and extensive channelization.

The Chippewa River Watershed contains several major and hundreds of lesser, clear, fertile lakes, located primarily in the northern and eastern sections of the watershed. Some of the major lakes include: Emily, Minnewaska, Norway, Florida, Chippewa, Lobster, Reno, Aaron, Moses, and Red Rock. These lakes have relatively stable water levels because of good ground water contributions and are important recreational resources. Often connected to local creeks or streams these lakes provide an important storage function in the watershed and are effective in reducing downstream peakflows.

An interesting topographic feature in the lower watershed is a glacial river channel known as Watson Sag, connecting the Chippewa River to Lac Qui Parle Lake. The channel has been modified so that during periods of floods, flows greater than 10,000 cfs are diverted into Lac Qui Parle Lake via Watson Sag, thus reducing floodwaters in the lower Chippewa and ultimately the Minnesota River itself. The east end of the channel, near the town of Watson, is relatively dry and is used as pasture; the west end is usually under water and constitutes an imposing swamp of floating vegetation and bare trees, known as the "Big Slough"

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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.

Table 4.20: Mean Total Phosphorus Concentrations Chippewa River

		Mean Annual TP Concentration (mg/l)
Chippewa River	annual	NA
Chippewa River	summer only	NA
Northern Glaciated Plains Ecoregion	annual	0.218
North Central Hardwood Ecoregion	annual	0.145
Minnesota River Basin	annual	0.251

Table 4.21 Water Quality Characteristics, Chippewa River Watershed

Phosphorus and Total Suspended Sediment	
Chippewa River Mean Annual Flow Minnesota River Mean Annual Flow	315 cfs 4,266 cfs
Total Phosphorus Estimated TP Load (March - Aug)[a]	60.9 tons 5.55%[a]

% of MN R Basin TP Load[b]	
Total Suspended Sediment Estimated TSS Load (March - Aug)[a] % of MN R Basin TSS Load[b]	17,528 tons 3.99%

[a] - Estimated by the University of Minnesota's Department of Soil, Water and Climate.
[b] - based on total load contributions to the Minnesota River (point and nonpoint sources)

For swimming areas and sewage effluent, state standards for bacteria are exceeded when fecal coliform counts are greater than 200 organisms per 100 ml of water as a geometric mean of not less than five samples in a calendar month, or if more than ten percent of all samples taken during any calendar month individually exceed 2,000 organisms per 100 milliliters. The presence of fecal coliforms, indicates recent fecal contamination from warm blooded animals and the possible presence of enteric (intestinal) pathogens.

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 the major watersheds 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 such a 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 4.23), 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 4.20 & 4.21).

Table 4.22: Water Quality Standard Exceedances, Chippewa River Watershed

* - percent of samples in violation do not meet the frequency of sampling requirements of state law (see above), but represent the percentage of pre-1997 samples collected over the last thirty years, which have exceeded 200 organisms/100 ml.

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 4.07) of feedlots in the Chippewa River Watershed that have received certificates of compliance, often referred to as feedlot permits *(coming soon)*.

Seasonal patterns often influence flow discharge patterns in the Chippewa River; the general trend is for flows to increase in spring, peak in late spring to early summer, and decline through late summer. Higher soil moisture contents, undeveloped crop canopies, and lower evapotranspiration rates, are the most likely factors influencing the observed trends. The mean annual discharge rate for the Chippewa River, at 315 cubic feet per second (cfs), is the highest of all average tributaries flows in the western portion of the Minnesota River basin (west of Redwood Falls). Flows average 683 cfs from April through June, while lesser flows averaging 228 cfs are the norm from July through August.

TABLE 4.23: **Estimates of Point Source Phosphorus Loads for the Chippewa River (1996)**

07020005	**Chippewa River**				
NPDES # (National Pollutant Discharge Elimination System Number)	**Permittee**	**Ave. Annual Flow** (MGD)	**Discharge Facility**	**Total Phos. Conc.** (mg/L)	**Total Phos Load** (lbs./yr.)
MN0054305	Millerville	0.0011	POTW*-pond	2.00	7
MN0025593	Davers	0.0036	POTW-pond	2.00	22
MN0024007	Lowry	0.0299	POTW-pond, lake	1.00	91
MN0052990	Murdock	0.0531	POTW-pond	2.00	323
MN0023582	Hancock	0.1970	POTW	4.00	2,395
MN0021598	Kensington	0.0439	POTW	4.00	534
MN0021199	Hoffman	0.0486	POTW-pond	2.00	295
MN0023329	Evansville	0.0588	POTW-lake	1.00	179
MN0020583	Kerkhoven	0.1498	POTW	4.00	1,821
MN0021415	Starbuck	0.2348	POTW-lake	1.00	714
MN0020036	Benson	0.5478	POTW	4.00	6,660
MN0020133	Montevideo	1.0128	POTW	4.00	12,313
MN0060496	Midwest Cylinder	0.0009	cleaning	1.00	3
MN0061573	Mooneys Inc-Chippewa	0.5833	quarry	0.10	177
MN0059919	Supreme Pet Food	0.0068	cooling	1.00	21

Total 25,555 * Publicly-Owned Treatment Works

Recreation

The lakes and wetlands of the Chippewa River watershed provide rich fish and wildlife resources, especially in the higher headwater regions. Many of these lakes contain a wide variety of sport fish, including, walleye, largemouth bass, northern pike, and panfish. Rough fish are abundant in the marginal-shallow lakes subject to occasional winterkill. In the lower area of the watersheds many wetlands and small tributaries provide rich resources for production of waterfowl and pheasants. Many of these areas are protected in state wildlife management areas and federal waterfowl production areas, both open to public hunting.

There are several state and county parks within the Chippewa River Watershed, including: Glacial Lakes State Park in the upper Chippewa watershed, containing outstanding examples of glacial moraines and outwash plains, Monson Lake State Park in the eastern part of the Chippewa River Watershed, the site of an Indian massacre of settlers during the 1862 Sioux uprising, Swift Falls County Park, on a wooded rocky section of the Chippewa which includes waterfalls, Sibley State Park on Lake Andrew, a headwater lake of Shakopee Creek

References

General

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More Information

For questions about the Minnesota River Basin management framework, contact Larry Gunderson at 651-297-3825.