Minnesota Pollution Control Agency

Minnesota River Basin

Redwood River Watershed.

Physiography And Description

The 703 square mile, Redwood River Watershed, is situated between the Yellow Medicine River Watershed to the east and the Cottonwood River Watershed to the west. The headwaters of the Redwood River begin in the Northern Glaciated Ecoregion on top of the Coteau des Prairies or "Highland of the Prairies," an impressive morainal plateau and important drainage divide, so named by French explorers.

Except for a few isolated wetlands set aside by state and federal agencies, many of the Coteau's wetlands have been drained and converted to cultivated fields. In addition, a large proportion of the Coteau's small creeks and streams have been ditched and straightened, permitting earlier planting and allowing more acres to be placed into production. The Redwood River wanders around the corners of Lincoln, Pipestone, Murray, and Lyon counties as a temporary stream, then flows northeast toward the slope of the Coteau, Characterized by landscapes with long northeast facing slopes of moderate steepness, the majority of the Coteau (72%) is classified as having moderate to high water erosion potential. It is well drained southwestern side sheds water into the Big Sioux River while on the other side of the divide, waters flow across well drained loamy soils and into the Des Moines and Minnesota rivers.

Between Russell and Marshall, the Redwood drops off the Coteau and falls nearly 300 feet over a span of approximately fifteen miles. In this reach, where it tumbles along the bottom of a wooded valley 100 feet deep is Camden State Park. At Marshal the Redwood River

characterized as being nearly level to gently sloping, ranging from 0-6% in steepness. The gradient of the river along this reach is only two to three feet per mile. Soils are predominantly loamy within the till plain and landscapes having a complex mixture of well drained and poorly drained soils. Drainage of depressional areas is often poor, and tile drainage is common. Water erosion potentials are moderate on the majority of these lands.

At the city of Redwood Falls, the Redwood River plunges into the wooded Minnesota River bottomlands, dropping 100 feet in one mile, tumbling and cascading over granite ledges.

The Redwood River derived it's name from the reddish bark of the willowlike dogwood called by the Indians "Kinniqkinnic," growing along the streams. They used the white inner bark as smoking tobacco (T. Waters, 1974).

Geology and Land Use

The oldest and deepest rocks of the Redwood River Watershed are Precambrian in age. These hard, relatively impermeable, crystalline rocks are of igneous and metamorphic origins. Overlying the Precambrian rocks throughout most of the watershed are sedimentary rocks of Cretaceous age. They consist mostly of shale and fairly continuous beds of poorly cemented siltstone and sandstone. Quaternary glacial drift covers the entire watershed and forms the present land surface. The drift overlies the Cretaceous rocks in all but the easternmost part of the watershed where it is in direct contact with the underlying crystalline rocks. The drift is mostly clayey till, although locally continuous deposits of sand and gravel are common within the drift and at its surface. The land surface slopes gently northeastward and eastward from altitudes greater the 1900 feet at the southwestern edge to less than 850 feet at the mouth of the Redwood River in the east. The area has slight local relief shaped by continental glaciation.

Land use within the Redwood River Watershed is primarily agricultural, accounting for approximately 82% of the available acres. Corn and soybeans are grown on approximately 86% 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 8.5% 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 (90%), the majority of the balance (9%) are ranked as low production acres.

1996 figures estimated there are roughly one million cattle and three million hogs in the Minnesota River Basin, of which, 30 percent of the cattle and 25 percent of the hogs are located in the southwestern portion of the basin.

Climate

The climate within the Redwood River Watershed is continental, with cold dry winters and warm wet summers. Temperatures over the last sixty four years at Redwood Falls have range from a low of -340 F in Jan. of 1981 to an all time high of 1100 in July of 1936. Average monthly temperatures recorded over this interval are 120 F. for Jan. and 740 F. for July. An average of twenty five to twenty six inches of precipitation annually fall within the watershed with more than 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 three inches. Over ninety percent of the precipitation falling within the watershed is returned to the atmosphere through the processes of evaporation and transpiration.

Water Quality

Ground Water

The glacial drift and sedimentary rocks underlying the watershed yield generally adequate water supplies for municipalities, households, and farms. Sandstone beds in the Cretaceous rocks, particularly at their base, yield substantial water supplies to wells in the central part of the watershed. In most of the eastern part of the watershed, Cretaceous rocks are absent. In the western part of the basin, water is generally available from overlying aquifers and few wells have yet been drilled into the Cretaceous strata. In that area, sedimentary rocks are as much as 700 feet thick and probably contain aquifers of potential value.

Regional ground water movement is toward the northeast, however, as groundwater reaches the eastern part of the watershed, movement is toward the Redwood River. The water table closely parallels, and in most areas is within 50 feet of the land surface. Although aquifers which can provide adequate yields to wells vary in depth throughout the area, all of the glacial and sedimentary deposits are saturated beneath the water table.

Water quality varies with location in the watershed. In the western part of the watershed, mainly a groundwater recharge area, water in the glacial drift contains primarily calcium, magnesium, sulfate, and bicarbonate ions. Water movement in the drift is principally downward to sedimentary rock aquifers where the water is modified to a sodium-chloride-sulfate-bicarbonate type. The degree of change or softening effect on the water depends upon the thickness of sedimentary rock penetrated. Drift aquifers and thin sedimentary aquifers located in the eastern part of the watershed are recharged by precipitation, streamflow, and the ground-water flow system to the west. Thus, ground water in this area may exhibit chemical properties of the drift water, sedimentary rock water, or a mixture of the two.

Surface Water

Draining from the Coteau des Prairies and following a course established by glacial meltwater draining the margins of the Des Moines Lobe, the Redwood River has a shallow drainage channel that has been eroded into the broadly smoothed and nearly flat prairie of the Blue Earth Till Plain. Above Redwood Falls, the Redwood River has a valley no more

than 25 to 50 feet deep; but at and below the city, within a distance of one mile, the river descends 100 feet in a succession of cascades and rapids before entering the broad bottomland of the Minnesota River Valley. A forty-foot dam at Redwood Falls was previously operated as a hydroelectric generating facility. The impoundment is now utilized for recreational purposes.

The main tributaries of the Redwood River include Coon Creek, originating in Lake Benton up on the Coteau, Three Mile Creek, which joins the Redwood on the plains below Marshal, and Ramsey Creek, which empties into the Redwood in the Minnesota Valley after a spectacular waterfall in Ramsey Park. A large portion of the Redwood is ditched on the low-plains reach as are hundreds of miles of small tributaries. The stream flows about ninety miles from its highest sources in tiny tributaries to its mouth in the Minnesota and drops about 1,000 feet, an average gradient of twelve feet per mile. The Redwood's mean discharge at Redwood Falls is 125 cubic feet per second (cfs), but it's maximum flood discharge was 19,700 cfs after an intense thunderstorm in June of 1957.

Table 4.24

Mean Total Phosphorus Concentrations Redwood River		
		Mean Annual TP Concentration (mg/l)
Redwood River	annual	0.285
Redwood River	summer only	0.289
Western Corn Belt Ecoregion	annual	0.304
Minnesota River Basin	annual	0.251

Table 4.25

Water Quality Characteristics Redwood River Phosphorus and Total Suspended Sediment	
Redwood River Mean Annual Flow Minnesota River Mean Annual Flow	125 cfs 4,266 cfs
Total Phosphorus Estimated TP Load (March - Aug)[a] % of MN R Basin TP Load[b]	 25.14 tons 2.13%
Total Suspended Sediment Estimated TSS Load (March - Aug)[a] % of MN R Basin TSS Load[b]	 4,935 tons 1.04%

[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)

Table 4.26: Water Quality Standard Exceedances Redwood River Watershed

Parameter	Percent of Samples Exceeding Assigned Water Quality Limits		
	Standards	**April - June**	**July - August**
Turbidity	25 NTU	11%*	0%
Fecal Coliform*	200 org./100 ml	56%	48%

* Monitoring samples were collected downstream of the dam: percent of samples in violation to not meet the frequency of sampling requirements dictated by federal law (see above), but only represent the percentage of pre-997 samples collected over the last thirty years, which have exceeded 200 organisms/100 ml.

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.

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 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 4.27), 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 4.24 & 4.25).

Table 4.27: Estimates of Point Source Phosphorus Loads (1996)

7020006	**Redwood River Watershed**				
NPDES# (National Pollutant Discharge Elimination System Number)	Permittee	Ave. Annual Flow (MGD)	Discharge Facility	Total Phos. Conc. (mg/L)	Total Phos. Load (lbs./yr.)
MN 0041211	MILROY	0.0161	POTW*-pond	2.00	98
MN0021580	VESTA	0.0182	POTW-pond	2.00	111
MN0039730	GHENT	0.0145	POTW-pond	2.00	88
MN0052434	LYND	0.0208	POTW-pond	2.00	126
MN0049654	RUTHTON	0.0423	POTW-pond	2.00	257
MN0024686	RUSSELL	0.0575	POTW-pond	2.00	350
MN0022039	TYLER	0.1805	POTW-	2.00	1,097

			pond		
MN0020401	REDWOOD FALLS	0.7536	POTW	4.00	9,162
MN0022179	MARSHALL	3.4982	POTW	5.25	55,819
MNG640060	MARSHALL WTP	0.15	water	1.00	456
MN0049441	FARMERS UNION (central bi)	0.041	rendering	26.00	3,240
MN0057037	MINN. CORN PROCESSORS	0.249	corn processors	1.00	757
MN0061115	OCHS BRICK & TILE-MORTON	0.0053	quarry	0.10	2
				TOTAL	71,563

* - Public Owned Treatment Works

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 4.08) of feedlots in the Redwood 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 Redwood 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 Redwood River is 125 cubic feet per second (cfs). Flows average 256 cfs from April through June, while lesser flows averaging 72 cfs are the norm from July through August.

As with discharge, seasonal patterns of turbidity and fecal coliform are evident in the Redwood River. Levels of these parameters are generally greater for the July through August period than for the April through June period. Monitoring data collected periodically over the last 30 years was compiled and summarized by the University of Minnesota's Department of Soil Water and Climate according to the percent of samples in the entire record that exceed state or federal water quality standards (Table 4.26). State standards for turbidity are expressed in terms of nephelometric turbidity units (NTU's), which is a measure of light scattered by suspended sediment and organic particles. The state standard for turbidity is exceeded in water with turbidities greater than 25 NTU's. 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. Through the Redwood-Cottonwood Rivers Control Area (RCRCA), there is currently (1997) an MPCA-Clean Water Partnership Project on the Redwood River. The project is in "Phase II," or the implementation stage. With local and CWP funds, the RCRCA has been instrumental in implementing agricultural waste systems and upland conservation practices within the section of the Redwood River Watershed in Lincoln County (approximately 25% of the county).

Recreation

Camping, hunting, fishing, and other outdoor activities can all be found within the Redwood River Watershed. In the upper reaches of the Redwood River is Camden State Park, a spacious section of densely wooded river valley, much used for camping, picnicking, hiking, and skiing. The river is the center of attraction at Camden, having sufficient springwater tributaries to provide some trout habitat and an occasionally trophy brown. Also located within the headwaters area is Lake Benton, the largest lake in the watershed. Although the maximum depth is less than 11 feet, Benton supports an excellent fishery, with northern pike, walleye, and panfish present. The State maintains a public access at the extreme western edge of the lake. Recreational areas are concentrated on the southern shore at both ends of the lake.

Over twenty five wildlife management areas are spread throughout the Redwood River Watershed. Having been acquired by the State, the purpose of these lands is to preserve natural habitat for upland game, furbearers, and migratory waterfowl.

The gorge section of the Redwood River includes Alexander Ramsey City Park in Redwood Falls. The park contains some of the most unusual river environments in Minnesota. The swift rapids and cascades rushing over ancient granite are reminiscent of northern Minnesota, and the falls of Ramsey Creek, a straight, muddy ditch in its plains headwaters, plunges into the Minnesota Valley with beauty equal to the most remote waterfalls of the north. Many miles of trails, campgrounds, soaring bluffs of weathered granite, and rocky river rapids can be enjoyed in this island of wild river on the prairie (T. Waters, 1974).

References

General

Waters, T. F., 1977. The Streams and Rivers of Minnesota: University of Minnesota Press, Mpls., Minnesota

More Information

For questions about the Minnesota River Basin management framework, contact Norm Senjem at (507)280-3592.