



# **STATE OF THE MINNESOTA RIVER**

**Summary of Surface Water Quality  
Monitoring 2000-2005**

## Acknowledgments

The State of the River Report is a joint venture between Minnesota Pollution Control Agency, Minnesota Department of Agriculture, Minnesota State University, Mankato Water Resources Center, and Metropolitan Council Environmental Services.

Many individuals contributed to collecting data, writing, editing, and preparing maps and graphics for this report. Core editorial team members include: Patrick Baskfield, Robert Finley, Eileen Campbell, Minnesota Pollution Control Agency; Bill VanRyswyk, Minnesota Department of Agriculture; Kimberly Musser and Scott Matteson, Minnesota State University, Mankato Water Resources Center. A special thanks to researchers and writers Greg Payne and Heather Johnson for their expertise and assistance writing this document.

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Martin County Environmental Services  
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Cover photo: Blue Earth River

# STATE OF THE MINNESOTA RIVER

## Summary of Surface Water Quality Monitoring

### 2000-2005



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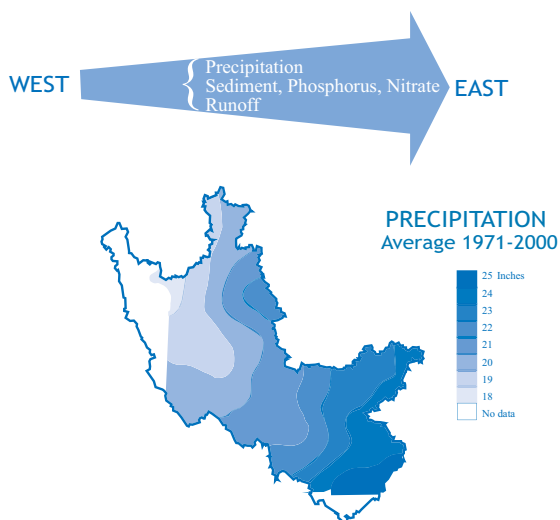
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# BACKGROUND

## Basin Overview

The Minnesota River flows more than 335 miles from its source near the Minnesota-South Dakota border to its confluence with the Mississippi River at Minneapolis/St. Paul. It winds through diverse landscapes and drains nearly 20 percent of Minnesota (16,770 square miles total, 14,840 in Minnesota). Agriculture, primarily corn and soybean production, accounts for the majority of the basin's land use (USGS, 2000). As the river enters the Twin City Metropolitan area, the Basin is characterized by densely populated urban landscapes.



Across the basin, the amount of precipitation varies geographically, seasonally and from year to year. In general, the eastern portion of the basin receives more rain than the western portion. Data in this report show that watershed yields of key water quality pollutants also follow a general pattern of increasing yield from west-to-east across the basin.



# BACKGROUND

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## Water Quality

Water-quality data have been collected throughout the Minnesota River Basin during the past 30 years, but focused attention was placed on water quality issues when the Minnesota River Assessment Project, a comprehensive study conducted 1989-94, concluded that the Minnesota River was impaired by excessive nutrient and sediment concentrations. Previous studies had found that the river did not meet standards for bacteria, turbidity, dissolved oxygen and ammonia. Subsequent to those findings, considerable attention and support have been given to clean up efforts. In recent years, there have been substantial improvements in point source pollution control as well as continued adoption of conservation and best-management practices to reduce non-point source pollution within the Minnesota River Basin.

## Monitoring the River's Condition

At present, several organizations throughout the basin have responsibility for monitoring water quality in the Minnesota River and tributary streams. A multi-agency monitoring coordination effort was initiated in 2000 to assure standardization of field and laboratory methods and comparability of results. The purpose of the monitoring is to provide annual assessments of the current status of the Minnesota River with respect to water quality standards and goals, identify problem areas, and detect changes in water quality with time. A multi-agency team reviews and evaluates water quality data annually and prepares reports. Team partners include Minnesota State University-Mankato, state and federal agencies and many watershed projects throughout the basin.

## Results

This report presents selected results from water quality monitoring at four mainstem Minnesota River locations and fourteen outlets of major tributary streams (streams draining watersheds greater than 100,000 acres). The information represents results from more than 2,200 water-quality samples collected from 2000-05. This Report highlights findings regarding excessive sediment, nutrient enrichment, and environmental health concerns documented in the Minnesota River Basin. It serves as a companion document to the *State of the Minnesota River, Water Quality Summary 2000 to 2005*. All reports can be downloaded at: <http://mrbdc.mnsu.edu>



Photos: Monitoring on Le Sueur River (left) and Cottonwood River (right).

# KEY TERMS

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## Box Plot

Box plots are used throughout this report to visually summarize data. These graphs depict the following statistical measures: median, upper and lower quartiles.

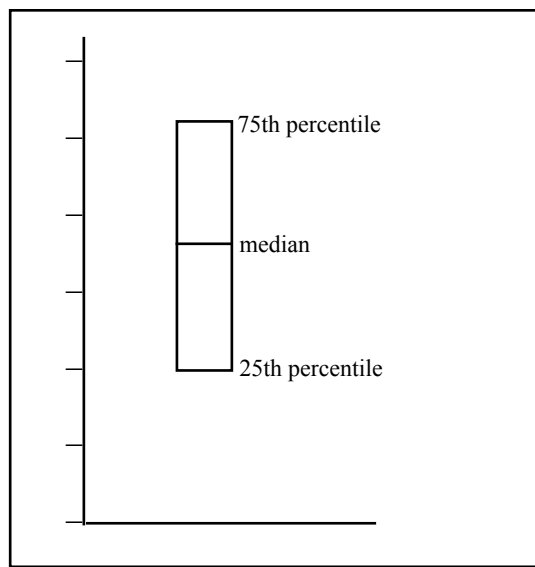
The boxplot is interpreted as follows:

The box itself contains the middle 50 percent of the data.

The upper edge of the box indicates the 75th percentile of the data set, and the lower edge of the box indicates the 25th percentile.

The line in the box indicates the median value of the data.

If the median line within the box is not equidistant from the edges of the box, then the data is skewed.



## Flow-Weighted Mean Concentration – FWMC

Many calculations are used to describe water quality such as load, yield, and concentration. This summary focuses on: flow-weighted mean concentrations (FWMC), load, and yield. FWMC is calculated by dividing the total load (mass) for the given time period by the total flow or volume. It refers to the concentration (mg/L) of a particular pollutant taking into account the volume of water passing a sampling station over the entire sampling season. Conceptually, a FWMC would be the same as routing all of the flow that passed a monitoring site during a specific time frame into a big, well-mixed pool, and collecting and analyzing one sample from the pool to give the average concentration.

## Load

A load is the estimate of pollutant total amount (mass), passing a specific location on a river during a specified interval of time.

## Yield

One way to assess pollutant contributions from watersheds of different sizes is to determine the “yield” or mass per unit area (such as lbs./acre) of a constituent coming out of a watershed during a given time period (monitoring season in this report). Yield normalizes mass on the basis of area, and allows for more relative comparisons of pollutant contributions to be made among watersheds. Yield is calculated by dividing the total mass or load of a constituent by the area (acres) of the watershed.

## Runoff

Runoff is the part of the precipitation which appears in rivers and streams, including baseflow, storm flow, flow from ground water, and flow from point sources. Essentially, runoff is all the flow passing a particular location on the river. To calculate monitoring season runoff, the total flow volume or the amount of water which passes by the station during the monitoring period is calculated and converted to acre-inches of water. This number is then divided by the total number of watershed acres to determine the inches of runoff. Conceptually, this is equivalent to redistributing all the river flow equally over the watershed, then measuring that water depth in inches.



### FLUX

FLUX is an interactive program developed by the U.S. Army Corps of Engineers that allows the user to estimate loadings from grab sample concentration data and continuous flow records. Most participating organizations in the Report used the FLUX program. Water quality data was derived from either composite or continuous sampling with sampling equipment, or grab sampling. These samples were paired with the flow data for that specific time period. Flow records for monitored sites were derived from continuous stage measurements.

Six alternative calculation methods are provided in the FLUX program. These calculations determine the flow/concentration relationship and estimate the associated pollutant load (mass).

## MONITORING SITES

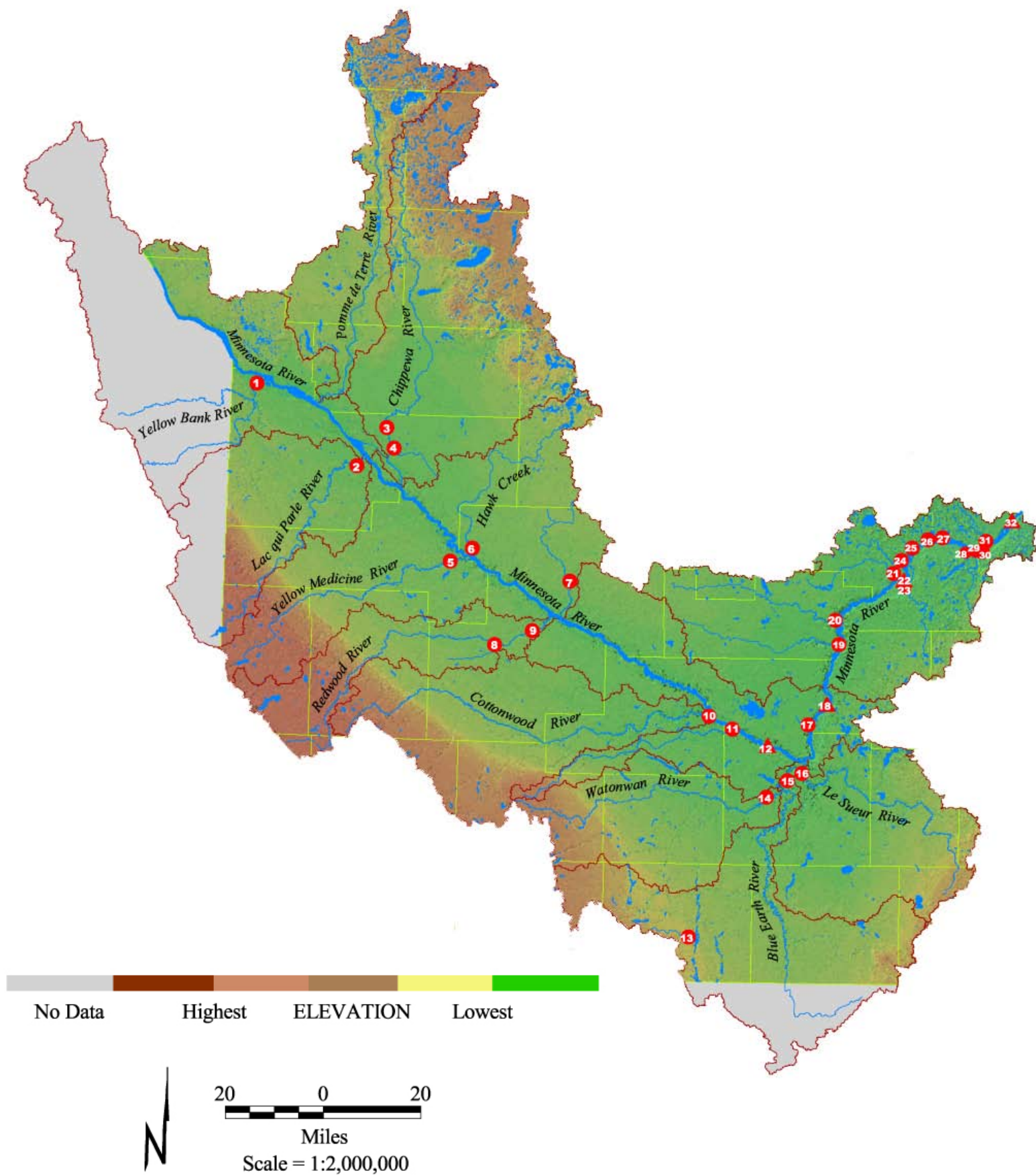
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Although water quality monitoring data have been compiled and analyzed for sites throughout the Minnesota River Basin, this report focuses on Minnesota River mainstem and Major Tributary (greater than 100,000 acres) sites. Data for these and other monitoring sites are available on the DNR/MPCA Cooperative Stream Gaging website: <http://www.dnr.state.mn.us/waters/csg/index.html>

### Mainstem, Major Tributary, and Minor Tributary Monitoring Sites in the Minnesota River Basin

<b>Mainstem</b>	<b>Major Tributary &gt;100,000 acres</b>	<b>Minor Tributary &lt;100,000 acres</b>
Minnesota River at Judson	Yellow Bank River	Dry Weather Creek
Minnesota River at St. Peter	Lac qui Parle River	WF Beaver Creek
Minnesota River at Jordan	Chippewa River	Clear Creek
Minnesota River at Fort Snelling	Yellow Medicine River	Dutch Creek
	Hawk Creek	Seven Mile Creek
	Redwood River	Bevens Creek
	Cottonwood River	Chaska Creek
	Little Cottonwood River	Carver Creek
	Watonwan River	Bluff Creek
	Blue Earth River	Riley Creek
	Le Sueur River	Eagle River
	Rush River	Credit Creek
	High Island Creek	Willow Creek
	Sand Creek	Nine Mile Creek

# MONITORING SITES



# MONITORING SITES

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## SELECT MINNESOTA RIVER MONITORING SITES 2000-2005

1	Yellow Bank River near Odessa	LQPYB
2	Lac qui Parle River near Lac qui Parle	LQPYB-USGS
3	Chippewa River near Milan	CRWP-USGS
4	Dry Weather Creek near Watson	CRWP
5	Yellow Medicine River near Granite Falls	YMRW-USGS
6	Hawk Creek and County Road 52	HCWP
7	West Fork Beaver Creek Henryville Twp	HCWP
8	Clear Creek near Seaforth	RCRCA
9	Redwood River near Redwood Falls	RCRCA-USGS
10	Cottonwood River near New Ulm	RCRCA-USGS
11	Little Cottonwood River near Courtland	BNC-USGS
12	Minnesota River at Judson	MCES-MDA
13	Dutch Creek near Fairmont	MARTIN CO
14	Watowwan River near Garden City	WATONWAN CO-MPCA-USGS
15	Blue Earth River at Dam in Rapidan Twp	MCES-MDA-USGS
16	Le Sueur River at Hwy 66 in South Bend Twp	MCES-MDA
17	Seven Mile Creek near St. Peter	BNC
18	Minnesota River at St. Peter	MCES
19	Rush River at Hwy 93 near Henderson	SIBLEY
20	High Island Creek near Henderson	SIBLEY-USGS
21	Bevens Creek at Co Rd 40 Bridge	MCES
22	Minnesota River near Jordan	MCES-USGS
23	Sand Creek at 2nd St in Jordan	MCES
24	Carver Creek at Co Rd 40	MCES
25	Chaska Creek at Co Rd 10	MDA
26	Bluff Creek at Flying Cloud Drive	MCES
27	Riley Creek at Hwy 169 in Eden Prairie	MCES
28	Eagle Creek 50 m up from 126th Street	MCES
29	Credit River at 123rd St Bridge in Savage	MCES
30	Willow Creek 300 m down from 106th St	MCES
31	Nine Mile Creek 500 m down from 106th St	MCES
32	Minnesota River at Fort Snelling State Park	MCES-USGS

Contributors: Barr Engineering, Brown-Nicollet-Cottonwood Water Quality Board (BNC); Chippewa River Watershed Project (CRWP); Hawk Creek Watershed Project (HCWP); High Island Creek Watershed Assessment Project (HCWAP); Lac qui Parle-Yellow Bank Watershed Project; Martin SWCD; Metropolitan Council Environmental Services Program (MCES); Minnesota Department of Agriculture (MDA); Minnesota Pollution Control Agency (MPCA); Minnesota State University, Mankato Water Resources Center (MSUWRC); Redwood-Cottonwood Rivers Control Area (RCRCA); Rush River Assessment Project (RRAP); U.S. Geological Survey (USGS); Watowwan River Clean Water Partnership (WRCWP); Yellow Medicine River Watershed (YMRW).

# EXCESS SEDIMENT

## What are Total Suspended Solids?

The transport of sediment is a natural function of rivers. Modification of the landscape has accelerated the rate of erosion of soil into waterways. Increased runoff has resulted in stream bank erosion. Elevated sediment (suspended soil particles) has many impacts. It makes rivers look muddy, affecting aesthetics and swimming. Sediment carries nutrients, pesticides, and other chemicals into the river that may impact fish and wildlife species. Sedimentation can restrict the areas where fish spawn, limit biological diversity, and keep river water cloudy, reducing the potential for growth of beneficial plant species. Primary sources of sediment include: agricultural fields, streambanks and gullies, urban stormwater, and construction sites.

## Turbidity

Turbidity refers to how clear the water is. The greater the amount of total suspended solids (TSS) in the water, the murkier it appears and the higher the measured turbidity.



The photos above show the dramatic increase in turbidity that often occurs when heavy rains fall on unprotected soils. Upon impact, raindrops dislodge soil particles while runoff waters easily transport fine particles of silt and clay across fields or through drainage systems to ditches and tributary streams throughout the Minnesota River Basin. Photos: Chetomba Creek, Hawk Creek Watershed



The photos above show a transparency tube. It is a tool for measuring stream water clarity: how much sediment, algae, and other materials are suspended in the water. This 60 cm long tube has a colored disk at the bottom for measuring the depth at which the disk is visible.

Photos: Blue Earth River



# EXCESS SEDIMENT

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Excessive amounts of sediment degrade the ecological health and aesthetics of the Minnesota River and its tributaries. When suspended sediment, measured by TSS (total suspended solids), is elevated, turbidity increases, water clarity decreases, and light penetration is reduced. Reduced light penetration shifts stream productivity away from beneficial periphyton and favors undesirable floating algae. An overabundance of floating algae (phytoplankton) further increases turbidity, compounding the problem. Fine-grained sediments that settle on stream beds cover and degrade the desirable rock and gravel substrates that form essential habitats for invertebrates and fish. During periods of high turbidity, streams take on a murky brownish-green cast, greatly reducing their appeal to people who enjoy water-based recreational activities such as boating, fishing, or swimming.



Streambanks and gullies contribute sediment to the streams and rivers in the Minnesota River Basin.



The sediment laden Minnesota River (left) flows into the Mississippi River (right).



The Mississippi River carries sediment downstream and it settles in Lake Pepin. Most of Lake Pepin's sediment is coming from the Minnesota River. The lake is filling in at 10 times its natural rate.



# EXCESS SEDIMENT

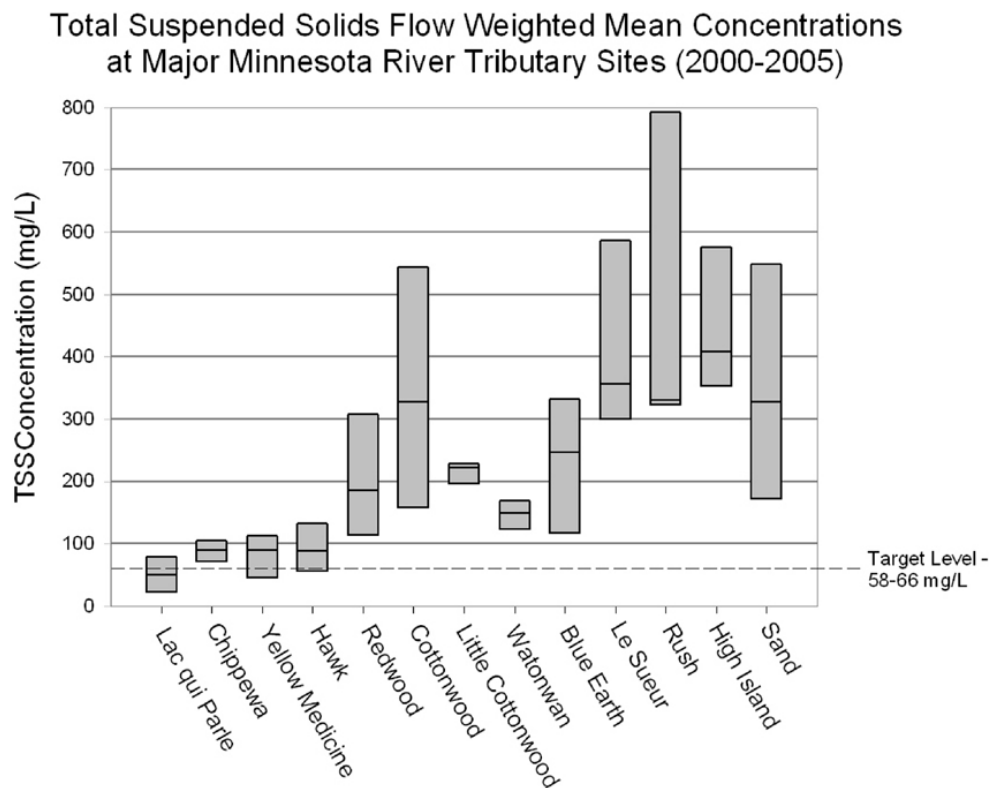


Figure 1.  
Boxplot  
showing the  
monitoring season  
(approximately  
April through  
September)  
TSS flow-  
weighted mean  
concentrations  
(FWMC) for major  
Minnesota River  
tributary streams  
in the Minnesota  
River Basin.

Tributaries are displayed in downstream order from left to right (west to east) on Figure 1. The tributaries in the middle and downstream parts of the Minnesota River Basin have, in general, greater flow weighted mean concentrations (FWMC) and greater year-to-year variability than tributaries in the western, upstream, part of the basin. The horizontal line indicates threshold level (58 mg/L and 66 mg/L ) established by Minnesota Pollution Control Agency for streams in the Western Corn Belt Plains and Glaciated Plains ecoregion (MPCA, 1993). The TSS FWMC values are indicators of the condition of the tributary streams and are a measure of their potential to affect water quality in the Minnesota River (Figure 2). FWMC are calculated on a monitoring season basis (approximately April through September).



Photo: Le Sueur River water quality samples collected throughout the 2002 monitoring season. This illustrates the variability in turbidity throughout the year.

# EXCESS SEDIMENT

Total Suspended Solids Flow Weighted Mean Concentrations  
at Minnesota River Mainstem and Greater Blue Earth River Sites (2000-2005)

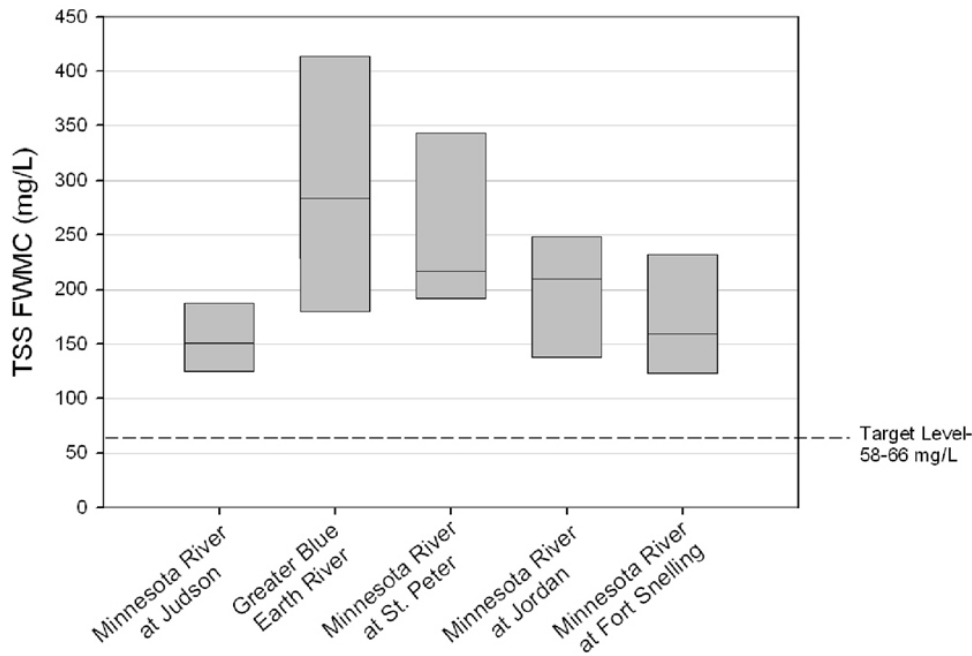


Figure 2.  
Boxplot showing  
monitoring season  
total suspended  
solids flow-  
weighted mean  
concentrations  
(FWMC) for  
Minnesota River  
and Greater  
Blue Earth River  
sampling sites.



Photo: Lake Pepin, a natural impoundment along the Upper Mississippi River just downstream of St. Paul. The Minnesota River, while only accounting for 25% of the flow into the lake is responsible for 88% of the sediment load.

Photo courtesy of Explore Minnesota Tourism.

# EXCESS SEDIMENT

Yields, shown as pounds of sediment delivered per watershed acre, are indicators of the severity of erosion in each tributary watershed. Figures 3 and 4 show that sediment yields generally increase from west to east across the Minnesota River Basin and that watersheds in the eastern, downstream, part of the Basin have greater year-to-year variability in sediment yield. Tributary streams that have greater yields and large watersheds like the Le Sueur have the greatest potential to affect water quality in the Minnesota River mainstem. Recent studies have indicated an approximate ten fold increase in post-settlement sedimentation rates in Lake Pepin, a natural impoundment along the Upper Mississippi River just downstream of St. Paul. Furthermore, the Minnesota River, while only accounting for 25% of the flow into the lake is responsible for 88% of the sediment load (Engstrom and Almendinger, 1997).

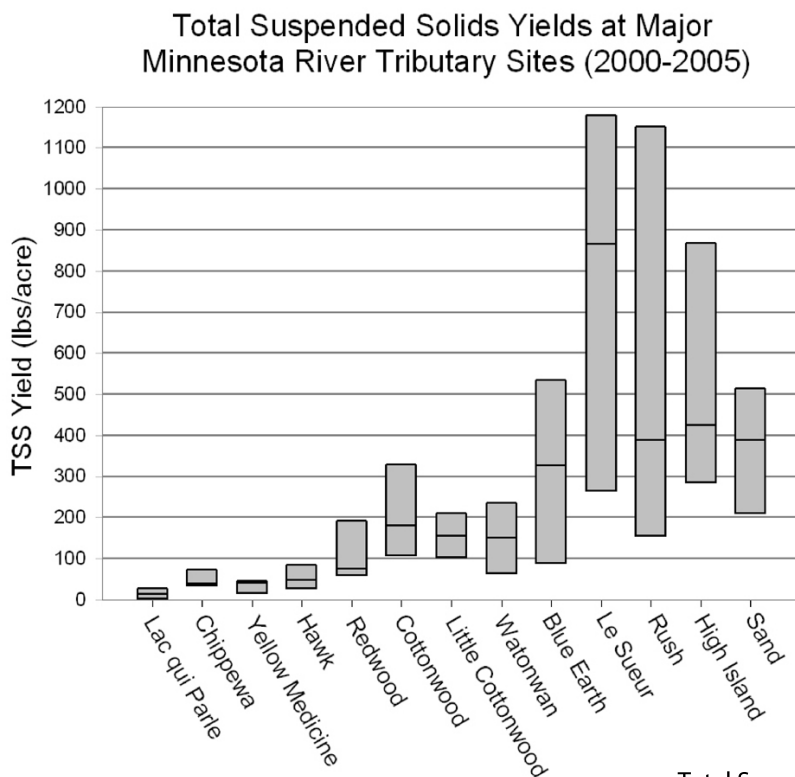
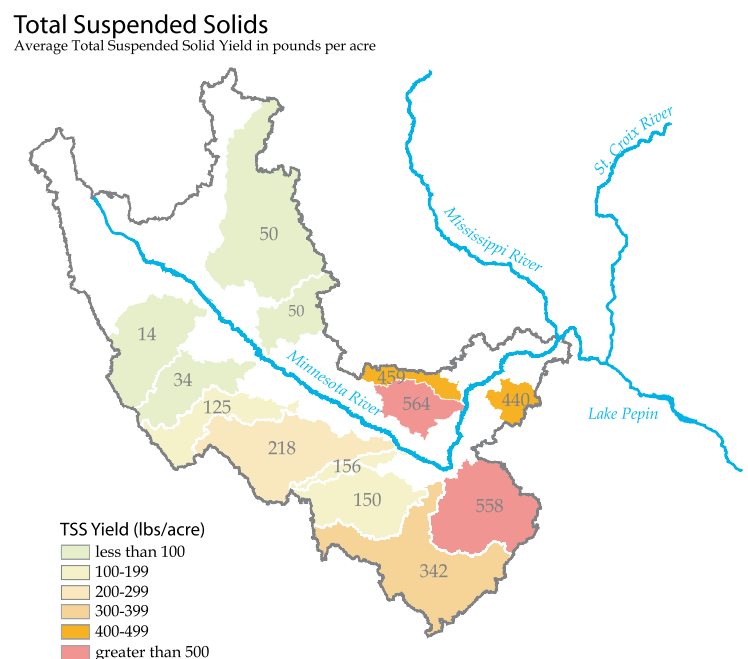


Figure 3.  
Boxplot showing monitoring season TSS yields for major tributary streams in the Minnesota River Basin.

Figure 4 displays the pattern of the six year yields indicating the disproportionate contribution from the watersheds in the eastern part of the basin.



# NUTRIENT ENRICHMENT: PHOSPHORUS

Phosphorus-enriched streams are commonplace in the Minnesota River Basin. Phosphorus stimulates the growth of algae and elevated phosphorus concentrations often lead to eutrophy, which is characterized by undesirably high levels of algal growth. An overabundance of algae and sediment contributes to increased turbidity and reduced light penetration. Water clarity is greatly reduced under these conditions, impairing recreational use and aesthetics of the river environment. Furthermore, algal cells eventually die and their subsequent decomposition consumes in-stream oxygen. This oxygen demand can lower dissolved oxygen in the streams and impair the stream's ability to support aquatic life. Some outbreaks of highly elevated algal growth, termed algal blooms, release toxins into the water. Instances of this have occurred within the Minnesota River Basin and resulted in the death of animals (including pets) that ingested these toxins. Phosphorus arises from both point (e.g. municipal and industrial discharges) and non-point (e.g. runoff from agricultural lands and urban areas) sources.



Watonwan River algal bloom.



Blue Earth River algal bloom.



Lake Pepin algal bloom.  
The lake is accumulating phosphorus at 15 times the natural rate.

Total Phosphorus (TP) concentrations in the tributaries show substantial variation across the Basin. During 2000 to 2005, the median TP concentration in the Minnesota River mainstem reach from Judson to Fort Snelling was 0.34 mg/L as indicated in the horizontal line in Figure 5. Concentrations in the major tributary streams are shown in Figure 7. The horizontal lines in Figures 5 and 6 show the TP threshold value of 0.26 mg/L. Data analysis (MPCA, 1997) has indicated that a reduction in undesirable algal growth cannot be expected unless mainstem TP concentrations are brought below that threshold. Figure 6 and Figure 7 indicates that few of the tributaries meet that criterion.

## What is Phosphorus?

Phosphorus is an important nutrient for plant growth. Total phosphorus is the measure of the total concentration of phosphorus present in a water sample. Excess phosphorus in the river is a concern because it can stimulate the growth of algae. Excessive algae growth, death, and decay can severely deplete the oxygen supply in the river, endangering fish and other forms of aquatic life. Low dissolved oxygen rates are a concern particularly during low-flow times or in slow-flowing areas such as reservoirs and the lower reaches of the Minnesota River. Large total phosphorus loads can have major impacts both locally and on downstream receiving waters such as Lake Pepin.

Point-source phosphorus comes mainly from municipal and industrial discharges to surface waters. Nonpoint-source phosphorus comes from runoff from urban areas, construction sites, agricultural lands, manure transported in runoff from feedlots and agricultural fields, and human waste from noncompliant septic systems.

# NUTRIENT ENRICHMENT: PHOSPHORUS

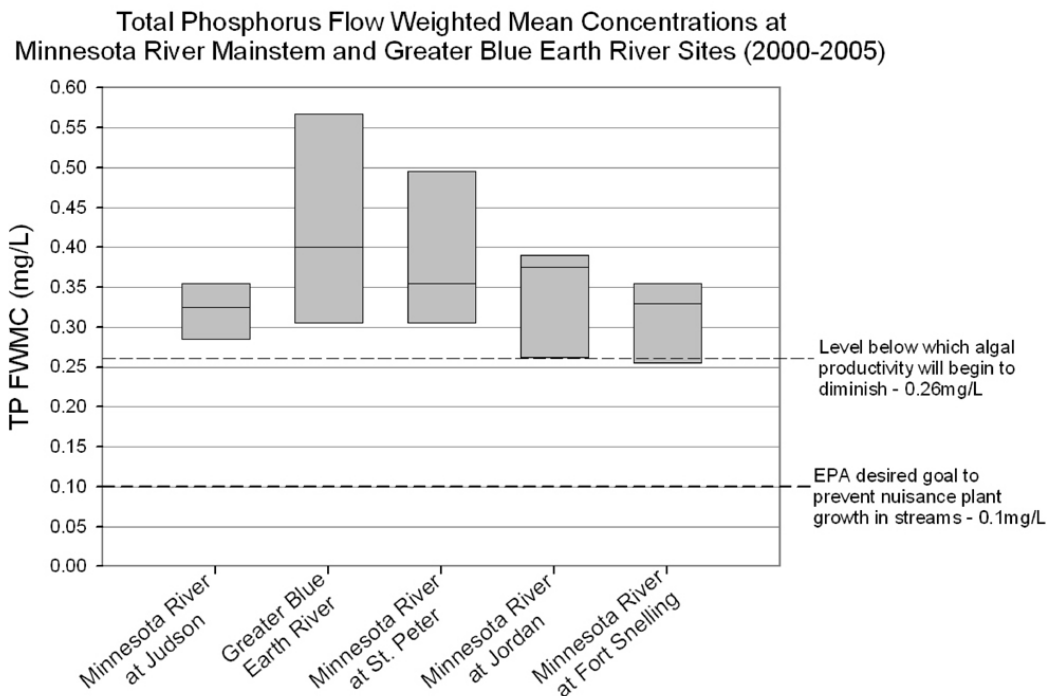


Figure 5. Boxplots showing monitoring season total phosphorus (TP) flow-weighted mean concentrations (FPMC) at Minnesota River and Greater Blue Earth River sampling sites.

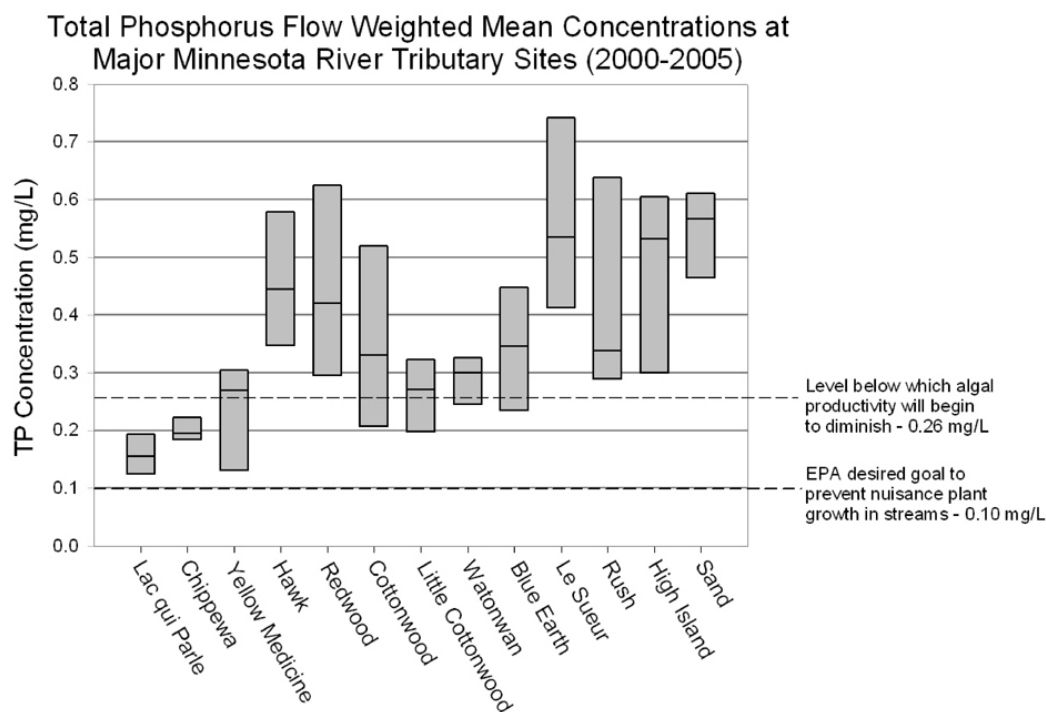


Figure 6. Boxplots showing monitoring season TP FPMC in major tributary streams in the Minnesota River Basin.



# NUTRIENT ENRICHMENT: PHOSPHORUS

## Total Phosphorus

Average Flow-Weighted Mean Concentrations in milligrams per liter

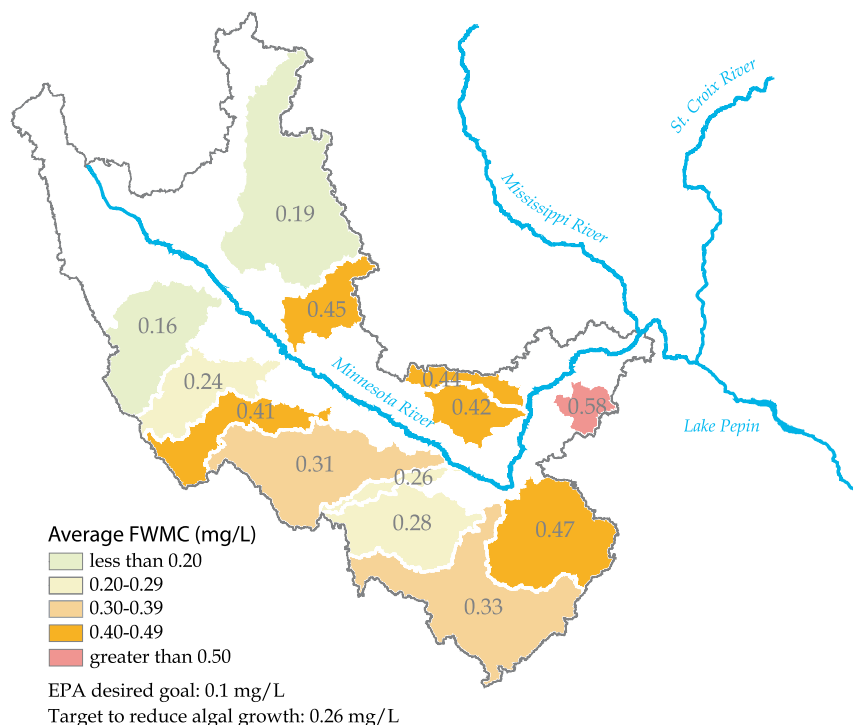
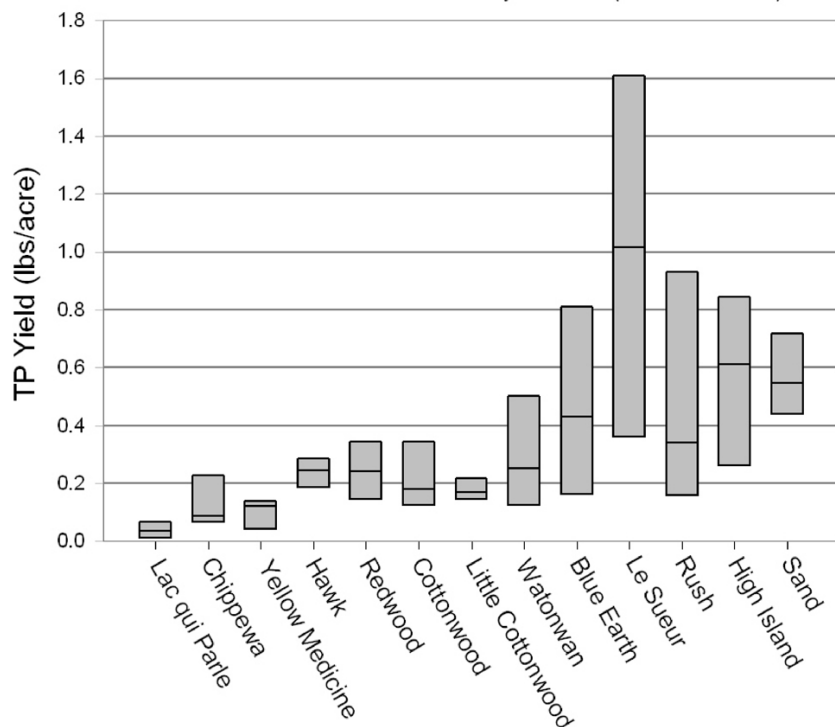


Figure 7.  
2000 to 2005  
average monitoring  
season TP FWMC  
for major tributary  
streams in the  
Minnesota River  
Basin.

## Total Phosphorus Yields at Major Minnesota River Tributary Sites (2000-2005)



The boxplots in Figure 8 appear in downstream order, left to right (west to east) across the basin. The yields, expressed in pounds of TP delivered per watershed acre, show the variation in TP yields from each major watershed. Watersheds in the eastern part of the basin yield more TP per acre compared to watersheds in the western part. The range of yields is greater in the eastern part of the basin.

Figure 8. Boxplots showing total phosphorus (TP) yields from major tributary watersheds in the Minnesota River Basin.

# NUTRIENT ENRICHMENT: PHOSPHORUS

Total Phosphorus includes sediment bound phosphorus, phosphorus contained in organic matter and soluble inorganic phosphorus, also known as orthophosphorus. Orthophosphorus is readily available to algae and under certain conditions algal growth can increase very rapidly, often leading to undesirable algal blooms. Its bio-availability and presence in elevated concentrations in streams is a concern. Although typically present in lower concentrations compared to sediment-attached phosphorus (compare with TP boxplots in Figures 5 and 6), its bio-availability and presence in relatively high concentrations in some streams is a concern. The horizontal dashed line shows the median orthophosphorus (0.10 mg/L) concentration in the Minnesota River mainstem, 2000 to 2005 (Figure 9).

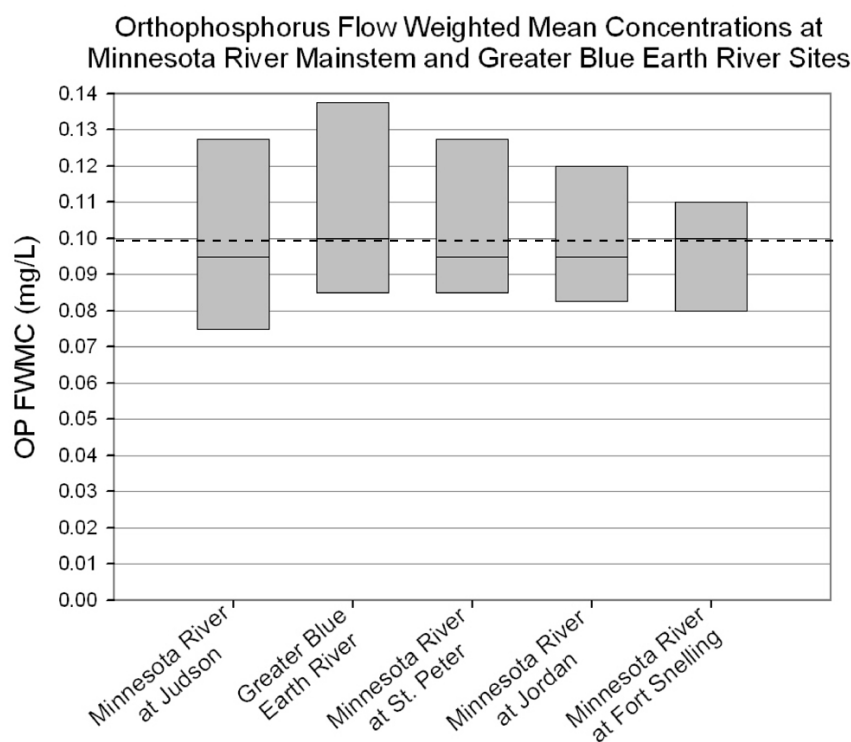


Figure 9. Boxplots showing monitoring season orthophosphorus (OP) flow-weighted mean concentrations (FPMC) at Minnesota River mainstem and Greater Blue Earth River sampling sites.

## What is Orthophosphorus?

Under natural conditions, phosphorus is typically scarce in the aquatic environment. Human activities, however, have resulted in excessive loading of phosphorus into many freshwater systems. A portion of the total phosphorus concentration in surface waters is available to plants to support their growth. The available portion is commonly called bioavailable phosphorus. Excess bioavailable phosphorus in freshwater systems can result in accelerated plant growth. Phosphorus is the principal nutrient causing excessive growth of algae and other aquatic plants in Minnesota's surface waters.

Phosphorus exists in water in either a dissolved phase or a particulate phase. Dissolved inorganic phosphate (orthophosphate) is the form required by plants for growth. Orthophosphates are immediately available in the aquatic environment for algal uptake. A particular concern is that under certain conditions it can stimulate excess algae growth leading to subsequent depletion of dissolved oxygen

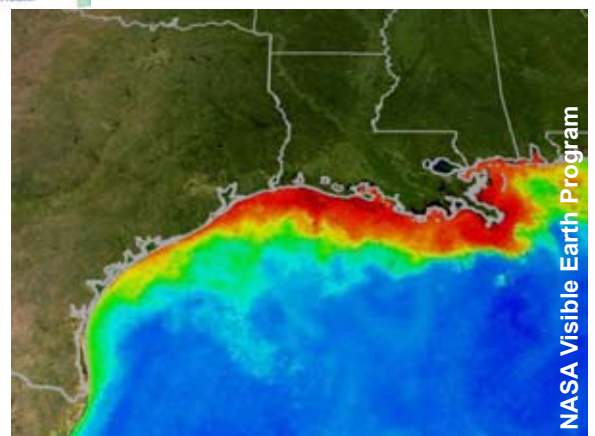
Natural processes produce orthophosphates, but major man-influenced sources include: partially treated and untreated sewage; runoff from agricultural sites; and application of some lawn fertilizers. Orthophosphate concentrations in a water body vary widely over short periods of time as plants take it up and release it.

# NUTRIENT ENRICHMENT: NITROGEN

Nitrate-nitrogen is important because it is biologically available and is the most abundant form of nitrogen in Minnesota River Basin streams. Like phosphorus, nitrate can stimulate excessive and undesirable levels of algal growth in waterbodies. In recent years, this problem has been particularly severe in the Gulf of Mexico where development of a hypoxia zone (hypoxia means “low oxygen”) has been linked to excessive amounts of nitrate carried to the Gulf by the Mississippi River. Reduced oxygen levels in the hypoxic zone, brought on by decomposition of algae, have damaged the shellfish industry and threaten the aquatic ecosystem of the Gulf Region. The Minnesota River has been identified as a substantial contributor of excess nitrate to the Mississippi River and the Gulf Region. In addition to over-stimulation of algae, elevated levels of nitrate in drinking water can cause methemoglobinemia, or blue-baby syndrome in infants.

## What are Nitrates?

Nitrogen exists in the environment in many forms. Nitrate is the oxidized form of Nitrogen that is commonly found in the rivers and streams of the Minnesota River Basin. Because it is highly mobile, and biologically available, it is of special concern for aquatic systems. In recent decades, there has been a substantial increase in nitrogen fertilizer use. Elevated nitrate-N in the Minnesota River can pollute aquifers it recharges. Therefore, nitrogen can affect drinking water. At high enough concentrations, nitrate-N can cause infants who drink the water to become sick and even die (methemoglobinemia). Downstream, nitrate-N from the Minnesota River contributes to hypoxia (low levels of dissolved oxygen) in the Gulf of Mexico by stimulating the growth of algae which, through death and decay, consume large amounts of dissolved oxygen and thereby threaten aquatic life.



This image shows the hypoxic zone (sometimes referred to as the dead zone) in the Gulf of Mexico.

Reds and oranges indicate areas of low oxygen concentration. In July 2006, the hypoxic zone was mapped at 6,662 square miles — similar to the size of Connecticut and Rhode Island combined.

Photo courtesy of NASA Visible Earth Program.

# NUTRIENT ENRICHMENT: NITROGEN

Nitrate-Nitrogen Flow Weighted Mean Concentrations at Major Minnesota River Tributary Sites (2000-2005)

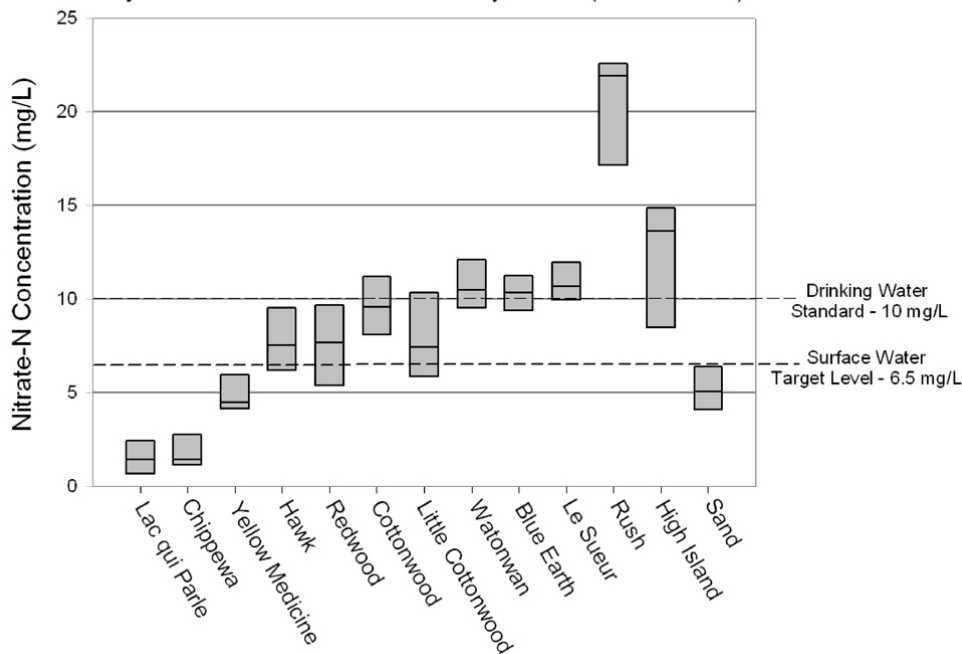


Figure 10. Boxplots showing monitoring season nitrate-nitrogen flow-weighted mean concentrations (FWMC) in major tributary streams, Minnesota River Basin, 2000-05.

The boxplots in Figure 10 show the variability in nitrate concentrations in major tributary streams. The sites are arranged in downstream order, west to east, in the graphic. The uppermost dashed horizontal line shows the drinking water standard for nitrate (10 mg/L). Flow-weighted mean nitrate concentrations, in general, are greater in the central and eastern parts of the Minnesota River Basin. Average ecoregion values for minimally impacted rivers in the Minnesota River Basin can be used for comparison with major tributary FWMC Nitrate-N concentrations. Ecoregions are areas with similar physical landscape characteristics. The ecoregion target values for these rivers includes Nitrate-N concentrations in the 0.9 to 6.5 mg/L range.

Total Nitrate-Nitrogen  
Average Flow-Weighted Mean Concentrations in milligrams per liter

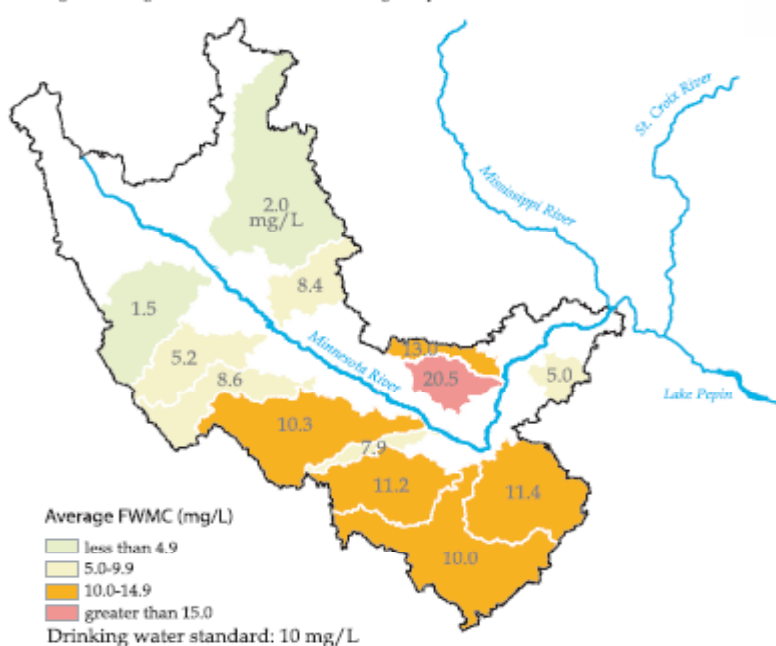


Figure 11 indicates nitrate concentrations across the basin. The watersheds shown in orange and red have concentrations that exceed the drinking water standard (10 mg/L). Most of the nitrate in the Minnesota River comes from agricultural drainage.

# NUTRIENT ENRICHMENT: NITROGEN

Yields of nitrate nitrogen vary substantially across the Minnesota River Basin (Figure 12) and are generally greater in streams that drain watersheds in the central and eastern part of the basin. Streams that have greater yields also have greater year-to-year variability in yields. The east to west increase in yield coincides with a gradient of increased rainfall and runoff, west to east, across the basin.

In addition to yield variability associated with natural rainfall variability, agricultural practices affect nitrate yield. Gowda and others (2007) modeled nitrate losses from the Bevens Creek and Sand Creek Watersheds in the eastern part of the basin. These watersheds receive similar average rainfall amounts, but differ in nitrate load and yield. The calibrated models showed that nitrate losses were sensitive to fertilizer application rates, timing of fertilizer application (fall vs. spring), and the percentage of cropped land drained by subsurface tile. The model results show that nitrate losses increase with increased application rates, fall applications, and increases in subsurface drainage.

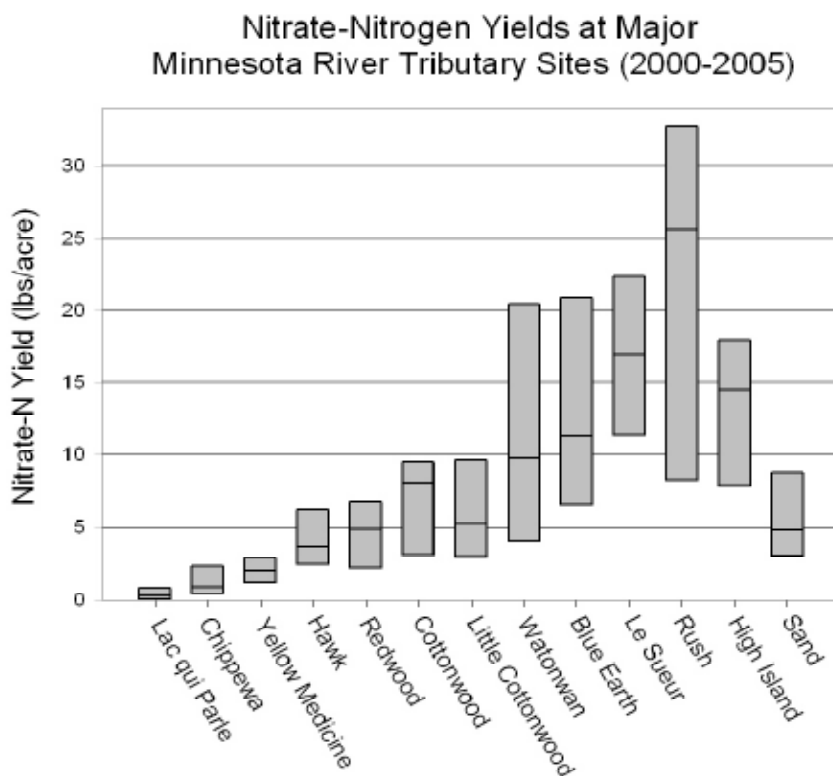


Figure 12.  
Boxplots showing nitrate-nitrogen monitoring season yields in major tributary streams, Minnesota River Basin, 2000-05.



## Nitrate in Drinking Water

As noted earlier, elevated levels of nitrate in drinking water can cause methemoglobinemia, or blue-baby syndrome. Because of this, both State and Federal regulations limit nitrate in drinking water to 10 parts per million (ppm) to protect prenatal and infant children. During the 2000 to 2005 monitoring period, several tributary streams in the Minnesota River Basin periodically exceeded the 10 ppm standard. The City of Mankato draws drinking water from a shallow aquifer that is connected to, and partially recharged by, the Blue Earth River. Nitrate-N levels in the Blue Earth River strongly influence nitrate levels in Mankato's water intake supply.

## Pesticides

The Minnesota Department of Agriculture (MDA) is the lead state agency for most aspects of pesticide and fertilizer regulatory functions. The MDA Monitoring Unit collects pesticide samples from multiple stream locations in the Minnesota River Basin. Pesticide monitoring data indicate the seasonal presence of several chemicals sometimes at levels of concern. The MPCA has proposed listing three Minnesota River Basin stream segments as impaired for the herbicide acetochlor based upon a draft standard. For more information, see the MDA website for the latest information and reports:  
<http://www.mda.state.mn.us/>



## Mercury

In Minnesota, mercury contamination of fish is a well-documented problem. Mercury is tightly bound to proteins in all fish tissue, including muscle. There is no way to reduce the amount of mercury in a fish through cooking or cleaning it. The Minnesota Department of Health advises people to restrict their fish consumption due to mercury accumulation in sport fish from lakes and rivers. Large amounts of mercury in your body may harm your nervous system. For more information, see the Minnesota Department of Health's guideline on fish consumption at:

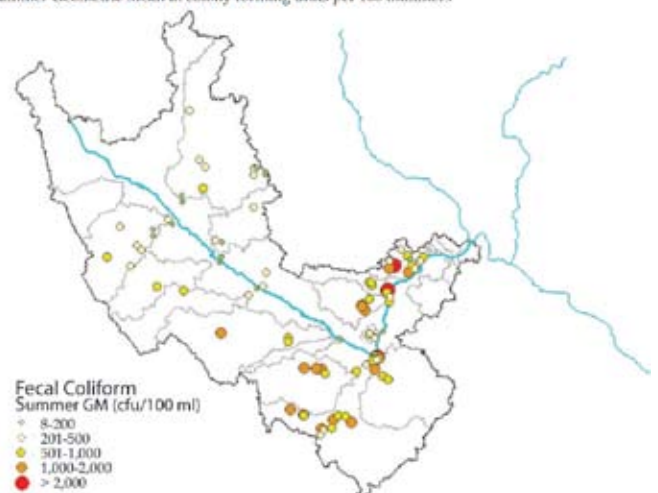
<http://www.health.state.mn.us/divs/eh/fish/index.html>



## Fecal Coliform Bacteria

Fecal coliform levels are elevated across the entire Minnesota River Basin with over 90 percent of monitored streams exceeding health standards (200 cfu/100ml). Data show the highest concentrations in the eastern portion of the Basin. Many streams require a 80 to 90 percent reduction in bacteria levels to meet standards.

**Fecal Coliform Bacteria**  
Summer Geometric Mean in colony forming units per 100 milliliters



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