# LOWER MINNESOTA RIVER

LOWER MINNESOTA RIVER
WATERSHED DISTRICT

# 1. History of the Minnesota River

The Minnesota River, formerly named St. Peter's River, flows more than 300 miles before entering the Lower Minnesota River Watershed District (LMRWD). The river lies in a broad, deep valley that the River Warren carved as it drained the outflow from Lake Agassiz; the River Warren and Lake Agassiz were glacial features that occurred more than 10,000 years ago. According to Featherstonhaugh (1847) the American Indian name of the St. Peter's River is *Minnay Sotor*, or "Turbid Water," because the water looked as if whiteish clay had been dissolved in it. The US Congress voted in 1852 that the official name of the river should be Minnesota (Minnesota Historical Society [MNHS] n.d.).

For centuries, the Dakota American Indian community has maintained strong connections to the Minnesota River and its many tributaries, prospering while coexisting with the natural resource community (Minnesota River Basin Data center [MRBDC] n.d.). Today, the Shakopee Mdewakanton Sioux community, which includes direct descendants of the Dakota people, is located along the lower end of the Minnesota River near the Twin Cities. The community concentrates on a wide range of services, including those related to protecting and restoring the natural environment back to pre-European American settlement conditions. These efforts include prairie restoration, drinking water protection, and energy production from natural materials (MRBDC n.d.).

The Minnesota River watershed, shown on the following map, is nearly 17,000 square miles ([$mi^2$] 44,000 square kilometers [$km^2$]). It drains much of western and southern Minnesota. The main channel of the river starts near northwestern South Dakota; flows southeast toward Mankato, Minnesota; then flows north-northeast to where it meets the Mississippi River in the Twin Cities, Minnesota. The Minnesota River doubles the flow of the Mississippi River where they join (Musser, Kudelka, and Moore 2009). Nearly all the land that was prehistorically prairie, open range, or wooded has been converted to agricultural land uses (Musser, Kudelka, and Moore 2009). The desire to increase tillable acreage resulted in filling or draining many of the wetlands that originally covered the land. Changing the landscape is implicated in changing the flow characteristics of streams and rivers, which has increased runoff from the watershed. Changing flow characteristics can result in the movement and transport of contaminants to downstream areas.

***Find available information on stream location, characteristics, and fisheries at the Minnesota Department of Natural Resources (MnDNR) stream ID [M-055](M-055).***

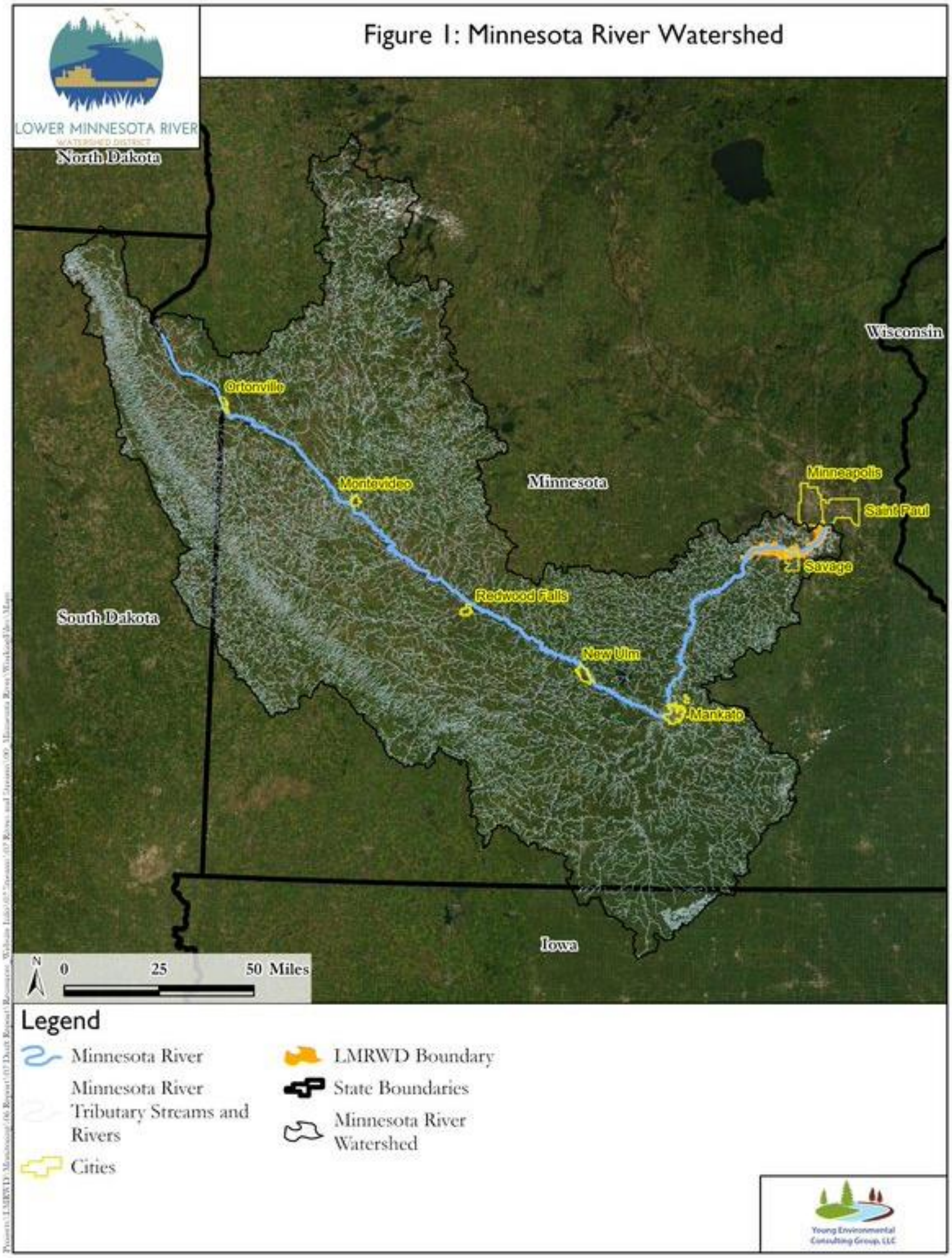
## Key Terms

- **Watershed:** An area of land where water falls and drains to a common outlet.

## Key Takeaways

- The Minnesota River has an important cultural history as a unique resource.

# Figure 1: Minnesota River Watershed



# 2. Progress Toward a Cleaner Minnesota River

Sediment and associated materials the Minnesota River carries have been implicated for having adverse effects on downstream receiving waters, including the Mississippi River and Lake Pepin. Lake Pepin is 59 river miles downstream of the Minnesota River (USACE 2022a) and is the largest lake on the Mississippi River (MnDNR 2022). Engstrom (2000) describes that since the 1830s when the area started becoming populated with nonindigenous settlers, the Minnesota River has contributed more than 70 percent of the sediments measured in Lake Pepin.

The Minnesota River attracted considerable attention in the late 1980s because of unhealthy fish populations, algal blooms, and sediment. In 1992, former Governor Arne Carlson announced an ambitious plan to clean up the Minnesota River, issuing a challenge to make it “swimmable and fishable” within 10 years. That challenge promoted many studies and efforts toward achieving the stated goal. Measurable progress has been made, but more work remains (MRBDC 2007; Steil 2002).

Ongoing efforts implemented at scales ranging from basin-wide to site-specific are leading to a cleaner Minnesota River. The implementation of best management practices, the Conservation Reserve Program, and the Conservation Reserve Enhancement Program all have reduced the amount of sediment and nutrients reaching the river. Programs applied throughout the watershed and at focused locations have led to upgraded inputs from wastewater treatment systems, confined animal feeding operations, and other sources of materials that otherwise would have added to the pollutant load of the river. The Minnesota Pollution Control Agency summarizes much of the work that has been and continues to be done in the Lower Minnesota River (Minnesota Pollution Control Agency [MPCA] n.d.).

Water that drains from 16,200 $mi^2$ (42,000 $km^2$) of the 17,000 $mi^2$ Minnesota River watershed funnels into the upstream end of the LMRWD. The part of the Minnesota River watershed that drains directly to the Lower Minnesota River is only about 800 $mi^2$ (2,100 $km^2$). The Minnesota River morphs from a free-flowing river to an almost lake-like, slow-moving system as it courses through the LMRWD because the channel slope becomes relatively flat. The lower river supports recreation and commerce and receives inflow from streams; groundwater; stormwater runoff; and treated wastewater from a variety of land uses, including rural, agricultural, and urban areas. Many of the streams that empty into the Lower Minnesota River bring runoff-associated materials from upland rural, agricultural, and urban areas.

Understanding Minnesota River characteristics as the river flows through the LMRWD will provide for informed and wise management of this resource. Many of the lakes and wetlands along the Lower Minnesota River have unique, rare characteristics and are given special protection.

Precipitation that falls in the Lower Minnesota River watershed can run off to streams and lakes while some of it infiltrates to recharge the underlying groundwater aquifers. Much of the water that begins as recharge in upland areas along the Lower Minnesota River flows for miles through underground aquifers and discharges along the sides of the valley. This groundwater discharges at seeps and springs, providing water to wetlands, streams, and other waterbodies in the LMRWD. The quantity and quality of the recharge water can have consequences for the waterbodies and ecosystems that rely on the groundwater discharge.

The Lower Minnesota River presently receives treated wastewater from the Blue Lake and Seneca wastewater facilities, which are the third and fourth largest treatment plants in the state, respectively (MetCo n.d.). The Xcel Energy Black Dog power plant uses Minnesota River water while generating electricity. Stormwater runoff from the Minneapolis–St. Paul International Airport, including deicer, also discharges to the river. The organizations responsible for managing these and numerous other inputs to the river have spent extraordinary effort to ensure they do not adversely affect, and that they often enhance, the quality of the resource.

The following map shows the path of the Lower Minnesota River as it meanders across the approximately one-mile-wide modern-day floodplain, which roughly corresponds to the channel that glacial River Warren carved as it drained glacial Lake Agassiz. The image extends from about the uppermost routine monitoring site that is 39.4 miles (Mile 39.4) upstream of the confluence with the Mississippi River to the most downstream routine monitoring site, which is 3.5 miles (Mile 3.5) upstream of the confluence with the Mississippi River. The LMRWD starts at about Mile 33 and extends to Mile 0 at the mouth of the river. It is common to use mileage designations for locations along streams and rivers, especially when they are used for commercial navigation.

## Key Terms

- **Sediment:** Naturally occurring material that comes from erosion.
- **Best Management Practices:** Projects or methods on a landscape that help manage water pollution.
- **Groundwater:** Water held underground or in soil.
- **Stormwater Runoff:** Rain water that washed off the land from developed areas, such as parking lots or streets.
- **Treated Wastewater:** Water that has been treated to remove suspended sediment.
- **Runoff-Associated Materials:** These include materials captured by water runoff from fields or lands, which may include fertilizer, soil, and more.

## Key Takeaways

- Anything that enters the Minnesota River travels downstream to various communities, and ultimately reached Lake Pepin.
- Progress has been made to improve water quality by limiting what items flow into the river, but there is still more work to be done.

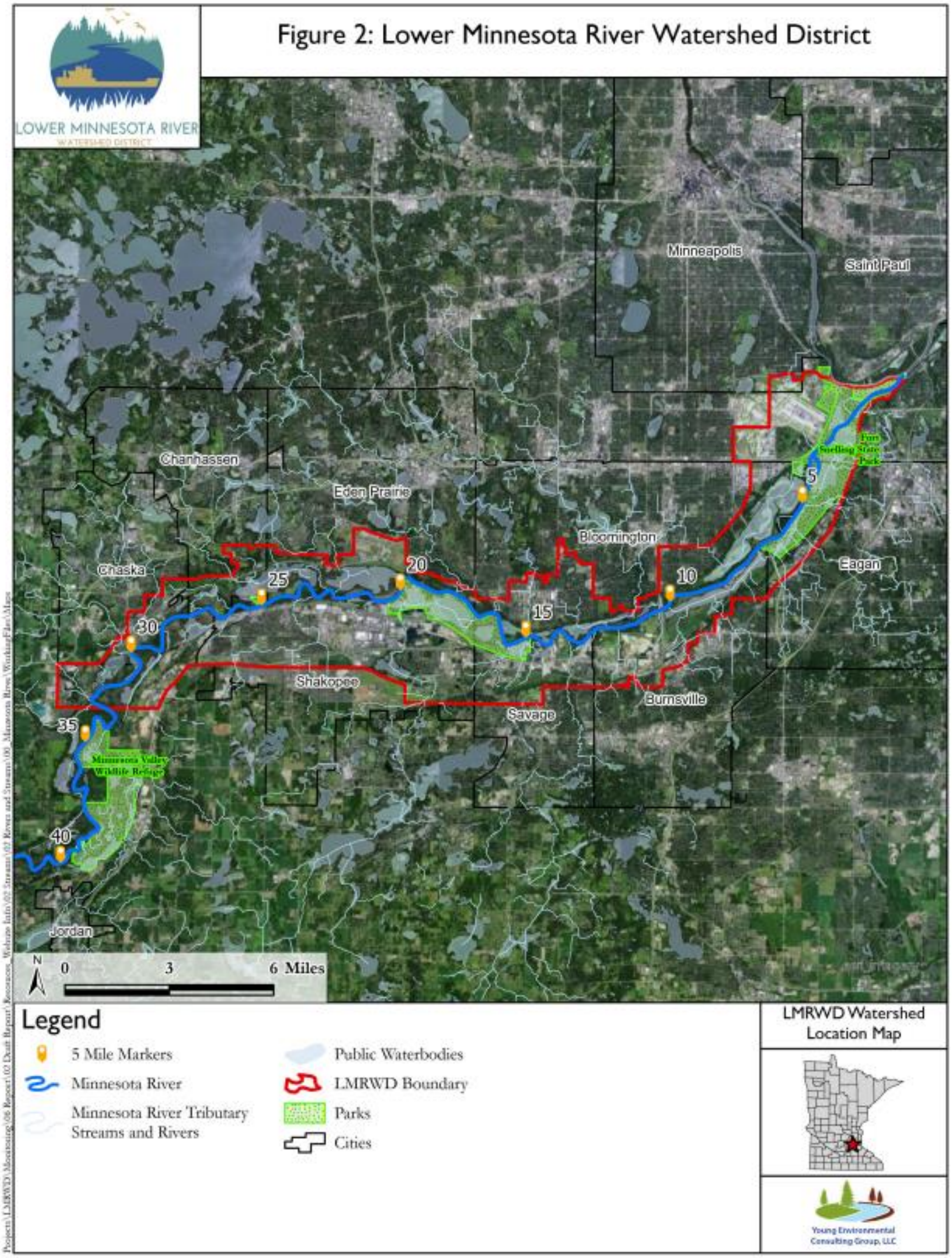



Figure 2: Lower Minnesota River Watershed District

# 3. Varied Uses Along the Minnesota River

Many lakes and wetlands are present along the floodplain of the Lower Minnesota River, and many are included within the Minnesota River Valley National Wildlife Refuge (MRVNWR). These lakes and wetlands provide important habitat for migratory waterfowl and other wildlife. The MRVNWR is complemented by Fort Snelling State Park, which includes most of the bottomlands along the last three to four miles above the confluence with the Mississippi River.

The Minnesota River was used mostly as a conduit for native populations until fur trading and other commercial operations increased its importance for transportation. The first steamboat to pass up the Minnesota River past Carver (Mile 36) was the Anthony Wayne, a Mississippi River boat, which came from St. Paul in 1850 (MRBDC n.d.). Steamboating on the Minnesota River was most active during the 10-year period from 1855 to 1865, with shipments occasionally extending upstream of Mankato (river mile 105). Much of the traffic was restricted to river stretches below Carver Rapids, which can form a barrier to riverboat passage when streamflow is too low. Maintaining the Minnesota River as navigable lingered for decades after the steamboat era, but the coming of railroads and their river-spanning bridges in the late 1860s ruined the idea.

During modern times, the 15 miles of the Minnesota River from Savage to the mouth are a multimillion-dollar transportation route as barges carrying grain, construction materials, and other products are pushed to and from ports in Savage, Minnesota.

**During the five years of 2008–2012, about half of the 10 million tons of material, worth more than 2 billion dollars, transported annually to and from ports along the Mississippi River in Minnesota were handled at the Savage, Minnesota, port along the Minnesota River (MnDOT 2014).**

*Source: Young Environmental*

This transportation requires that the US Army Corps of Engineers (USACE) maintain a nine-foot navigation channel during nearly the entire open-water season (USACE 2022b). The USACE (2022b) states, “Channel maintenance is 100% federally funded except for short segments of the Mississippi River in Minneapolis and on the Minnesota River. Nonfederal sponsors are responsible for furnishing dredged material placement sites on those segments.”

The LMRWD is responsible for disposing of this dredged material and must manage where to place it safely away from the river. It also creates a marketing opportunity for the large amounts of dredged sand and gravel.

## Key Terms

- **Wetland:** A distinct ecosystem that is flooded or saturated by water and provides habitat for wildlife like waterfowl.
- **Floodplain:** The low-lying land adjacent to a river, which is subject to flood depending on river flow.
- **Navigation Channel:** A navigable inland waterway that boats, like commercial barges, can use during transport along a river.
- **Dredged Material:** Sediment that is removed from the bottom of navigable waters. Removed material is transported to a site where it dries and is disposed of.

## Key Takeaways

- Over its history, the Minnesota River has a variety of uses from natural (habitat for wildlife) to human (commerce and transportation).
- The Minnesota River provides transportation for millions of tons of material, which is critical for various types of commerce.
- The transportation has created the need for a nine-foot navigation channel. The LMRWD manages this channel and removed dredged material to be placed on another site.

# 4. The LMRWD Manages Water Resources

The LMRWD is a local, special-purpose unit of government that was established in 1960 to be a legal entity for providing local participation to the USACE to construct and maintain the nine-foot navigation channel in the Lower Minnesota River (LMRWD, Lower Minnesota River Watershed District: Our History 2022). The LMRWD is actively involved in channel maintenance and manages Lower Minnesota River lakes, streams, and other water resources in areas that extend well beyond the navigation channel (LMRWD, Lower Minnesota River Watershed District: Our History 2022).

The need to maintain the navigation channel in the Minnesota River is one of several reasons to understand **sediment transport** and deposition in the river. Considerable effort continues to be spent to understand and control erosion and transport of sediment in the watershed (MPCA 2015). That sediment often is associated with runoff of agricultural chemicals and other materials that may be detrimental to river water quality.

Interest in reducing the amount of sediment transported by the Minnesota River has resulted in many studies to identify sources and sinks of sediment that could guide efforts to mitigate those sources. The most recent of those studies, conducted during 2010 to 2014, sampled and assessed different components of the sediment transported into and through the Lower Minnesota River and some of its larger upstream tributaries (Groten, Ellison, and Hendrickson 2016). Most of the suspended sediment captured at all sample sites was finer than sand. Bedload, which is the coarser sediment carried near the stream bottom, comprised less than 1% of the total sediment load at Mile 39.4 and Mile 3.5. The reach of the Minnesota River above the LMRWD from near Mile 112 at Mankato, Minnesota, to Mile 39.4 was determined to be a major source of sediment. Between Mile 39.4 and Mile 3.5, the sediment yield decreased substantially, indicating that much of the sediment the river carries is deposited along this reach (Groten, Ellison, and Hendrickson 2016).

Because the Lower Minnesota River is an important resource, and there is a desire to document components of stormwater runoff and other materials it may contain, many agencies and organizations have sampled it to better understand the resource. These efforts are often intended to document trends and find opportunities to improve the resource. The following table lists, in downstream order, many of the sites that government agencies with an interest in the river have been or are sampling.

This list does not specifically include the many focused studies that other agencies and nongovernmental organizations that also have an interest in the river have been and are conducting. It is likely that sampling sites for these other studies will be co-located near one of these established sites because they are at convenient access points and may have existing information that supports the data being collected. Samples that have been collected from Minnesota River sites may include more than a thousand physical, chemical, organic, and biological measurements made from various media, including water, suspended sediment, riverbed material, and plant or animal tissues that are associated with the river.

**Sampling Sites along the Lower Minnesota River**

| Site Name | River Mile | Sampling Organization |
|---|---|---|
| Minnesota River near Jordan, MN | 39.4 | MCES, USGS |
| Minnesota River near Chaska, MN | 30.5 | USGS |
| Minnesota River upstream of CSAH 101 in Shakopee, MN | 25.3 | MPCA |
| Minnesota River at CSAH 101 in Shakopee, MN | 25.2 | MPCA, USGS |
| Minnesota River at Shakopee, MN | 25.1 | MCES, MnDNR |
| Minnesota River at River MI 21, 0.5 mi of MN-101 in Shakopee, MN | 21.0 | MPCA |
| Minnesota River at Bloomington Ferry Bridge (US 169), MN | 17.5 | MPCA |
| Minnesota River at River MI 15, .5 MI N OF MN-101 in Bloomington, MN | 15.0 | MPCA |
| Minnesota River at Savage, MN | 14.3 | MCES, MnDNR |
| Minnesota River at Vernon Ave in Savage, MN | 14.0 | USGS |
| Minnesota River at Burnsville, MN | 10.5 | MPCA, USGS |
| Minnesota River at Black Dog Lake, MN | 8.5 | MCES |
| Minnesota River at MN-77 Bridge in Bloomington, MN | 7.0 | MPCA, USGS |
| Minnesota River at Fort Snelling State Park, MN | 3.5 | MCES, USGS |
| Minnesota R. downstream of MN-55 Bridge in Mendota Heights, MN | 1.5 | MPCA |

[MCES, Metropolitan Council Environmental Services; MnDNR, Minnesota Department of Natural Resources; MPCA, Minnesota Pollution Control Agency; USGS, US Geological Survey]

The Minnesota Pollution Control Agency (MPCA) is associated with the greatest number of sampling sites, which are often operated for short-duration (months-to-years) studies upstream and downstream of sites or outflows where a particular water quality concern is being addressed. Other organizations typically collect samples over long time periods to establish conditions from which to document changes or trends in water quantity and quality.

The US Geological Survey (USGS) has been measuring streamflow since October 1934 from the Minnesota River near Jordan, Minnesota, at Mile 39.4. Because it is the most downstream station, it can provide an accurate record of streamflow draining the watershed and supplying water to the Mississippi River. When the site was established, engineers recognized that flooding on the Mississippi River could back Minnesota River water all the way up to Carver Rapids, which is a few miles downstream of the Mile 39.4 site. This backwater effect biases the calculation of streamflow data, and the Mile 39.4 site avoids this backwater effect. Streamflow at the mouth of the river is so important to water managers that it is calculated using the flow at Mile 39.4, accounting for the travel-time of the water and adding the flow from tributary streams and other inflows in the intervening stream reach. Those calculated estimates of flow near the mouth were not considered sufficiently accurate to publish.

The need to accurately know the flow near the mouth of the river seemed to be addressed by new technology that could accurately measure water flow no matter what backwater conditions were encountered. That additional site, located at Mile 3.5 at Fort Snelling, was operated from October 2004 through September 2017, with irregular operation until 2019. Operating both upstream and downstream sites on the lower Minnesota River provided a clearer picture of the streamflow gains and losses that accumulated from tributaries, other inflows, and appropriations of the river water.

The valuable equipment used to measure streamflow at Mile 3.5 was exposed to a variety of hazards including flooding, barge traffic, and large debris that took their toll on the equipment and the associated infrastructure. The gage was discontinued after 2019 because of equipment problems and operational costs that could not be justified. However, a new, safer location is being assessed, and funding is being pursued that may result in a replacement gage near the mouth (Fallon 2022).

The Metropolitan Council Environmental Services (MCES) operates water quality monitors at the Mile 39.4 and Mile 3.5 sites to measure and record water temperature, specific conductance, pH, and dissolved oxygen concentration. The USGS operated similar equipment on behalf of the MCES before the MCES was able to take over the data collection. There are many cases where sampling performed by one organization was discontinued and that sampling was picked up by a different organization, although sampling may have been conducted for different reasons.

## Key Terms

- **Sediment Transport:** The movement of sediment along the river through natural flow. As sediment enters the river from various points (bluffs, landscape), it will be moved to a location downstream.
- **Erosion:** A natural occurrence where soil, rock, or dissolved material moves from one location to another.
- **Water Sampling:** A test to understand chemicals and pollutants in a waterbody.
- **Water Flow:** The volume of water moving past a particular point at a given time.

### Key Takeaways

- The LMRWD is responsible for managing the Lower Minnesota River. This involves many partnerships across governmental jurisdictions. Throughout the history of its governance, the LMRWD has worked to expand partnerships; most recently, exploring the development of a Minnesota River Basin Commission.
- While the LMRWD works to effectively manage the Lower Minnesota River and nine-foot navigation channel, challenges persist, including the fact that the watershed district boundary does not conform to an actual watershed.
- Through research like water sampling, the LMRWD does have a good understanding of where most of the non-natural sediment is entering the Minnesota River.
- Sediment carried through the river is closely related to the flow of the water.

## 5. Fishing the Minnesota River

One of the most relevant aspects of the Lower Minnesota River is the fisheries. People often relate to the fishability of streams, and the presence of a healthy fish population suggests a healthy river. The following table lists in downstream order the **index of biological integrity (IBI)** scores that resulted from fisheries surveys at selected sites conducted since 2010 along the Minnesota River by the MnDNR (MnDNR 2021). The MnDNR and other organizations use the IBI as a tool to provide an accurate measure of the condition of the biological communities (MPCA 2022a). Although many sites along the entire river from near the headwaters to near the mouth are sampled, only the most downstream sites, starting near Mankato at Mile 112, are included in the table. The last three sites are within the LMRWD, and the three upstream sites are included for comparison. No IBI assessments were conducted during 2020 because of the COVID-19 pandemic. Low water conditions during 2021 prevented completion of the sampling at some sites, so those results were not reported.

**Fish IBI Scores for Selected Sites on the Minnesota River Sampled 2010–2021 (MnDNR, Minnesota River IBI River Survey Report 2021).**

| | Year | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Location** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021*** | **Mean** |
| **Mile 112** | 66 | 73 | 66 | 56 | 67 | 68 | 58 | 58 | 68 | 75 | - | 82 | 67 |
| **Mile 100** | 70 | 63 | - | 72 | 73 | 64 | 65 | 59 | 68 | 73 | - | - | 67 |
| **Mile 75** | 67 | 59 | 61 | 63 | 73 | 66 | 60 | 69 | 76 | 61 | - | 73 | 66 |
| **Mile 36** | 57 | 40 | - | 54 | 60 | 55 | - | 57 | 58 | 66 | - | - | 56 |
| **Mile 26** | 80 | 65 | 72 | 39 | 73 | 75 | 68 | 65 | 68 | 73 | - | 70 | 68 |
| **Mile 10** | 69 | 69 | 76 | 66 | 76 | 68 | 72 | 71 | 78 | 83 | - | 77 | 73 |

*2021 sampling was affected by low water conditions.

All sites evaluated during 2021 had fish IBI scores that indicated good biological condition. The historical mean fish IBI score for the Minnesota River has exceeded this level since annual IBI assessments were implemented in 2010. Results from the 2021 IBI assessment should be interpreted carefully since many of the sites were not assessed, and low water levels during most of July through September created abnormal river conditions during electrofishing assessments (MnDNR 2021).

The following table lists the species that were captured during the 2021 fisheries surveys at the most downstream sites on the Minnesota River. The sampling results for the Carver site were not reported because the water was too low for the equipment and method used to provide reliable data.

**Species Collected during 2021 Minnesota River IBI Assessment.**

| Species | Shakopee Total Catch | I-35 Total Catch |
|---|---|---|
| Bluegill | 1 | 10 |
| Brook Silverside | 2 | - |
| Bullhead Minnow | 4 | 8 |
| Burbot | 1 | - |
| Channel Catfish | 2 | - |
| Common Carp | 9 | 15 |
| Emerald Shiner | 736 | 468 |
| Fathead Minnow | - | 1 |
| Flathead Catfish | 1 | 5 |
| Freshwater Drum | 2 | 13 |
| Gizzard Shad | 11 | 21 |
| Green Sunfish | - | 2 |
| Largemouth Bass | - | 2 |
| Mimic Shiner | 2 | 1 |
| Sauger | 1 | 1 |
| Shorthead Redhorse | 1 | 3 |
| Shortnose Gar | 3 | - |
| Smallmouth Bass | - | 2 |
| Smallmouth Buffalo | 2 | 1 |
| Spotfin Shiner | 17 | 16 |
| Spottail Shiner | 1 | 3 |
| Walleye | - | 2 |
| White Bass | - | 1 |
| White Sucker | 2 | 1 |
| Yellow Perch | 1 | 1 |

## Key Terms

- **Fisheries: A** fishing ground where fish are caught.
- **Index of Biological Integrity:** A tool or metric used to identify the effect water pollution may have on ecosystems, such as fish life.
- **Electrofishing Assessment:** A method used by biologists to collect fish by using an electric field to temporarily stun fish to find key data.

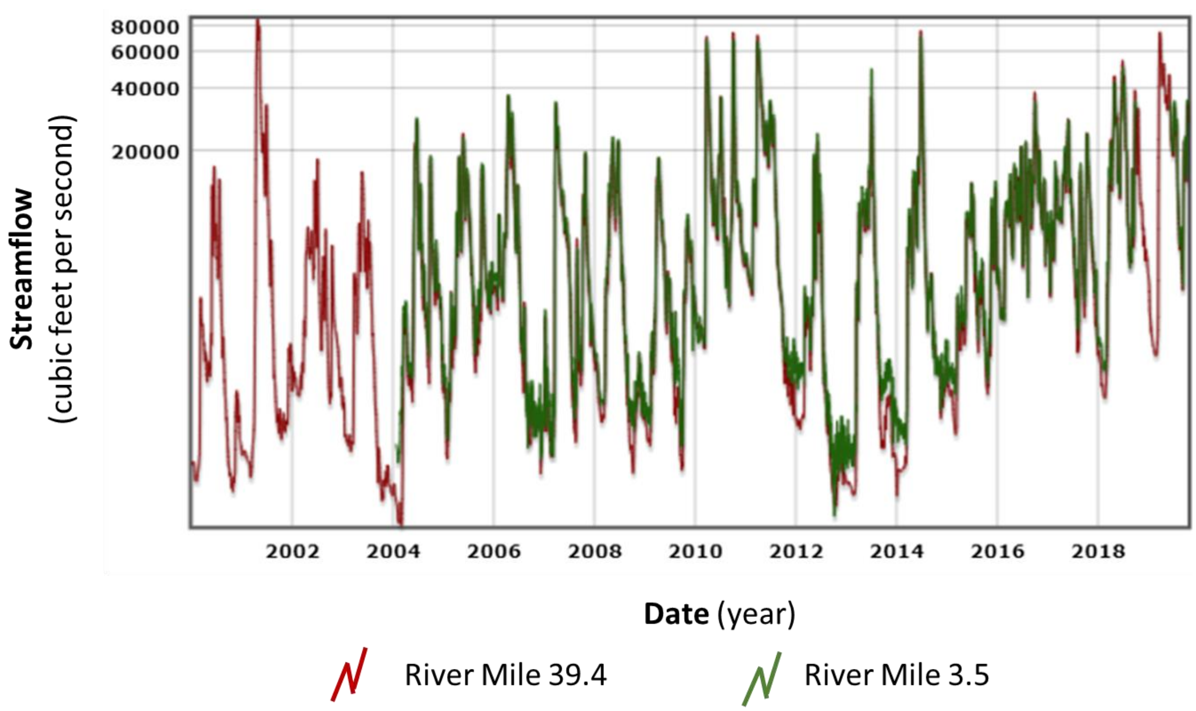
## Key Takeaways

- The Minnesota River is home to a healthy fish population, which shows promising signs of the river's overall health.

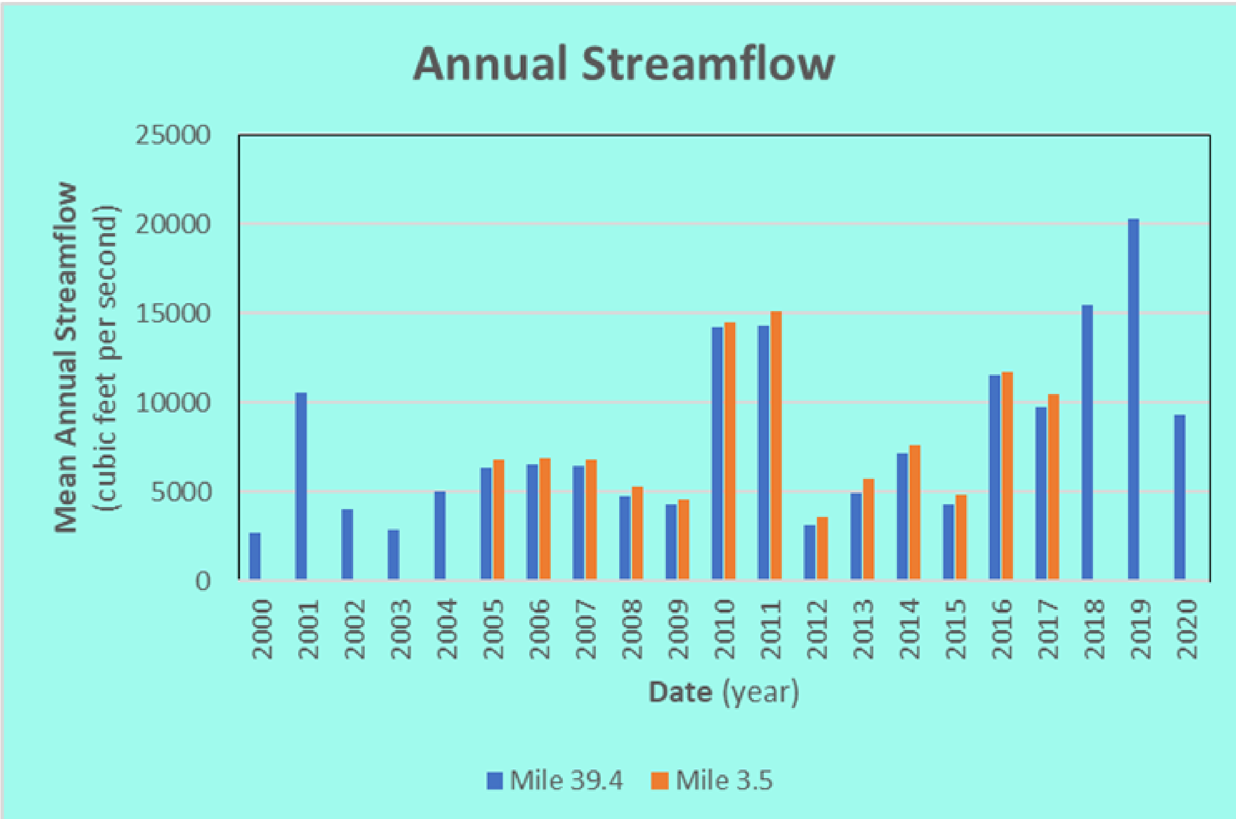
## 6. Flooding and Streamflow

The USGS has measured the **streamflow** of the Minnesota River site near Jordan, Minnesota, (Mile 39.4) since October 1934. During that time, the average annual streamflow was 5,290 cubic feet per second (cfs), which is 150 cubic meter per second (cms). The daily mean streamflow has ranged from 85 cfs (2.4 cms) in 1940 to 112,000 cfs (3170 cms) in the record-breaking floods of 1965 (MNDNR 2019). The almost annual flooding of the Lower Minnesota River bottomlands during snowmelt runoff refreshes the backwater lakes and wetlands and reworks the backwater sediments and river channel streambanks. The flooding river may cut new channels through its floodplain. The frequent flooding prevents anything more than seasonal or temporary uses unless structures can tolerate inundation and river currents.

The USGS measured streamflow of the Minnesota River at Fort Snelling (Mile 3.5) from 2004 to 2019. Data from sites near the upstream and downstream ends of the Lower Minnesota River provide the opportunity to assess the amount of water that is gained by or lost from the river as it flows through the LMRWD. The graphic provided from the USGS National Water Information System Web Interface shows streamflow from the two sites during 2000 to 2019. It is difficult to distinguish streamflow differences between the two sites because they are hidden by the variability, and the traces of the data often overlie one another.



The following graph shows the mean annual streamflow determined for the upstream and downstream Minnesota River sites during 2000 to 2020. The Mile 3.5 streamflow monitoring was operational from 2004 to 2019 as discussed previously. During that time the streamflow at Mile 3.5 averaged 485 cfs more than was measured at Mile 39.4. That is about an 8% difference, showing a net gain from tributary inflows, groundwater discharge, and water from other sources along the river.




## Key Terms

- **Streamflow:** The flow of water in a stream or river.

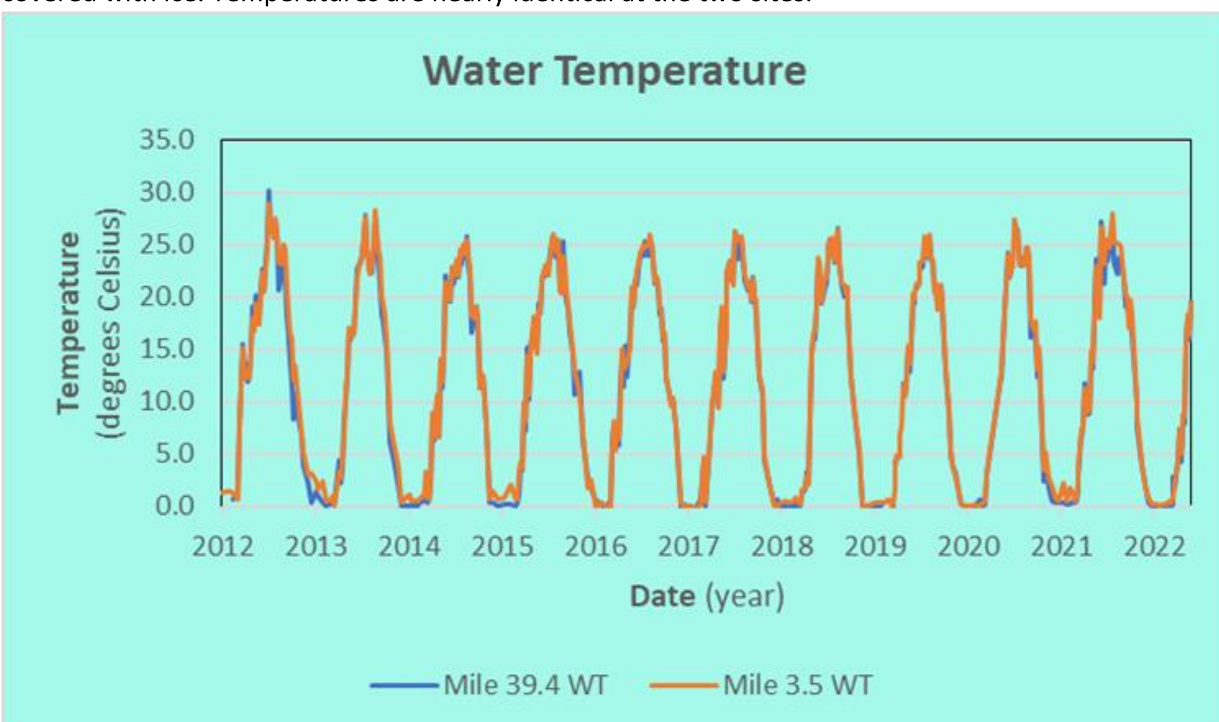
## Key Takeaways

- There is a wide range of historical streamflow information for the Minnesota River, dating back to 1934.
- Over the last 20 years, streamflow has increased, which could be creating more erosion and sediment transport within the river.

## 7. Water Quality Trends

The following graphs display selected water quality data collected during the past decade near Jordan, Minnesota, at Mile 39.4, the most upstream; and Fort Snelling at Mile 3.5, the most downstream routinely monitored sites on the Lower Minnesota River. Located near the upstream and downstream ends of the Lower Minnesota River, these sites can provide some indication about changes in the quality of the river along this 36-mile reach. There are many inflows along the river that have the potential to affect the river quality. The data portrayed are those the MCES[i] collected, although many agencies have collected large amounts of data. Both sites are typically sampled on the same day, so the downstream results do not show the same water that was sampled upstream because it can take days for the water from the uppermost sampling site to reach the downstream site. The time for water to travel from the upstream to the downstream sampling site varies based on the velocity that is proportional to the streamflow.

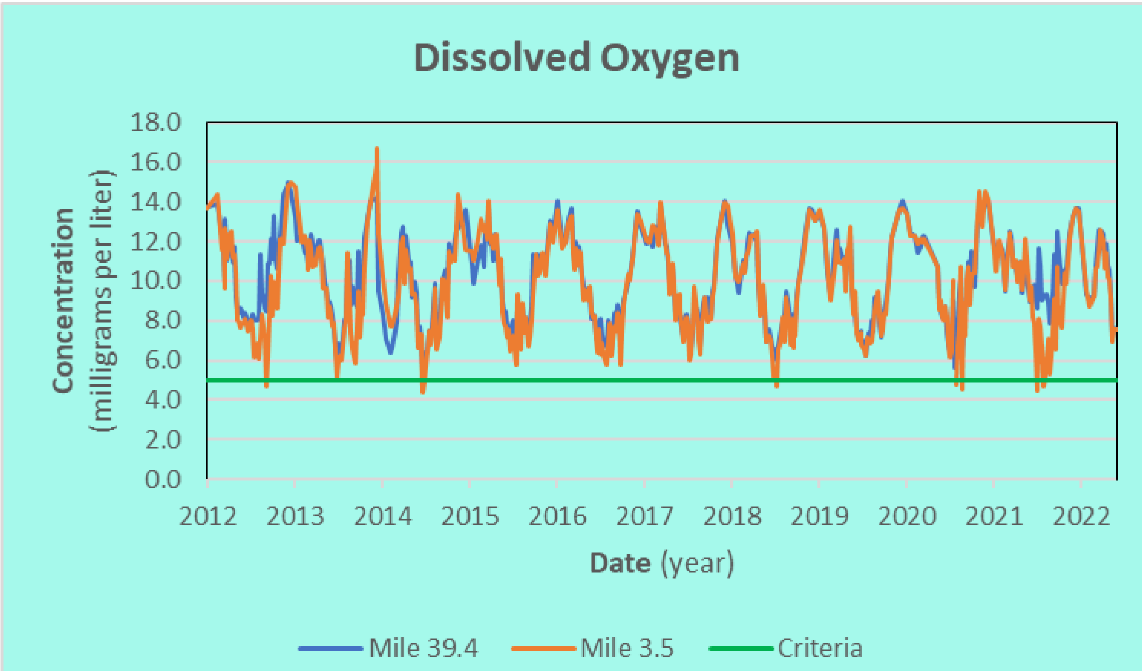
The **water temperature** of the Lower Minnesota River is important for habitat because warm water holds less of the dissolved oxygen that aquatic organisms need. Minnesota standards for aquatic life and recreation state that temperature should not exceed 5°F (2.8°C) above natural in streams, based on monthly average of the maximum daily temperatures, except in no case shall it exceed the daily average temperature of 86°F (30°C; Statutes 2021). Temperatures at the sampling sites fluctuate seasonally, often exceeding 77°F (25°C) in the summer and near 32°F (0°C) in the winter when the river is often covered with ice. Temperatures are nearly identical at the two sites.




### Key Terms

- **Water Quality:** Describes the general condition of the water, including chemical and biological characteristics as they relate to the water's intended uses.

Measurements of **dissolved oxygen (DO)** concentration show that the Lower Minnesota River is usually well oxygenated. Aquatic animals typically need at least 5 milligrams per liter (mg/L) of DO to thrive (MnDNR, 2021). Seasonal fluctuations are normal as the solubility of oxygen changes with the water's temperature. The DO at Mile 3.5 occasionally drops below the 5 mg/L criteria. Reduced DO at Mile 3.5 could result from depletion by respiring organisms using the available oxygen, oxygen-demanding materials in the water, reduced aquatic-plant photosynthesis, poor mixing with oxygen in the atmosphere, or a combination of these factors.



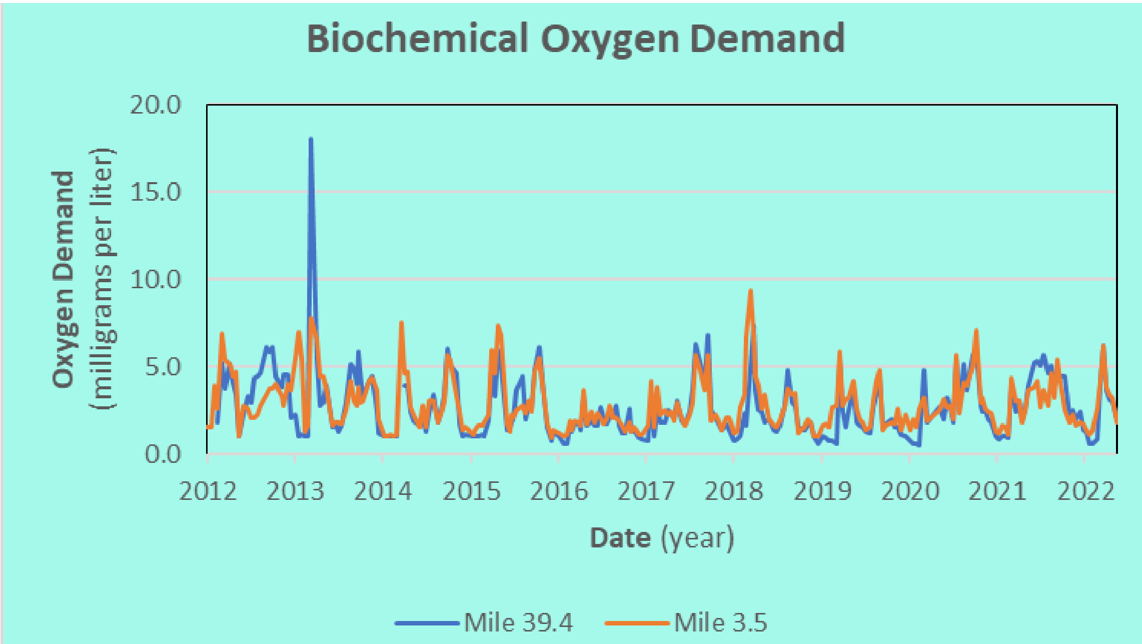

## Key Terms

- **Dissolved Oxygen:** A measure of the oxygen in water that provides oxygen to living organisms, such as fish and plants.
- **Aquatic Organisms:** An animal or plant that lives underwater.

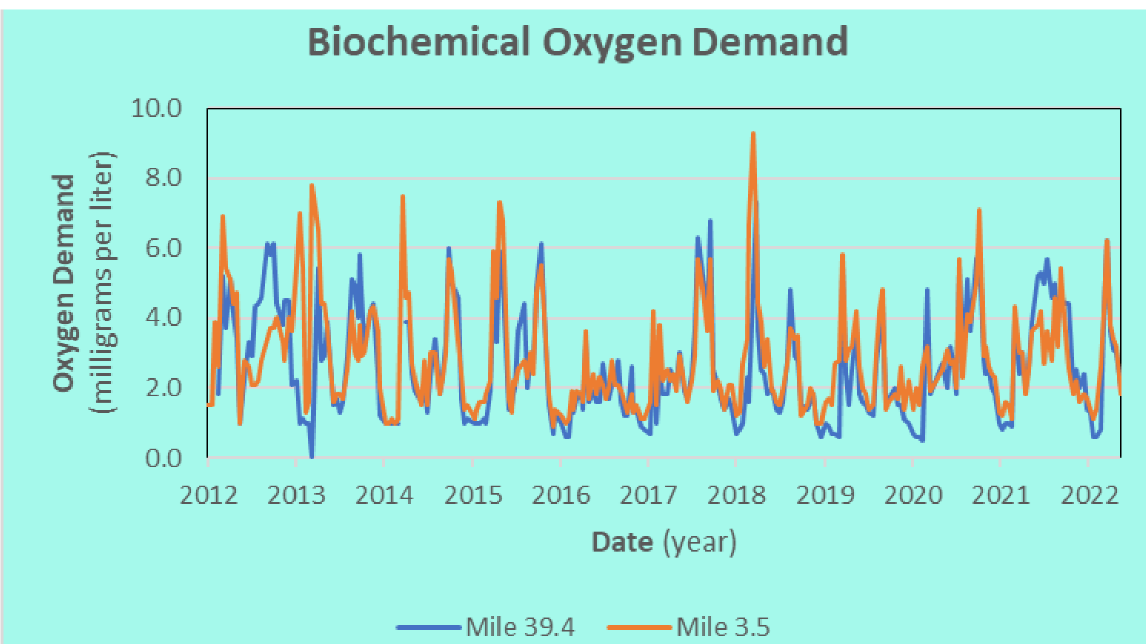
## Key Takeaways

- The Minnesota River typically has the oxygen fish and other aquatic species need to survive.

Breathing organisms and other materials in the Lower Minnesota River water could use some of the available DO, resulting in the declines observed in the dissolved oxygen graph. The following graph shows the **biochemical oxygen demand (BOD)** measured in samples collected from the river. Although the BOD is variable, the concentrations do not appear substantially different at the two sites. The mean BOD of 2.65 mg/L at Mile 39.4 is not substantially different from the 2.82 mg/L at Mile 3.5.




The exceptionally high 18 mg/L BOD measured at Mile 39.4 in 2013 was removed to show more detail in the following graph. It shows that the BOD variability still overwhelms differences that might be expected between the two sites.

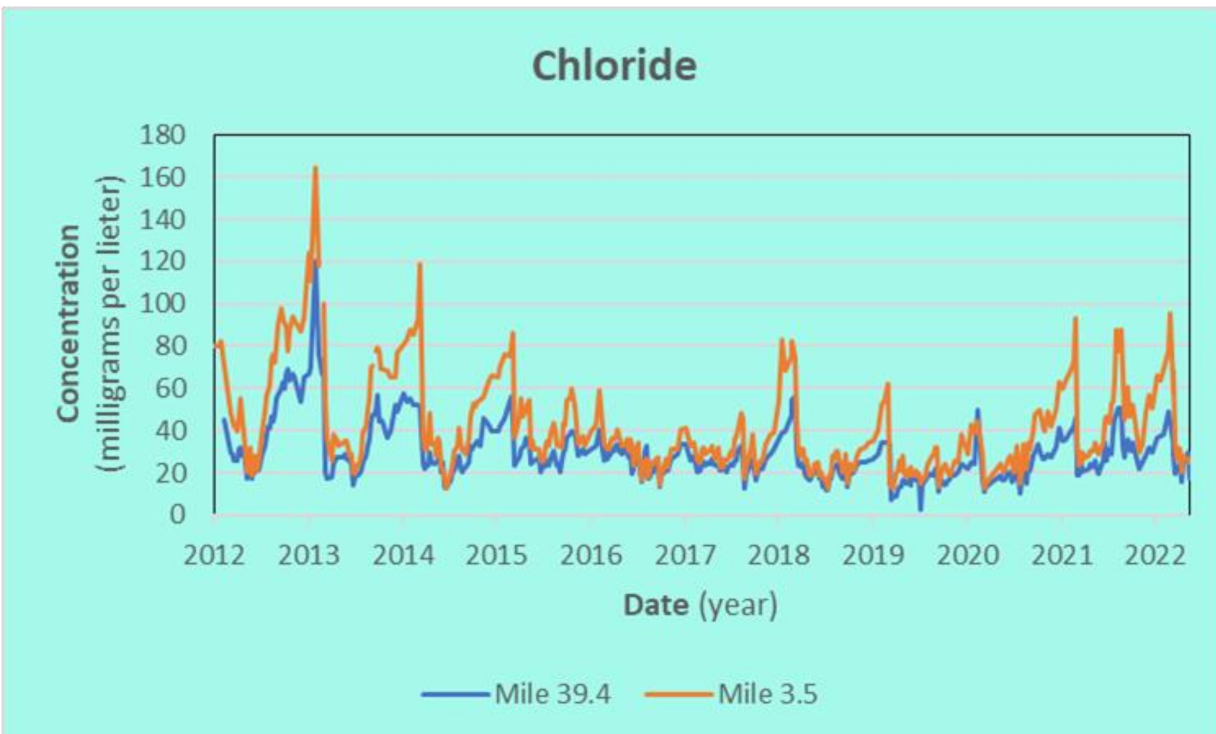


## Key Terms

- **Biochemical Oxygen Demand:** The amount of dissolved oxygen needed for microorganisms to decompose the organic matter in the water.

**Chloride**, a primary component of road deicing and water-softening salt, represents a growing concern for many streams and lakes. The chronic standard for chloride in Minnesota waters to protect cool and warm water fisheries is 230 mg/L (MPCA 2018).

The following graph shows the Lower Minnesota River chloride concentrations at the upstream and downstream sampling sites during the past 10 years. Concentrations at both sites remained well below the 230 mg/L chronic standard. However, concentrations typically are higher downstream than upstream. The average chloride concentration at Mile 3.5 is about 40 mg/L, whereas the average concentration upstream at Mile 39.4 is 29 mg/L. This suggests that the river water quality is influenced by the urbanization downstream of Mile 39.4.



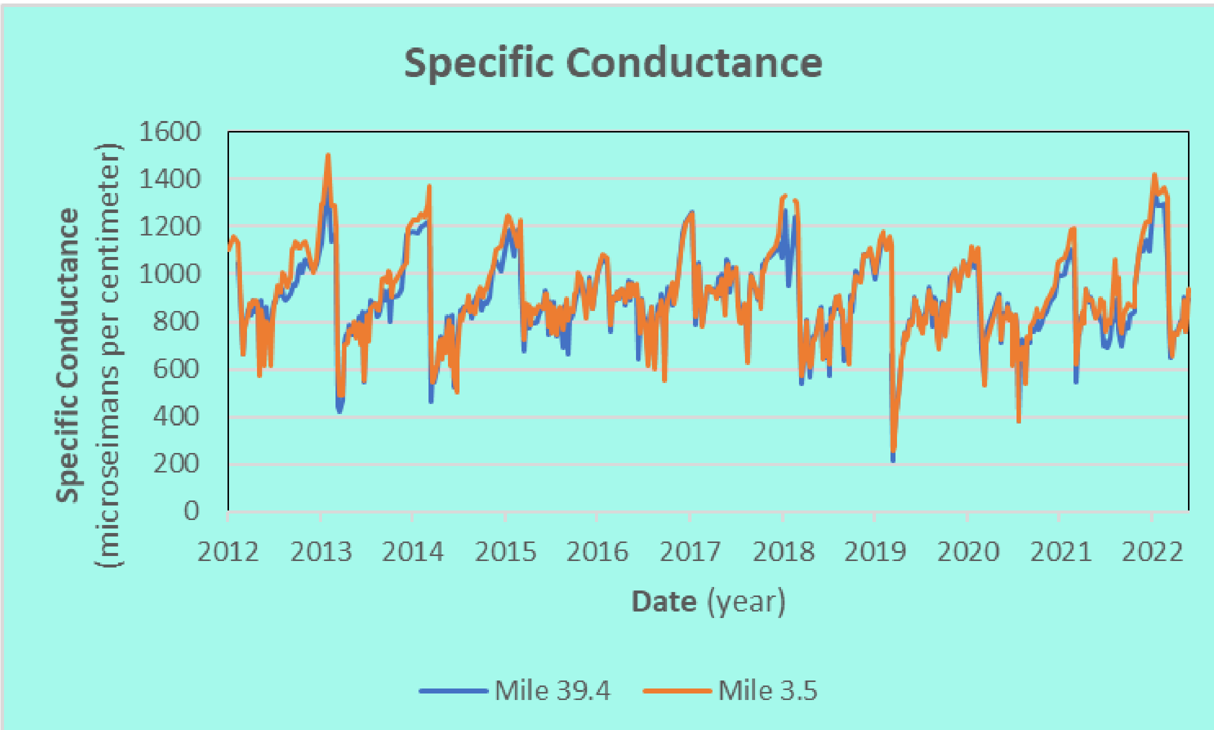

## Key Terms

- **Chloride:** A compound of chlorine with another element or group, often found as salt or hydrochloric acid.

## Key Takeaways

- Chloride concentrations are within the standards, but they are still monitored given the growing concerns surrounding chloride. Levels are higher in the downstream portion of the river.

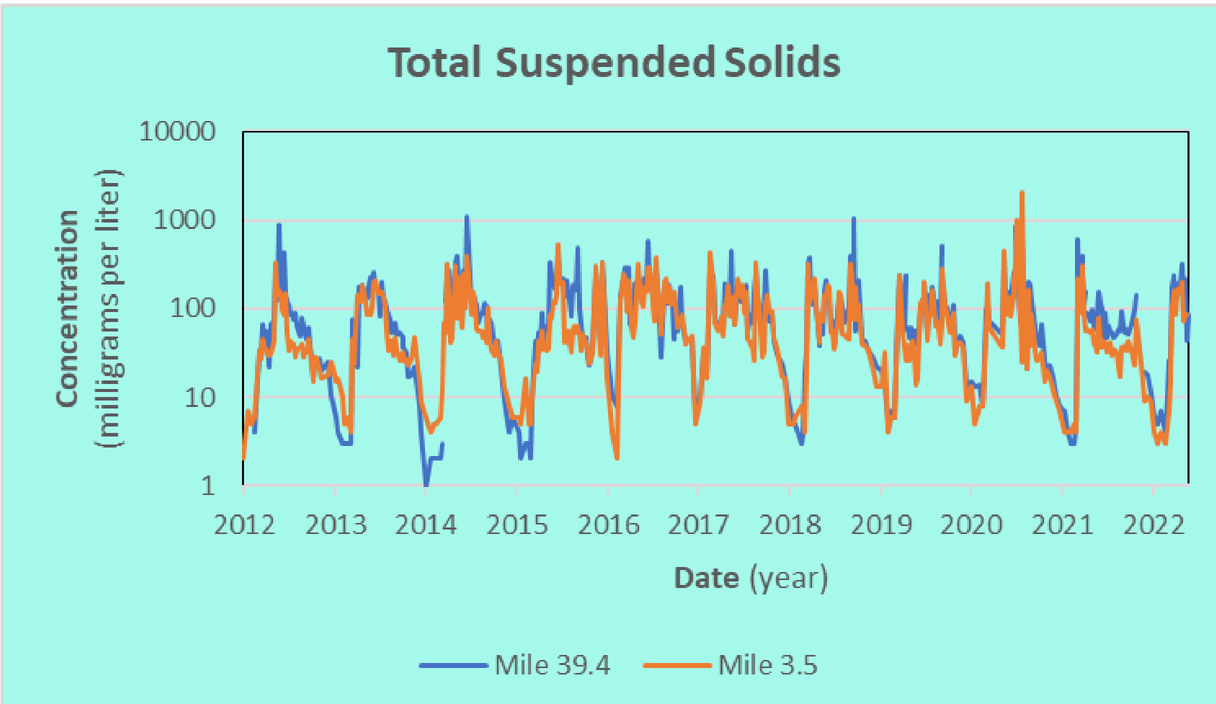
**Specific conductance (SC)** is a measure of the ability of water to conduct electricity and is related to the quantity of ions dissolved in the water. Because these ions typically originate from dissolved salts, SC is sometimes used as a surrogate for the concentration of chloride ions, but that can be misleading. The SC indirectly measures the electrical activity of many ions dissolved in the water, not just chloride. Rain and other forms of precipitation have low SC, whereas water that has been in contact with various minerals, as would occur in the ground or on man-made surfaces, has higher SC. This may be used to suggest the source of the water measured. The SC at the two sites on the Lower Minnesota River track closely without notable differences. Seasonal variations in the SC are evident at both sites showing low SC in the spring that probably is from snowmelt runoff with increasing SC after that runoff passes and water that has been dissolving minerals prevails.




## Key Terms

- **Specific Conductance:** a measure of water's ability to conduct electricity, related to the amount of ions dissolved in water.

**Total suspended solids (TSS)** is a measure of the particulate material that streams carry. TSS is an indirect measure of material that causes water to appear turbid or cloudy. Turbidity, TSS, and suspended sediment concentrations often are considered equivalent measurements but have distinct differences making them incomparable. There are also many ways to measure turbidity. High TSS in a stream indicates cloudy water that carries greater amounts of fine sediment, which interferes with visibility. Low TSS implies that the stream carries less sediment. Sediment typically originates from erosion and runoff of exposed soils and erosion of streambanks. It also is used to suggest the amount of material that can accumulate in downstream areas. The levels of TSS at the two Lower Minnesota River sites appear to track closely with each other and vary seasonally at both sites.




## Key Terms

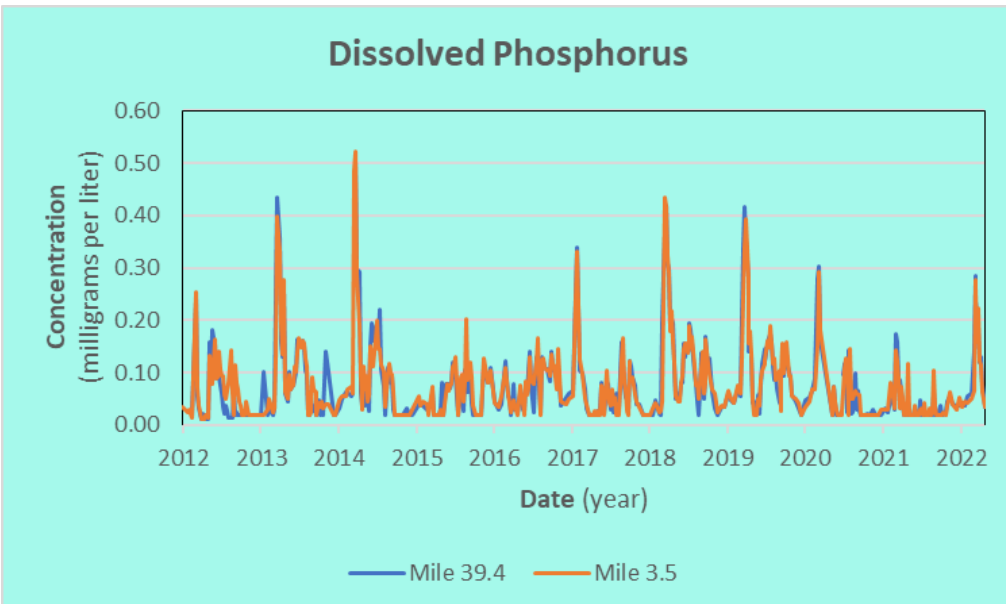
- **Total Suspended Solids:** suspended particles, such as sediment, that are large enough to be trapped in a filter but are not dissolved in water.

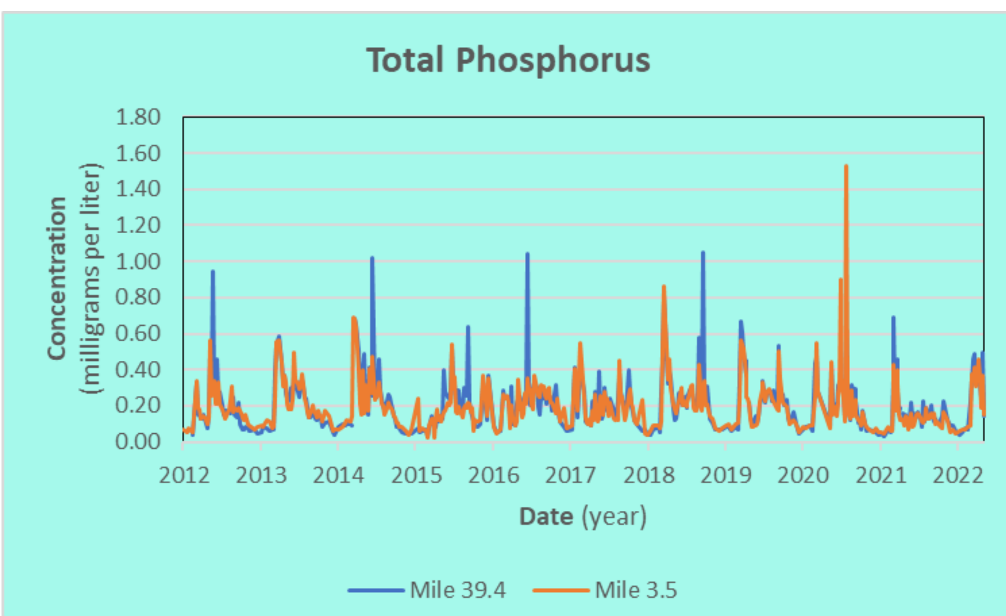
## Key Takeaways

- The amount of sediment in the Minnesota River continues to be a challenge, which is studied and managed by water organizations like the LMRWD.

**Phosphorus** is an essential plant nutrient that streams carry. Naturally occurring phosphorus concentrations may be enriched from animal waste and fertilizers, and it is often introduced with runoff. Phosphorus is often associated with sediment but is more available to plants when it is dissolved in the water. The following graphs show the concentrations of phosphorus in samples from Mile 39.4 and Mile 3.5 on the Lower Minnesota River.

The first graph shows the total amount of phosphorus in the water, including the part associated with suspended sediment and other particulate matter. The second graph shows the phosphorus remaining in the water after the sample has been filtered to remove the sediment-associated phosphorus. Concentrations of both total and dissolved phosphorus track closely at the two sites, with the exception of occasional peak concentrations of total phosphorus. In comparing the total and dissolved concentrations, it is also evident that much of the phosphorus the river carries is associated with suspended materials that are removed when the samples are filtered.



## Key Terms

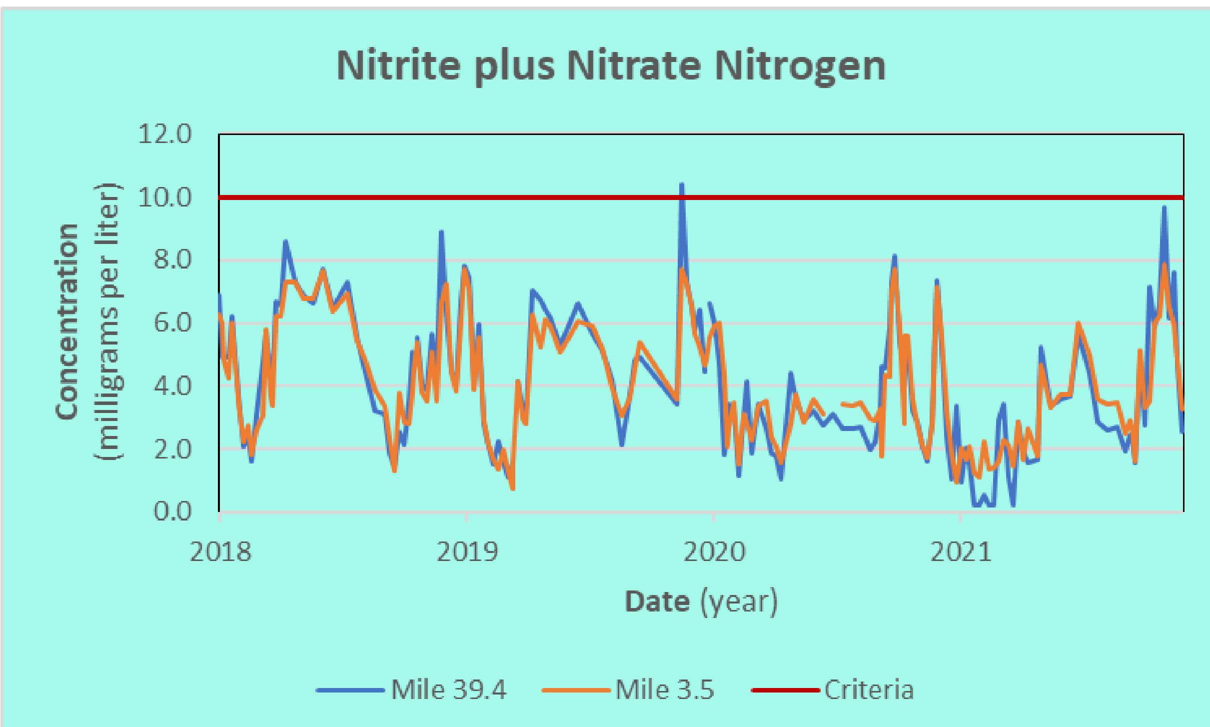
- **Phosphorus:** a chemical element of the nitrogen family, often associated with sediment.

## Key Takeaways

- Phosphorus is a naturally occurring plant nutrient often found in streams and rivers, but levels observed in the Minnesota River indicate that additional phosphorus is being added to the water through human activities such as using fertilizer or not properly cleaning up animal waste.

**Nitrogen** occurs naturally in various forms in streams but may become enriched from fertilizers, wastewater inputs, and runoff. The various forms of nitrogen are routinely measured in stream samples collected by the MCES and are shown in the following graphs.

**Nitrite plus nitrate nitrogen,** which is almost entirely nitrate in natural waters, is often associated with agricultural runoff. Nitrate is considered a threat to human health when concentrations in drinking water exceed a 10 mg/L threshold (Statutes 2021). Although drinking untreated water from the Lower Minnesota River is not recommended, removing nitrate through treatment is difficult and expensive. Nitrate nitrogen is a plant nutrient, which is good for field crops but not good for water, where it supports nuisance plant growth.



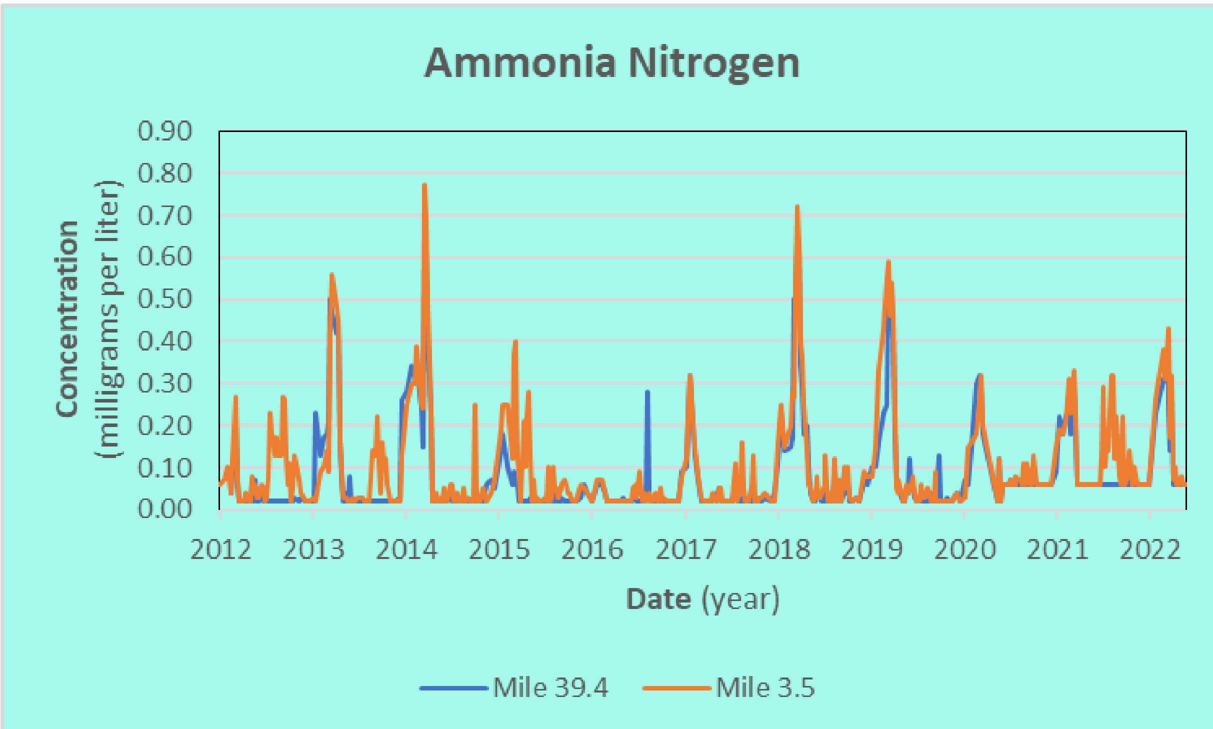

## Key Terms

- **Nitrogen:** a chemical element of the nitrogen family, a key nutrient element for plants.

## Key Takeaways

- Similar to phosphorus, nitrogen is a naturally occurring element, but is found in water in unnatural levels, often when water is washed from land that uses fertilizers or other chemicals.

**Ammonia nitrogen** concentrations often are a concern in rivers that are affected by agricultural runoff and wastewater inputs. Adding oxygen to water helps remove ammonia, but slow-moving rivers like the Lower Minnesota have limited ability to absorb oxygen from the atmosphere. The following graph displays the ammonium ion concentration at Mile 39.4 and Mile 3.5. The minimum values are limited by the ability of the analytical method to quantify the ammonium ion below a concentration of 0.02 mg/L and 0.05 mg/L in recent years. Because the concentration at each of the sites track so closely, it is difficult to distinguish much difference between the two sampling sites. The average ammonia concentration at Mile 3.5 was 0.10 mg/L compared to 0.08 mg/L at Mile 39.4; however, these averages are biased because values below 0.02 or 0.05 mg/L are not provided. The concentration of free, unionized ammonia, which may be toxic at elevated concentrations, was not calculated for this report.



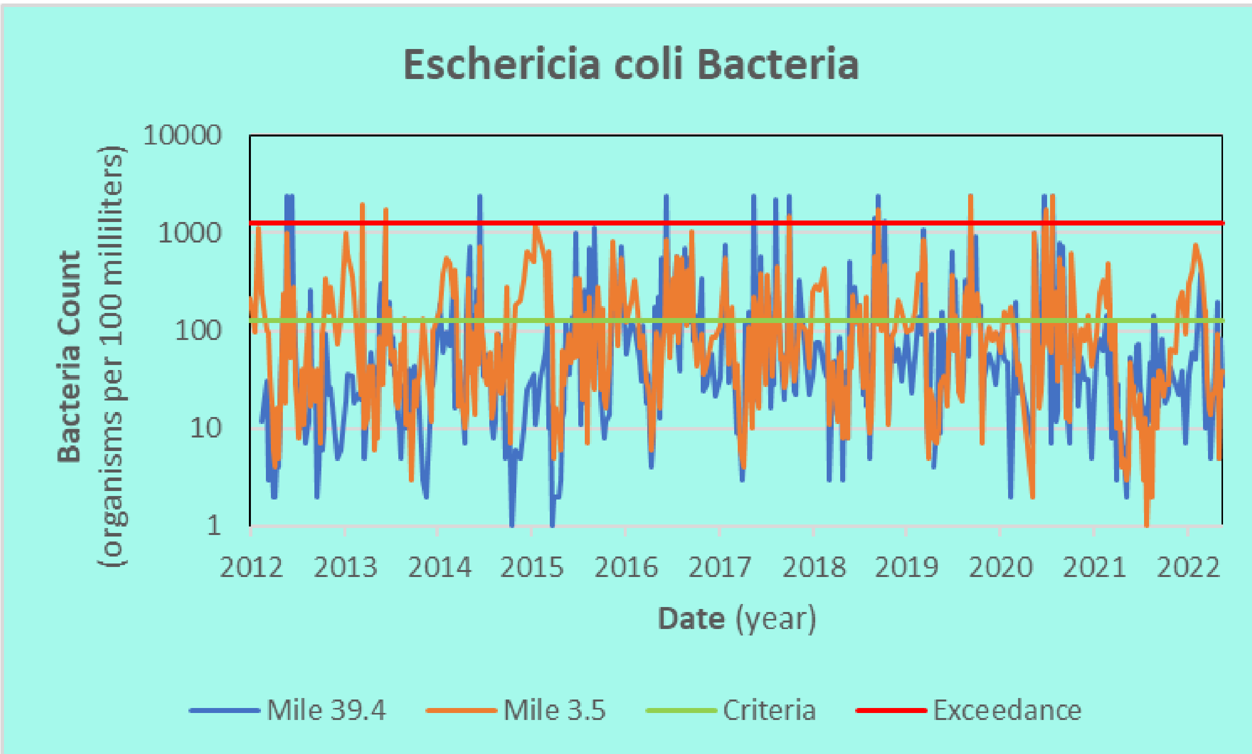

## Key Terms

- **Ammonia Nitrogen:** a measure for the amount of ammonia, a toxic pollutant often found in landfill runoff and waste product like sewage.

## Key Takeaways

- The Minnesota River is likely affected by ammonia nitrogen as a river affected by agricultural runoff and wastewater sites. The graph shows historical spikes at various points in time.

**Escherichia coli (E. coli)** is an organism used to indicate the amount of fecal contamination in lakes and streams. Swimming in or ingesting water with high levels of E. coli could result in illness. The number of E. coli bacteria counted in samples from the most upstream and downstream sites are shown in the following graph. Values are reported as less than one if no organisms were identified in the sample and greater than 2,420 if there were too many to count. The bacteria counted at both the upstream and downstream sampling sites were highly variable and do not appear to correlate between the sites; a high count at the upstream site may not result in a high count at the downstream site. Likewise, a low upstream count does not appear to show up in the downstream count. Comparing average upstream and downstream E. coli counts revealed little difference with 174 colonies per 100 milliliters (ml) at Mile 39.4 and 166 colonies per 100 ml at Mile 3.5.




## Key Terms

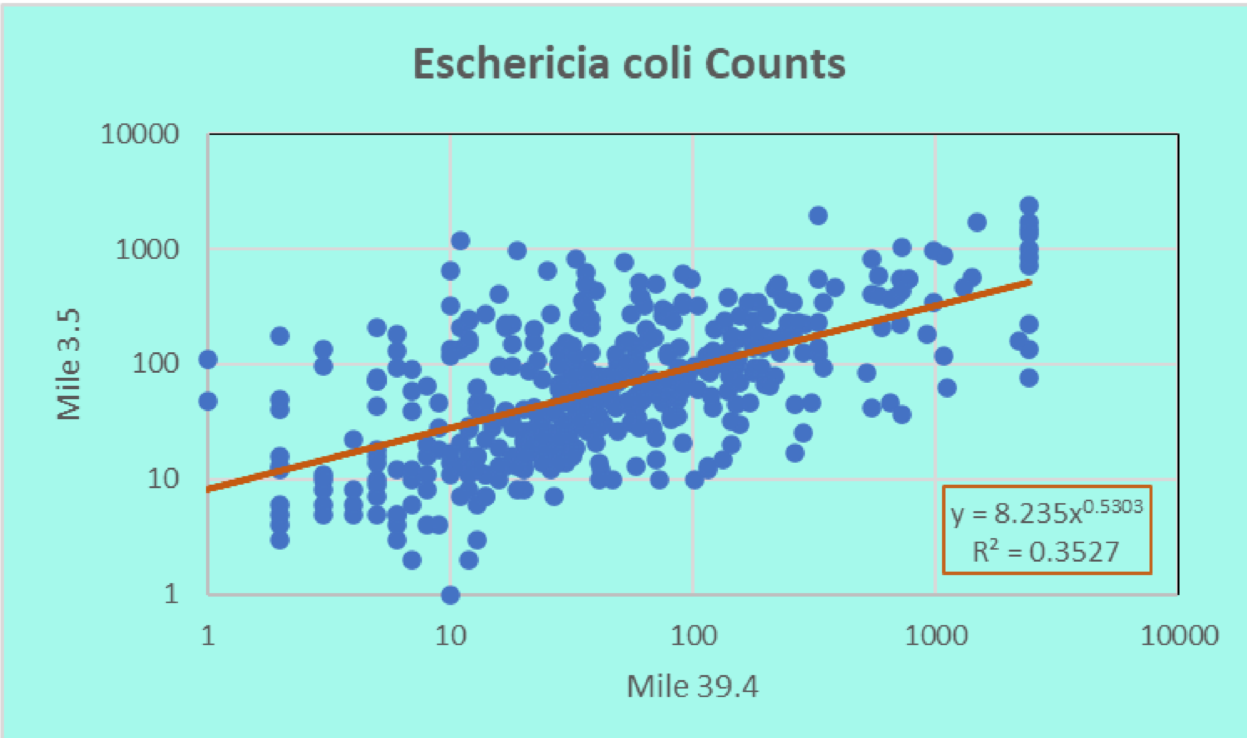
- **Escherichia coli (E. coli):** an organism used to measure the level of fecal contamination in water.

## Key Takeaways

- E.coli levels are steady between upstream and downstream portions of the river. While highly variable over time, they sometimes exceed the standard for healthy levels for swimming or ingesting water.

The bacteria counts at both sites are often high relative to the 126 organisms per 100 milliliter criteria that are shown on the graph. There are occasions at each site when levels exceed the 1,260 organisms per 100 milliliter criteria. The criterion is not an absolute number but is defined as follows: "Not to exceed 126 organisms per 100 milliliters as a geometric mean of not less than five samples representative of conditions within any calendar month, nor shall more than ten percent of all samples taken during any calendar month individually exceed 1,260 organisms per 100 milliliters. The standard applies only between April 1 and October 31" (Statutes 2021).

Bacteria counts at each of the sites are compared in the following graph. Although there appears to be some relation in this log-transformed scale, it is not strong with a coefficient of determination (R-squared) of 0.35.




Assessments of the Lower Minnesota River have shown that some sections are impaired for aquatic life because plant-nutrient concentrations and turbidity exceed state guidelines for a healthy ecosystem. Some reaches are impaired for aquatic recreation because indicators of fecal contamination exceed state guidelines. The consumption of fish or other aquatic organisms is cautioned in many areas because of elevated mercury in tissue and water and elevated polychlorinated biphenyls in tissue (MPCA 2022b).

The Minnesota River appears to meet many of the water quality goals that have been proposed and continues to be closely monitored to ensure that its quality complies with established standards. Based on the data reviewed, most measurements show that the quality of the Lower Minnesota River is similar at the upstream and downstream sampling sites. Because the river drains a watershed that is predominantly agricultural, that agricultural influence on its waters may be difficult to overcome. However, efforts to improve the quality of the river are likely to continue and appear to be achieving the intended results. Changes in the quality of the river may result from continuing urbanization and other development along the Lower Minnesota River. There also may be concerns about appropriation for domestic uses of river water and groundwater that supplies flow to the river.

Based on accounts that early European explorers provided, the Minnesota River has historically carried materials that make the water appear cloudy, so goals intended to result in a clear, pristine stream may not be practical.

## Key Terms

- **Bacteria:** Small, single-celled organisms found almost everywhere on Earth.

## Key Takeaways

- Some sections of the Lower Minnesota River are impaired for aquatic life; mercury has been found in some samples of fish from the river.
- The river meets many of its water quality goals and appears to be relatively similar between the upstream and downstream sampling sites.
- Agricultural runoff can pose a challenge to the water, but efforts to create best management practices can help protect the water.
- Historical accounts of the river show that the water appeared cloudy, so clear water is not necessarily an indicator of health.

# 8. Managing Dredge Material for Continued Commerce

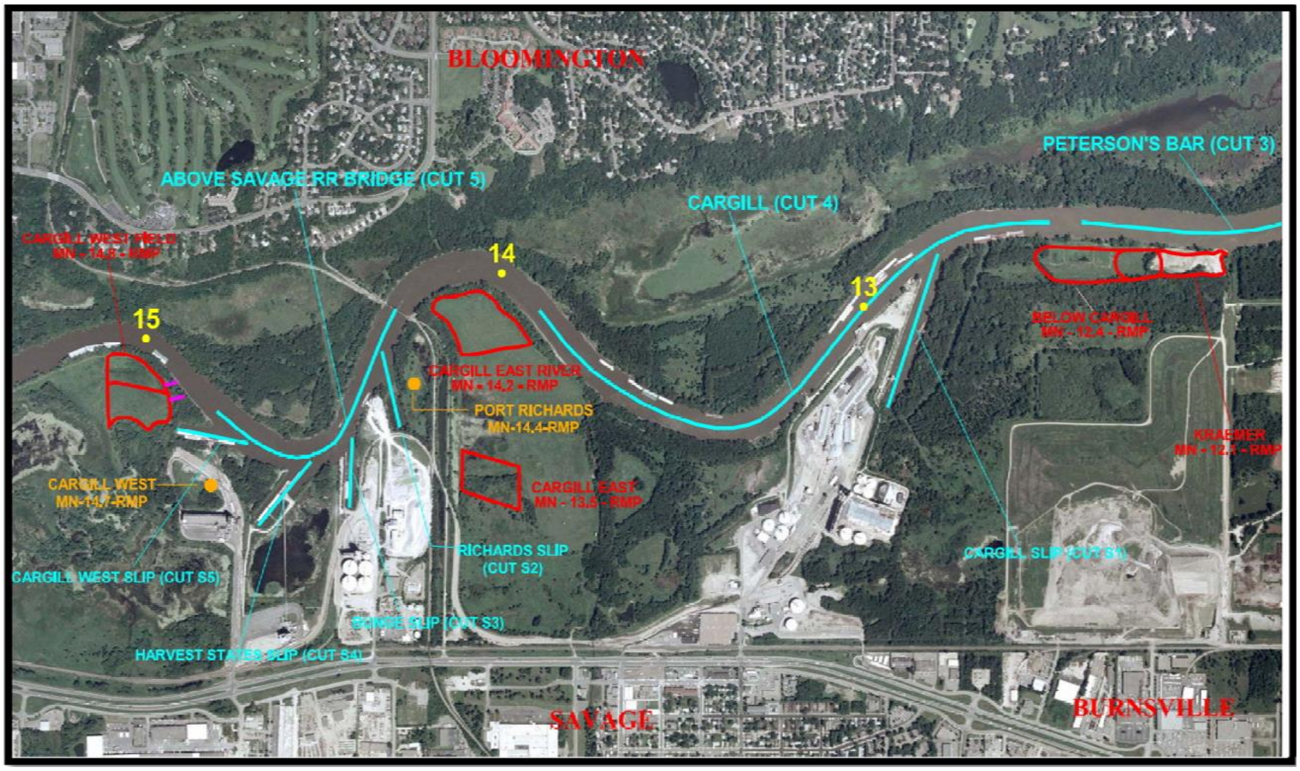
The following information is summarized from a report documenting the dispensation of material dredged from the Minnesota River (LMRWD 2013). Additional information can be found in that document.

The Minnesota River is a significant branch of the inland navigation system. Several of the world's largest grain marketing companies operate terminals on the river. These terminals serve as important nodes in the flow of grain from the Upper Midwest to domestic and foreign markets. In addition to grain, other miscellaneous commodities move through Minnesota River terminals and docks. Since 2007, the traffic level on the river has averaged over 2 million tons. The primary commodities moved on the river are farm products (wheat, corn, soybeans, oats, barley) bound for Gulf of Mexico ports. These account for approximately 64 percent of total traffic on the river. Other commodities include dry fertilizer, salt, sand and gravel, metal products, and other miscellaneous commodities.

Analysis of the cost to move grains from Midwest harvests to worldwide markets using terminals on the Minnesota River compared to other conveyances revealed cost savings of about $12 per ton. The total annual savings for moving grain using terminals on the Minnesota River are estimated at $22.2 million.

Since the 1960s, the LMRWD has been and continues to be the state's local sponsor to work with the USACE to maintain the nine-foot channel. The USACE developed a Dredge Material Management Plan (DMMP) in 2007 for the Minnesota River above the Interstate 35W Bridge to address concerns that surfaced in 1988 (USACE 2007). Concerns ranged from capacity at dredge material placement sites to complaints by industrial users about the condition of the channel. The DMMP identified 11 potential placement sites. Only the following six sites were determined to be practical and cost-effective locations that were selected for detailed evaluation: Cargill West Field Site (River Mile [Mile] 14.8); Cargill East River (Mile 14.2); Cargill East (Mile 13.5); Below Cargill (Mile 12.4); Kraemer (Mile 12.1); and NSP (Mile 10.1). After alternative formulation and detailed analysis and evaluation of sites individually and in combination with others, the Cargill East River (Mile 14.2) site and the Kraemer (Mile 12.1) site were the USACE's recommended alternative. The LMRWD acquired the Cargill East River (Mile 14.2) site in 2007. An ownership change resulted in higher fees to use the Kraemer (Mile 12.1) site, so the Cargill East River (Mile 14.2) site has been used exclusively for dredge material placement.

The following map shows the location of the Cargill East River (Mile 14.2) dredge material placement site and the surrounding area. Placing the materials close to their origin, dredge cuts, and the river minimizes transportation costs.



Location of the Cargill East River (Mile 14.2) dredge material placement site and the surrounding area including dredge cuts 3, 4, and 5. (Red: nearby considered dredge material placement sites, Yellow: River Mile, Blue: anticipated dredge cuts along Minnesota River).

In anticipation of handling potentially hazardous materials, samples of bottom sediments where channel dredging is expected were collected and analyzed in 1999. Analyses included particle size, concentration of selected trace elements, and physical characteristics. Results from the analyses are presented in LMRWD (2013) and are summarized here.

| Measurement | Units | Maximum |
|---|---|---|
| Arsenic | Milligrams per kilogram | 5.6 |
| Cadmium | Milligrams per kilogram | 0.69 |
| Chromium | Milligrams per kilogram | 9.5 |
| Copper | Milligrams per kilogram | 10. |
| Mercury | Milligrams per kilogram | 0.020 |
| Manganese | Milligrams per kilogram | 960 |
| Nickel | Milligrams per kilogram | 25 |
| Lead | Milligrams per kilogram | 15 |
| Zinc | Milligrams per kilogram | 46 |
| Cyanide | Milligrams per kilogram | <0.20 |
| Ammonia (elutriate) | Milligrams per liter | 0.55 |
| Total organic carbon | Percent | 0.72 |
| Total solids | Percent | 99.7 |
| Volatile solids | Percent | 2.92 |
| Particle size | Percent | Not applicable |

In general, the sediment from the main channel dredging on the Minnesota River can be characterized as predominantly sand, containing an average of 1 percent to 4 percent silt and clay, depending on the dredge cut. The potentially toxic chemicals were typically below the lower exposure limit.

Other tests have been performed on the dredged material, including assessments of the suitability of dredged material for other uses such as fill and construction materials. The material generally was found to be suitable for a variety of purposes.

As dredged material continues to add to the accumulating piles at the Cargill East River (Mile 14.2) dredge material placement site, it will be prudent to find other places where the material can be used or stored. The LMRWD report (2013) discusses some of those options in considerable detail. If other uses have not been identified, the dredged material could be hauled to nearby landfills for off-site disposal.

The long-term requirements for placement of dredged material have been estimated, but those estimates are qualified with uncertainty about the rates of sediment accumulation in the river navigation channel. Based on the adjusted dredging quantities shown in the tables provided (LMRWD 2013), approximately 21,800 cubic yards per year on average are estimated to be removed in total from dredge cuts 3 (Peterson's Bar), 4 (Cargill), and 5 (Savage Bridge) through 2025. These dredge cuts are shown on the preceding map showing the location of the Cargill East River (Mile 14.2) dredge material placement site.

The overall estimates of dredged material originating from the five dredge cuts along the Minnesota River navigation channel provided the following adjusted projections:

| Timeframe | Amount Dredged |
|---|---|
| 1976–1998 actual average | 19,547 cubic yards |
| Adjusted average per year | 24,800 cubic yards |
| 1999–2025 total | 670,000 cubic yards |

## Key Takeaways

- The Minnesota River is an important tool to transport commercial items like grain,  such as grain and other commodities to global recipients.
- Dredging of the Minnesota River occurs regularly and the management of dredged material is a major responsibility of the LMRWD.
- Dredged material is tested for toxic material, though the sediment is generally characterized as sand, silt, and clay—natural materials.
- The removal and management of dredged material is costly and cumbersome. A more proactive approach involves limiting the amount of sediment entering the Minnesota River at upstream locations, meaning less cost and effort to deal with the material at lower points of the river, and its ultimate destination: Lake Pepin.

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