
# WATER QUALITY REPORT


## Village of Bannockburn

GHA Project No. 8101.052
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*Section 1*

# Executive Summary

## PURPOSE AND BACKGROUND

This water quality test analysis was developed for the Village of Bannockburn for the purpose of demonstrating compliance with the minimum standards required by the Illinois Environmental Protection Agency (IEPA) General Storm Water Permit ILR40 for discharges from Small Municipal Separate Storm Sewer Systems (MS4s).

Test results obtained through this project were compared against the Water Quality Standards (WQS) established by the Illinois Pollution Control Board (IPCB) under Title 35 of the Illinois Administrative Code; *Standard Methods for the Examination of Water and Wastewater*, a joint publication of the American Public Health Association (APHA), American Water Works Association (AWWA), and the Water Environment Federation (WEF); or *Volunteer Stream Monitoring: A Methods Manual*, published by the United States Environmental Protection Agency, Office of Water.

Environmental Monitoring and Technologies, Inc. (EMT) collected water samples and performed lab testing for the following parameters:

- Ammonia
- Chloride
- Fluoride
- Biochemical Oxygen Demand (BOD)
- Phenolics
- Total Phosphorus
- Total Suspended Solids (TSS)
- Total Kjeldahl Nitrogen (TKN)
- Potassium
- Temperature
- pH

Six (6) sites within the Village were tested, at locations upstream and downstream of the MS4 discharge:

- Half Day_N;
- Duffy;
- Chicago_S;
- Waukegan;
- ChicagoRiv_N; and
- ChicagoRiv_NB

## SUMMARY OF RESULTS

The following tables summarize the testing results. Comprehensive data is provided in *Section 4. Results and Recommendations*, and the parameter graphs provided in *Section 5. Appendix*.

### Results by Site

All testing sites were within the acceptable range for every parameter, with the following exceptions:

| Testing Site | Parameter | Accepted Limits | Test Results | Within Range |
|---|---|---|---|---|
| Half Day_N | Total Phosphorus (mg/L) | 0.05 | 0.08 | N |
| | pH | 6.5 - 9.0 | 9.6 | N |
| Chicago_S | BOD (mg/L) | <8 | 8.1 | N |
| | Total Phosphorus (mg/L) | 0.05 | 0.32 | N |
| | TSS (mg/L) | 15.0-30.0 | 108 | N |
| Waukegan | Total Phosphorus (mg/L) | 0.05 | 0.21 | N |
| | TSS (mg/L) | 15.0-30.0 | 100 | N |
| ChicagoRiv_N | Total Phosphorus (mg/L) | 0.05 | 0.3 | N |
| | TSS (mg/L) | 15.0-30.0 | 194 | N |
| ChicagoRiv_NB | Total Phosphorus (mg/L) | 0.05 | 0.21 | N |

### Results by Parameter

All parameters were within acceptable range at every testing site, with the following exceptions:

| Parameter | Testing Site | Test Results | Within Range |
|---|---|---|---|
| Total Phosphorus (0.05 mg/L) | Half Day_N | 0.08 | N |
| | Chicago_S | 0.32 | N |
| | Waukegan | 0.21 | N |
| | ChicagoRiv_N | 0.3 | N |
| | ChicagoRiv_NB | 0.21 | N |
| TSS (15.0-30.0 mg/L) | Chicago_S | 108 | N |
| | Waukegan | 100 | N |
| | Chicago Riv_N | 194 | N |
| BOD (<8.0 mg/L) | Chicago_S | 8.1 | N |
| pH (6.5 - 9.0) | Half Day_N | 9.6 | N |

This analysis is in no way intended to identify violations of the IPCB Standards.

*Section 2*

# Program Overview

## PURPOSE AND BACKGROUND

The purpose of water quality testing analysis is to demonstrate compliance with the minimum standards required by the Illinois Environmental Protection Agency (IEPA) General Storm Water Permit ILR40 for discharges from Small Municipal Separate Storm Sewer Systems (MS4s). The permit requires annual monitoring of receiving waters upstream and downstream of the MS4 discharges, use of indicators to gauge the effects of storm water discharges on the physical/habitat-related aspects of the receiving waters and/or monitoring of the effectiveness of the Best Management Practices (BMPs). MS4 components include the conveyance or system of conveyances including roads with drainage systems, municipal streets, catch basins, gutters, ditches, swales, manmade channels or storm sewers. Storm water run-off naturally contains numerous constituents; however, urbanization and urban activities (including municipal activities) typically increase concentrations to levels that may impact water quality. Pollutants associated with storm water include sediment, nutrients, bacteria and viruses, oil and grease, metals, organics, pesticides and gross pollutants.

Water pollution control programs are designed to protect the beneficial uses of the water resources within the state. Each state has the responsibility to set water quality standards (WQS) that protect these beneficial uses, commonly referred to as “designated uses”. In Illinois, waters are designated for various uses including aquatic life, wildlife, agricultural use, primary contact (e.g., swimming, water skiing), secondary contact (e.g., boating, fishing), industrial use, drinking water, food-processing water supply and aesthetic quality. Illinois’ WQS provide the basis for assessing whether the beneficial uses of the state’s waters are being attained. The purpose of this study is to assess the quality of receiving waters and provide recommendations for BMPs that will target the identified areas of concern.

## TESTING METHODS AND PARAMETERS

Water quality test results are compared against published water quality standards. The purposes of these standards are to protect existing uses of all waters of the State of Illinois, maintain above standard water quality, and prevent unnecessary deterioration of waters of the State.

A majority of the standards referred to in this report have been established by the Illinois Pollution Control Board (IPCB), and can be found in the Illinois Administrative Code Title 35, Environmental Protection; Subtitle C, Water Pollution; Chapter I, Pollution Control Board; Part 302, Water Quality Standards, or Part 304, Effluent Standards (http://www.ipcb.state.il.us/SLR/IPCBandIEPAEnvironmentalRegulations-Title35.asp).

The IPCB has not established standards for three of the parameters measured (Total Kjeldahl Nitrogen, Conductivity, and Potassium). For purposes of this report, the standards for these parameters have been established as follows:

- Total Kjeldahl Nitrogen – As published in *Standard Methods for the Examination of Water and Wastewater*, a joint publication of the American Public Health Association (APHA), American Water Works Association (AWWA), and the Water Environment Federation (WEF) (http://www.standardmethods.org/)
- Conductivity – As published in *Volunteer Stream Monitoring: A Methods Manual*, November 1997 by the United States Environmental Protection Agency, Office of Water (http://water.epa.gov/type/rsl/monitoring/upload/2002_08_13_volunteer_stream_stream.pdf)
- Potassium – No acceptable limit for potassium has been established by the IPCB or other regulatory agency. For purposes of this report, the limit for potassium is identified as 20.0 mg/L.

For proper analysis, water samples are taken at locations upstream and downstream of the MS4 discharge and kept on ice during transport to the laboratory for processing. Upstream and downstream results are compared to determine if the Village's MS4 discharges are contributing to water pollution in receiving waters. Water samples are tested for Ammonia, Chloride, Fluoride, Biochemical Oxygen Demand (BOD, 5 day), Phenolics, Total Phosphorus, Total Dissolved Solids, Total Kjeldahl Nitrogen, Total Suspended Solids and Metals (Potassium).

On-site testing is also performed utilizing a Handheld Multiparameter Water Quality Meter. Measurements are taken for Dissolved Oxygen, Total Dissolved Solids, Temperature, Conductivity and pH.

The following describes each parameter tested and the implications that can be drawn from the results.

1. **Ammonia**

   Ammonia ($NH_3^+$) is a gas that is fairly soluble in water. The source of most ammonia in water bodies is from sprawl and urban areas, specifically in the form of road run-off, lawn pesticides and human wastes. Fish and other aquatic life forms contribute to the production of ammonia in streams by producing waste. Aqueous solutions of ammonia are widely used by water treatment facilities as carbonate removing agents to treat for hard water. High ammonia concentrations > 50.0 milligrams per liter (mg/L) may indicate contamination of liquid wastes from industrial sites.

   The established limit of total ammonia (measured as nitrogen, N) is 15.0 mg/L (IPCB Title 35, Subtitle C, Chapter 1, Part 302, Subpart B: *General Use Water Quality Standards*).

2. **Chloride**

   Chloride, in small doses, is essential to life. Chloride may enter a water system from rocks containing chlorides, agricultural run-off, industrial wastewater, oil well wastes, wastewater treatment plant effluents and road salts. However, when chloride builds up in large quantities, it can have negative impacts on aquatic life. Aquatic life forms cannot survive high chloride levels.

   The established limit for chloride is 500.0 mg/L (IPCB Title 35, Subtitle C, Chapter 1, Part 302, Subpart C: *Public and Food Processing Water Supply Standards*).

3. **Fluoride**

   Fluoride is a naturally occurring element that exists in combination with other elements as a fluoride compound. It is a constituent of minerals in rocks and soil. Small amounts of soluble fluoride are present in virtually all water sources. Fluoride is also typically added to drinking water to protect against tooth decay. However, high fluoride concentrations, such as those associated with manufacturing emissions and agricultural runoff, are linked to toxicity in aquatic organisms.

   The established limit for fluoride is 1.4 mg/L (IPCB Title 35, Subtitle C, Chapter 1, Part 302, Subpart D: *Secondary Contact and Indigenous Aquatic Life Standards*).

4. **Dissolved Oxygen (DO)**

   One of the most important measures of stream health is the amount of available dissolved oxygen (DO) in the water. Oxygen ($O_2$) dissolves in water through the mixing of the water surface with the atmosphere. Oxygen is vital to fish and other animals for respiration. If the levels of DO fall too low, many species of fish, macroinvertebrates and plants cannot survive. The level of DO in the water is inversely related to the water temperature. The lower the temperature, the more oxygen can dissolve in the water. Aquatic animals are most vulnerable to lowered DO levels in the early morning on hot summer days when stream flows are low, water temperatures are high and aquatic plants have not been producing oxygen since sunset. Low DO levels may indicate effluents from pulp and paper mills, wastewater treatment plants, feedlots, food-processing plants, failing septic systems and urban storm water run-off. Low levels of DO cause aquatic organisms to become stressed and die.

The established minimum for DO is 5.0 parts per million (ppm) between March and July, and 3.5 ppm between August and February (IPCB Title 35, Subtitle C, Chapter 1, Part 302, Subpart C: *General Use Water Quality Standards*).

**5. Biochemical Oxygen Demand (BOD)**

Biochemical oxygen demand (BOD) represents the amount of oxygen consumed by microorganisms in decomposing organic matter within stream water. Sources of BOD include leaves and woody debris, dead plants and animals, pet wastes, effluents from pulp and paper mills, wastewater treatment plants, feedlots, food-processing plants, failing septic systems and urban storm water run-off. The rate of oxygen consumption in a stream is affected by a number of variables: temperature, pH, the presence of certain kinds of microorganisms and the type of organic and inorganic material in the water.

The greater the BOD reading, the more rapidly oxygen has been depleted from the water system. This translates to less available DO for higher forms of aquatic life. The consequences of a high BOD reading are the same as those for low DO reading: aquatic organisms become stressed and die. This test is a widely used parameter to indicate water quality.

The established limit for BOD is 8.0 mg/L (IPCB Title 35, Subtitle C, Chapter 1, Part 304, Section 120: *Deoxygenating Wastes)*.

**6. Phenolics**

Phenolics are a very common group of chemicals that can be found in foods, plants, medicines, cleaning products, industrial products and by-products. Generally, the appearance of phenolics in storm water indicates a misconnected industrial sewer to a storm drain or ditch. A phenolics value greater than 0.100 mg/L would most likely indicate the presence of an illicit discharge. Toxicity to aquatic life and an unpleasant taste in fish and shellfish are the effects of phenolics contaminated waters.

Industrial sources of phenolics include the following:

- Chemical manufacturing (organic)
- Textile manufacturing
- Paint and coatings manufacturing
- Metal coating
- Resin manufacturing
- Tire manufacturing
- Plastics fabricating
- Electronics
- Oil refining and re-refining
- Naval stores (turpentine and other wood treatment chemicals)
- Pharmaceutical manufacturing
- Paint stripping (for example, automotive and aircraft)

- Military installations (rework and repair facilities)
- Coke manufacturing
- Iron production
- Ferro-alloy manufacturing

Other sources of phenolics include improper handling and disposal of cleaning compounds by institutions such as hospitals and nursing homes.

The established limit for phenolics is 0.100 mg/L (IPCB Title 35, Subtitle C, Chapter 1, Part 302, Subpart D: *Secondary Contact and Indigenous Aquatic Life Standards*).

**7. Total Phosphorus**

Total phosphorus is one of the key elements necessary for animal and plant growth. Phosphates ($PO_4^{3-}$) are formed chemically through oxidation. Rainfall causes varying amounts of phosphates and phosphorus to wash away from farm soils and certain pesticides into waterways in the form of run-off. Phosphates stimulate the growth of algae and aquatic plants that provide food for fish. This may cause an increase in the fish population. However, excess phosphates may cause disproportionate growth in algae and aquatic plants, choking waterways and consuming large amounts of oxygen, known as eutrophication.

The established limit for total phosphorous is 0.05 mg/L for any reservoir or lake with a surface area of ≥ 20.0 acres, or in any stream at the point where it enters any such reservoir or lake (IPCB Title 35, Subtitle C, Chapter 1, Part 302, Subpart B: *General Use Water Quality Standards*).

**8. Total Dissolved Solids (TDS)**

Total dissolved solids (TDS) are comprised of inorganic salts (principally calcium, magnesium, potassium, sodium, bicarbonates, chlorides and sulfates) and some small amounts of organic matter that are dissolved in water. While not a health hazard, elevated TDS levels decrease the aesthetic quality of water and can cause the water to become corrosive. Additionally, elevated TDS concentrations in water can cause a salty or brackish taste, interference & decreased efficiency of hot water heaters and lime-scale formation. Elevated TDS concentrations indicate elevated levels of ions that are above the Primary or Secondary Drinking Water Standards.

The established limit for TDS is 1000.0 ppm (IPCB Title 35, Subtitle C, Chapter 1, Part 302, Subpart C: *Public and Food Processing Water Supply Standards*).

**9. Total Suspended Solids (TSS)**

Total suspended solids (TSS) are particulate solid materials (organic and inorganic) that have relatively low density and are too small to settle. Usually TSS includes silt, plankton, mud and industrial wastes. As TSS increases, turbidity increases (meaning the transparency of the water decreases). High concentrations of TSS can lower water quality by absorbing light which raises the temperature of the water thereby decreasing DO levels. The combination of warmer water, less light and less oxygen makes it impossible for some forms of life to exist.

The established limit for TSS is 30.0 mg/L (IPCB Title 35, Subtitle C, Chapter 1, Part 304, Section 124: *Additional Contaminants*).

## 10. Total Kjeldahl Nitrogen (TKN)

Total Kjeldahl Nitrogen (TKN) is the sum of organic nitrogen, ammonia ($NH_3^+$) and ammonium ($NH_4^+$) of soil, water or wastewater (e.g. sewage treatment plant effluent). Proteins and other forms of organic nitrogen are found in waters due to waste discharges and natural decomposition processes. Organic nitrogen compounds decompose to ammonium. The ammonium concentration can be measured and is known as TKN (organic nitrogen and ammonium). Various compounds of nitrogen are found in storm water run-off from sources including fertilizers, animal wastes and plant decay.

Soil microbes break down ammonia to nitrite, which is then broken down further to nitrate. Nitrate is a useable form of nitrogen. However, excess nitrates in water cause excessive algal growth. As nutrients become limited, the algae die which supports excessive bacteria growth and consumes large amounts of oxygen, resulting in low DO levels.

The established limit for TKN is < 20.0 mg/L (*Standard Methods for the Examination of Water and Wastewater*).

## 11. Potassium

Potassium occurs naturally in various minerals, from which it becomes available via weathering processes. It is a primary component of the most commonly used fertilizer (potassium nitrate) and is abundant in animal waste. Although not normally toxic itself, the presence of potassium strongly indicates possible contamination from more damaging compounds. Potassium is found at relatively high concentrations in sewage, and in extremely high concentrations in many industrial process waters. Consequently, potassium can serve as a useful indicator for industrial wastes.

No acceptable limit for potassium has been established by the IPCB or similar regulatory agency. For purposes of this report, the established limit for potassium is 20.0 mg/L.

## 12. Temperature

The rates of biological and chemical processes depend on temperature. Organisms are dependent on certain temperature ranges for their optimal health. Optimal temperatures for fish depend on the species: some survive better in colder water, whereas others prefer warmer water. Benthic macroinvertebrates are also sensitive to temperature and will relocate to find their optimal temperature. If temperatures are outside this optimal range for a prolonged period of time, organisms become stressed and can die.

Temperature affects the oxygen content of the water (oxygen levels become lower as temperature increases), the rate of photosynthesis by aquatic plants, the metabolic rates of aquatic organisms and the sensitivity of organisms to toxic wastes, parasites and diseases. Causes of temperature change include weather, removal of shading streambank vegetation, impoundments (a body of water confined by a barrier, such as a dam), discharge of cooling water and urban storm water and groundwater inflows to the stream. Upstream and downstream temperatures were measured to identify changes in water temperature through the Village. The established maximum limit for temperature is 60° F from December through March and 90° F from April through November (General Use WQS Limits). Moreover, the water temperature at any site should not exceed the maximum limits by more than 3° F (IPCB Title 35, Subtitle C, Chapter 1, Part 302, Subpart B: *General Use Water Quality Standards*).

## 13. Conductivity

Conductivity is a measure of the ability of water to pass through an electrical current. Conductivity in water bodies is affected by the presence of inorganic dissolved solids such as chlorides, nitrates, sulfates, phosphate anions (ions that carry a negative charge) or sodium, magnesium, calcium, iron and aluminum cations (ions that carry a positive charge). Organic compounds like oil, phenolics, alcohol and sugar do not conduct electrical current very well and therefore have a low conductivity level in water. Conductivity is also affected by temperature: the warmer the water, the higher the conductivity.

Discharges to streams can change conductivity depending on their composition. For example, a failing sewage system would raise conductivity due to the presence of chloride, phosphate and nitrate, while an oil spill would lower conductivity.

The basic unit of measurement for conductivity is the mho or siemens, where one mho or siemens (S) is equal to the reciprocal of one ohm Ω (measurement of electrical resistance named after Georg Simon Ohm). Conductivity is measured in micromhos per centimeter (µmhos/cm) or microsiemens per centimeter (µs/cm).

The acceptable range for conductivity, as published in the United States Environmental Protection Agency Office of Water's November 1997 *Volunteer Stream Monitoring: A Methods Manuel*, is 50.0-1500.0 µs/cm.

## 14. pH

Most discharge flow types are neutral, having a pH value of approximately 7.0, (although groundwater concentrations can be somewhat variable). pH is a reasonably good indicator for liquid wastes from industries, which can have very high or low pH (ranging from 3.0 to 12.0). The pH of residential wash water tends to be rather basic (pH of 8.0 or 9.0). Although pH data is often not conclusive by itself, it can identify problem areas that merit follow-up investigations using more effective indicators.

The established range for pH is 6.5-9.0 (IPCB Title 35, Subtitle C, Chapter 1, Part 302, Subpart B: *General Use Water Quality Standards*).

The following table summarizes the accepted limits for each water quality parameter, as referenced in this report.

| Water Quality Parameters | Referenced Publication [1] | Standards/Accepted Limits |
|---|---|---|
| Off-site Testing | | |
| Ammonia | 302.212 | 15.0 mg/L |
| Chloride | 302.304 | 500.0 mg/L |
| Fluoride | 302.407 | 1.4 mg/L |
| BOD | 304 | < 8.0 mg/L |
| Phenolics | 302.407 | 0.100 mg/L |
| Phosphorous, Total | 302.205 | 0.05 mg/L |
| Total Suspended Solids | 304 | 15.0-30.0 mg/L |
| Total Kjeldahl Nitrogen | *Standard Methods for the Examination of Water and Wastewater* | < 20.0 mg/L |
| Potassium | None given | 20.0 mg/L |
| On-site Testing | | |
| Dissolved Oxygen | 302.206 | Mar – Jul at least 5.0 ppm<br>Aug – Feb at least 3.5 ppm |
| Total Dissolved Solids | 302.304 | 1000.0 ppm |
| Temperature | 302.211 | Dec – Mar 60.0° F Max<br>Apr – Nov 90.0° F Max |
| Conductivity | USEPA *Volunteer Stream Monitoring: A Methods Manual* | 50.0 – 1500.0 µs/cm |
| pH | 302.304 | 6.5 – 9.0 |

[1] IPCB Title 35, Subtitle C, Chapter 1, unless otherwise noted