Water Quality & Monitoring

Clean water doesn't happen by accident — it's the result of a healthy watershed, intact riparian zones, and limited pollution inputs. Learning to **measure, interpret, and monitor water quality** is at the heart of aquatic ecology fieldwork.

1. Why water quality matters

Water quality describes the chemical, physical, and biological characteristics of water that determine its suitability for aquatic life, drinking, recreation, and other uses. A single parameter out of range can stress or kill aquatic organisms — and because parameters interact with each other, problems rarely occur in isolation.

In New Brunswick, water quality is monitored by the Department of Environment and Local Government (DELG), Environment and Climate Change Canada (ECCC), watershed groups, and citizen scientists using standardized protocols. The Canadian Council of Ministers of the Environment (CCME) sets the national water quality guidelines used as benchmarks across Canada.

CCME WATER QUALITY GUIDELINES

The Canadian Council of Ministers of the Environment (CCME) publishes Water Quality Guidelines for the Protection of Aquatic Life — the science-based national standard. These guidelines set maximum concentrations or acceptable ranges for hundreds of substances and physical parameters. They are the benchmark used across Canada for assessing whether a water body is healthy. CCME guidelines are separate from Health Canada's drinking water guidelines.

2. Physical parameters

Physical parameters describe the measurable characteristics of water that don't require chemical analysis — but that have profound effects on aquatic life.

Temperature

Water temperature controls nearly everything in an aquatic ecosystem: metabolic rates, dissolved oxygen levels, the toxicity of pollutants, and which species can survive. Cold-water fish species like Atlantic salmon and brook trout are especially sensitive.

CCME guideline: Maximum 18–19°C for salmonids (salmon and trout). As water warms above this threshold, salmon become stressed, stop feeding, and become susceptible to disease. Above 25°C, most cold-water fish cannot survive.

Factors that raise stream temperature: removal of riparian trees (loss of shade), shallow water, dark substrate, warm air temperatures, reduced flow, and discharge of warm water from industry or stormwater.

Turbidity

Turbidity measures how cloudy or murky water is — caused by suspended particles including sediment, algae, bacteria, and organic matter. It is measured in Nephelometric Turbidity Units (NTU).

High turbidity: reduces light penetration (limiting photosynthesis), clogs fish gills, smothers benthic macroinvertebrates and fish eggs in spawning gravel, and signals sediment erosion in the watershed.

CCME guideline: During clear flow conditions, turbidity should not increase by more than 8 NTU above background. Spawning gravel must not exceed 12 mm median diameter.

Secchi depth — measuring water clarity

A Secchi disk is a simple, low-cost tool for measuring water clarity in lakes and ponds. The black-and-white disk is lowered into the water until it disappears, then raised until it reappears. The average of those two depths is the Secchi depth — a quick indicator of turbidity and eutrophication status.

Secchi disk getting lowered into a lake.

https://ecoreportcard.org/report-cards/chesapeake-bay/indicators/water-clarity/

3. Chemical parameters

Chemical parameters describe the dissolved substances in water — their concentrations determine whether the water supports aquatic life. The key parameters for Envirothon are dissolved oxygen, pH, conductivity, nutrients (nitrate and phosphate), and total dissolved solids.

Dissolved oxygen (DO)

Dissolved oxygen is the amount of oxygen gas dissolved in water. It is measured in milligrams per litre (mg/L) or as percent saturation. DO is arguably the single most important water quality parameter for aquatic life — fish and most macroinvertebrates breathe oxygen directly from the water through their gills.

Cold water holds more oxygen than warm water. Fast-moving, turbulent water picks up oxygen from the atmosphere. Stagnant, warm, or nutrient-rich water often has low DO — especially at night when algae and plants are respiring (consuming oxygen) rather than photosynthesizing.

DO level (mg/L)	Condition	Effect on aquatic life
> 9.5	Excellent	Optimal for cold-water species including Atlantic salmon and brook trout (CCME guideline)
7–9.5	Good	Supports most fish; healthy streams typically fall in this range
6.0	Spawning threshold	Minimum for successful salmon and trout spawning and egg development
5–6	Acceptable	Adequate for most warm-water fish; stress begins for cold-water species
3–5	Stressful	12–24 hour tolerance zone; most fish show avoidance behaviour
< 3	Critical	Fish kills likely; most cold-water species cannot survive
< 1	Dead zone	Near-complete anoxia; only anaerobic bacteria survive

WHY DO DROPS AT NIGHT

Dissolved oxygen levels follow a daily cycle. During the day, aquatic plants and algae produce oxygen through photosynthesis. At night, all organisms — including plants — respire, consuming oxygen. In eutrophic water bodies with heavy algal growth, DO can crash to dangerous levels before dawn. This is why fish kills often happen overnight or in the early morning.

pH

pH measures the acidity or alkalinity of water on a scale of 0–14. A pH of 7 is neutral; values below 7 are acidic, above 7 are alkaline (basic). Most freshwater aquatic organisms thrive in the range of 6.5–8.5.

Acidic conditions (low pH) can be caused by acid rain (historically a major issue in eastern Canada), peat bogs (natural), or acid mine drainage. High pH can result from heavy algal growth (photosynthesis removes CO_2) or industrial discharge.

pH range	Effects on aquatic life
< 4.5	Lethal to most fish and macroinvertebrates. Only acid-tolerant species survive.
4.5–5.0	Lethal to many fish; salmon eggs fail to hatch; macroinvertebrate diversity drops sharply.
5.0–6.0	Stressful; sensitive species (salmon, mayflies) begin to disappear.

6.0–8.5	Optimal range for most freshwater aquatic life (CCME guideline: 6.5–9.0).
8.5–9.0	Some algal dominance; stress begins for sensitive species.
> 9.0	Harmful to most fish and invertebrates; ammonia becomes more toxic at high pH.

Conductivity

Conductivity measures water's ability to pass electrical current, which reflects the concentration of dissolved ions (salts, minerals). It is measured in microsiemens per centimetre (µS/cm). While not directly harmful, conductivity is a useful indicator of water source and pollution.

Conductivity (µS/cm)	Interpretation	What it may indicate
0–200	Pristine	Undisturbed headwater streams; minimal human impact
200–1,000	Normal	Typical for most major rivers; some mineral content
1,000–10,000	Elevated	Road salt runoff, agricultural inputs, industrial discharge
> 10,000	Highly impacted	Severe salinization; few freshwater species can survive

Total dissolved solids (TDS)

TDS measures the total mass of all particles dissolved in water, expressed in parts per million (ppm). It is often measured alongside conductivity and is used to gauge overall water purity. TDS below 50 ppm is ideal for drinking water; above 500 ppm is considered unfit by EPA standards.

Nutrients: phosphate and nitrate

Phosphorus (as phosphate) and nitrogen (as nitrate) are essential nutrients for aquatic plant growth - but in excess, they drive eutrophication and harmful algal blooms. Both are major non-point source pollutants in NB, originating from agricultural fertilizers, septic systems, and urban runoff.

Nutrient	No evidence of pollution	Some concern	High pollution
Phosphate (ppm)	< 0.02	0.02–0.1	> 0.1 (algal blooms likely)
Nitrate (ppm)	< 0.2	0.2–1.0	> 2 (CCME: < 3 mg/L N)

THE PHOSPHORUS-ALGAE-OXYGEN CHAIN

Excess phosphorus feeds algal growth. When algae die and decompose, bacteria break down the organic matter — consuming large amounts of dissolved oxygen in the process. This can create hypoxic (oxygen-depleted) or anoxic (no oxygen) zones in the water. Fish and macroinvertebrates suffocate. This chain reaction is called cultural eutrophication and is one of the most significant water quality problems in NB lakes and slow-moving rivers.

E. coli

Escherichia coli (E. coli) is used as an indicator of fecal contamination in water. Its presence signals that water may contain pathogens from sewage, livestock, or wildlife. E. coli itself can cause serious illness if ingested. NB's Department of Health issues beach and recreational water advisories when E. coli counts exceed safe thresholds.

CCME recreational water guideline: Not to exceed 200 colony forming units (CFU) per 100 mL for recreational water contact. Septic systems, livestock near waterways, and stormwater overflow are the primary NB sources.

CCME water quality guideline summary (freshwater aquatic life)

Parameter	Unit	Healthy range	Concern level	Why it matters
Temperature	°C	≤ 18–19°C (salmonids)	> 20°C stress; > 25°C lethal	Controls metabolism, DO solubility, disease susceptibility
Dissolved oxygen	mg/L	≥ 9.5 (cold-water fish)	< 6.5 spawning concern; < 3 fish kills	Decreases as temperature rises; critical at night in eutrophic water
pH	pH units	6.5–9.0	< 5.0 or > 9.5 toxic to most fish	Affects ammonia toxicity; acid rain historically impacted NB
Turbidity	NTU	< 8 NTU above background	> 25 NTU impairs fish gills and eggs	Key indicator of erosion and sedimentation in watershed
Phosphate	ppm	< 0.02	> 0.1 triggers algal growth	Primary driver of eutrophication in NB lakes
Nitrate	mg/L N	< 0.2	> 3 mg/L N (CCME limit)	Agricultural fertilizer runoff is main NB source
Conductivity	µS/cm	0–200 (pristine)	> 1,000 elevated; > 10,000 critical	Road salt a growing concern in NB urban streams
E. coli	CFU/100 mL	< 200 (recreational)	> 200 beach advisory issued	Indicator of fecal contamination; septic and livestock sources

4. Cyanobacteria — NB's growing water quality concern

Cyanobacteria (commonly called blue-green algae) are photosynthetic bacteria found naturally in freshwater. Under certain conditions - warm temperatures, high nutrient levels, low water flow, and extended sunlight - they can multiply rapidly and form visible blooms.

TWO TYPES OF BLOOMS IN NB

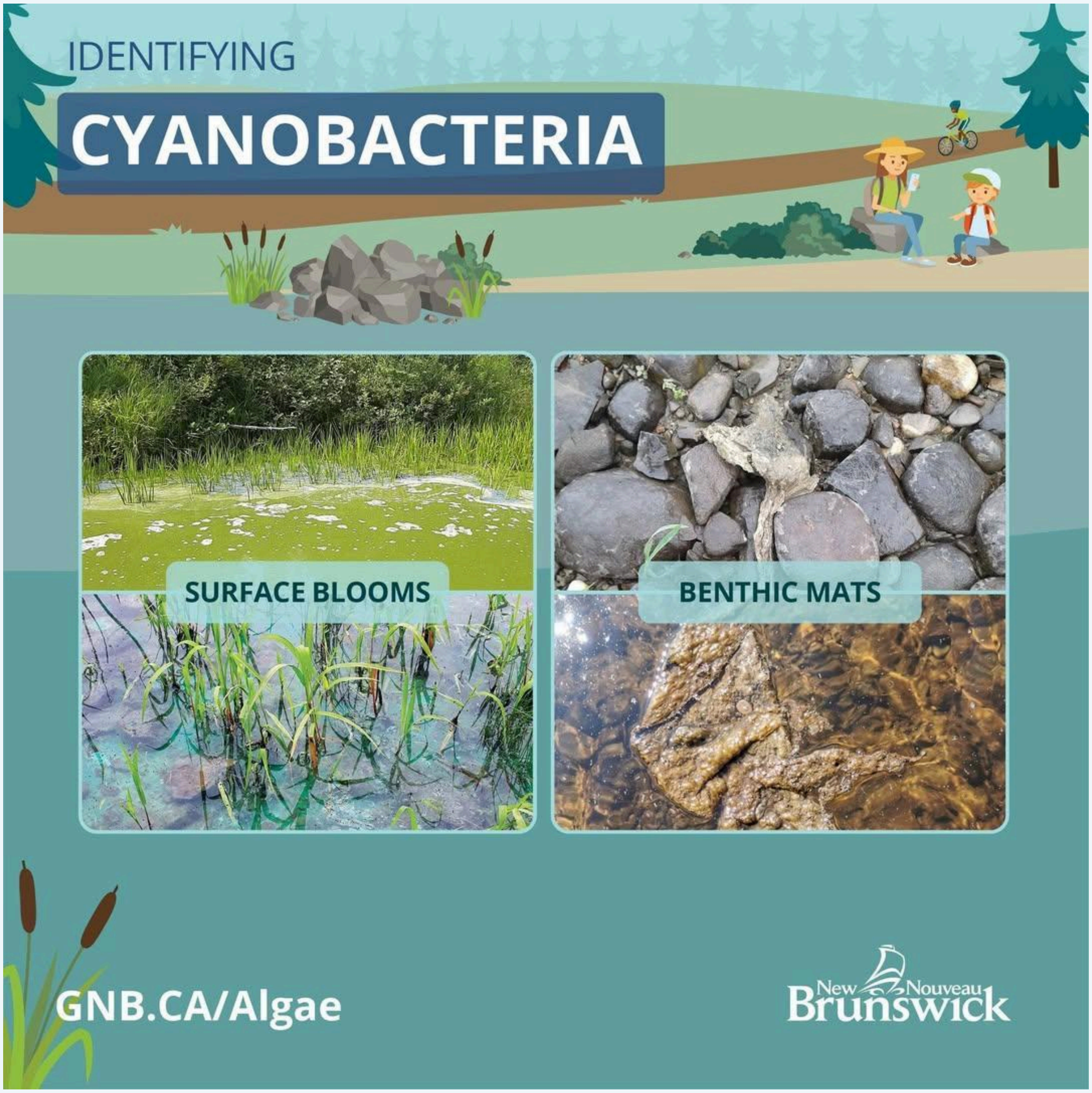
Surface blooms: Green or blue-green scum on the water surface. Can look like spilled paint, grass clippings, or wet wool. Most likely in warm, still water. Can produce microcystins - toxins that cause skin irritation, gastrointestinal illness, and serious harm if ingested.

Benthic mats: Slimy mats or clumps on the river or lake bottom. Present in rivers including the Wolastoq (Saint John River). Considered especially dangerous to dogs, which are attracted to the smell and may ingest mat material. A recent increase in benthic blooms has been observed at monitoring sites on the Wolastoq.

In 2025, NB researchers recorded 15 reports of cyanobacteria - a significant increase from 3 in 2024 - partly due to hot, dry summer conditions lowering water levels and increasing bloom likelihood, and partly due to increased public awareness and reporting. Cyanobacterial blooms are projected to increase in frequency and severity globally as climate change drives warmer water temperatures.

WHAT TO DO IF YOU SUSPECT A BLOOM

Do not swim, paddle, or let pets enter the water. Do not drink or cook with untreated water — boiling does NOT remove cyanotoxins. Shower after any contact. Report any suspected bloom to the NB Department of Environment and Local Government regional office. The province issues public health advisories when blooms are confirmed.



Cyanobacteria surface blooms and benthic mats.

https://www2.gnb.ca

5. Biological monitoring — CABIN

Chemical parameters tell us what's in the water right now — but a single snapshot can miss episodic pollution events. Biological monitoring uses organisms as long-term indicators of water quality: if the water has been healthy, pollution-sensitive species will be present. If it has been degraded, they will have disappeared.

What is CABIN?

The Canadian Aquatic Biomonitoring Network (CABIN) is a collaborative national program managed by Environment and Climate Change Canada (ECCC). Launched nationally in 2006, CABIN provides standardized protocols for sampling benthic macroinvertebrates alongside water quality, habitat, and hydrology data. CABIN's online database allows data sharing and comparison across the country.

CABIN uses benthic macroinvertebrates as indicators because they: live in one place (can't flee a pollution event), have varying pollution tolerances across species, are present year-round, and integrate conditions over months rather than a single point in time.

> **CABIN IN NEW BRUNSWICK**
> CABIN online training was originally developed in partnership with the University of New Brunswick. CABIN sampling sites exist across NB, contributing to national-scale assessments of freshwater ecosystem health. Watershed groups and First Nations organizations are increasingly participating in CABIN training (now managed by ECCC) and data collection. The CABIN database is publicly accessible through the Open Government Portal.

How CABIN works

A CABIN study involves standardized collection of benthic macroinvertebrates at a target site, compared against reference sites (undisturbed streams with similar physical characteristics). The Reference Condition Approach (RCA) asks: what macroinvertebrate community would we expect here if the site were undisturbed? The difference between expected and observed tells us the degree of biological impairment.

CABIN step	What happens
Study design	Define the question, identify target and reference sites, plan sampling season
Field sampling	Collect benthic macroinvertebrates using standardized kick-net protocol in riffle habitat
Habitat assessment	Record stream channel width, substrate, riparian cover, canopy shading, bank erosion
Water quality	Measure in-situ parameters (temperature, DO, pH, conductivity) with a multi-probe
Lab processing	Preserve, sort, and identify macroinvertebrates to order level (or lower)
Analysis	Compare community to reference condition; calculate metrics (EPT richness, diversity indices)
Reporting	Upload data to CABIN database; generate assessment report

EPT richness — the biological health indicator

One of the most useful CABIN metrics is EPT richness — the number of species from the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). These three groups are highly sensitive to pollution and are among the first to disappear when water quality degrades. High EPT richness = healthy water.

EPT richness	Water quality	What you typically find
High (many species)	Excellent to good	Stoneflies, caddisflies, mayflies abundant; high overall diversity
Moderate	Fair	Some EPT present but reduced; more tolerant groups increasing
Low (few or none)	Poor to very poor	EPT absent; dominated by midges, worms, and other tolerant taxa

6. Field monitoring tools

Water quality monitoring in the field uses a combination of electronic instruments, chemical test kits, and biological sampling equipment. Students should be familiar with both what each tool measures and how to interpret the results.

Tool	What it measures	Notes
Multi-probe (e.g. YSI)	Temperature, DO, pH, conductivity, turbidity simultaneously	Electronic; requires calibration before each use; widely used in CABIN
Secchi disk	Water clarity / light penetration depth	Simple, low-cost; good for lake monitoring; reports depth in metres
Turbidity tube	Turbidity (NTU) of stream water	Cost-effective field alternative to electronic turbidity meters
Nutrient test kits	Phosphate, nitrate concentrations (ppm)	Colourimetric kits; photometer gives more precise readings
E. coli test	Fecal coliform / E. coli counts	Requires incubation; results in CFU/100 mL after 24 hours
Kick-net / D-net	Benthic macroinvertebrate community	Standardized CABIN protocol; sweep in riffle habitat for 30 seconds
Cyanobacteria rapid test	Phycocyanin (cyanobacteria pigment)	Fluorescence sensors (e.g. CyanoTracker) detect blooms in real time

Field monitoring equipment.

7. New Brunswick spotlight — water quality in practice

Petitcodiac Watershed Alliance monitoring

The Petitcodiac Watershed Alliance (PWA) conducts ongoing water quality monitoring in the Petitcodiac watershed, tracking parameters including temperature, pH, dissolved oxygen, turbidity, nutrients, and E. coli. Their 2022 Water Quality Monitoring Report is a useful reference for current baseline data in one of NB's most intensively monitored rivers. The PWA also uses CABIN protocols for macroinvertebrate monitoring.

Grand Lake — CyanoTracker real-time monitoring

The Jemseg Grand Lake Watershed Association has partnered with researchers to deploy a CyanoTracker in Grand Lake — a real-time sensor that records water temperature, turbidity, chlorophyll-a (green algae indicator), and phycocyanin (cyanobacteria indicator) every 30 minutes. Data is available publicly online. This citizen-science approach to early bloom detection is a model being considered for other NB lakes.

Wolastoq (Saint John River) - cyanobacteria monitoring

The Wolastoq has seen a concerning increase in benthic cyanobacteria mats at monitoring sites, particularly in the reach from the Mactaquac Dam downstream to Lincoln near Fredericton. The Canadian Rivers Institute at UNB has been investigating the causes of cyanobacterial outbreaks in NB lakes and rivers since 2010. This research is critical for understanding how climate change and nutrient loading are interacting in NB's most important river system.

ENVIROTHON EXAM TIP

You may be asked to interpret a water quality data table. Key things to check: Is dissolved oxygen (DO) above 6.5 mg/L? Is pH between 6.5 and 9.0? Is turbidity low? Are phosphate and nitrate below concern levels? Are there EPT taxa present? One red flag doesn't necessarily mean disaster — but multiple parameters out of range together paints a clear picture of a stressed ecosystem.

8. Key terms

water quality The chemical, physical, and biological characteristics of water that determine its suitability for various uses and aquatic life.	**CCME** Canadian Council of Ministers of the Environment — sets national water quality guidelines used as benchmarks across Canada.
dissolved oxygen (DO) The amount of oxygen gas dissolved in water, measured in mg/L. The single most critical parameter for aquatic life.	**turbidity** Cloudiness of water caused by suspended particles. Measured in NTU.
pH Measure of acidity or alkalinity on a scale of 0–14. Optimal freshwater range: 6.5–9.0.	**conductivity** Water's ability to conduct electricity, reflecting dissolved ion concentration. Measured in µS/cm.
phosphate A form of phosphorus; essential nutrient but drives algal blooms when excessive. Key non-point source pollutant.	**nitrate** A form of nitrogen; stimulates aquatic plant growth; CCME guideline < 3 mg/L N for aquatic life.
eutrophication Nutrient enrichment of a water body, leading to algal blooms, oxygen depletion, and ecosystem degradation.	**cyanobacteria** Photosynthetic bacteria that can form toxic surface blooms and benthic mats in warm, nutrient-rich water.
cyanotoxin Toxins produced by some cyanobacteria species; can cause illness in humans and death in pets and livestock.	**E. coli** Indicator organism for fecal contamination; used to assess recreational water safety.
CABIN Canadian Aquatic Biomonitoring Network — national standardized biological monitoring program using benthic macroinvertebrates.	**EPT richness** Number of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisfly) species at a site; key indicator of water quality.
Reference Condition Approach CABIN method comparing observed macroinvertebrate community to what would be expected at an undisturbed reference site.	**Secchi depth** Depth at which a Secchi disk disappears from view; a simple measure of water clarity and trophic status in lakes.
biomonitoring	**hypoxia**

Using organisms (usually macroinvertebrates) to assess ecosystem health over time, rather than relying on point-in-time chemical measurements.	Condition of very low dissolved oxygen in a water body, typically < 2–3 mg/L; stressful or lethal for most aquatic life.

9. Quick check

Test yourself before moving on. Can you answer all of these?

Quick Check — Review Questions

1. Name four physical and four chemical water quality parameters. For each, explain what it measures and why it matters.
2. A stream test shows: temperature 22°C, DO 4.5 mg/L, pH 6.2, turbidity 35 NTU, phosphate 0.15 ppm. Identify which parameters are concerning and explain the ecological effects of each.
3. Why does dissolved oxygen drop at night in a eutrophic lake? Trace the complete chain of events.
4. What is CABIN and why is biological monitoring important in addition to chemical water quality monitoring?
5. What does EPT richness tell you about a stream, and why are these three orders particularly useful as bioindicators?
6. Describe the two types of cyanobacteria blooms in NB. Which is considered more dangerous and why?
7. A lake in NB has a Secchi depth of 0.5 metres in August. What does this suggest about the lake's water quality, and what are the likely causes?
8. BONUS: A farmer upstream from a monitoring station applies nitrogen fertilizer in spring. By August, phosphate levels at the station are 0.3 ppm and a cyanobacteria bloom has appeared. Trace the complete pathway from fertilizer application to bloom.

10. Further resources

🌐 **CCME Water Quality Guidelines** National standards for the protection of aquatic life. Includes searchable summary table. *ccme.ca/en/resources/water-aquatic-life*

🌐 **CABIN — Canadian Aquatic Biomonitoring Network** ECCC's national biomonitoring network. Training, protocols, and open data portal. *canada.ca/en/environment-climate-change/services/canadian-aquatic-biomonitoring-network.html*

🌐 **ACAP Saint John — Cyanobacteria Guide** Plain-language explanation of NB cyanobacteria types, health risks, and how to report blooms. *acapsj.org/cyano*

🌐 **NB DELG — Cyanobacteria Advisories** Current NB public health advisories and information on cyanobacteria in recreational water. *gnb.ca (search: cyanobacteria)*

🌐 **Petitcodiac Watershed Alliance — Water Quality Reports** Annual water quality monitoring data for the Petitcodiac watershed; excellent local case study. *petitcodiac.org*

🌐 **Jemseg Grand Lake Watershed — CyanoTracker Data** Real-time water quality and cyanobacteria sensor data from Grand Lake, NB. Updated every 30 minutes. *jemseggrandlakewatershed.ca*

📄 **DataStream — Water Quality Guidelines** CCME and EPA guidelines in a searchable visualization tool with NB watershed data. *datastream.org/en-ca/documentation/guidelines*

← **Previous:** Module 2: Aquatic Environments & Wetlands
→ **Next:** Module 4: Benthic Macroinvertebrates