Historical Data Consolidation and Recommendations for the Otty Lake Association Water Sampling Program

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Table of Contents

Executive Summary

The Otty Lake Association (OLA) has over 50 years of water quality data in various formats. Given a lack of volunteers with appropriate scientific background, the Board of the OLA decided to contract out the review and consolidation of this data. The objectives of the review were twofold:

1. To organize and consolidate the historical data and
2. To make recommendations on the ongoing priorities for the Otty Lake Association water sampling and monitoring program.

This report outlines how the historical data was organized into a single data set. It reviews how the future collected data can be added and reviewed. The consolidated spreadsheet tracks historical sampling events and supports trend analysis by keeping all the data in one place in a consistent format. The incorporated "Pivot tables" provide consistent charts to visualize changes in key parameters over time. The standardized data entry protocols ensure consistency and accuracy.

The report reviews the value of the data that has been collected and outlines its implications for public safety, public health, and for understanding climate change resilience.

There are occasional spikes on E.coli above safe thresholds were observed in past years, but recent data show improvement. A declining trend in dissolved oxygen (DO) levels suggests increasing stratification stress, possibly linked to climate change. Total phosphorus (TP) levels are stable, but total nitrogen (TKN) shows episodic spikes, indicating potential nutrient loading events. The high nitrogen-to-phosphorus ratios may promote cyanobacterial growth under warming conditions.

The report provides strategic recommendations to guide future monitoring efforts. It is suggested to expand the TP and TKN Sampling to focus on inflow points, shallow bays, and areas near septic systems to identify nutrient hotspots. It is suggested to increase E. coli sampling near shore recreational sites to better assess public health risks. In addition, outflow points and shoreline runoff zones, where found, may be underrepresented and could be added as additional sampling sites. Additional Depth-Specific Temperature Monitoring probes or loggers to track thermal stratification would be helpful. Citizen Science Integration would encourage community participation in Secchi depth readings, shoreline observations, and basic water chemistry testing such as conductivity and pH.

It is recommended to have continued collaboration with the Rideau Valley Conservation Authority (RVCA) and the Lake Partners Program (LPP) for deep-water profiling.

Introduction

The Otty Lake Association (OLA) has accumulated over 50 years of water quality data. This report was commissioned to help organize that data and provide recommendations for future monitoring efforts. The goal is to support lake stewardship under a limited budget, with a focus on:

1. **Ensure Public Safety**
   To determine how and which historical water quality data contributes to understanding and mitigating risks that may affect the safety of recreational and residential water use.

2. **Protect Public Health**
   To determine how and which historical data supports the identification of potential threats to human health, such as bacterial contamination (e.g., E. coli), nutrient loading, and to inform timely management actions that safeguard drinking water sources and recreational use.

3. **Support Climate Change Resilience**
   To determine how and which long-term trends in ecological parameters reflect the impacts of climate change, and to use this data to support adaptive lake management practices that enhance ecosystem resilience.

Summary

The Otty Lake Association (OLA) has over 50 years of water quality data. This report organizes the historical data and provides strategic recommendations to guide future monitoring efforts under budget constraints. The focus is on three key objectives:

1. **Ensure Public Safety**
   Monitoring recreational water quality to ensure safe swimming and boating conditions, particularly through E. coli testing and Secchi depth readings.
2. **Protect Public Health**
   Identifying risks such as bacterial contamination, nutrient loading, and septic system influence using parameters like E. coli, Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Dissolved Oxygen (DO).
3. **Support Climate Change Resilience**
   Using long-term trends in temperature, DO, and ice-on/ice-off dates to assess ecological responses to climate change and guide adaptive lake management.

Key Findings

- **E. coli**: Occasional spikes above safe thresholds were observed in past years, but recent data show improvement.
- **DO**: A declining trend in dissolved oxygen levels suggests increasing stratification stress, possibly linked to climate change.
- **TP and TKN**: TP levels are stable, but TKN shows episodic spikes, indicating potential nutrient loading events.
- **Nutrient Ratios**: High nitrogen-to-phosphorus ratios may promote cyanobacterial growth under warming conditions.

Recommendations

- **Expand TP and TKN Sampling**: Focus on inflow points, shallow bays, and areas near septic systems to identify nutrient hotspots.
- **Increase E. coli Sampling**: Target nearshore recreational sites to better assess public health risks.
- **Depth-Specific Temperature Monitoring**: Use temperature probes or loggers to track thermal stratification.
- **Citizen Science Integration**: Encourage community participation in Secchi depth readings, shoreline observations, and basic water chemistry testing (e.g., conductivity, pH).
- **Collaboration with RVCA**: Continue leveraging RVCA's deep-water profiles and watershed data while OLA focuses on nearshore monitoring.
- **Data Management**: Maintain a consistent record of research findings in a single consolidated spreadsheet to track historical sampling events and supports trend analysis.
- **Data Consistency**: Keep a standardized data entry protocol to ensure consistency and accuracy.
- **Data Visulization**: Use pivot tables and charts to visualize changes in key parameters over time.

Data Consolidation Instructions

This spreadsheet consolidates historical water quality data for the Otty Lake Association.
It is designed to:

1) Track and compare sampling efforts across years

2) Support ongoing stewardship and monitoring

3) Anyone entering data should use this guide to ensure entries are consistent, accurate, and easy to analyze.

Structure of the historical record entry

Each **row = one sampling event** at a specific site on a specific date.
Each **column = metadata or measurement.**

Columns Explained:

Date: Sampling date in format 'YYYY-MM-DD'.

Sample Site: Descriptive site name (e.g., Stn A, Mid-lake). Keep naming consistent.

Latitude/Longitude: Optional, enter if recorded.

Coordinates: Optional combined lat/long (for mapping tools).

Temperature (°C): Surface or depth temperature. Leave blank if not measured.

Parameter: What was measured (e.g., E. coli, TP, TKN, DO).

Use exact terms listed in the '*Parameter Definitions'* sheet.

Value: Numeric result. If below detection, record as < X (e.g., < 2).

Do **not** use "ND" or "non-detect."

Unit: Units of measurement (e.g., cfu/100 mL, mg/L). Match historical entries exactly.

Depth (m): Depth at which sample was taken (e.g., 0.5). Leave blank if unknown.

Source: Where the data was obtained (e.g., Excel, RVCA, hard copy records).

Structure of the separate worksheets

'Historical Time Series Data'

Data Entry Rules:

Add New Data Below Existing Entries
Never overwrite existing rows. Always start a new row for each measurement.

One Parameter = One Row
If a sample includes multiple parameters, repeat the metadata (date, site, etc.) for each parameter on separate rows.

Consistent Formats

Dates: YYYY-MM-DD

Depth: numeric only (e.g., 1.5)

Values: use decimals, not commas (1.5, not 1,5)

Below detection: record as < X

Leave Blank if Not Measured
Do not enter "0" unless zero is the true, confirmed result.

Check for Errors Before Saving
Double-check **date, site name, and values** before closing the file.

'Live Trends Data' and 'Live Trends'

Add New Data Below Existing Entries
Never overwrite existing rows. Always start a new row for each measurement.

One Parameter = One Row
If a sample includes multiple parameters, repeat the metadata (date, site, etc.) for each parameter on separate rows.

Consistent Formats

Dates: YYYY-MM-DD

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Below detection: record as < X

Leave Blank if Not Measured
Do not enter "0" unless zero is the true, confirmed result.

Check for Errors Before Saving
Double-check **date, site name, and values** before closing the file.

Using the ‘Live Trends Data’ and ‘Live Trends’ Sheets

These sheets allow you to **visualize data trends** and check for gaps.

‘Live Trends Data’: contains the pivot-ready version of the raw data.

‘Live Trends’: contains pivot tables and charts that automatically update.

How to Update Charts

a) Enter your new data into the **Historical Time Series Data** sheet.

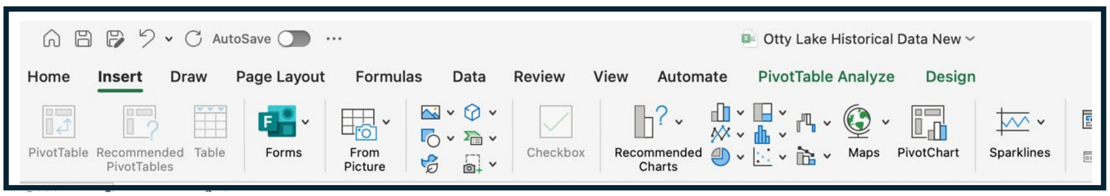
b) Copy the same data into the **Live Trends Data** sheet.

c) Go to the **Live Trends** sheet.

d) Click anywhere inside the pivot table.

e) On the top ribbon, select **PivotTable Analyze → Refresh.**

f) The charts will automatically update.



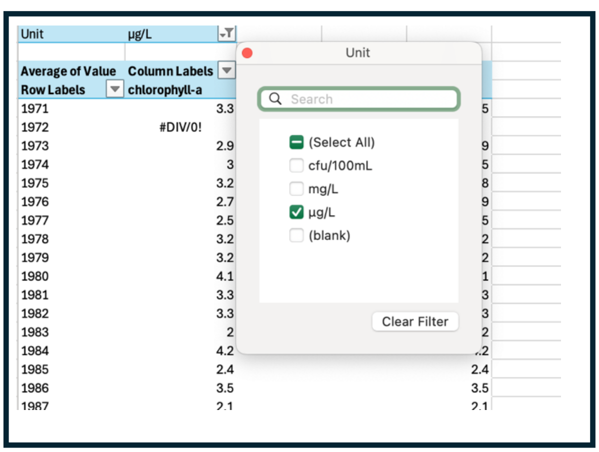
Filtering by Units

Because parameters have different units, make sure you filter:

In the top-left of the pivot table, find the dropdown labelled **Unit.**

Click the arrow and select the desired unit (e.g., cfu/100 mL).

Click ‘**OK’.**



Charts will now only show results for that unit.

Examples of Charts Available:

- E. coli levels over time
- Total Phosphorus (TP) over time
- Total Kjeldahl Nitrogen (TKN) over time
- Dissolved Oxygen (DO) over time
- Chlorophyll-a over time

Now, your pivot table and any linked charts will only show data with that specific unit

Following this guide ensures Otty Lake's data remains **accurate, consistent, and comparable across years.**

Parameter Definitions

See the **Parameter Definitions** in the Excel sheet for the full list of parameters and standard naming conventions. Always use these terms when entering data.

Data Assessment

To determine how and which historical data support the identification of potential threats to human health, such as bacterial contamination (e.g., E. coli), nutrient loading, and to inform timely management actions that safeguard drinking water sources and recreational use.

Overview of Otty Lake Monitoring Parameters

Total Phosphorus (**TP**): A key nutrient influencing algal growth; high levels can lead to eutrophication and harmful algal blooms.

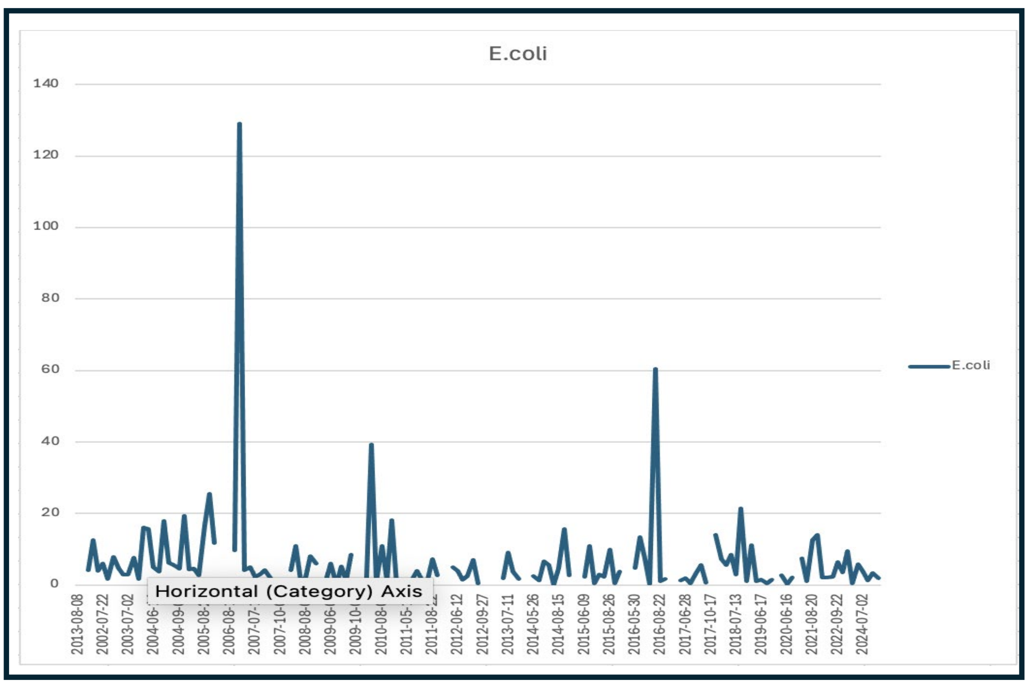
Total Nitrogen (**TKN**): Another essential nutrient contributing to plant and algal productivity. The nitrogen-to-phosphorus (N:K:P) ratio helps indicate which nutrient is limiting.

Water Temperature and Dissolved Oxygen (**DO**): Indicators of seasonal stratification, oxygen availability, and overall aquatic habitat quality.

E. coli: A bacterial indicator of fecal contamination and public health risk for recreational water use.

E. coli

While most E. coli values are low, there are notable spikes above **100** CFU/100 mL around 2006, 2010, and 2016, which exceed recreational safety thresholds. After 2016, E. coli levels appear more consistent and lower overall, indicating possible improvements in watershed management or natural variability.

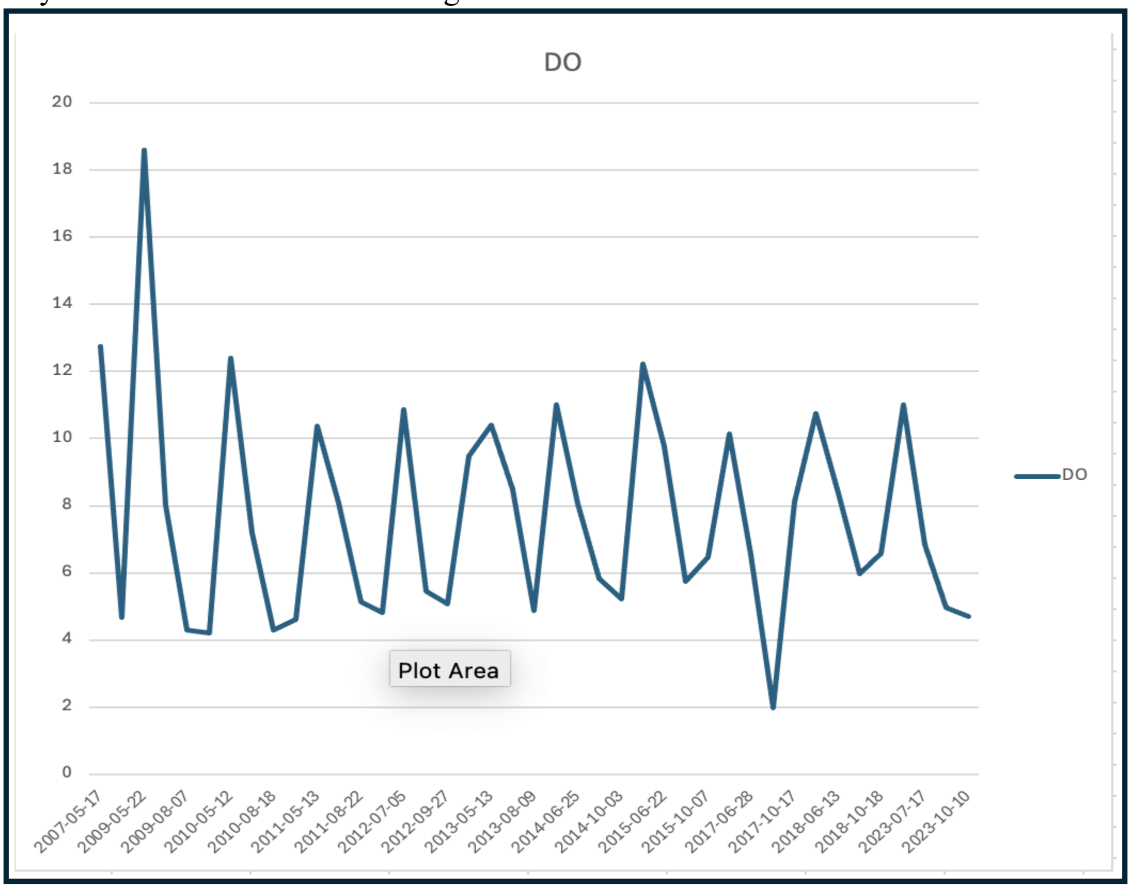


Interpretation:
Overall, current water quality for recreational use is generally acceptable, but occasional spikes in E. coli from previous years still pose episodic public health risks, potentially from areas with higher human or animal activity.

Dissolved Oxygen (DO)

DO levels from 2007 to 2023 show a clear seasonal cycle, with values typically peaking in the spring and early summer (above 12 mg/L) and declining in late summer.

However, there's a noticeable declining trend in DO levels in recent years, with lower annual peaks and a dip below 5 mg/L in 2023, which approaches hypoxic conditions that can be potentially harmful to fish and benthic organisms.



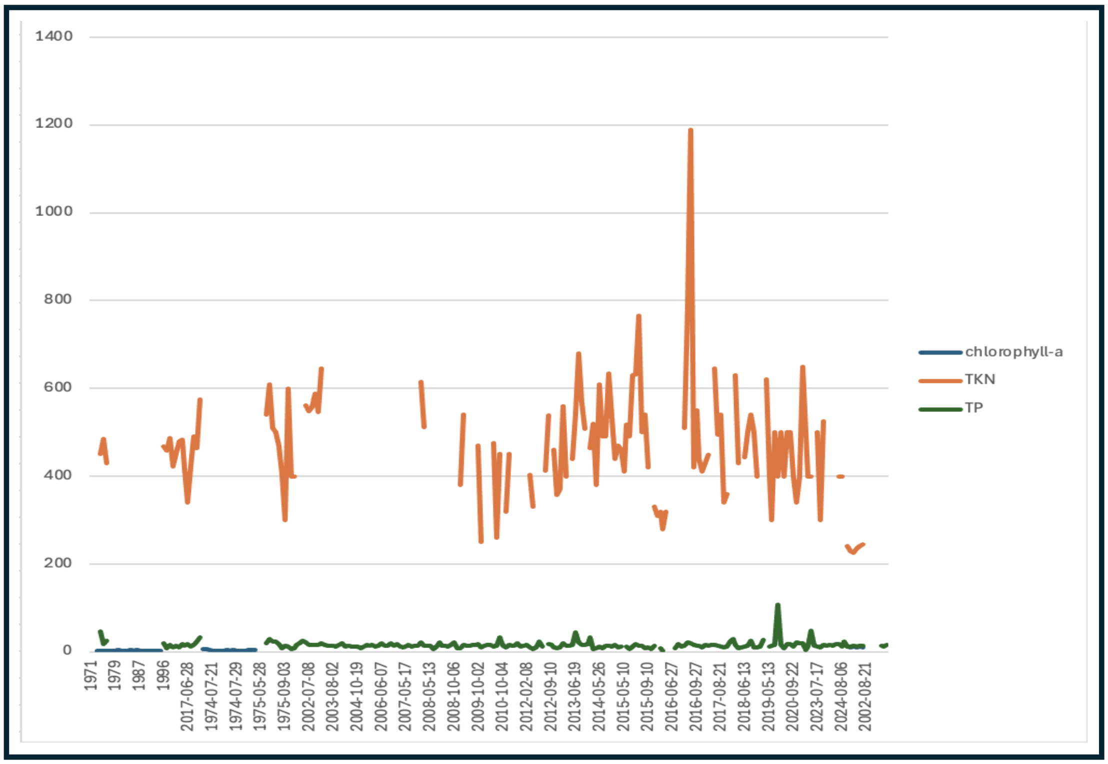
Interpretation:
The decline in DO may reflect increased water temperatures, longer stratification periods, or organic matter decomposition, all of which are potentially exacerbated by climate change. This could stress cold-water fish species and other sensitive aquatic organisms.

Total Nitrogen (TKN), Total Phosphorus (TP), and Chlorophyll-a

TKN concentrations fluctuate considerably over time but generally remain in the 400–600 µg/L range, with periodic spikes above 1000 µg/L (notably in 2016), suggesting episodes of high nitrogen input.

TP levels remain relatively stable and low over time, mostly within the 10–20 µg/L range, aligning with mesotrophic conditions. Occasional spikes are visible but are not sustained.

Chlorophyll-a levels have remained relatively low and stable from 2013 onward. This suggests that algal biomass in the lake is under control, and Otty Lake continues to maintain mesotrophic conditions — however low sample size has implications for general trend accuracy.



Interpretation:

Nutrient Ratios: The relatively high TKN levels compared to TP indicate a high nitrogen-to-phosphorus ratio, which can promote the dominance of certain algal species, including cyanobacteria, under warm conditions.

While TP trends are encouraging, the TKN spikes and DO decline suggest nutrient dynamics and oxygen availability need continued monitoring to avoid ecological stress.

Recommendations

The primary purpose of Otty Lake's monitoring program is to detect early signs of ecological or public health risks, evaluate the success of ongoing management practices, and build a long-term record of environmental change. The interpretation of results should therefore focus on identifying threshold exceedances, long-term trends, and site-specific anomalies that inform proactive lake management.

Public Safety

Sampling results should be evaluated to ensure that recreational water quality remains within safe limits for swimming and other contact activities.
Specifically, we are looking for:

- E. coli concentrations below 100 CFU/100 mL, consistent with provincial recreational water standards.
- Absence or low frequency of cyanobacterial blooms and non-detectable cyanotoxin levels (microcystins < 1 µg/L).
- Stable or improving water clarity (Secchi depth) that supports safe visibility for swimmers and boaters.

Public Health

Results for nutrient, bacterial, and general water chemistry parameters should help determine whether the lake is at risk of nutrient enrichment, bacterial contamination, or septic influence.
Key signals to look for include:

- Stable or declining TP (<20 µg/L) and TKN concentrations to limit algal bloom potential.
- Low variability in E. coli levels across sites, with no consistent "hotspots" indicating septic or runoff issues.
- Conductivity and chloride trends that remain stable or decreasing over time, signalling no major inputs from road salt or wastewater.
- DO concentrations above 5 mg/L in deep-water zones indicate sufficient oxygen for aquatic life and minimal organic loading.

Climate Change Resilience

Long-term datasets should be used to assess how Otty Lake is responding to warming temperatures, altered stratification, and changing hydrology.
In particular, the monitoring program should look for:

- Gradual warming trends in surface and deep-water temperatures.
- Earlier onset and longer duration of stratification, paired with declining bottom-water oxygen levels.
- Changes in Secchi depth and chlorophyll-a as indicators of shifting productivity.

- Fluctuations in water levels or altered ice-on/ice-off timing that reflect changing hydrological and seasonal patterns.

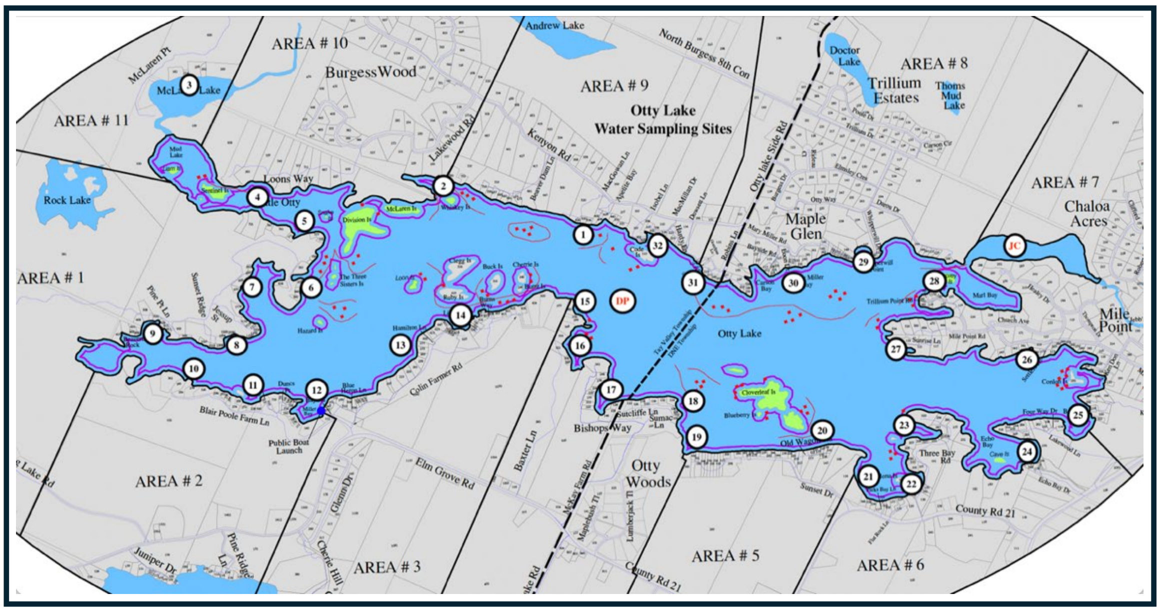
Sampling Locations

Current sampling sites are well-distributed across deep basins, nearshore areas, and inflow points. Additional sites are recommended at outflow points, shallow bays with high development, and upstream tributaries to capture nutrient and bacterial inputs more effectively.

Suggested Additions:

- Outflow site (if one exists).
- Upstream tributaries (to catch issues before they reach the lake).
- Hotspot bays prone to algae or weed growth.

* Adding a few extra purposefully chosen sampling locations in high-risk or important areas of the lake could strengthen your monitoring program.



GPS and Data Accuracy

Recording GPS coordinates for all sampling sites is critical for consistency, trend analysis, and mapping. Coordinates should be added to the master database and sampling forms using handheld GPS devices or smartphone apps.

Sampling Frequency and Coordination

Deep sites should be sampled monthly with full profiles. E. coli sampling should occur more frequently at recreational sites, especially before weekends. Sampling should be coordinated within a 1–3-day window for comparability, with standardized monthly dates and flexibility for weather conditions.

Data Protocols and External Collaboration

The Otty Lake Association (OLA) has a strong foundation in volunteer-led water quality monitoring, particularly through its ongoing E. coli sampling and contributions to the Lake Partner Program (LPP) via Secchi depth and surface temperature readings. These efforts are essential for assessing recreational safety and basic ecological conditions. However, expanding the scope to include more frequent and spatially diverse sampling of Total Phosphorus (TP) and Total Kjeldahl Nitrogen (TKN) is strongly recommended. These nutrients are key indicators of eutrophication risk and can signal the potential for harmful algal blooms, especially under warming climate conditions. Historical data show episodic spikes in TKN and a gradual decline in dissolved oxygen, suggesting that nutrient dynamics and stratification stress may be increasing. By sampling TP and TKN at inflow points, shallow bays, and areas near septic systems or agricultural runoff, OLA can better identify nutrient hotspots and intervene early. Although TP/TKN analysis costs approximately $52.32 per sample plus HST, the insights gained are critical for long-term lake health and can help avoid more costly remediation efforts. Expanding E. coli sampling to additional nearshore recreational sites also improves public health protection by identifying localized contamination risks. Continued collaboration with the Rideau Valley Conservation Authority (RVCA) is recommended for deep water profiles and broader watershed data. OLA should foocus its efforts on nearshore and community-relevant monitoring. Overall, the modest increase in sampling costs is justified by the enhanced ability to detect ecological stressors, protect public health, and support adaptive lake management in the face of climate change.

Cost Breakdown for 2025 Sampling:

- E. coli: $19.32 per sample (plus HST)
- TP/TKN (low level): $52.32 per sample (plus HST)
- Environmental disposal fee: $3.00 per submission (plus HST)

Collaboration with the Rideau Valley Conservation Authority (RVCA) remains essential. RVCA provides:

- Deep water profiles and seasonal stratification data
- Long-term nutrient and chlorophyll a trends
- Hydrological data such as water levels and watershed inflows

This external data complements OLA's nearshore and recreational monitoring efforts. **OLA should focus its volunteer-based sampling on areas with direct human interaction**, while continuing to leverage RVCA's broader watershed data for long-term planning and climate resilience assessments.

Data Integrity

To ensure consistency and data integrity, recommendations to existing protocols (ex: E. coli) are the following:

- **GPS coordinates** should be recorded for all sampling sites to ensure consistent sampling locations year-over-year and improve spatial analysis.
- **Sampling schedules** should be standardized monthly, with flexibility for weather.
- **Protocols should be documented and shared** with volunteers to maintain quality and comparability across years.
- **Include Depth-Specific Temperature Readings** to help assess thermal stratification and climate change impacts. This can be achieved using a thermometer or a temperature probe to record surface and bottom temperatures at each site.
    - Recommended Equipment and Techniques:
      Depth-specific temperature readings can be collected using **digital temperature probes** or **multi-parameter sondes** (e.g., YSI ProDSS or HOBO Water Temp Pro v2). For community-based monitoring, **Water Rangers kits** or **simple thermistor chains** are cost-effective options.
      Estimated Costs: Basic temperature loggers range from **$100–$300 CAD** per unit. More advanced sondes may cost **$1,000** but can be shared across volunteers or borrowed through conservation authority partnerships.
      Resources:
        - Water Rangers Equipment Guide
        - HOBO Data Loggers
        - Rideau Valley Conservation Authority may offer equipment loans or technical support.

Additional Monitoring

Based on feasibility, additional parameters may be considered to strengthen long-term objectives.

For public safety:

While Otty Lake's long-term data on *E. coli* provides a good baseline for recreational water safety, sampling could be strengthened by collecting nearshore *E. coli* data specifically at popular swimming areas and boat launches. These sites better represent the water quality conditions that residents and visitors experience directly. Occasional testing for **cyanotoxins** (e.g., microcystins) during visible algal blooms would also be valuable for identifying potential health risks to swimmers and pets. Additionally, the use of **temperature loggers** could provide a more complete picture of thermal conditions that influence bacterial growth and bloom formation. Community members could contribute by recording **visual observations of algal blooms** using smartphone photos submitted through platforms such as *Water Rangers* or *iNaturalist*.

For public health:

To further understand human-related stressors, monitoring could expand to include chloride and conductivity as indicators of road salt and septic system influence, and pH and alkalinity to assess the lake's buffering capacity against acidification. Tracking nutrient ratios (nitrogen to phosphorus) is helpful in identifying shifts in the types of algal growth likely to occur. Beyond in-lake sampling, integrating shoreline land use data or collaborating with the township to gather septic inspection information could strengthen the link between observed water quality patterns and local management practices. These measures would help identify and mitigate sources of nutrient and contaminant loading before they pose risks to human health or aquatic ecosystems.

For climate change and resiliency:

To evaluate long-term ecosystem change, it would be valuable to establish consistent tracking of ice-on and ice-off dates, a highly sensitive indicator of changing climate patterns. Similarly, reinitiating water level monitoring and collecting temperature profiles at various depths would reveal how warming and altered stratification patterns are affecting oxygen levels and nutrient cycling. Community members can also play an active role in invasive species monitoring through photo-based reporting, which supports early detection of climate-driven species shifts. Together, these datasets will strengthen Otty Lake's ability to detect ecological change and guide adaptive management strategies that enhance lake resilience

Citizen Science Integration

Easiest for Residents (Low training required)

- Secchi depth readings
    - Classic citizen science method (used by Ontario Lake Partner Program).
    - Residents with boats can measure water clarity once or twice a month.

- Shoreline observations
    - Photograph and report algal blooms, foam, oil sheens, aquatic plants, or unusual wildlife events
    - Simple phone app reporting (e.g., Water Rangers, iNaturalist).

- Ice-on / ice-off dates
    - Residents note when the lake completely freezes over and when ice fully disappears.
    - Valuable for long-term climate tracking.

- Invasive species spotting
    - Volunteers trained to recognize key species (e.g., Eurasian watermilfoil, zebra mussels).
    - Submissions through citizen apps or local training workshops.

Moderately Easy (Some training/equipment)

- Shoreline E. coli sampling
    - Residents collect water in sterile bottles from beaches/docks.
    - Samples delivered to a central lab drop-off point (or handled through health unit partnerships).
    - Particularly useful after rain events.
- Conductivity & pH testing
    - Conductivity reflects the presence of dissolved ions, often from road salt, septic leakage, or fertilizer runoff. Rising conductivity may indicate increasing anthropogenic influence.
    - pH measures acidity or alkalinity. Otty Lake's pH should ideally remain between 6.5 and 8.5. Deviations may signal acid rain effects or biological activity shifts.
    - Combined Trends: When conductivity increases while pH decreases, it may suggest nutrient loading or contamination from human sources.
        - Water Rangers Test Kits (approx. $150–$250 CAD) include conductivity and pH meters suitable for citizen science.
        - Handheld meters (e.g., Hanna Instruments or Oakton) offer higher precision for trained volunteers
            - Resources:
                - Water Rangers (https://waterrangers.com)
                - Hanna Instruments Canada (https://hannacan.com)
                - Readings logged by volunteers online.
- Wildlife sightings (loons, fish kills, amphibians)
    - Annual loon survey or fish habitat observations.
    - Helps link water quality with biodiversity trends.
- Macro Invertebrate count or EPT index
    - Measure: visual surveys, eDNA sampling.
    - Macroinvert count or EPT index.
    - E (mayflies), P (stoneflies), and T (caddisflies) are species that are very sensitive to poor water quality.
    - A high abundance of these organisms indicates good water quality conditions at a sample location.

Advanced (With support/partnerships)

- Continuous temperature loggers
    - Volunteers deploy and retrieve loggers at their dock or designated deep-water spots.
    - Data downloaded annually by a coordinator.
- Nearshore nutrient "snapshot days"
    - Residents collect grab samples from multiple locations on the same day.
    - Creates a spatial picture of nutrient hotspots (with professional lab analysis).