Hutchinson
Environmental Sciences Ltd.

McKenzie Lake Scoped Management and Monitoring Plan

Prepared for: McKenzie Lake Property Owners Association
Job #: 210081

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Draft Report

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Executive Summary

The McKenzie Lake Property Owners Association (McKLPOA) retained Hutchinson Environmental Sciences Ltd. (HESL) in 2022 to conduct a background review and field investigation with the goals of characterizing the lake's water quality and shoreline development, reviewing shoreline development policies, and providing recommendations for future monitoring and management of McKenzie Lake. Historical data were obtained from the McKLPOA archives and the Ministry of Environment, Conservation, and Parks (MECP). The lake was surveyed by HESL on 16 August 2022.

The water quality of McKenzie Lake is generally good, with relatively low concentrations of nutrients, chloride, metals, *E. coli*, and phytoplankton. Clarity is relatively low for an oligotrophic lake due to the export of dissolved organic carbon (DOC) from the lake's forested catchment. Clarity has decreased over time which could be the result of increasing DOC concentrations, consistent with trends in south-central Ontario lakes over a similar timeframe (Palmer et al. 2011).

There is good habitat for cold-water fish in the lake's relatively well-oxygenated hypolimnion. Internal phosphorus loading appears to be of limited magnitude based on available data. The only two water quality guideline exceedances were for iron (just above the sediments) and nitrite (on a single date in 2004; possibly an erroneous value).

Climate change, brownification (i.e., increased DOC), and changes to hydrology have resulted in conditions conducive to the proliferation of nuisance and harmful algal blooms. In Central Ontario, this includes a marked recent increase in algal blooms in low-nutrient lakes. The observation of aggregations of a potentially toxic, bloom-forming cyanobacterium of the genus *Planktothrix* is of some concern, but toxic blooms have not been reported (to our knowledge) and this genus is known to thrive in low-light environments, which may explain its presence in the relatively brown waters of McKenzie Lake.

The majority of existing development on McKenzie Lake is typical of true "cottage" development and is well-buffered; intense waterfront development (e.g., large homes, vast impermeable surfaces, wake-surfing boats, and manicured lawns) is largely absent. Responsible waterfront development often requires the enforcement of appropriate planning policies such as those present in the Official Plan, and stewardship/education initiatives implemented by volunteer groups such as McKLPOA. The development character on McKenzie Lake, including intact vegetated shoreline buffers, will help to maintain water quality. Protective Official Plan policies are in place which will help to mitigate development-related impacts if the policies are implemented through education and/or enforcement.

HESL has two recommendations based on the results of this study:

1) The Spills Action Centre should be called at 1-866-MOETIPS (663-8477) if a cyanobacteria ("blue-green algae") bloom is suspected in the future. If a bloom is present, MECP will collect samples to determine if cyanobacteria are present and if there is potential for toxins to be produced based on the particular genus or species identified. If it is confirmed that harmful cyanobacteria are present, additional analyses are completed to determine microcystin concentrations and compare concentrations to the drinking water limit of 1.5 µg/L and recreational limit of 10 µg/L.

2) The Lake Partner Program (LPP), coordinated by MECP provides the best possible entry point to lake monitoring for lake associations with limited resources. The stated goal of the LPP is to protect and understand the water quality of Ontario's inland lakes. This is accomplished by involving citizens in a volunteer-based monitoring program. Total phosphorus (TP) concentrations (2002–2004, 2006, 2010, 2019, 2020, 2021) and water clarity measurements (i.e., Secchi depth; 2001 and 2002) have been collected in McKenzie Lake through the LPP but sampling has been somewhat sporadic and primarily focused on one parameter (TP) and one sampling location. It is recommended that two sites are routinely monitored following LPP instructions and that samples are also assessed for calcium and chloride.

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Acronyms

CWQG – Canadian Water Quality Guideline

DO – Dissolved Oxygen

DOC – Dissolved Organic Carbon

HESL – Hutchinson Environmental Sciences Limited

LPP – Lake Partner Program

MECP – Ministry of Environment, Conservation and Parks

McKLPOA – McKenzie Lake Property Owners Association

MVWHDO – Mean Volume Weighted Hypolimnetic Dissolved Oxygen

NE – Northeast

NW – Northwest

PWQO – Provincial Water Quality Objective

SE – Southeast

TP – Total Phosphorus

1. Introduction

McKenzie Lake is a Central Ontario waterbody located east of Highway 127, approximately 35 km NW of Bancroft, largely within the Township of South Algonquin (District of Nipissing). The lake is relatively small and deep, with a surface area of 3.1 km^2 and a maximum depth of approximately 27 m. The lake's watershed is approximately 60 km^2 and is predominantly (~90%) forested. The lake receives inputs from upstream lakes, including North Chainy Lake (to the SE), Princess Lake (to the NW), and Cross Lake (to the NE), and drains to the north via Moore Creek.

The McKenzie Lake Property Owners Association (McKLPOA) retained Hutchinson Environmental Sciences Ltd. (HESL) in 2022 to conduct a background review and field investigation with the goals of characterizing the lake's water quality and shoreline development, reviewing shoreline development policies, and providing recommendations for future monitoring and management of McKenzie Lake.

2. Water Quality Characterization

2.1 Data Collection

Historical data for McKenzie Lake were obtained from the McKLPOA archives (courtesy of Chris Ursulak), the Ministry of Environment, Conservation, and Parks (MECP) Technical Support Section–Eastern Region (courtesy of Sarah Baxter), and from the MECP's online data portal for the Lake Partner Program (LPP).

In addition, the lake was surveyed by HESL on 16 August 2022. Field measurements and samples were collected at 3 sites (Figure 1). Temperature, dissolved oxygen (DO), pH, and specific conductance were measured throughout the water column at a 1-m interval using a YSI sonde. Vertical profiles of the chlorophyll-a fluorescence of different phytoplankton groups were recorded using a field fluorometer (bbe FluoroProbe). Samples were collected from the upper mixed layer (surface to Secchi depth) by weighted bottle and from 1-m above the lakebed ("1 mob") using a Kemmerer sampling device. Water samples were analyzed by ALS Laboratories for a broad suite of standard limnological parameters (nutrients, bacteria, metals, etc.).

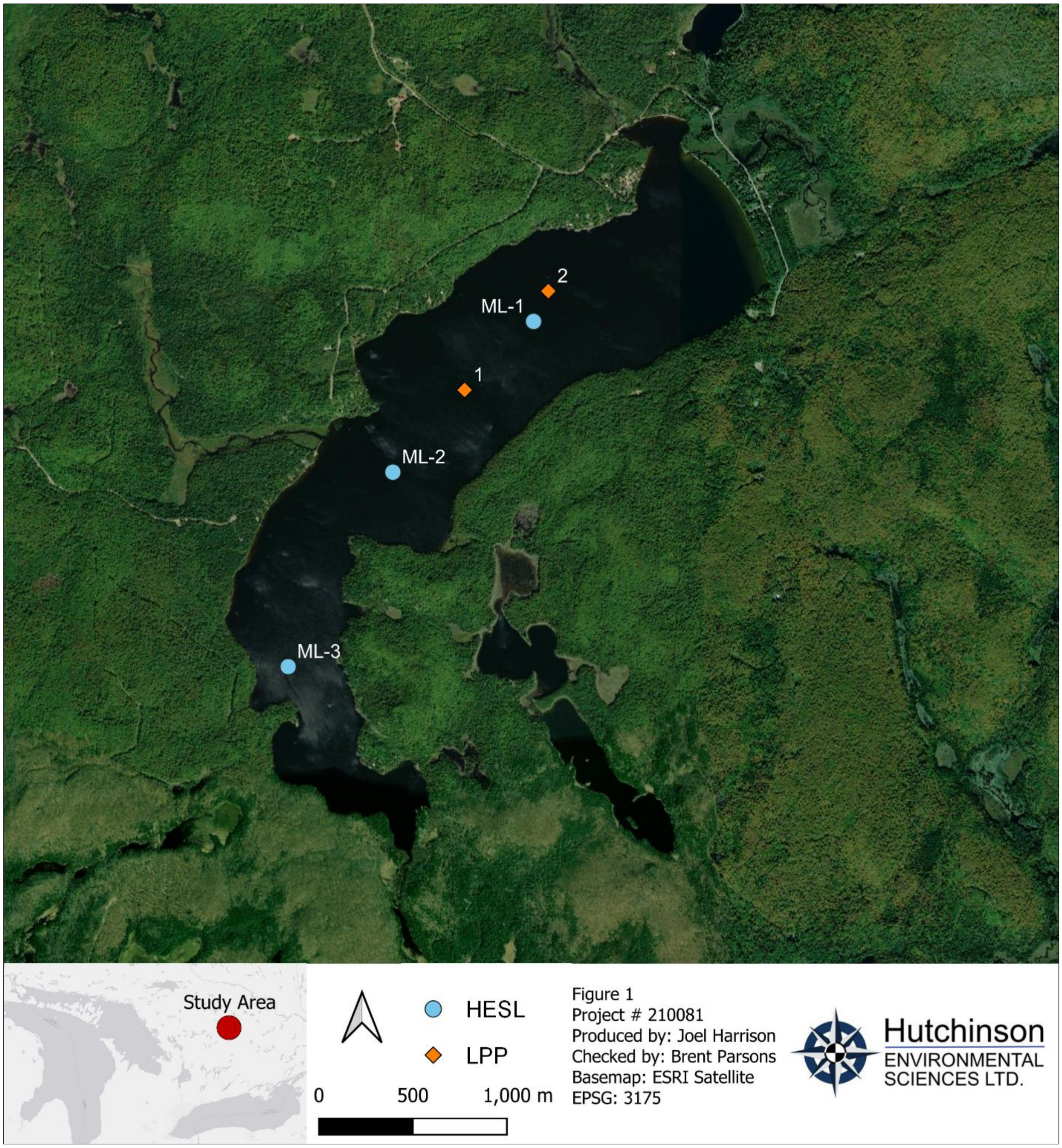


Figure 1. McKenzie Lake sampling locations.

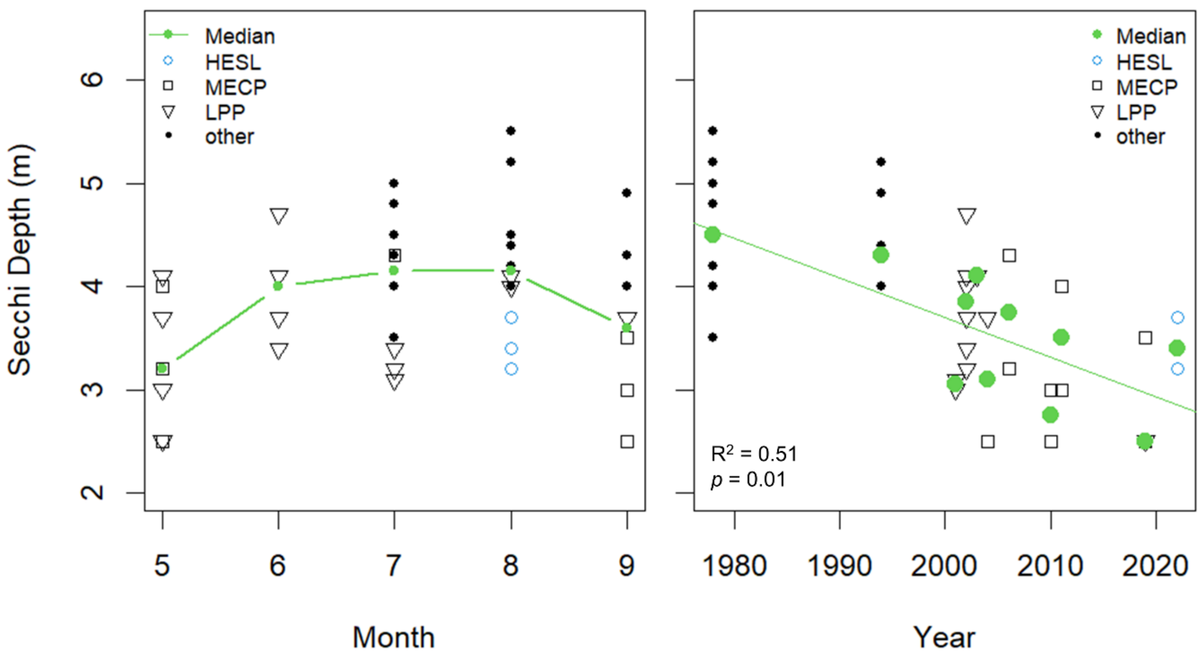
2.2 Water Clarity

HESL recorded Secchi depths of 3.7, 3.2, and 3.4 m at sites ML-1, ML-2, and ML-3, respectively, on 16 August 2022. These Secchi depths are indicative of moderate water clarity; this is predominantly due to light absorption by dissolved organic carbon (DOC), the various molecules that impart a "tea-stained" appearance to water. The average DOC concentration of McKenzie Lake was 7.1 mg/L at the time of the HESL survey, higher than the median of 5.6 mg/L observed by MECP for the period 2004–2019 (range: 5.2–7.0 mg/L)

Historical data indicate that transparency was higher in the summer than in the spring or fall (

Figure 2), likely reflective of increased DOC supply to the lake during periods of higher runoff. There has been a decreasing trend (~0.04 m per year) in the annual median Secchi depth of McKenzie Lake over the past four decades (R^2=0.51; p=0.01;

Figure 2); however, there are large gaps in the record prior to 2001, and no significant trend was detected



between 2001 and 2022 (R^2=0.19; p=0.25) or if only summer (July & August) data are considered (R^2=0.44; p=0.15).

Figure 2. Temporal variation in water clarity (Secchi depth) of McKenzie Lake.

2.3 Stratification and Dissolved Oxygen

The water column of McKenzie Lake thermally stratifies in the summer, with a surface mixed layer (epilimnion) depth of 5–8 m and a hypolimnion (bottom layer) extending from a depth of approximately 10 m down to the lakebed (Figure 3; Figure 4). The mean volume weighted hypolimnetic dissolved oxygen (MVWHDO) concentration of the hypolimnion has varied from 6.65 mg/L to 8.74 mg/L during 2004–2022, with lower MVWHDO values corresponding to later dates of assessment during the open-water season (**Table 1**). These MVWHDO concentrations are above or only slightly (<0.5 mg/L) below the 7 mg/L threshold recommended by the Ministry of Natural Resources and Forestry (MNRF) to ensure high-quality habitat is available for Lake Trout (*Salvelinus namycush*). MVWHDO was not calculated by HESL for 1985 or 1970 due to the low vertical resolution of the hypolimnetic oxygen data available from these years (Figure 3); however, based on the oxygen concentrations reported, MVWHDO would likely be comparable to that calculated for 2004–2022.

Table 1. Hypolimnetic oxygen concentrations in McKenzie Lake.

Date	Agency	MVWHDO (mg/L)	Range of Hypolimnetic DO (mg/L)	Top of Hypolimnion (m)	Profile Depth (m)
2004-09-02	MECP	8.13	1.30–8.84	11	27
2010-09-14	MECP	6.71	1.60–7.22	11	26
2011-09-13	MECP	7.08	5.82–7.35	11	25
2019-09-17	MECP	6.65	3.33–7.31	10	26
2022-08-16	HESL	8.74	2.77–9.17	10	27

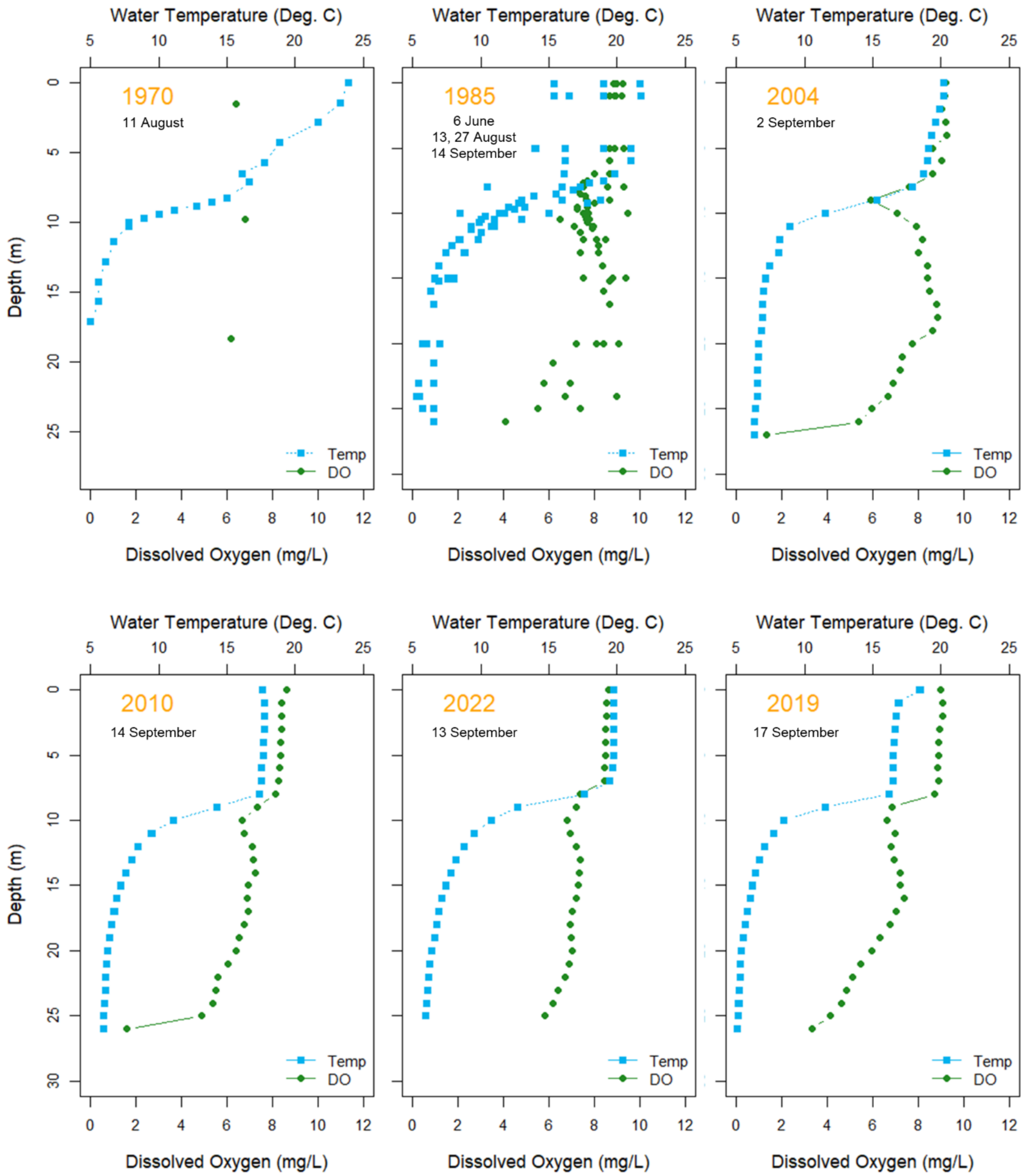


Figure 3. Vertical profiles of temperature and DO based on historical provincial monitoring.

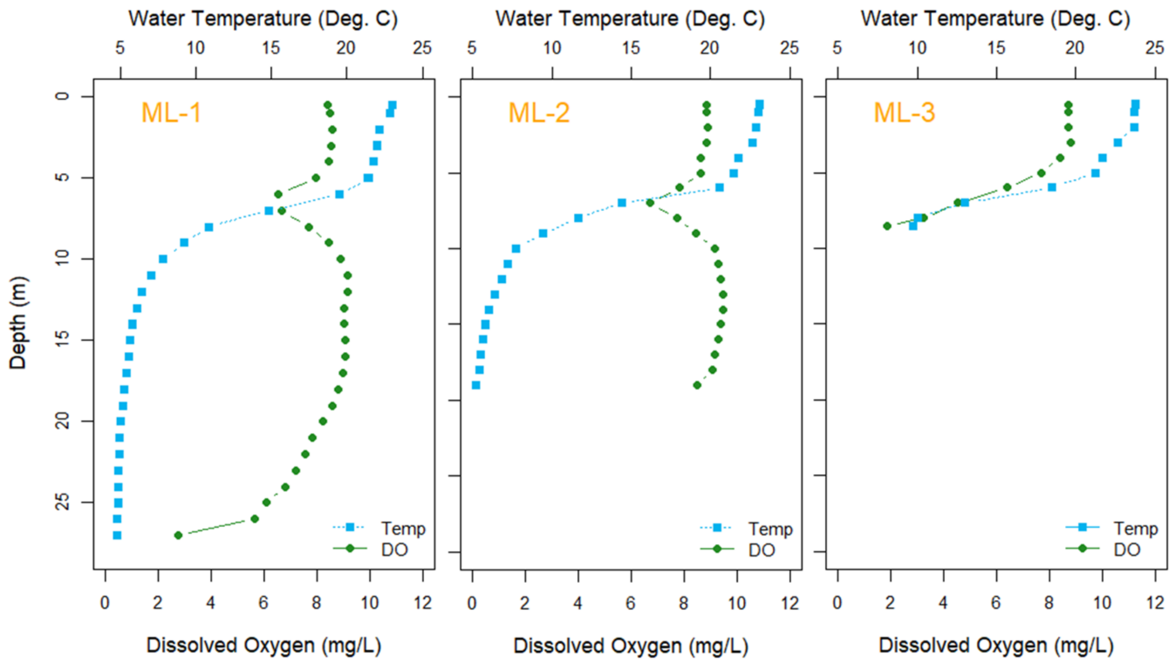


Figure 4. Vertical profiles of temperature and DO measured by HESL on 16 August 2022.

2.4 Water Chemistry

An overview of important lake chemistry characteristics is provided in this section; the full HESL (Appendix A) and MECP (Appendix B) datasets are appended to this report.

2.4.1 General Water Chemistry

McKenzie Lake is a dilute lake, with low suspended solids, low ions/hardness, low alkalinity, and circum-neutral pH (Table 2). These characteristics are common to lakes underlain by the bedrock geology of the Precambrian Shield; the lack of calcium and magnesium carbonates in the watershed soils results in soft water (low ions) with little buffering capacity (low alkalinity). The low concentration of suspended solids (particles) reflects limited phytoplankton biomass (see following sections) and a lack of sediment inputs from eroded soils (as in agricultural areas) or from stormwater (as in urban areas). pH was consistently within the PWQO range of 6.5–8.5 (Table 2).

Table 2. General water chemistry of McKenzie Lake.

Parameter	HESL (16 Aug. 2022)			MECP (2004–2019)	
	ML1	ML2	ML3	Median	Range
Alkalinity (mg-$CaCO_3$/L)	8.6	7.4	6.6	6.8	4.4–106
Hardness (mg-$CaCO_3$/L)	10.6	10.8	10.9	11.4	9.9–113
*pH	7.20	6.98	6.96	7.08	6.61–7.55
Total Dissolved Solids (mg/L)	22	26	20	25	21–143
Total Suspended Solids (mg/L)	<3.0	<3.0	<3.0	1.6	0.7–4.3
*Specific Conductance (µS/cm)	36	36	36	39	33–216

** Values of specific conductance and pH for the HESL survey were calculated from field measurements as the average for the epilimnion (0–5 m).*

2.4.2 Phosphorus

Epilimnetic total phosphorus (TP) concentrations were 6.9, 6.0, and 6.6 µg/L at sites ML-1, ML-2, and ML-3, respectively, on 16 August 2022. Based on these relatively low TP concentrations, McKenzie Lake can be described as oligotrophic. These concentrations are below the interim PWQO of 10 µg/L recommended for a high degree of protection against aesthetic deterioration (MOEE 1994).

The TP concentrations of August 2022 are within the range historically observed for McKenzie Lake based on provincial monitoring (2–18 µg/L) and very close to the long-term median TP of 6 µg/L (**Figure 5**). There is no apparent seasonality in McKenzie Lake's TP concentration (**Figure 5**), nor has there been a statistically significant trend in annual median TP concentrations since 1978 (R^2=0.00; *p*=0.84) or since more intensive monitoring began in 2002 (R^2=0.00; *p*=0.93).

On certain summer dates (including the HESL survey) samples were collected from the hypolimnion (1 m above the lakebed) in addition to the epilimnetic (surface mixed layer) samples described above to determine if the internal loading of nutrients from sediment was present. On these dates, the hypolimnetic TP (median: 10.3 µg/L; range: 8.0–14.3 µg/L; *n* = 8) was generally higher than epilimnetic TP (median: 6.3 µg/L; range: 5.0–9.0 µg/L; *n* = 8); however, the difference in concentrations is relatively small and not statistically significant (Pearson's *r* = 0.16*;* *p* = 0.71), though this is likely due in part to the small sample size (*df* = 6).

In summary, the TP concentration of McKenzie Lake is relatively low, stable, and does not appear to be strongly influenced by the lake's sediments (i.e., internal phosphorus loading is not significant).

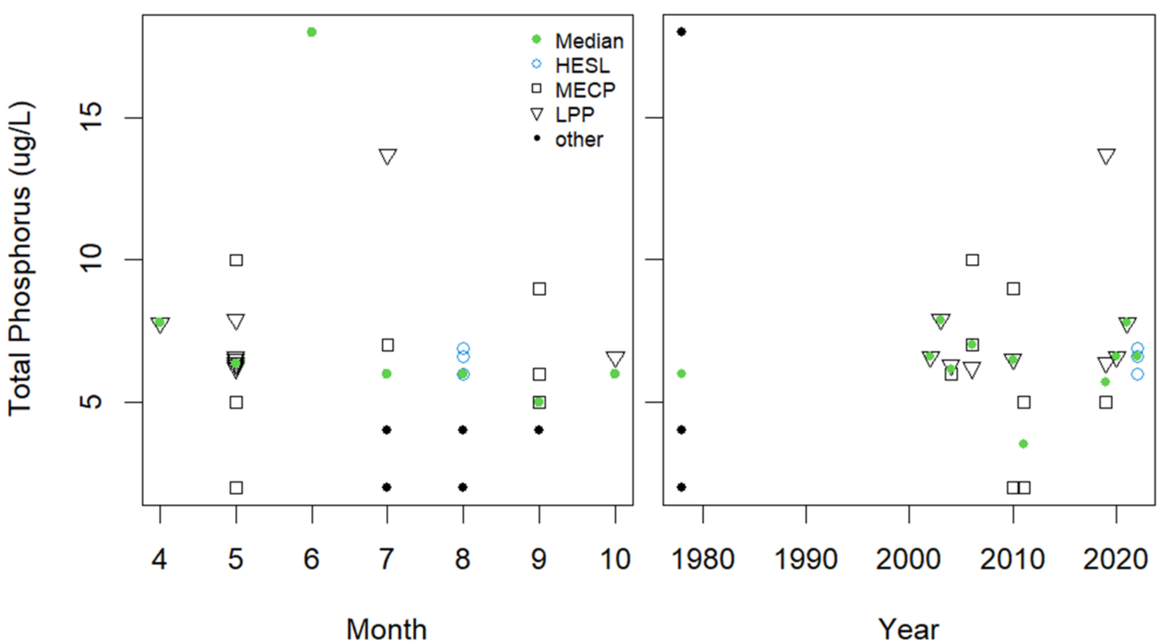


Figure 5. Temporal variation in the epilimnetic total phosphorus concentration of McKenzie Lake.

2.4.3 Nitrogen

Inorganic nitrogen concentrations were low on 16 August 2022, with ammonia, nitrite, and nitrate concentrations well below guidelines; similar results have been obtained via MECP monitoring (Table 3), with the exception of a single CWQG exceedance for nitrite on 25 May 2006 (i.e., 0.100 mg-N/L vs. the guideline of 0.060 mg-N/L); this value may represent laboratory error as all other nitrite values reported by MECP were ≤0.005 mg-N/L and nitrite is typically very low in unpolluted lakes (as it is rapidly oxidized to nitrate).

Based on the long-term median TP concentration of 6 µg/L and the median TN concentration of 0.31 mg/L, the TN:TP mass ratio is approximately 52 (equivalent to a molar ratio of 114) which suggests that primary production in McKenzie Lake is constrained by phosphorus availability rather than nitrogen availability (Guildford and Hecky 2000).

Table 3. Nitrogen concentrations in McKenzie Lake.

Parameter	Guideline	HESL (16 Aug. 2022)			MECP (2004–2019)	
		ML1	ML2	ML3	Median	Range
Ammonia (µg-N/L)	16.4	<0.04	<0.02	0.03	0.09	0.01–1.80
Nitrate	3	0.025	<0.020	<0.020	0.017	0.000–0.351
Nitrite	0.06	<0.010	<0.010	<0.010	0.002	0.001–0.100
Total Kjeldahl Nitrogen	-	-	-	-	0.28	0.22–0.41
Total Nitrogen	-	-	-	-	0.31	0.24–0.64

Note: Concentrations are mg-N/L for all parameters except for un-ionized ammonia (µg-N/L). The ammonia guideline is the PWQO; the guidelines for nitrate and nitrite are CWQGs (there are no PWQOs for nitrate and nitrite). Total Kjeldahl Nitrogen and Total Nitrogen were requested by HESL but the analyses were not performed by the laboratory.

2.4.4 Chloride

Chloride concentration was low when assessed by HESL in August of 2022 (3.5–3.6 mg/L) and MECP in May and September of 2019 (3.2–4.9 mg/L) relative to the CWQG of 120 mg/L. Road salting in lake catchments is the major source of chloride to lakes. The low chloride concentrations in McKenzie Lake are due to the predominance of forest cover and low level of urbanization in the lake's drainage basin.

2.4.5 Metals

Metal concentrations were generally quite low in McKenzie Lake when assessed by HESL on 16 August 2022. Concentrations were below the detection limit (at all 3 sites) for 18 of the 39 metals quantified. No epilimnetic metal concentration exceeded its PWQO. Iron was 1.3 mg/L (above the PWQO of 0.3 mg/L) in the hypolimnion (i.e., 1 m above the lakebed) at the deepest site (ML-1); this likely reflects release from the sediments and is thus localized, transient, and inconsequential in the context of recreation, household water use, or toxicological effects on aquatic life.

2.5 Bacteria

The PWQO for *Escherichia coli* bacteria is a maximum of 100 *E. coli* per 100 mL based on a geometric mean calculated from 5 samples collected from one site within a month (MOEE 1994). The only *E. coli* data available for McKenzie Lake (to our knowledge) are from our 2022 survey; thus, quantitative evaluation of McKenzie Lake's *E. coli* concentrations relative to the PWQO is not possible. Based on the *E. coli* concentrations of August 2022 (i.e., ≤1 MPN[1]/100 mL at all sites), and what is known about the lake in general, it is considered likely that McKenzie Lake would usually meet the PWQO for *E. coli* (i.e., does not have serious issues with fecal contamination).

2.6 Phytoplankton

Chlorophyll-a concentration is relatively simple and inexpensive to determine and for this reason it is a commonly used surrogate for phytoplankton biomass in lakes. The chlorophyll-a concentration within the epilimnion of McKenzie Lake was 3.5, 3.9, and 3.2 µg/L at sites ML-1, ML-2, and ML-3, respectively, on 16 August 2022. These chlorophyll concentrations are indicative of moderate phytoplankton biomass, which is consistent with the lake's relatively low nutrient concentrations (see Section 2.4). The chlorophyll concentrations observed in 2022 are within the ranges determined via provincial monitoring in 1978 (avg. = 2.0 µg/L; range = 1.0–5.1 µg/L) and 1994 (avg. = 4.0 µg/L; range = 1.5–15.5 µg/L), suggesting that no major changes in trophic status have occurred over the past 4 decades.

Based on fluorescence, green algae (and possibly euglenoids) comprised the majority of the phytoplankton community on 16 August 2022, with cryptophytes, chrysophytes, diatoms, dinoflagellates, and cyanobacteria collectively comprising less than 25% of the total estimated biomass ().

Macroscopic aggregations of phytoplankton (i.e., large particles) were observed dispersed throughout the water column on 16 August 2022. A sample was collected from site ML-3 and the cells (Figure 7. Cyanobacterial filaments collected from McKenzie Lake on 16 August 2022.) have been tentatively identified by HESL as belonging to the genus *Planktothrix (aka Oscillatoria[2])*, a group of filamentous cyanobacteria ("blue-green algae") that is commonly observed in temperate lakes; species of this genus can form surface blooms and may produce toxins (Komárek et al. 2003), predominantly the hepatotoxin microcystin (Kurmayer et al. 2016). However, as noted above, cyanobacteria did not constitute a large fraction of the phytoplankton community at the time of the HESL survey; the majority of the phytoplankton were eukaryotes (algae), which do not produce toxins or form surface blooms in lakes and are an important component of aquatic food webs.

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[1] *ALS Laboratories is now reporting E. coli in MPN ("most probable number") as well as CFU ("colony forming units"); the different units correspond to different analytical protocols.*

[2] *The taxonomy of the genus* Planktothrix *is somewhat ambiguous; the genus is considered valid under the International Code of Botanical Nomenclature, but its species are still considered part of the genus* Oscillatoria *according to the International Code of Nomenclature of Prokaryotes (Kurmayer et al. 2016).*

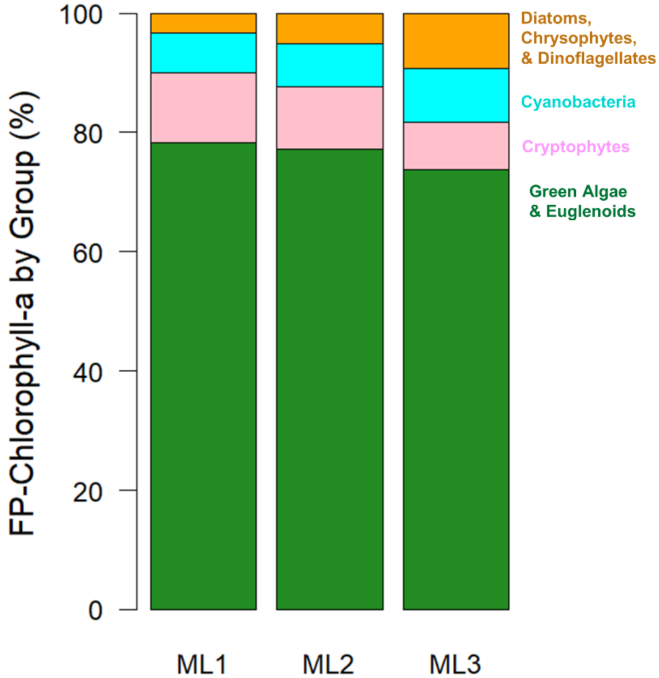

Figure 6. Epilimnetic (0–5 m) phytoplankton community composition of McKenzie Lake on 16 August 2022, as inferred from FluoroProbe profiles.

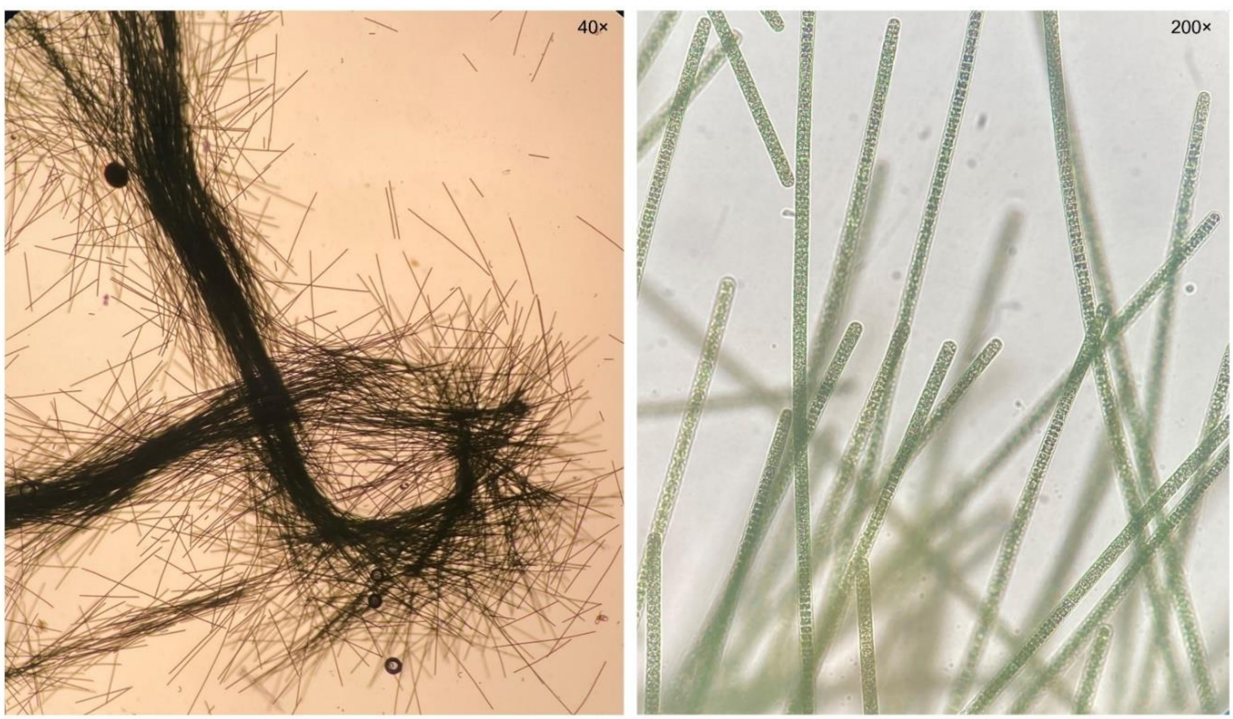

Figure 7. Cyanobacterial filaments collected from McKenzie Lake on 16 August 2022.

3. Shoreline Development

3.1 Shoreline Vegetative Buffers

The Official Plan - Township of South Algonquin Official Plan (2012) contains a variety of policies that help dictate development throughout the Township. Several of the policies are focused on waterfront development and are applicable to McKenzie Lake. Policies 5.3.11 and 5.3.12 are focused on shoreline vegetative buffers:

"5.3.11 The maintenance of shoreline vegetation is beneficial to:

a) protect the riparian and littoral zones and associated habitat;
b) prevent erosion, siltation and nutrient migration;
c) maintain shoreline character and appearance; and
d) provide fish habitat.

5.3.12 Clearing of natural vegetation along the shoreline should be restricted to that needed for access, recreational use, limited view of the water and safety of residents. The shoreline frontage of the lot should be maintained in natural shoreline vegetation, including trees, in the water and upland along the water's edge. The extent of removal in the shoreline areas will be considered within the following parameters:

a) A maximum of 30% of the shoreline frontage or up to 15 metres, whichever is the lesser, for shoreline/linear residential development;"

Shorelines link terrestrial and aquatic ecosystems, acting as a transition zone between land and water. They are biological hotspots and highly productive habitats that provide myriad ecological services, including maintenance of water quality, flood protection, and wildlife habitat. Shoreline buffers can play an important role in protecting lake health. The physical separation they provide between upland human activity and the aquatic environment can aid in mitigating the effects of development and site alteration on water quality, erosion and flood control, and wildlife habitat. Much of McKenzie Lake's shoreline is undeveloped (Photograph 1). There is no road access to the SE areas of the lake's perimeter and this land remains in a predominantly forested state. Most of the developed lots on McKenzie Lake were observed to have vegetative buffer zones (i.e., the presence of plants that help to minimize runoff and associated pollutants such as nutrients and soil particles; Photographs 2–4) in accordance with Official Plan policies.

Photographs 1 and 2. Undeveloped shoreline (top) and a view of waterfront development along the northern shoreline exhibiting intact natural vegetated buffers (bottom).

Photographs 3 and 4. Another example of waterfront development that is well buffered from the lake (top) and a representative view of development on the northeastern shoreline where beachfront is present.

Policies exist for shoreline buffers as discussed in Section 3, while Policies 5.44, 5.5, and 5.3.4–5.3.5 are also aimed at mitigating development-related impacts on McKenzie Lake.

3.2 Setbacks

Waterfront development generates stormwater and wastewater which can negatively impact adjacent waterbodies. Shorelines provide numerous benefits, and, in general, larger setbacks and buffers are better at consistently providing a range of protective functions. The scientific literature demonstrates that a 30-m buffer provides a range of ecological services, and this buffer size is commonly recommended in the peer-reviewed literature focused on shoreline development (aligning with Provincial guidance). While smaller buffers provide some benefits for water quality and aquatic habitat protection, larger buffers provide more ecological services to a greater extent. Policy 5.4.4 in the Official Plan is focused on setbacks:

"5.4.4 Development and site alteration will be set back from all watercourses within the Township in order to protect the natural features and functions of the watercourse, provide riparian habitat, and minimize the risk to public safety and property. Buildings, structures and sewage disposal systems will be set back at least 30 m (100 feet) from the high water mark of all of lakes, rivers and streams."

3.3 Conversion from Seasonal to Permanent

The conversion from a seasonal to permanent use could negatively impact McKenzie Lake because of a variety of increased stressors such as greater loading of septic effluent or changes to built form such as enlarging dwellings. Policies 5.5.1 – 5.5.3 are in place to ensure that septic systems can treat increased sewage loading rates, while buffer and setback requirements should also help mitigate impacts associated with building alterations should conversions from seasonal to permanent use occur:

"5.5.1 There is a substantial proportion of the population of the Township of South Algonquin that is identified as seasonal given that their principal residence is located elsewhere. Ongoing trends suggest that some second-home owners will likely be interested in locating in the Township at their part-time residence on a full-time basis. Applications for such seasonal residential conversions will be considered by the Township.

5.5.2 While it is anticipated that the number of actual seasonal residential conversions to year round use will be low, there may be some land use implications that arise as a result of this action. Residents intending to convert their seasonal dwellings into year-round homes shall be aware that the conversion of a seasonal dwelling into a year-round home is insufficient, by itself, to encourage upgrading of municipal services to the home. The Township must evaluate all factors, including the costs to other taxpayers, before proceeding with any service upgrades. The Township may pass by-laws clearly identifying how such properties may be subject to limited services.

5.5.3 The conversions of seasonal dwellings to year-round use shall require proof that an approved sewage system has been installed."

3.4 Development Capacity

The development capacity of lakes in Ontario is typically determined via Lakeshore Capacity Assessment (Ministry of Environment 2010), while the MNRF threshold for MVWHDO of 7 mg/L is also considered for lakes that support Lake Trout populations such as McKenzie Lake. Lakeshore Capacity Assessment wasn't completed as part of this scope of work while MVWHDO concentrations have fluctuated below and above the 7 mg/L threshold indicating that the determination of development capacity based on MVWHDO is uncertain. Official Plan policies 5.3.4 - 5.3.6 are, however, in place to determine development capacity and mitigate development-related impacts if policies are enforced:

"5.3.4 No development will be permitted which would result in a waterbody being developed to a point of being over capacity as identified by the Ministry of the Environment, the Ministry of Natural Resources, or Council. When reviewing development proposals, Council shall consider:

a) the biological capacity of the lake in terms of the number of cottages, dwellings or tourist units that can be accommodated on a water body while maintaining sufficient levels of fish habitat, water clarity and water quality; and

b) the recreational capacity of the lake in terms of maintaining a reasonable level of enjoyment on the surface of the lake for persons presently using the lake for recreational purposes.

5.3.5 New lot creation is not permitted on "at capacity" lake trout lakes. However, Council may consider the creation of new lots in certain circumstances where it can be proven to the satisfaction of council, in consultation with the Ministry of the Environment and the Ministry of Natural Resources, through detailed environmental studies; that development shall result in no negative impact on the lake. The Ministry of the Environment and the Ministry of Natural Resources shall be consulted in situations where one or more of the following conditions exist:

a) the severance is to separate existing habitable dwellings, each of which has a separate septic system, provided the land use would not change; or

b) all new septic system tile fields are located such that they would drain into a drainage basin which is not at capacity; or

c) all new tile fields are set back at least 300 meters from the shoreline of the lake or permanently flowing tributary to the lake; or

d) the effluent pathway from a tile field would flow in a manner for a distance of at least 300 meters to the lake. This must be supported by a report prepared by a qualified professional that is a licensed member of the Professional Engineers of Ontario who is qualified to practice geoscience; or

e) where a site-specific soils investigation prepared by a qualified professional demonstrates that phosphorus can be retained in deep, native, acidic soils on-site, to satisfaction of the Ministry of the Environment.

5.3.6 Lake trout lakes classified by the Ministry of the Environment and Ministry of Natural Resources as "not at capacity" can sustain additional development subject to the following criteria:

a) development, including the septic system tile bed, must be set back a minimum of 30 metres from the high water of the lake with non-disturbance of the native soils and vegetation;

b) modeling of the lake to determine whether it can accommodate additional development;

c) stormwater management via infiltration galleries, redirection of surface water runoff away from the lake;

d) large development proposals (i.e., greater than five lots or resort/condominium developments) must be supported with a study by a qualified consultant. This study is an impact assessment of a proposed development on a water body to ensure water quality protection. The study should take into consideration the existing water quality of the water body, surface water run-off, impact and loadings of phosphorous from septic systems, type of soils, stormwater management and nature of vegetation. The classification of lakes in the Official Plan is subject to change and may change in the future based on factors such as an assessment of new water quality data and/or changes in water quality standards. Therefore, the possibility exists that a lake trout lake that is classified in the Official Plan as "not at capacity" or "at capacity" at a certain point in time may change during the life of the Official Plan. Any changes to the classification of lakes will require an Official Plan Amendment."

4. Summary and Recommendations

4.1 Water Quality Summary

The water quality of McKenzie Lake is generally good, with relatively low concentrations of nutrients, chloride, metals, *E. coli*, and phytoplankton. Clarity is relatively low for an oligotrophic lake due to the moderate DOC concentration of the water caused by export of organic carbon from the lake's forested catchment. Clarity has decreased over time which could be the result of increasing DOC concentrations which have increased in south-central Ontario lakes over a similar timeframe (Palmer et al. 2011).

There is good habitat for cold-water fish in the lake's relatively well-oxygenated hypolimnion. Internal phosphorus loading appears to be of limited magnitude based on available data. The only two water quality guideline exceedances were for iron (just above the sediments) and nitrite (on a single date in 2004; possibly an erroneous value).

Climate change, brownification (i.e., increased DOC) and changes to hydrology have resulted in conditions conducive to the proliferation of nuisance and harmful algal blooms. In Central Ontario, this includes a marked recent increase in algal blooms in low nutrient lakes. The existing scientific body of literature suggests that the conventional understanding and management of algal blooms, that is based on controlling phosphorus concentrations in the water column, is not adequate to manage the development of oligotrophic blooms in nutrient-poor lakes (Reinl et al. 2021). The observation of aggregations of a potentially toxic, bloom-forming cyanobacterium of the genus *Planktothrix* is of some concern, but toxic blooms have not been reported (to our knowledge) and this genus is known to thrive in low-light environments (Kurmayer et al. 2016), which, with its relatively brown waters, may explain its presence in McKenzie Lake.

4.2 Shoreline Development Summary

The majority of existing development on McKenzie Lake is typical of true "cottage" development and is well-buffered; more intense waterfront development (e.g., large homes, vast impermeable surfaces, wake-surfing boats, and manicured lawns), which would place greater stress on McKenzie Lake, appears to be largely absent. Responsible waterfront development often requires the enforcement of appropriate planning policies such as those present in the Official Plan, and stewardship/education initiatives implemented by volunteer groups such as McKLPOA. Recommendations

4.3 Recommendations

Water quality data in McKenzie Lake is generally good. Water clarity has declined over the years and blue-green algae was observed, both of which are likely driven by changes in climate and DOC concentrations. The development character on McKenzie Lake, complete with intact vegetated shoreline buffers will help to maintain water quality and protective Official Plan policies are in place which will help to mitigate development-related impacts if they are implemented through education and/or enforcement.

HESL has two recommendations based on the results of this study:

(1) The Spills Action Centre should be called at 1-866-MOETIPS (663-8477) if a cyanobacteria ("blue-green algae") bloom is suspected in the future. If a bloom is present, MECP will collect samples to determine if cyanobacteria are present and if there is potential for toxins to be produced based on the particular genus or species identified. If it is confirmed that harmful cyanobacteria are present, additional analyses are completed to determine microcystin concentrations and compare concentrations to the drinking water limit of 1.5 µg/L and recreational limit of 10 µg/L.

(2) The Lake Partner Program (LPP), coordinated by MECP provides the best possible entry point to lake monitoring for lake associations with limited resources. The stated goal of the LPP is to protect and understand the water quality of Ontario's inland lakes. This is accomplished by involving citizens in a volunteer-based monitoring program. TP concentrations (2002–2004, 2006, 2010, 2019, 2020, 2021) and water clarity measurements (i.e., Secchi depth; 2001 and 2002) have been collected in McKenzie Lake through the LPP but sampling has been somewhat sporadic and primarily focused on one parameter (TP) and one sampling location. It is recommended that two sites are routinely monitored following LPP instructions and samples are also assessed for calcium and chloride. The MECP provides sampling instructions and the equipment needed to participate in the LPP (https://www.ontario.ca/page/lake-partner-program-sampling-instructions). This includes a basic sampling bottle, plastic funnel with Nitex mesh (to screen out large particles), Secchi disk, pre-paid Canada Post labels for sample return, sample containers and instructions. Water samples are collected once annually, at least 2 weeks following ice off (i.e., in April or May), and water clarity measurements with a Secchi disk are performed 1–2 times per month during the ice-free period. Lake associations interested in participating in the Lake Partner Program should contact the Program Coordinator at lakepartner@ontario.ca for new registrations or questions.

5. References

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Appendix A. Water quality data from HESL survey

Parameter	Units	ML1	ML2	ML3
chlorophyll a	µg/L	3.54	3.92	3.2
alkalinity, bicarbonate (as CaCO3)	mg/L	8.6	7.4	6.6
alkalinity, carbonate (as CaCO3)	mg/L	<2.0	<2.0	<2.0
alkalinity, hydroxide (as CaCO3)	mg/L	<2.0	<2.0	<2.0
alkalinity, total (as CaCO3)	mg/L	8.6	7.4	6.6
hardness (as CaCO3), from total Ca/Mg	mg/L	10.6	10.8	10.9
pH	pH units	8.39	7.09	7.01
solids, total dissolved [TDS]	mg/L	22	26	20
solids, total suspended [TSS]	mg/L	<3.0	<3.0	<3.0
solids, total suspended [TSS] - 1 MOB	*mg/L*	*<3.0*	*<3.0*	*<3.0*
ammonia, total (as N)	mg/L	<0.0050	<0.0050	0.008
chloride	mg/L	3.54	3.58	3.53
nitrate (as N)	mg/L	0.025	<0.020	<0.020
nitrite (as N)	mg/L	<0.010	<0.010	<0.010
phosphate, ortho-, dissolved (as P)	mg/L	<0.0030	<0.0030	<0.0030
phosphate, ortho-, dissolved (as P) - 1 MOB	mg/L	<0.0030	<0.0030	<0.0030
phosphorus, total	mg/L	0.0069	0.006	0.0066
phosphorus, total - 1 MOB	*mg/L*	*0.0101*	*0.0143*	*0.0104*
sulfate (as SO4)	mg/L	3.33	3.22	3.2
carbon, dissolved organic [DOC]	mg/L	7.1	7.14	7.04
coliforms, total	MPN/100mL	165	>201	>201
coliforms, Escherichia coli [E. coli]	MPN/100mL	<1	1	1
aluminum, total	mg/L	0.0231	0.0227	0.0273
antimony, total	mg/L	<0.00010	<0.00010	<0.00010
arsenic, total	mg/L	0.00014	0.00016	0.00015
barium, total	mg/L	0.0106	0.0103	0.011
beryllium, total	mg/L	<0.000020	<0.000020	<0.000020
bismuth, total	mg/L	<0.000050	<0.000050	<0.000050
boron, total	mg/L	<0.010	<0.010	<0.010
cadmium, total	mg/L	6.8E-06	5.6E-06	7.6E-06
calcium, total	mg/L	2.94	3.02	3.01
cesium, total	mg/L	<0.000010	<0.000010	<0.000010
chromium, total	mg/L	<0.00050	<0.00050	<0.00050
cobalt, total	mg/L	<0.00010	<0.00010	<0.00010
copper, total	mg/L	<0.00050	0.00053	0.00158
iron, total	mg/L	0.062	0.057	0.118
iron, total - 1 MOB	*mg/L*	*1.3*	*0.189*	*0.244*
lead, total	mg/L	<0.000050	0.000064	0.00013
lithium, total	mg/L	<0.0010	<0.0010	<0.0010
magnesium, total	mg/L	0.803	0.796	0.813
manganese, total	mg/L	0.0143	0.0123	0.053
molybdenum, total	mg/L	0.000063	0.000061	0.000058
nickel, total	mg/L	<0.00050	<0.00050	<0.00050
potassium, total	mg/L	0.505	0.497	0.511
rubidium, total	mg/L	0.00105	0.00101	0.00104
selenium, total	mg/L	0.000084	0.000057	0.000058
silicon, total	mg/L	2.61	2.52	2.67
silver, total	mg/L	<0.000010	<0.000010	<0.000010
sodium, total	mg/L	2.86	2.76	2.77
strontium, total	mg/L	0.0206	0.0213	0.0208
sulfur, total	mg/L	1.12	1.08	1
tellurium, total	mg/L	<0.00020	<0.00020	<0.00020
thallium, total	mg/L	<0.000010	<0.000010	<0.000010
thorium, total	mg/L	<0.00010	<0.00010	<0.00010
tin, total	mg/L	<0.00010	<0.00010	<0.00010
titanium, total	mg/L	<0.00030	0.00033	0.00035
tungsten, total	mg/L	<0.00010	<0.00010	<0.00010
uranium, total	mg/L	0.00001	<0.000010	0.000011
vanadium, total	mg/L	<0.00050	<0.00050	<0.00050
zinc, total	mg/L	0.0054	0.0115	0.0082
zirconium, total	mg/L	<0.00020	<0.00020	<0.00020

Appendix B. MECP water quality data

		2004-09-02		2006-05-25	2006-07-17		2010-05-05	2010-09-14		2011-05-16	2011-09-13		2019-05-21	2019-09-17	
		Surface	***1 MOB***	**Surface**	**Surface**	***1 MOB***	**Surface**	**Surface**	***1 MOB***	**Surface**	**Surface**	***1 MOB***	**Surface**	**Surface**	***1 MOB***
Total Phosphorus	mg/L	0.006	*0.012*	0.010	0.007	*0.008*	0.002	0.009	*0.011*	0.002	0.005	*0.008*	0.005	0.005	*0.009*
Ammonia	mg-N/L	0.015	*0.007*	0.050	0.012	*0.005*	0.030	0.002	*0.010*	0.029	0.043	*0.034*	0.022	0.306	*0.219*
Nitrite	mg-N/L	0.002	*0.002*	0.100	0.002	*0.001*	0.003	0.002	*0.002*	0.002	0.005	*0.004*	0.003	0.001	*0.002*
Nitrate+Nitrite	mg-N/L	0.013	*0.172*	0.100	0.016	*0.168*	0.354	0.017	*0.145*	0.111	0.044	*0.187*	0.020	0.032	*0.215*
Total Kjeldahl Nitrogen	mg-N/L	0.25	*0.25*	0.30	0.29	*0.28*	0.29	0.41	*0.28*	0.27	0.27	*0.28*	0.22	0.28	*0.26*
Dissolved Organic Carbon	mg/L	5.7	*5.5*	5.2	5.6	*5.5*	5.4	7.0	*5.5*	6.0	6.2	*5.8*	5.6	5.2	*5.6*
Dissolved Inorganic Carbon	mg/L	1.3	*1.8*	25.1	1	*1.6*	0.9	1.5	*1.2*	1.5	0.9	*1.4*	1.4	1	*1.8*
pH	-	7.08	*6.93*	7.55	6.98	*6.75*	7.00	7.05	*6.68*	7.28	7.14	*7.04*	6.61	7.08	*6.66*
Total Alkalinity	mg/L	8	*7*	106	8	*7*	5	6	*6*	7	7	*6*	4	6	*6*
Conductivity	uS/cm	43	*43*	216	43	*43*	37	39	*40*	41	36	*37*	33	36	*38*
Total Suspended Solids	mg/L	-	-	2.0	1	*0.6*	1.3	1.8	*1.7*	1.9	1	*3*	4.3	0.7	*0.5*
Total Dissolved Solids	mg/L	-	-	143	28	*28*	24	25	*26*	26	23	*24*	21	24	*24*
Calcium	mg/L	3.2	*3.2*	3.6	3.4	*3.3*	3.1	3.0	*2.9*	3.4	2.7	*2.9*	2.9	3.3	*3.3*
Magnesium	mg/L	0.88	*0.88*	5.93	0.90	*0.90*	0.84	0.88	*0.84*	0.97	1.16	*1.08*	0.64	0.75	*0.74*
Sodium	mg/L	-	-	-	-	-	-	-	-	-	-	-	2.50	2.64	*2.51*
Potassium	mg/L	-	-	-	-	-	-	-	-	-	-	-	0.51	0.51	*0.51*
Hardness	mg/L	11	*11*	113	12	*12*	11	11	*11*	12	12	*12*	10	11	*11*
Chloride	mg/L	-	-	-	-	-	-	-	-	-	-	-	3.2	4.3	*4.9*
Sulphate	mg/L	-	-	-	-	-	-	-	-	-	-	-	3.4	3.7	*3.4*