SUMMERSIDE LAKE 2020
LIMNOLOGICAL MONITORING REPORT

Enviro Mak Inc.
Environmental Management Consultants

SUMMERSIDE LAKE 2020 LIMNOLOGICAL MONITORING REPORT

Submitted to:

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OF

SUMMERSIDE LAKE RESIDENTS' ASSOCIATION

EDMONTON, ALBERTA

Submitted by:

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1.0 INTRODUCTION AND BACKGROUND

Summerside Lake is a private urban recreational lake located in Edmonton, Alberta. Summerside Lake was constructed in 1999-2000 and filled with water in 2000. The lake provides residents of the community with various opportunities for recreation and aesthetic use including swimming, fishing, non-motorized boating, skating and "natural area" viewing. The Summerside Lake Residents' Association (herein referred to as the "Association") manages the use and maintenance of the lake. Over the course of operation, the Association has contracted EnviroMak Inc. Environmental Management Consultants to provide science-based information contributing to lake management decision-making and action including limnological monitoring of the aquatic ecosystem, stocked fishery management and specific concern investigation and response. Further background of these components of the environmental management of the lake are noted below.

1.1 Limnological Monitoring Background

The 2020 limnological monitoring gathered data and provided interpretations as to whether various aquatic ecosystem indicators remain within acceptable limits for fish health as well as monitors aquatic ecosystem indicator trends to evaluate the overall status of the lake to provide recommendations for continued management of a functional urban lake environment meeting the targets and expectations of the stakeholders. Monitoring of the water quality and limnologic status of Summerside Lake has been conducted periodically since 2001. Generally, data gathered has focused on standard indicators for limnological health; however, periodically, modifications to the monitoring plan have occurred to address specific issues or concerns.

In 2015, the limnological analysis noted trends indicative of changing water quality (i.e. increased aquatic vegetation, coliforms, total dissolved solids and conductivity), fortifying the effort to continue monitoring. Rooted aquatic vegetation in 2017 was noted as a concern by users and lake management; thus, a temporary increased intensity of assessment of vegetation coverage, abundance and diversity indicators occurred along with a substrate characterization of the lake sediments. From 2018 through 2020, the aquatic vegetation was characterized in a similar manner as 2016 with consideration of 2017 methods and results for trend analysis but with less intensity. In 2018, an odour concern related to the aeration system operation was noted by the users and lake management, and additional testing of threshold odours was undertaken in response. In 2020, concerns from users and lake management focused primarily on potential presence of blue-green algae, potential increased presence of green algae and occurrences of swimmer's itch. Increased sampling and monitoring effort were applied to respond to these concerns.

1.2 Recreational Fishery Management Background

With respect to the stocked fishery at Summerside Lake and following assessments conducted by EnviroMak Inc. in 2001 and 2002, Rainbow Trout (*Oncorhynchus mykiss*) were stocked annually for recreational angling. In 2005, Triploid Grass Carp (*Ctenopharyngodon idella*) were stocked in the lake to support aquatic vegetation control. In July 2007, Mr. Gerald Trach (former Manager of Summerside Lake) indicated that he observed some small fish, however, was unsure as to what species they may have been. EnviroMak Inc. undertook sampling in July 2007 and observed stocked Rainbow Trout and Triploid Grass Carp. No other fish species was found or observed at that time. Mr. Craig Beaton's (former manager of Summerside Lake) observations of fish ("small minnows") at Summerside Lake in Edmonton, Alberta in late July 2009 resulted in the subsequent sampling effort undertaken by EnviroMak in 2009 at which time Yellow Perch (*Perca flavescens*) were confirmed to be present within Summerside Lake.

Yellow Perch were likely introduced by persons who illegally transported the fish into the private lake. Yellow Perch is a species that is not permitted for stocking in privately-owned waters (Alberta Government Regulations). A presentation and discussion at the Summerside Lake Association Annual General Meeting in June 2011 led to the decision to reduce the Yellow Perch (*Perca flavescens*) population so as to fortify the health of the stocked trout population and continue to meet stakeholder expectations for recreational use. As a result, the Yellow Perch removal project has occurred every year from 2012 – 2020.

In 2010, the efficiency of Yellow Perch catch combined with the potential for mortality of Rainbow Trout resulted in the cessation of fishing after two days. In 2011 the ice remained on the lake until May 8, 2011 and water temperatures increased rapidly to 8ºC on May 9, 2011 and fish capture began on May 10. In 2011, fish spawning began quickly and appeared to end quickly as well (after 3 to 4 days). In 2012 the fishing persisted for 5 days and could have continued as relatively large catches continued. In 2013 and 2014, fish spawning again began quickly after the ice cover melted and appeared to end quickly as well (after 3 to 4 days). In 2015, ice cover melted relatively early, and fish removal efforts were completed before the majority of the fish had begun to spawn. Decreasing daily catches in 2015 were the deciding factor to stop fish removal efforts on April 24, 2015. In 2016, ice cover melted relatively early, and fish removal efforts were commenced before the majority of the fish had begun to spawn. In 2016, the fishing occurred consecutively from April 8 to April 12, 2016 following which a break in fishing effort was conducted due to low catch rates. Fishing then continued again from April 18 to April 20, 2016 at which point fishing efforts were ceased as the majority of fish had spawned. In 2017, ice cover melted relatively late; however, removal efforts were completed before the majority of the fish had completed spawning. Fishing occurred consecutively from May 5 to 7, 2017. In 2018, fishing efforts began on May 3 when ice melted and ceased after two days due to low catch rates. The 2019 fishing efforts were conducted on April 18 and 19, and efforts were ceased after one net set due to low catch rates. 2020 effort was similar to 2019 effort with fishing conducted on April 28 and 29. An innovative spruce bough egg collection effort was applied in 2018, 2019 and 2020 to supplement the Yellow Perch netting removal program.

Yellow Perch usually spawn during the spring in waters less than 10 m deep at temperatures ranging between 6.7°C to 12.2°C. They prefer submergent and emergent vegetation types, which are utilized to attach their large adhesive egg masses to (Langhorne et al, 2001). Yellow Perch are owned by the province; thus, the management of this fish species is the responsibility of the Alberta government. The legal implications of the Alberta Fishery Regulations would include licensing, catch limits, angling prohibitions and all regulations applicable to Yellow Perch. Since Yellow Perch are present and owned by the provincial government, the habitat that they live within is technically a fish habitat as defined under the Fisheries Act and managed by the Department of Fisheries and Oceans (DFO). The legal implications of fish habitat could technically apply to Summerside Lake which could include numerous fish habitat protection measures that may influence development in the "fish habitat" areas. However, DFO has formally decided not to consider Summerside as a fish habitat under their legislation.

During previous years in conjunction with the Yellow Perch removal program approximately 19,530 Yellow Perch fish were relocated from Summerside Lake to Halfmoon Lake including ~3850 fish in 2013, ~7140 fish in 2014 and ~8540 fish in 2015. Alberta Environment and Parks (AEP) declined to support a fish relocation effort in 2016 due to concerns about the spread of invasive species and disease; however, some Yellow Perch were removed from Summerside Lake and translocated to a private pond by AEP in 2019 (D. Marchuk, per. comm.).

Rainbow Trout, Brook Trout and Triploid Grass Carp were stocked by the Association under provincial government permits. These fish are the responsibility of the Association. In 2018, EnviroMak provided an updated Fish Stocking Plan to the association, and, subsequently, Brook Trout (*Salvelinus fontinalis*) were added to the stocked fishery diversity along with continued stocking of Rainbow Trout. Fish stocking recommendations were also provided in 2020 with respect to species and addition of larger fish sizes as available by the hatcheries for increased angler satisfaction.

In 2019, a visual observation by a resident of a potential additional invasive fish species (Goldfish, *Carassius auratus*) was brought to the attention of the Lake Manager. Minnow trapping was conducted in both 2019 and 2020 to potentially capture any Goldfish; however, no Goldfish or other invasive fish species (other than Yellow Perch) were captured or observed during both years. No further reports of Goldfish or other invasive fish species (other than Yellow Perch) were recorded in 2020.

1.3 Other Specific Concerns Addressed in 2020

In addition to the annual limnological monitoring scope, some additional sampling and effort occurred that was in response to specific concerns arising in 2020. These concerns including the potential presence of blue-green algae (cyanobacteria), potential increased abundance of filamentous green algae and reported occurrences of swimmer's itch. Sampling, interpretation and recommendations relevant to these concerns were conducted and/or provided in 2020. Where applicable and for the purposes of this report, the results of these specific concerns prompting increased sampling effort are integrated with the overall limnological monitoring results.

Strategies for the long-term water safety, improved water clarity and aesthetics and enhanced fishing experience were reviewed by EnviroMak in early 2020. A document including decision making matrices and recommendations were provided to the Lake Manager in May 2020 for consideration in the overall management of the lake.

2.0 OBJECTIVES

This report compiles the results of the 2020 Summerside Lake limnological monitoring, fisheries management and specific issue investigation and/or response as well as provides annual recommendations to continue to address future lake management strategies.

The overall objective of the 2020 limnological monitoring was to assess whether various aquatic ecosystem indicators remained within acceptable limits for fish health and to monitor aquatic ecosystem indicator trends including water quality to evaluate the overall status of the lake and provide recommendations for continued management of a functional urban lake environment meeting the targets and expectations of the stakeholders. The ecological and limnological data gathered over the course of the year was considered with historical data for trend characterization. This data was then used to produce conclusions and recommendations to guide future action for management of a healthy lake ecosystem servicing the surrounding community.

The overall objective of the 2020 fisheries management was to continue to remove as many Yellow Perch and Yellow Perch eggs as possible from Summerside Lake during the pre-spawning to spawning period in spring. The project objectives also included minimal assessment of the size and age characteristics of the Yellow Perch population for interpretation of trends in the population. Considering the resident observation of two potential invasive Goldfish in 2019, the Yellow Perch removal program, which was slightly modified in 2019 to capitalize on effort being expended on Yellow Perch removal to include observation for and attempted removal of other invasive fish species if encountered, continued to include these objectives in 2020.

Objectives included additional lake sampling, interpretation of results and provision of recommendations in 2020 in relation to various specific concerns brought forth by users and/or the Lake Manager. Sampling for verification of presence and determination of toxin concentration of blue-green algae (cyanobacteria) was conducted in 2020. Increased effort to respond to concerns of aquatic vegetation and reported occurrences of swimmer's itch were applied. With this, additional water quality testing, assessments, and other efforts were conducted in 2020 to verify and/or assess the status of these concerns and provide guidance for response and/or action.

3.0 METHODS

3.1 Limnological Monitoring

Limnological monitoring efforts were conducted during both open water and ice-covered periods (Table 3.1.1). Appendix 9.0 details the spatial and temporal sampling protocol and sampling techniques applied to Summerside Lake. Additional sampling periods of specific parameters occurred in 2020 to address specific concerns relevant to blue-green algae and vegetation (Table 3.1.1).

Water samples for a variety of water quality parameters were collected and tested onsite as well as submitted to a qualified laboratory for appropriate analyses. Water clarity (light penetrance) was recorded in the field using a Secchi disk. Vegetation sampling was undertaken during the open water period, and aquatic macrophytes were harvested using a modified vegetation rake sampler. Plankton sampling was conducted with standard plankton net using a 3.0 m horizontal draw. Macroscopic plankton were counted and recorded as a number count per volume unit. Substrate/sediment sampling was conducted with an Eckman dredge to characterize the substrate/sediments. Several of the water quality parameters were measured in an accredited Edmonton laboratory (Element Laboratory accredited by all relevant federal and provincial agencies including the Canadian Association for Environmental Analytical Laboratories and the Standards Council of Canada) while other parameters were measured with EnviroMak Inc. calibrated meters and laboratory equipment (Appendix 9.2).

Table 3.1.1. Summerside Lake 2020 environmental consultant activity summary.

Date in 2020	Activity Type	Description	Analysis
March 17	Field Sampling	Winter water quality sampling	- Water quality
April 14 (installation) May 8 (removal)	Field Sampling	Spruce bough installation for Yellow Perch egg capture and removal	- Fish egg quantification
April 28/29	Field Sampling	Spring limited water quality sampling and Yellow Perch (and invasive species) removal	- Water quality - Fish
June 24	Field Sampling	Limited limnological and water quality assessment (beach/dock/boat launch)	- Water quality - Plankton - Microcystin - Cyanobacteria sample collection and microscopic identification - Others
July 8	Field Sampling	Snail removal and habitat disturbance for Swimmer's Itch	- Snail identification and enumeration
August 5 (conducted prior to scheduled mechanical vegetation removal)	Field Sampling	Aquatic vegetation assessment	- Aquatic vegetation
August 13	Field Sampling	Comprehensive summer limnological and water quality assessment	- Water quality - Plankton - Sediment/substrate - Microcystin - Others

3.2 Yellow Perch (Invasive Fish) Removal

The Yellow Perch (and invasive fish as encountered) removal and sampling occurred on April 28 and 29, 2020 (Table 3.1.1). Fish collection was conducted utilizing gill nets and minnow traps. The selection of these fishing techniques was based on the rationale that the Yellow Perch population is not a native or naturally occurring population and the intent is to remove as many fish as possible within a short time frame in a cost-effective manner. Eight gill nets were set on April 28 and removed on April 29, 2020. Ten minnow traps were set on April 28 and removed on April 29, 2020. A Fisheries Research License authorizing the Yellow Perch removal was obtained from Alberta Environment and Parks (AEP) (FRL #20-3805). The FRL stipulates conditions relevant to fish handling procedures as well as data management.

The data collected from the invasive Yellow Perch included a select sampling for lengths, weight, sex, age and maturity (i.e. spawning status). Yellow Perch were aged using opercular bones. Other species of fish that may have been captured during the targeted Yellow Perch removal effort were counted, identified, measured and released back into the lake when possible; however, some fish were sacrificed as they were deceased upon net removal. Other species expected included Rainbow Trout (stocked), Brook Trout (stocked) and Triploid Grass Carp (stocked). Stomach contents of these species were observed randomly. Twice daily water temperatures were recorded during the fish removal project to identify likely spawning timing for optimized removal effort scheduling.

In addition to fish removal, an innovative effort to remove Yellow Perch eggs was initiated in 2018 and continued through 2020 to bolster the removal results. Spruce boughs were temporarily installed along key locations of the shoreline where perch may be expected to expel their eggs. Following a period of time, the spruce boughs were removed along with any eggs which were counted using a volumetric methodology to estimate total number of eggs removed.

3.3 Snail Removal and Habitat Disturbance Effort

On Wednesday, July 8, 2020, an EnviroMak biologist alongside divers from Northwest Scuba implemented a snail collection and habitat disturbance effort within the lake swimming area and an area ~10 m to the north and west in an attempt to influence the swimmer's itch parasite that the snail hosts as well as to gather information on snail composition, abundance and food source (Table 3.1.1). Spatial grids were delineated to guide the activity of removing as many snails from the swimming area as possible. Prior to the efforts, snail identification was reviewed with the team to ensure understanding of target species. Approximately 4 hours of effort were applied, including three passes of both non-disturbance and raking passes, as follows.

- One non-disturbance pass where the snails were removed from the top of the substrate and aquatic vegetation as observed.
- One pass of raking throughout the beach area. This included disturbing the substrate (sand) as well as removing and bagging aquatic vegetation as needed.
- One non-disturbance pass of removing snails from the beach area as observed.

4.0 RESULTS

4.1 Limnological Monitoring

4.1.1 Limnological Field Data Collection Results 2020

Water quality samples were taken on March 17, April 28, June 24 and August 13, 2020. Water quality parameters sampled included but were not limited to turbidity, conductivity, total dissolved solids, pH, alkalinity, dissolved oxygen and threshold odour number (Table 4.1.1). Water samples taken on August 13, 2020 were also tested for bacteria, nutrients, metals, herbicides and other water quality parameters (Tables 4.1.2 and 4.1.3; Tables 9.3.1a, 9.3.1b and 9.3.1c in Appendix 9.3).

Dissolved oxygen (DO) levels were sampled at various depths at ~1 m increments. The dissolved oxygen levels were sampled in March, April, June and August. In March, measured DO levels were predominantly greater than 6.0 mg/L with the exception of readings below 2.0 – 2.5 m depth, which were generally <5 mg/L. The maximum measured DO in winter was 8.35 mg/L at the surface (approximately 15 cm depth). In August, DO was measured at 8.10 mg/L at the surface and 8.08 mg/L at 3 m depth. The maximum dissolved oxygen measured was 8.44 mg/L at 3.3 m depth (Table 4.1.1).

Table 4.1.1. Routine water quality analysis results at Summerside Lake during 2020.

Parameter	Sampling Date			
	March 17, 2020	April 28, 2020	June 24, 2020	August 13, 2020
Turbidity (NTU)	0.82	1.81	2.98	1.12
Conductivity (µs/cm)	799	640	648	619
Total Dissolved Solids (mg/L)	569	457	457	444
pH	8.41	8.93	8.84	8.81
Alkalinity (mg/L)	153	119	122.4	102
Dissolved Oxygen (mg/L)	8.35 (Surface) 7.65 (1 m depth) 6.94 (2 m depth) 4.03 (3 m depth)	-	9.61 (Surface)	8.10 (Surface) 8.09 (1 m depth) 8.08 (2 m depth) 8.08 (3 m depth)
Temperature (ºC)	0.5	6.4	20.6	19.2
TON	4.5	-	-	8.0*

TON – Threshold Odour Number

*Due to the Covid-19 Pandemic, TONs were not measured by multiple testers then averaged. As such, results are not typical and should be considered with caution in trend analysis.

Table 4.1.2. Supplemental water quality analysis results for Summerside Lake on August 13, 2020.

Water Quality Parameter	Result
Routine	
Alkalinity (mg/L)	92
Conductivity (µs/cm)	615
Dissolved Chloride (mg/L)	8.5
Dissolved Sulfate (mg/L)	218
Hydroxide (mg/L)	<5
Carbonate (mg/L)	<6
Bicarbonate (mg/L)	112
Hardness (mg/L)	206
pH	8.59
TDS (mg/L)	408
Nutrients	
Total Kjeldahl Nitrogen (mg/L)	0.45
Total Phosphorus (mg/L)	<0.05
Dissolved Phosphorus (mg/L)	<0.05
General Water Quality	
Chlorophyll a (µg/L)	4
Phaeophytin (µg/L)	0.9
Microcystin (µg/L)	<0.2
Microbiological	
Total Coliforms (CFU/100ml)	79
E coli (CFU/100ml)	14
Fecal Streptococci/Enterococci (CFU/100ml)	6
Metals	
Aluminum (mg/L)	0.02
Calcium (mg/L)	44.8
Copper* (mg/L)	<0.001
Iron (mg/L)	<0.05
Lead (mg/L)	<0.0001
Magnesium (mg/L)	22.7
Manganese (mg/L)	0.040
Phosphorus (mg/L)	<0.05
Potassium (mg/L)	4.1
Sodium (mg/L)	54.5
Zinc (mg/L)	<0.004

Microcystin concentration was an added parameter for analysis in 2018 intending to provide information on potential eutrophication (harmful cyanobacteria blooms caused by excess nutrients in the water) issues. Microcystins are toxins produced by cyanobacteria (blue-green algae) that can cause severe liver damage, and their concentrations are directly correlated with increased cyanobacteria blooms (ALMS 2017). Alberta's recreational guidelines sets the limits for microcystin at 20 µg/L, and the June 2018 microcystin levels were below these guidelines at <0.2 µg/L (Table 4.1.6). Sampling for microcystin occurred in 2019; however, due to an error during the outsourced laboratory analysis, microcystin level results were not provided in 2019. Sampling again occurred in 2020 in both the June and August during which microcystin levels were measured at <0.2 µg/L, well below the Alberta recreational guideline limits set at 20 µg/L (Table 4.1.9). Microcystins were sampled more frequently in 2020 due to the visual observation of blue-green algae within a small area along the shoreline of Summerside Lake in June 2020. However, the presence was relatively short in duration and limited in spatial extent, thus did not result in elevated microcystin levels.

Water clarity was tested using a secchi disk lowered into the water and could be last viewed at depths of 3.2 m, 3.3 m and 3.5 m in north, central and south areas of Summerside Lake, respectively (Table 4.1.4).

Zooplankton was present in 2 samples collected from the north and south areas of the lake. 79 zooplankton individuals were observed in the north 25 mL sample and 56 individuals in the south 25 mL sample (Table 4.1.5). It could be extrapolated from the lower count of these samples that approximately 1100 zooplankton per 500 ml sample would be expected.

Table 4.1.3. Herbicide detection at Summerside Lake on August 13, 2020.

Herbicide type	Result
Neutral Herbicide (µg/L)	<0.5
Acidic Herbicide (µg/L)	<0.1

Table 4.1.4. Secchi disc reading results for Summerside Lake on August 13, 2020.

Parameter	Result		
	North	Central	South
Secchi Reading Depth (m)	3.2	3.3	3.5

Table 4.1.5. Total zooplankton observed within 25 ml samples of Summerside Lake on August 13, 2020.

Parameter	Result	
	North	South
Zooplankton (#/25mL)	79	56

Aquatic vegetation was sampled from the perimeter of the lake to a maximum water depth of 3.0 m at 25 sample sites on August 5 (Figure 9.2.2). Of the 25 samples sites, 6 exhibited high abundance of aquatic vegetation, 12 exhibited medium/moderate abundance and 7 exhibited scant/sparse abundance for an estimated average moderate abundance for all sample sites. A moderate to high abundance of water common stonewort (*Chara vulgaris*) was found at most sample sites. Sparse to moderate amounts of small-leaf pondweed (*Potamogeton pusillus*) and *Myriophyllum* sp. (a macrophytic algae) were observed around the northern portion of the lake. Emergent species, including Cattail (*Typha latifolia)* and Common Great Bulrush (*Scirpus tabernaemontani*), were observed on the northeast shores of the lake (Table 4.1.6). Very abundant green algae (*Cladophora* spp.) was observed at most of the aquatic vegetation sample sites, as well as covering other types of aquatic vegetation. A total of four (4) different species of aquatic vegetation and/or algae were observed.

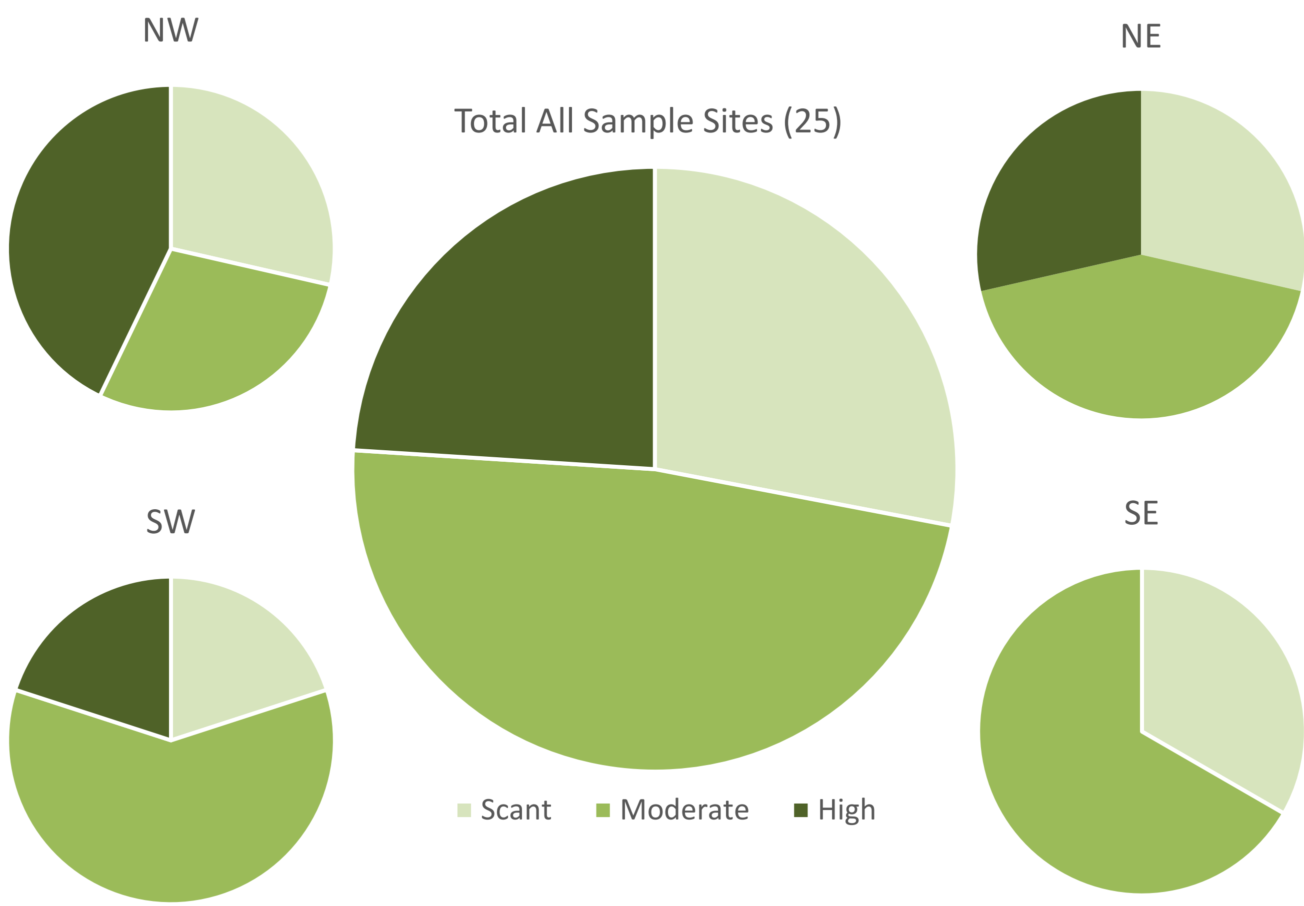

Figure 4.1.1. Aquatic vegetation abundance at 25 sampling sites (depicted by central pie) around the perimeter of Summerside Lake on August 5, 2020. Smaller outer pies depict the abundance within specific areas of the lake including SE – Southeast, SW – Southwest, NE – Northeast and NW – Northwest; Abundance described as H - High, M - Medium/Moderate, S - Sparse/Scant.

Table 4.1.6. Aquatic vegetation species composition and abundance at Summerside Lake on August 5, 2020 utilizing modified vegetation rake sampler, Eckman dredge and visual observation methods.

Sample Location		Water Depth	Aquatic Vegetation Species	Abundance
SE	**2**	1.5 m	*Myriophyllum* sp., *Potamogeton pusillus*	S
	3	1.0 m	*Chara vulgaris, Myriophyllum* sp., *Potamogeton pusillus, Cladophora* spp.	M
	4	2.5 m	*Myriophyllum* sp.	S
	5	1.0 m	*Chara vulgaris, Potamogeton pusillus, Cladophora* spp.	M
	6	3.0 m	*Chara vulgaris, Potamogeton pusillus*	M
	7	2.5 m	*Myriophyllum* sp., *Potamogeton pusillus, Cladophora* spp.	M
			Subtotal	**2 S; 4 M**
SW	**8**	1.0 m	*Chara vulgaris, Potamogeton, Myriophyllum* sp., *Cladophora* spp.	H
	9	1.2 m	*Chara vulgaris; Cladophora* spp.	S
	10	2.3 m	*Chara vulgaris, Myriophyllum* sp.	M
	11	1.3 m	*Chara vulgaris, Myriophyllum* sp., *Potamogeton pusillus*	M
	12	2.3 m	*Chara vulgaris*	M
			Subtotal	**1 S; 3 M; 1 H**
NW	**13**	1.2 m	*Chara vulgaris, Potamogeton pusillus, Cladophora* spp.	H
	14	2.6 m	*Chara vulgaris, Cladophora* spp.	S
	15	1.0 m	*Myriophyllum* sp., *Potamogeton pusillus, Cladophora* spp.	H
	16	3.0 m	*Chara vulgaris*	M
	17	1.0 m	*Myriophyllum* sp., *Chara vulgaris, Cladophora* spp.	H
	18	2.8 m	*Chara vulgaris*	M
	19	1.0 m	*Potamogeton pusillus, Chara vulgaris, Cladophora* spp.	S
			Subtotal	**2 S; 2 M; 3 H**
NE	**1**	2.1 m	*Myriophyllum* sp.	S
	20	1.0 m	*Potamogeton pusillus, Chara vulgaris, Cladophora* spp.	M
	21	3.0 m	*Chara vulgaris, Cladophora* spp.	H
	22	2.2 m	*Chara vulgaris*	M
	23	1.0 m	*Myriophyllum* sp., *Chara vulgaris, Cladophora* spp.	H
	24	1.0 m	*Potamogeton pusillus, Chara vulgaris, Cladophora* spp.	M
	25	1.0 m	*Cladophora* spp.	S
			Subtotal	**2 S; 3 M; 2 H**
All			**Total (25 sample sites)**	**7 S; 12 M; 6 H (Average All Sites = M)**

Abundance: H – High, M – Moderate/Medium, S- Scant/Sparse, Z- Zero

Lake bed sediment/substrate sampling was conducted on August 13, 2020. Collection and analysis of five substrate samples, collected in primarily the littoral zone of the four corners of the lake (NE, NW, SE, SW), was conducted. Characteristics including composition, texture, odour and appearance were described for each sample collected (Table 4.1.7).

Table 4.1.7. Lake bed substrate/sediment sample results from Summerside Lake on August 13, 2020.

Sample Location within Lake	Sample Location (Littoral or Deepwater)	Water Depth at Sample Site	Sediment Odour Description	Settled Sediment Sample Jar Depth Following Agitation	Colour (Munsell)	Texture	Sample Comments
SE	Littoral	1.7 m	Natural - sulphur	0 - 63 mm	100% Black (10YR 2/1)	Organic	High abundance of *Chara vulgaris* at sampling location.
NW	Littoral	1.4 m	Natural - sulphur	0 - 51 mm	100% Black (10YR 2/1)	Organic with some sand content	High abundance of *Chara vulgaris* at sampling location.
	Deepwater	8.9 m	Natural - sulphur	0 – 0.5 mm	17% Dark Grayish Brown (10YR 4/2)	Sandy Silt	No vegetation noted in sample.
				0.5 – 60 mm	83% Black (10YR 2/1)	Organic with some sand content	
NE	Littoral	2.2 m	Natural - sulphur	0 – 58 mm	100% Black (10YR 2/1)	Organic	High abundance of *Chara vulgaris* at sampling location.
SW	Littoral	2.1 m	Natural - sulphur	1 – 0.5 mm	1% Light Olive Brown (2.5Y 5/4)	Organic with some sand content	High abundance of *Chara vulgaris* at sampling location.
				0.5 – 46 mm	99% Black (10YR 2/1)	Organic with some sand content	

4.1.2 Comparative Limnological Analysis (2001 to 2020)

Water quality samples have been collected since August 8, 2001 (Tables 4.1.8 and 4.1.9). While turbidity, conductivity, pH, and alkalinity have fluctuated since 2001, overall there have been limited changes in these parameters (Table 4.1.8). Total dissolved solids (TDS) do appear to have increased since 2001. Between 2001 and 2006, the maximum TDS value was 256 mg/L, and from 2009 to 2020 TDS ranged from 291 to 520 mg/L. The 2020 TDS value of 444 mg/L was slightly lower than the 2019 value of 453 mg/L.

Threshold odour number (TON) appears to have slightly increased over time (Table 4.1.9; Figure 4.1.5). In 2001, the TON value of the new lake was 1.3. From 2012 to 2019, TON has ranged from a minimum of 2.1 to a maximum of 6.5 (measured in 2017). In 2020, a measured value of 8.0 was recorded for the August sampling. However, due to the COVID-19 pandemic, the TON testing methodology was altered due to safety mitigation utilizing only 1 tester rather than an averaging of 3 to 5 testers. As such, this value should be interpreted with caution with respect to trend analysis.

Water samples have also been tested for bacteria at various locations and for various dates between 2001 and 2020 (Table 4.1.9). Total Coliforms decreased from 84 CFU/100 mL in 2012 to 8 CFU/100 mL in both 2016 and 2017 then increased to 130 CFU/100 mL in 2018 (Table 4.2.9). In 2020, Total Coliforms and *Escherichia coli* were both analyzed from the beach area, with Total Coliforms analyzed at 79 CFU/100 mL and *E. coli* at 14 CFU/100 mL. When discussing coliforms, there is high potential for a single sample to misrepresent the state of the waterbody as a whole. Per the Government of Canada's Guidelines for Canadian Recreational Water Quality (2012), "pathogens are usually present at low levels and are unevenly distributed in recreational waters" and the Environmental Quality Guidelines for Alberta Surface Waters' Surface Water Quality Guidelines (AB WQG) for Recreation and Aesthetics (2018) notes that a single point sample typically does not characterize the bacterial abundance within the lake.

Nutrient levels have remained relatively consistent since 2001, with rare fluctuations such as the spikes noted in 2015 (Table 4.1.9). Total Kjeldahl Nitrogen (TKN) was slightly decreased in 2020 at 0.45 mg/L from 0.55 mg/L in 2019. Overall, TKN is slightly increased from initial lake construction levels of <0.05 mg/L in 2001 to 0.45 mg/L in 2020 and with a recorded spike in concentration of 0.93 mg/L in 2015 (Figure 4.1.4). Total Phosphorous (TP) has decreased since construction with 2015 to 2020 all measuring the same concentration of <0.05 mg/L (Figure 4.1.2). Chlorophyll a increased slightly from 2 µg/L in 2019 to 4 µg/L in 2020 but has been relatively consistent since 2015 (Figure 4.1.3). Phaeophytin (µg/L) has been relatively consistent since sampling for this parameter was initiated in 2011 at which time it was measured at 2 µg/L. In 2020, phaeophytin was measured at a concentration of 0.9 µg/L.

Since 2001, limited changes have been observed in most metal parameters. Sodium has appeared to increase from 42.1 mg/L in 2011 to 54.5 mg/L in 2020; however, sodium levels have generally been consistent since 2018 (Table 4.1.9).

Since 2002, dissolved oxygen levels have remained fairly consistent and suitable for fish survival, with expected seasonal fluctuations as observed during winter sampling in March 2011 (Table 4.1.9). Since 2015, dissolved oxygen levels have been measured above 8.09 mg/L (Table 4.1.9). Environmental parameters including water temperature and algae abundance can affect the dissolved oxygen levels, as well as the use of lake aerators.

Aquatic vegetation was sampled in 2001, 2003, 2004, 2006, 2011, 2012, 2014, 2015 and 2017 - 2020 (Table 4.1.10). In 2003, muskgrass (*Chara* sp.) was the first persistent aquatic vegetation observed within Summerside Lake. Green algae (*Cladophora* sp.) was also observed in 2003 and has generally been observed in the lake each year with the exception of two of those years. In both 2019 and 2020, *Cladophora* sp. was noted as highly abundant in several locations in the lake. Small-leaf pondweed (*Potamogeton pusillus*) and water milfoil (*Myriophyllum* sp.) have been observed throughout Summerside Lake since 2004 (Table 4.1.10). In 2015, *Ceratophyllum demersum* was observed and continued to be observed until 2019. However, this species was not observed during the 2020 assessment. Between 2017 and 2019, aquatic buttercup (*Ranunculus aquatilis var.*), was added to the list of observed aquatic vegetation in Summerside Lake; however, this species was not observed in 2020.

During the 2020 assessment, 4 species of aquatic vegetation including algae were noted which is reduced from 6 species identified in 2017 to 2019. It is possible that large amounts of *Cladophora* spp. at the time of the assessment could have limited ability to observe other types of aquatic vegetation. Further, some removal of vegetation as part of maintenance activity had been occurring in 2020 prior to and after the assessment (D. Marchuk, per. comm.). However generally, the long-term trend data suggests increased composition and diversity of aquatic vegetation has occurred (from 0 species present in 2001 to 4-6 species present in 2017-2020). Abundance and spatial extent of vegetation coverage has increased since original construction. The more recent past three years of monitoring suggests an average moderate abundance of aquatic vegetation in sample sites versus high abundance noted in 2015-2017 (Table 4.1.10). Although overall moderate abundance of aquatic vegetation was observed throughout the lake in 2020, vegetation abundance appeared to be higher in the swimming/beach area, leading to increased mechanical removal efforts of aquatic vegetation from these problem areas. The key lake concern appears to be associated with the presence of green algae (*Cladophora* spp.) that has increased over time and become more abundant in the past 3 to 4 years.

Microcystin concentration, an added parameter for analysis beginning in 2018, has consistently measured below the nominal detection limit of 0.2 μg/L. Sampling for microcystin occurred in 2019; however, due to an error during the outsourced laboratory analysis, microcystin levels were not analyzed in 2019. The 2020 microcystin levels, sampled in both June and August, were <0.2 μg/L (Table 4.1.9).

Zooplankton counts had increased between 2006 and 2017 with an average of 30 zooplankton/500 mL sample in 2006 to a peak of 5330 zooplankton/500 mL sample in 2017 but have since exhibited a decrease since 2018. The average zooplankton counts of both the north and south sampling locations in 2019 and 2020 were 1660 zooplankton/500 mL sample and 1350 zooplankton/500 mL sample, respectively (Table 4.2.11).

Lake bed substrate sampling has only been conducted since 2017. Composition, odour, colour and texture of the lake substrate in 2018 were similar to 2017 with a layer of silt on top of clay and/or organic material present in all sampled areas. In 2020, the samples appeared to have been primarily composed of organic material with some silt and sand content throughout (Table 4.1.7). This may be due in part to the heavy presence of aquatic vegetation (most prominently *Cladophora* spp.) present throughout the lake in the last few years (Table 4.1.10).

Table 4.1.8. Cumulative summary of routine water quality results at Summerside Lake on various dates from 2001 to 2020.

Parameter	Aug 8, 2001	Sept 2, 2003	Sept 16, 2004	June 2, 2006	July 30, 2009	March 28, 2011	Sept 15, 2011	Aug 24, 2012	May 6, 2013	Sept 15, 2014	April 22, 2015
Turbidity (NTU)	2.87	1.16	0.42	0.94	2.80	1.37	2.74	-	1.44	1.04	2.32
Conductivity (µs/cm)	298	491	457	504	628	666	579	590	671	672	687
Total Dissolved Solids (mg/L)	148	246	231	256	316	333	291	295	477	340	480
pH	8.53	8.4	7.65	8.43	7.15	6.75	6.76	7.55	8.41	8.14	8.26
Alkalinity (mg/L)	120	120	120	120	140	130	160	120	130	120	120
Temperature (ºC)[1]	-	17.7	13.3	-	-	2.5	15.9	20.3	9.5	14.6	8.0

Parameter	March 24, 2015	Aug 20, 2015	March 9, 2017	May 5, 2017	Aug 16, 2017	April 24, 2018	May 3, 2018	Aug 14, 2018	Aug 14, 2019	Aug 13, 2020
Turbidity (NTU)	4.08	0.86	2.34	0.98	1.21	1.90	1.41	1.47	1.52	1.12
Conductivity (µs/cm)	591	730	811	528	683	476	609	633	632	619
Total Dissolved Solids (mg/L)	422	520	573	374	478	330	433	470	453	444
pH	9.22	8.67	8.58	8.99	8.81	8.50	9.02	8.54	8.47	8.81
Alkalinity (mg/L)	100	200	40.8*	102	110.5	47.6*	102.0	108.8	102	102
Temperature (ºC)[1]	2.1	19.7	1.4	8.1	20.1	6.7	7.9	19.6	18.9	19.2

[1]Temperature readings taken at a depth of 0-20 cm below the water surface. *Result may be indicative of error in sample analysis.

Table 4.1.9. Cumulative summary of supplemental water quality results at Summerside Lake on various dates from 2001 to 2020.

Water Quality Parameter	Aug 8, 2001 - March 1, 2002	July 4, 2002 - Aug 7, 2002	Sept 2, 2003	Sept 16, 2004	June 2, 2006 - Oct 5, 2006	June 11, 2007 - Aug 7, 2007	March 28, 2011	Sept 15, 2011	Aug 24, 2012	Sept 23, 2014	Mar 24, 2015	Aug 20, 2015	Aug 16, 2017	Aug 14, 2018	Aug 14, 2019	Aug 13, 2020
Oil and Grease (mg/L)	0	-	<5	0	-	-	62.0	<5	-	-	<0.5	<5	<5	33	<5	<5
Total Kjeldahl Nitrogen (mg/L)	<0.05	0.07-00.15	0.24	0.22	0.26-<0.5	0.33-0.4	0.71	0.50	0.52	<0.25	0.52	0.93	0.41	0.52	0.55	0.45
Total Phosphorus (mg/L)	0.21	<0.05-0.11	<0.05	<0.05	<0.05-0.12	<0.05	<0.05	<0.05	0.0080	0.010	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Dissolved Phosphorus (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05	<0.05
Chlorophyll a (µg/L)	1.3	<1	0.5	2.333	0.345-2.7	0.8-1.9	10	3.6	2.57	1.9	10	2	2	2	2	4
Phaeophytin (µg/L)	-	-	-	-	-	-	2	1.2	-	-	1	<0.5	<0.5	1	<0.5	0.9
Dissolved Chloride (mg/L)	-	-	-	-	-	-	7.2	7.7	6.0	6.9	7.4	7.2	7.7	8.5	8.9	8.5
Dissolved Sulfate (mg/L)	-	-	-	-	-	-	205	191	200	230	207	237	220	221	218	218
Hydroxide (mg/L)	-	-	-	-	-	-	<5	<5	Not Detected	<0.50	<5	<5	<5	<5	<5	<5
Carbonate (mg/L)	-	-	-	-	-	-	<6	<6	Not Detected	<0.50	<6	<6	<6	<6	<6	<6
Bicarbonate (mg/L)	-	-	-	-	-	-	160	129	120	110	130	115	124	114	107	112
Hardness (mg/L)	-	-	-	-	-	-	248	219	210	210	212	213	212	216	205	206
Clarity (m)	2.14	6.8-8.75	5.7	4.71	4.08-6.5	9.42	-	-	4.6	3.0	-	4.2 – 5.0	4.8-5.0	3.2-3.75	4.0-4.5	3.3
Dissolved Oxygen (mg/L)	-	9.28-12.34	7.30-8.48	11.55-13.10	10.71-11.7	9.69-9.75	5.29 - 7.60	8.20-9.0	9.16	8.22	~7	8.53	9.11-9.20	-	8.60-10.78	8.09-8.10
TON	1.3	0.43-1.15	0.43	1	0-4.3	-	-	-	2.1	3.25	3.8	North: 2.8 South: 5.5	6.5	3.25	3.85	8*
Total Coliforms (CFU/100ml)	<1-380	<1	-	<1	1-125	7	3	2 (East) 2 (West)	84	250[1]	-	8	8	130	>80**	79 (Beach)
E coli (CFU/100ml)	<1-111	<1	<1-1	2	<1-89	5	<1	1 (East) 2 (West)	3.0	2.0	-	4	<1	96	>60**	14 (Beach)
Fecal Streptococci/Enterococci (CFU/100ml)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6
Microcystin (µg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.2	See footnote[2]	<0.2

Water Quality Parameter		Aug 8, 2001 - March 1, 2002	July 4, 2002 - Aug 7, 2002	Sept 2, 2003	Sept 16, 2004	June 2, 2006 - Oct 5, 2006	June 11, 2007 - Aug 7, 2007	March 28, 2011	Sept 15, 2011	Aug 24, 2012	Sept 23, 2014	Mar 24, 2015	Aug 20, 2015	Aug 16, 2017	Aug 14, 2018	Aug 14, 2019	Aug 13, 2020
Metals (mg/L)	Aluminum	0.058	0.027-0.117	0.017	0.006	0.012-0.669	-	0.04	0.04	0.013	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02
	Boron	-	-	-	-	-	-	-	-	-	-	-	-	-	0.069	0.062	0.064
	Calcium	-	-	-	-	-	-	53.2	53.2	49	43.7	43.7	48.3	49.2	49.2	44.2	44.8
	Copper	0.014	0.001-0.004	0.002	0.004	0.002-0.006	-	<0.001	<0.001	0.0016	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001
	Iron	-	-	-	-	-	-	0.06	0.06	Not Detected	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
	Lead	<0.002	<0.0001-0.0002	<0.0001	0.0001	<0.0001-0.0052	-	<0.0001	<0.0001	Not Detected	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Magnesium	-	-	-	-	-	-	20.8	20.8	22	18.0	18.0	22.9	22.1	23.6	23.1	22.7
	Manganese	-	-	-	-	-	-	0.070	0.070	0.011	<0.05	0.009	0.022	0.010	0.025	0.035	0.040
	Phosphorus	-	-	-	-	-	-	<0.05	<0.05	Not Detected	3.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
	Potassium	-	-	-	-	-	-	3.3	3.3	3.6	41.4	3.2	4.2	3.8	4.1	4.0	4.1
	Selenium	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.0002	<0.0002	<0.0002
	Sodium	-	-	-	-	-	-	42.1	42.1	43	0.002	41.4	53.6	51.5	54.6	54.2	54.5
	Zinc	0.0076	0.001-0.006	<0.001	0.008	0.002-0.034	-	0.001	0.001	Not Detected	<0.0030	0.002	0.001	0.001	0.002	<0.001	<0.004

[1]Lab analysis may have errors due to care of sample while in possession of laboratory.

[2]Microcystin not analyzed in 2019 due to laboratory error.

*Note 2020 TON analysis was influenced by Covid-19 Pandemic and should not be considered or should be considered with caution in trend analysis.

**Laboratory error applied surface water guideline criteria to result entry. Results do not indicate samples were in exceedance of a guideline.

Table 4.1.10. Summary of aquatic vegetation sampling results at Summerside Lake from 2001 to 2020.

Parameter	Dates Measured											
	Aug 8, 2001	Sept 2, 2003	Sept 16, 2004	June – Oct 2006	Sept 15, 2011	Aug 24, 2012	Sept 15, 2014	Aug 20, 2015	July 20, 2017	Aug 14, 2018	Aug 14, 2019	Aug 4, 2020
Aquatic Vegetation Species Present (including algae; not including semi-aquatic species)	-	*Chara vulgaris*	*Chara vulgaris*	*Chara vulgaris*	*Chara vulgaris*	*Chara vulgaris*	*Chara vulgaris*	*Chara vulgaris*	*Chara vulgaris*	*Chara vulgaris*	*Chara vulgaris*	*Chara vulgaris*
	-	*Cladophora sp.*	-	*Cladophora sp.*	*Cladophora sp.*	*Cladophora sp.*	*Cladophora sp.*	-	*Cladophora sp.*	*Cladophora sp.*	*Cladophora sp.*	*Cladophora sp.*
	-	*Alisma gamineum*	-	-	-	-	-	-	-	-	-	-
	-	-	*Myriophyllum sp.*	*Myriophyllum sp.*	*Myriophyllum sp.*	*Myriophyllum sp.*	*Myriophyllum sp.*	*Myriophyllum sp.*	*Myriophyllum sp.*	*Myriophyllum sp.*	*Myriophyllum sp.*	*Myriophyllum sp.*
	-	-	*Potamogeton pusillus*	*Potamogeton pusillus*	*Potamogeton pusillus*	*Potamogeton pusillus*	*Potamogeton pusillus*	*Potamogeton pusillus*	*Potamogeton pusillus*	*Potamogeton pusillus*	*Potamogeton pusillus*	*Potamogeton pusillus*
	-	-	-	-	-	-	-	*Ceratophyllum demersum*	*Ceratophyllum demersum*	*Ceratophyllum demersum*	*Ceratophyllum demersum*	-
	-	-	-	-	-	-	-	-	*Ranunculus aquatilis var.*	*Ranunculus aquatilis var.*	*Ranunculus aquatilis var.*	-
Number of Species	0	3	3	4	4	4	4	4	6	6	6	4
Average Abundance (Average of all Sample Sites)	None	Low abundance	Moderate abundance	Areas of abundant growth	High abundance	High abundance	High abundance	High abundance	High abundance	Moderate abundance	Moderate abundance	Moderate abundance
Maximum Depth of Observed Presence (m)	0	Shoreline surveyed only	3.4 (most species <1.0m)	1.2	2.8	6.0	6.0	6.0	6.0	7.3	>2.2m	8.0

Abundance: H – High, M – Moderate/Medium, S- Scant/Sparse, Z- Zero Note: Semi-aquatic plants, *Typha latifolia* and *Scirpus* sp., have not been included.

Note that vegetation removal (by diver and mechanical boat removal) occurring in 2020 at various times.

Table 4.1.11. Total zooplankton at Summerside Lake from 2006 to 2020.

Parameter	Result															
	June – Oct 2006[1]		September 15, 2011		August 24, 2012		August 20, 2015		August 16, 2017		August 14, 2018		August 14, 2019		August 13, 2020	
	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South
Number of Zooplankton (#/500 mL sample derived from 25 mL sample count)	~13	~47	6	63	73	118	883	600	4960	5700	2730	3210	1400	1920	1580	1120

[1]Average of 5 water samples taken in the open water season.

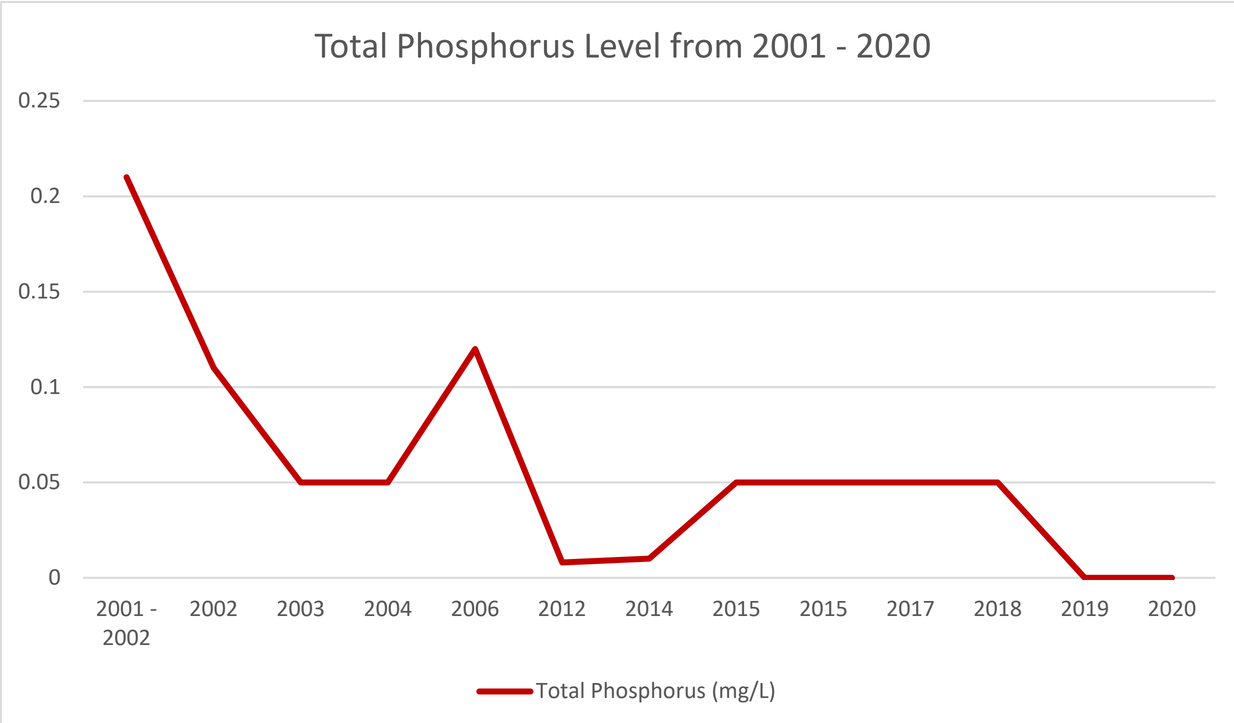

Figure 4.1.2. Total phosphorus levels (mg/L) in Summerside Lake from 2001 to 2020.

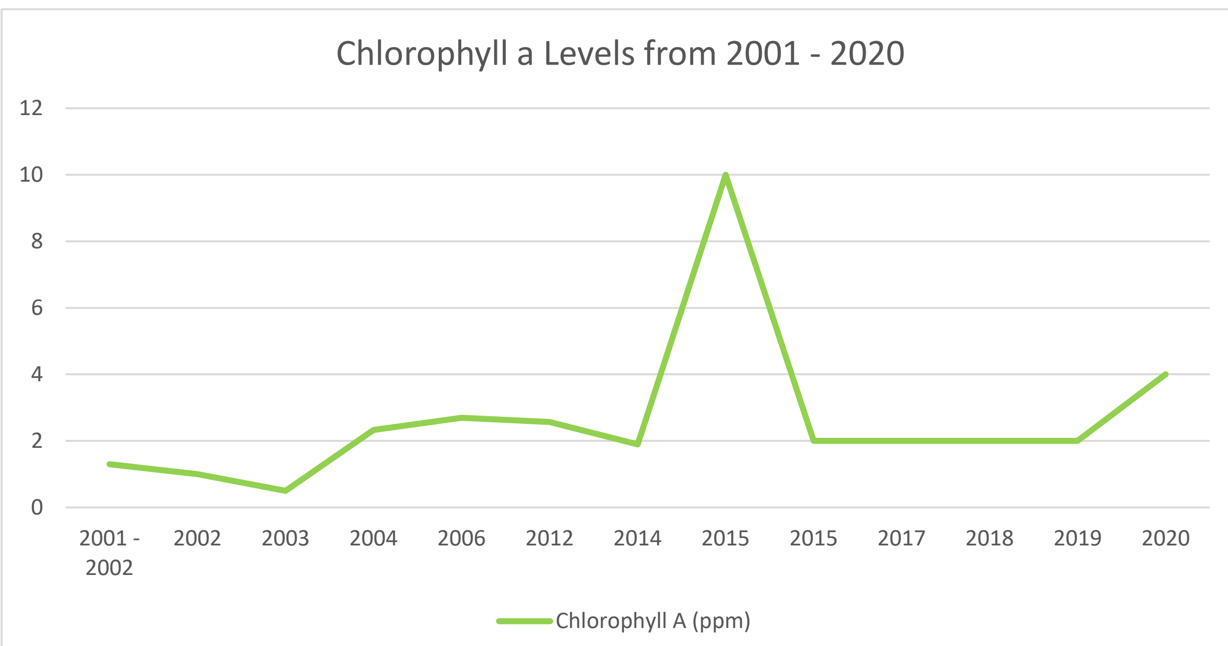

Figure 4.1.3. Chlorophyll a levels (μg/L) in Summerside Lake from 2001 to 2020.

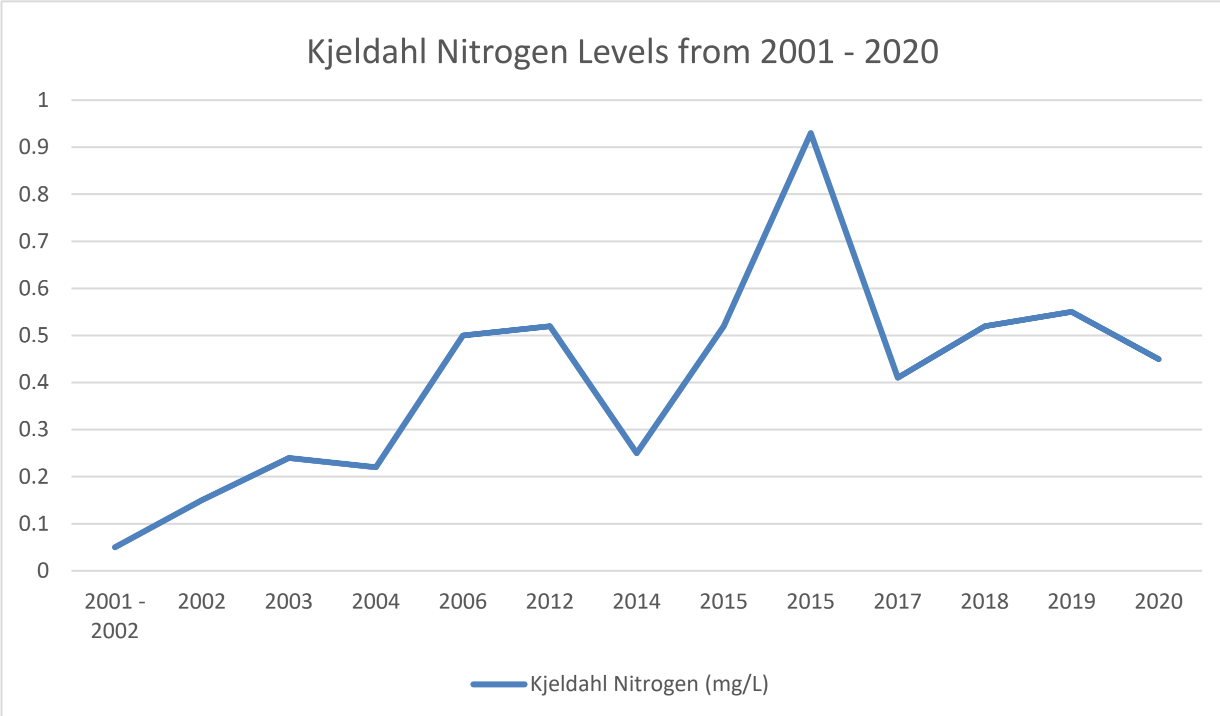

Figure 4.1.4. Total Kjeldahl Nitrogen (TKN) levels (mg/L) in Summerside Lake from 2001 to 2020. No TKN analysis was conducted from 2007 – 2011.

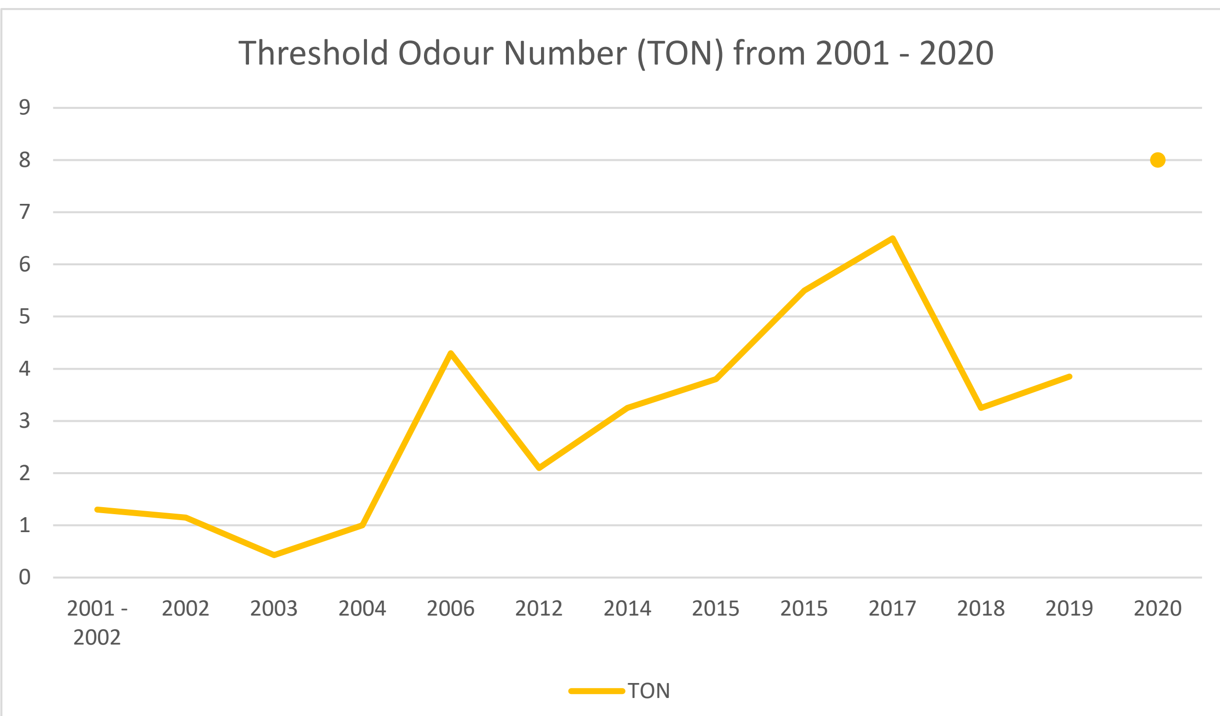

Figure 4.1.5. Threshold Odour Number (TON) in Summerside Lake from 2001 to 2020. [Note 2020 analysis was influenced by Covid-19 Pandemic and should be considered with caution in trend analysis.]

4.2 Yellow Perch (Invasive Fish) Removal

4.2.1 Gill Netting Effort Results

Description of the April 28 and 29, 2020 Yellow Perch removal results is provided below.

1. Eight gill nets (50 m length, 38 mm mesh size) were set in areas targeted as having the highest potential for Yellow Perch spawning habitat. One overnight net set (22.25 hours per net) was conducted.

2. Gill nets were set overnight and inspected in the morning for a total of 178 hours of combined gill net fishing effort. A total of 26 fish, including three species, were captured in the gill nets (Table 4.2.1). The fish composition included 5 Rainbow Trout (*Oncorhynchus mykiss*), 4 Brook Trout (*Salvelinus confluentus*) and 17 Yellow Perch (*Perca flavescens*) (Table 4.2.1).

3. The captured Rainbow Trout ranged in length from 255 mm to 370 mm (Table 4.2.2). Of the 5 Rainbow Trout captured, 2 were successfully released back into the lake, while 3 others were removed and disposed of as they were deceased upon collection.

4. Of the 4 Brook Trout captured, 1 was released alive back into the lake while 3 were deceased. The captured Brook Trout ranged in length from 124 mm to 242 mm (Table 4.2.2).

5. The 17 Yellow Perch captured were euthanized and disposed of according to the provincial research permit requirements. Typically, a sample population subset of 100 Yellow Perch are assessed for additional measurements; however, due to the low catch rate, only 17 were measured as the sample population subset (Table 4.2.3).

6. The subset of sampled Yellow Perch ranged in length from 127 mm to 170 mm with females averaging 140 mm and males averaging 157 mm (Table 4.2.3; Figure 4.2.1; Figure 4.2.2).

7. The subset of sampled Yellow Perch ranged in weight from 21 g to 50 g with females averaging 27 g and males averaging 38 g (Table 4.2.3).

8. The subset of sampled Yellow Perch consisted of five age classes with the average age of both males and females being 4 years old (Table 4.2.3; Figure 4.2.1).

9. The subset of sampled Yellow Perch consisted of 35% females and 47% males. Most of the mature male Perch were exhibiting signs of milt production, and most of the mature females exhibited signs of egg production. Of the 17 Yellow Perch captured, 3 were immature and sex was not able to be determined.

10. Some stomach contents of the deceased Rainbow Trout and Brook Trout were examined in 2020 and included dragonfly nymphs, back swimmers, freshwater shrimp (scuds) and beetles.

Table 4.2.1. Daily catch summary of gill net fishing effort at Summerside Lake on April 28 to 29, 2020.

Days	Gill nets (50m lengths)		
	Effort/Time (hrs of 50yd)	Net size (mm)	Number & Species of Fish Caught
April 28-29, 2020	178	38 mm (8)	17 YLPR, 5 RNTR, 4 BKTR
Total	**178**	**8 nets per set**	**17 YLPR, 5 RNTR, 4 BKTR**

YLPR – Yellow Perch (*Perca flavescens*) RNTR – Rainbow Trout (*Oncorhynchus mykiss*)
BKTR – Brook Trout (*Salvelinus confluentus*)

Table 4.2.2. Fish species and size composition of sample population subset of measured fish captured from Summerside Lake on April 28 to 29, 2020.

Fish Species	Fork Length (mm) of Fish Captured									
	<50	50 - 69	70 - 89	90 - 109	110 - 149	150 - 199	200 - 249	250 - 299	>300	Total
YLPR	-	-	-	-	10	7	-	-	-	**17**
RNTR	-	-	-	-	-	-	-	4	1	**5**
BKTR	-	-	-	-	1	1	2	-	-	**4**
Total	**-**	**-**	**-**	**-**	**11**	**8**	**2**	**4**	**1**	**26**

YLPR – Yellow Perch (*Perca flavescens*) RNTR – Rainbow Trout (*Oncorhynchus mykiss*)
BKTR – Brook Trout (*Salvelinus confluentus*)

Table 4.2.3. Yellow Perch sample population characteristics at Summerside Lake from 2010 to 2020.

Population Characteristic	April 2010	May 2011	May 2012	May 2013	May 2014	April 2015	April 2016	May 2017	May 2018	April 2019	April 2020
Range of lengths (mm)	150-270	105-255	105-208	122-193	133-190	134-191	135-240	135-205	80-266	125-270	127-170
Mean length males (mm)	188	151	139.6	142	147.4	149.7	158.9	174.2	171.5	162.6	157.3
Mean length females (mm)	216	204	145.7	153	163.6	162.7	190.0	168.7	174.4	196.0	140.2
Range of weights (gr)	105-300	-	10.6-88	16-69	28-60	27-56	13-170	50-210	3-165	20-234	21-50
Mean weight of males (gr)	105	-	27.3	27	30.9	35.7	36.9	106	45	46.5	38.4
Mean weight of females (gr)	221	-	33.2	35.1	40.5	48.0	75.9	104	53	92.9	26.8
Mean age males	4.0	3.2	3.9	2.4	3.4	3.8	4.2	4.1	4.2	4.3	3.8
Mean age females	4.4	4.1	4.4	2.6	4.5	4.5	5.6	4.0	3.4	5.0	4.0
Overall mean age	4.3	3.4	4.0	2.5	3.9	4.1	4.5	4.1	4.0	4.4	4.0
Sample size (n)	31	30	73	80	76	68	150	101	100	52	17

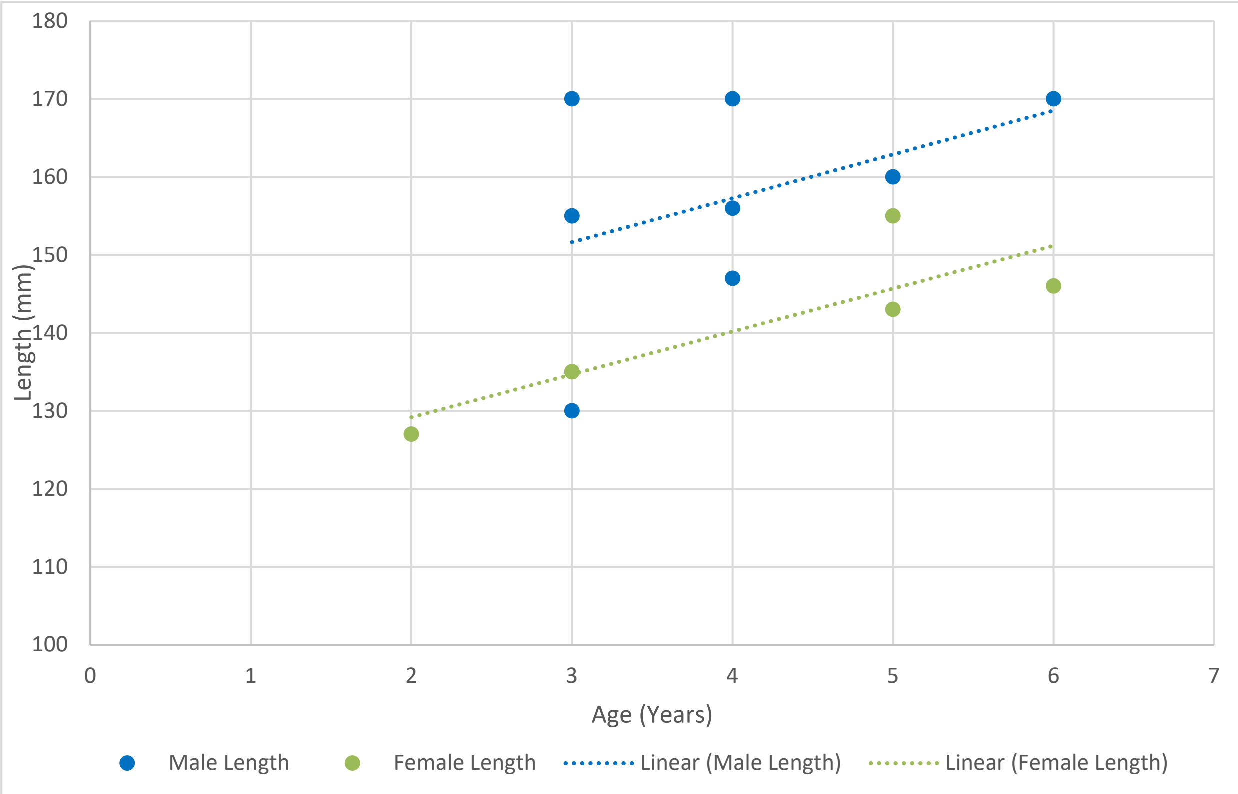

Figure 4.2.1. Age-length relationship of Yellow Perch population sample captured from Summerside Lake on April 28 and 29, 2020.

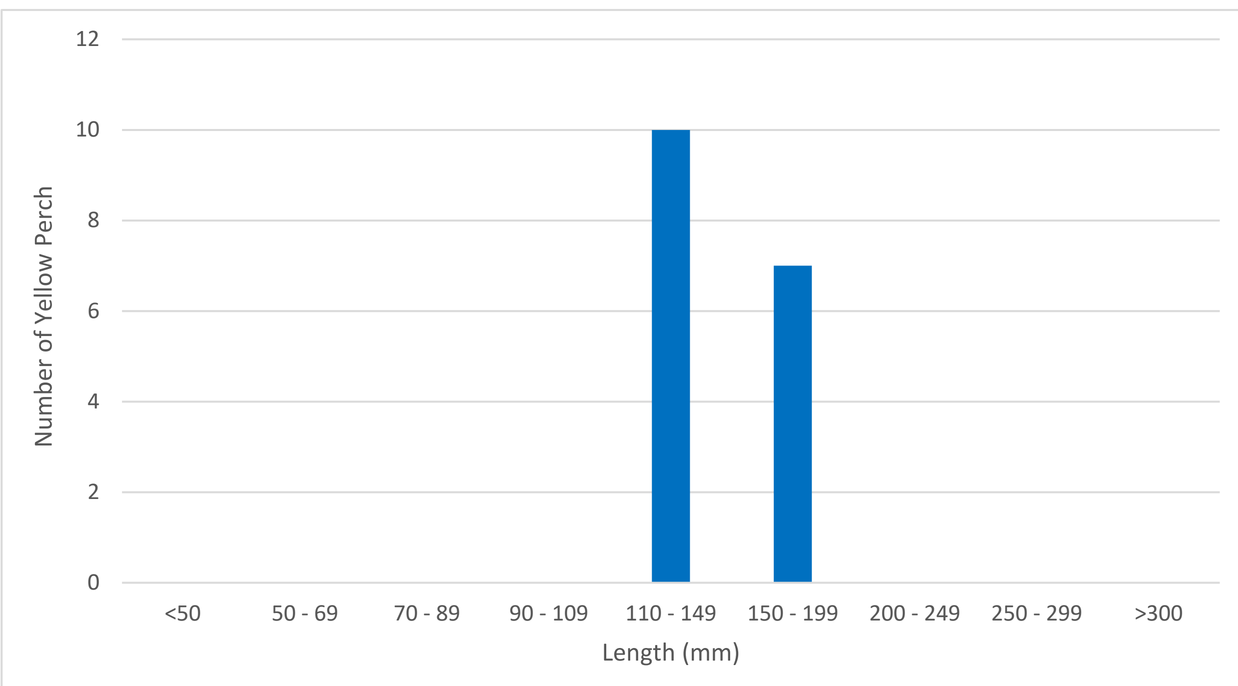

Figure 4.2.2. Length-number frequency relationship of Yellow Perch population sample captured from Summerside Lake on April 28 and 29, 2020.

4.2.2 Minnow Trapping Effort Results

Minnow traps were set on April 28, 2020 and removed on April 29, 2020 to supplement the gill netting technique for removal of Yellow Perch as well as for effort to capture other invasive species, namely goldfish (*Carassius auratus*). Ten (10) minnow traps were set on the northeast side of the lake on April 28, 2020. No goldfish or other fish species were captured within the minnow traps other than 37 Yellow Perch which were disposed of (Table 4.2.4).

Table 4.2.4. Summary of minnow trap catch characteristics at Summerside Lake in April 2020.

Date Set	Minnow Traps	
	Effort/Time (hrs)	Number & Species of Fish Caught
April 18, 2019	215	0 GOFS 37 YLPR
Total	**215**	**0 GOFS** **37 YLPR**

YLPR – Yellow Perch (*Perca flavescens*) GOFS – Goldfish (*Carassius auratus*)

4.2.3 Spruce Bough Egg Removal Results

As part of the Yellow Perch Control Program at Summerside Lake and in addition to removing adult perch, EnviroMak placed approximately 20 to 30 spruce boughs divided into bunches on top of the ice in 10 select positions around the shoreline of the lake to facilitate the capture and removal of Yellow Perch eggs prior to hatch (Figure 9.2.3; Photographs in Appendix 9.1). Each spruce bough bunch consisted of 2 to 3 spruce boughs tied together and weighted down then fastened to an EnviroMak notice sign staked in the ground. The boughs were installed such that they would sink into the water upon spring melting of the ice. Lake ice thickness ranged between 0.4 – 0.5 m within the southern portion of the lake at the time of installation on April 14, 2020.

Boughs were observed periodically following ice melt during the open water period, and, on May 8, 2020 following the spring fish spawning window for Yellow Perch, the boughs were removed from the lake along with any deposited fish eggs. The eggs were removed from the boughs, and volumetric counts of the eggs were conducted. Counts determined that approximately 8,822 Yellow Perch eggs were removed from the spruce boughs placed into the lake in 2020.

Similar methods with some variation in the number of boughs installed, locations and duration were applied in 2019 and 2018 with varying results. No eggs were observed/removed from the approximately 20 spruce boughs bunched in 6 locations during the 2019 season (April 2 – May 3). By comparison in the 2018 season (April 24 – May 7), approximately 12 spruce boughs were placed on the ice in 6 locations from which 330,000 fertilized perch eggs were removed and destroyed.

4.2.4 Comparison of Yellow Perch Harvest 2010 to 2020

Overall, the Yellow Perch catch rates appeared to increase from 2010 to 2013, declined in 2014, and again increased in 2015. In 2016 to 2020, it appeared catch rates by gill netting significantly decreased when compared with efforts of the previous four years (2012 to 2015) (Table 4.2.5; Figures 4.2.3 and 4.2.4). Between 2012 and 2016, the fishing effort consisted of four to five days per year. However, in 2017 and 2018, effort was reduced to 2 days as a result of the previous year low catch number, and effort was further reduced to 1 day for 2019 and 2020 following a catch rate of 0.3 Yellow Perch per hour in 2019 and 0.1 Yellow Perch per hour in 2020 (Table 4.2.5). In the past, the focus on 38 mm gill net mesh sizes has effectively targeted Yellow Perch and limited needless capture and handling of stocked Rainbow Trout and Brook Trout. However, in 2019 and 2020, due to the smaller sized Brook Trout and Rainbow Trout having been stocked in the lake, some undesirable incidental catch of trout species did occur in the nets.

Table 4.2.5. Yellow Perch (YLPR) fish catch characteristics at Summerside Lake from 2010 - 2020.

Year	Number of Days GN Fished	Total Number of YLPR Caught[1]	Mean Length of YLPR (mm) [Males M Females F]	Number of YLPR Caught per 50yd Gill Net (GN) Hour	Comments
2010	2	31	188 M 216 F	66 net hours 0.47 YLPR/hr	Multi-mesh nets used to sample; Initial scoping; 63 Rainbow Trout
2011	3	370	151 M 204 F	132 net hours 2.8 YLPR/hr	Two mesh sizes used (38mm and 63.5mm); 3-5 nets/night; Short pre-spawning and ice out period of <3 days; 30 Rainbow Trout
2012	5	4,766	140 M 146 F	312 net hours 15.3 YLPR/hr	Two mesh sizes used (38mm and 63.5mm); 3-6 nets/night; Long pre-spawning and ice out period of >5 days; 3 Rainbow Trout
2013	5	~8,692	142 M 153 F	477.75 net hours 18.2 YLPR/hr	One mesh size used (38mm); 6 nets/night; Short pre-spawning and ice out period of ~3 days; 8 Rainbow Trout
2014	4	~6,919	147.4 M 163.55 F	*636 net hours 10.9 YLPR/hr	One mesh size focused (38mm); two other sizes used but did not capture YLPR); 9 nets/night; Short pre-spawning and ice out period of ~3 days; 10 Rainbow Trout
2015	4	~10,082	149.7 M 162.7 F	*646 net hours 15.6 YLPR/hr	One mesh size focused (38mm); two other sizes used but did not capture YLPR; 8 to 9 nets/night; Long ; pre-spawning and ice out period of >5 days; 1 Rainbow Trout
2016	5	1,975	159.1 M 195.1 F	804 net hours 2.5 YLPR/hr	One mesh size used (38mm); 8 nets/night; Long pre-spawning and ice out period of >5 days; however only 3 capture days conducted in pre-spawning period than 2 further capture dates during/post-spawning; 16 Rainbow Trout; 1 Triploid Grass Carp
2017	2	452	174.2 M 168.7 F	352 net hours 1.3 YLPR/hr	One mesh size used (38mm); 8 nets/night; Fishing effort completed prior to end of spawning period; 11 Rainbow Trout
2018	2	545	171.5 M 174.4 F	290 net hours 1.9 YLPR/hr	One mesh size used (38mm); 8 nets/night; 11 Rainbow Trout
2019	1	302 (52 GN, 250 MT)	162.6 M 196.0 F	168 net hours 0.3 YLPR/hr	One mesh size used (38mm); 8 nets/night; 11 Rainbow Trout, 23 Brook Trout; Low catch rate first day halted additional gill netting
2020	1	54 (17 GN, 37 MT)	157.3 M 140.2 F	178 net hours 0.1 YLPR/hr	One mesh size used (38mm); 8 nets/night; 5 Rainbow Trout, 4 Brook Trout, 2 deceased triploid Grass Carp observed

*Only 38mm nets used in net hour count as the other nets did not effectively capture Yellow Perch.
[1]Total capture from fishing methods.

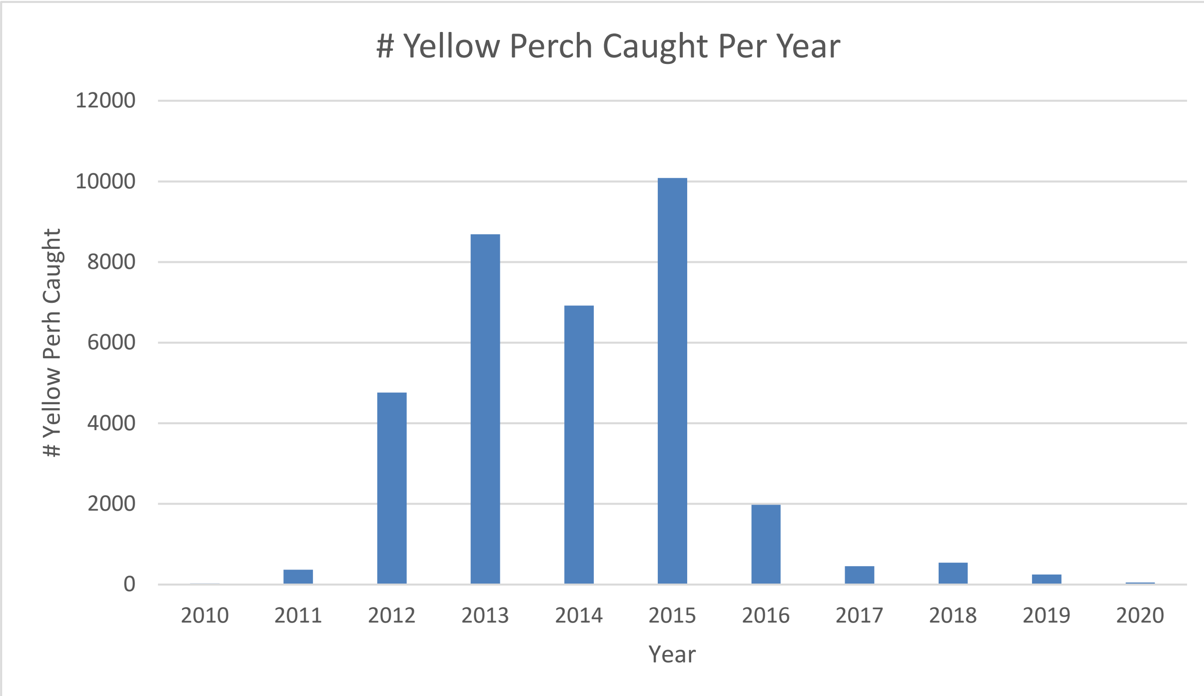

Figure 4.2.3. Number of Yellow Perch captured annually from Summerside Lake in Edmonton from 2010 to 2020.

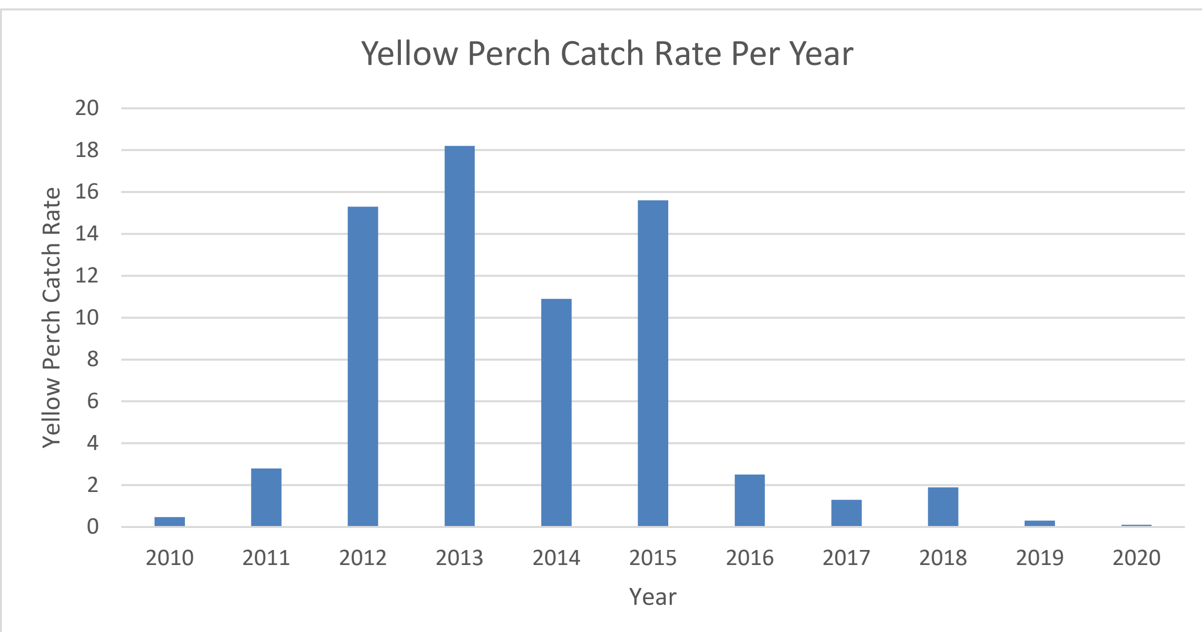

Figure 4.2.4. Yellow Perch gill net catch rate (number of Yellow Perch caught per 50 yard gill net hour) per year from Summerside Lake from 2010 to 2020.

4.3 Snail Removal and Habitat Disturbance

Snail removal and habitat disturbance efforts were conducted on July 8, 2020 within the roped-off swimming area, as well as approximately 10 m to the north and the west in order to try to control the swimmer's itch parasite that the snail plays host to.

Two hundred and twenty (220) snails, of three different species, were removed. These included: 63 Tadpole Snail (*Physa gyrina*); 50 Ash Gyro Snail (*Gyraulus parvus*); and 107 Three-ridge Valvata (*Valvata tricarinata*). Species within both Physa and Gyraulus are known to be hosts to schistosomes, the parasitic flatworms that cause swimmer's itch (Reimink and Hanington 2019). It is unknown whether *Valvata tricarinata* can be a host, as no literature exists on this species and whether it can be a host to schistosomes. Additionally, 3 large leeches were removed from the beach area.

Of the three removal/disturbance passes conducted throughout the study area by the divers, the majority of snails (209) were removed during the first pass which as a non-disturbance pass where the snails were removed from the top of the substrate and aquatic vegetation as observed. The second pass through the study area was a disturbance pass during which the substrate (sand) was raked and aquatic vegetation was removed and bagged. The third pass conducted throughout the study area by the divers was a non-disturbance pass of removing snails from the beach area as observed. Eleven (11) additional snails were removed during this pass. Following the raking, few additional snails were observed on the lake bed, suggesting they were not burrowing into the sand.

5.0 DISCUSSION AND CONCLUSIONS

The following discussion and conclusions are generated from the interpretation of data compiled during the 2020 monitoring of Summerside Lake.

5.1 Limnological Monitoring

1. Water quality in 2020 was generally within acceptable limits in parameters relevant for fish survival. Targets, indicators and guidelines for water quality for fish health are provided in Appendix 9.3.

2. Dissolved oxygen levels in winter were generally acceptable at surface and most depths at most sampling sites for fish survival; however, during the winter at depths lower than 2.0 – 2.5 m most sample sites indicated dissolved oxygen concentrations of <5 mg/L.

3. Nutrient and trophic status indicator parameters indicate some general stability despite limited temporary measured increases in parameters such as Chlorophyll a and Total Kjeldahl Nitrogen (TKN) in 2015. Stability and/or slight decreases in Total Phosphorous and TKN levels, owing in part to sufficient prevention of inputs of nutrients into the lake, may contribute to limiting the growth and production of undesirable algae (i.e. blue-green algae). Secchi disc reading depths were measured at 3.2 to 3.5 m in 2020 and are indicative of overall lake health. Appendix 9.3 provides further information on indicators of the trophic status of lakes.

4. Water samples taken on August 13, 2020 were also tested for nutrients, metals, herbicides and other water quality parameters. None of these elements exceeded the Canadian Environmental Quality Guidelines for Protection of Freshwater Aquatic Life or Alberta Environmental Quality Guidelines for the Protection of Freshwater Aquatic Life (Appendix 9.3). Bacteria (coliforms) were sampled; however, the results were not interpreted to the guidelines as site specific requirements may apply to Summerside Lake and regular sampling by lake maintenance is undertaken to verify compliance for public health relevant to swimming and bacteria (i.e. coliforms).

5. Water quality results including Threshold Odour, clarity, turbidity and pH appear to meet the Guidelines for Canadian Recreational Water Quality (Appendix 9.3). pH is in the higher range for the lake; however, it is still acceptable. Threshold odour has increased over the long-term; however, it is still considered within the acceptable limits. Clarity in 2020 continues to be very good with respect to the guidelines.

6. Lake bed substrate sampling has only been conducted since 2017; however, no major changes were noted in substrate sampling that would warrant action.

7. Aquatic vegetation has increased in diversity (number of species present) over the long-term with a maximum of 6 species observed in 2017 to 2019. Only 4 species were observed in 2020; however, high abundance of *Cladophora* sp. impacting ability to observe other vegetation and previous vegetation removal efforts may have influenced this result. High abundance of various aquatic vegetation species at various sample locations was noted particularly in 2015-2017; however, between 2018 and 2020 moderate abundance for the overall lake was determined from the average of sample sites. *Cladophora* sp. (green algae) was noted as being very abundant in most areas in the lake in 2019 and 2020.

8. Limited amounts of blue-green algae were observed in 2020 and confirmed by microscopic examination. Laboratory water quality analyses were conducted which determined levels (microcystins) were acceptable for recreational use in the lake.

5.2 Fishery Management

1. In 2020, fishing efforts began on April 28 and were completed April 29, with water temperatures around 6.4°C. Very low catch rates (0.1 YLPR/hour and 17 Yellow Perch total) occurred. The Yellow Perch daily catch and catch rate were lower in 2020 than in any previous years of the perch removal program (2012-2019). In addition to this, an undesirable higher catch rate for stocked non-target trout species occurred. A total of 54 Yellow Perch were removed using both gill net and minnow trapping techniques in 2020.

2. Reduced gill net mesh sizes during the course of the Yellow Perch removal program have effectively targeted Yellow Perch and reduced capture of stocked Rainbow Trout and Triploid Grass Carp. However, due to the selective pressures of Yellow Perch removal, decreased numbers of Yellow Perch are being captured in the gill net mesh size used. Increased unintended catch of Rainbow Trout and Brook Trout occurred due to the smaller size of the stocked fish.

3. Two deceased previously stocked Grass Carp were observed, both by EnviroMak biologists and Summerside residents, during the Yellow Perch removal.

4. Numbers of Yellow Perch captured were greater than the Rainbow Trout, especially with the use of smaller gill net mesh at 38 mm. In 2020, 5 Rainbow Trout and 4 Brook Trout were captured, while 17 Yellow Perch were removed via gill nets. All of the captured Yellow Perch were euthanized and disposed of. Three of the 5 Rainbow Trout and 3 of the 4 Brook Trout were sacrificed, as they were deceased upon capture; the remainder were released alive.

5. In addition to gill nets, minnow traps were also set to capture Yellow Perch and potentially other invasive species. Over 215 minnow trap hours, 37 Yellow Perch were captured and disposed of. No other species were captured via this method.

6. No aquatic invasive species, including goldfish or other species of the carp family, were captured during gill netting and minnow trapping and no observations of these species were recorded during any of the site visits.

7. Yellow Perch were present in most places within the lake and included fish that were up to 6 years of age. Several age classes were mature including females at two years of age and males at three years of age. Fewer females were captured than males (6 females to 8 males in the population sample), and they generally appeared to be smaller in both fork length and weight than the males. Both males and females had an average age of 4 years old. All of the female Yellow Perch captured via gill netting were ripe. Sex was not able to be determined for 3 individuals which were deemed immature.

8. No gill net location yielded significantly higher catch rates at that location than any other net set location. However, Net #4, located along the northwest corner of Summerside Lake and south of the Entry Park, yielded the lowest catch at 1 Yellow Perch.

9. In 2020, an attempt to collect and remove Yellow Perch eggs was conducted with the use of spruce boughs used to attract spawning perch and to provide a spawning substrate. Approximately 8,822 Yellow Perch eggs were deposited on the spruce boughs. This was an increase from 2019 during which no eggs were retrieved utilizing this method and a decreased from 2018 during which 330,000 perch eggs were collected and removed via the spruce boughs.

10. The densities of Yellow Perch in similar environments in central Alberta have been calculated at a water supply reservoir by EnviroMak in 2009. In a pond having a surface area of 1.0 ha (100 m x100 m), a total of 11,839 fish of one species, Yellow Perch (*Perca flavescens*), were salvaged (with similar age distribution). The density of fish salvaged in this raw water pond was 1.18 fish per square meter of pond area. This may suggest that, without removal efforts, Summerside Lake could have had approximately 154,000 Yellow Perch with 33% being young-of-year fish. Such numbers could potentially be expected in Summerside Lake without a management/removal program.

11. The removal of Yellow Perch and their eggs during the past years appears to have potentially influenced the size, age and density of the population as less fish were captured in 2020 than in previous years.

12. No natural fish kills within Summerside Lake were noted during the past year.

13. Observations from Summerside personnel, visitors and divers during the summer of 2010 to 2014 had indicated that large numbers of Yellow Perch were present. Observations by EnviroMak during the spring of 2015 also verified large numbers of Yellow Perch were still present during the spawning period. Observations from Summerside residents, divers and EnviroMak during the spring of 2016, 2017 and 2018 indicated a potential decrease in number of Yellow Perch present. In 2020, numerous sightings of Yellow Perch were noted by Summerside personnel, residents, divers and EnviroMak personnel. Schools of smaller sized Yellow Perch were observed throughout the lake.

14. With the continued presence of Yellow Perch, several issues arise as to the future management of the fishery and this includes legal implications of possessing Yellow Perch in these privately-owned waters. From the 2013 to 2015 fish removal programs, high catches of Yellow Perch were recorded. During the 2016 to 2020 removal program, a decrease in the number of fish caught was observed. The effective and efficient elimination of Yellow Perch without substantive harm to the Rainbow Trout, Brook Trout and Triploid Grass Carp populations using specific gill netting mesh sizes or trap (fyke) nets may have potential to control but not eliminate Perch populations. Overall, the periodic removal of Yellow Perch via a netting program or a catch and remove program to reduce Perch densities may influence both the quality of the Yellow Perch population as well as the quality of the stocked trout population.

5.3 Other Concerns

1. Swimmer's itch was reported to the SSRA in 2020 by some residents after swimming/wading in the beach swimming area and southeast coves. Following the manual removal of 220 snails of three different species, substrate and vegetative habitat disturbance effort and limited investigative effort conducted by divers and biologist, it appeared that the majority of snail habitat within the investigative area was located within the rooted aquatic vegetation surrounding the roped-off beach. Presence of green algae as a food source for snails and presence of birds within the lake were observed, both of which may influence the complex life cycle of the parasite that causes the itch. Although some larger Tadpole snails were observed on the sand in the shallow area, the majority of snails appeared to be very small in size (~2-5 mm), difficult to remove mechanically and observed within the aquatic vegetation surrounding the swimming area. Raking disturbance of the beach area as well as mechanical removal of vegetation were anticipated to influence (potentially to reduce) the amount of snail habitat surrounding the beach area to potentially influence the occurrence of swimmer's itch; however, no confirmatory sampling or scientific effort was conducted to verify efficacy. While tracking of occurrences of swimmer's itch reports could be utilized to evaluate effectiveness of the effort, the effort was undertaken later in the season when occurrences would be expected to naturally decrease in frequency in general terms. While the parasite can overwinter in lakes, other conditions that may contribute to the occurrence of swimmer's itch, such as air temperature, may not be anticipated to be the same every year.

6.0 RECOMMENDATIONS

Recommendations for the aquatic management of Summerside Lake are provided below.

1. Water quality analysis continues to indicate that Summerside Lake water quality remains within acceptable limits for fish health and recreational use. Continued annual sampling during the winter particularly for dissolved oxygen and summer particularly for aquatic vegetation and water quality is recommended.

2. Increased monitoring and sampling during the open water period (June and July) for microcystin (blue-green algae toxin), bacteria and aquatic vegetation may be desirable by the users for confirmation of acceptability for recreational use and adaptive management purposes.

3. Optimized routine mechanical vegetation removal should continue particularly in those areas of the lake in and near the beach as well as specific coves identified as areas of concern by users. Vegetation removal occurring earlier in the season and more frequently during the open water period is recommended along with tracking of removal effort and removed vegetation amounts. Vegetation removal may have benefits for improved aesthetics as well as potential reduction in swimmer's itch occurrences.

4. Frequency and duration of operation of the aeration system may be adjusted to evaluate whether this management technique may influence abundance of green algae. It should be noted that the use of aeration may also influence presence and abundance of cyanobacteria (blue-green algae) and is not anticipated to be the same every year; therefore, impacts of changes to aeration use are not entirely predictable.

5. Application of microbiological and/or other lake treatments could be considered by the Association for increased algae control with consideration of the strategy information and recommendations provided in 2020. Some applications are not suitable to Summerside Lake and/or have other negative consequences, therefore should not be applied.

6. The continued selective reduction of Yellow Perch via gill netting (one annual 24-hour effort) and minnow trapping for potential invasive species (i.e. goldfish) capture and Yellow Perch removal should be applied in 2021. The target and schedule would still be to capture Yellow Perch at a pre-spawning period at a lake ice-out condition that would avoid conflict with other recreational water-based activities. A continued low effort of one removal day could be targeted assuming low catch rates are observed. The one-day removal effort would establish an understanding of the Yellow Perch population trend that would contribute to the future and continued management of the fish resources of Summerside Lake particularly with the observations of small sized perch schools during the 2020 open water period. An additional day of fishing effort could be applied in early summer 2021 should angler users report increased dissatisfaction with the fishery.

7. Due to the selective pressures imposed on the Yellow Perch population within Summerside Lake, both male and female perch are beginning to mature at an overall smaller size. With this, it would be advantageous to target smaller sized individuals (that are not typically captured via the existing gill net mesh size). This could include decreasing gill net mesh size and conducting increased minnow trapping. Discussion regarding removal efforts in 2021 should address and consider these methods.

8. Considering both the success of the spruce bough egg removal and retrieval method in 2018 and 2020 and despite the absence of eggs on the boughs in 2019, spruce boughs should again be placed on ice and attached to shore in early April 2021 and withdrawn post-spawning to remove perch eggs to bolster the perch removal effort. A volumetric estimation of egg numbers removed should be obtained for trend analysis to provide recommendations for future application of the methodology. Egg collection via the installation of spruce boughs is a relatively low-cost and low-effort method to aid in perch removal and to analyze potential numbers of spawning individuals in the lake.

9. The use of other catch methodologies and efforts, other than the gill netting, minnow trapping and spruce bough egg collection methods applied in 2020, are not recommended at this time.

10. Stocking of both Rainbow and Brook trout species was recommended and conducted in 2018 and 2020 per the Fish Stocking plans prepared by EnviroMak Inc., with the stocking of both Rainbow Trout and Brook Trout recommended to continue and or be increased annually. Due to the capture of some Brook Trout and Rainbow Trout during the invasive fish species removal effort and with consideration of the goal of continued and/or increased enjoyment of anglers, the future stocking should ensure that a larger size of stocked Brook Trout and Rainbow Trout are used as available. The lack of availability of the larger sized trout by the supplier resulted in the increased capture of the Brook Trout by the mesh sizes used to capture the Yellow perch in 2020. Historically, incidental trout capture during the Yellow Perch removal effort has been minimal.

11. Continued management of the invasive fish population(s) is recommended to protect the trout fishery and prevent the invasive population(s) from becoming the dominant species. Continued effort to secure regulatory approval to stock Tiger Trout should continue in this regard. Further, observations of other invasive fish species (i.e. Goldfish) should be reported, documented and tracked. Should additional sightings be reported, a review of potential response should occur.

12. Occurrences of swimmer’s itch should continue to be recorded and tracked with public notification occurring when incidences are reported. With the information collected during the snail removal and habitat disturbance, is recommended that increased vegetation removal started earlier in the open water season be conducted surrounding the beach area to remove the habitat that may house the smaller snail species. During the assessment, divers noted that >5-foot-tall vegetation was present surrounding the swimming area (towards the center of the lake), which is a breeding ground for snails that can carrying the swimmers itch parasite. The divers noted that the vegetation in this area have an abundance of

snails within it. Areas north and south of the beach up to the dock to the north and the rocky point to the south should also have aquatic vegetation removed as possible to control the snail population.

13. Bird deterrence efforts should be applied in early spring and throughout the open water period to discourage birds from accessing the lake to further influence the swimmer's itch parasite life cycle. Deterrence may include resident dog walking program, physical deterrence flagging/measures particularly near the dock and swimming area, installation of predator decoys, noise and/or predator call auditory deterrence measures and other methods/techniques as available and/or feasible. Care should be taken not to destroy and/or disturb active nesting per the Alberta Wildlife Act and Migratory Bird Convention Act; therefore, early intervention is recommended prior to nesting occurring.

14. Public information on diligent prompt drying and rinsing after swimming should be distributed during swimming season. Other actions to address swimmer's itch could be evaluated and applied as feasible should occurrences in 2021 increase.

15. The preparation of a Summerside Lake EHSMP (Environmental Health and Safety Management Plan) is recommended to develop a lake specific plan for this body of water that provides recreational swimming of users. These waterbodies provide unique recreational opportunities, but also specific risks associated with bodily contact of water. The plan is intended to: describe the physical conditions of the lake for emergency response planning; provide a description of lake background relevant to potential risks; identify microbiological, chemical and other biological hazards; identify physical hazards and aesthetic considerations; provide a risk assessment of the identified hazards; identify facilities and safety provisions; and identify and describe preventative and mitigative management actions relevant to various risks and/or risk levels. The living document could be updated regularly and would be a management tool for continued achievement of lake safety.

7.0 LIMITATIONS AND CLOSURE

In conducting the assessment and rendering our conclusions, EnviroMak gives the benefit of its best judgment based on its experience and in accordance with generally accepted professional standards for this type of assessment in present time. This report was submitted with the best information to date and on the information provided. This report has been prepared for the exclusive use of the proponent/client. Any use which any other third party makes of this report, or any reliance on or decisions to be made on it, are the responsibility of such third parties. EnviroMak accepts no responsibility for damages, if any, suffered by any other third party as a result of decisions made or actions based on this report.

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Sincerely,

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Attachments: Bibliography and Appendix (Photographs)

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9.0 APPENDICES

9.1 Photographs

Photograph 1. Summerside Lake spruce bough installation on April 14, 2020; facing north from boat dock during spruce bough installation prior to ice melt.

Photograph 2. Summerside Lake Yellow Perch removal on April 28, 2020; facing south from boat launch.

Photograph 3. Summerside Lake Yellow Perch removal on April 29, 2020; captured Yellow Perch with deceased Rainbow Trout bycatch.

Photograph 4. Summerside Lake Yellow Perch removal on April 29, 2020; Yellow Perch captured in minnow traps.

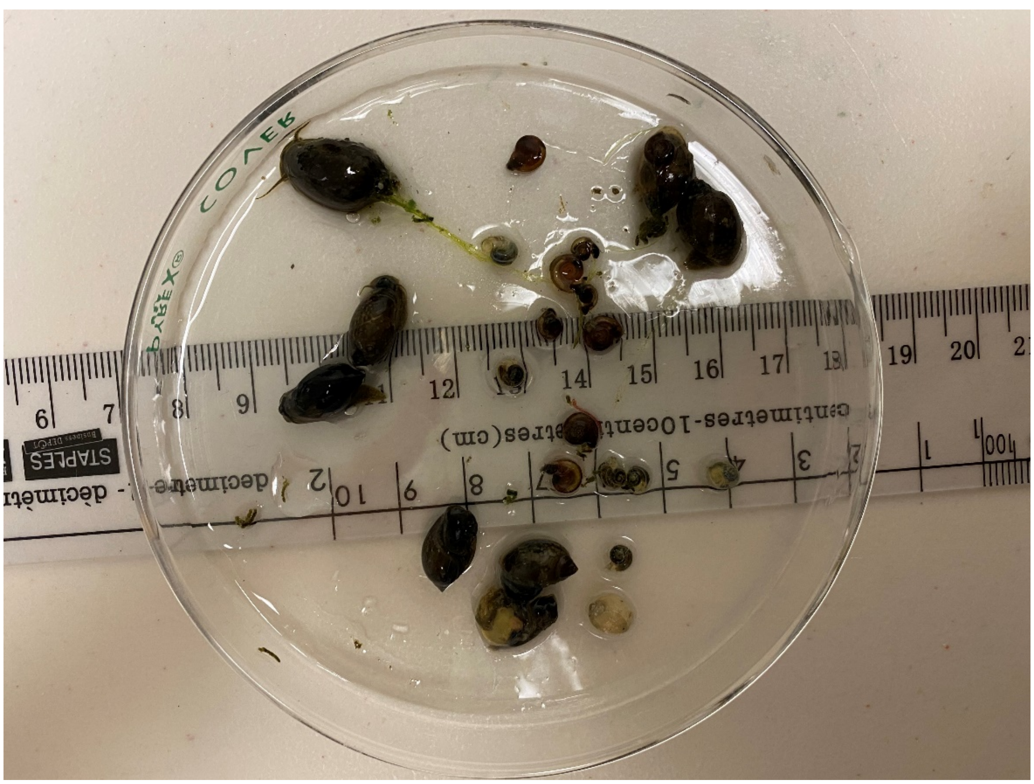
Photograph 5. Summerside Lake Yellow Perch removal on April 29, 2020; live Rainbow Trout captured, measured and released.

Photograph 6. Summerside Lake Yellow Perch eggs collected from spruce boughs on May 8, 2020.

Photograph 7. Summerside Lake on June 24, 2020; blue-green algae (cyanobacteria) observed along the shore of the boat launch area.

Photograph 8. Summerside Lake on June 24, 2020; blue-green algae (cyanobacteria) observed near the boat launch area.

Photograph 9. Summerside Lake snail removal and habitat disturbance on July 8, 2020; divers entering beach area for manual snail removal and raking/disturbance of snail habitat.



Photograph 10. Summerside Lake snail removal and habitat disturbance on July 8, 2020; sub-sample of snails manually removed from beach area.

Photograph 11. Summerside Lake aquatic vegetation assessment on August 5, 2020; green algae (*Cladophora* sp.) located in the southeast cove.

Photograph 12. Summerside Lake aquatic vegetation assessment on August 5, 2020; high abundance of aquatic vegetation within the south littoral areas of the lake.

Photograph 13. Summerside Lake limnological monitoring on August 13, 2020; facing north into northeast cove.

Photograph 14. Summerside Lake limnological monitoring on August 13, 2020; facing east towards beach from centre sampling point.

9.2 Sampling Plan and Methods

Table 9.2.1. Spatial and temporal sampling plan for Summerside Lake limnological monitoring 2020.

Parameters	Measurement Unit	Sampling Method	Sampling Location	Sampling Date(s)
Water Quality				
Temperature	Celsius degrees	Alcohol or mercury field thermometer and/or PCSTestr 35 Multi-Parameter	Central, End of Dock	Spring, Summer, Winter
pH		Oakton PCSTestr 35 Multi-Parameter	Central, End of Dock	Spring, Summer, Winter
Conductivity	Microsiemens per cm (µs/cm)	Oakton PCSTestr 35 Multi-Parameter	Central, End of Dock	Spring, Summer, Winter
Total Dissolved Solids	mg/L	Oakton PCSTestr 35 Multi-Parameter	Central, End of Dock	Spring, Summer, Winter
Dissolved Oxygen	mg/L	Orion Star A223 RDO Optical DO Meter and Dissolved Oxygen Sensor	Central, End of Dock	Spring, Summer, Winter
Alkalinity	mg/L	Hach Model AL-AP Test Kit	Central, End of Dock	Spring, Summer, Winter
Turbidity	Nephelometric Turbidity Units (NTU)	Hach 2100Q Turbidimeter	Central, End of Dock	Spring, Summer, Winter
Light Penetration	m	Secchi Disc	North, South, End of Dock	Summer
Nutrients and Metals	mg/L	Water Sample Set – Laboratory Procedures	Central, End of Dock	Summer, Winter
Chlorophyll a	µg/L	Water Sample Set – Laboratory Procedures	Central, End of Dock	Summer
Microcystins (Total)	µg/L	Water Sample Set – Laboratory Procedures	Central, End of Dock, Beach	Summer
Selenium	mg/L	Water Sample Set – Laboratory Procedures	Central	Summer
Bacteria (Fecal and Total)	Coliforms/100mL	Water Sample Set – Laboratory Procedures	Central	Summer*
Herbicides	µg/L	Water Sample Set – Laboratory Procedures	Central	Summer
TON (Threshold Odour No.)	Scale	Water Sample Set – Laboratory Procedures	Central, South	Summer, Winter
Aquatic Vegetation				
Species Composition Relative Abundance	Observed Amount	Visual observation	Northeast-L Northwest-L Southeast-L Southwest-L Northwest-D South Entry Park Beach	Summer
Species Composition Relative Abundance	Presence or absence	Modified rake sampler and Ekman dredge		
Species Composition Relative Abundance	Visual: High Moderate Scant Zero	Visual observation	Perimeter	Summer

*Bacteria (including Enterococci) is sampled more frequently directly by the Association during swimming season.

PARAMETERS	MEASUREMENT UNIT	SAMPLING METHOD	SAMPLING LOCATION	SAMPLING DATE(S)
FISH				
Invasive Fish Presence/Absence and Removal Effort	# fish caught Other parameters per Research Licence conditions	Minnow trapping Gill netting	Throughout Lake	Spring
	# of eggs collected (volumetric count)	Spruce Bough Egg Collection	Select locations around littoral zone	Spring
PLANKTON				
Relative Abundance	# / 500 mL	Plankton net pull	North and South	Summer
SUBSTRATE/SEDIMENT				
Lake bed substrate composition	Visual Observation	Eckman dredge	Northeast, Northwest, Southeast, Southwest; Littoral, Deep	Summer

Table 9.2.2. Sampling legend and locations for Summerside Lake limnological monitoring 2020.

Parameter Measured	Sample ID	General Location in Lake	UTM Location (Zone 12N)	Water Depth
Aquatic Vegetation	V1	Beach Deep	335815.00 m E, 5921582.00 m N	2.1 m
	V2	Beach Littoral	335845.00 m E, 5921437.00 m N	1.0 m
	V3	Southeast Littoral 1	335927.00 m E, 5921391.00 m N	1.0 m
	V4	Southeast Deep 1	335914.00 m E, 5921386.00 m N	2.5 m
	V5	Southeast Littoral 2	335890.00 m E, 5921361.00 m N	1.0 m
	V6	Southwest Deep 2	335885.00 m E, 5921372.00 m N	3.0 m
	V7	South Deep	335855.00 m E, 5921372.00 m N	2.5 m
	V8	South Littoral	335722.00 m E, 5921365.00 m N	1.0 m
	V9	Southwest Littoral 1	335590.00 m E, 5921281.00 m N	1.2 m
	V10	Southwest Deep 1	335579.00 m E, 5921294.00 m N	2.3 m
	V11	Southwest Littoral 2	335568.00 m E, 5921291.00 m N	1.3 m
	V12	Southwest Deep 2	335571.00 m E, 5921318.00 m N	2.3 m
	V13	Entry Park Littoral 1	335559.00 m E, 5921658.00 m N	1.2 m
	V14	Entry Park Deep	335582.00 m E, 5921679.00 m N	2.6 m
	V15	Entry Park Littoral 2	335590.00 m E, 5921719.00 m N	1.0 m
	V16	Northwest Deep 1	335674.00 m E, 5921763.00 m N	3.0 m
	V17	Northwest Littoral 1	335675.00 m E, 5921777.00 m N	1.0 m
	V18	Northwest Deep 2	335683.00 m E, 5921769.00 m N	2.8 m
	V19	Northwest Littoral 2	335686.00 m E, 5921786.00 m N	1.0 m
	V20	Northeast Littoral 1	335840.00 m E, 5921750.00 m N	1.0 m
	V21	Northeast Deep 1	335848.00 m E, 5921746.00 m N	3.0 m
	V22	Northeast Deep 2	335886.00 m E, 5921755.00 m N	2.2 m
	V23	Northeast Littoral 2	335889.00 m E, 5921766.00 m N	1.0 m
	V24	Boat Launch Littoral 1	335928.00 m E, 5921661.00 m N	1.0 m
	V25	Boat Launch Littoral 2	335923.00 m E, 5921610.00 m N	1.0 m
Water Quality	North	North	335710.00 m E, 5921675.00 m N	8.9 m
	Central	Central	335721.00 m E, 5921584.00 m N	3.3 m
	South	South	335722.00 m E, 5921456.00 m N	9.1 m
	End of Dock	End of Dock	335847.31 m E, 5921611.38 m N	Not Collected
Lake Bed Substrate Sampling	NE-L	Northeast Littoral	335897.00 m E, 5921666.00 m N	2.2 m
	NW-L	Northwest Littoral	335578.00 m E, 5921687.00 m N	1.4 m
	NW-D	Northwest Deep	335668.00 m E, 5921704.00 m N	8.9 m
	SE-L	Southeast Littoral	335841.00 m E, 5921372.00 m N	1.7 m
	SW-L	Southwest Littoral	335654.00 m E, 5921373.00 m N	2.1 m
Threshold Odour Number (TON)	TON	Central	335721.00 m E, 5921584.00 m N	3.3 m
Zooplankton	North	North	335710.00 m E, 5921675.00 m N	8.9 m
	South	South	335722.00 m E, 5921456.00 m N	9.1 m

Urban Constructed Lake Limnological Monitoring Methodology

9.2.1 Water Quality Parameters

9.2.1.1 Spatial Monitoring Plan

- The sampling sites are indicated in the figure below and tables inserted above.

9.2.1.2 Temporal Monitoring Plan

- Water quality parameters will be measured in spring, summer, and winter (if feasible) to capture variable seasonal conditions in Summerside Lake per the tables inserted.

9.2.1.3 Techniques

- All water samples collected from Summerside Lake will be handled in the following manner:
  - Water samples for a variety of water quality parameters will be collected with appropriately sized sterilized sample bottles. Samples are generally taken from approximately 15 cm below the water surface. Sample preservatives shall be utilized as necessary.
  - Chlorophyll a, total phosphorus, Total Kjeldahl Nitrogen, phaeophytin, microcystin, total chlorides and heavy metals (i.e., Al, Cu, Pb, Zn) will be measured at Element Laboratory in Edmonton, which is certified by the Canadian Association of Environmental and Analytical Laboratories (CAEAL).
  - Dissolved oxygen, turbidity, water clarity, conductivity, total dissolved solids, alkalinity and pH will be measured on site with appropriate metres and analysis kits that are accurately calibrated and maintained for quality assurance/quality control.
  - The Threshold Odour Number will be measured in the EnviroMak Inc. laboratory as per the Standard Methods for the Examination of Water and Wastewater (American Public Health Association 20th Edition 1999).
  - Light penetration will be measured using a Secchi disk. The Secchi disk is a circular disk, patterned with alternating black and white quadrants. The disk is lowered into the water on a graduated line until it is no longer visible in the water column, dropped slightly further, and then pulled up until it becomes visible. The depth of the water level on the graduated Secchi disk line will be recorded when the disk is no longer visible, and again once it becomes visible (the average of the two depths is the Secchi depth) (Alberta Environment, 2006).

9.2.2 Aquatic Vegetation

9.2.2.1 Spatial Monitoring Plan

- Four general sample stations identified as Northwest, Northeast, Southwest and Southeast (Figure below) establish the aquatic vegetation sampling plan for Summerside Lake. The first sampling site along each shoreline will be targeted for a depth of 2.0 m. Increased resolution of sample stations within these areas may be established in some years.

- Additional sample points (V1 through V25) will be characterized around the perimeter of the lake as relative amounts of vegetation and species change (Figure below). Relative abundance and species composition will be observed visually noted at each sample point.

9.2.2.2 Temporal Monitoring Plan

- Aquatic vegetation will be measured in summer to capture optimal vegetation growth in Summerside Lake.

9.2.2.3 Techniques

- Aquatic macrophytes will be harvested using a benthic rake system (Makowecki 1973) where the rake rotates around a spike that has been driven into the substrate. The rake has a width of 35 centimetres, thereby raking an area of 0.38 m^2 at each site. Samples will be placed in pre-labelled pails and put into a cooler for transport to the laboratory for identification.
- A secondary method to capture aquatic macrophytes will include an Ekman dredge. The dredge is lowered in a controlled fashion into the waterbody with the jaws on the dredge set to the locked open position. The dredge will be lowered to be in contact with the lake substrate. The messenger on the dredge will be dropped (if applicable) and the dredge is slowly raised to the water surface level. The dredge is deemed acceptable if the desired depth of penetration was achieved, and the sampler has completely closed and was not inserted on an angle or tilted upon retrieval. Contents will be removed from the dredge, placed in pre-labelled pails, and macrophyte presence or absence will be recorded (Alberta Environment, 2006).

9.2.3 Bacteria

9.2.3.1 Spatial Monitoring Plan

- The sampling sites are indicated in the figure below and tables inserted above.

9.2.3.2 Temporal Monitoring Plan

- Bacteria levels will be measured in summer per the tables inserted.

9.2.3.3 Techniques

- All water samples collected from Summerside Lake will be collected in designated bacteria sampling bottles. Bacteria will be measured at Element Laboratories in Edmonton, which is certified by the Canadian Association of Environmental and Analytical Laboratories (CAEAL).

9.2.4 Macro-Zooplankton

9.2.4.1 Spatial Monitoring Plan

- The sampling sites are indicated in the figure below and tables inserted above.

9.2.4.2 Temporal Monitoring Plan

- Zooplankton samples will be collected in summer months from Summerside Lake.

9.2.4.3 Techniques

- Samples collected from Summerside Lake will be handled using a zooplankton net in the following manner:
  - Prior to immediate use, the plankton net will be rinsed with lake water to dislodge any attached material prior to sampling.
  - Plankton will be collected by undertaking three-metre horizontal tows through the water near the surface using a standard plankton net. The plankton net is lowered vertically into the euphotic zone of the lake and towed at a continuous rate to minimize escaping of the net by fast-swimming zooplankton (Alberta Environment, 2006).
  - Captured plankton will be rinsed from the collection screen into pre-labelled bottles and transported to the lab for immediate analysis.
  - Identification of amphipods and other macro-zooplankton and a total count for each sample will be conducted in the laboratory.
  - The plankton net and bucket will be rinsed with lake water between sites.
  - Triplicate sampling will be conducted at each sample station in Summerside Lake.

9.2.5 Fish Capture

9.2.5.1 Spatial Monitoring Plan

- Fish sampling stations conducted throughout Summerside Lake targeting areas as having the highest potential for Yellow Perch spawning habitat.

9.2.5.2 Temporal Monitoring Plan

- Fish sampling will be collected during a one-time fishing event during the spring, immediately following ice melt.

9.2.5.3 Techniques

- Samples collected from Summerside Lake will be handled using gill nets in the following manner:
    - Three size classes of nets are allocated for Yellow Perch capture. These include; 25.4mm, 38mm, and 50.8mm sized gill nets. A selection of these nets will be applied.
    - Nets are to be set and pulled daily (or as per frequency identified in Fish Research Licence) in areas targeted as having highest Yellow Perch spawning habitat.
    - Any incidental fish captured that are not the targeted species will be returned live to the lake if possible.
    - Target species captured in gill nets will be removed from nets and living individuals will be relocated as per the issued Fish Research Licence. Deceased individuals will be appropriately disposed of.
    - Any additional sampling requirements set forth in the issued Fish Research Licence will be adhered to.
- Samples collected from Summerside Lake will be handled using minnow traps in the following manner:
    - Minnow traps with 5mm mesh size and 0.11m by 0.22m dimensions will be set and pulled daily (or as per frequency identified in Fish Research Licence) in areas targeted as having highest Yellow Perch spawning habitat.
    - Dry cat food shall be used as bait for the minnow traps.
    - Any incidental fish captured that are not the targeted species will be returned live to the lake.
    - Target species captured in gill nets will be removed from nets and living individuals will be relocated as per the issued Fish Research Licence. Deceased individuals will be appropriately disposed of.
    - Any additional sampling requirements set forth in the issued Fish Research Licence will be adhered to.

- Spruce boughs for egg collection may be laid on ice prior to annual ice melt in spring and removed after a period of time as defined by the biologist. Eggs on the boughs are to be collected and counted with volumetric method. Fertilization status of eggs to be verified.

9.2.6 Wildlife

Other notable wildlife observations will be recorded during environmental data collection.

9.2.7 Substrate/Sediment Composition

- Lake bed substrate/sediment samples from Summerside Lake will be collected in the following manner:

    1. The sampler should be "set" according to the manufacturer's instructions and lowered through the water column.
    2. Dredges should never be allowed to free fall into the substrate. The sampler should be carefully lowered the last few feet to minimize dispersal of fine material due to a sampler induced shock wave.
    3. In shallow waters, some samplers can be pushed directly into the sediment. Five and ten foot extension handles can be attached to Eckman dredges for sampling in shallow waters to plunge the sampler into the sediment. These handles can minimize some of the limitations of the dredge.
    4. The sampler is then tripped either with the weight or extension handle.
    5. The sampler should be slowly raised through the water column and placed in the sieve. Allow the water from the sieve to drain into a 5 gal pail.
    6. If an insufficient or improper sample is collected, additional weights should be added (if appropriate) to the sampler to allow deeper penetration into the sediment.

- Samples are then analysed in-house and the following physical characteristics are recorded:

    - Composition/texture/particle size
    - Appearance
    - Colour (using Munsell soil colour chart)
    - Odour

9.2.8 Quality Assurance/Quality Control (QA/QC)

Standard operating procedures for sample handling and data management (transfer and verification) have been developed and will be used for all aspects of the monitoring program. These procedures have been described as part of the description of the methods.

The laboratory QA/QC are worthy of noting and utilize basic methods of insuring confident results, and these methods include:

- Periodic calibration of equipment used to measure turbidity and other water quality parameters.

- Triplicate sampling to measure turbidity and other water quality parameters (to establish replication consistency).

Sample handling will consist of:

- storing samples in sealed coolers to maintain a constant temperature (4 degrees Celsius);
- completing a field data sheet that ensures a chain of custody and continuity;
- shipping and analyzing samples as soon as possible following collection; and
- random duplicate testing of samples.

Data is recorded in hard copy and digital formats and the laboratory records provide a verification of calculations for follow up should they be required. Laboratories continually assess their calibration standards and validate periodically.

9.2.9 Bibliography

Alberta Environment. 2006. Aquatic Ecosystems Field Sampling Protocols. Alberta Environment, Environmental Monitoring and Evaluation Branch. March 2006. 137 pp.

American Public Health Association. 1999. Methods for the Examination of Water and Wastewater. 20th Edition.

Makowecki, R. 1973. The trophy pike, *Esox lucius*, of Seibert Lake. M.Sc. Thesis, University of Alberta, Dept. of Zoology. 273 pp.

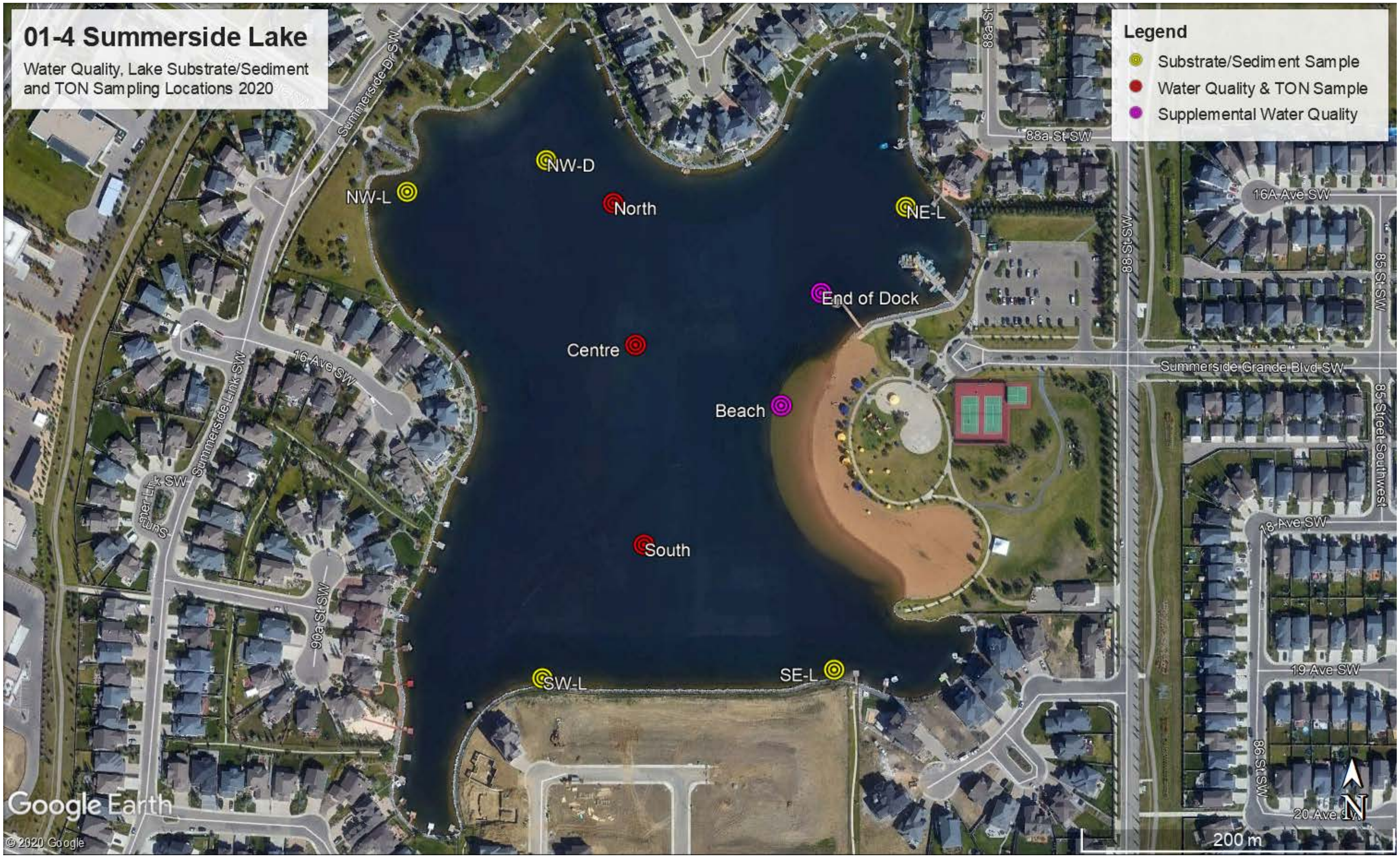


Figure 9.2.1. Water quality, substrate/sediment and threshold odour number (TON) sampling locations in Summerside Lake in 2020.

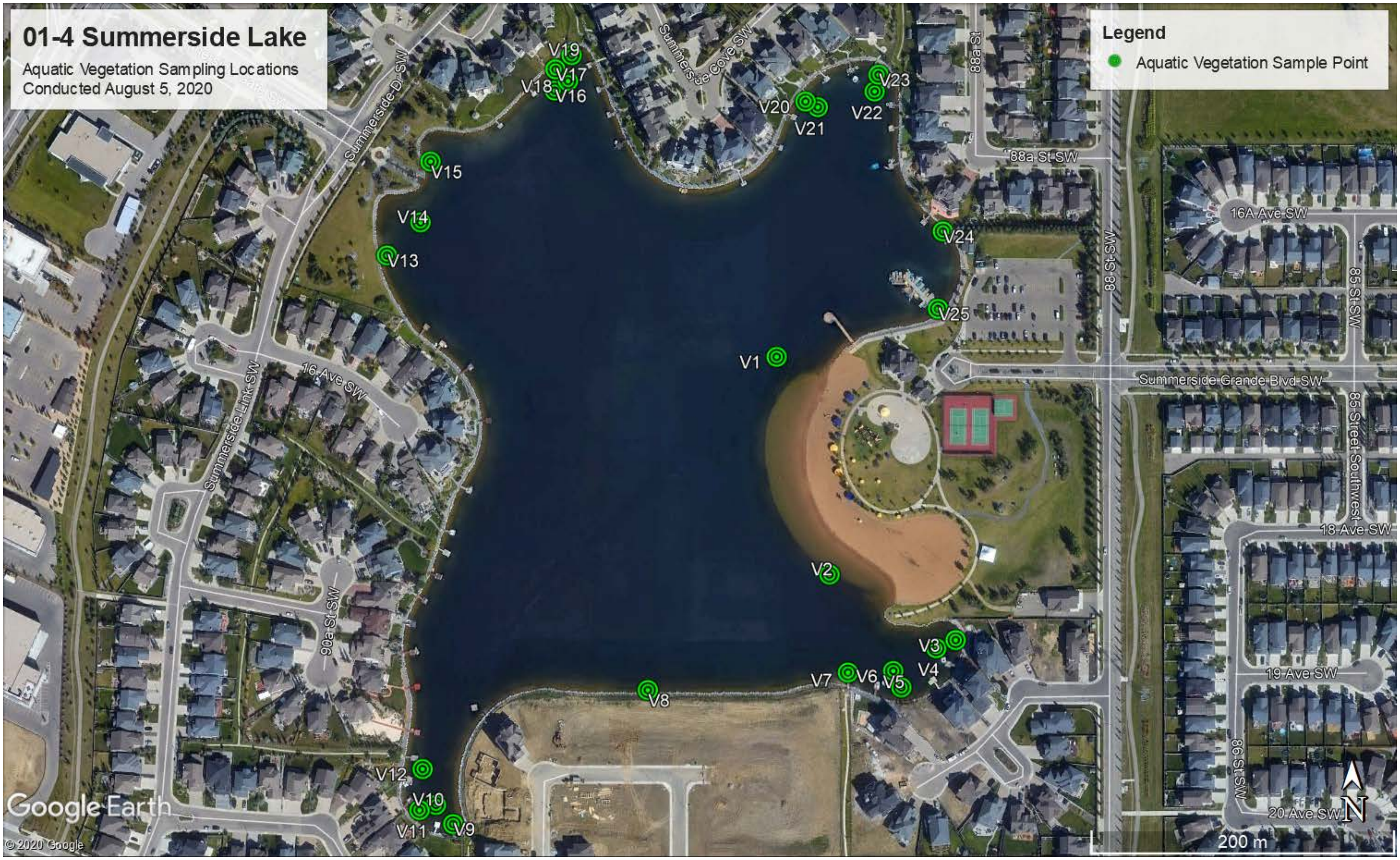


Figure 9.2.2. Aquatic vegetation sampling locations in Summerside Lake on August 5, 2020.

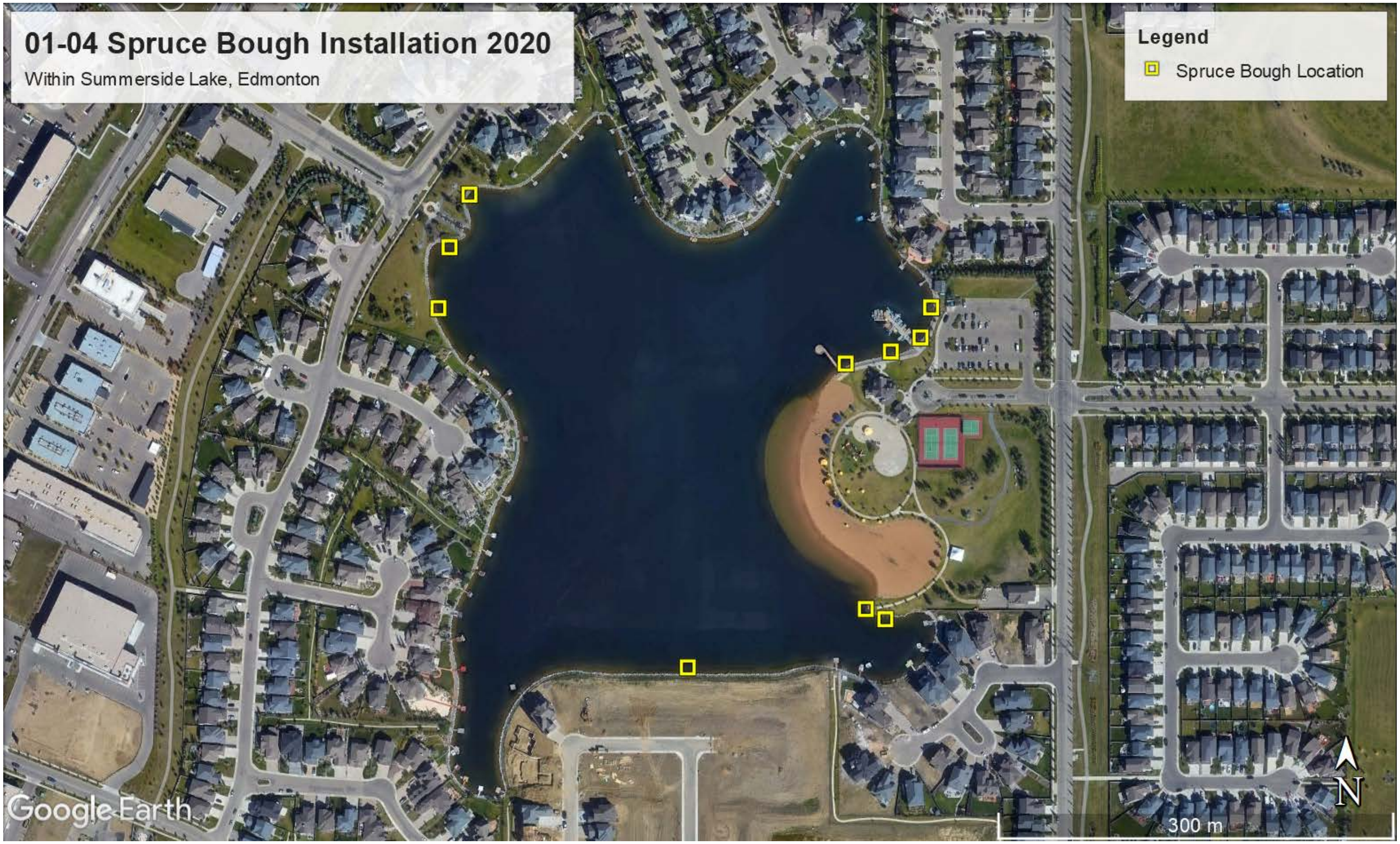


Figure 9.2.3. Spruce bough fish egg collection locations in Summerside Lake on April 14, 2020.

9.3 General Water Quality Guidelines, Targets and Indicators

Table 9.3.1a. Desired targets and/or allowable concentrations for selected water quality parameters.

Parameter	[1]EQGASW Guidelines for Protection of Freshwater Aquatic Life		[2]AB WQG for Recreation & Aesthetics
	Long-term	Short-term	
Metals - Total			
Mercury (mg/L)	0.000005	0.000013	-
Aluminum – dissolved (mg/L)	0.05 (pH dependent)	0.1 (pH dependent)	-
Arsenic (mg/L)	0.005	-	-
Barium (mg/L)	-	-	-
Boron (mg/L)	1.5	29	-
Cadmium (mg/L)	0.0003*	0.0046*	-
Chromium (mg/L)	0.001	-	-
Cobalt (mg/L)	0.0014*	-	-
Copper (mg/L)	0.007	0.034*	-
Lead (mg/L)	0.007*	-	-
Molybdenum (mg/L)	0.073	-	-
Nickel (mg/L)	0.1*	0.9*	-
Selenium (mg/L)	0.002	-	-
Silver (mg/L)	0.00025	-	-
Thallium (mg/L)	0.0008	-	-
Uranium (mg/L)	0.015	0.033	-
Zinc (mg/L)	0.03	-	-
Routine and Nutrients			
pH	6.5 to 9.0	-	5.0 to 9.0
Iron (dissolved) (mg/L)	0.3	-	-
Chloride (dissolved) (mg/L)	120	640	-
Nitrate-N (mg/L)	3.0	124	-
Nitrite-N (mg/L)	0.10	0.30	-
Sulfate (dissolved) (mg/L)	429	-	-
T-Alkalinity as $CaCO_3$ (mg/L)	20	-	-
Turbidity (NTU)	2 units above background levels	8 units above background levels	<50
Dissolved Oxygen (mg/L)	6.5 – 9.5	5	-
Microcystin – total (µg/L)	-	-	20
Phosphorus - total (mg/L)	Narrative[5]	Narrative[5]	Relates to algae status
Nitrogen (TKN) (mg/L)	Narrative[5]	Narrative[5]	Relates to algae status
Ammonia (mg/L)	Equation varies with pH and temperature	-	-
Aggregate Organic Constituents			
Oil and Grease	See footnote[3]	See footnote[3]	See footnote[4]
Microbiological Analysis			
Total Coliforms (CFU/100 mL)	-	-	-
Escherichia coli (CFU/100 mL)	-	-	≤100[6]
Fecal Streptococci/Enterococci	-	-	≤ 30
Herbicides & Pesticides			
Diclofop-methyl (µg/L)	6.1	-	-
Metribuzin (µg/L)	1	-	-
Triallate (µg/L)	0.24	-	-
Trifluralin (µg/L)	0.2	-	-
Bromoxynil (µg/L)	5	-	-
Dicamba (µg/L)	10	-	-
Dinoseb (µg/L)	0.05	-	-
MCPA (µg/L)	2.6	-	-
Mecoprop (µg/L)	13	10,000	-
Picloram (µg/L)	29	-	-

Parameter	[1]EQGASW Guidelines for Protection of Freshwater Aquatic Life Long-term	Short-term	[2]AB WQG for Recreation & Aesthetics
Other Parameters			
Blue-green Algae	-	-	Visible scums to be avoided
Microcystin (µg/L)	-	-	20
Chlorophyll a (µg/L)	-	-	Relates to algae status and lake trophic status; See Table 9.3.1b
Odour (TON)	-	-	<8
Clarity			Sufficient to estimate depths and see surface hazards; Relates to lake trophic status; See Table 9.3.1b

[1]Environmental Quality Guidelines for Alberta Surface Waters' Surface Water Guidelines (EQGASW) for the Protection of Freshwater Aquatic Life (2018).
[2]Environmental Quality Guidelines for Alberta Surface Waters' Surface Water Quality Guidelines (AB WQG) for Recreation and Aesthetics (2018).
[3]Oil and grease attributable to human activities should not be present in amounts that:

- cause visible sheens, films, or discolouration;
- can be detected by odour;
- cause tainting of edible aquatic biota;
- form deposits on shores or bottom material that are detectable by sight or odour, or are deleterious to resident biota.

[4]Should not be present in concentrations that can be detected as a visible film, sheen discolouration or odour, or that can form deposits on shorelines or bottom sediments that are detectable by sight or odour.
*Calculated at a hardness of 216 mg/L dissolved as CaCO3.
[5]For surface waters not covered by specific guidelines, nitrogen (total) and phosphorus concentrations should be maintained so as to prevent detrimental changes to algal and aquatic plant communities, aquatic biodiversity, oxygen levels, and recreational quality. Where priorities warrant, develop site-specific nutrient objectives and management plans. Previous to 2018, phosphorous (total) was noted as 0.15 mg/L for maximum short-term guideline and nitrogen (TKN) was 1 mg/L for maximum short-term guideline. See table 9.3.1b.
[6]Public Health Act indicates maximum of 20 for artificial beaches. See table 9.3.1c for more Canadian recreational water guidelines. Site specific requirements may apply to individual lakes and/or facilities.

Table 9.3.1b. Indicators of the trophic status of lakes according to Thomann and Mueller (1987) and, in brackets, the Atlas of Alberta Lakes (Mitchell & Prepas 1990).

Parameter	Oligotrophic	Mesotrophic [LONG-TERM TARGET]	Eutrophic
Chlorophyll a (µg/L)	<4 (<2.5)	4-10 (2.5-25)	>10 (>25)
Total Phosphorus (mg/L)	<0.01 (<0.01)	0.01-0.02 (0.01-0.035)	>0.02 (>0.035)
Secchi Disc Readings (m)	>0.27	0.11-0.27	<0.11

Table 9.3.1c. Guidelines for Canadian recreational water quality: summary table (reproduced).

Guidelines		
Parameter	**Considerations**	**Guideline**
Escherichia coli (Primary-Contact Recreation)*	Geometric mean concentration (minimum 5 samples) Single sample maximum concentration	≤ 200 *E. coli* /100 mL ≤ 400 *E. coli* /100 mL
Enterococci (Primary-Contact Recreation)*	Geometric mean concentration (minimum 5 samples) Single sample maximum concentration	≤ 35 Enterococci /100 mL ≤ 70 Enterococci /100 mL
Pathogenic Microorganisms (bacteria, viruses, protozoa)	Testing only needed when there is epidemiological or other evidence to suggest that this is necessary	No numerical guideline value
Cyanobacteria Cyanobacterial toxins	Total Cyanobacteria Total Microcystins	≤ 100,000 cells/mL ≤ 20 µg/L
Other Biological Hazards (e.g. schistosomes causing swimmer's itch; aquatic vascular plants and algae)	Recreational activities should not be pursued in waters where the responsible authority deems the presence of these organisms poses a risk to the health and safety of the users	No numerical guideline value
pH	For waters used for primary contact recreation	5.0 to 9.0
Temperature	Should not cause an appreciable increase or decrease in the deep body temperature of swimmers	No numerical guideline value
Chemical Hazards	Risks associated with specific chemical hazards will be dependent on the particular circumstances of the area and should be assessed on a case-by-case basis.	No numerical guideline value
Aesthetic Objectives		
Parameter	**Considerations**	**Aesthetic Objective**
Turbidity	To satisfy most recreational uses	50 NTU
Clarity	Clarity should be sufficient for users to estimate depth and to see subsurface hazards	Secchi Disc visible at a depth of 1.2 m
Colour	Colour should not be so intense as to impede visibility in areas used for swimming	No numerical value
Oil and Grease	Should not be present in concentrations that can be detected as a visible film, sheen, discolouration or odour; or that can form deposits on shorelines or bottom sediments that are detectable by sight or odour	No numerical value
Litter	Areas should be free from floating debris as well as materials that will settle to form objectionable deposits	No numerical value

* Advice regarding waters intended for secondary-contact recreational activities is provided in Section 4.2 of guideline.