

# Highlands Lakes Water Quality Assessment 1997 – 2003



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## **Executive Summary**

The District of Highlands is located on southern Vancouver Island and offers its residents a unique, rural lifestyle free from commercial development. The Highlands contains a significant portion of greenspace which includes several small lakes. There is a keen interest in the local stewardship of these lakes and volunteers have been quite active in recent years working towards protecting water quality.

Data collected by volunteers and Ministry of Water, Land and Air Protection staff were assessed to determine the status of water quality for six Highlands Lakes: Fork, Teanook, Third, Pease, Eagles and Mitchell. A wide range of parameters were included with detailed assessment focussing on nutrients (phosphorus and nitrogen) and bacteria (fecal coliforms).

Overall, the results indicated good water quality. Fork Lake had the most extensive data set and the most recent results for measured parameters did not exceed guidelines for the protection of aquatic life and drinking water. The results showed reductions in total phosphorus loadings in recent years which may be the result of strong local stewardship efforts in this watershed. Teanook Lake also demonstrated good water quality; however, the results showed total phosphorus levels elevated slightly above guideline limits. Third Lake data was limited to one year of data and some total beryllium and total cadmium results were above the guidelines for the protection of aquatic life. Pease Lake data was also limited to one year but the results suggest good water quality. Eagles Lake and Mitchell Lake data were insufficient to draw any conclusions with respect to water quality. Recommendations include continued stewardship of the lakes by local volunteers to protect water quality in the long term, and additional monitoring at spring overturn for Third, Pease, Eagles and Mitchell lakes to complete baseline data sets.



**Table of Contents**

1.0 Introduction ..... 3  
2.0 Site Descriptions..... 4  
    2.1 Bathymetric Data ..... 6  
    2.2 Land Use ..... 6  
3.0 Methods and Data Analysis ..... 7  
4.0 Results and Discussion ..... 8  
    4.1 Fork Lake ..... 8  
        4.1.1 Fork Lake Results ..... 8  
            4.1.1.1 Secchi depth ..... 8  
            4.1.1.2 General water chemistry ..... 8  
            4.1.1.3 Nutrients ..... 8  
            4.1.1.4 Bacteria ..... 9  
        4.1.2 Fork Lake Discussion ..... 10  
    4.2 Teanook Lake ..... 12  
        4.2.1 Teanook Lake Results ..... 12  
            4.2.1.1 General water chemistry ..... 12  
            4.2.1.2 Nutrients ..... 12  
            4.2.1.3 Bacteria ..... 12  
        4.2.2 Teanook Lake Discussion ..... 13  
    4.3 Third Lake ..... 14  
        4.3.1 Third Lake Results ..... 14  
            4.3.1.1 Bacteria ..... 14  
            4.3.1.2 Metals ..... 14  
        4.3.2 Third Lake Discussion ..... 15  
    4.4 Pease Lake ..... 15  
        4.4.1 Pease Lake Results ..... 15  
        4.4.2 Pease Lake Discussion ..... 15  
    4.5 Eagles Lake ..... 16  
        4.5.1 Eagles Lake Results ..... 16  
        4.5.2 Eagles Lake Discussion ..... 16  
    4.6 Mitchell Lake ..... 17  
        4.6.1 Mitchell Lake Results ..... 17  
        4.6.2 Mitchell Lake Discussion ..... 17  
5.0 Conclusions and Recommendations ..... 18  
6.0 References ..... 20  
  
Appendix 1: Bathymetric maps ..... 21  
Appendix 2: Summary of Fork Lake water quality results ..... 22  
Appendix 3: Summary of Teanook Lake water quality results ..... 22  
Appendix 4: Summary of Third Lake water quality results ..... 22  
Appendix 5: Summary of Pease Lake water quality results ..... 22  
Appendix 6: Summary of Eagles Lake water quality results ..... 22  
Appendix 7: Summary of Mitchell Lake water quality results ..... 22

**List of Figures**

Figure 1: Location of District of Highlands ..... 4  
Figure 2: Location of Highlands Lakes ..... 5  
Figure 3: Fork Lake secchi depths ..... 8  
Figure 4: Fork Lake average total phosphorus concentrations ..... 9  
Figure 5: Fork Lake average nitrogen concentrations ..... 10  
Figure 6: Fork Lake average fecal coliform counts ..... 10  
Figure 7: Teanook Lake average total phosphorus concentrations ..... 12  
Figure 8: Teanook Lake average nitrogen concentrations ..... 13  
Figure 9: Teanook Lake average fecal coliform counts ..... 13

**List of Tables**

Table 1: Bathymetric data for the Highlands lakes ..... 5



## **1.0 Introduction**

The District of Highlands is a rural residential community with an abundance of natural areas, greenspace and parklands. Residents are attracted to the peaceful quality of this area, and preserving and protecting the natural environment is a priority for many. The area includes several small lakes which add to the unique quality of life for shoreline residents.

The Friends of Fork Lake stewardship group was established in 1996 with the goals of protecting the water quality of Fork Lake to ensure safe drinking water and maintain property values. With support from the Ministry of Water, Land and Air Protection (formerly Environment, Lands and Parks), a volunteer water quality monitoring program was implemented to establish a baseline data base to help identify changes to the lake. In 1998 the program was expanded to include Teanook Lake and later to Third, Pease, Eagles and Mitchell Lakes.

This report summarizes the results of data collected on six Highlands lakes. The purpose is to assess the water quality of the lakes based on the available data, support continued long-term stewardship of these waterbodies and determine if long-term volunteer monitoring is warranted.

## 2.0 Site Descriptions

The District of Highlands is located in the Capital Regional District on southern Vancouver Island (Figure 1). The Highlands is bordered by Saanich Inlet to the northwest, the District of Saanich to the east, the Town of View Royal to the southeast and the District of Langford to the south. It covers an area of 4,036 ha and, as of 2001, had a population of 1,674 and 721 residential properties. This area is subject to increasing pressure for residential development although municipal bylaws prevent commercial development within the District. A significant portion of the Highlands (33%) is dedicated to provincial, regional and municipal parkland including Gowland/Tod Provincial Park, Mount Work Regional Park and Lone Tree Hill Regional Park. The main recreational activities on the Highlands lakes are swimming, canoeing and fishing, although the fisheries values are somewhat limited on these small lakes.



Figure 1: Location of the District of Highlands, Vancouver Island, BC.

Figure 2 shows the location of the lakes covered in this report. Fork and Eagles Lake are in the Craigflower watershed, which supports populations of coho salmon (*Oncorhynchus kisutch*) and cutthroat trout (*Oncorhynchus clarki clarki*). Fork Lake flows south from a man made outlet to Fizzle Lake, then into Craigflower Creek and eventually into Portage Inlet. Eagles Lake is a dredged wetland located in the headwaters of Craigflower Creek. Teanook Lake is also within the Craigflower watershed but does not discharge directly to Craigflower Creek or any other outflow system. Smallmouth bass (*Micropterus dolomieu*) are present in Teanook Lake.





Figure 2: Location of Highlands lakes.

Third Lake and Mitchell Lake are in the Millstream watershed, which also supports coho and cutthroat populations. Third Lake flows south to Second Lake, which flows into Mitchell Lake then into Millstream Creek. Millstream Creek ultimately flows into Esquimalt Harbour.

Pease Lake is located in the northern portion of the Highlands and is contained within its own watershed. The inflow to the lake is from the south and Pease Lake discharges to Pease Creek on the southeast shore which flows into McKenzie Bight in Saanich Inlet. Cutthroat trout are present in this watershed and the Canadian waterweed (*Elodea canadensis*) has been a problem at times in Pease Lake.

Of particular concern to all these lakes is the presence of the American bullfrog (*Rana catesbeiana*). This introduced species is an aggressive predator which preys on native frogs and other native animals. There is a significant population in Teanook Lake and they have been present in Fork and Mitchell Lakes.

## 2.1 Bathymetric Data

Bathymetric data for the lakes are listed in Table 1. Data for Eagles Lake are limited at this time. Bathymetric maps are provided in Appendix 1 for the lakes (except Eagles) listed in Table 1.

Table 1: Bathymetric data for the Highlands lakes

Lake	Elevation (m)	Surface area (ha)	Volume (m <sup>3</sup> )	Average depth (m)	Maximum depth (m)	Perimeter (m)
Fork	213	4.03	91,500	2.3	10.0	1,020
Teanook	91	3.28	84,250	2.4	7.6	813
Third	198	3.48	84,620	2.7	4.9	829
Pease	137	3.86	99,100	2.6	6.0	854
Mitchell	152	2.96	52,790	1.8	7.9	1,158
Eagles		0.93			5.0	

## 2.2 Land Use

These headwaters lakes are all located upstream from the more intensely developed areas of Langford and View Royal. The predominant land use can be described as rural residential with some light agricultural activities. Many of the properties are well vegetated with considerable riparian vegetation and mature timber. All homes are on septic systems and most residences have wells to supply domestic water; however, there are some homes that withdraw water from the lakes.

Fork Lake is the most developed of the six with respect to the number of homes; there are 19 homes around the lake and 15 are permanent residences. The northwest shore of the lake is included in Mount Work Regional Park which limits the impacts on this area.

There are eight residences, all permanent, around Teanook Lake. All homes draw water from the lake but most are not using it for drinking. The area is well vegetated and riparian growth is good.

There are only two residences on Third Lake, both of which draw domestic water from the lake. The land around the lake is well forested and in a natural state.

There are two homes on Pease Lake, which are on wells, and a small horse pasture. The majority of the shoreline is included in Mount Work Regional Park to the east and Gowland Tod Provincial Park to the west and is well vegetated in natural forest.

Eagles Lake was created when a spring-fed wetland was dredged in 1976. The lake consists of an open water portion to the west and a wetland to the east. The open water portion is entirely within municipal parkland, protecting about half of the shoreline. There is one home on the open portion of Eagles Lake and five homes on the wetland.

Mitchell Lake is all within private property and is surrounded largely by natural forest. There is a small parcel of leased land which is used to raise goats (approximately 30 animals) adjacent to Millstream Creek just upstream from its inflow into Mitchell Lake.

### 3.0 Methods and Data Analysis

The majority of data presented in this study were collected by volunteers who were trained by ministry staff and followed ministry approved sampling procedures. Several sampling sites were established on the lakes and EMS (Environmental Monitoring System) numbers assigned. Grab samples were taken for chemical and bacteriological analyses. Water column samples were collected using a Van Dorn bottle except for the top one metre depth. Water samples were shipped in coolers with ice to government-contracted laboratories for analysis.

For lakes with more than one year of fecal coliform data, results from all sites were pooled by sampling date and average counts were calculated and plotted over time. Results reported as <1 CFU/100 mL were assigned a value of 0 and results reported as <2 CFU/100 mL were assigned a value of 1. Nutrients (total phosphorus, total nitrogen and nitrates) were also pooled by sampling date and average concentrations plotted over time. For general water quality parameters (alkalinity, true colour, hardness, pH, suspended and dissolved solids, silica, specific conductance, sulfates and turbidity), halides and metals, the data were pooled and average values calculated for comparison against approved and working water quality guidelines. Data from inflow and outflow streams were not included.

Fork Lake has the largest data set with data collection beginning in April 1997 through to February 2003. There are also limited data from spring overturn monitoring in 1988 and 1991 but these were not included in this assessment. The majority of data were from the deep station (E207467) and these data were used to calculate the average phosphorus and nitrogen concentrations. Secchi data were also recorded by the volunteers for this lake.

Data for Teanook Lake were collected from January 1999 to March 2002. Because of the relatively small sample sets for each individual site and the close proximity among sites, all data were pooled for calculation of average concentrations.

Water chemistry samples were collected in 2000 on Third and Pease Lakes and data were pooled for all sites for each lake. Fecal coliform samples were collected from 2000 to 2003 for Third Lake and from 2000 to 2002 for Pease Lake.

Eagles Lake was sampled only once in 2001. These were surface samples collected at the centre of the lake (E244274).

Mitchell Lake has also just been sampled once, by ministry staff, at spring overturn in April 2003 with the intention of collecting data for three years to establish a baseline data set. Samples were taken at the top and bottom (7 m) of the water column and analyzed for physical and chemical water quality parameters.

## 4.0 Results and Discussion

A summary of all results for Fork, Teanook, Third, Pease, Eagles and Mitchell lakes are presented in Appendices 2 through 7, respectively. The majority of parameters showed average values below guideline (approved and working) levels for the protection of drinking water sources and aquatic life or below the detection limits of the analytical methods used at the laboratory. There are no guidelines developed for some other parameters; however, levels were generally low from these lakes. Results for selected parameters in Fork, Teanook, Third and Pease Lakes are discussed more thoroughly in the following sections. The data for Eagles and Mitchell Lake are insufficient to draw any conclusions on trends in water quality; however, results are low and there is no reason for concern at this time.

### 4.1 Fork Lake

#### 4.1.1 Fork Lake Results

##### 4.1.1.1 Secchi depth

Secchi depths have been periodically recorded on Fork Lake since March, 1997 (Figure 3). A minimum depth of 1.4 m was measured in September 1997. Water clarity has increased since that time and measurements in excess of 4 m were taken in August 2003.

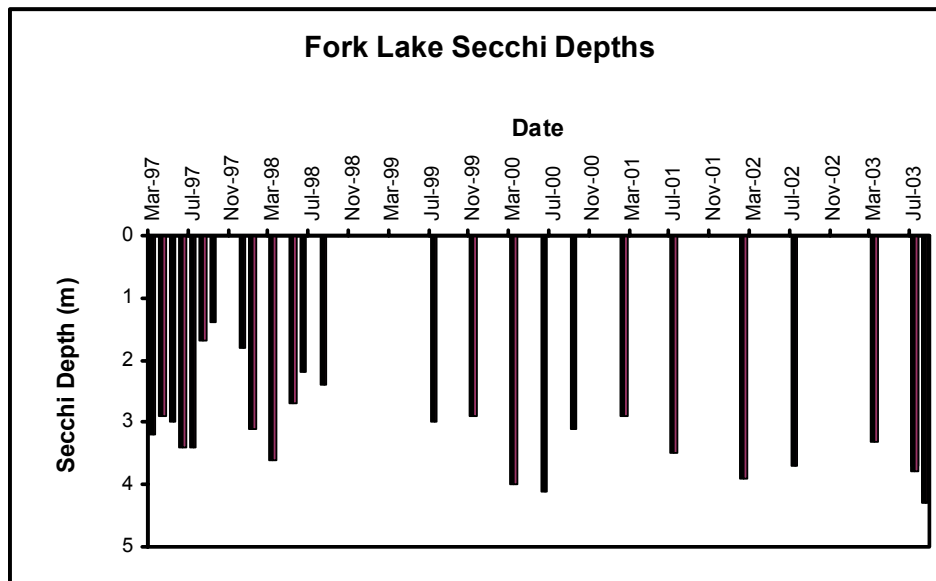


Figure 3: Secchi depths for Fork Lake at the deep station (E207467).

##### 4.1.1.2 General water chemistry

**Colour, true** – Fork Lake data show an average of approximately 22 colour units, although the most recent sampling effort showed colour levels of 10 and 15 units. The average exceeds the guideline for drinking water aesthetics of 15 units.

##### 4.1.1.3 Nutrients

**Total phosphorus (P)** – The average total P concentration for Fork Lake, for the period from 1997 to 2003, is 16 µg/L; however, a closer look at the data provides a more

favourable interpretation. Figure 4 shows average total P concentrations, by sampling dates, over time at the Fork Lake deep station (E207467). In addition to the overall decreasing trend it is important to note that the total P concentration at spring overturn decreased each year, from 15  $\mu\text{g/L}$  in 1997 to 8  $\mu\text{g/L}$  in 2002. Total P was measured at 9.7  $\mu\text{g/L}$  at spring overturn in 2003 which is still below the drinking water and recreational use guideline of 10  $\mu\text{g/L}$ .

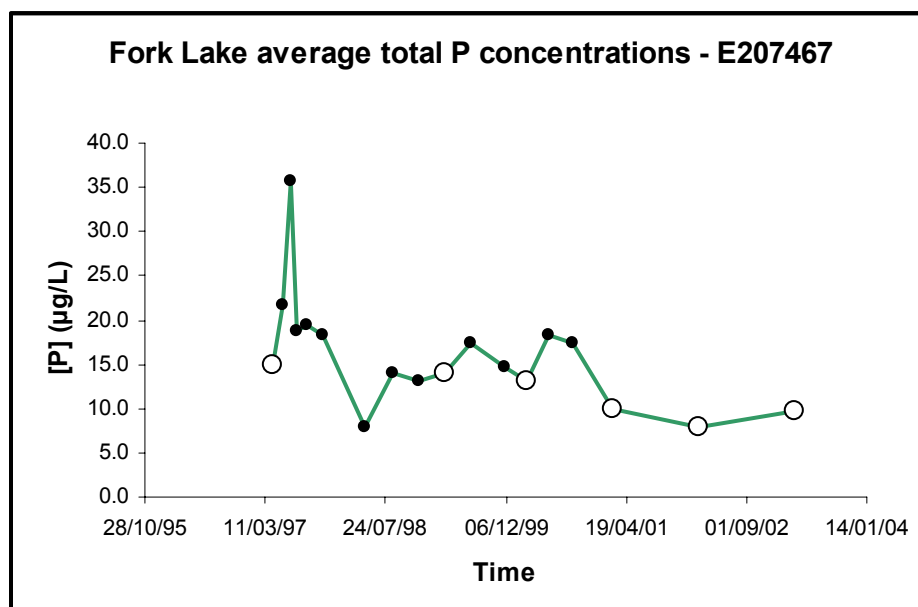


Figure 4: Average total P concentrations for Fork Lake at the deep station (E207467). Spring overturn values are denoted with  $\circ$ .

**Nitrogen** – Average total nitrogen and dissolved nitrate concentrations over time for Fork Lake are illustrated in Figure 5. Average concentrations for each parameter were low for the period from 1997 to 2003: total N was 0.31 mg/L and dissolved nitrate was 0.045 mg/L which is well below the guideline of 10 mg/L for the protection of drinking water sources.

#### 4.1.1.4 Bacteria

**Fecal coliforms** – For statistical purposes, at least 10 samples are required within a 30-day period when monitoring fecal coliforms (Warrington, 1988). For logistical purposes, the Ministry has adopted a regimen of collecting five weekly samples in a 30-day period. Although the data do not satisfy this requirement, the trend illustrated in Figure 6 does show fairly low levels on a consistent basis except for one high value in March 1997. If Fork Lake water (or any other surface water) is being used for drinking and domestic purposes it should be disinfected to prevent any health risks.

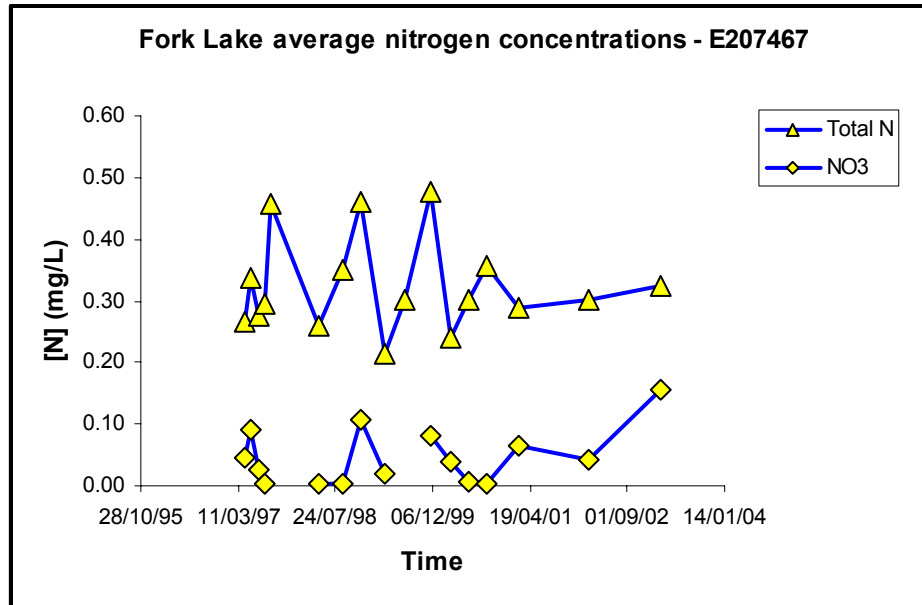


Figure 5: Average total nitrogen and dissolved nitrate concentrations and for Fork Lake at the deep station (E207467).

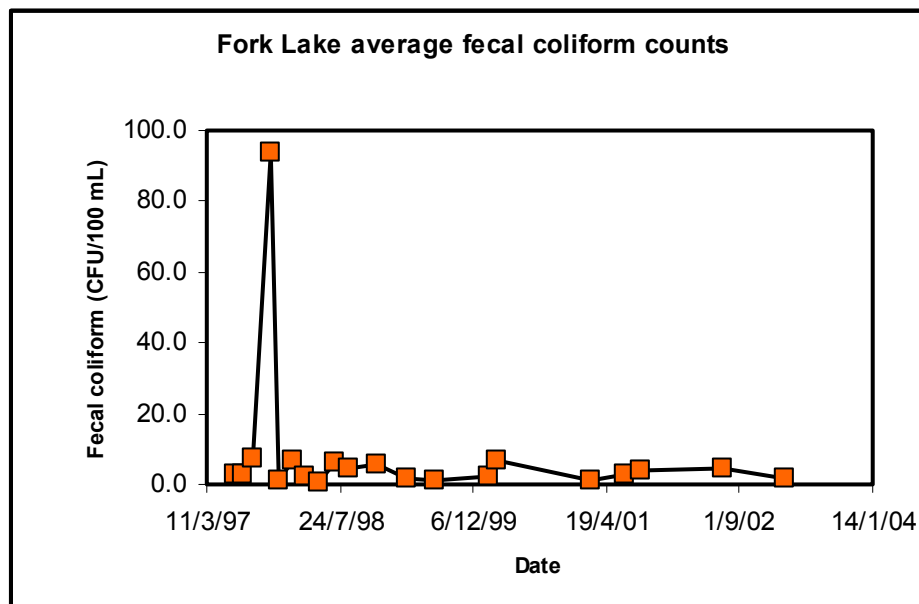


Figure 6: Average fecal coliform counts for Fork Lake.

#### 4.1.2 Fork Lake Discussion

Fork Lake is the most highly developed lake discussed in this report, with 19 residences, 15 of which are permanent. With the majority of total P values falling between 10 and 30  $\mu\text{g/L}$  and the total N values being fairly low and consistent (i.e. 0.35 mg/L – 0.65 mg/L), Fork Lake can be considered mesotrophic (i.e. moderately productive) (Kalff, 2002).

Nitrogen and phosphorus are the elements normally in highest demand by aquatic plants and microbes (Kalff, 2002) and are important components of freshwater ecosystems. Phosphorus is usually the most limiting nutrient in freshwater systems and therefore small inputs can cause extreme proliferations of algal growth (BC MELP, 1998). Because both P and N are present in reasonable amounts, but below guideline levels, it can be assumed that Fork Lake is a properly functioning system with respect to nutrients.

Average total P measurements at spring overturn have decreased over the five years of monitoring, contributing to the overall good water quality of the lake. This apparent decreasing trend in P corresponds to increasing secchi depth readings over the same period. Secchi depths tripled for late summer measurements from 1997 to 2003 (1.4 m in September, 1997 to 4.3 m in August, 2003). Secchi depth is a measure of water clarity, which is directly related to the productivity of the lake and the amount of available nutrients. Monitoring results at spring overturn in 1988 and 1991 showed average total P concentrations of 9 µg/L and 8 µg/L, respectively, suggesting that the productivity indicated by secchi depth and total P concentration in 1997 was greater than it had been in the past. It is unclear whether this peak in productivity was caused by processes within the watershed or the lake itself, but the water clarity appears to have improved over the past six years. This improvement may be, in part, the result of the efforts of lakeshore residents to have their onsite septic systems (which are all located within 100 m of the lake) serviced on a regular basis to prevent nutrient and bacterial inputs to the lake.

True colour is a measure of the dissolved colouring compounds in water and is attributed to the presence of organic and inorganic compounds (BC MELP, 1998). A guideline of 15 colour units has been developed to protect the aesthetic qualities of drinking water sources and recreational uses of the waterbody. True colour measurements for Fork Lake exceed these guidelines. Natural colour levels, however, vary and can be considerably higher than guideline levels. The slightly elevated average level for Fork Lake likely reflects the naturally high organic content of the runoff in this watershed as there are no obvious anthropogenic sources.

Fecal coliform are common to the intestinal tracts of both humans and animals. They are used as an indicator organism for fecal contamination, with their presence suggesting the potential presence of pathogenic organisms also found in wastes (BC MELP, 1998). It is important to understand that these organisms may be present in small quantities, even in the most pristine waterbodies, because of the presence of wildlife. Fecal coliform levels were generally low but water should be disinfected before being used for domestic purposes to prevent any health risks.

Overall, the water quality of Fork Lake is good. The current state and apparent improving trend of phosphorus may be a reflection of the strong local stewardship efforts in this watershed in recent years. These efforts should continue to help protect water quality in the long term. Monitoring at Fork Lake should be reduced in terms of the variables measured. We recommend continued nutrient, physical and bacteriological sampling as well as secchi depths. Other variables need not be measured unless it is suspected that future developments in the watershed may impact water quality.

## 4.2 Teanook Lake

### 4.2.1 Teanook Lake Results

#### 4.2.1.1 General Water Chemistry

**Colour, true** – Teanook Lake data showed an average value of 20 colour units, which is above the aesthetics guideline of 15 for the protection of drinking water sources.

#### 4.2.1.2 Nutrients

**Total phosphorus** – The average total P concentrations over time are illustrated in Figure 7. The results show higher average values in 1999 with more recent results closer to the guideline for protection of drinking water sources of 10 µg/L. The average concentration at spring overturn, however, has remained consistent at 12 µg/L to 13 µg/L.

**Nitrogen** – Average total nitrogen and dissolved nitrate concentrations over time for Teanook Lake are illustrated in Figure 8. Average concentrations for each parameter were low: total N was 0.28 mg/L and dissolved nitrate was 0.048 mg/L, well below the guideline of 10 mg/L for the protection of drinking water sources.

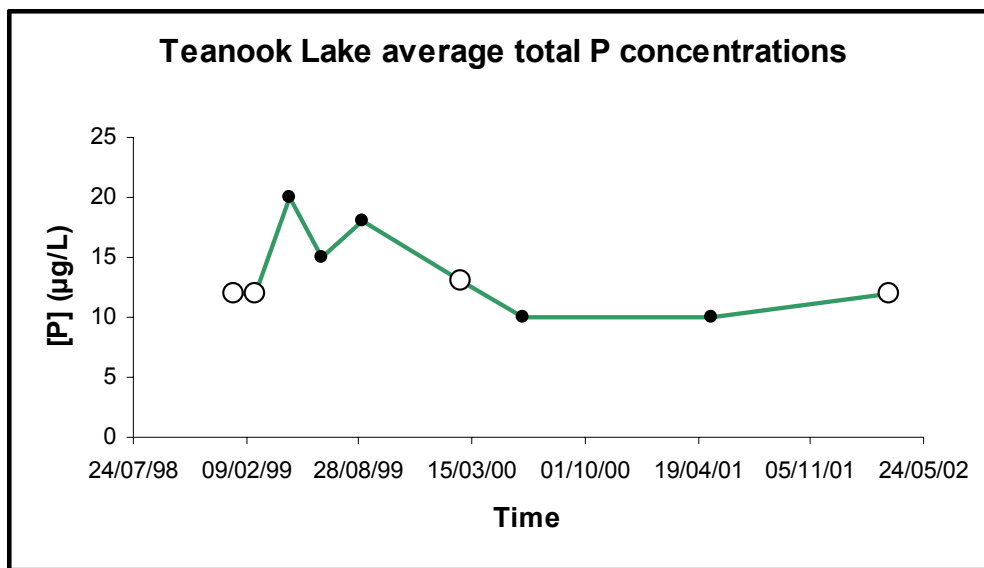


Figure 7: Average total P concentrations for Teanook Lake. Spring overturn values are denoted with ○.

#### 4.2.1.3 Bacteria

**Fecal coliforms** – Average fecal coliform counts are illustrated in Figure 9. The data collected do not satisfy the statistical requirements for properly analysing this parameter. The data show an apparent decreasing trend since 1999 and concentrations, especially the most recent results, are fairly low. Despite these low results, all surface waters to be used for domestic purposes should be disinfected before use to prevent any health risks.



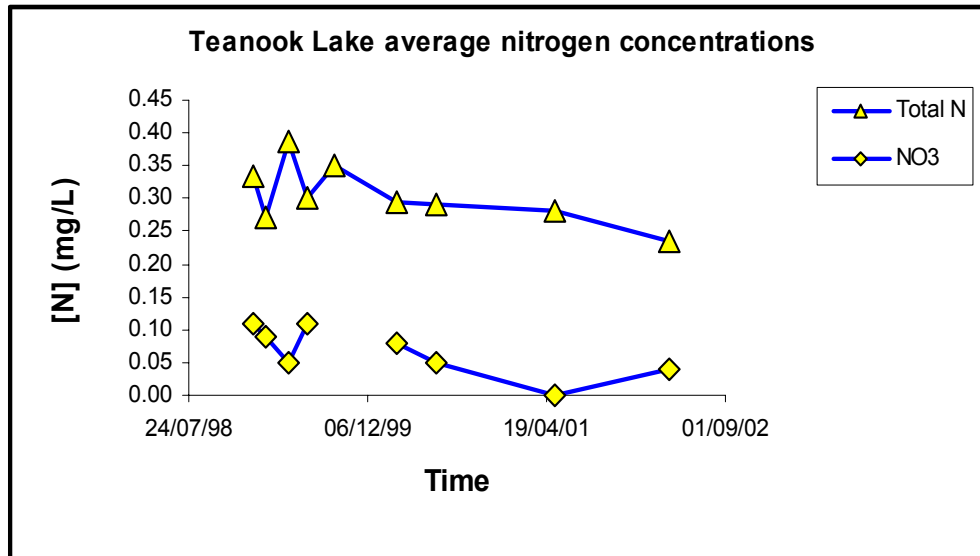


Figure 8: Average total nitrogen and dissolved nitrate concentrations and for Teanook Lake.

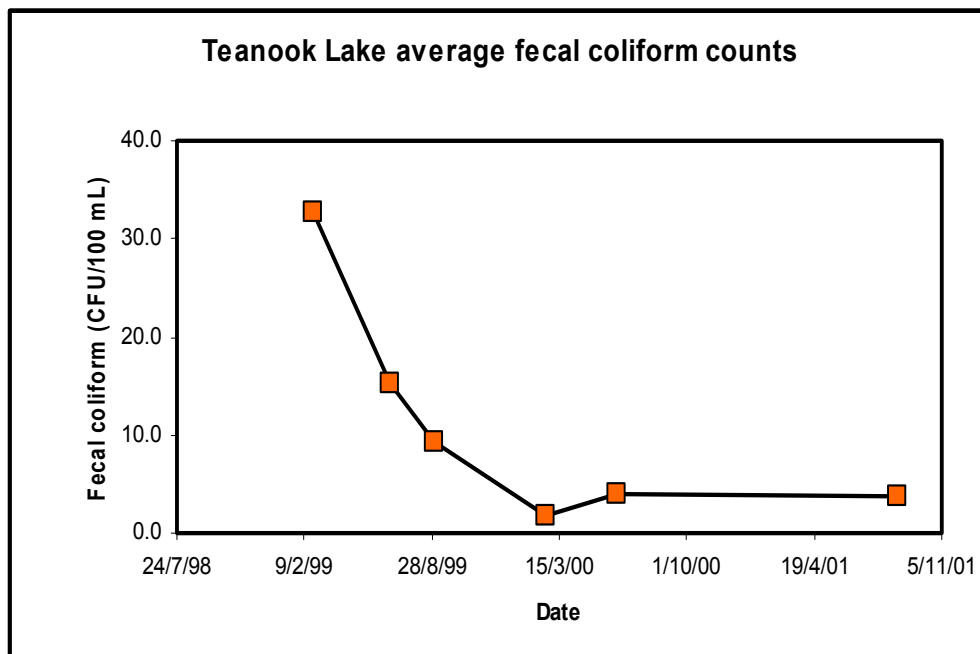


Figure 9: Average fecal coliform counts for Teanook Lake.

#### 4.2.2 Teanook Lake Discussion

The nutrient concentrations measured indicate that this lake is mesotrophic. The P concentration at spring overturn has been slightly higher than the guideline of 10  $\mu\text{g/L}$  for the protection of drinking water source water and recreational use; further sampling should be conducted at spring overturn to confirm these levels. Volunteers have started

to take regular secchi depths which will be useful for monitoring the productivity and general water quality of the lake. To prevent unnecessary nutrient inputs to the lake and future water quality problems, residents within the catchment should consider implementing appropriate best management practices including regular septic system maintenance and reducing or eliminating the use of any fertilizers.

True colour measurements were elevated over the aesthetic guidelines but, like Fork Lake, there are no obvious anthropogenic activities that would cause this. In addition, total organic carbon levels measured were within the natural range of 1 – 30 mg/L (BC MELP, 1998). Therefore, it can be assumed that the true colour levels of Teanook Lake are naturally elevated from watershed sources.

High fecal coliform counts measured in the first sampling effort influenced the trend seen in the data and subsequent sampling efforts showed fairly low results. Despite these low results, any surface water used for domestic purposes should be disinfected prior to use to prevent any health risks.

Overall, the water quality of Teanook Lake can be considered good, but efforts should be made to prevent nutrient inputs from human activities and land use. Monitoring at Teanook Lake should be reduced in terms of the variables measured. We recommend continued nutrient, physical and bacteriological sampling as well as secchi depths. Other variables need not be measured unless it is suspected that future developments in the watershed may impact water quality.

### **4.3 Third Lake**

#### **4.3.1 Third Lake Results**

The majority of parameters measured in Third Lake, including nutrients, showed average concentrations below guideline or analytical detection limits, suggesting good overall water quality. Average total phosphorus, total nitrogen and dissolved nitrate concentrations were low throughout the period sampled (March 2000 – July 2000). Parameters of concern are discussed in more detail below.

##### **4.3.1.1 Bacteria**

The results of samples collected for fecal coliforms showed consistently low levels and as a result there is very little concern related to this parameter. Despite these low results, all surface waters used for domestic purposes should be disinfected before use to prevent any health risks.

##### **4.3.1.2 Metals**

The focus of this discussion is on beryllium (Be) and cadmium (Cd) since guidelines were exceeded for these parameters. Average total metal concentrations were calculated from results from two sampling dates and a total of four sites (n = 7). The average Be concentration (14 µg/L) exceeded the working guideline for the protection of aquatic life (5.3 µg/L). The average Be concentration from inflows to Third Lake was 16 µg/L.

The working guideline for Cd for the protection of freshwater aquatic life was calculated at 0.008 µg/L based on a hardness of 20.2 mg/L using the following formula:

$$\text{Cadmium guideline} = 10^{\{0.86[\log(\text{hardness})] - 3.2\}} \text{ (CCME, 1999).}$$

The maximum acceptable concentration of Cd in drinking water at the tap is 5 µg/L (CCME, 1999). The average concentration of cadmium for Third Lake was 12 µg/L while the average Cd concentration from its inflows was 9 µg/L.

#### **4.3.2 Third Lake Discussion**

Monitoring results for Third Lake are limited to one year and therefore additional sampling should be done to confirm the initial results in this report. Nutrient levels were low and this can be expected considering the low level of development around this lake. Based on the average total phosphorus and total nitrogen concentrations, Third Lake is a low to moderately productive lake (Kalff, 2002).

Fecal coliform levels were also low and not of concern. Water used for domestic purposes should be disinfected to prevent any health risks.

Total beryllium and total cadmium levels exceeded the working guidelines for the protection of aquatic life for each parameter. However, these results are questionable because the results from the individual sampling dates contradict each other. For both Be and Cd, the results of samples collected on March 1, 2000 exceeded guideline levels. There were a total of six samples for this date including three samples taken at multiple depths at the deep station. Two months later, on May 5, 2000, a grab sample was taken at the deep station and results for both Be and Cd were below the analytical detection limits. Further testing will be required to determine if the metal concentrations in Third Lake are a concern. Analyses should include dissolved as well as total metal concentrations.

### **4.4 Pease Lake**

#### **4.4.1 Pease Lake Results**

For parameters with approved or working guidelines, average values were either below guidelines or below the analytical detection limits. The average total phosphorus concentration (9 µg/L) was below the drinking water and recreational use guideline of 10 µg/L. Total nitrogen levels were also low and the average nitrate concentration (0.032 mg/L) was well below the guideline of 10 mg/L for the protection of drinking water sources.

Fecal coliform counts were low (average count was 2 CFU/100 mL) and showed results of <1 CFU/100 mL for the most recent samples taken. Despite these low results, all surface waters to be used for domestic purposes should be disinfected before use to prevent any health risks.

#### **4.4.2 Pease Lake Discussion**

The available data indicate that the overall water quality of Pease Lake is good. This can be expected because of the low level of development around this lake. The results,

however, only represent one year of data and further monitoring should be conducted to confirm these results.

## **4.5 Eagles Lake**

### **4.5.1 Eagles Lake Results**

Data are only available from one sampling date (July 2001) and are presented in Appendix 6. Most results were below guideline levels or analytical detection limits suggesting good water quality overall; however, the total P level was 12 µg/L exceeding the recreational use guideline of 10 µg/L. Further monitoring would be necessary to establish baseline conditions for this lake.

### **4.5.2 Eagles Lake Discussion**

Although residents are not using Eagles Lake as a source of domestic water, it is heavily used for swimming in the summer months and baseline data would be useful. The water chemistry of Eagles Lake has only been sampled once (July 2001) and the data are insufficient to draw conclusions on the current state of its water quality.

Eagles Lake was dredged in 1976 to provide recreational opportunities, however there are no water quality data available to indicate the water quality of the lake at that time. Researchers have reported initial decreases in water quality following reservoir formation followed by gradual improvements and eventual stabilization (Ioriya *et al.*, 1998; Scharf, 1998; Chang and Wen, 1997). Increases in nutrient concentrations were attributed to disturbed soils and the decay of former terrestrial vegetation. The length of time required to achieve the stability in water quality appears to be a function of the characteristics of the individual watershed, such as water retention time, external nutrient loadings, basin morphometry, reservoir hydrology and climate (Chang and Wen, 1997).

There are two possibilities for Eagles Lake with respect to future water quality trends. First, it would be reasonable to assume that the water quality of Eagles Lake will follow the same trend noted in the literature. Initial water quality, with respect to nutrients, would have been degraded due to disturbances to the wetland sediments and the decay of terrestrial vegetation. Over time, and assuming there were no additional nutrient inputs, an improvement in water quality could be expected and eventually an equilibrium would be reached. The second possibility is that since Eagles Lake was formed from a wetland, it may be reasonable to speculate that there were high nutrient levels to begin with and the dredging resulted in the removal of nutrients from dead and decaying plant material. Over the long-term, it is possible the conditions that originally caused the wetland to form may be repeated since the waterbody acts as a nutrient sink for the surrounding watershed.

It is unclear, because of the lack of data, where Eagles Lake is in this process. Establishing a baseline of data collected at spring overturn would help assess the water quality of the lake and may provide an indication of any future changes that may be expected.

## **4.6 Mitchell Lake**

### **4.6.1 Mitchell Lake Results**

There are limited data available for Mitchell Lake and these are presented in Appendix 7. Most results are below guideline levels or analytical detection limits suggesting good water quality overall. Further monitoring would be desirable to establish baseline conditions for these lakes.

### **4.6.2 Mitchell Lake Discussion**

There are not sufficient data to draw conclusions on the water quality of Mitchell Lake; however, because the lake was sampled at spring overturn the results provide a reasonable indication of what to expect if conditions remain the same. Based on the available results the water quality appears to be good. Nutrients (total phosphorus and nitrate) were below guideline levels as were the general water quality parameters and total metals.

There are no bacteriological data available for Mitchell Lake and this should be considered in light of the goat operation at the inflow to the lake. It is recommended that nutrients and bacteriological monitoring be undertaken, and that local residents record secchi depth measurements to compliment this data collection effort.

## **5.0 Conclusions and recommendations**

### **Fork Lake**

The overall water quality of Fork Lake is good. Fork Lake can be considered mesotrophic (moderately productive), based on the total phosphorus and nitrogen levels measured, and the true colour levels are naturally elevated. Average total phosphorus levels at spring overturn have decreased over the five years of monitoring and total nitrogen and nitrate levels are not a concern in Fork Lake. Recommendations for Fork Lake include:

- continuing local stewardship efforts of the lake and watershed to ensure that good water quality is maintained.
- collecting regular secchi readings by volunteers to be used as an indicator of general water quality.
- conducting spring overturn sampling again in 2006 to assess water quality.

### **Teanook Lake**

The overall water quality of Teanook Lake is good. Average total phosphorus levels at spring overturn are slightly higher than the water quality guideline for drinking water of 10 µg/L. Teanook Lake is mesotrophic and true colour levels are naturally elevated.

Recommendations for Teanook Lake include:

- conducting spring overturn sampling in 2004 to verify total P concentrations.
- collecting regular secchi readings by volunteers to be used as an indicator of general water quality.
- encouraging lakeshore residents to have septic systems serviced regularly and limit or eliminate fertilizer use to minimize nutrient inputs to the lake.

### **Third Lake**

The limited data available suggest that the water quality of Third Lake is good and this can be expected given the low level of land development in the watershed. Further sampling at spring overturn will be required to confirm this and establish a baseline for future reference. Recommendations for Third Lake include:

- conducting spring overturn sampling in 2004 and 2005 and include dissolved as well as total metals analyses to confirm the beryllium and cadmium concentrations.

### **Pease Lake**

The limited data available suggest that the water quality of Pease Lake is good and this can be expected given the low level of land development in the watershed. Further sampling at spring overturn will be required to confirm this and establish a baseline for future reference. Recommendations for Pease Lake include:

- conducting spring overturn sampling in 2004 and 2005 in order to establish baseline data.

### **Eagles Lake**

The data available for Eagles Lake are insufficient to accurately assess the water quality at this time. Further sampling at spring overturn will be required to establish a baseline for future reference. Recommendations for Eagles Lake include:

- conducting spring overturn sampling during 2004 to 2006, inclusive in order to establish baseline data.

**Mitchell Lake**

The data available for Mitchell Lake are insufficient to accurately assess the water quality at this time; however, results from 2003 suggest overall good water quality. Further sampling at spring overturn will be required to confirm this and establish a baseline for future reference. Recommendations for Mitchell Lake include:

- conducting spring overturn sampling in 2004 and 2005 in order to establish baseline data.
- bacteriological sampling at the inflow to determine any impacts from the goats upstream from the lake.

## 7.0 References

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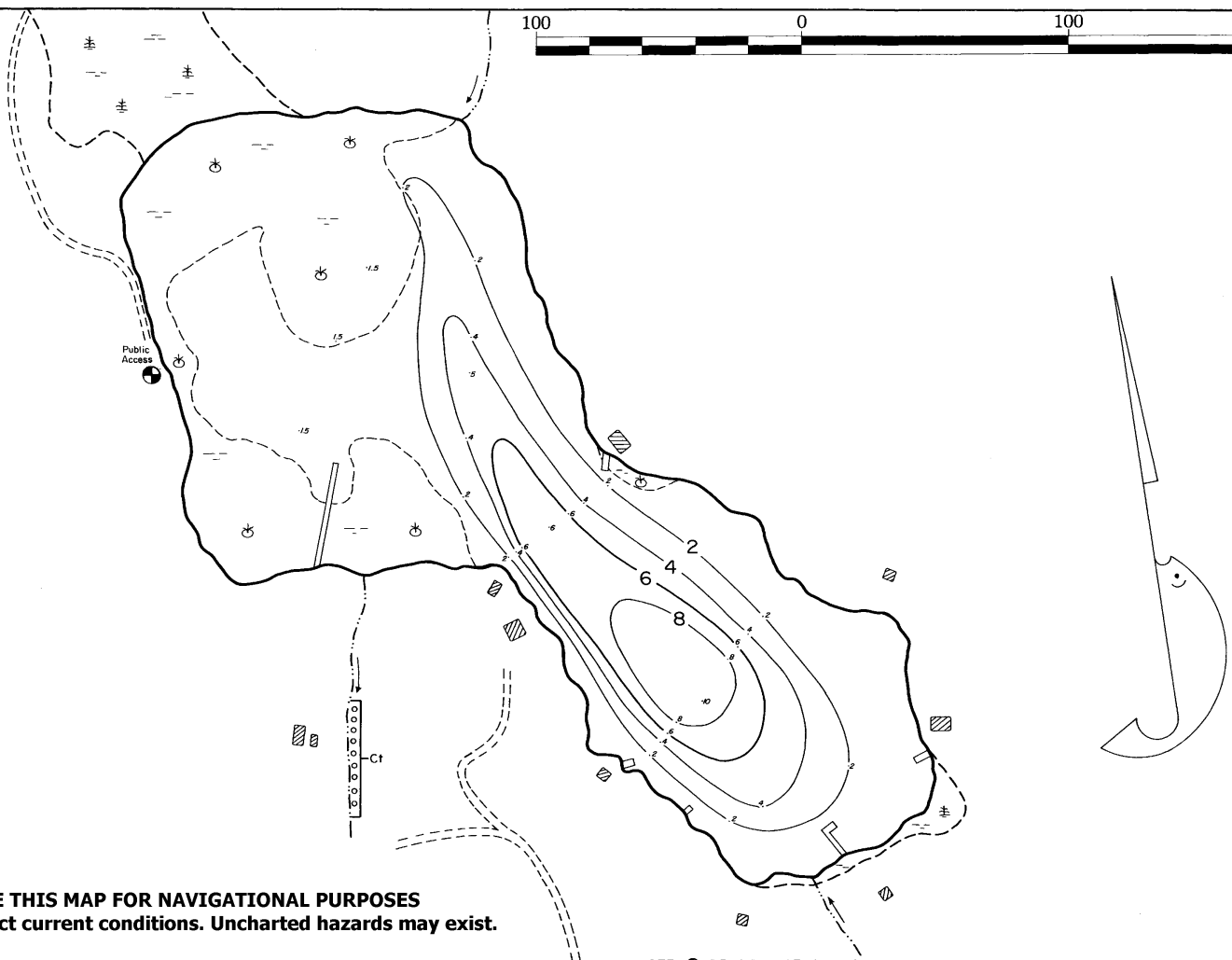
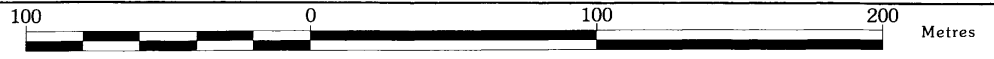
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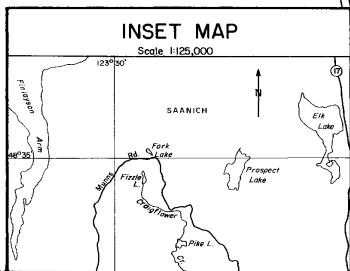
# Appendix 1

## Bathymetric Maps



**CAUTION: DO NOT USE THIS MAP FOR NAVIGATIONAL PURPOSES**  
 This map may not reflect current conditions. Uncharted hazards may exist.

NOTE DENOTES BENCH MARK



SURVEYED BY: C. MILLER DATE: JUNE 16, 1982  
 OUTLINE SOURCE: AIR PHOTO B.C. 79019-145 MAY 1979

**STATISTICS AT TIME OF SURVEY**

1. ELEVATION	213m.
2. SURFACE AREA	40,300 sq. m.
3. VOLUME	91,500 cu. m.
4. EST. ANNUAL FLUCTUATION	-
5. MEAN DEPTH	2.3 m.
6. MAX. DEPTH	10m.
7. PERIMETER	1020m.
8. AREA ABOVE 6m. CONTOUR	35,700sq.m.
9. HEIGHT OF BENCH MARK ABOVE WATER LEVEL	2m.

**AQUATIC STUDIES BRANCH**  
 MINISTRY OF ENVIRONMENT

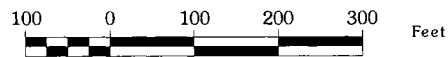
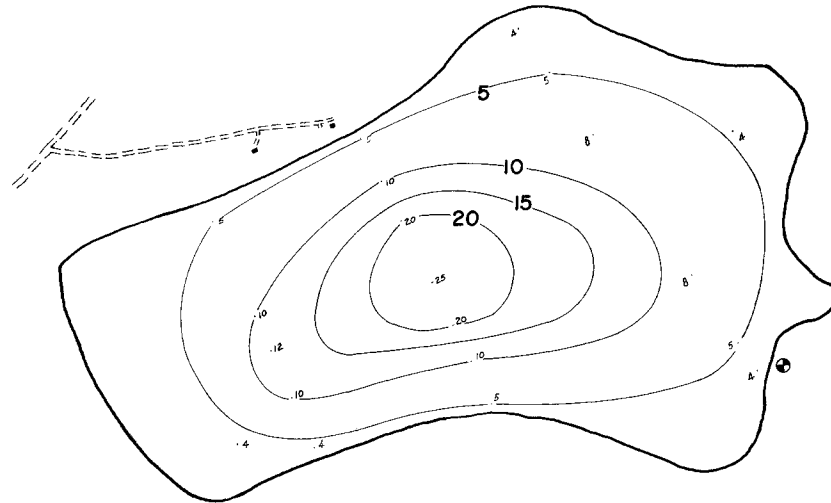
INVENTORY OPERATIONS UNIT

# FORK LAKE

DEPTHS IN METERS

WATERSHED CODE NO. 92-6100		
M. U. 1-1	U.T.M. CO-ORDINATE: 10-4643-53739	
DATE: NOV 15, 1983	DRAWN: R.S.D.	SCALE: 1:1200
CALCULATIONS: C.L.M.	CHECK: J.G.N.	
PLOTTING: R.S.D.	APPROVED:	N.T.S. No. 92B/11
FAIR DWG. B.D.		

**CAUTION: DO NOT USE THIS MAP FOR NAVIGATIONAL PURPOSES**  
 This map may not reflect current conditions. Uncharted hazards may exist.



NOTE:  DENOTES BENCH MARK

SURVEYED BY: R. J. KLEIN      DATE: MAY 5, 1972  
 SHORE OUTLINE FROM: AIR INTERIM

**STATISTICS AT TIME OF SURVEY**

1. ELEVATION	300 FT.
2. SURFACE AREA	8.1 ACRE
3. VOLUME	69.3 AC. FT.
4. EST. ANNUAL FLUCTUATION	
5. MEAN DEPTH	7.8 FT.
6. MAX. DEPTH	25 FT.
7. PERIMETER	2,670 FT.
8. AREA, 20 FT. CONTOUR	7.7 ACRES
9. HEIGHT OF BENCH MARK ABOVE WATER LEVEL	5 FT. 6 IN.


**FISH AND WILDLIFE BRANCH**  
 DEPARTMENT OF RECREATION AND CONSERVATION

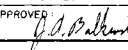
*TEANOOK L.*

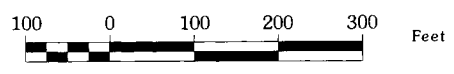
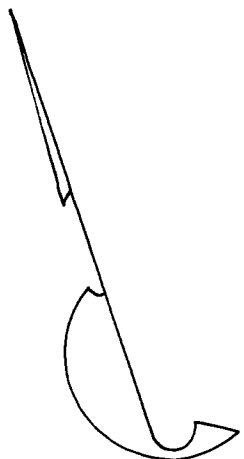
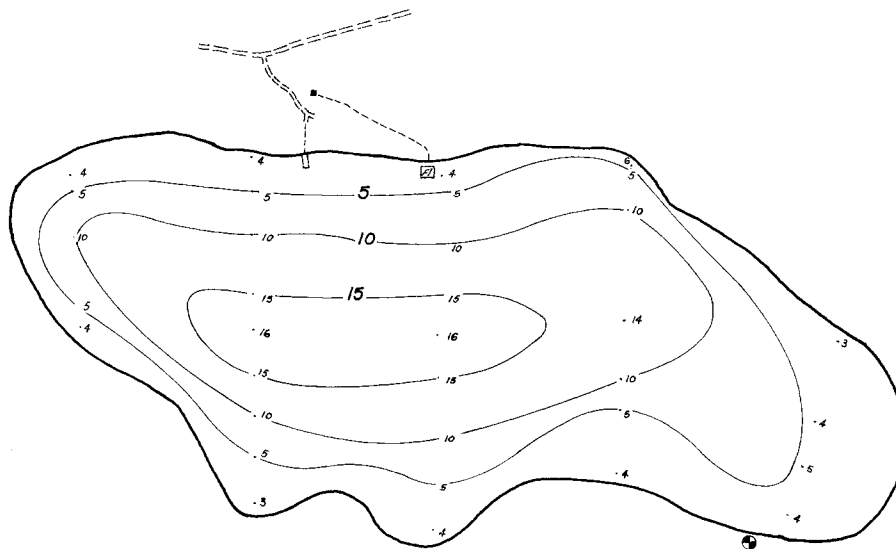
DATE: <i>Jan 73</i>	DRAWN: <i>J. B. Bland</i>	SCALE: <b>1" = 100'</b>
CALCULATIONS: <i>J. B. Bland</i>	CHECK: <i>J. B. Bland</i>	DWG. NO. <b>92-B-5e</b>
APPROVED: _____		



**CAUTION: DO NOT USE THIS MAP FOR NAVIGATIONAL PURPOSES**  
 This map may not reflect current conditions. Uncharted hazards may exist.

NOTE  DENOTES BENCH MARK

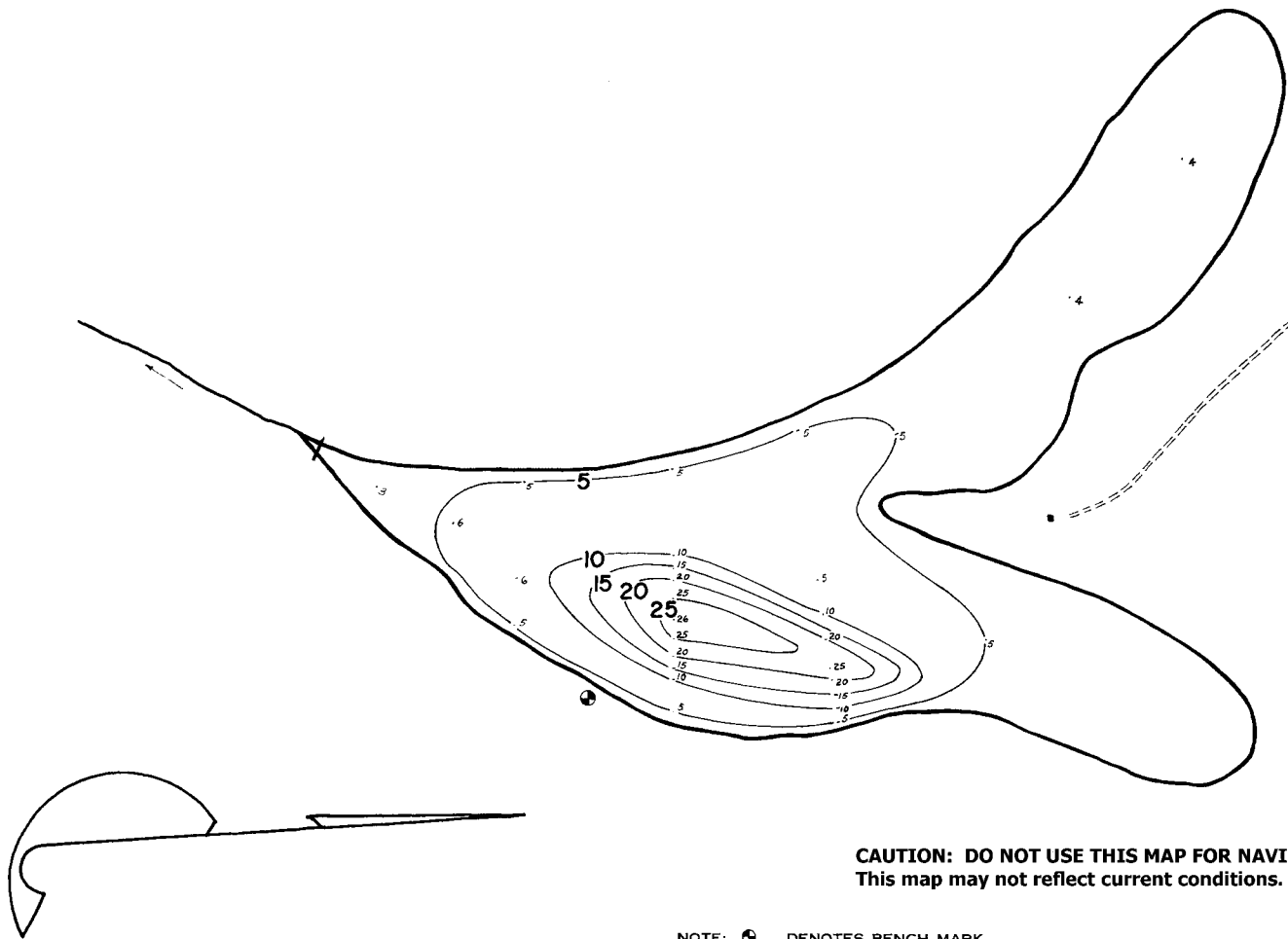
INSET MAP	SURVEYED BY: T. Pendroy      DATE: May 8, 1981 SHORE OUTLINE FROM: AIR PHOTO BCC 248 046	RESOURCE ANALYSIS BRANCH MINISTRY OF THE ENVIRONMENT	
	STATISTICS AT TIME OF SURVEY 1. ELEVATION                    137 m. 2. SURFACE AREA                38,600 sq. m. 3. VOLUME                        99,100 cu. m. 4. EST. ANNUAL FLUCTUATION    — 5. MEAN DEPTH                  2.6 m. 6. MAX. DEPTH                  6 m. 7. PERIMETER                    854 m. 8. AREA ABOVE 6m. CONTOUR    0.59 sq. m. 9. HEIGHT OF BENCH MARK ABOVE WATER LEVEL        1.5 m.	BIOLOGICAL SYSTEMS SECTION <b>PEASE LAKE</b> DEPTHS IN METERS	
		REGION: 1	UTM. CO-ORDINATE: 10 4643 53768
		DATE: AUGUST 16, 1982	DRAWN: R.S.D.      SCALE: 1:1000
		CALCULATIONS: T.N.W.	CHECK: J.A.B.
		PLOTTING: R.B.D.	APPROVED:  NTS No. 92 B/11
		FAIR DWG. D.R.	




**CAUTION: DO NOT USE THIS MAP FOR NAVIGATIONAL PURPOSES**  
 This map may not reflect current conditions. Uncharted hazards may exist.

NOTE:  DENOTES BENCH MARK

SURVEYED BY: R. J. KLEIN		DATE: OCT. 17, 1972	
SHORE OUTLINE FROM: AIR INTERIM			
<b>STATISTICS AT TIME OF SURVEY</b>			
1. ELEVATION		55.0 FT.	
2. SURFACE AREA		8.6 ACRES	
3. VOLUME		68.6 AC./FT.	
4. EST. ANNUAL FLUCTUATION			
5. MEAN DEPTH		9.0 FT.	
6. MAX. DEPTH		16 FT.	
7. PERIMETER		2720 FT.	
8. AREA, 20 FT. CONTOUR		0.0 ACRE	
9. HEIGHT OF BENCH MARK ABOVE WATER LEVEL		5 FT. 9 IN.	
<b>FISH AND WILDLIFE BRANCH</b>		<b>DEPARTMENT OF RECREATION AND CONSERVATION</b>	
<h1>THIRD LAKE</h1>			
DATE: Jan. 1973	DRAWN: J. A. B. [Signature]	SCALE: 1" = 100'	
CALCULATIONS: J. A. B. [Signature]	CHECK: [Signature]	APPROVED:	
			DWG. NO. 92-B-11W



**CAUTION: DO NOT USE THIS MAP FOR NAVIGATIONAL PURPOSES**  
 This map may not reflect current conditions. Uncharted hazards may exist.

NOTE:  DENOTES BENCH MARK

SURVEYED BY: R. J. KLEIN      DATE: MAY 5, 1972  
 SHORE OUTLINE FROM: AIR INTERIM

STATISTICS AT TIME OF SURVEY

- |  |              |
|--|--------------|
| 1. ELEVATION                                 | APP. 500 FT. |
| 2. SURFACE AREA                              | 7.3 ACRES    |
| 3. VOLUME                                    | 42.8 Ac./Ft. |
| 4. EST. ANNUAL FLUCTUATION                   |              |
| 5. MEAN DEPTH                                | 5.9 FT.      |
| 6. MAX. DEPTH                                | 26 FT.       |
| 7. PERIMETER                                 | 3,800 FT.    |
| 8. AREA, 20 FT. CONTOUR                      | 0.4 ACRES    |
| 9. HEIGHT OF BENCH MARK<br>ABOVE WATER LEVEL | 5 FT. 6 IN.  |

FISH AND WILDLIFE BRANCH  
 DEPARTMENT OF RECREATION AND CONSERVATION

**MITCHELL L.**

DATE: Jan 1973      DRAWN: J. A. Belland      SCALE: 1" = 100'  
 CALCULATIONS: J. A. Belland      CHECK: J. A. Belland

APPROVED:

DWG. NO. 92-B-12e

Appendix 2 - 7  
Summaries of Results

Appendix 2: Summary of Fork Lake water chemistry results (units are mg/L unless otherwise stated).

Parameter	mean	std. dev.	min	max	n=	Notes
<b>General</b>						
Alkalinity pH 4.5/4.2	14.3	3.1	10.5	19.7	26	Results indicate Fork Lake aquatic life is moderately sensitive to acidic inputs
Alkalinity Total 4.5	12.7	2.7	11.0	18.6	12	
Colour True (Col.unit)	22	7	10	50	51	Aesthetic guidelines are 15 units
Hardness Total	17.6	2.2	13.4	23.0	54	Below guidelines
pH (pH units)	7.0	0.4	6.5	8.2	33	Within guidelines
Residue Filterable 1.0µ	48	9	24	60	35	Below guidelines
Residue Non-filterable	2	4	0	10	15	Below guidelines
Residue Total	51	6	40	60	20	No guidelines
Silica Dissolved	5.6	1.3	2.5	7.3	20	No guidelines
Specific Conductance (µS/cm)	60	10	47	88	56	Below guidelines
Sulfate Dissolved	4.0	0.7	2.7	6.0	29	Below guidelines
Sulfate Total	4.3	1.7	2.9	8.5	9	Below guidelines
Turbidity (NTU)	0.8	0.4	0.5	2.3	34	Below guidelines
<b>Nutrients</b>						
Ammonia Dissolved	0.015	0.013	0.005	0.078	57	Guidelines based on pH and temperature
Carbon Total	9.9	1.3	7.6	13.1	31	No guidelines
Carbon Total Inorganic	4.5	1.2	3.1	7.6	34	No guidelines, natural waters are frequently <25 mg/L
Carbon Total Organic	4.8	1.2	2.5	6.6	40	No guidelines, natural waters range from 1 - 30 mg/L
Nitrate (NO <sub>3</sub> ) Dissolved	0.045	0.052	0.002	0.280	48	Below guidelines
Nitrate + Nitrite Dissolved	0.038	0.051	0.002	0.292	51	No guidelines
Nitrite Total	0.005	0.003	0.002	0.014	12	Below guidelines
Nitrogen - Nitrite Dissolved	0.003	0.002	0.000	0.005	45	Results are below detection limits
Nitrogen Total	0.31	0.09	0.17	0.62	60	No guidelines
Ortho-Phosphate Dissolved	0.05	0.02	0.00	0.07	29	Results are below detection limits
Phosphorus Total	0.016	0.013	0.007	0.100	64	See discussion
Phosphorus Total Dissolved	0.006	0.002	0.002	0.014	63	No guidelines
<b>Bacteria</b>						
Fecal Coliform (CFU/100mL)	8	35	1	364	124	See discussion
Total Coliform (CFU/100mL)	15	8	8	26	6	No guidelines



Appendix 2: Summary of Fork Lake water chemistry results (units are mg/L unless otherwise stated).

Parameter	mean	std. dev.	min	max	n=	Notes
<b>Halides</b>						
Bromide Dissolved	0.05	0.02	0.00	0.10	38	Below working guidelines
Chloride Dissolved	7.34	1.89	5.20	14.80	38	No guidelines, average concentration in freshwater is 8.3 mg/L
Fluoride Dissolved	0.01	0.01	0.00	0.02	18	No guidelines
Fluoride Total	0.01	0.00	0.01	0.02	17	Below guidelines
<b>Metals</b>						
Aluminum Total	0.10	0.06	0.06	0.36	54	Below guidelines
Antimony Total	0.05	0.02	0.00	0.07	54	Results are below detection limits
Arsenic Total	0.05	0.02	0.00	0.06	54	Results are below detection limits
Barium Total	0.004	0.001	0.001	0.008	54	Below guidelines
Beryllium Total	0.001	0.000	0.000	0.001	54	Results are below detection limits
Bismuth Total	0.02	0.03	0.00	0.05	9	No guidelines
Boron Total	0.01	0.01	0.00	0.02	54	Below guidelines
Cadmium Total	0.005	0.002	0.000	0.006	54	Most results are below detection limits
Calcium Total	5.1	0.6	3.9	6.7	65	No guidelines
Chromium Total	0.008	0.006	0.000	0.037	54	Below guidelines
Cobalt Total	0.006	0.002	0.000	0.012	54	No guidelines
Copper Total	0.007	0.005	0.000	0.034	54	Below guidelines
Iron Total	0.224	0.294	0.070	1.950	54	Below guidelines
Lead Total	0.05	0.02	0.00	0.09	54	Results are below detection limits
Magnesium Total	1.2	0.2	0.9	1.5	65	Below guidelines
Manganese Total	0.030	0.055	0.006	0.272	54	Below guidelines
Molybdenum Total	0.01	0.00	0.00	0.01	54	Below guidelines
Nickel Total	0.02	0.01	0.00	0.02	54	Below guidelines
Potassium Total	0.3	0.2	0.0	1.0	65	No guidelines
Selenium Total	0.06	0.03	0.00	0.13	54	Results are below detection limits
Silver Total	0.01	0.00	0.00	0.01	54	Results are below detection limits
Silicon Total	2.42	0.78	0.74	3.56	56	No guidelines
Sodium Total	4.2	1.2	2.7	7.4	65	Below guidelines
Strontium Total	0.017	0.002	0.013	0.024	54	No guidelines
Sulfur Total	1.35	0.19	1.03	1.80	54	No guidelines
Tin Total	0.05	0.02	0.00	0.06	54	Results are below detection limits
Titanium Total	0.004	0.004	0.000	0.020	54	Below guidelines
Vanadium Total	0.01	0.00	0.00	0.01	54	Results are below detection limits
Zinc Total	0.008	0.007	0.000	0.035	54	Below guidelines

Appendix 3: Summary of Teanook Lake water chemistry results (units are mg/L unless otherwise stated).

Parameter	mean	std. dev.	min	max	n=	Notes
<b>General</b>						
Alkalinity Total 4.5	25.6	1.2	23.9	28.4	15	Results indicate Teanook Lake aquatic life has a low sensitivity to acidic inputs
Colour True (Col.unit)	20	5	10	40	47	Aesthetic guidelines are 15 units
Hardness Total	26.5	4.0	16.1	36.4	35	Below guidelines
pH (pH units)	7.2	0.2	6.6	7.5	47	Within guidelines
Residue Total	67	9	50	90	17	No guidelines
Silica Dissolved	5.6	1.7	3.8	9.7	17	No guidelines
Specific Conductance (µS/cm)	86	10	62	105	47	No guidelines
Sulfate Dissolved	4.2	0.3	3.8	4.8	17	Below guidelines
Turbidity (NTU)	0.7	0.5	0.3	2.9	45	Below guidelines
<b>Nutrients</b>						
Ammonia Dissolved	0.022	0.043	0.005	0.283	47	Guidelines based on pH and temperature
Carbon Total	11.5	1.6	10.0	15.0	12	No guidelines
Carbon Total Inorganic	6.9	1.2	6.0	9.0	12	No guidelines, natural waters are frequently <25 mg/L
Carbon Total Organic	4.5	0.7	3.5	6.0	13	No guidelines, natural waters range from 1 - 30 mg/L
Nitrate (NO <sub>3</sub> ) Dissolved	0.048	0.045	0.001	0.148	34	Below guidelines
Nitrate + Nitrite Dissolved	0.038	0.044	0.002	0.153	47	No guidelines
Nitrogen - Nitrite Dissolved	0.003	0.002	0.002	0.006	47	Results are below detection limits
Nitrogen Total	0.28	0.06	0.19	0.52	47	No guidelines
Ortho-Phosphate Dissolved	0.05	0.00	0.05	0.05	15	No guidelines
Phosphorus Total	0.010	0.007	0.004	0.035	46	Below guidelines
Phosphorus Total Dissolved	0.006	0.003	0.002	0.019	47	No guidelines
<b>Bacteria</b>						
Fecal Coliform (CFU/100mL)	11	20	1	110	40	See discussion
<b>Halides</b>						
Bromide Dissolved	0.04	0.02	0.00	0.05	19	Below working guidelines
Chloride Dissolved	9.91	3.43	3.10	20.80	19	No guidelines, average concentration in freshwater is 8.3 mg/L
Fluoride Dissolved	0.01	0.00	0.01	0.01	15	No guidelines

Appendix 3: Summary of Teanook Lake water chemistry results (units are mg/L unless otherwise stated).

Parameter	mean	std. dev.	min	max	n=	Notes
<b>Metals</b>						
Aluminum Total	0.08	0.05	0.06	0.30	39	Below guidelines
Antimony Total	0.06	0.01	0.00	0.06	39	Results are below detection limits
Arsenic Total	0.06	0.01	0.00	0.06	39	Results are below detection limits
Barium Total	0.004	0.001	0.001	0.008	39	Below guidelines
Beryllium Total	0.001	0.000	0.000	0.001	39	Results are below detection limits
Boron Total	0.01	0.00	0.00	0.02	39	Below guidelines
Cadmium Total	0.006	0.001	0.000	0.006	39	Most results are below detection limits
Calcium Total	7.7	1.3	4.8	11.7	39	No guidelines
Chromium Total	0.010	0.007	0.000	0.035	39	Below guidelines
Cobalt Total	0.006	0.002	0.000	0.015	39	No guidelines
Copper Total	0.013	0.042	0.000	0.266	39	Below guidelines
Iron Total	0.212	0.224	0.088	1.040	39	Below guidelines
Lead Total	0.06	0.01	0.00	0.06	39	Results are below detection limits
Magnesium Total	1.8	0.3	1.0	2.4	39	Below guidelines
Manganese Total	0.033	0.053	0.001	0.304	39	Below guidelines
Molybdenum Total	0.01	0.00	0.00	0.01	39	Below guidelines
Nickel Total	0.02	0.00	0.00	0.02	39	Below guidelines
Potassium Total	0.3	0.1	0.0	0.5	39	No guidelines
Selenium Total	0.06	0.01	0.00	0.06	39	Results are below detection limits
Silver Total	0.01	0.00	0.00	0.01	39	Results are below detection limits
Silicon Total	2.41	0.80	1.15	4.81	38	No guidelines
Sodium Total	5.2	1.0	2.4	7.8	39	Below guidelines
Strontium Total	0.023	0.004	0.016	0.029	39	No guidelines
Sulfur Total	1.45	0.13	1.17	1.88	39	No guidelines
Tin Total	0.06	0.01	0.00	0.06	39	Results are below detection limits
Titanium Total	0.004	0.003	0.000	0.016	39	Below guidelines
Vanadium Total	0.01	0.00	0.00	0.01	39	Results are below detection limits
Zinc Total	0.008	0.028	0.000	0.176	39	Below guidelines

Appendix 4: Summary of Third Lake water chemistry results (units are mg/L unless otherwise stated).

Parameter	mean	std. dev.	min	max	n=	Notes
<b>General</b>						
Alkalinity Total 4.5	18.3	0.1	18.2	18.4	3	Results indicate Third Lake has a moderate sensitivity to acidic inputs
Alkalinity Total 4.5/4.2	15.6	1.2	14.1	17.2	18	
Colour True (Col.unit)	11	3	3	15	21	Below guidelines
Hardness Total	20.2	2.1	18.5	24.5	7	Below guidelines
pH (pH units)	6.9	0.2	6.8	7.3	21	Within guidelines
Residue Total	52	9	30	70	20	No guidelines
Silica Dissolved	6.5	0.5	5.7	7.4	21	No guidelines
Specific Conductance ( $\mu\text{S}/\text{cm}$ )	59	1	58	61	28	No guidelines. Natural waters vary between 50 - 1,500 $\mu\text{S}/\text{cm}$
Sulfate Dissolved	3.4	1.0	0.5	4.0	21	Below guidelines
Turbidity (NTU)	0.3	0.1	0.2	0.5	21	Below guidelines
<b>Nutrients</b>						
Ammonia Dissolved	0.007	0.002	0.005	0.013	29	Guidelines based on pH and temperature
Carbon Total	7.0	0.4	6.6	8.0	11	No guidelines
Carbon Total Inorganic	4.1	0.1	4.0	4.3	11	No guidelines, natural waters are frequently <25 mg/L
Carbon Total Organic	2.9	0.4	2.6	3.9	11	No guidelines, natural waters range from 1 - 30 mg/L
Nitrate (NO <sub>3</sub> ) Dissolved	0.030	0.026	0.002	0.107	22	Below guidelines
Nitrate + Nitrite Dissolved	0.027	0.027	0.002	0.112	29	No guidelines
Nitrogen - Nitrite Dissolved	0.004	0.001	0.002	0.005	29	Below guidelines
Nitrogen Total	0.188	0.044	0.140	0.350	29	No guidelines
Ortho-Phosphate Dissolved	0.21	0.73	0.05	3.40	21	No guidelines
Phosphorus Total	0.008	0.002	0.004	0.014	29	Below guidelines
Phosphorus Total Dissolved	0.005	0.001	0.003	0.008	29	No guidelines
<b>Bacteria</b>						
Fecal Coliform (CFU/100mL)	2	3	0	12	53	See discussion
<b>Halides</b>						
Bromide Dissolved	0.05	0.02	0.05	0.10	21	Results are below detection limits
Chloride Dissolved	4.77	1.08	0.10	5.20	21	No guidelines, average concentration in freshwater is 8.3 mg/L
Fluoride Dissolved	0.02	0.01	0.01	0.04	21	No guidelines

Appendix 4: Summary of Third Lake water chemistry results (units are mg/L unless otherwise stated).

Parameter	mean	std. dev.	min	max	n=	Notes
<b>Metals</b>						
Aluminum Total	0.13	0.11	0.06	0.37	7	Below guidelines
Antimony Total	0.06	0.01	0.06	0.09	7	Most results below detection limits
Arsenic Total	0.10	0.08	0.06	0.27	7	Most results below detection limits
Barium Total	0.010	0.004	0.002	0.013	7	Below guidelines
Beryllium Total	0.014	0.006	0.001	0.019	7	Exceeds working guidelines for freshwater aquatic life
Boron Total	0.04	0.00	0.04	0.04	7	Below guidelines
Cadmium Total	0.012	0.005	0.006	0.020	7	Exceeds guidelines for drinking water
Calcium Total	6.3	0.9	5.6	8.0	7	No guidelines
Chromium Total	0.015	0.008	0.006	0.028	7	Below guidelines
Cobalt Total	0.027	0.015	0.006	0.056	7	No guidelines
Copper Total	0.013	0.004	0.006	0.018	7	Below guidelines
Iron Total	0.050	0.021	0.018	0.082	7	Below guidelines
Lead Total	0.07	0.02	0.06	0.11	7	Most results below detection limits
Magnesium Total	1.1	0.0	1.1	1.2	7	Below guidelines
Manganese Total	0.013	0.005	0.003	0.016	7	Below guidelines
Molybdenum Total	0.01	0.00	0.01	0.02	7	Below guidelines
Nickel Total	0.02	0.01	0.02	0.03	7	Below working guidelines
Potassium Total	0.2	0.0	0.1	0.2	7	No guidelines
Selenium Total	0.06	0.00	0.06	0.06	7	Most results below detection limits
Silver Total	0.02	0.02	0.01	0.05	7	Most results below detection limits
Silicon Total	3.06	0.20	2.63	3.20	7	No guidelines
Sodium Total	2.6	0.2	2.3	2.8	7	Below guidelines
Strontium Total	0.024	0.004	0.016	0.027	7	No guidelines
Sulfur Total	1.34	0.08	1.21	1.44	7	No guidelines
Tin Total	0.27	0.36	0.06	1.04	7	No guidelines
Titanium Total	0.014	0.007	0.002	0.022	7	Below working guidelines
Vanadium Total	0.02	0.03	0.01	0.08	7	Below working guidelines
Zinc Total	0.005	0.003	0.002	0.011	7	Below guidelines

Appendix 5: Summary of Pease Lake water chemistry results (units are mg/L unless otherwise stated).

Parameter	mean	std. dev.	min	max	n=	Notes
<b>General</b>						
Alkalinity Total 4.5	30.7	1.8	28.4	34.3	24	Results indicate Pease Lake has a low sensitivity to acidic inputs.
Colour True (Col.unit)	7.5	3.5	2.5	15.0	24	Below guidelines
Hardness Total	30.3	3.2	28.2	38.1	8	Below guidelines
pH (pH units)	7.2	0.2	7.0	7.8	24	Within guidelines
Residue Total	68.8	11.7	50.0	90.0	17	No guidelines
Silica Dissolved	7.9	0.9	6.2	9.1	24	No guidelines
Specific Conductance (µS/cm)	80.1	3.0	76.0	88.0	31	No guidelines - natural waters vary from 50 to 1,500 µS/cm
Sulfate Dissolved	3.6	0.6	2.0	4.1	17	Below guidelines
Turbidity (NTU)	0.4	0.2	0.3	1.1	24	Below guidelines
<b>Nutrients</b>						
Ammonia Dissolved	0.007	0.003	0.005	0.015	31	Guidelines based on pH and temperature
Carbon Total	8.9	0.3	8.7	9.6	10	No guidelines
Carbon Total Inorganic	6.9	0.2	6.8	7.4	8	No guidelines, natural waters are frequently <25 mg/L
Carbon Total Organic	2.0	0.1	1.9	2.2	8	No guidelines, natural waters range from 1 - 30 mg/L
Nitrate (NO <sub>3</sub> ) Dissolved	0.032	0.032	0.002	0.090	24	Below guidelines
Nitrate + Nitrite Dissolved	0.028	0.032	0.002	0.095	31	No guidelines
Nitrogen - Nitrite Dissolved	0.004	0.002	0.002	0.005	31	Below guidelines
Nitrogen Total	0.182	0.047	0.130	0.360	31	No guidelines
Ortho-Phosphate Dissolved	0.05	0.00	0.05	0.05	17	No guidelines
Phosphorus Total	0.009	0.002	0.006	0.013	31	Below guidelines
Phosphorus Total Dissolved	0.006	0.002	0.003	0.008	31	No guidelines
<b>Bacteria</b>						
Fecal Coliform (CFU/100mL)	2	3	0	12	50	See discussion
<b>Halides</b>						
Bromide Dissolved	0.05	0.00	0.05	0.05	17	All results below detection limit
Chloride Dissolved	4.14	0.20	4.00	4.60	17	No guidelines, average concentration in freshwater is 8.3 mg/L
Fluoride Dissolved	0.01	0.00	0.01	0.02	17	No guidelines

Appendix 5: Summary of Pease Lake water chemistry results (units are mg/L unless otherwise stated).

Parameter	mean	std. dev.	min	max	n=	Notes
<b>Metals</b>						
Aluminum Total	0.07	0.02	0.06	0.12	8	Below guidelines
Antimony Total	0.06	0.00	0.06	0.06	8	All results below detection limits
Arsenic Total	0.06	0.00	0.06	0.06	8	Most results below detection limits
Barium Total	0.003	0.003	0.001	0.010	8	Below guidelines
Beryllium Total	0.003	0.005	0.001	0.016	8	Below guidelines
Boron Total	0.01	0.00	0.01	0.02	8	Below guidelines
Cadmium Total	0.007	0.003	0.006	0.014	8	Most results below detection limits
Calcium Total	7.6	1.0	7.0	10.0	8	No guidelines
Chromium Total	0.007	0.002	0.006	0.012	8	Below guidelines
Cobalt Total	0.010	0.010	0.006	0.033	8	No guidelines
Copper Total	0.006	0.001	0.006	0.009	8	Below guidelines
Iron Total	0.047	0.019	0.031	0.091	8	Below guidelines
Lead Total	0.06	0.00	0.06	0.07	8	Most results below detection limits
Magnesium Total	2.7	0.2	2.6	3.2	8	Below guidelines
Manganese Total	0.006	0.004	0.003	0.016	8	Below guidelines
Molybdenum Total	0.02	0.01	0.01	0.05	8	Below guidelines
Nickel Total	0.02	0.00	0.02	0.02	8	Most results below detection limits
Potassium Total	0.1	0.0	0.1	0.2	8	No guidelines
Selenium Total	0.06	0.00	0.06	0.06	8	All results below detection limits
Silver Total	0.01	0.00	0.01	0.01	8	All results below detection limits
Silicon Total	3.78	0.30	3.08	4.09	8	No guidelines
Sodium Total	2.5	0.1	2.4	2.5	8	Below guidelines
Strontium Total	0.028	0.030	0.016	0.102	8	No guidelines
Sulfur Total	1.41	0.04	1.34	1.47	8	No guidelines
Tin Total	0.07	0.02	0.06	0.13	8	Most results below detection limits
Titanium Total	0.005	0.006	0.002	0.018	8	Below guidelines
Vanadium Total	0.01	0.00	0.01	0.02	8	Below guidelines
Zinc Total	0.004	0.003	0.002	0.010	8	Below guidelines

Appendix 6: Summary of Eagles Lake water chemistry results (units are mg/L unless otherwise stated).

Parameter	mean	std. dev.	min	max	n=	Notes
<b>General</b>						
Colour True (Col.unit)	20	0	20	20	1	Aesthetic guidelines are 15 units
Hardness Total	39.1	0.0	39.1	39.1	1	Below guidelines
pH (pH units)	7.3	0.0	7.3	7.3	1	Within guidelines
Residue Total	80	0	80	80	1	No guidelines
Specific Conductance (µS/cm)	106	0	106	106	1	No guidelines
Turbidity (NTU)	1.3	0.0	1.3	1.3	1	Below guidelines
<b>Nutrients</b>						
Ammonia Dissolved	0.005	0.000	0.005	0.005	1	Guidelines based on pH and temperature
Nitrate + Nitrite Dissolved	0.002	0.000	0.002	0.002	1	No guidelines
Nitrogen - Nitrite Dissolved	0.002	0.000	0.002	0.002	1	Below guidelines
Nitrogen Total	0.33	0.00	0.33	0.33	1	No guidelines
Phosphorus Total	0.012	0.000	0.012	0.012	1	Recreational use guideline is 0.01 mg/L at spring overturn
Phosphorus Total Dissolved	0.003	0.000	0.003	0.003	1	No guidelines
<b>Bacteria</b>						
Fecal Coliform (CFU/100mL)	7	1	5	8	4	
<b>Metals</b>						
Aluminum Total	0.06	0.00	0.06	0.06	1	Below detection limits
Antimony Total	0.06	0.00	0.06	0.06	1	Below detection limits
Arsenic Total	0.06	0.00	0.06	0.06	1	Below detection limits
Barium Total	0.003	0.000	0.003	0.003	1	Below guidelines
Beryllium Total	0.001	0.000	0.001	0.001	1	Below detection limits
Boron Total	0.01	0.00	0.01	0.01	1	Below guidelines
Cadmium Total	0.006	0.000	0.006	0.006	1	Below detection limits
Calcium Total	11.2	0.0	11.2	11.2	1	No guidelines
Chromium Total	0.006	0.000	0.006	0.006	1	Below detection limits
Cobalt Total	0.006	0.000	0.006	0.006	1	Below detection limits
Copper Total	0.006	0.000	0.006	0.006	1	Below guidelines
Iron Total	0.136	0.000	0.136	0.136	1	Below guidelines
Lead Total	0.06	0.00	0.06	0.06	1	Below detection limits
Magnesium Total	2.7	0.0	2.7	2.7	1	Below guidelines
Manganese Total	0.007	0.000	0.007	0.007	1	Below guidelines



Appendix 6: Summary of Eagles Lake water chemistry results (units are mg/L unless otherwise stated).

Parameter	mean	std. dev.	min	max	n=	Notes
Molybdenum Total	0.01	0.00	0.01	0.01	1	Below guidelines
Nickel Total	0.02	0.00	0.02	0.02	1	Below detection limits
Potassium Total	0.1	0.0	0.1	0.1	1	Below detection limits
Selenium Total	0.06	0.00	0.06	0.06	1	Below detection limits
Silver Total	0.01	0.00	0.01	0.01	1	Below detection limits
Silicon Total	3.21	0.00	3.21	3.21	1	No guidelines
Sodium Total	4.9	0.0	4.9	4.9	1	Below guidelines
Strontium Total	0.031	0.000	0.031	0.031	1	No guidelines
Sulfur Total	0.99	0.00	0.99	0.99	1	No guidelines
Tin Total	0.06	0.00	0.06	0.06	1	Below detection limits
Titanium Total	0.002	0.000	0.002	0.002	1	Below guidelines
Vanadium Total	0.01	0.00	0.01	0.01	1	Below guidelines
Zinc Total	0.002	0.000	0.002	0.002	1	Below guidelines

Appendix 7: Summary of Mitchell Lake water chemistry results (units are mg/L unless otherwise stated).

Parameter	mean	std. dev.	min	max	n=	Notes
<b>General</b>						
Colour True (Col.unit)	13	4	10	15	2	Below guidelines
Hardness Total	31.1	3.0	28.9	33.2	2	Below guidelines
pH (pH units)	7.4	0.1	7.3	7.4	2	Within guidelines
Residue Total	77	10	70	84	2	No guidelines
Residue Nonfilterable (TSS)	4	0	4	4	2	Below detection limits
Silica Dissolved	6.9	0.1	6.8	7.0	2	No guidelines
Specific Conductance ( $\mu\text{S}/\text{cm}$ )	85.0	7.1	80.0	90.0	2	No guidelines
Turbidity (NTU)	0.92	0.37	0.66	1.18	2	Below guidelines
<b>Nutrients</b>						
Ammonia Total	0.022	0.006	0.017	0.026	2	Guidelines based on pH and temperature
Carbon Total Inorganic	3.2	0.4	2.9	3.5	2	No guidelines, natural waters are frequently <25 mg/L
Carbon Total Organic	3.3	0.2	3.1	3.4	2	No guidelines, natural waters range from 1 - 30 mg/L
Nitrate + Nitrite Dissolved	0.095	0.057	0.055	0.135	2	No guidelines
Nitrogen Total	0.21	0.09	0.14	0.27	2	No guidelines
Nitrogen - Organic Total	0.10	0.00	0.10	0.10	2	No guidelines
Nitrogen - Kjeldahl Total	0.11	0.04	0.08	0.13	2	No guidelines
Ortho-Phosphate Dissolved	0.002	0.001	0.001	0.002	2	No guidelines
Phosphorus Total	0.010	0.001	0.009	0.010	2	Below guidelines
Phosphorus Total Dissolved	0.009	0.001	0.008	0.009	2	No guidelines
<b>Metals</b>						
Aluminum Total	0.03	0.00	0.03	0.03	2	Below guidelines
Antimony Total	0.05	0.00	0.05	0.05	2	Below detection limits
Arsenic Total	0.05	0.00	0.05	0.05	2	Below detection limits
Barium Total	0.003	0.001	0.002	0.003	2	Below guidelines
Beryllium Total	0.0002	0.0000	0.0002	0.0002	2	Below detection limits
Bismuth Total	0.05	0.00	0.05	0.05	2	No guidelines
Boron Total	0.022	0.004	0.019	0.024	2	Below guidelines
Cadmium Total	0.002	0.000	0.002	0.002	2	Below guidelines
Calcium Total	9.77	0.89	9.14	10.40	2	No guidelines
Chromium Total	0.005	0.000	0.005	0.005	2	Below guidelines
Cobalt Total	0.005	0.000	0.005	0.005	2	Below detection limits
Copper Total	0.005	0.000	0.005	0.005	2	Below guidelines

Appendix 7: Summary of Mitchell Lake water chemistry results (units are mg/L unless otherwise stated).

Parameter	mean	std. dev.	min	max	n=	Notes
Iron Total	0.071	0.016	0.060	0.082	2	Below guidelines
Lead Total	0.03	0.00	0.03	0.03	2	Below detection limits
Magnesium Total	1.62	0.21	1.47	1.76	2	Below guidelines
Manganese Total	0.008	0.004	0.005	0.010	2	Below guidelines
Molybdenum Total	0.005	0.000	0.005	0.005	2	Below guidelines
Nickel Total	0.008	0.000	0.008	0.008	2	Below detection limits
Potassium Total	1	0	1	1	2	No guidelines
Selenium Total	0.03	0.00	0.03	0.03	2	Below detection limits
Silver Total	0.01	0.00	0.01	0.01	2	Below detection limits
Sodium Total	4.09	0.23	3.92	4.25	2	Below guidelines
Strontium Total	0.021	0.002	0.019	0.022	2	No guidelines
Sulfur Total	1.8	0.2	1.6	1.9	2	No guidelines
Tellurium Total	0.05	0.00	0.05	0.05	2	No guidelines
Thallium Total	0.03	0.00	0.03	0.03	2	Below detection limits
Tin Total	0.02	0.00	0.02	0.02	2	Below detection limits
Titanium Total	0.003	0.000	0.003	0.003	2	Below detection limits
Vanadium Total	0.005	0.000	0.005	0.005	2	Below detection limits
Zinc Total	0.005	0.000	0.005	0.005	2	Below detection limits
Zirconium Total	0.005	0.000	0.005	0.005	2	No guidelines