



**King EPCM**  
3780 14<sup>th</sup> Ave., Unit 211,  
Markham, ON L3R 4B7  
T: 647-459-5647  
[www.KingEPCM.com](http://www.KingEPCM.com)  
[General@KingEPCM.com](mailto:General@KingEPCM.com)

## **LAKESHORE CAPACITY ASSESSMENT REPORT**

**AT**

**ELEPHANT LAKE COTTAGES  
HARCOURT, DYSART ET AL, ONTARIO**

**PREPARED FOR:**

2463756 Ontario Inc.

December 20, 2023

## Table of Contents

1. Site Background .....	3
2. Site Description .....	3
3. Lakeshore Capacity Assessment.....	4
3.1. Objective and Modeling Scenarios .....	6
3.2. Catchment and lake areas .....	7
3.3. Land use areas .....	7
3.4. Measured Total Phosphorus Data .....	8
4. Model Assumptions and Uncertainty.....	11
5. Capacity Assessment .....	11
5.1. Existing Conditions (Scenario 1) .....	12
5.2. Future Conditions (Scenario 2) .....	12
6. Conclusions .....	14
7. Reliance & Signature.....	14
8. References.....	15
APPENDIX I – Site Plan .....	16
APPENDIX II –Lakeshore Capacity Model - Coefficients .....	17
APPENDIX III – Land use areas .....	18
APPENDIX IV – Lakeshore Capacity Model – Existing Condition .....	19
APPENDIX V –Lakeshore Capacity Model – Proposed Condition.....	20

## 1. Site Background

King EPCM was retained by 2463756 Ontario Inc. (Client) to conduct engineering investigations and services for the property located along the shoreline of Elephant Lake and Benoir Lake in the County of Haliburton, Municipality of Dysart et al. (Site), as part of cottage permit submissions. This is a preliminary report of the lakeshore capacity assessment used to design the property. The goals of lakeshore capacity assessment are to help maintain the quality of water in recreational inland lakes and to protect fish habitat by keeping changes in the nutrient status of inland lakes within acceptable limits. Phosphorus and dissolved oxygen are commonly used indicators of water quality.

The Site property is approximately 2000 acres in size, divided into two different Blocks, one of them located east of the Benoir Lake, behind the Benoir Lake Road (Phase 1); and the other located north of the Elephant Lake (Phase 2), near the shoreline. In the proposed development project, 63 new lots along with an 8<sup>th</sup> m width private condo laneway (Block A) plus one public community boat launch area (Block B) will be built. See Appendix I for more details on the proposed development.

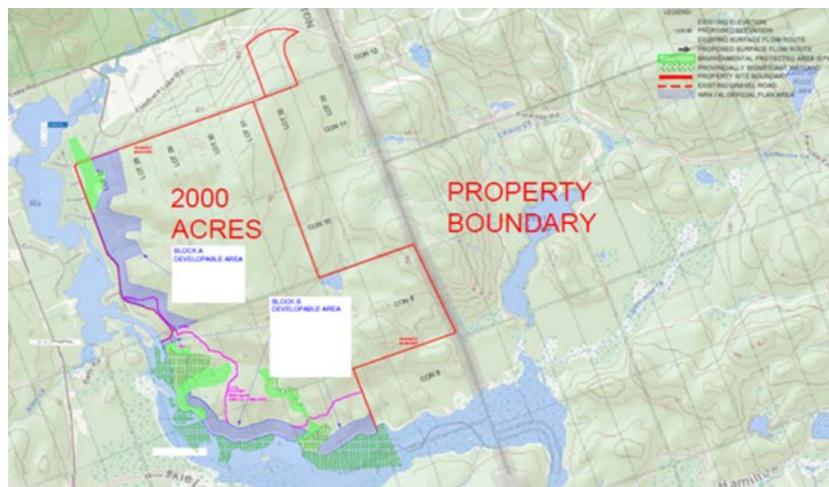


Figure 1 – Topographic map of site area, Haliburton, ON (Ontario MNRF)

## 2. Site Description

Benoir and Elephant Lakes were created by the Ontario Department of Public Works and the Ontario Hydro Electric Power Commission in 1931 at the effluence of the York River from Baptiste Lake. These lakes are located northwest of Bancroft and are part of a three-lake chain that includes Baptiste Lake. The York River is in the Saint Lawrence River drainage basin and flows from the southern extension of Algonquin Provincial Park to the Madawaska River. It spans out into Elephant, Benoir, and Baptiste Lakes and passes through Bancroft. Benoir Lake and Elephant Lake have surface areas of 92.3 and 884.6 hectares, respectively.

The Benoir Lake is approximately 228 acres in size with a maximum depth of 60 feet and a mean depth of 18.4 feet. Unlike Elephant Lake, Benoir Lake is highly developed. Shoreline development around the

lakes consists of 212 extended seasonal residences, 1 resort with 51 rooms (i.e., Nomi Resort at the southwest bank of the lake), and 1 tourist trailer park located at the northwest with approximately 60 trailer tenants.

Elephant Lake is approximately 2186 acres in size with a maximum depth of about 23 feet and a mean depth of 6 feet. It is a large, picturesque shallow lake. Shoreline development around this lake consists of 114 extended seasonal residences, 1 tourist trailer park located at the Midwest bank of the lake with approximately 15 trailer tenants, and 20 vacant lots that are recognizable on satellite images.

### 3. Lakeshore Capacity Assessment

The Lake Capacity Assessment Handbook (2010) takes a watershed approach and defines shoreline development as being within 300 meters of a lake or any permanently flowing tributary of the lake and includes lakes upstream in the watershed. A refined version (v4.2, Fall 2012) of Ontario's Lakeshore Capacity Model (LCM) was used to assess potential changes in water quality from the proposed development area within the Benoir and Elephant Lakes watershed.

At first, the model was developed by Dillon and Rigler (1975) and it was calibrated on Canadian Shield lakes in Ontario (Dillon et al. 1986; Hutchinson et al. 1991). The LCM is a mass balance, steady-state model that quantifies the natural and human phosphorus inputs to a watershed and estimates the resulting phosphorus concentrations of the watershed's lakes using the assumptions and recommended coefficients and constants provided by the MOE (MOE, 2010).

If predicted phosphorus concentrations are within acceptable levels of measured values, the LCM can be used as a planning tool to estimate changes in lake phosphorus concentrations resulting from proposed development applications, conversions of seasonal cottages to permanent homes, or other land use activities that may increase or decrease phosphorus loadings to the lake.

Model data were gathered from assessment of satellite imagery (e.g., Google Earth, Ontario Imagery Web Map Service), the Ministry of Natural Resources and Forestry (MNRF)'s Flow Assessment Tool, Bancroft Ontario website, the Ministry of Environment and Climate Change's (MOECC) Lake Partner Program (LPP) and Runoff Lookup Database, and water quality sampling as listed in Table 1. The model is also used to predict how future land developments may impact the lake's phosphorus concentrations.

Using this information the model calculates:

- Hydraulic budget;
- Phosphorus loads from all land use, point sources, and septic systems; and
- Predicted lake total phosphorus concentrations.

**Table 1- Information on the data used in the Lakeshore Capacity Assessment**

Type of data	Inputs	Source
Physical	Lake area and depth	Bancroft Ontario
	Catchment and wetland area	Ontario Flow Assessment Tool (MNRF, 2017)
Development	Lots and occupancies	Municipality of Dysart et al., County of Haliburton, Township of Harcourt, and satellite imagery
Water Chemistry	Total Phosphorus	Field sampling by King EPCM
		MOECC Lake Partner Program
Hydrological	Annual runoff	MOECC Runoff Lookup Database

Detailed methods and assumptions of the model are provided in MOE (2010). The following provides a description and brief rationale for the selection of various coefficients and assumptions used in the modeling of Benoir and Elephant Lakes:

- The lakes and catchments area of Benoir and Elephant Lakes are 37,270 and 46,937 ha (373 and 469 km<sup>2</sup>), respectively.
- Total phosphorus (TP) loading from the land area in the whole watershed (Benoir Lake catchment is part of the whole Elephant Lake catchment) was determined using the following equation, because the percentage of wetland in the catchment was greater than 3.5%, and cleared or pastured land was less than 15%:

$$\text{TP (kg/yr)} = \text{catchment area (km}^2\text{)} \times (0.47 \times \% \text{ wetland area} + 3.82)$$

- A TP loading rate of 0.167 kg/ha/yr was used to calculate TP loads to the surface of the lakes from atmospheric deposition.
- Mean annual runoff values from 0.438 and 0.44 m/yr were determined from the runoff lookup table provided by the MOECC to calculate water loads from the lakes basin.
- TP loads from septic systems located within 300 m of the shoreline of the lakes were calculated assuming a loading rate of 0.66 kg/capita/yr for each septic system. For existing conditions, septic usage rates of 1.27, 0.69, 1.18, and 0.69 per capita yrs/yr for extended seasonal, seasonal, resort, and trailer park residences were used.
- All lots included an overland runoff TP load of 0.04 kg/lot/yr.
- The model assumes that vacant lots of record will eventually be converted into extended seasonal cottages and future usage is equal to 1.27 capita years/yr. Although the shorelines of Benoir Lake were fully developed, there appeared to be about 20 vacant lots on the Elephant Lake shorelines.

See Appendix II for more details about the coefficients used in this modeling.

The Lakeshore Capacity Model (LCM) contains several types of shoreline development that have been used in this project:

- **Extended Seasonal:** non-permanent residences that have year-round reliable access, but are not occupied full-time like most developments around the Benoir Lake.
- **Seasonal:** cottages that are occupied for summer, weekends, and long weekend use

- **Resort:** a number of resort units (i.e., rooms) that are serviced, housekeeping cabins, or meal supply units; assuming a use period of 140 days/yr (Victoria Day to Thanksgiving weekend) and a mean occupancy of 3.07 people/day.
- **Trailer Parks:** permanent mobile homes and trailers commonly used on a seasonal basis.
- **Vacant Lots of Record:** shoreline lots that are designated as development lots, but have not yet been cleared for development.

### 3.1. Objective and Modeling Scenarios

The objective of the modeling was to evaluate the long-term impact of new development in the southeast shoreline of Benoir Lake (Phase 1) and the North shoreline of Elephant Lake (Phase 2) watersheds on their phosphorus concentrations. To complete this, the catchment area of Elephant Lake was delineated at the junction with Baptiste Lake (45° 09' 30.99" N, 78° 05' 22.96" W), which also included the catchment area of Benoir Lake (i.e., Benoir Lake catchment was part of the whole Elephant Lake catchment). Therefore, the catchment area of Benoir Lake was delineated separately at the junction with Elephant Lake (45° 10' 3.97" N, 78° 08' 24.67" W). Then, the phosphorus concentrations were modeled for the lake in each catchment. Two land use scenarios (Pre-development as current status and Post-Development as proposed scenario by the Engineer) were modeled and investigated in this report.

The modeling scenarios included one current scenario and one future scenario:

1. Modeling Scenario 1: Existing Conditions;
2. Modeling Scenario 2: Future/Proposed Developments;

Scenario 1 represented the existing land use conditions in the lake's watershed (Figure 2). The surface areas occupied by the different land uses in the whole catchment (for each lake separately at the outlet to the upstream) were interpreted through analysis of satellite imagery using the Ontario Flow Assessment Tool (OFAT). The Existing Conditions scenario was used to calibrate the Lake Capacity Model to the measured phosphorus concentration of the lakes as presented in Appendix IV.

Scenario 2 land use was based on the Existing Conditions Scenario with modifications to represent future developments that have been identified in the watershed (Appendix V). The proposed developments included two separate blocks of waterfront residential lots (cottages) along the shoreline of Benoir Lake and Elephant Lakes. Phase 1 consisted of 25 lots located east of Benoir Lake, behind Lake Road and Phase 2 consisted of 38 lots located north of the Elephant Lake.

Scenario 2 assumed that the Uplands wastewater treatment facilities or septic systems would remain in operation with phosphorus discharges remaining the same as in the Existing Conditions. The scenario also assumed that all septic systems in the Existing Conditions would remain in place and discharge phosphorus would be the same as in the Existing Conditions.

### 3.2. Catchment and lake areas

For each lake, the catchment area and lake surface area were calculated using Ontario Flow Assessment Tool as an online, spatially-based application to automate a series of labor-intensive technical hydrology tasks. OFAT is an online map-based tool that creates watersheds and can be used to calculate watershed characteristics, execute simple hydrology models and report water flow statistics. The surface area of Lakes was taken to be the open water not including wetlands. The other information (i.e., water depth) was provided by Bancroft Ontario. Results were presented in Table 2.

**Table 2- Morphology of Benoir and Elephant Lakes Catchments**

Lake	Catchment Surface Area (ha)	Surface Area (ha)	Maximum Depth (m)	Average Depth (m)
Benoir Lake	37,270	92.3	18.29	5.6
Elephant Lake	46,937	884.6	7.01	1.83

### 3.3. Land use areas

Phosphorus contributions from land use areas depend on the type of vegetative covering in undeveloped areas and the number of impervious surfaces in developed areas. The surface areas occupied by the different land uses in each catchment were interpreted through analysis of satellite images within OFAT. The areas occupied by each land use category were presented in Tables 3 and 4, and displayed in Appendix III for each lake catchment.

The most important data required for LCM modeling were percent wetland and cleared land in each catchment, and shoreline development numbers broken down according to the seven usage categories: permanent, extended seasonal, seasonal, resort, trailer parks, youth camps, campgrounds/tent trailers, and vacant lots of record discussed above. Based on the OFAT hydrological model outputs, the lake and wetland areas in the catchment area of Benoir and Elephant Lakes were 22.86, 25.43 km<sup>2</sup>, and 31.22, 38.17 km<sup>2</sup>, respectively.

**Table 3- Benoir Lake Watershed Land use**

Land Cover Type	Area (Sq. Km.)	Percent
Cloud/Shadow	0.53	0.14%
Clear Open Water	32.78	8.80%
Bog	1.94	0.52%
Sparse Treed	13.41	3.60%
Deciduous Treed	197.24	52.95%
Mixed Treed	94.73	25.43%
Coniferous Treed	29.38	7.89%
Community/Infrastructure	0.84	0.23%
Agriculture and Undifferentiated Rural Land Use	1.64	0.44%

**Table 4- Elephant Lake Watershed Land use**

Land Cover Type	Area (Sq. Km.)	Percent
Cloud/Shadow	0.53	0.11%
Clear Open Water	47.28	10.08%
Bog	2.77	0.59%
Sparse Treed	16.59	3.54%
Deciduous Treed	248.92	53.06%
Mixed Treed	113.83	24.26%
Coniferous Treed	34.07	7.26%
Community/Infrastructure	0.84	0.18%
Agriculture and Undifferentiated Rural Land Use	4.28	0.91%

### 3.4. Measured Total Phosphorus Data

Measured Total phosphorus (TP) data were compared with modeled TP results to determine the ability of the LCM to accurately estimate TP concentrations. The province recommends that differences between measured and modeled results be less than 20% to confidently use the model to assess capacity (MOE, 2010). A negative residual would indicate that the model was under-predicting, while a positive residual would indicate that the model was over-predicting.

TP sampling is often best completed during spring turnover when the water column is mixed to assess whole lake conditions for studies of lake capacity. Phosphorus samples have been collected from the East End of Elephant Lake, by Rock Cliff between 2002 and 2008 as part of MOECC’s Lake Partner Program (Table 5). Recently, four new samples were collected from central parts of Elephant Lake by King EPCM on May 25th, 2021, and were tested by TESTMARK Laboratories LTD (Table 6). The historical and new sample locations were also shown in Figure 2.

As shown in the Figure, no TP data were available for Benoir Lake, and for these studies, the closest sample taken from the north part of Elephant Lake, 1.4 km from the Benoir Lake outlet, was used for LCM modeling (i.e., Sample 3 in which TP = 15 µg/L). To model the elephant lake capacity, the average of all 18<sup>th</sup> samples taken from 2002 to 2021 was used with the value of 14.36 µg/L.

The average spring phosphorus data indicated that both lakes were mesotrophic or moderately nutrient-enriched (10-20 µg/L) and it could accommodate small increases in phosphorus levels

**Table 5- Phosphorus measurements from Elephant Lake 2002-2008-all samples collected from station 1356 in East End, by Rock Cliff (45°08'02" N, 78°07'24" W) through MOECC's Lake Partner Program (LPP)**

Date	Phosphorus Concentration (µg/L)	Average Annual Phosphorus Concentration (µg/L)
2002-05-23	10.8	9.9
	9.0	
2003-05-03	27.14	27.14
	27.14	
2004-06-09	14.55	14
	13.45	
2005-05-22	11.35	11.65
	11.95	
2006-05-23	10.96	10.96
	10.96	
2007-05-05	13.19	13.67
	14.15	
2008-05-11	11.99	12.05
	12.12	

**Table 6- Phosphorus measurements from Elephant Lake 2021-05-25 (each sample collected from different locations in the south and north mid-part of the lake by King EPCM)**

Sample	Location	Water Temperature (°C)	Phosphorus Concentration (µg/L)	Description
1	725,836E 5,003,368N	19.9	18	7-9 ft maximum depth
2	726,231E 5004,449N	20	15	9ft maximum area, surrounded by shallower areas of 4-6ft
3	725,747E 5,004,394N	20	15	7ft deep surrounded by 3ft shallow water
4	725,970E 5,004,603N	N/A	14	9ft deep channel (historic York River) next to the shoreline, below
<b>Average Annual Phosphorus Concentration (µg/L)</b>			<b>15.5</b>	

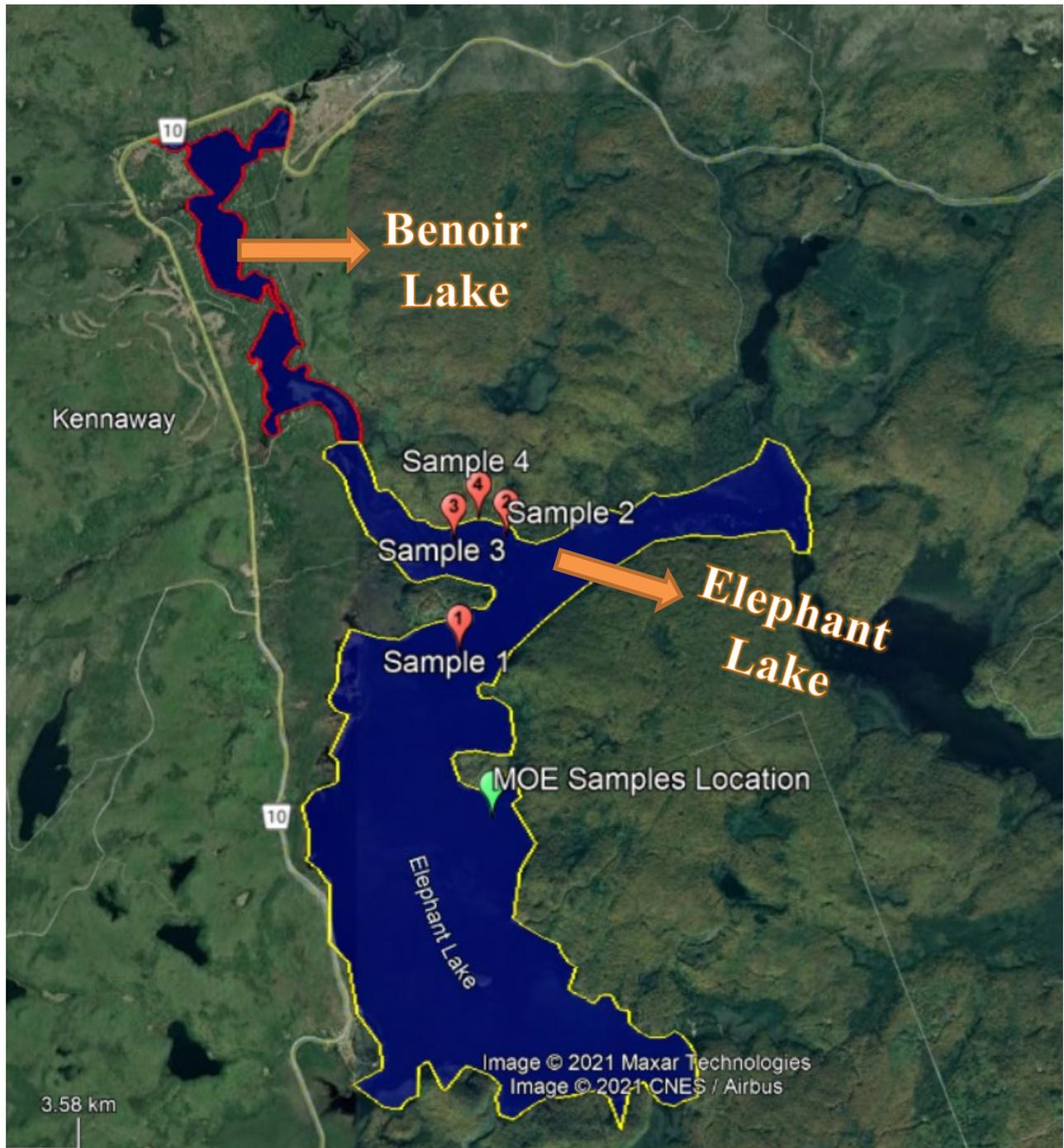


Figure 2 – TP Sample Locations (MOE historical samples and new samples were taken by the Engineer)

## 4. Model Assumptions and Uncertainty

As described in LCM Users' Manual, phosphorus runoff coefficient models such as the LCM rely on several assumptions. Understanding these assumptions allows for a better interpretation of the model's output results and adjustment of its variables to optimize the model for conditions within the target watershed.

- A key assumption used in this application of LCM was that the existing measured lake water quality conditions were the result of the land use conditions represented by Scenario 1 – Existing Conditions. So, the model parameters were adjusted to calibrate the model, and the predicted TP values were in close agreement with the measured conditions. Due to the uncertainty and variability in the lake water quality conditions, the modeled phosphorus export from land use inherently had a level of uncertainty similar to the measured lake water quality.
- A major assumption in this modeling was that the amount of phosphorus transported overland by surface runoff to the lake was independent of the transport distance. This meant that each land use would contribute the same phosphorus per unit of area to the lake independent of where it was located. This assumption simplified the model's use but was likely not an accurate representation of phosphorus transport. It was logical to presume that the more phosphorus would be removed from stormwater, the greater it traveled the overland distance. This was because there was a higher probability that phosphorus would be immobilized or consumed by plants over increasing distances. A related assumption was that no phosphorus was assimilated or retained in watercourses en route to the lake. However, retention of phosphorus could result from sedimentation, sorption to stream sediments, and uptake by organisms (Wagner et al., 1996). Behredt and Opitz (2000) indicated as much as 20 – 40% of phosphorus load was retained in some streams before reaching the lake. The retention of phosphorus from water as it traveled through the watershed could be approximated in the LCM by varying the phosphorus export coefficient as needed.
- The model also assumed that all residences on septic systems within 300 m of the lake shore or a tributary contributed equally to the phosphorus load within the lake. This assumption has not been validated and so different retention factors have been proposed depending on the septic system distance from tributaries (Hutchinson, 2002).
- The model assumed groundwater did not contribute to the hydraulic load or flow through the watershed. Adding groundwater to the hydraulic load of a watershed would have the effect of diluting the phosphorus load and decreasing the lake's phosphorus concentration.

## 5. Capacity Assessment

The Lakeshore Capacity Model was used to determine the current and proposed development capacity for Benoir and Elephant Lakes. The results were presented and discussed in the following sections.

## 5.1. Existing Conditions (Scenario 1)

The phosphorus model for the current condition of both Lakes was provided in Appendix IV. Elephant Lake was considered a second-order lake; it was fed by one lake greater than 25 hectares in size (Benoir Lake) as well as several wetlands, streams, and ponds. The catchments of both lakes were located within the Precambrian Shield and had approximately less than 1% cleared land and more than 6% wetland. Recent monitoring data indicated that both Lakes were oxic and thermally stratify during the ice-free period.

The LCM model over-predicts measured spring overturn concentrations for Benoir Lake by 15.9% while it under-predicts for Elephant Lake by less than 2.8%, indicating that the model predictions were within acceptable ranges for both lakes (Table 7). The results showed that these lakes were not over capacity in terms of total phosphorus concentration.

**Table 7- Summary of phosphorus model predictions for Benoir and Elephant Lakes- Scenario 1**

Phosphorus Concentration	Benoir Lake		Elephant Lake	
	Predicted	Measured*	Predicted	Average Measured
TP <sub>So</sub>	17.39	15	13.96	14.36
TP <sub>Lake</sub>	16.69	N/A	13.29	N/A
TP <sub>background</sub>	15.02	N/A	12.45	N/A
TP <sub>background+50%</sub>	22.53	N/A	18.67	N/A

\* One nearest sample (i.e., sample 3 in Table 6)

In addition, Secchi depth was a measure of water clarity which could be influenced by zooplankton biomass, algae biomass, turbidity, dissolved organic carbon, and suspended particulate matter. The average Secchi depths measured by the LPP (2000-2001) were 3.65 meters in Elephant Lake and it was reduced to 1.8 meters through the Engineer measurement the last May which indicated a relative decline in water clarity, but the reason was the breaking of white-caps and the sediments stirred up.

## 5.2. Future Conditions (Scenario 2)

This scenario model proposed development by Engineer consisted of 25 and 38 new waterfront residential lots/cottages (a total of 63 lots) along the shoreline of Benoir and Elephant Lakes, respectively (Table 8). The predicted phosphorus concentration in Scenario 2 was 17.39 and 13.96 µg/L, for Benoir and Elephant Lakes, respectively which represented an increase of 2.39 µg/L (15.9%) and a decrease of 0.4 µg/L (-2.8%) over current concentrations (15 and 14.36 µg/L) due to future development. These values (17.39 and 13.96 µg/L) were below the recommended water quality objective of 20 µg/L (moderately nutrient-enriched). However, it was greater than the early measured value (15 µg/L) for Benoir Lake.

The change in phosphorus concentrations in Scenario 2 came primarily from the development of forested land to residential cottages (Appendix I & III). The residential land use category contained more paved

and impermeable surfaces resulting in greater phosphorus export than undeveloped land. The summary of modeling results for each lake can be expressed as follows:

- **Benoir Lake:** When we compared Total Phosphorus modeled background (15.02 µg/L) / sampled current condition based on the nearest sample taken (15.00 µg/L)/modeled current condition (17.39 µg/L) / future condition (16.69 µg/L), there was an increase of 1.69 µg/L of TP between current and future conditions. Taking into account the overestimation rate of the model (+15.5%), it can be said that the post-development TP rate would reduce to 14.10 µg/L which is still lower than the current measured value.
- **Elephant Lake:** When we compared Total Phosphorus modeled background (12.45µg/L) / sampled current condition (14.36 µg/L)/modeled current condition (13.96 µg/L) / future condition (13.33 µg/L), there was a decrease of 1.03 µg/L of TP between current and future conditions. Taking into account the underestimation rate of the model (-2.8%), it can be said that the post-development TP rate would go up to 13.7 µg/L which is still lower than the current measured value. Both the current condition and the proposed condition are below the average sampled total phosphorus, but not in any significant divergence.

The phosphorus model showed that the capacity of Benoir Lake development could be increased to 574 permanent OR 1140 extended seasonal OR 2046 seasonal cottages. Corresponding values for Elephant Lake were 1446 permanent OR 2870 extended seasonal OR 5150 seasonal cottages (Table 9).

**Table 8- Summary of phosphorus model predictions for Benoir and Elephant Lakes-Scenario 2**

Phosphorus Concentration	Benoir Lake		Elephant Lake	
	Predicted	Measured*	Predicted	Average Measured
TP <sub>SO</sub>	17.39	15	13.96	14.36
TP <sub>Lake</sub>	16.69	N/A	13.29	N/A
TP <sub>background</sub>	15.02	N/A	12.45	N/A
TP <sub>background+50%</sub>	22.53	N/A	18.67	N/A
TP <sub>future</sub>	16.69	N/A	13.33	N/A

\* One nearest sample (i.e., sample 3 in Table 6)

**Table 9- Summary of lakes capacity and loads-Scenario 2**

Lake	Available Capacity (#)			Loads (kg/yr)			
	Permanent OR	Extended seasonal OR	Seasonal cottages OR	Bk +50% P load	Current P load	Allowable P load	Future P load
Benoir Lake	569	1130	2028	3770.62	2793.36	977.26	2793.36
Elephant Lake	1441	2860	5133	8636.24	6145.21	2491.03	6162.77

## 6. Conclusions

The LCM in this study was used to predict how future developments in the Benoir and Elephant Lakes catchments would affect lake water quality in the future. The LCM was a simple model with several assumptions that contribute to uncertainty in the precision of the modeled values. This application of the LCM attempted to reduce the uncertainty in the model by adjusting parameters in the model to reflect the local conditions of the watershed. However, given the inherent uncertainty in the model, the values should be viewed in the context of a narrative describing how activities in the watershed will affect the lake water quality.

The results of the LCM phosphorus model predicted that the development in the watershed without phosphorus reduction offsets would increase the phosphorus concentration in Benoir Lake and push the water quality closer to the upper mesotrophic range. There was an increase of 1.69 µg/L of TP and a decrease of 1.03 µg/L of TP between current and future conditions for Benoir and Elephant Lakes, respectively. The amount of phosphorus output in the proposed development for Benoir Lake increased to 16.69 µg/L, whereas it would be decreased to 13.33 µg/L in Elephant Lake.

By applying the over/under prediction coefficients of the model for both lakes, it can be said that both the current condition and the proposed condition would be below the average sampled total phosphorus (in that case, corrected TP<sub>future</sub> would be 14.10 and 13.7 µg/L for Benoir and Elephant Lakes, respectively).

## 7. Reliance & Signature

This report is the intellectual property of King EPCM and has been prepared for the sole use of 2463756 Ontario Inc. (the Client). King EPCM accepts no liability for claims arising from the use of this report, or from actions taken or decisions made as a result of this report, by parties other than the Client. The Client may submit this report to the County of Haliburton, and Municipality of Dysart et al. in regard to the Client's residential development project at Elephant Lake, Harcourt, Dysart et al., Ontario.

Respectfully,

*A. Samadi*

Amir Samadi, PhD, EIT  
Senior Engineer – Water Resources  
King EPCM

Supervised and reviewed by:

*Yu Tao (Tony) Wang*

Yu Tao (Tony) Wang, P. Eng  
Principal Engineer  
King EPCM



## 8. References

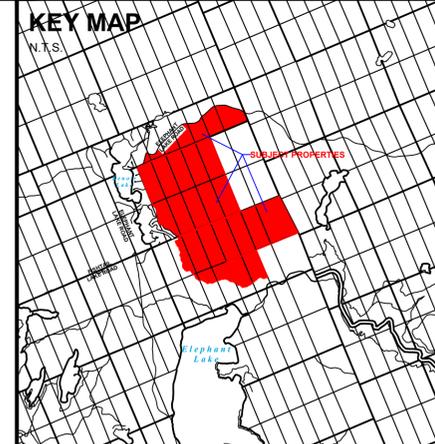
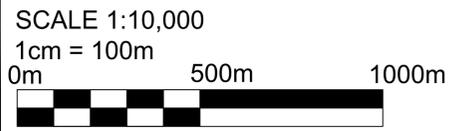
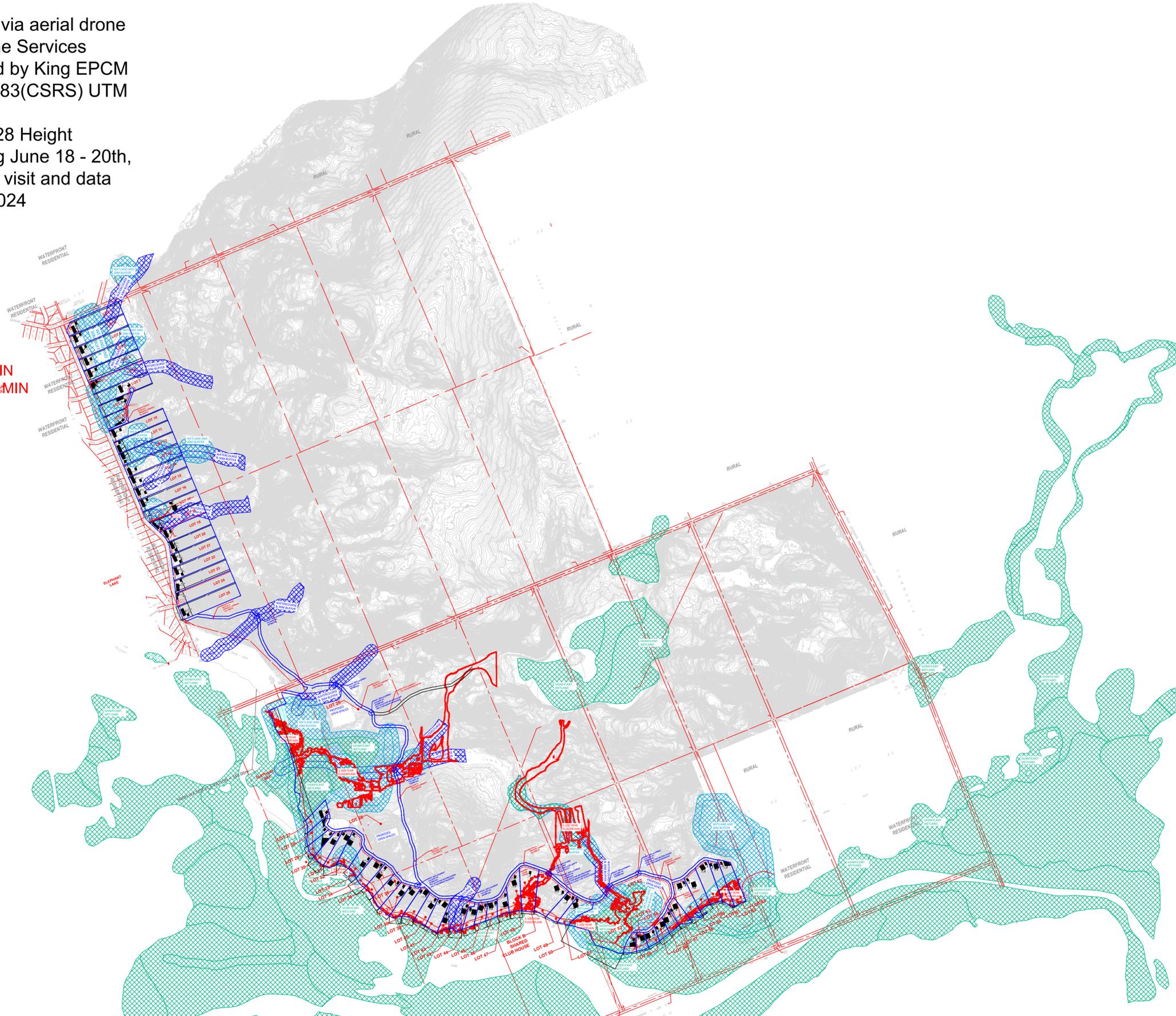
- Behrendt H., and Opitz D. (2000). Retention of nutrients in river systems: dependence on specific runoff and hydraulic load. *Hydrobiologia*. 410: 111–122.
- Dillon, P.J. and F.H. Rigler. (1975). A simple method for predicting the capacity of a lake for development based on lake trophic status. *J. Fish. Res. Bd. Can.* 32: 1519-1531.
- Dillon, P.J., K.H. Nicholls, W.A. Scheider, N.D. Yan, D.S. Jeffries. (1986). Lakeshore Capacity Study: Trophic status. Ontario Ministry of Municipal Affairs and Housing.
- Hutchinson, N.J. (2002). Limnology, plumbing and planning; Evaluation of nutrient-based limits to shoreline development in Precambrian Shield watersheds. In: R.L. France (ed.), *Handbook of Water Sensitive Planning and Design*, CRC Press, London, pp. 647-680.
- Hutchinson, N.J., B.P. Neary and P.J. Dillon. (1991). Validation and use of Ontario's trophic status model for establishing lake development guidelines. *Lake and Reserv. Manage.* 7(1):13-23.
- Ontario Ministry of the Environment. (2012). Lakeshore Capacity Model User's Manual, Version 4.2. Fall 2012. 41p.
- Ontario Ministry of the Environment. (2010). Lakeshore Capacity Assessment Handbook, Protecting Water Quality in Inland Lakes on Ontario's Precambrian Shield, May 2010.
- Ontario Ministry of Natural Resources and Forestry. (MNRF). (2020). User Guide for Ontario Flow Assessment Tool (OFAT).
- Ontario Ministry of Natural Resources and Forestry. (2010). Lake Fact Sheet.
- Ontario Ministry of the Environment, Dorset Environmental Science Centre, Lake Partner Program. [www.ene.gov.on.ca/en/water/lakepartner/index.php](http://www.ene.gov.on.ca/en/water/lakepartner/index.php)
- Ministry of Natural Resources and Forestry. (2017). Ontario Flow Assessment Tool. Toronto: Queen's Printer for Ontario.  
<http://www.gisapplication.lrc.gov.on.ca/webapps/OFAT/Viewer/Viewer.html?lang=en-US>
- Wagner, R.A., T.S. Tisdale and J. Zhang. (1996). A framework for phosphorus transport modeling in the Lake Okeechobee watershed. *Wat. Res. Bull.* 31(1): 57-73

## APPENDIX I – Site Plan

**GENERAL NOTES:**

- Topographic LiDAR survey via aerial drone was sub-contracted to Drone Services Canada Inc. and supervised by King EPCM
- Horizontal Projection - NAD83(CSRs) UTM Zone 17N
- Vertical Projection - CGVD28 Height
- Field work completed during June 18 - 20th, 2024, with King EPCM field visit and data verification on June 19th, 2024

**PROPOSED ZONING**  
**WATERFRONT RESIDENTIAL 4**  
**FRONT YARD SETBACK = 7.5M MIN.**  
**REAR YARD SETBACK = 7.5M MIN.**  
**SIDEYARD SETBACK, DWELLING = 4.5 MIN**  
**SIDEYARD SETBACK, ACCESSORY = 1.0 MIN**



DRAWN	<b>TW</b>	
DATE	<b>DEC 18, 2024</b>	

**KING** E P C M

**King EPCM**  
 211-3780 14th Ave,  
 Markham, ON, L3R 9Y5  
 www.KingEPCM.com  
 647-459-5647  
 General@KingEPCM.com

CLIENT

**95 DEVELOPMENT**

PROJECT NAME

**ELEPHANT LAKE -  
 NORTH AND SOUTH  
 PHASE**

PROJECT LOCATION

**ELEPHANT LAKE,  
 HARCOURT, DYSART ET AL**

PRINT TITLE

**MASTER SITE PLAN**

FILE No.

**EGR-1.1**

No.	ISSUED FOR:	DATE	DRAW BY	CHECK
V25	ISSUED FOR SUBMISSIONS	DEC 11, 2024	TW	TW

## APPENDIX II -Lakeshore Capacity Model - Coefficients

## Lakeshore Capacity Model - Coefficients

### Anthropogenic Supply

<u>Shoreline Development Type</u>	<u>Usage</u>	<u>Units</u>
Permanent	2.56	capita years/yr
Extended Seasonal	1.27	capita years/yr
Seasonal	0.69	capita years/yr
Resort	1.18	capita years/yr
Trailer Parks	0.69	capita years/yr
Youth Camps	0.125	kg/capita/yr
Campgrounds/Tent trailers/RV par	0.37	capita years/yr
Vacant Lots of Record	1.27	capita years/yr
Per lot TP load	0.04	kg/lot/yr
Per capita load	0.66	kg/capita/yr

### Intensive Land Use

Crop agriculture	30	mg/m <sup>2</sup> /yr	
Urbanization	50	mg/m <sup>2</sup> /yr	
Golf course	14	mg/m <sup>2</sup> /yr	(Winter et al. 2006)

### Natural Supply

P in Precipitation/Atmospheric Dep	16.7	mg/m <sup>2</sup> /yr	For lakes that are located west of Thunder Bay, an atmospheric deposition value of 20 mg/m <sup>2</sup> /yr must be used. This deposition value was determined for the Experimental Lakes Area (ELA).
------------------------------------	------	-----------------------	---

### Watershed Descriptors

Default Wetland	15	%
-----------------	----	---

### Forested Watersheds

< 15% cleared land	5.5	mg/m <sup>2</sup> /yr
≥ 15% cleared land	9.8	mg/m <sup>2</sup> /yr

### Wetland Export Equation

Natural P load from catchment = $Ad * (0.47 * \% \text{ wetland area} + 3.82)$		
Slope	0.47	
Constant	3.82	

### Sedimentation

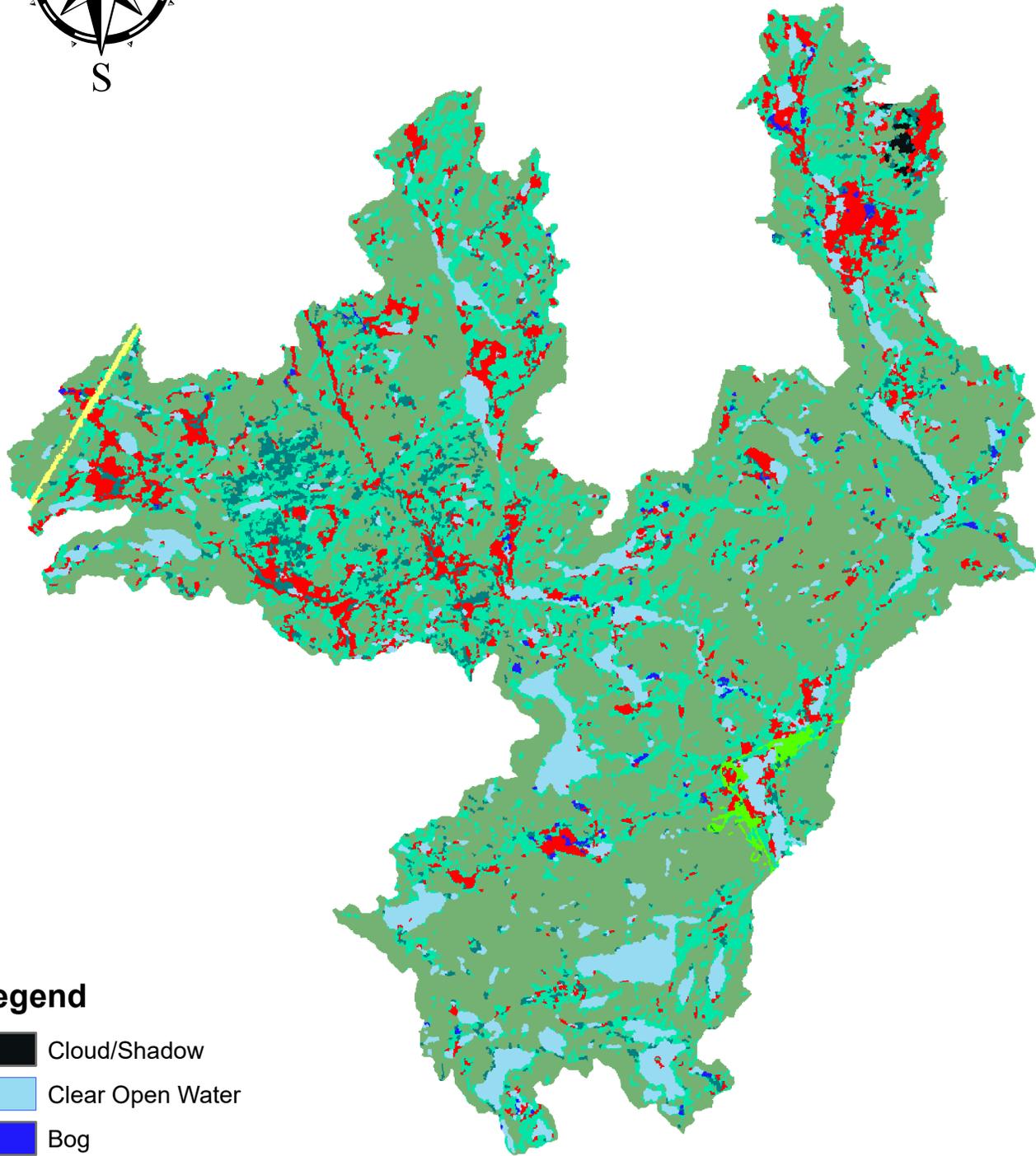
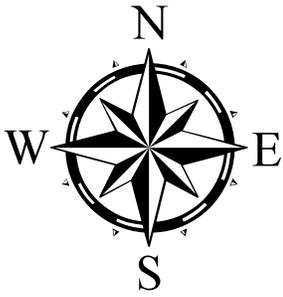
Retention coefficient (Rp) = $v / (v + qs)$		
Anoxic	7.2	m/yr
Oxic	12.4	m/yr

### Relationship between Spring Overturn and Mixed Whole Lake TP (based on long-term mean; Clark et al. 2010)

TP <sub>lake</sub> = $0.992 * TP_{so} - 0.563$		
Slope	0.992	
Constant	-0.563	

## APPENDIX III – Land use areas

# Benoir Lake Catchment Land-use

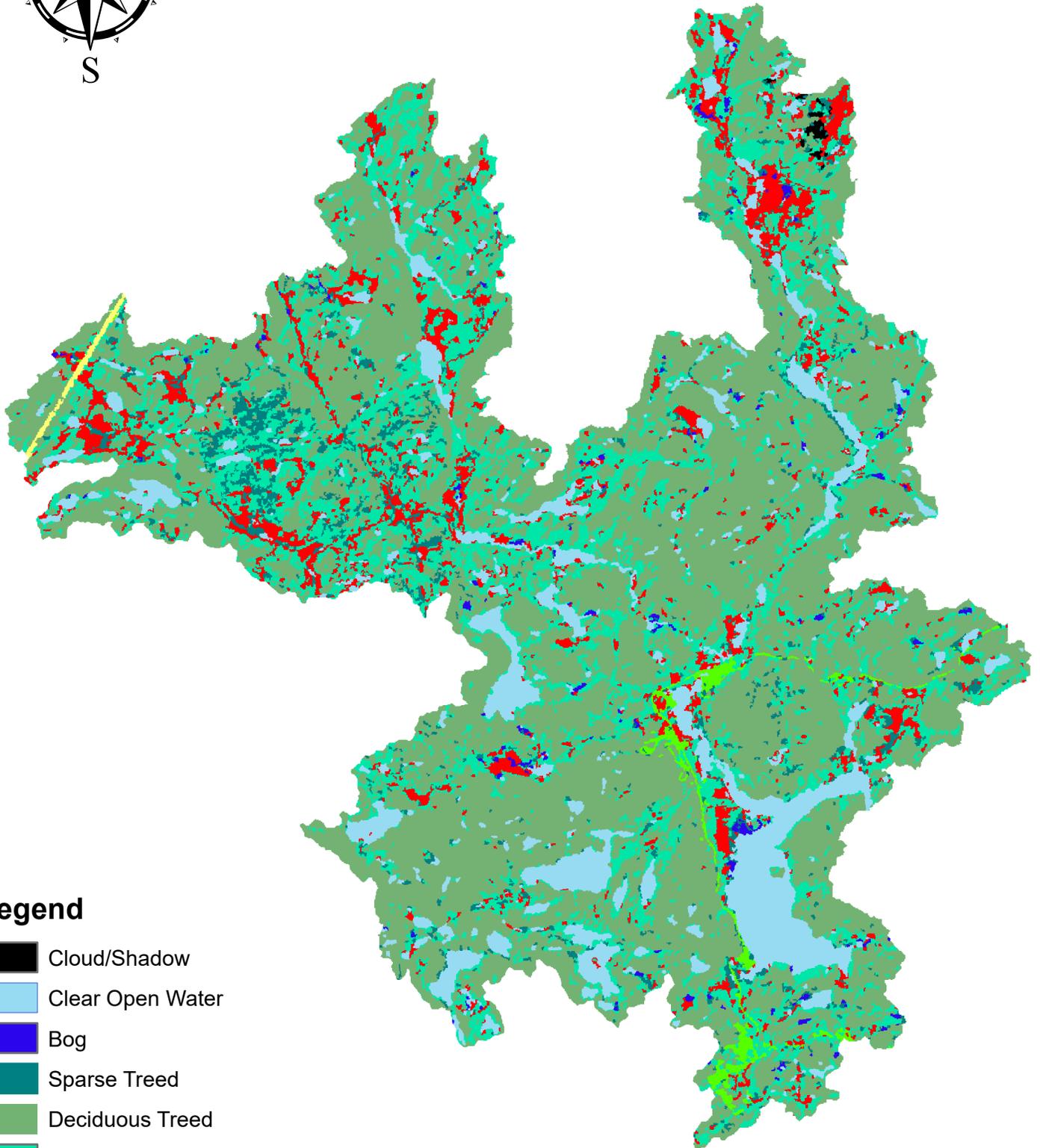


## Legend

- Cloud/Shadow
- Clear Open Water
- Bog
- Sparse Treed
- Deciduous Tree
- Mixed Tree
- Coniferous Treed
- Community/Infrastructure
- Agriculture and Undifferentiated Rural Land Use

0 1 2 4 6 8 Kilometers

# Elephant Lake Catchment Land-use



## Legend

- Cloud/Shadow
- Clear Open Water
- Bog
- Sparse Treed
- Deciduous Treed
- Mixed Treed
- Coniferous Treed
- Community/Infrastructure
- Agriculture and Undifferentiated Rural Land Use

0 1 2 4 6 8 Kilometers

## **APPENDIX IV – Lakeshore Capacity Model – Existing Condition**

## Lakeshore Capacity Model - Info on Version 4.2 (last updated Fall 2012)

1. This model has been updated to reflect the Ontario Ministry of the Environment's Lakeshore Capacity Assessment Handbook released in July 2010.
2. Unless otherwise specified, coefficients are derived from Paterson et al. (2006).
3. The model is calibrated to predict the whole lake ice-free mean total phosphorus concentration of the lake. This is reflected in the final output value T<sub>lake</sub>.
4. Lakes that are smaller than 25 ha are not modeled, unless they have significant shoreline development. These lakes should be coloured grey in the model. The surface and catchment area of lakes <25 ha without significant development are added to the catchment area of the larger downstream lake.
5. For lakes that are located west of Thunder Bay, an atmospheric deposition value of 20 mg/m<sup>2</sup>/yr must be used. This deposition value was determined for the Experimental Lakes Area (ELA).
6. Vacant lots of record refers to lots that are designated as residential, but have not yet been cleared for development. The model assumes that these lots will eventually be developed into extended seasonal cottages, unless otherwise specified. Vacant lots of record are used when calculating future anthropogenic load.

**NOTE: As a demonstration of how to link upstream lakes to downstream lakes, Lake 1 is already connected Lake 2 in this file  
THESE LINKS ARE AN EXAMPLE AND SHOULD BE DELETED IF NOT RELEVANT TO YOUR WATERSHED**

Lakeshore Capacity Model - Inputs															
Lake	Lat	Long	Runoff (m) from Database	Surface area, Ao (ha)	Catchment area, Ad (ha)	% Wetland	% Cleared	Years of spring TP sampling	No. of TP samples	Avg. Measured TPso (µg/L)	Anoxic?	Max Depth (m)	Mean Depth (m)	Trout Lake? (y/n)	Hydrologic Flow
Benoir Lake	45° 10' 3.97"	78° 08' 24.67"	0.438	92.3	37,270	6.1	1.0	1	1	15.00	n	18,288	5.6	n	Flows into Elephant Lake
Elephant Lake	45° 09' 30.99"	78° 05' 22.96"	0.440	884.6	46,937	6.7	1.0	8	18	14.36	n	7,0104	1.8288	n	TARGET

Anthro Inputs Using Extended Seasonal Cottages

Lakeshore Capacity Model - Anthropogenic Inputs												
Lake	Lat	Long	Permanent	Extended Seasonal	Seasonal	Resort	Trailer Parks	Youth Camps	Campgrounds/ Tent tailers/ RV parks	Vacant Lots of Record	Other (e.g., agriculture, urbanization, golf course)	Comments
Benoir Lake	45° 10' 3.97"	78° 08' 24.67"	0	212	0	51	60	0	0	0		
Elephant Lake	45° 09' 30.99"	78° 05' 22.96"	0	114	0	0	15	0	0	20		
all grayed out lakes are not included in the analysis												

Lakeshore Capacity Model

Benoir Lake

Anthropogenic Supply			Sedimentation	
Shoreline Development Type	Number	Usage (capita years/yr)	Is the lake anoxic?	n
Permanent	0	2.56	Settling velocity (v)	12.4 m/yr
Extended Seasonal	212	1.27	In lake retention (Rp)	0.07
Seasonal	0	0.69		
Resort	51	1.18		
Trailer Parks	60	0.69		
Youth Camps	0	0.125	kg/capita/yr	
Campgrounds/Tent trailers/RV parks	0	0.37		
Vacant Lots of Record	0	1.27		
Retention by soil (Rs) (0-1)	0			
<b>Catchment</b>			<b>Monitoring Data</b>	
			Years of spring TP data	1
			Average Measured TPso	15.00 µg/L
			Measured vs. Predicted TPso	15.0 %
			Is the model applicable?	y
			Over or under predicted?	over
			<b>Modeling Results</b>	
			TPlake	16.56 µg/L
			TPout	15.83 µg/L
			TPso	17.25 µg/L
			TPfuture	16.56 µg/L
			<b>Phosphorus Thresholds</b>	
			TPbk	15.02 µg/L
			TPbk+40	21.02 µg/L
			TPbk+50	22.53 µg/L
			TPbk+60	24.03 µg/L
			*if TPbk+40% < TPlake < TPbk+60% cell is orange	
			*if TPlake > TPbk+60% cell is red	
			<b>No. of allowable residences to reach capacity:</b>	
			# Permanent OR	582
			# Extended seasonal OR	1155
			# Seasonal cottages OR	2073
			<b>Loads</b>	
			Natural Load w/no developmer	2513.75 kg/yr
			Background + 50% Load	3770.62 kg/yr
			Current Load	2771.41 kg/yr
			Future Load	2771.41 kg/yr
			<b>Outflow Loads</b>	
			Background Outflow Load	2349.48 kg/yr
			Current Outflow Load	2590.31 kg/yr
			Future Outflow Load	2590.31 kg/yr
			<b>Upstream Loading</b>	
			Background Upstream Load 1 kg/yr	
			Background Upstream Load 2 kg/yr	
			Background Upstream Load 3 kg/yr	
			Current Total Upstream Load 1 kg/yr	
			Current Total Upstream Load 2 kg/yr	
			Current Total Upstream Load 3 kg/yr	
			Future Upstream Load 1 kg/yr	
			Future Upstream Load 2 kg/yr	
			Future Upstream Load 3 kg/yr	
			<b>Anthropogenic Loading</b>	
			Current Anthropogenic Load 257.66 kg/yr	
			Future Anthropogenic Load 257.66 kg/yr	
			<b>Areal Load Rate</b>	
			Current Total Areal Loading Rate (L <sub>T</sub> ) 3003.64 mg/m <sup>2</sup> /yr	
			Future Total Areal Loading Rate (L <sub>FT</sub> ) 3003.64 mg/m <sup>2</sup> /yr	

Lakeshore Capacity Model

Elephant Lake

Note: Lake 2 reflects upstream contributions from Lake 1

If this is not appropriate for your model, you must delete the contributions (in blue cells)

<b>Anthropogenic Supply</b>			<b>Sedimentation</b>	
Shoreline Development Type	Number	Usage (capita years/yr)	Is the lake anoxic?	n
Permanent	0	2.56	Settling velocity (v)	12.4 m/yr
Extended Seasonal	114	1.27	In lake retention (Rp)	0.23
Seasonal	0	0.69	<b>Monitoring Data</b>	
Resort	0	1.18	Years of spring TP data	8
Trailer Parks	15	0.69	Average Measured TPso	14.36 µg/L
Youth Camps	0	0.125	Measured vs. Predicted TPso	-3.4 %
Campgrounds/Tent trailers/RV parks	0	0.37	kg/capita/yr	
Vacant Lots of Record	20	1.27	Is the model applicable?	y
Retention by soil (Rs) (0-1)	0		Over or under predicted?	under
<b>Catchment</b>			<b>Modeling Results</b>	
			<b>Upstream Lakes</b>	
Lake Area (Ao)	884.6	ha	TPlake	13.20 µg/L
Catchment Area (Ad)	46936.6	ha	TPout	12.62 µg/L
Wetland	6.7	%	TPso	13.87 µg/L
Cleared	1.0	%	TPfuture	13.24 µg/L
<b>Hydrological Flow</b>			<b>Phosphorus Thresholds</b>	
Mean annual runoff	0.440	m/yr	TPbk	12.45 µg/L
Lake outflow discharge (Q)	374061955	m3/yr	TPbk+40	17.43 µg/L
Areal water loading rate (qs)	42.28	m/yr	TPbk+50	18.67 µg/L
Inflow 1	163648487	m3/yr	TPbk+60	19.92 µg/L
Inflow 2		m3/yr	*if TPbk+40% < TPlake < TPbk+60% cell is orange	
Inflow 3		m3/yr	*if TPlake > TPbk+60% cell is red	
<b>Natural Loading</b>			<b>No. of allowable residences to reach capacity:</b>	
Atmospheric Load	147.74	kg/yr	# Permanent OR	1464
Runoff Load	3260.27	kg/yr	# Extended seasonal OR	2906
			# Seasonal cottages OR	5215
<b>Upstream Loading</b>			<b>Loads</b>	
Background Upstream Load 1	2349.48	kg/yr	Natural Load w/no developmer	5757.49 kg/yr
Background Upstream Load 2		kg/yr	Background + 50% Load	8636.24 kg/yr
Background Upstream Load 3		kg/yr	Current Load	6105.86 kg/yr
Current Total Upstream Load 1	2590.31	kg/yr	Future Load	6123.43 kg/yr
Current Total Upstream Load 2		kg/yr	<b>Outflow Loads</b>	
Current Total Upstream Load 3		kg/yr	Background Outflow Load	4451.94 kg/yr
Future Upstream Load 1	2590.31	kg/yr	Current Outflow Load	4721.31 kg/yr
Future Upstream Load 2		kg/yr	Future Outflow Load	4734.89 kg/yr
Future Upstream Load 3		kg/yr		
<b>Anthropogenic Loading</b>				
Current Anthropogenic Load	107.55	kg/yr		
Future Anthropogenic Load	125.11	kg/yr		
<b>Areal Load Rate</b>				
Current Total Areal Loading Rate (L <sub>T</sub> )	690.21	mg/m2/yr		
Future Total Areal Loading Rate (L <sub>FT</sub> )	692.19	mg/m2/yr		

Lakeshore Capacity Model - Summary Results

Lake	Model Predictions (µg/L)									Measured TPso (µg/L)	Measured vs. Predicted TPso (%)	Model applicable?	Trout Lake? (y/n)	Comment	Over or under predicted?	TPfuture vs. TPbk+50%	Over capacity?	Available Capacity			Loads (kg/yr)			
	TP out	TP lake	TP so	TP future	TP bk	TP bk+40%	TP bk+50%	TP bk+60%	# Permanent OR									# Extended seasonal OR	# Seasonal cottages OR	Bk +50% P load	Current P load	Allowable P load	Future P load	
Benoir Lake	15.83	16.56	17.25	16.56	15.02	21.02	22.53	24.03	15.00	15.0	y	n		over	-5.97	n	582	1155	2073	3770.62	2771.41	999.21	2771.41	
Elephant Lake	12.62	13.20	13.87	13.24	12.45	17.43	18.67	19.92	14.36	-3.4	y	n		under	-5.43	n	1464	2906	5215	8636.24	6105.86	2530.38	6123.43	

## **APPENDIX V –Lakeshore Capacity Model – Proposed Condition**

## Lakeshore Capacity Model - Info on Version 4.2 (last updated Fall 2012)

1. This model has been updated to reflect the Ontario Ministry of the Environment's l
2. Unless otherwise specified, coefficients are derived from Paterson et al. (2006).
3. The model is calibrated to predict the whole lake ice-free mean total phosphorus c
4. Lakes that are smaller than 25 ha are not modeled, unless they have significant sl  
The surface and catchment area of lakes <25 ha without significant development are
5. For lakes that are located west of Thunder Bay, an atmospheric deposition value c  
This deposition value was determined for the Experimental Lakes Area (ELA).
6. Vacant lots of record refers to lots that are designated as residential, but have not  
The model assumes that these lots will eventually be developed into extended seaso  
Vacant lots of record are used when calculating future anthropogenic load.

**NOTE: As a demonstration of how to link upstream lakes to downstream lakes,  
THESE LINKS ARE AN EXAMPLE AND SHOULD BE DELETED IF NOT RELEVAN**

Lakeshore Capacity Model - Inputs															
Lake	Lat	Long	Runoff (m) from Database	Surface area, Ao (ha)	Catchment area, Ad (ha)	% Wetland	% Cleared	Years of spring TP sampling	No. of TP samples	Avg. Measured TPso (µg/L)	Anoxic?	Max Depth (m)	Mean Depth (m)	Trout Lake? (y/n)	Hydrologic Flow
Benoir Lake	45° 10' 3.97"	78° 08' 24.67"	0.438	92.3	37,270	6.1	1.0	1	1	15.00	n	18,288	5.6	n	Flows into Elephant Lake
Elephant Lake	45° 09' 30.99"	78° 05' 22.96"	0.440	884.6	46,937	6.7	1.0	8	18	14.36	n	7,0104	1.8288	n	TARGET

Anthro Inputs Using Extended Seasonal Cottages

Lakeshore Capacity Model - Anthropogenic Inputs												
Lake	Lat	Long	Permanent	Extended Seasonal	Seasonal	Resort	Trailer Parks	Youth Camps	Campgrounds/ Tent tailers/ RV parks	Vacant Lots of Record	Other (e.g., agriculture, urbanization, golf course)	Comments
Benoir Lake	45° 10' 3.97"	78° 08' 24.67"	0	237	0	51	60	0	0	0		
Elephant Lake	45° 09' 30.99"	78° 05' 22.96"	0	114	38	0	15	0	0	20		
all grayed out lakes are not included in the analysis												

Lakeshore Capacity Model

Benoir Lake

Anthropogenic Supply			Sedimentation		
Shoreline Development Type	Number	Usage (capita years/yr)	Is the lake anoxic?	n	
Permanent	0	2.56	Settling velocity (v)	12.4	m/yr
Extended Seasonal	237	1.27	In lake retention (Rp)	0.07	
Seasonal	0	0.69			
Resort	51	1.18			
Trailer Parks	60	0.69			
Youth Camps	0	0.125			
Campgrounds/Tent trailers/RV parks	0	0.37			
Vacant Lots of Record	0	1.27			
Retention by soil (Rs) (0-1)	0				
		kg/capita/yr			
Catchment			Upstream Lakes		
Lake Area (Ao)	92.3	ha			
Catchment Area (Ad)	37270.4	ha			
Wetland	6.1	%			
Cleared	1.0	%			
Hydrological Flow			Monitoring Data		
Mean annual runoff	0.438	m/yr	Years of spring TP data	1	
Lake outflow discharge (Q)	163648487	m3/yr	Average Measured TPso	15.00	µg/L
Areal water loading rate (qs)	177.36	m/yr	Measured vs. Predicted TPso	15.9	%
Inflow 1		m3/yr	Is the model applicable?	y	
Inflow 2		m3/yr	Over or under predicted?	over	
Inflow 3		m3/yr			
Natural Loading			Modeling Results		
Atmospheric Load	15.41	kg/yr	TPlake	16.69	µg/L
Runoff Load	2498.34	kg/yr	TPout	15.95	µg/L
			TPso	17.39	µg/L
			TPfuture	16.69	µg/L
Upstream Loading			Phosphorus Thresholds		
Background Upstream Load 1		kg/yr	TPbk	15.02	µg/L
Background Upstream Load 2		kg/yr	TPbk+40	21.02	µg/L
Background Upstream Load 3		kg/yr	TPbk+50	22.53	µg/L
Current Total Upstream Load 1		kg/yr	TPbk+60	24.03	µg/L
Current Total Upstream Load 2		kg/yr			
Current Total Upstream Load 3		kg/yr			
Future Upstream Load 1		kg/yr			
Future Upstream Load 2		kg/yr			
Future Upstream Load 3		kg/yr			
Anthropogenic Loading			No. of allowable residences to reach capacity:		
Current Anthropogenic Load	279.62	kg/yr	# Permanent OR	569	
Future Anthropogenic Load	279.62	kg/yr	# Extended seasonal OR	1130	
			# Seasonal cottages OR	2028	
Areal Load Rate			Loads		
Current Total Areal Loading Rate (L <sub>T</sub> )	3027.43	mg/m2/yr	Natural Load w/no developmer	2513.75	kg/yr
Future Total Areal Loading Rate (L <sub>FT</sub> )	3027.43	mg/m2/yr	Background + 50% Load	3770.62	kg/yr
			Current Load	2793.36	kg/yr
			Future Load	2793.36	kg/yr
			Outflow Loads		
			Background Outflow Load	2349.48	kg/yr
			Current Outflow Load	2610.83	kg/yr
			Future Outflow Load	2610.83	kg/yr

Lakeshore Capacity Model

Elephant Lake

Note: Lake 2 reflects upstream contributions from Lake 1

If this is not appropriate for your model, you must delete the contributions (in blue cells)

<b>Anthropogenic Supply</b>			<b>Sedimentation</b>	
Shoreline Development Type	Number	Usage (capita years/yr)	Is the lake anoxic?	n
Permanent	0	2.56	Settling velocity (v)	12.4 m/yr
Extended Seasonal	114	1.27	In lake retention (Rp)	0.23
Seasonal	38	0.69	<b>Monitoring Data</b>	
Resort	0	1.18	Years of spring TP data	8
Trailer Parks	15	0.69	Average Measured TPso	14.36 µg/L
Youth Camps	0	0.125	Measured vs. Predicted TPso	-2.8 %
Campgrounds/Tent trailers/RV parks	0	0.37	kg/capita/yr	
Vacant Lots of Record	20	1.27	Is the model applicable?	y
Retention by soil (Rs) (0-1)	0		Over or under predicted?	under
<b>Catchment</b>			<b>Modeling Results</b>	
			<b>Upstream Lakes</b>	
Lake Area (Ao)	884.6	ha	TPlake	13.29 µg/L
Catchment Area (Ad)	46936.6	ha	TPout	12.70 µg/L
Wetland	6.7	%	TPso	13.96 µg/L
Cleared	1.0	%	TPfuture	13.33 µg/L
<b>Hydrological Flow</b>			<b>Phosphorus Thresholds</b>	
Mean annual runoff	0.440	m/yr	TPbk	12.45 µg/L
Lake outflow discharge (Q)	374061955	m3/yr	TPbk+40	17.43 µg/L
Areal water loading rate (qs)	42.28	m/yr	TPbk+50	18.67 µg/L
Inflow 1	163648487	m3/yr	TPbk+60	19.92 µg/L
Inflow 2		m3/yr	*if TPbk+40% < TPlake < TPbk+60% cell is orange	
Inflow 3		m3/yr	*if TPlake > TPbk+60% cell is red	
<b>Natural Loading</b>			<b>No. of allowable residences to reach capacity:</b>	
Atmospheric Load	147.74	kg/yr	# Permanent OR	1441
Runoff Load	3260.27	kg/yr	# Extended seasonal OR	2860
			# Seasonal cottages OR	5133
<b>Upstream Loading</b>			<b>Loads</b>	
Background Upstream Load 1	2349.48	kg/yr	Natural Load w/no developmer	5757.49 kg/yr
Background Upstream Load 2		kg/yr	Background + 50% Load	8636.24 kg/yr
Background Upstream Load 3		kg/yr	Current Load	6145.21 kg/yr
Current Total Upstream Load 1	2610.83	kg/yr	Future Load	6162.77 kg/yr
Current Total Upstream Load 2		kg/yr	<b>Outflow Loads</b>	
Current Total Upstream Load 3		kg/yr	Background Outflow Load	4451.94 kg/yr
Future Upstream Load 1	2610.83	kg/yr	Current Outflow Load	4751.73 kg/yr
Future Upstream Load 2		kg/yr	Future Outflow Load	4765.32 kg/yr
Future Upstream Load 3		kg/yr		
<b>Anthropogenic Loading</b>				
Current Anthropogenic Load	126.37	kg/yr		
Future Anthropogenic Load	143.94	kg/yr		
<b>Areal Load Rate</b>				
Current Total Areal Loading Rate (L <sub>T</sub> )	694.65	mg/m2/yr		
Future Total Areal Loading Rate (L <sub>FT</sub> )	696.64	mg/m2/yr		

Lakeshore Capacity Model - Summary Results

Lake	Model Predictions (µg/L)									Measured TPso (µg/L)	Measured vs. Predicted TPso (%)	Model applicable?	Trout Lake? (y/n)	Comment	Over or under predicted?	TPfuture vs. TPbk+50%	Over capacity?	Available Capacity			Loads (kg/yr)			
	TP out	TP lake	TP so	TP future	TP bk	TP bk+40%	TP bk+50%	TP bk+60%	# Permanent OR									# Extended seasonal OR	# Seasonal cottages OR	Bk +50% P load	Current P load	Allowable P load	Future P load	
Benoir Lake	15.95	16.69	17.39	16.69	15.02	21.02	22.53	24.03	15.00	15.9	y	n		over	-5.84	n	569	1130	2028	3770.62	2793.36	977.26	2793.36	
Elephant Lake	12.70	13.29	13.96	13.33	12.45	17.43	18.67	19.92	14.36	-2.8	y	n		under	-5.35	n	1441	2860	5133	8636.24	6145.21	2491.03	6162.77	