4.0 Callander

4.1 Introduction & Summary of Findings

This Section includes analyses of vulnerability with respect to both water quantity and water quality for the surface water intake for the Municipality of Callander. General methodology for the water quality portion is described in Section 3.1 of this report. The information in this Section is based primarily on the Callander Drinking Water Source Protection Technical Studies Update, 2010, prepared by Hutchinson Environmental Services (HESL), and includes the following:

- intake characterization (including water treatment plant and raw water quality)
- intake protection zone (IPZ) delineations
- uncertainty analysis of IPZ delineations and vulnerability scores
- drinking water issues evaluation
- threat identification and assessment, and
- gap analysis and recommendations.

A technical advisory committee oversaw the technical aspects of the report; local knowledge was solicited from the community at large as well as the Callander Bay Watershed Advisory Committee on several occasions during the process. The findings were presented to the public and comments were received. Additional peer review was not conducted because the technical challenges posed by the assessment were considered well within the expertise of the consultant. The full technical report is available at www.actforcleanwater.ca directly from the North Bay-Mattawa Conservation Authority.

The water treatment plant for the Municipality of Callander is located on Part Lot 2, Concession 26 in the Municipality of Callander. Water is drawn from Callander Bay, a relatively isolated bay connected to the extreme east end of Lake Nipissing. The intake pipe is 400 mm in diameter and extends approximately 1,000 m from the shoreline (Fig. 4-1) where the intake is located at a depth of approximately 8 m.

A water budget and water quantity stress assessment is usually required to determine whether the water supply within a subwatershed is adequate to meet both the current and long-term demands of the municipality and other users. However where the source is a Great Lake or other very large water body which would provide a substantial source water supply, such an assessment is not needed. Because Callander draws its water from Lake Nipissing, a water budget was not required. (Rule 4)

Threats in the identified vulnerable areas were assessed utilizing the "threats approach" and it was determined there are no existing significant drinking water threats in the vulnerable area of the Callander drinking water intake.

The issues approach for identification of threats determined that microcystin, a toxin sometimes produced by some cyanobacteria (blue-green algae), is a drinking water issue for the Callander drinking water supply. Because phosphorus contributes to the production of cyanobacteria any activity that occurs in the Issue Contributing Area (Fig. 4-5) which can result in the input of phosphorus to Callander Bay is considered a significant threat regardless of the score of the vulnerable area in which it occurs.

Figure 4-1. Callander Intake on Callander Bay of Lake Nipissing

Lake Nipissing, the drinking water source for the Town of Callander, is the fourth largest lake in Ontario with a surface area of 874 km^2. Lake Nipissing is shallow, with water depths mostly less than 10 m and exceeding 20 m only near the outflow of the lake to the French River.

It supports a productive warm water fishery. Given the shallow nature of the lake and its 60 km length, the water column is easily mixed to the bottom by wind and wave action preventing thermal stratification in all but a very small portion of the Lake. Water levels are controlled by three dams near the headwaters of the French River, which are used to gradually lower lake levels over the winter by approximately 1.3 m to accommodate spring runoff. The watershed area for the lake is large (12,047 km^2) with drainage from 26 quaternary watersheds. However, only a small portion, 300 km^2 (2.5% of that area), contributes to Callander Bay including all of the Wistiwasing (Wasi) River watershed and portions of the LaVase River and Bear-Boileau Creeks watersheds.

4.2 Water Budget and Water Quantity Stress Assessment

A water budget and water quantity stress assessment is usually required to determine whether the water supply in a subwatershed is adequate to meet both the current and long-term demands of the municipality and other users. However where the source is a Great Lake or other very large water body, such an assessment is not needed. Because Callander draws its water from Lake Nipissing, a water budget was not required. Technical Rule 4 states the following:

> An area represented by a conceptual water budget or water budget prepared in accordance with rule 3 shall not include any part of a surface water body that is a Great Lake, a connecting channel, Lake Simcoe, Lake Nipissing, Lake St. Clair or the Ottawa River.

4.3 Intake Characterization

Source Water

Like the main portion of the Lake, Callander Bay is shallow and generally the water column is easily mixed to the bottom by wind and wave action. However, weak stratification, which prevents mixing, sometimes occurs and oxygen concentrations in the lower portions of the water column subsequently drop. This happens because oxygen is consumed by the decomposition of organic matter.

This lack of oxygen (anoxia) in bottom waters has important implications for phosphorus cycling in Callander Bay. If periods of stratification are maintained for a sufficiently long period of time, there is a risk of complete oxygen depletion near the sediments. Phosphorus is normally bound to sediments under oxygenated conditions, but can be released into the water column under anoxic conditions. This process is called internal phosphorus loading. In lakes that maintain thermal stratification over the summer and only mix in late fall, phosphorus released by internal loading is confined to the deep cool dense layer of water (the hypolimnion) and remains mostly unavailable for uptake by algae until mixing of the water column in late fall. Callander Bay, however, mixes frequently over the summer months and so phosphorus in bottom waters from internal loading could be introduced into the surface waters at the height of the growing season, promoting aquatic plant growth.

General water chemistry surveys have been conducted for Callander Bay by the Ministry of the Environment (MOE) from 1988 to1990 and again from 2003 to 2004, and the results were compared to applicable Ontario Drinking Water Quality Standards, Objectives and Guidelines (O.Reg 169/03; MOE, 2006g). Water quality data were also available for the Wistiwasing (Wasi) River (2007) from MOE’s Provincial Water Quality Monitoring Network (PWQMN) database.

Based on available water quality surveys, the lake water is circumneutral (pH = 7.4), has low alkalinity (18.4 mg/L), and is ionically dilute with a conductivity of 82.5 µS/cm. Callander Bay has slightly greater ionic strength than most Shield lakes, and hence higher pH and alkalinity likely due to the slightly thicker soils and glacial deposits in the catchment, the large size of the catchment area, as well as the influence of abundant wetlands in the catchment. In addition, the bay supports large aquatic plant communities that would contribute to the relatively higher pH and alkalinity. All measured raw water parameters for Callander Bay are within applicable Ontario Drinking Water Standards, Objectives and Guidelines, but aluminum and iron concentrations exceeded the guidelines in the Wasi River, a primary tributary to Callander Bay, in 2007. Aluminum concentrations are further discussed in Section 4.6 as they relate to potential drinking water issues for source protection planning.

In terms of trophic state conditions, Callander Bay is highly productive, or 'eutrophic' as indicated by its nutrient rich conditions and high chlorophyll *a* concentrations. In most Shield lakes, phosphorus limits production of aquatic plants including algae. Mean total phosphorus concentration in Callander Bay during the ice-free season is 0.022 mg/L (1988-2008), which exceeds the Provincial Water Quality Objective of 0.020 mg/L for protection against nuisance aquatic plant growth, and likely contributes to the high algal production observed in the bay.

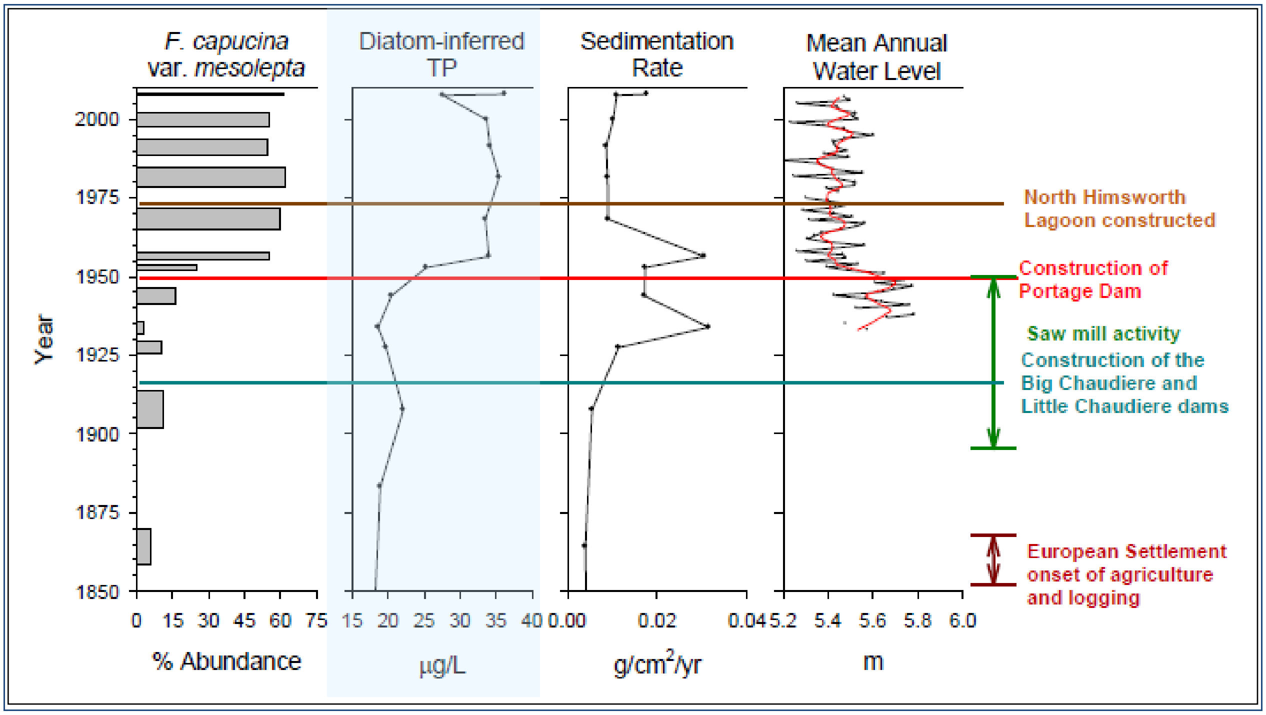
There are no apparent changes in total phosphorus concentrations in Callander Bay over the past 15-20 years, based on measured spring concentrations. Monitoring data prior to about 1990 may not be reliable due to analytical constraints, and therefore, long-term changes in phosphorus concentrations in Callander Bay prior to this time are uncertain based on measured data.

Due to the concern about algal productivity in Callander Bay, the NBMCA conducted a water quality survey in 2007 to characterize algal (i.e., phytoplankton) community composition and biomass over the open water season. As the summer progressed, the phytoplankton assemblages became strongly dominated by cyanobacteria, commonly known as blue-green algae, representing between 66% and 96% of the total algal biomass in Callander Bay.

To determine long-term changes in phosphorus concentrations in Callander Bay, a paleolimnological study was completed by AECOM for the NBMCA (AECOM, 2009). This study reconstructed historic total phosphorus concentrations by analyzing fossil diatom assemblages preserved in a dated sediment core from the bay. Diatoms are a unicellular group of algae with cell walls that are composed of silica and preserve well in the sediments. They are abundant in most freshwater environments and are excellent indicators of environmental conditions because they have well defined ecological preferences. Total phosphorus concentrations were reconstructed by applying a model developed from Ontario lakes to the fossil diatom assemblages in Callander Bay to give a reliable record of changes that have occurred over the past ~ 400 years.

Results from this study confirmed that total phosphorus concentrations have remained relatively stable in recent decades, but that a significant increase occurred coincident with construction of the Portage Dam in 1949-1950 at the westerly outlet of Lake Nipissing (Figure 4-2) (Hutchinson Environmental Sciences Ltd, 2010; and AECOM, 2009).

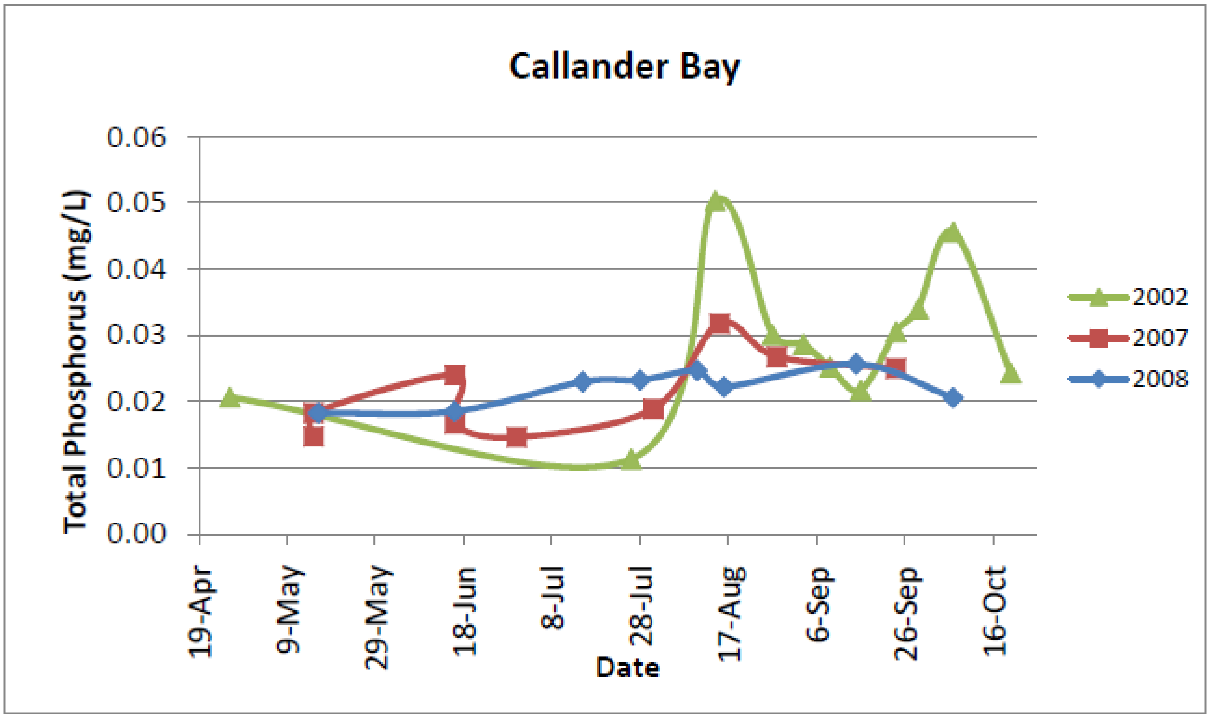
Figure 4-2. Paleoenvironmental Summary of Callander Bay (1850 to 2008)



Blasting of the channel and subsequent operation of the dam resulted in an overall decrease in water levels in Lake Nipissing, particularly during the spring melt period. The influence of this hydrological change may have resulted in a combination of physical changes to Callander Bay including an altered mixing regime, changes in flushing rates and mixing with waters in the main basin of Lake Nipissing, exposure of productive low lying areas, and expansion of the shallow littoral zone, all of which could contribute to increased phosphorus concentrations. While the exact mechanism of change cannot be determined without further study, it is apparent that phosphorous concentrations in Callander Bay were sensitive to this major hydrological change. Other factors related to post-war activities in the watershed may also have played a part in this significant ecological change in the state of Callander Bay at this time.

As previously reported by the MOE (Neary and Clark, 1992) total phosphorus concentrations in Callander Bay increase over the course of the growing season (Fig. 4-3) (Hutchinson Environmental Sciences Ltd., 2010).

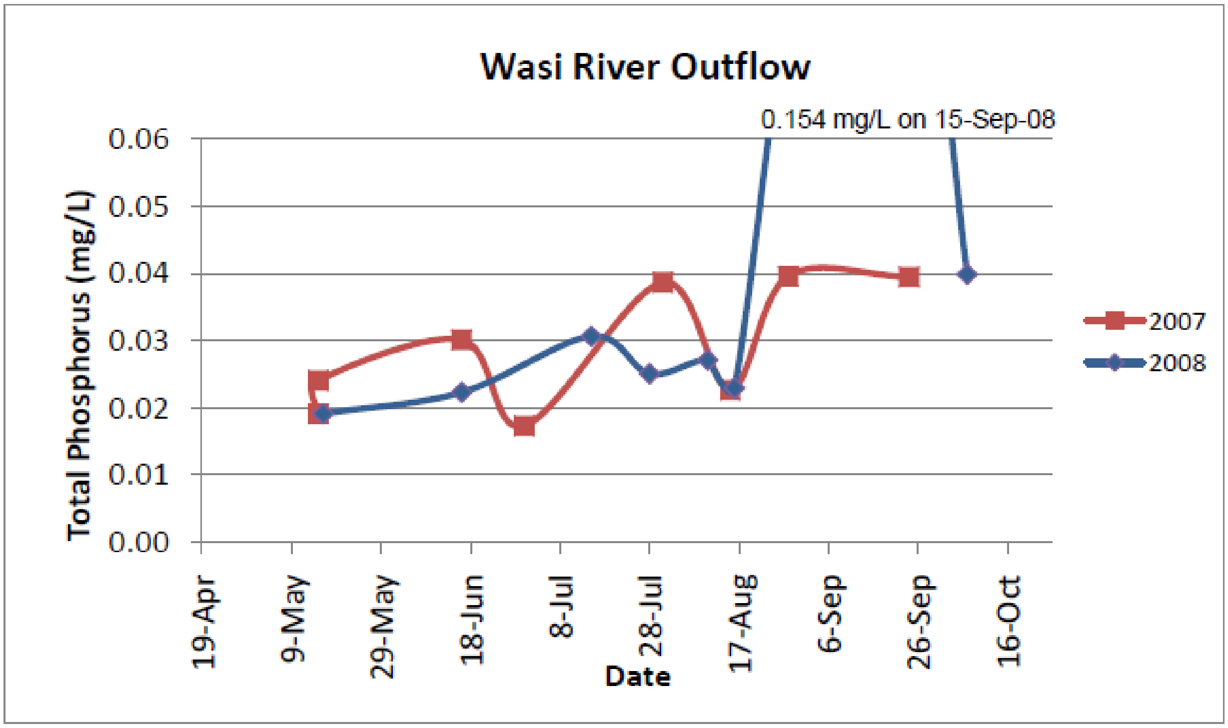
Figure 4-3. Total Phosphorus Concentrations in Callander Bay During Open Water Season



The MOE attributed increased phosphorus concentrations in the late fall (1988-1990) to decomposition of abundant aquatic plants. In addition to this mechanism, it is suggested that earlier increased phosphorus concentrations (i.e., in late summer) may result from internal phosphorus loading due to anoxia and/or sediment resuspension. Evidence from temperature and dissolved oxygen profiles suggests that Callander Bay is prone to oxygen depletion in bottom waters under conditions of sustained periods of stratification, which could lead to internal phosphorus loading from the sediments. Subsequent mixing of the water column would effectively introduce this phosphorus into the surface waters thereby increasing phosphorus concentrations during the open-water season. In addition, strong mixing events to the bottom of Callander Bay can promote sediment resuspension, which could also increase total phosphorus concentrations. Additional sampling of bottom water during periods of prolonged stratification would be required to confirm internal phosphorus loading in Callander Bay.

Phosphorus loads from the Wistiwasing (Wasi) River, the largest tributary to Callander Bay, may also contribute to the observed increase in phosphorus concentrations in Callander Bay over the ice-free season. Monitoring data collected by the NBMCA during 2007 and 2008 indicate phosphorus concentrations at the outlet of the Wasi River over the ice-free season are highly variable and increase to levels that exceed the Provincial Water Quality Objective (PWQO) of 0.030 mg/L for rivers (Fig. 4-4). Notably, total phosphorus concentrations reached 0.154 mg/L on September 15, 2008 following a rain event.

Figure 4-4. Total Phosphorus Concentrations at the Wasi River Outlet to Callander Bay during the Ice-Free Season



With respect to drinking water quality, there is no Ontario standard, objective or guideline for phosphorus because at the levels present in lake water, consumption of phosphorus poses no known human health risk. However, high algal productivity resulting from high phosphorus concentrations can impair the aesthetic quality of drinking water by reducing water clarity (increasing turbidity and colour) and by producing compounds that cause taste and odour problems (e.g., geosmin). In addition, certain types of blue-green algae (cyanobacteria) can produce toxins, notably microcystin, that are potentially harmful to human health.

In June 2009, Ministry of Environment confirmed a toxic bloom of cyanobacteria in the south end of Wasi Lake. In August 2009, MOE confirmed a toxic bloom of cyanobacteria in Callander Bay. In both instances, the North Bay Parry Sound District Health Unit was notified. The Health Unit posted signs warning the public with respect to appropriate precautions.

Sediment Characterization

There are no known studies that characterize sediment quality in Callander Bay. In several areas of Callander Bay, there is substantial accumulation of sawmill debris and, potentially, contaminants in the sediments from historic practices in the watershed as well as urban drainage including lagoon discharges. Due to the shallow nature of the bay and its susceptibility to complete mixing, sediments are easily resuspended, potentially releasing nutrients and contaminants into the water column and influencing water quality near the intake. The municipality now participates in the Drinking Water Surveillance Program whereby raw water will be analyzed on a regular basis for the presence of contaminants. There is direct evidence for sediment resuspension from a sediment core collected from near the centre of Callander Bay in August, 2007. The sediments were highly organic and flocculent in the top 5 cm of the core, and sediment particles were suspended in the water of the core tube above the sediment-water interface. The high algal productivity in the bay results in a high rate of accumulation of sediment.

Hydrology

There are six tributaries that drain to Callander Bay, including the Wistiwasing River, Burford Creek, three unnamed tributaries and Windsor Creek that drains part of the Bear-Boileau Creeks watershed. A hydrological study performed in October 1993 determined that the dominant flow in the Main Channel connecting Callander Bay to Lake Nipissing is toward the main basin of the lake (Northland Engineering Limited, 1993) (Table 4-1). These flows were observed to be greatest coincident with the lowering of Lake Nipissing water levels to accommodate spring runoff inputs, but also with a high wind event that occurred on October 21st. However, lowering of the lake level during the sampling interval of the study would be unlikely to cause the elevated flows because levels are lowered only by approximately 1 cm per month (beginning in October). It is more likely that the high wind event, potentially in combination with a seiche[5] on Lake Nipissing, caused the high flow. Frequent, but minor flow reversals into Callander Bay via the Main Channel appear to occur as a result of seiche events on the main basin of the lake (Northland Engineering Limited 1993). These findings indicate that there is only limited mixing of waters from the main basin of Lake Nipissing with waters in Callander Bay. This conclusion is also supported by water quality characteristics of the bay that are distinct from those of the main lake (Neary and Clark, 1992).

Table 4-1. Water Currents in Callander Bay, October 1993 (from Northland Engineering, 1993)

Parameter	Units	Main Channel	North Shore	East Shore
Latitude	N	46° 12’ 04”	46° 13’ 34”	46° 13’ 05”
Longitude	W	79° 25’ 00”	79° 23’ 18”	79° 22’ 17”
Resultant Current	cm/s	0.92	0.53	0.30
Resultant Current Direction	° from Magnetic North	276	337	221
Mean Current Speed	cm/s	2.52	2.35	2.02
Maximum Current	cm/s	20.0	15.4	14.9
Minimum Current	cm/s	1.5	0.5	1.1

Based on the observed currents in 1993 in Callander Bay (Table 4-1), the minimum time for water to move 1 km is approximately 1.4 to 1.9 hours at maximum current speeds and 11.0 to 13.8 hours at mean current speeds, respectively (assuming constant speed and direction). Delineation of Intake Protection Zone 2 (IPZ-2) must encompass a minimum two hour travel time for contaminants to reach the intake (see Section 3.1). As the current speeds observed in the main channel of Callander Bay reflect channelized flow from Callander Bay to the main basin of Lake Nipissing, the maximum current speeds observed at the North Shore more appropriately depict maximum speeds that would be generated within Callander Bay and are therefore more appropriate for calculating time-of-travel for the purposes of the IPZ-2

[5] A seiche is a long standing wave that affects the motion of the entire water mass of a lake. Seiches are most commonly created by wind-induced tilting of the water surface. Wind pushes water to one end of the lake and as the wind stress is removed, the tilted water surface flows back. Once established, these waves have great momentum and continue to rock back and forth.

delineation. At the maximum current speed observed along the North Shore of Callander Bay of 0.154 m/s, water would travel 1.11 km in two hours.

Wind can affect wave patterns and currents on lakes, which in turn can influence water quality conditions and the movement of contaminants. Dominant winds in the Lake Nipissing region are from the southwest throughout most of the year with north winds prevailing in winter and early spring (February to April) based on meteorological data from the North Bay Airport (Table 4-2). Mean wind speeds are 13 km/h with maximum hourly speeds ranging from 51 to 72 km/h between 1971 and 2000. The maximum wind speed observed in October 1993 during the Callander Bay hydrological study (Northland Engineering, 1993) was 54 km/h, which is within the range of the 1971-2000 maximum hourly speeds. This suggests that the current speeds observed in the Northland Engineering (1993) study reflect the current speeds that can occur under maximum wind conditions in Callander Bay.

There are no known hydrological studies related to wind and wave action for the main basin of Lake Nipissing. Given the long fetch[6] of the lake across an east-west axis and dominant winds from the southwest, seiche events are likely common in the main basin of the lake. This supports the observations of Northland Engineering for frequent flow reversals in the Main Channel that direct flow from the main lake basin into Callander Bay (Northland Engineering, 1993).

Table 4-2. Wind Pattern Normals (1971-2000) at the North Bay Airport (WMO Station 71731), Environment Canada

	Speed	Most Frequent Direction	Max. Hourly Speed	Max. Gust Speed	Direction of Max. Gust	Days with Winds >= 52 km/h	Days with Winds >= 63 km/h
	km/h		km/h	km/h			
Jan	13.6	SW	58	100	S	0.7	0.1
Feb	13.6	N	64	90	NE	0.4	0
Mar	14.8	N	**72**	89	E	0.7	0.2
Apr	14.8	N	59	97	SW	0.5	0.2
May	13.5	SW	64	93	W	0.3	0.1
Jun	12.2	SW	64	**115**	SW	0.1	0
Jul	11.5	SW	56	82	NW	0.3	0.1
Aug	10.7	SW	56	91	S	0	0
Sep	11.8	SW	51	89	S	0	0
Oct	13.1	SW	70	96	S	0.4	0.1
Nov	13.9	W	68	96	SW	0.5	0.2
Dec	13.2	E	59	85	SW	0.6	0.1
Year	13.1	SW			SW	4.6	1.1
Oct-93	13.8	SW	54				

In 1988 a study of bacterial concentrations in the lagoon effluent draining through the wetland into Callander Bay, fecal coliforms reached 70,000 counts per 100 mL (Lake 1988). The Northland Engineering report's analysis of circulation was used to determine maximum current

[6] Fetch distance over which wind can blow uninterrupted by land.

speeds in the bay and the potential two-hour travel distance of a contaminant near the intake. Findings also indicated that there is only limited mixing of waters from the main basin of Lake Nipissing with the waters in Callander Bay. This conclusion is consistent with the significant water quality differences observed between the main body and the bay. It should be noted however that flows may be affected by high wind events.

System Details

Treatment of raw water at the Callander Water Treatment Plant includes filtration, coagulation, sedimentation, and disinfection by chlorination. The gravity flow filters use granulated activated carbon to treat for taste and odour problems caused by algae in Callander Bay. Backwash from the wastewater is decanted to the storm sewer and sludge is pumped to the sanitary sewer. There is one elevated water storage tank (standpipe) with a capacity of 2,272 m^3, providing water reserves for approximately three days at maximum daily flow demands or six days at average demand. Based on available flow data from 2001 to 2007, water demand averaged 400 m^3/day with a maximum of approximately 844 m^3/day representing 28% of the rated capacity for the plant (3,000 m^3/day). Daily flows vary over the course of the year with the highest average demand occurring in the summer months. Average daily flow rates have been increasing since 2001. The response time to shut down the plant outside of hours it is normally staffed is between one and two hours.

4.4 Delineation and Scoring of Vulnerable Areas

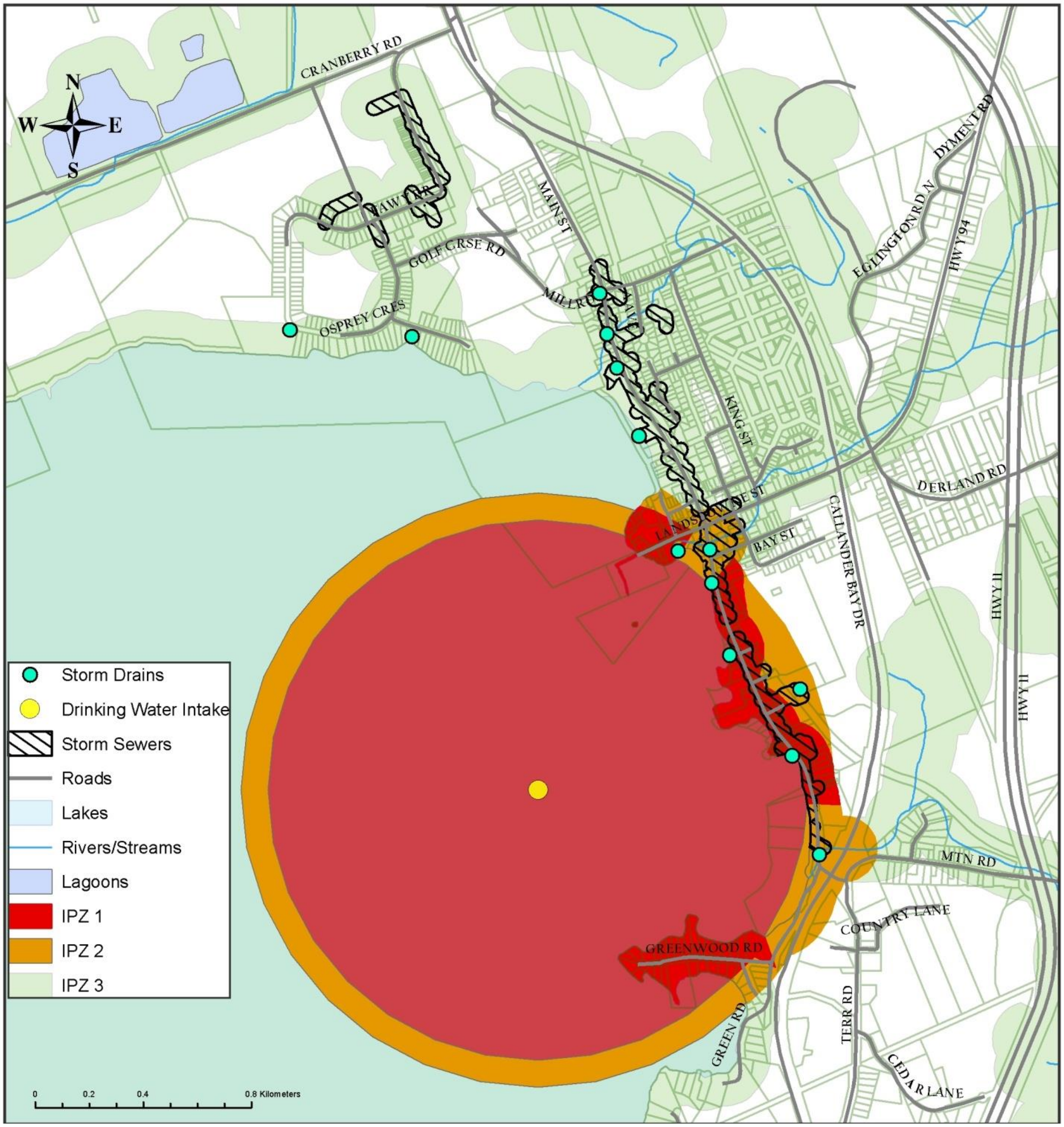
4.4.1 Defining the Vulnerable Areas (Intake Protection Zones)

The vulnerable area for the Callander drinking water intake includes three Intake Protection Zones (IPZs) following Part VI of the Technical Rules for a Type D intake. Of the three protection zones, Intake Protection Zone 1 (IPZ-1) is considered the most vulnerable to contamination. If a contaminant enters this zone, there may be little potential for dilution and limited time to respond before the contaminant reaches the intake. IPZ-1 was delineated as the surface area of Callander Bay within a 1 km radius centered on the drinking water intake in Callander Bay, and where this area abuts land, a maximum setback of 120 m inland from the high water table (Figure 4.5).

Intake Protection Zone 2 (IPZ-2) is the secondary protection zone. If a spill or other event were to occur in the IPZ-2 that may impair water quality at the intake, the plant operator should have sufficient time to respond. IPZ-2 did not include land or water that lies within IPZ-1 and was delineated using the following criteria:

- the surface area of Callander Bay within 1.11 km of the drinking water intake, which represents a two-hour time of travel to the intake based on research presented in the Northland Engineering Study (1993) as summarized in the Hydrology section above, and
- where this area abuts land, a maximum setback of 120 m along the abutted land measured from the high water mark;
- the area of the stormwater system that discharges into Callander Bay within 1.11 km of the drinking water intake; and
- the surface area and associated 120 m land buffer of tributaries to Callander Bay that lie within 1.11 km of the drinking water the intake and extending upstream along the tributaries to encompass a two-hour time of travel.

Figure 4-5. Callander Intake Protection Zone 1 and 2.



The Northland Engineering Study (1993), cited above, measured current speed and direction at various locations within the bay. The maximum current speed of 0.154 m/s along the North Shore was judged to be most representative of maximum current speed within the bay. This corresponds to a travel distance of 1.11 km in the required two-hour target response period.

IPZ-2 is extended to include any storm sewersheds which drain within the IPZ-2 (Figure 4-5). To identify the area of storm sewer contribution, sewer and sewershed mapping was obtained from the Muncipality.The area of the stormwater sewershed draining to Callander Bay that lies within 1.11 km of the intake was included to approximate a two hour time-of-travel to the intake in accordance with Rule 65(2). Time-of-travel in the sewershed is unknown, but is likely to be slower than that which occurs due to wind driven surface currents in Callander Bay. The 1.11km distance to the intake is therefore a conservative estimate to approximate the necessary distance to encompass a two-hour time-of-travel to the intake from the sewershed area. Further evaluation would be required to determine the exact area of the sewershed within the residual time of travel that may contribute water to the intake.

The IPZ-2 is also extended 205 m upstream of Burford Creek and 130 m upstream of Creek 323 to encompass a two-hour time-of-travel to the intake. This extension of the IPZ-2 is considered to be very conservative as the Wistiwasing River is a larger river with substantially greater flow velocities than that which would be observed in the smaller creeks. The IPZ-2 therefore may require modification in subsequent phases of Source Water Protection planning if measured velocities are obtained for Burford Creek and Creek 323 that differ from those found in Wistiwasing River.

We note, however, that the creeks discharge to Callander Bay at some distance to the intake, requiring that the IPZ-2 only be extended to include a time-of-travel of 4 and 6.8 minutes for Creek 323 and Burford Creek, respectively. Use of measured flow velocities for these creeks would result in minimal change to the delineation of less than 205 m for Burford Creek and 130 m for Creek 323. This flow data was collected from these creeks over the 2009 ice-free season and could be used to assess the validity of the delineations. There is an on-going monitoring plan in place for the collection of flow data; however the 2009 data was not received until after the production of the technical report which formed the basis of this assessment.

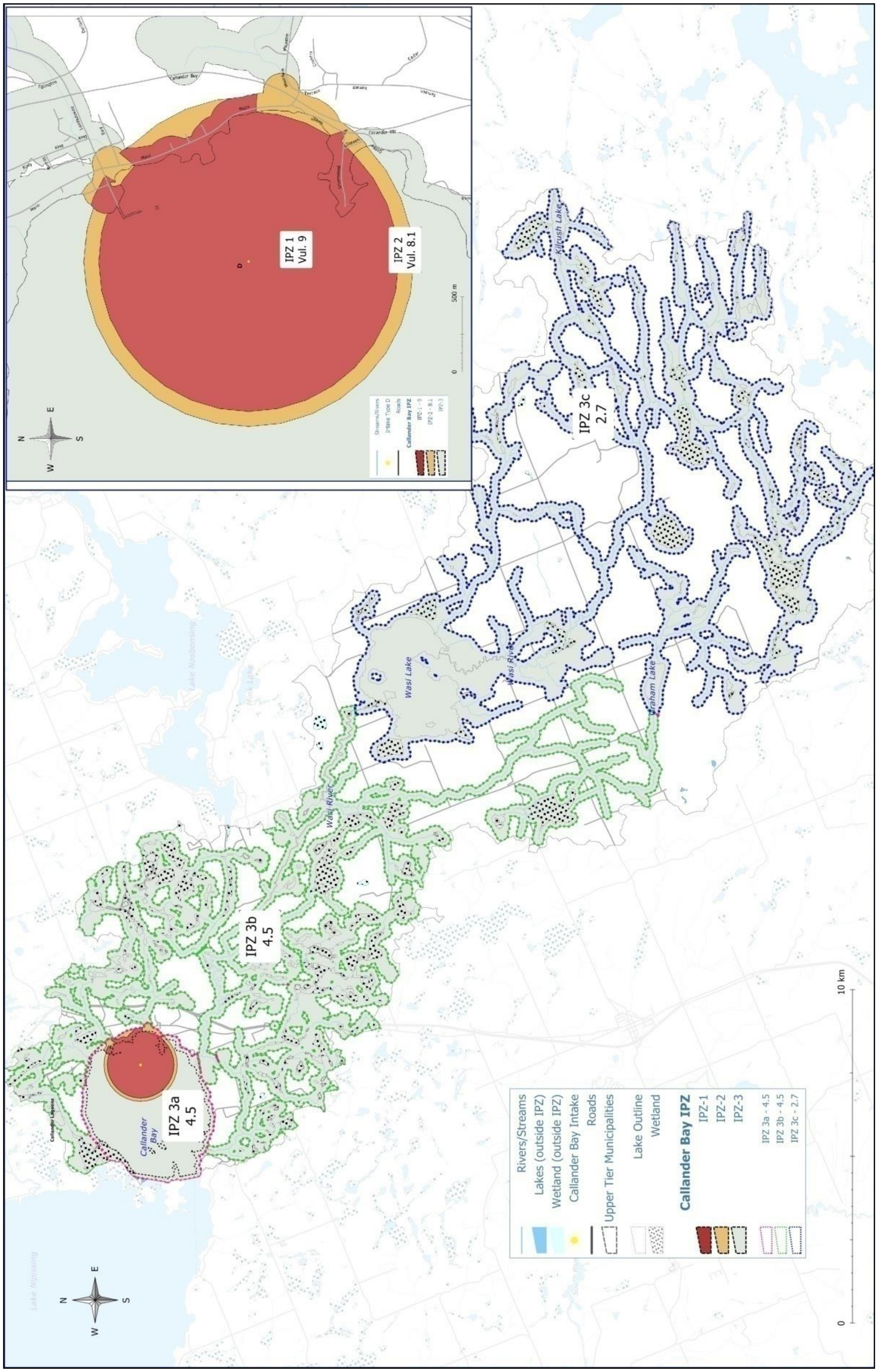
Intake Protection Zone 3 (IPZ-3) is intended to incorporate the area of each surface water body within the Source Protection Area for the Callander intake that could contribute water to the intake. Where these areas abut land, a 120 m setback is included. The IPZ-3 was extended to include the portion of the Callander sewer system that drains to Callander Bay outside of IPZ-2.

The Callander intake is classified as a Type D, inland water intake. As the Callander intake is located in Lake Nipissing, Rule 68 requires that IPZ-3 be delineated to include the area within each surface water body through which, modelling or other methods demonstrate that contaminants released during an extreme event may be transported to the intake. However, based on an analysis of available data regarding measured flows during extreme wind events, the configuration of Callander Bay and distinct differences in water quality between the bay and the main body of the lake, application was made to the Director under Rule 15.1 to permit the use of Rule 70 rather than Rule 68 for the delineation of IPZ-3. Following review by the Ministry of Environment and their concurrence that potential for contaminants in the main body of the lake to reach the intake during an extreme storm event was very low, approval was granted by the Director on July 28, 2010 and a copy of same is included in Appendix E to this Assessment Report.

For easy reference inserted below, Figure 4-5 depicts the vulnerable areas for the Callander intake and their scores. A larger format is included in Appendix A of this report.

Figure 4-6. Callander Intake Protection Zone 1, 2, and 3

Note: larger 11" x 17" version is available in Appendix A.



Transport pathways are natural or constructed drainage routes that have the potential to facilitate the movement of contaminants to the water intake. The Intake Protection Zones were surveyed to identify potential contaminant transport pathways. Several were identified and are described in the next Section.

4.4.2 Vulnerability Scoring

Vulnerability scores were used to assess the likelihood that a contaminant originating within the intake protection zones would reach the Callander intake. These scores were based on:

- the percentage of the area that is composed of land;
- land cover, soil type, permeability of the land, and the slope of setbacks;
- hydrological and hydrogeological conditions in the area that contribute water to transport pathways;
- depth of the intake from the surface;
- distance of the intake from land; and
- history of water quality concerns at the intake.

Vulnerability scores are calculated by multiplying the Source Vulnerability Factor by the Area Vulnerability Factor (Rule 87). Guidance for calculating these vulnerability factors is provided in Part VIII.2 and Part VIII.3 of the Technical Rules.

The Source Vulnerability Factor (SVF) is based on characteristics of the intake and ranges between 0.8 and 1.0. Scoring it considers the following:

- depth of the intake from the surface of the water (deeper scores lower)
- distance of the intake from land (further from land scores lower), and
- history of drinking water concerns relating to the intake (no history of concerns scores lower).

The Callander Bay intake is assigned a Source Vulnerability Factor of 0.9. The following characteristics contribute to the vulnerability of the source:

- the intake is relatively shallow (~8m deep) and the water of the bay mixes frequently over the open water season, thus allowing potential contaminants from surface waters to move to the depth of the intake, and
- there have been past instances of drinking water concerns related to the intake including seven drinking water issues identified under Rule 114.

The source vulnerability is moderated in Callander Bay because the intake is located relatively far from shore (the closest distance to land from the intake is ~0.7 km), and while drinking water issues exist, these are all primarily the result of natural causes. The vulnerability scores for all IPZ are outlined in Table 4-3.

Table 4-3. Vulnerability Scores (Vs) for the Callander Vulnerable Areas

Area	Source Vulnerability Factor	Area Vulnerability Factor	Vulnerability Score
IPZ-1	0.9	10	9.0
IPZ-2	0.9	9	8.1
IPZ-3a	0.9	5	4.5
IPZ-3b	0.9	5	4.5
IPZ-3c	0.9	3	2.7

Area Vulnerability Factors (AVF) were assigned to the IPZs in accordance with Technical Rules 88-93. The area vulnerability is a fixed value of 10 for the IPZ-1. For the IPZ-2 and IPZ-3, the area vulnerability factors consider the following aspects:

- the percentage of area that is composed of land, where a greater land area increases vulnerability;
- land cover, soil type, permeability of the land and the slope of any setbacks (attributes that reduce runoff reduce score);
- hydrological and hydrogeological conditions in the area that contribute water to the area through transport pathways (few transport pathways scores lower); and
- in respect of the IPZ-3, the proximity of the IPZ-3 area to the intake (increased distance scores lower).

The specific methodology for assigning area vulnerability factors for each of the surface water intakes is provided in section 3.1. For each of the subzones, the Area Vulnerability Factor was calculated as the sum of individual scores (0, 1 or 2) assigned for each of the four aspects listed above. This procedure weighted all factors equally. The maximum aspect score that could be generated is 6 for the IPZ-2 (three aspects times maximum score of 2) and 8 for the IPZ-3 subzones (four aspects times maximum score of 2). The aspect score was then pro-rated to determine the AVF for each zone.

The IPZ-2 was assigned an AVF of 9 (possible range of 7 to 9, see Table 4-4) based on the following:

- land area consists primarily of urban and residential lands with a relatively high percentage of cleared area and impermeable surfaces (69%) that create high potential for runoff;
- the setback areas along the southwest shore of Callander Bay have steep slopes, enhancing water movement toward the bay; and
- there are several transport pathways that drain urban and residential lands facilitating the transport of potential contaminants to Callander Bay. These include the Green Road transport pathway, two stormwater outfalls that drain areas of the stormwater system and two intermittent creeks that drain areas of the Municipal yard.

Rule 90 allows for different Area Vulnerability Factors (AVF) to be assigned to different subzones within the IPZ-3, but these values must be lower than those of the IPZ-2, and so must range between 1 and 8 for this intake. The IPZ-3 was initially subdivided into 6 subzones IPZ3a-f based on differences in physical characteristics of each area including distance to the intake. Once the calculation of vulnerability scores revealed identical scores for subzones b, c, d and e, the latter were consolidated into subzone IPZ-3b for this report. The breakdown of the scoring is provided in Table 4-4 and the rationale for the scoring follows.

Table 4-4. Callander Bay IPZ-2 and 3 Area Vulnerability Factors

Aspect	IPZ-2	IPZ-3a	IPZ-3b	IPZ-3c
% land area	1	0	1	1
Land cover, soils, permeability, slope of setbacks	2	1	0	0
Transport pathways	2	2	2	1
Proximity to the intake	NA	2	1	0
Total Aspect Score	5/6 = 83%	5/8 = 63%	4/8 =50%	2/8 = 25%
Possible AVF range	7 to 9	1 to 8	1 to 8	1 to 8
Area Vulnerability Factor (AVF) calculated as: %Aspect score x difference between maximum and minimum AVF range + minimum possible AVF) score)	9 (83% x 2 + 7)	5 (63% x 7 + 1)	5 (50% x 7 + 1)	3 (25% x 7 + 1)

Subzone IPZ-3a includes the surface area of Callander Bay and the associated 120 m setbacks on land. The AVF for this subzone was calculated at five. The area is comprised primarily of water, reducing vulnerability. There are numerous transport pathways draining land areas (stormwater outlets, stormwater pond drainage, the inlet of the lagoon discharge channel) and the area lies in close proximity to the intake. Both of these characteristics increase the vulnerability of the area. Land cover of the setback area is variable with some cleared areas with low density residential/cottage development, moderate amounts of impermeable surface area where roads are present, and some greatly sloping areas, particularly along the east shoreline south of the low lift station pump house. Therefore this factor was assessed at 1 out of a possible range of 0 to 2.

Subzone IPZ-3b was assigned an AVF of 5. While this area comprises more land, and that increases vulnerability, it is considered less vulnerable than the IPZ-3a subzone, as the setbacks on land have less impermeable surfaces (<2%) and cleared area, and the subzones are more distant from the intake.

Subzone IPZ-3c encompasses the surface area of Wasi Lake and upstream water bodies, and associated 120-m setbacks on land. This subzone was assigned a low Area Vulnerability Factor of three. As with IPZ-3b, IPZ-3c is comprised of nearly equal amounts of land and water. Land cover in the subzone is primarily natural (89% forest and wetland). There is little impermeable area in the subzone and slopes within the setback are low. Vulnerability of this zone is greatly reduced due to its distance from the intake. Transport pathways were not identified in this zone, but given the agricultural land use in the subzone, there are likely constructed pathways that could increase vulnerability.

The resulting vulnerability scores for the vulnerable area of the Callander intake are summarized in Table 4-3 and illustrated in Figure 4-6. A larger version of the latter is included in Appendix A. Potential locations for significant, moderate and low drinking water threats are presented in Table 4-6 of section 4.6.1. Low threats can occur in any area with a vulnerability score greater than 4; moderate threats can only occur in areas where the vulnerability score is 6 or greater; and significant threats can only occur in areas where the vulnerability is greater than or equal to 8. The vulnerable area scores are shown in Fig 4-6 (enlarged format in Appendix A).

4.4.3 Uncertainty Analysis

Part I.4 of the Technical Rules requires that an uncertainty rating of high or low be made with respect to the delineation of the surface water intake protection zones (Rule 13 (3)) and the assessment of vulnerability of the zones (Rule 13(4)) based on the consideration of factors set out in Rule 14, including:

- distribution, variability, quality and relevance of data used in the preparation of the assessment report,
- ability of the methods and models used to accurately reflect the flow processes in the hydrological system,
- quality assurance and quality control procedures applied,
- extent and level of calibration and validation achieved for models used or calculations or general assessments completed, and
- accuracy to which the Area Vulnerability Factor and the Source Vulnerability Factor effectively assesses the relative vulnerability of the hydrological features.

In general, the distribution, variability, quality and relevance of the data were adequate to confidently delineate the IPZs and assign vulnerability scores, resulting in an uncertainty rating of "low".

Geographical information available from the Ministry of Natural Resources provided the data necessary to identify water bodies and water courses to delineate watershed areas. This delineation was used to characterize setback areas for the vulnerability scoring. The position of the intake is accurate having been confirmed by divers.

A degree of uncertainty exists, for the delineation of the IPZ-2 due to the lack of a recent hydrodynamic model to estimate time-of-travel in Callander Bay and two creeks (Burford Creek and Creek 323). The vulnerability assessment that was used measured current information from a 1993 study and based time-of-travel calculations on maximum observed velocities in October of that year assuming constant current direction toward the intake. This method of calculating time-of-travel is conservative based on the available data, but is unable to provide confident time-of-travel estimates under storm conditions (such as a 20-year storm event). Despite this uncertainty, time-of-travel estimates derived using the 1993 data are consistent with time-of-travel estimates using general limnological principals for maximum surface water current speeds, lending confidence to the calculations for the Callander intake.

Additional uncertainty exists for the delineation of the IPZ-2 as there were no known available flow or modelling data to calculate flow velocities in Burford Creek or Creek 323 at the time of the study. The IPZ-2 was extended upstream of these creeks to capture a two-hour time-of-travel under the flow velocity for a 100-year flood event of 0.5 m/s. The flow velocity was based on the rate determined for the nearby Wistiwasing River in the Wasi River Management Study (A. J. Robinson and Associates, Inc., 1986).

A low level of uncertainty exists for the vulnerability scoring of the IPZ-3. Transport pathways were not identified by site investigations for this large area, but given the great distance of the IPZ-3 to the intake, the existence of transport pathways in this vulnerable area would not significantly influence the vulnerability scoring of this zone.

While there is some uncertainty in the IPZ-2 delineation and vulnerability scoring for IPZ-3, as described above, this uncertainty is considered to be low and additional data to reduce the uncertainty would not likely result in significant changes to the delineations or the vulnerability scores. In summary, an overall 'low' uncertainty is given to all of the IPZ delineations and the associated vulnerability scores.

4.5 Issues Identification

Drinking water issues, as defined in Part XI.1 of the Technical Rules relate to the presence of a 'listed parameter'[7] in water at the intake if:

- the parameter is present at a concentration that may result in the deterioration of the quality of the water for use as a source of drinking water; or
- there is an increasing trend of the parameter that would result in the deterioration of water quality for use as drinking water.

The analysis of raw water quality was based on:

- a single sampling date (March 28, 2001);
- available Monthly Process Reports for colour, turbidity, pH and iron (2000-2002, 2006-2007 (January to July);
- DWIS data for E. coli (2005, 2006) and total coliform (2003-2004).

Information pre-dating 2001 was obtained from the Engineers' Report for Water Works by RAL Engineering Limited (2001).

Based on a detailed assessment of raw and treated water quality records from the Callander Water Treatment Plant (WTP) and an evaluation of potential cyanotoxin production in Callander Bay, seven listed parameters were identified as drinking water issues as per Rule 114 under clause 15(2)(f) of the *Clean Water Act (2006)* in accordance with Rule 115 (Table 4-5). With the exception of *E. coli*, these are also considered as drinking water issues in respect of drinking water systems not mentioned in clause 15(2)(e) of the Act that draw water from Callander Bay (Rule 114 (3)).

Table 4-5. List of Drinking Water Issues for the Municipality of Callander Drinking Water Supply

Issue	Water Source
Turbidity	Treated and Raw
Aluminium	Raw
Colour	Raw
Organic Nitrogen	Raw
E. coli	Raw
Iron	Raw
Microcystin	Raw*

*(*based on documented bloom activity dominated by toxin producing cyanobacteria taxa)*

7 *Parameters listed in Schedule 1, 2 or 3 of the Ontario Drinking Water Quality Standards http://www.e-laws.gov.on.ca/html/regs/english/elaws_regs_030169_e.htm or Table 4 of the Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines http://www.ene.gov.on.ca/envision/techdocs/4449e.htm*

It should be noted that with the exception of turbidity, none of the listed drinking water issues exceeded applicable guidelines in treated water (note that microcystin has not been measured in treated water). This suggests that the water treatment plant has effectively treated these parameters at the concentrations at which they occur in raw water. There are presently insufficient long-term data, however, to assess whether there is an increasing trend in any of these parameters that may affect the ability of the plant to treat them. The determination of drinking water issues should consider treatment capabilities of the plant. In future years as these parameters continue to be monitored, if it is determined that there is no significant increase in concentrations that would affect treatment capability, then HESL recommends that the Source Protection Committee reassess these parameters as listed drinking water issues.

All of the drinking water issues with the exception of microcystin LR were considered to be primarily a result of natural causes. A further description of these issues under Rule 115 (identification of an issue contributing area and drinking water threats that contribute or may contribute to the issue) is not required as this rule only applies to drinking water issues that result or partially result from anthropogenic, not natural, causes.

Microcystin-producing cyanobacteria are likely naturally occurring in Callander Bay. However, anthropogenic sources of phosphorus to the bay are probably contributing to cyanobacterial production and the recent bloom activity (see Section 4.3). Identification of an issue contributing area and drinking water threats that contribute or may contribute to microcystin production are therefore required under Rule 115.

The Issue Contributing Area includes the entire vulnerable area of the Callander intake (IPZs) because activities, conditions that result from past activities, and naturally occurring conditions in this area may all contribute to the phosphorus concentration in Callander Bay. A detailed phosphorus budget was completed in 2011 to assess human sources of phosphorus in the Callander Bay watershed and to evaluate the appropriateness of the Issue Contributing Area for phosphorus. The phosphorus budget concluded that the Issue Contributing Area captures the primary sources of phosphorus to Callander Bay from human activities and recommended that the Issue Contributing Area remain as defined.

Drinking water threats that contribute or may contribute to phosphorus concentration in Callander Bay in accordance with Technical Rules 118, 119 and 126 are described in Section 4.6.2.

4.6 Threats Identification and Assessment

Threats are defined as those activities or conditions that could cause contamination of drinking water by a chemical or pathogen within one of the three Intake Protection Zones (IPZs). Activities must be assessed and reported whether or not they currently occur within the vulnerable areas. Ontario Regulation 287/07 Section 1.1 (1) under the *Clean Water Act (2006)* lists 19 activities (see Table 3-1) that may result in threats to drinking water quality. (Two additional prescribed activities pose threats to quantity.) Conditions, as defined by Part XI.3 of the Technical Rules, refer to past activities that have produced contaminants that may result in significant drinking water threats and include the presence of:

- a non-aqueous phase liquid in groundwater in a highly vulnerable aquifer, significant groundwater recharge area or wellhead protection area;
- a single mass of more than 100 L of one or more Dense Non-Aqueous Phase Liquids (DNAPLs) in surface water in a surface water IPZ;

- a contaminant in groundwater in a highly vulnerable aquifer, significant groundwater recharge area or wellhead protection area, if the contaminant is listed in, and its concentration exceeds, the potable groundwater standard in, Table 2 of the Soil, Ground Water and Sediment Standards;
- a contaminant in surface soil in a surface water IPZ if the contaminant is listed in, and its concentration exceeds the standard for industrial/commercial/community property in, Table 4 of the Soil, Ground Water and Sediment Standards; or
- a contaminant in sediment if the contaminant is listed in, and its concentration exceeds the standard in Table 1 of the Soil, Ground Water and Sediment Standards.

There are two major components to addressing drinking water threats to comply with the Technical Rules. These involve:

- the LISTING of activities that would be significant, moderate or low threats if they were conducted within the vulnerable areas, and
- the ENUMERATION of significant threats (activities or conditions) that presently exist in the vulnerable areas.

Further, it is required that areas be identified where activities and/or conditions are or would be significant, moderate or low threats. To interpret how the vulnerability of an area relates to the potential for threats, readers first must consult the map (Fig. 4-5) to determine the vulnerability score of the area of interest, and then check the table (Table 4-4) to see what levels of threats could occur based on that vulnerability score. Then, if more information is desired with respect to the specific nature of activities of concern and how they pose a threat, that can be found through the Tables of Circumstances.

4.6.1 Threats Approach

There were two approaches used to identifying threats; the *threats approach*, which is based on the vulnerability scores of the vulnerable areas and the *issues approach*, based on activities or conditions that contribute to existing drinking water issues listed under Rule 114. A third approach, the *events-based approach*, is based on modelling that demonstrates a chemical or pathogen release from an activity that could result in the deterioration of source drinking water. This approach was not used in the identification of threats.

Part XI.4 of the Technical Rules describe the methods for identifying significant, moderate and low drinking water threats related to activities in the vulnerable area of a drinking water intake.

A threat is deemed significant, moderate or low depending on:
1. the vulnerable area in which the activity occurs or would occur,
2. the vulnerability score of the vulnerable area
3. a set of prescribed activities and corresponding circumstances that constitute a threat

The Technical Rules require activities that would be a significant, moderate or low drinking water threat within the vulnerable areas to be listed in the Assessment Report, *regardless of whether or not the activities presently exist in the vulnerable area.*

Lists of significant, moderate and low drinking water threats related to chemicals and pathogens were compiled for each of the vulnerable areas of the Callander drinking water intake based on the MOE Tables of Drinking Water Threats.

Threats Approach - Potential Activities & Circumstances

Based on the resulting vulnerability scores the possible threat levels for (Table 4-4) were identified for each of the vulnerable areas shown in Figure 4-5. Due to the vulnerability scores within the IPZs, only IPZs-1 and 2 may contain potential significant chemical or pathogen threats. Other vulnerable areas score below the threshold of 8.

Table 4-6. Areas within Callander Intake Protection Zone where Activities are or would be Significant, Moderate and Low Drinking Water Threats

Threat Type	Vulnerable Area	Vulnerability Score	Threat Level Possible		
			Significant	Moderate	Low
Chemicals	IPZ-1	9	✓	✓	✓
	IPZ-2	8.1	✓	✓	✓
	IPZ-3a	4.5			✓
	IPZ-3b	4.5			✓
	IPZ-3c	2.7			
Pathogens	IPZ-1	9	✓	✓	✓
	IPZ-2	8.1	✓	✓	✓
	IPZ-3a	4.5			✓
	IPZ-3b	4.5			✓
	IPZ-3c	2.7			

The circumstances under which these threats may be considered as significant, moderate or low are referenced in the seventy-six MOE Provincial Tables of Circumstances. Table 4-7 lists the Tables of Circumstances relevant to each vulnerable area of the Callander drinking water intake.

The Provincial Table Codes listed within Table 4-7 (i.e. CIPZWE9S) refer to several of 76 tables and are titled using a combination of acronyms explained in the chart below. The Provincial Tables of Circumstances can be found at:
http://www.ene.gov.on.ca/environment/en/legislation/clean_water_act/STDPROD_081301.html

Once at the

Acronym	Definition
C	Chemical
P	Pathogen
W	Wellhead Protection Area
IPZ	Intake Protection Zone
IPZWE	IPZ and WHPA-E
(number)	Vulnerability score
S	Significant
M	Moderate
L	Low

For example: **CIPZWE9S** is a table of:

C **C**hemical Threats in an
IPZ **I**ntake **P**rotection **Z**one or
WE **W**ellhead Protection Area-**E** with a vulnerability score of
9 **9**, categorized as a
S **S**ignificant threat

Table 4-7. Summary of Tables of Circumstances Related to Threat Levels and Vulnerability Scores in the Vulnerable Area of the Callander Drinking Water Intake

Vulnerable Area	Vulnerability Score	Threat Level Possible		
		Significant	Moderate	Low
IPZ-1	9	CIPZWE9S PIPZWE9S	CIPZWE9M PIPZWE9M	CIPZWE9L PIPZWE9L
IPZ-2	8.1	CIPZWE8.1S PIPZWE8.1S	CIPZWE8.1M PIPZWE8.1M	CIPZWE8.1L PIPZWE8.1L
IPZ-3a	4.5	NA NA	NA NA	CIPZWE4.5L PIPZWE4.5L
IPZ-3b	4.5	NA NA	NA NA	CIPZWE4.5L PIPZWE4.5L
IPZ-3c	2.7	NA	NA	NA

Note: NA indicates that there are no threats of that level using the threats approach.

Threats Approach - Existing Significant, Moderate and Low Threats

Specific threats relating to drinking water within vulnerable areas for the Callander intake were identified primarily using a desktop research approach, which included review of data from the following sources of information:

- Occurrence Reporting Information System (ORIS)
- National Pollutant Release Inventory (NPRI)
- Technical Standards & Safety Authority (TSSA) (data provided by the Ministry of the Environment)
- Hazardous Waste Information System (HWIS)
- Federal Contaminated Sites Inventory (FCSI)
- Lands Information Ontario (LIO) (e.g., land cover, permeability)
- North Himsworth Waste Water Treatment annual reports
- Discussions with the Technical Advisory Committee

In addition, the presence of several threats was confirmed during field investigations (July, 2007; May 2008; February 2010) and by telephone inquiries to the Municipality of Callander and numerous local businesses.

Based on a review of the above information and several site investigations, numerous occurrences related to six prescribed drinking water threat activities were confirmed to exist in the vulnerable areas of the Callander drinking water intake (Table 4-8). [Drinking water threats as prescribed in Paragraphs 1 through 18 and paragraph 21 of subsection 1.1(1) of O.Reg. 287/07 (General)]

Each occurrence of an activity prescribed to be a drinking water threat was evaluated as significant, moderate or low based on the circumstances of that occurrence and using the MOE Tables of Drinking Water Threats.

Based on this evaluation and using the "threats approach" to identifying threats, there are no existing significant drinking water threats in the vulnerable area of the Callander drinking water intake.

There are, however, several occurrences of activities that have circumstances which cause them to be moderate or low threats, (Table 4-8). No significant, moderate or low threats presently exist in subzones IPZ-3a and IPZ-3c.

Table 4-8. Existing Moderate (M) and Low (L) Threats in the Vulnerable Area of the Callander Drinking Water Intake

Activity Prescribed To be a Threat	IPZ-1 Vs=9	IPZ-2 Vs=8.1	IPZ-3b Vs=4.5	Circumstance Reference #
establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	L	L		656
	L	L		657
	L			658
	L	L		660
	L	L		661
	L	L		662
	L	L		663
	L	L		664
	L	L		665
	L			666
	L	L		667
	L			668
	L	L		695
	L	L		696
	L	L		697
	L	L		698
	L	L		699
	L	L		700
	L	L		701
establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	M	L		702
	L	L		703
	M	L		704
	M	L		705
	M	L		706
handling and storage of a pesticide			L	73
application of road salt	M	M		92
	M	M		93
				90
				91
handling and storage of road salt		L		1435
		L		1436

Activity Prescribed To be a Threat	IPZ-1 Vs=9	IPZ-2 Vs=8.1	IPZ-3b Vs=4.5	Circumstance Reference #
handling and storage of fuel		L (2)		1364
		L (2)		1365
		L (2)		1366
		L (2)		1367
		L (2)		1368
		L (2)		152
		L (2)		153
		L (2)		154
		L (2)		155
		L (2)		156
	M (4)	L (2)		1349
	L (4)	L (2)		1350
	L (4)	L (2)		1351
	L (4)	L (2)		1352
	L (4)	L (2)		1353
	M (4)	L (2)		152
	L (4)	L (2)		153
	L (4)	L (2)		154
	L (4)	L (2)		155
	L (4)	L (2)		156
establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage				1949
	M (67)	M (43)		1956
	M	M		1958
			L	1959

Notes: Circumstance Reference Numbers refer to those provided in Table 1 or Table 2 of the Tables of Drinking Water Threats. Vs refers to vulnerability score; numbers in brackets refer to the number of occurrences of the threat if greater than 1

All existing and potential significant drinking water threats will be required to be addressed with mandatory compliance policies in the source protection plan. As previously stated there are currently no significant drinking water threats for the Callander intake other than those related to the microcystin issue. Table 4-9 lists the distribution of activities that are or would be threats to drinking water based on the category of Prescribed Activity into which they fall.

Table 4-9. Enumeration of Circumstances under which Prescribed Activities are or would be Significant Threats in the Vulnerable Area of the Callander Drinking Water Intake

Activities Prescribed to be Drinking Water Threats	# of Significant Threat Circumstances	
	Chemical	Pathogen
The application of agricultural source material to land.	6	1
The application of commercial fertilizer to land.	6	
The application of non-agricultural source material to land.	6	1
The application of pesticide to land.	11	
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	172	5
The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act.	20	1
The handling and storage of non-agricultural source material.	6	1
The handling and storage of pesticide.	2	
The handling and storage of road salt.	2	
The management of runoff that contains chemicals used in the de-icing of aircraft.	2	
The storage of agricultural source material.	6	2
The storage of snow.	8	
The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard. O. Reg. 385/08, s. 3.	4	2
Number of circumstances under which the threat is or would be significant	**253**	**13**

4.6.2 Issues Approach to Threat Identification

In addition to the above noted threats related to activities, Rule 115 requires that threats be listed for those drinking water *issues* listed under Rule 114 that result from, or partially result from human activities (anthropogenic).

Microcystin is a toxin which is sometimes produced by certain species of cyanobacteria (blue-green algae) and is listed as a parameter in the Ontario Drinking Water Quality Standards. Therefore, if it occurs in excess of the maximum acceptable level, it constitutes a drinking water issue. The fact that there have been several recorded incidents of toxic cyanobacteria blooms in Callander Bay is adequate evidence of exceedances of microcystin. Phosphorus contributes to the production of cyanobacteria. Therefore, any activity that occurs in the Issue Contributing Area (Fig. 4-5) which can result in the input of phosphorus to Callander Bay is considered a threat. Moreover, these threats are automatically considered to be significant threats regardless of the vulnerability scores of the vulnerable areas.

The activities that could contribute phosphorus to Callander Bay, as well as the number of circumstances related to those activities that constitute a significant threat, are listed in Table 4-10. Details of circumstances are presented in Appendix F.

Table 4-10. Enumeration of Circumstances that Are or Would Be Significant Drinking Water Threats Related to Prescribed Activities that Contribute Phosphorus to Callander Bay

Activity (Related to Phosphorus Loading)	# of Significant Threat Circumstances
The application of agricultural source material to land.	9
The application of commercial fertilizer to land.	9
The application of non-agricultural source material to land.	9
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	27
The establishment, operation or maintenance of a waste disposal site.	7
The handling and storage of commercial fertilizer.	8
The handling and storage of non-agricultural source material.	12
The storage of agricultural source material.	12
The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard.	6
Total	99

Issues Approach - Activities & Circumstances

As listed in Table 4-11 below, there are presently occurrences of five activities (out of nine listed in Table 4-10) that are Prescribed Drinking Water Threats related to phosphorus in the Issue Contributing Area (equal to the vulnerable area of the Callander intake) for microcystin.

As anthropogenic sources of phosphorus contribute to cyanobacteria production and hence microcystin production, these threats are considered to be significant drinking water threats regardless of the vulnerability scores.

The existing significant threats related to phosphorus and the number of occurrences of those threats are listed in Table 4-11 and explained further in Table 4-12, while the locations of significant threats within Callander's Issue Contributing Area are provided in Figure 4-6. Note that in Table 4-11 the total number of occurrences is summarized based on the prescribed drinking water threat, while Table 4-12 separates the number of occurrences by threat subcategory.

Information on the existing septic systems within the Callander subwatershed was derived from an in-house database. This data was originally provided by MOE, and is used for the Sewage/Septic program as well as Drinking Water Source Protection at NBMCA.

Parcels with agricultural activity were determined through site investigations conducted during the summer of 2013. There was a great degree of uncertainty in the 2011 assessment, which usedMunicipal Property Information Corporation (MPAC) data. The available MPAC data at the time of the assessment was outdated and did not necessarily reflect current conditions of the area. As such, agricultural activities within the subwatershed were verified though site investigaions to better reflect current conditions.

Table 4-11. Enumeration of Significant Threats Related to Phosphorus and Contributing to the Issue, Microcystin

IPZ	Prescribed Drinking Water Threat	Number of Occurrences
IPZ-1	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	39
IPZ-2		4
IPZ-3a		68
IPZ-3b		295
IPZ-3c		189
IPZ-3	The application of agricultural source material to land.	44
	The application of commercial fertilizer to land.	16
	The storage of agricultural source material.	6
	The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard. O. Reg. 385/08, s. 3.	44

Table 4-12. Existing Significant Drinking Water Threats Related to Phosphorus and Contributing to the Drinking Water Issue, Microcystin

Prescribed Drinking Water Threat	Threat Subcategory	Quantity Circumstance	Chemical Circumstance	Ref #	# of Occurrences
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	Discharge of untreated stormwater from a stormwater retention pond	Where the drainage area is 1 to < 10 ha and the predominant land use is rural, agricultural, or low density residential.	A stormwater management facility designed to discharge stormwater to groundwater (through infiltration) or surface water	313	2 (IPZ-3a)
	Sewage treatment plant effluent discharges (includes lagoons)	Sewage Treatment Plants that discharge treated effluent >2,500 m^3/d or < 17,500 m^3/d on an annual average	A sewage treatment plant effluent discharge, and the discharge is not a bypass. Plant is subject to the OWRA and requires a CofA	853	1 (IPZ-3b)

Prescribed Drinking Water Threat	Threat Subcategory	Quantity Circumstance	Chemical Circumstance	Ref #	# of Occurrences
	Sanitary sewers and related pipes	Sanitary sewer with a conveyance of >1,000 - 10,000 m^3/d	All pipes that are moving human waste that are not part of plumbing (sanitary sewer trunks, mainlines, service connections)	667	2 (1 in IPZ-1, 1 in IPZ-2)
	Septic system	Septic system that is subject to the Building Code.	Sewage system that is defined in O.Reg. 350 under the Building Code Act (*on-site* septic system), except a holding tank, that may discharge to groundwater or surface water	699	589 (37 in IPZ-1, 3 in IPZ-2, 66 in IPZ-3a, 294 in IPZ-3b, 189 in IPZ-3c)
	Sewage holding tank	Septic System holding tank is subject to the OWRA	Sewage system (on site septic system) that requires or uses a holding tank as defined in O.Reg. 350 under the Building Code Act, that may discharge to groundwater or surface water	717	1 in IPZ-1
The application of agricultural source material to land.	Application of Agricultural Source Material (ASM) To Land	Dependent upon % managed land and NU/acre of managed land	Land application of agricultural source material	2 4 6 8 10 12 14 16 18	44 in IPZ-3
The application of commercial fertilizer to land.	Application Of Commercial Fertilizer To Land	Dependent upon % managed land and NU/acre of managed land	Commercial fertilizer is applied to land and may result in a release to groundwater or surface water	24 26 28 30 32 34 36	16 in IPZ-3

Prescribed Drinking Water Threat	Threat Subcategory	Quantity Circumstance	Chemical Circumstance	Ref #	# of Occurrences
The storage of agricultural source material.	Storage Of Agricultural Source Material (ASM)	Dependent upon the weight or volume of manure stored annually on a Farm Unit	Where agricultural source material is stored partially below grade in a structure that is a permanent nutrient storage facility as defined under the Nutrient Management Act (O.Reg 267)	1202 1204 1206 1208 1210 1212 1214 1216 1218 1220 1222 1224	6 possible in IPZ-3
The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard. O. Reg. 385/08, s. 3. The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard. O. Reg. 385/08, s. 3	Management Or Handling Of Agricultural Source Material - Agricultural Source Material (ASM) Generation (Grazing and pasturing)	Dependent upon NU/acre	The use of land as livestock grazing or pasturing land, where agricultural source material may be generated, and may result in a release to land or water	201 203 205	44 in IPZ-3

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Figure 4-7. Location of Significant Threats Related to Phosphorus and Contributing to the Issue, Microcystin in the Callander Issue Contributing Area

Note: larger 11" x 17" version is available in Appendix A.

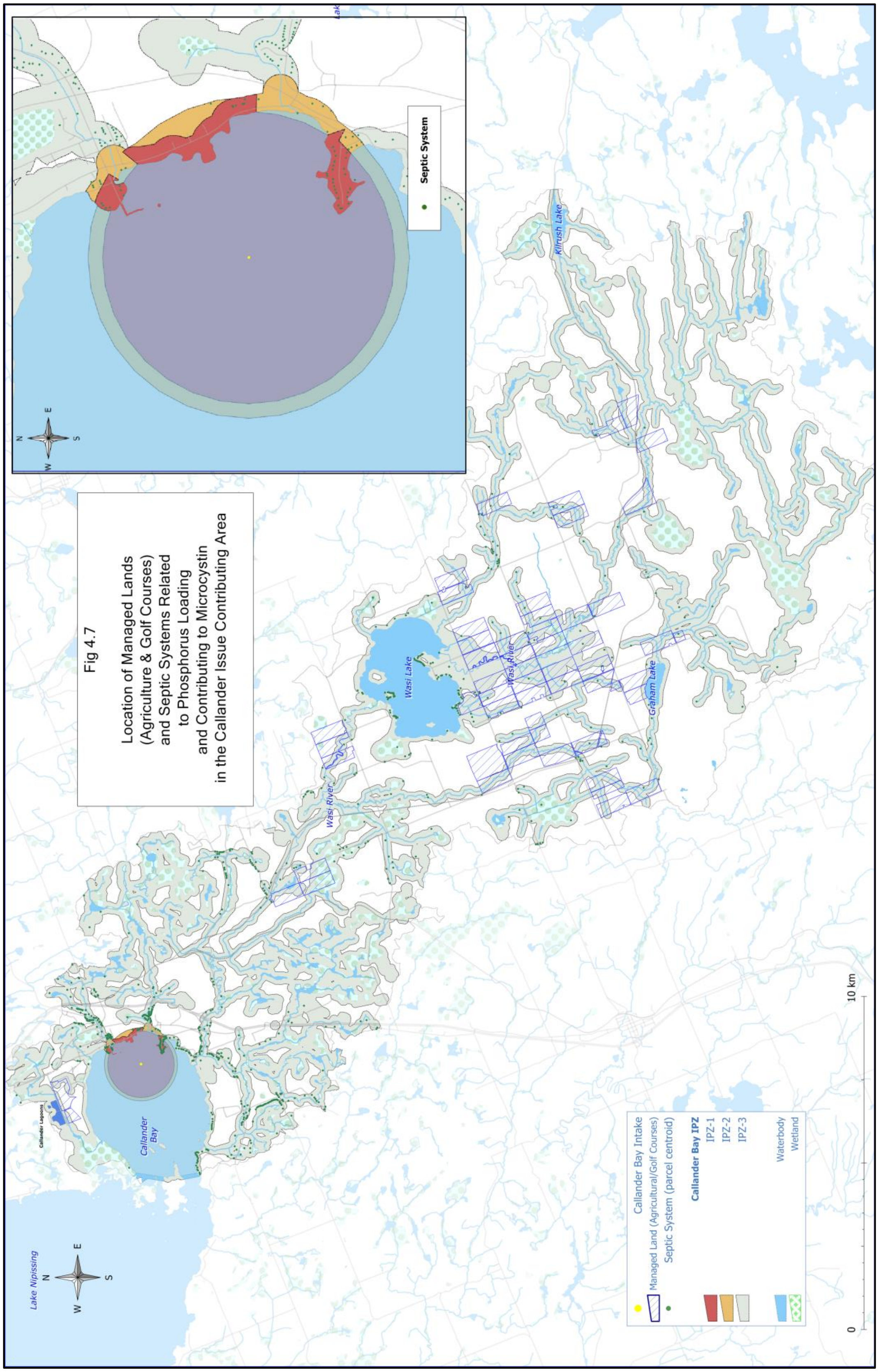

Fig 4.7

Location of Managed Lands (Agriculture & Golf Courses) and Septic Systems Related to Phosphorus Loading and Contributing to Microcystin in the Callander Issue Contributing Area

4.6.3 Conditions

There are presently no known conditions that exist in the vulnerable areas of the Callander intake.

Despite this, further evaluation of anthropogenic sources of phosphorus in sediments of Callander Bay is warranted as it relates phosphorus loading to the bay and its potential to contribute to microcystin-producing cyanobacteria. Phosphorus in lake sediments is not a listed parameter in Table 1 of the Soil, Ground Water and Sediments Standards and is therefore not considered a condition contributing to cyanobacteria biomass and the production of microcystin under the Technical Rules. As described in Section 4.3, however, phosphorus contained in sediments of Callander Bay may in fact contribute to internal phosphorus loading and this loading may represent a large portion of the total phosphorous load to the bay. If the results of a nutrient budget confirm that internal phosphorus loading is a significant component of the total phosphorus load to Callander Bay, then the Source Protection Committee should consider requesting that sediments in Callander Bay be classified as a condition under Rule 15.1.

4.6.4 Local Threat Considerations

The North Bay-Mattawa Source Protection Committee is concerned about the threat posed by the transportation of hazardous substances along a number of roadways within the Callander Intake Protection Zone which creates the potential for a spill to occur in the vulnerable area.

Although there is no prescribed threat activity related to the transportation of hazardous substances under the Clean Water Act, Technical Rule 119 allows Source Protection Committees to request that an activity be listed as a drinking water threat if:

1. The activity has been identified by the Source Protection Committee as an activity that may be a drinking water threat; and
2. The Director indicates that the chemical or pathogen hazard rating for the activity is greater than 4.

The Source Protection Committee submitted a formal request to the Ministry of Environment for the addition of transportation of hazardous substances as a non-prescribed (local) drinking water threat in the SP Area. This request was approved by the Director on February 8, 2011 (Appendix G). Included in the approval are the circumstances and hazard ratings for the activities considered.

Table 4.13 shows where significant, moderate and low threats relating to the transportation of hazardous substances are located in the Callander IPZs. There is one circumstance in which the threat is significant for the Callander intake. This occurs in IPZ-1 (Figure 4-5) and relates to a pathogen threat from the transportation of septage, for which a spill of any quantity may result in the presence of pathogens in surface water. No significant chemical threats relating to transportation exist for this intake.

Table 4-13. Areas within the Callander Intake Protection Zone where Transportation of Hazardous Substances is Considered a Significant, Moderate or Low Drinking Water Threat

Threat Type	Vulnerable Area	Vulnerability Score	Threat Level Possible		
			Significant	Moderate	Low
Chemicals	IPZ-1	9		✓	✓
	IPZ-2	8.1		✓	✓
Pathogens	IPZ-1	9	✓		
	IPZ-2	8.1		✓	
	IPZ-3a	4.5			✓
	IPZ-3b	4.5			✓

4.7 Recommendations and Work Plan

Primary information gaps that create uncertainty in the evaluation of drinking water issues and threats noted in this study include:

- Lack of sufficient long-term data to assess trends in parameters for the evaluation of drinking water issues.

The Municipality of Callander is now participating in the MOE's Drinking Water Surveillance Program (DWSP) and additional data collected under this program may be used, in time, to assess trends in parameters of concern. Once sufficient data become available, parameters that are presently listed as drinking water issues should be reassessed to determine if there is evidence of increasing trends that could affect the treatment capability of the plant. If not, the Source Protection Committee may consider their removal as drinking water issues.

- Redeliniation of the Intake Protection Zone 3 should be undertaken to only include those lands draining towards a surface water body or watercourse within 120 m

The Intake Protection Zone 3 includes all surface water bodies that may contribute water to the intake plus a setback of 120 m on land. Initial mapping did not consider slope and the direction of drainage. The land setback should only include land draining towards the adjacent surface water body. A reassessment of the Issue Contributing Area using a high resolution digital elevation model (which is now available) is required to better reflect conditions on the ground.