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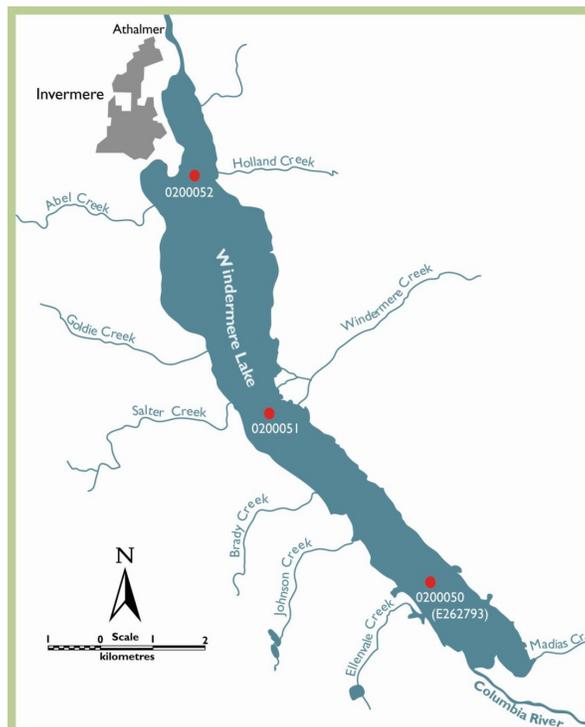
## Lake Windermere 2013 Water Quality Monitoring Results

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### Introduction

People living around and recreating on Lake Windermere depend on having water that is clean enough to swim in and recreate on, as well as to draw from as a drinking water source. Lake Windermere is home to sixteen species of fish and is used by several hundred species of resident and migratory birds: all of which depend on the water being in a good condition. From 2006 to 2009 the Lake Windermere Project worked to assess the quality of the lake's waters for wildlife and human recreational uses. In 2010, the Ministry of Environment took those five years of data, as well as historic data, and determined water quality "Objectives" for Lake Windermere. These Objectives now serve as a benchmark against which we can compare present conditions. They let us know if the lake is in good condition for recreation as well as for fish and wildlife. By continuing to test lake water quality every summer, the Lake Windermere Ambassadors are now adding to a baseline of seven years of water quality data. Their continued efforts will allow for detection of any changes in water quality.

In 2013, Lake Windermere Ambassadors' volunteers and staff sampled lake water at three locations monitored historically by the Ministry of Environment and then by the Lake Windermere Project. The sites cover the North and South end and center (Mid) of the lake.



Red Dots = Sampling Sites: North Station, Mid Station, South Station

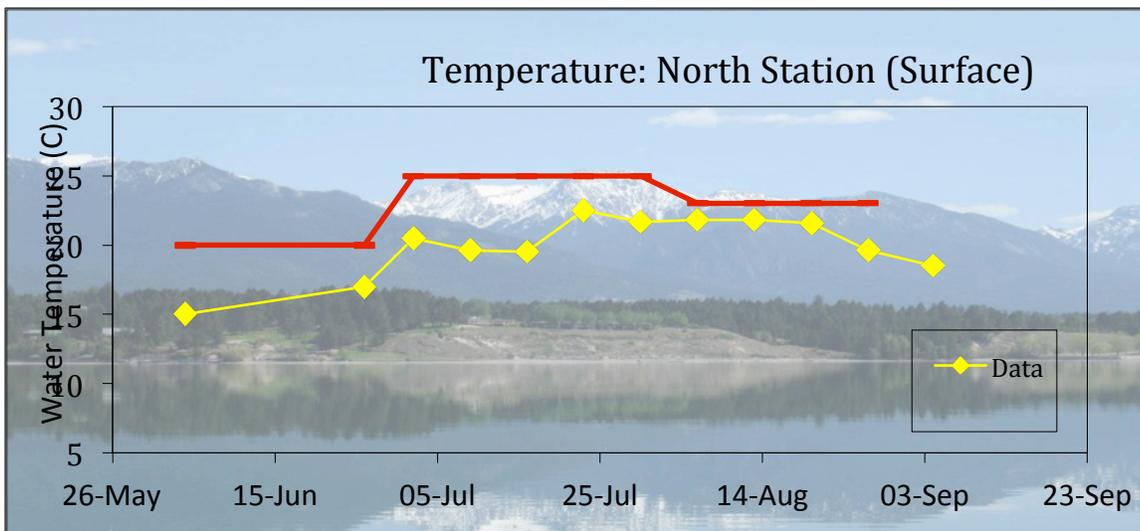
# Temperature

## Overview

Water temperature is important to the quality of drinking water and is of critical importance to aquatic life. Lower temperatures are generally more desirable for both uses. The Ministry of Environment determined how warm the lake can get during the summer before problems start to occur – those temperatures are the Water Quality Objectives for temperature.

## Results

The lake was relatively cool in the summer of 2013. Temperature at all three water monitoring stations was below the maximum recommended temperature, and therefore the lake met Water Quality Objectives for temperature.



Example of water temperature data, 2013. Yellow dots are samples taken – the yellow line is added to improve interpretation and does not represent continuous data. Red lines are Objectives, by month.

# Dissolved Oxygen



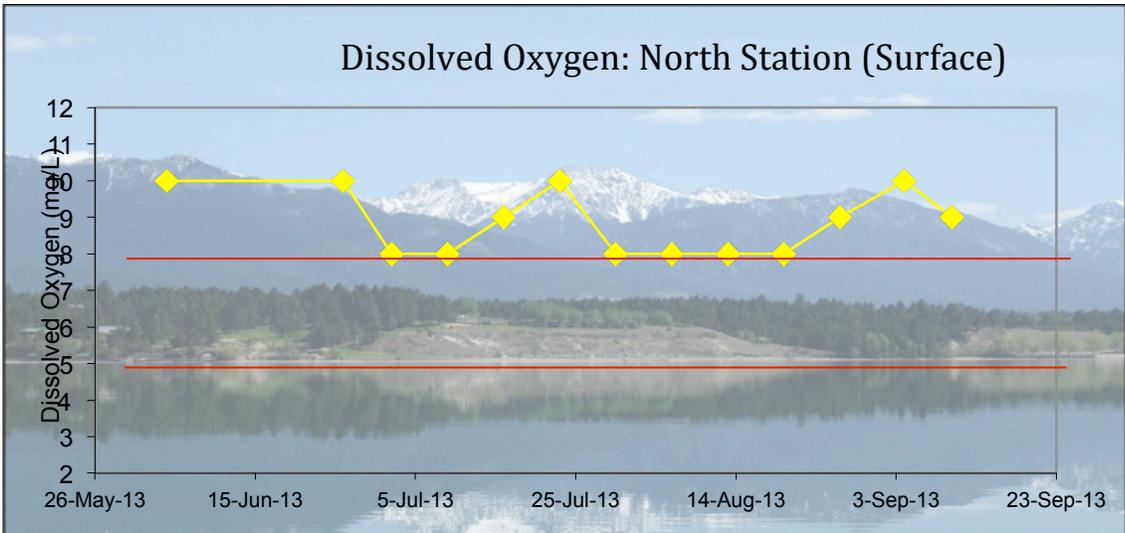
## Overview

Dissolved oxygen is a measure of the amount of oxygen dissolved in water. Fish and other aquatic life need oxygen. The Ministry of Environment determined levels of oxygen necessary to protect aquatic life in Lake Windermere (Water Quality Objectives).

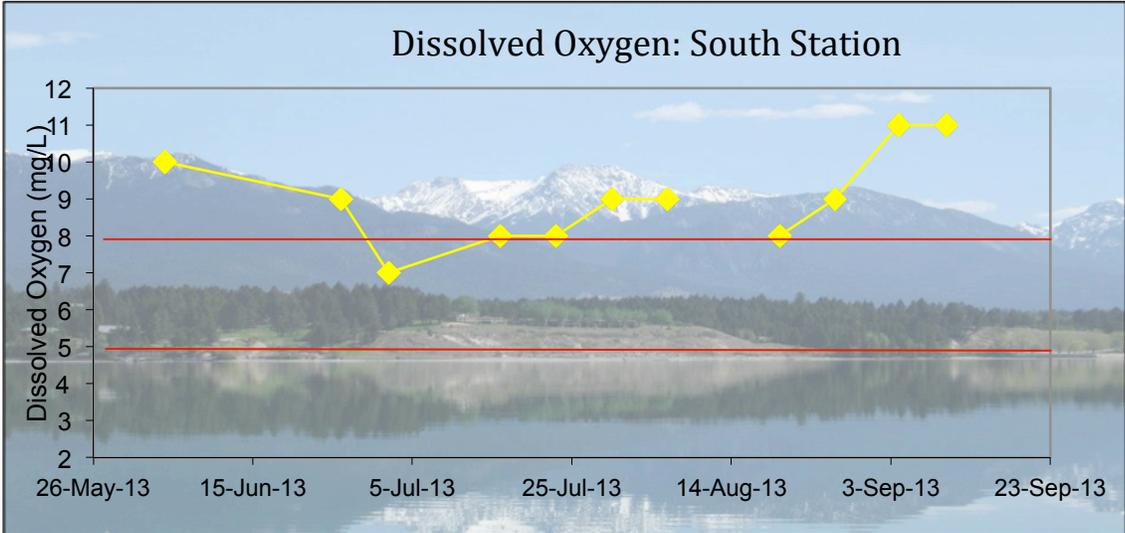
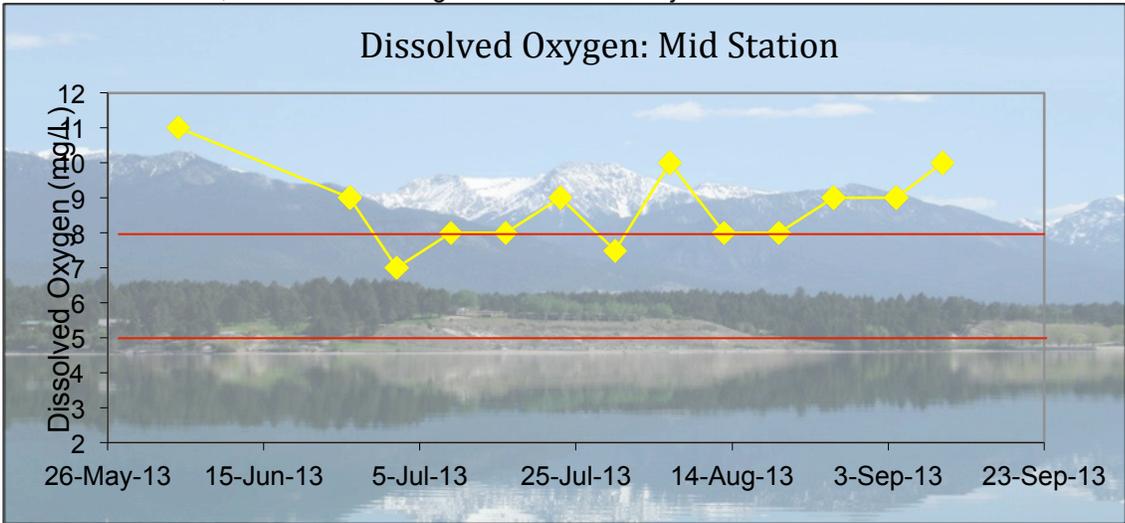
*How much oxygen is enough?* The Ministry of Environment determined that oxygen should never drop to or below 5 milligrams per liter (instantaneous minimum), and the average of five samples taken over 30 days should be at or above 8 milligrams per liter (mg/L) to support aquatic life.

## Results

Oxygen levels were always sufficient for aquatic life during the 2013 sampling season.



Yellow dots = data; red lines = average and minimum Objectives



Although daily DO levels dipped below 8 mg/L at the Windermere and South Station on some days, the 30-day mean was always sufficient to meet the Objective for aquatic life.

# Turbidity

## Overview

Turbidity is a measure of the light scattered by particles suspended in water, and indicates the cloudiness or clarity of the water. When waters are highly turbid, light cannot penetrate to reach aquatic plants- which reduces photosynthesis, and fish become stressed. Since aquatic life in Lake Windermere have adapted to seasonal flushes of sediment into the lake, how much turbidity should be in the water (Water Quality Objective) depends on time of year.



The Objectives for Lake Windermere for turbidity are set to protect recreational water quality and aquatic life. During spring runoff (May 1 – August 15), in what is known as “turbid flow”, the 95<sup>th</sup> percentile of turbidity measurements taken in five days over a 30-day period should not exceed 5 NTU (turbidity units). During “clear flow” (August 16 – April 30), the maximum turbidity at any time should be less than or equal to 5 NTU. Additionally, the objectives for “clear flow” state that the average of 5 samples over 30 days should not exceed 1 NTU.

## Results

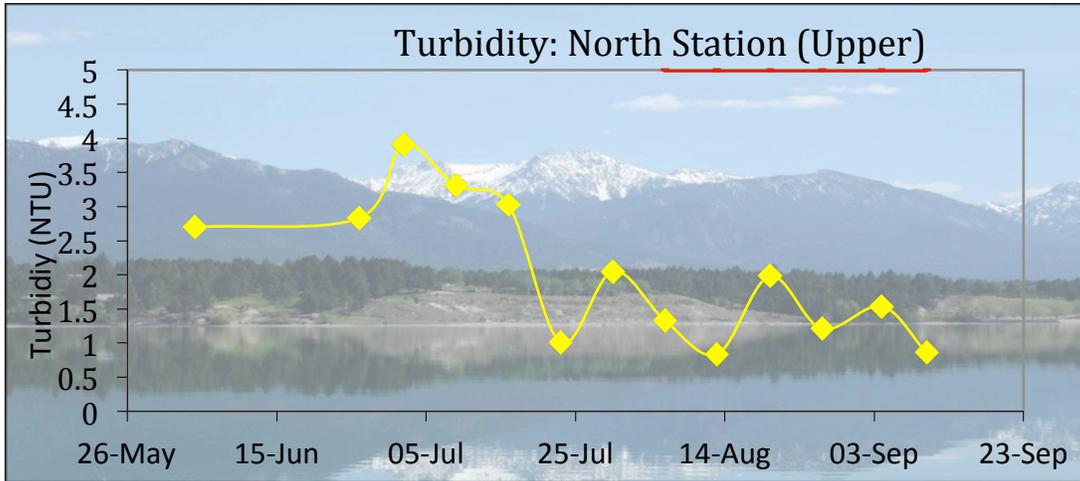
Turbidity levels in the lake in 2013 were anomalously high as they were in 2012 (the picture above is from July, 2012). These high turbidity levels in both years were not seen in the Lake Windermere Project data from 2006 onwards and they were reported as exceptionally high by local residents.

The graphs below show record high turbidity during sampling events on June 26<sup>th</sup> and July 2<sup>nd</sup>. These levels followed heavy rain storms which led to sediment transport on June 21 and 22, 2013. The same weather event that led to these turbidity levels caused serious flooding in Calgary and road washouts throughout the East Kootenays.

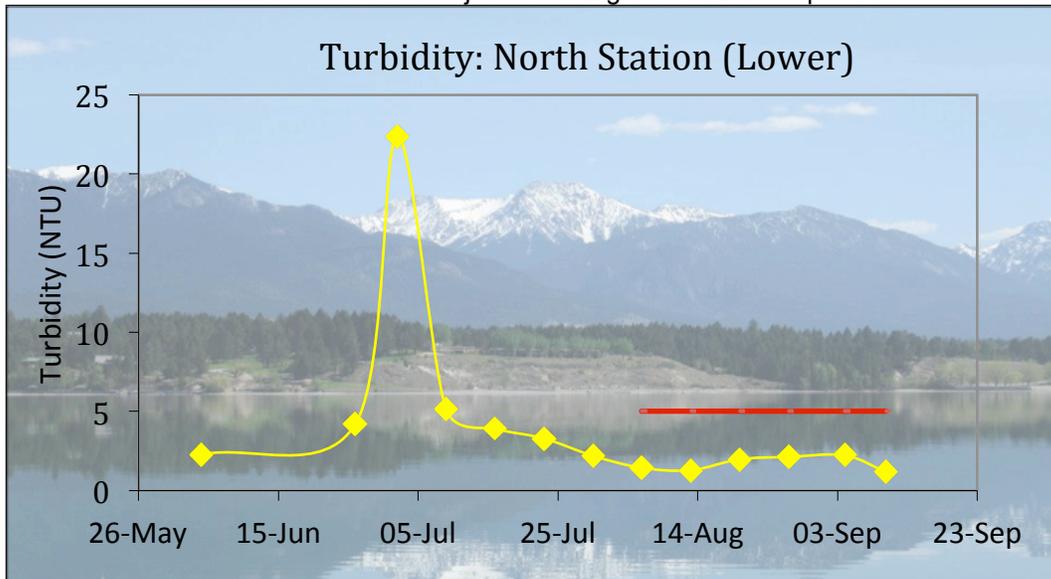
The South end of the lake had the highest turbidity of all sites on June 26<sup>th</sup> (53.6 NTU), indicating that the most sediment was being transported into the lake from the Columbia River (visual inspection showed this came from its tributary, Dutch Creek). The Windermere site also had high turbidity on June 26<sup>th</sup> (14.3 NTU). That site’s turbidity level peaked on July 2<sup>nd</sup> (18 NTU) indicating either the slow transport of sediment from the lake’s south end, or additional inputs flowing in from Windermere Creek at a later date.

An interesting phenomenon occurred on July 2<sup>nd</sup>. While turbidity was at record levels in the south and central part of the lake, the surface at the lake’s north end at Timber Ridge was only 3.91 NTU, within the Objective for this time of year. However, the lake water one metre from the bottom had turbidity of 22.4 NTU. This shows that heavy sediment loading coming into the south end of the lake, while still flowing towards the lake outlet, had settled to the bottom by the time it reached the north end.

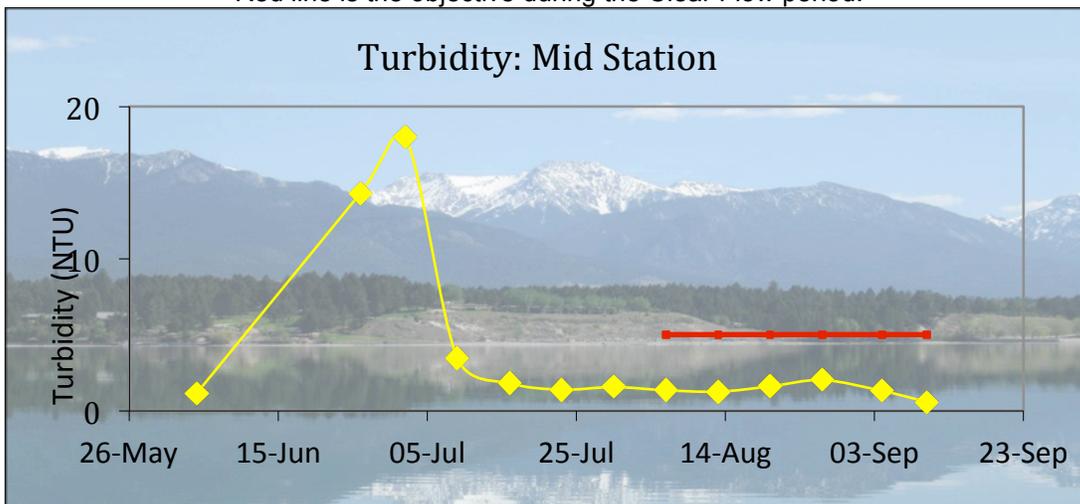
The Objectives for turbidity during the turbid flow period (95 percentile of 5 NTU) were exceeded at both the Windermere Station (16.9) and South Station (44.4). During “clear flow” after August 15<sup>th</sup>, the maximum turbidity objective value was never exceeded.



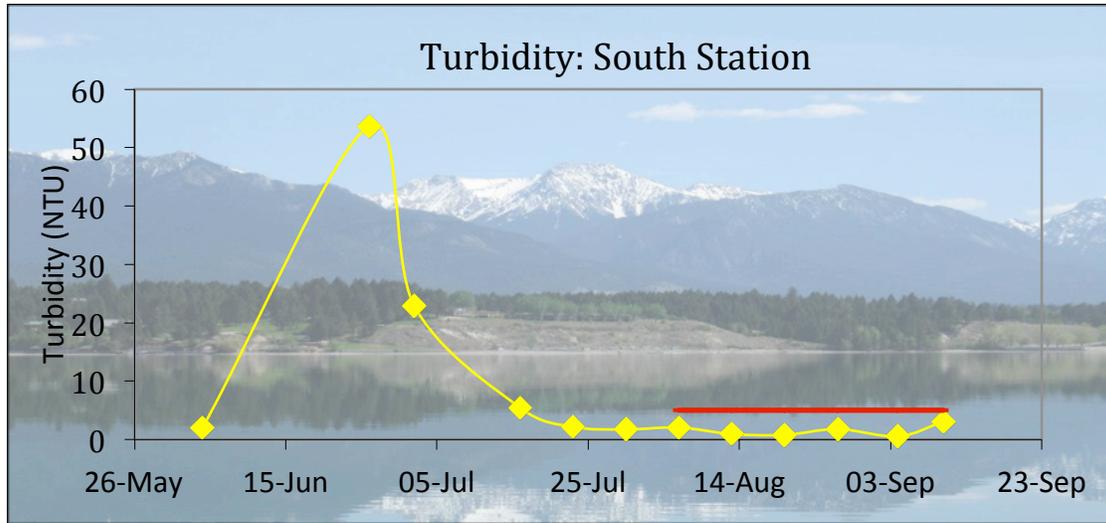
Note: Yellow points are turbidity values. Lines added to ease interpretation only - no continuous data were taken. Red line is the objective during the Clear Flow period.



These values represent turbidity taken 1 metre above the lake bottom. Note the high turbidity on July 2<sup>nd</sup>. Red line is the objective during the Clear Flow period.



Yellow points are turbidity values. Red line is the objective during the Clear Flow period.



Yellow points are turbidity values. Red line is the objective during the Clear Flow period.

## Secchi Depth

### Overview

A secchi disk gives us a reading of water transparency according to the depth of the measurement. Secchi depth, like turbidity, is a measure of the suspended particles in the water. These suspended particles can be a combination of things such as zooplankton, algae, pollutants, and silt. Secchi data collected year after year can provide valuable information on trends in transparency in monitored lakes.

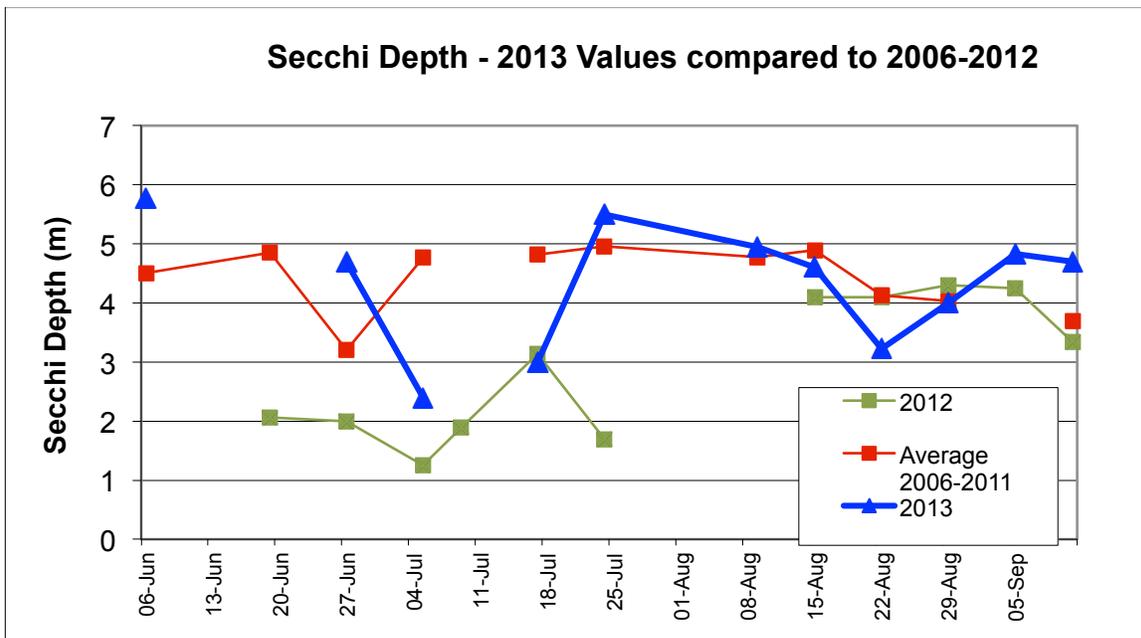


### Results

The average Secchi depth for Lake Windermere in 2013 was 4.43 metres. The average from 2006, 2007, 2008 and 2011 was 4.51 meters +/- 0.84 meters. In 2012, average secchi depth was lower, at 2.92.

The graph below shows that the lower secchi depths (more suspended particles in the water) occurred during the July in both 2013 and 2012, when lake turbidity was also high. The August depths were closer to historic conditions.

Compared to other lakes throughout BC measured during the BC Lake Stewardship Society's annual "Secchi Dip-in" in July, Lake Windermere's clarity was the 4<sup>th</sup> lowest. This means there is higher turbidity (lower clarity) in Lake Windermere compared to other BC lakes.



\*Note: Gaps in data occurred on windy, rough water days when the Secchi disk could not go straight down in to the water column for accurate readings

## Phosphorus

### Overview

Phosphorus is a nutrient that is usually found in limited quantities in natural lakes. In high quantities it leads to algae blooms. Unnatural inputs of phosphorus into lakes are one of the main contributors to algae blooms. Past results from sampling for phosphorus indicate that Lake Windermere is “oligotrophic.” This means that low nutrient levels and clear waters have been the norm in this lake.



The Ministry of Environment determined that the most total phosphorus that should be present in Lake Windermere (Objective) is a concentration of 0.01 milligrams per liter (mg/L), collected at spring ice-off, to protect drinking water sources and aquatic life.

### Results

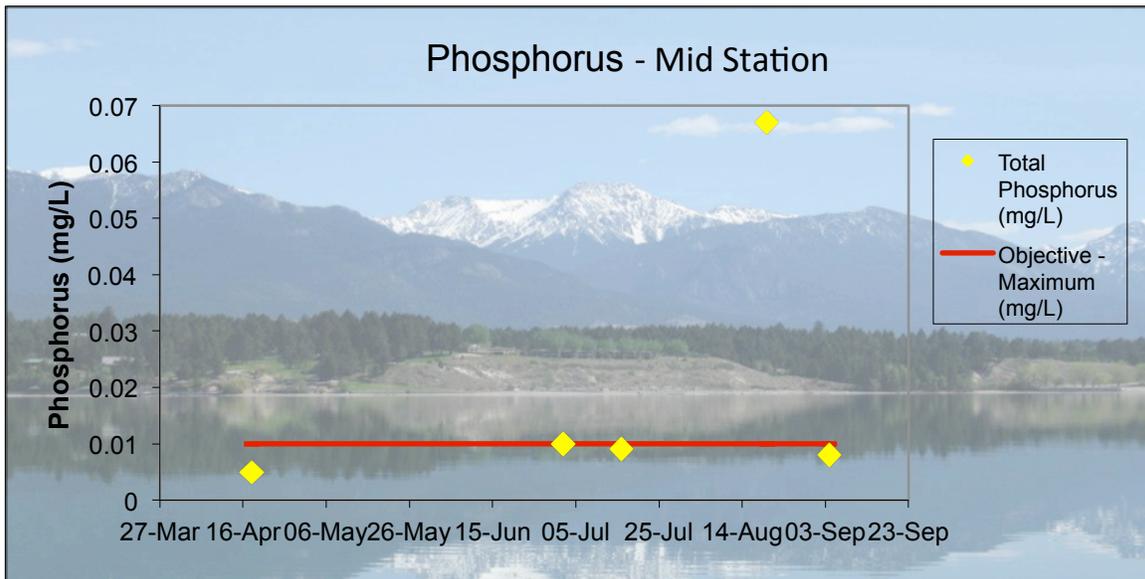
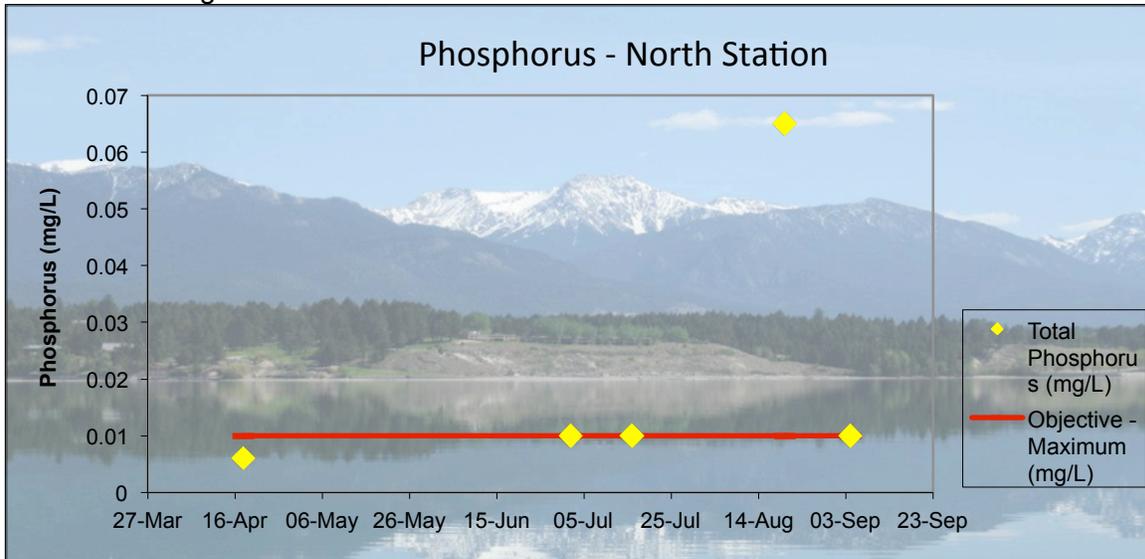
Phosphorus levels slightly exceeded the MOE’s recommended Objective at the South Station in April, 2013, at 0.011 mg/L. Repeat sampling at that site may have revealed the exceedance to be insignificant. Yet perhaps lending significance to this value is the fact that the next nutrient measurement, taken on July 2<sup>nd</sup>, 2013, was 0.012 mg/L.

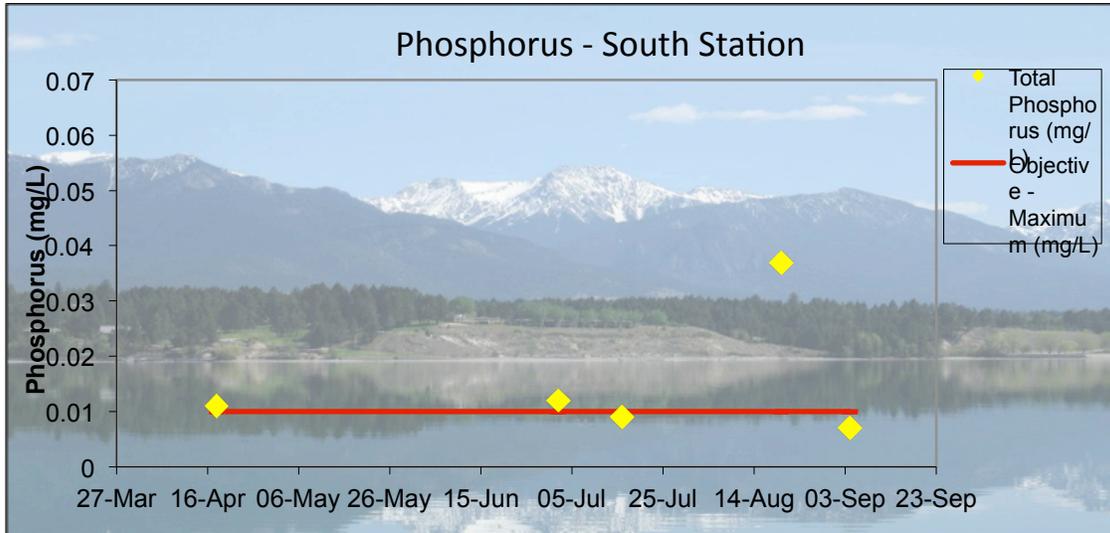
Although summer phosphorous levels were not set by the MOE for Lake Windermere, August phosphorus levels were higher than 0.01 mg/L and higher than previous years throughout the lake. At the Timber Ridge site (which represents a mixed sample of water from the surface and one metre above the lake bottom), phosphorous levels were 0.065 mg/L. The lake water near Windermere Creek, representing the surface only, was 0.067 mg/L, and the lake water near the

South end of the lake was 0.037 mg/L. Phosphorous as high as these concentrations was not found during the sampling undertaken by the Lake Windermere Project (max 2006-2009 Timber Ridge = 0.013 mg/L; Windermere Creek = 0.036 mg/L; South Station = 0.028 mg/L).

Sampling and lab tests were repeated on September 4<sup>th</sup> 2013 to see if these concentrations persisted, but levels had returned to below 0.01 mg/L by that time.

The “Water Quality Objectives for Lake Windermere” (MOE, 2010) report notes, “*phosphorus concentrations have remained quite similar, if not declined, since the 1970s.*” Any deviation from that strong trend deserves attention. Given the fact that this important nutrient was found to occur in high levels throughout the lake at all three sampling sites in late August 2013, increased vigilance in watching nutrient levels in the lake is warranted.



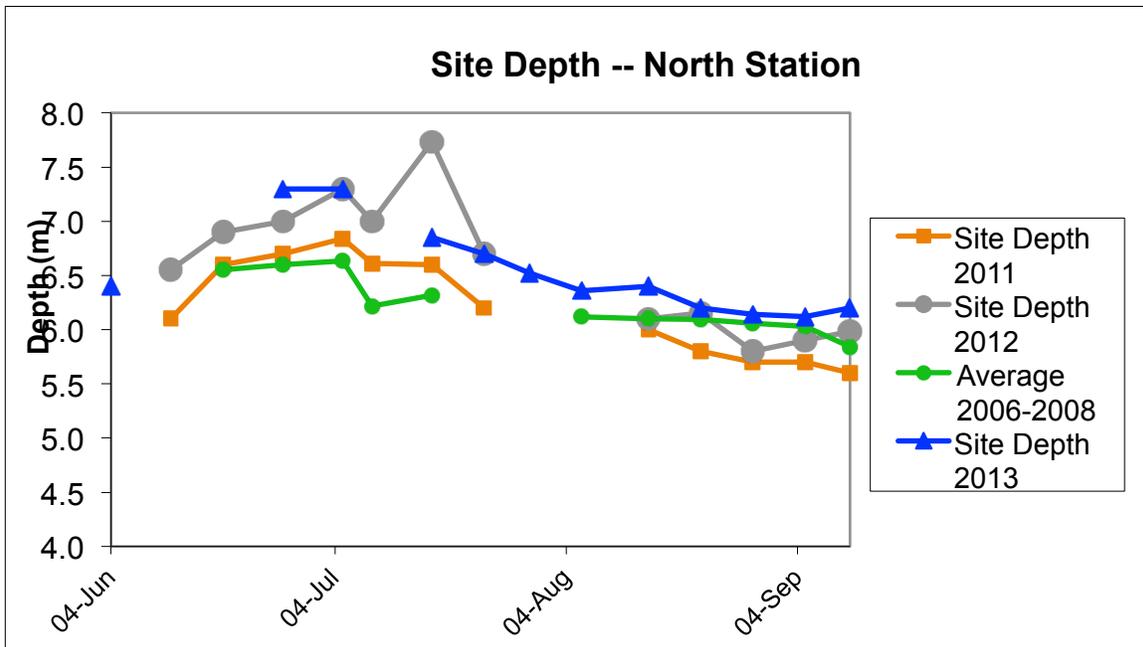


## Depth

The measured lake levels in 2013 were comparable to those in 2012, and higher than average levels between 2006-2008 and 2011.

Note that sampling conditions in 2013 made it difficult to get accurate readings of lake depth given that the instrument used is the Secchi disc. Field notes for July 9<sup>th</sup> say that depth was unmeasurable due to wind and drift. The boat anchor was lost after the Timber Ridge reading was taken on July 2<sup>nd</sup>, making depth and Secchi readings very difficult for the week thereafter.

Below is a graph showing lake depth in 2013 compared to 2012 and 2011 and the average between 2006 and 2008.



\*Note – data were not collected on all sampling days – some data points interpolated to smooth the line

## Beach Bacteria

The beach bacteria monitoring program faced several setbacks in 2013. First, on two occasions road conditions and/or problems with the Interior Health Authority's (IHA) transport system meant that the samples did not arrive at the lab in time for analysis. This meant that data were not available for two high risk days in July, and also that calculation of the 30-day geometric mean values necessary to assess recreational water quality was not possible. The second challenge to this program this year were funding cuts at Interior Health. We were told we must reduce our sampling regime to two sampling locations on Kinsmen Beach and James Chabot Beach, and one site on Windermere Beach. Sample analysis for the private Tretheway beach was no longer supported by IHA in 2013.

Despite these challenges, the data we did collect showed fewer incidents of water quality violations than in 2012. Of note, no water quality violations were noted on the previously problematic James Chabot Beach (see Figures below). Our field notes indicated that the washrooms on this public beach were closed throughout the summer (port-a-potties replaced them). Goose feces were noted in equal abundance in 2013 field notes as in 2012 and previous years, indicating that the 2012 high fecal levels were likely due to septic/sewage leaks from the washrooms.

### Health Canada – Guidelines for Canadian Recreational Quality

For fresh recreational waters used for primary contact activities, the guideline values are as follows:

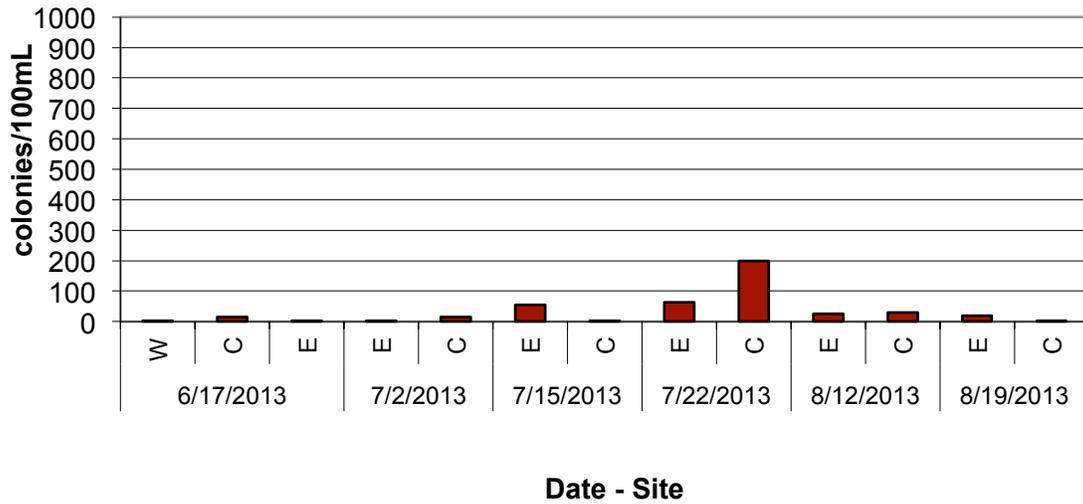
- Geometric mean concentration (minimum of five samples):  $\leq 200 E. coli/100 \text{ mL}$
- Single-sample maximum concentration:  $\leq 400 E. coli/100 \text{ mL}$

*\*Sampling for E-coli was unavailable by Interior Health during the 2013 monitoring season. Fecal coliform was used as an indicator during this season. In Interior Health's Beach Water Quality Notification Campaign, fecal coliform are used interchangeably with E-coli as an indicator of water pollution*

The only single-sample water quality exceedance was on July 2<sup>nd</sup> at the Kinsmen Beach east site (727 colonies/100 mL). Field notes for that day mention high levels of sediment at that sampling location. The sediment may have also carried particulate fecal matter.

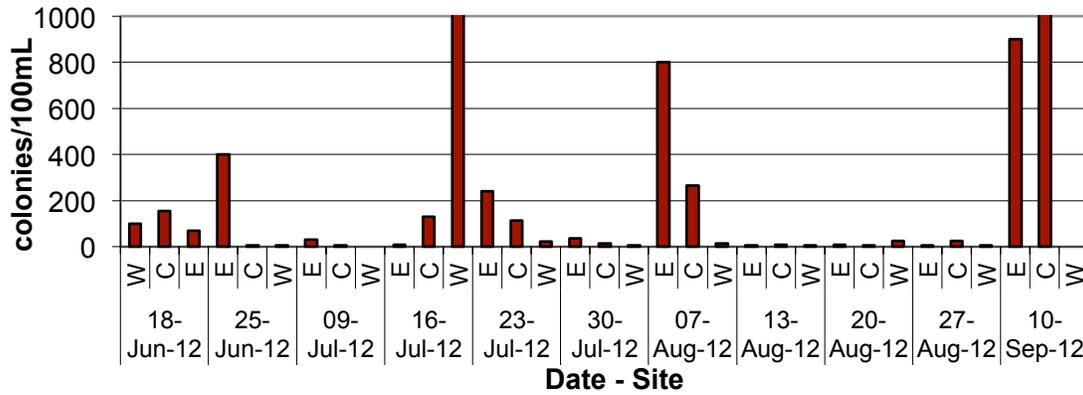
Geometric mean data taken across all summer sampling days did not exceed the 200 colonies/100 mL recommended for contact recreation on any of the public beaches (James Chabot geomean = 9.0; Kinsmen geomean = 3.3; Windermere geomean = 3.1).

### 2013 Beach Fecal Coliform - James Chabot



2013 Fecal Coliform colonies at James Chabot Beach. Geometric mean, all sites = 9.0

### 2012 Fecal Coliform - James Chabot



2012 Fecal Coliform colonies at James Chabot Beach

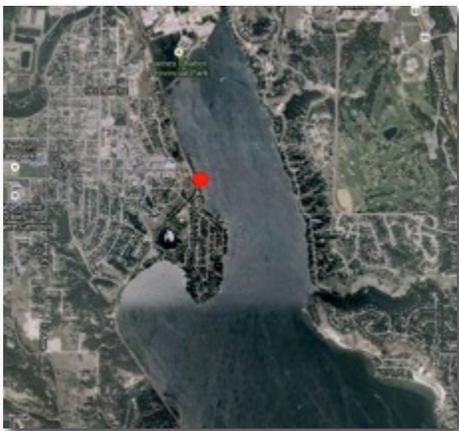
# Special Study: Stormwater Quality

## Overview

Stormwater is water that originates during precipitation events. It is water that does not soak into the ground, but becomes surface runoff, which either flows directly into surface waterways or is channeled into storm sewers, which eventually discharge to surface waters. Stormwater brings contaminants on dry land surfaces into aquatic ecosystems. It is an increasing source of water contamination around North America.



In 2013, the Lake Windermere Ambassadors initiated a special study on the water entering Lake Windermere from the District of Invermere's main stormwater outlet (pictured at right during storm event). The stormwater system in Invermere collects water from all of the downtown area and some of the residential area, delivering it to an outlet just north of the Bayshore Condos (location map below). The beach where the outlet is present is a popular boat launch area in the summer and a popular ice-fishing area in the winter. Thus, the quality of the water entering the lake at that point is important to users of the immediate beach environment as well as the general quality of the lake.



Our study examined stormwater for metals concentrations. Toxicity of metals in the environment is very complex. Toxicity to aquatic life varies with pH and hardness (as  $\text{CaCO}_3$ ). This is because metals are more soluble in acidic conditions and less likely to be taken up by fish in where calcium is present (more hardness).

The Ministry of Environment has set different Water Quality Criteria depending on "use" of the water ([http://www.env.gov.bc.ca/wat/wq/wq\\_guidelines.html#approved](http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#approved)). In this study, we compared our results to criteria for toxicity to freshwater aquatic life, where applicable. These are generally more restrictive than Criteria for recreation or irrigation.

## Results

During our study, we were only able to obtain stormwater samples during or immediately after rain events when water was present in the stormdrain. We took samples from the stormdrain during four spring/summer days: May 23<sup>rd</sup>, June 19<sup>th</sup>, June 20<sup>th</sup> and July 8<sup>th</sup> 2013.

The Ministry of Environment Water Quality Criteria specify that averages should be "30-Day Average Levels Based on Five Observations Collected Over a 30-Day Period." During our study, we were only able to obtain stormwater samples on four occasions. Thus, our "30-day averages" are based on those four samples.

The Ministry of Environment Water Quality Criteria vary depending on water hardness. The water's hardness varied during our sampling events. The table below is based on a hardness of 612 mg/L as  $\text{CaCO}_3$ , the average hardness across our four samples. The table below shows values that exceeded the Criteria in red.

ANALYTE	RESULT MAX (mg/L)	RESULT MEAN (mg/L)	MAXIMUM RECOMMENDED*	30 – DAY MEAN RECOMMENDED*
Hardness, (as CaCO <sub>3</sub> )	1620	612	N/A	N/A
Aluminum	<b>18</b>	<b>9.46</b>	0.1	0.05
Arsenic	<b>0.015</b>	0.005	0.005	N/A
Boron	0.53	0.14	1.2	N/A
Cobalt	0.014	<b>0.006</b>	0.11	0.004
Copper	<b>0.077</b>	0.033	0.025	0.058
Iron	<b>37.7</b>	15.83	1	N/A
Lead	<b>0.062</b>	<b>0.028</b>	0.020	0.011
Manganese	<b>112</b>	<b>41.9</b>	7.28	3.30
Mercury	0.0003	0	0.001	0.0002
Molybdenum	0.003	0.0015	2	1
Selenium	0	0	N/A	0.002
Silver	0.0005	0	0.003	0.0015
Zinc	<b>0.99</b>	<b>0.415</b>	0.42	0.40

<sup>1</sup> Provided Recommendations are for the protection of freshwater aquatic life, based on a pH greater than 6.5 and a hardness of 612 as CaCO<sub>3</sub>.

<sup>2</sup> Taken from the Water Quality Guidelines (Criteria) Reports, Environmental Protection Division, Ministry of Environment, Government of British Columbia. Accessed July 17<sup>th</sup> 2013.  
[http://www.env.gov.bc.ca/wat/wq/wq\\_guidelines.html#approved](http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#approved).

These results suggest potential threats to freshwater life from aluminum, arsenic, cobalt, copper, iron, lead, manganese and zinc entering the lake through this stormwater outlet.

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### Questions about this report?

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