# Muskoka Lakes Association Water Quality Initiative:

## Summary Report of 2006 Monitoring Program

**including instructions for accessing data via the Internet**

December 5, 2006

Logan Environmental Consulting
1040 Islander Avenue, PO Box 942
Bracebridge, Ontario, P1L 1V2
http://www.loganenvironmental.com

# Table of Contents

# Introduction

The Muskoka Lakes Association (MLA) water quality initiative uses two separate, yet complementary, methods of reporting on the quality of surface waters in our lakes. These methods reflect the two complementary *functions* of the initiative: monitoring and research. These functions are differentiated by how the data is used, and therefore, reported.

2006 marks the sixth year of the MLA water quality initiative, a program that has grown and evolved in order to meet the emerging needs of the community. Changes to the program and to the reports in 2006 are minimal, as the program has matured and reporting mechanisms that are effective in communicating program results to the public and to interested scientists have been developed.

Most readers will be mainly interested in the results of the monitoring function of the program. The monitoring function is an annual report of the results of a variety of parameters measured at various locations around the lakes that are part of the MLA program. The results of the monitoring function will indicate how the water quality in a particular location differs from water quality in other areas, and how water quality in a particular area varies through time (from season to season). Through monitoring and analysis of the results, we can recommend remedial measures for locations with impaired water quality or with water quality that is worsening over time. “Hot spots” can be identified, neighbours may be warned of any serious concerns to public health or the local ecosystem, and the appropriate government authorities can be notified of potential sources of contamination.

Due to the scope of information available and the importance of effectively disseminating it, these results are made available in electronic format to the public via the MLA website (a paper copy of these results would fill several hundred pages). The following short report summarizes the main findings of the monitoring function, and offers a detailed explanation of how to fully access the wealth of information in geo-referenced format via the MLA website.

Advanced readers will wish to read the results of the research function of the program. A traditional paper report outlining these results as well as the scientific theory, method, and quality assurance techniques of the program is available either in PDF format from the MLA website or from the MLA office in Port Carling.

## Summary of Results

The following is a basic summary of the results observed in the water quality initiative, focussing on 2006 results within the context of observations from previous years. The report shows how water quality in each area studied compares with water quality objectives and with water quality observed in all other areas studied. The report also shows how water quality parameters have changed since 2002. Full explanations of the significance of each parameter and descriptions of the sampling protocol used are referenced in the 2006 Annual Report.

When comparing water quality parameters, it is important to note that the conditions in various lakes and rivers differ significantly. Small, slow-moving, connective rivers like the Indian River and the Joseph River are quite similar to the large lakes that they join and in fact have been blasted and dredged to change their natural characteristics from riverine to lacustrine. In comparison, rivers like the Hoc Roc River and Shadow River are more natural watercourses that drain large catchment areas. These rivers are expected to have higher concentrations of contaminants, as they collect runoff (and the surficial contaminants that runoff carries) from large areas and concentrate it in a small area. Similarly, the natural function of wetlands is to concentrate contaminants and biological activity. Therefore, any sites near a wetland area will tend to feature higher counts of bacteria and higher concentrations of phosphorus, etc.

Conditions in lakes in Muskoka tend to be more comparable. Nearly all lakes in Muskoka are naturally oligotrophic, which means ‘nutrient-poor.’ This condition arises from the fact that the lake is carved out of granite, which erodes slowly and contains few nutrients. An increase in biological productivity in these lakes (represented here by total phosphorus concentration, but also observed through the growth of algae and other plants) is typically unhealthy. Brandy Lake, which is not naturally oligotrophic, is the single exception within the scope of the water quality initiative. Brandy Lake is a dystrophic lake, which means it has more dissolved organic carbon and total phosphorus regardless of human impacts. High total phosphorus in this case in not considered unhealthy.

## E.Coli

**What it is:** Organism indicating contamination by enteric bacteria originating in human and animal waste products. Can cause gastrointestinal disease if ingested.

**Safe Recreational Water Objective:**
- Less than 100 counts/100mL (Provincial standard)
- Less than 10 counts/100mL (MLA safe water objective)

Figure 1 shows *Escherichia Coli* (*E.Coli*) results from 2006. Average values shown on the figure are calculated geometric means. The dotted red line represents the MLA Safe Water Objective, first described in Section 5.3 of the 2002 Annual Report (the MLA has set higher water quality objectives than the Province of Ontario to reflect the typically excellent water quality in Muskoka's lakes). All areas recorded averages below the MLA's water quality objective, an improvement from 2005 when two areas had averages above this benchmark (high bacteria counts in general in 2005 were attributed to high temperatures throughout last summer, as noted in the 2005 Annual Report).

Once again, the Muskoka Sands area reported the highest *E.Coli* observed in the program area, and, as in 2005, these high average readings can be attributed to very high readings at site MSN-4 on the Hoc Roc River. The average reading at this site was 59 counts/100mL. This is significantly lower than last year's average reading at MSN-4, and lower than the provincial water quality objective (PWQO), however MSN-4 remains the single site in the program area that reports *E.*Coli significantly higher than the MLA water quality objective. Since only one isolated reading (measured on 10 July) exceeded the PWQO, there is little need or recourse for investigating the cause of these high readings. It is also important to note that the prime purpose of site MSN-4 is to monitor total phosphorus loading from the Taboo golf course; swimming is not expected in this marshy, riverine area.

**Site MSN-4**

A significant observation however, is that site MSN-2 also reported an average E.Coli reading above the MLA water quality objective, at 13 counts/100mL. A second site within the Muskoka Sands sampling area reporting impaired, albeit slight, water quality with respect to *E.Coli*, indicating that a trend may be present. This sampling area may therefore be a good candidate for further analysis through a community planning process.

Figure 2 shows the five-year average (geometric mean) of *E.Coli* readings. All lakes had a long-term average of below five *E.Coli* counts/100mL, which is very low. As noted previously, both the Hoc Roc River and Shadow River drain large catchment areas and essentially concentrate contaminants from a wide area. As *E.Coli* can indicate human faecal contamination, it is prudent for Shadow and Hoc Roc River residents to be particularly cognizant of any potential sources of human waste, such as malfunctioning septic facilities, and to report them to the MLA or the appropriate authorities.

Five-year trends for *E.Coli* readings are shown in Figure 3. Five year trends in some cases, and multiple years of data in many sampling areas, show that *E.Coli* readings are generally increasing slightly. This could be due to a number of factors, including the relatively warm temperatures in the sampling area over the past two years or an increased sensitivity of the ColiPlate test kits. As readings remain well below not only the PWQO but also the MLA water quality objective, this does not indicate an immediate threat to public health, however if this general trend continues into the future its cause should be determined. In contrast, the concerning *E.Coli* levels observed and reported in 2005 at Muskoka Sands, the Muskoka River, Windermere and Minett all decreased this year.

## *Total Coliforms*

**What it is:** Bacteria organism that could indicate contamination by enteric bacteria originating in human and animal waste products, but also originating in other sources not related to human health.

**Safe Recreational Water Objective:**

- Less than 1000 counts/100mL (former Provincial standard)
- Less than 100 counts/100mL (MLA safe water objective)

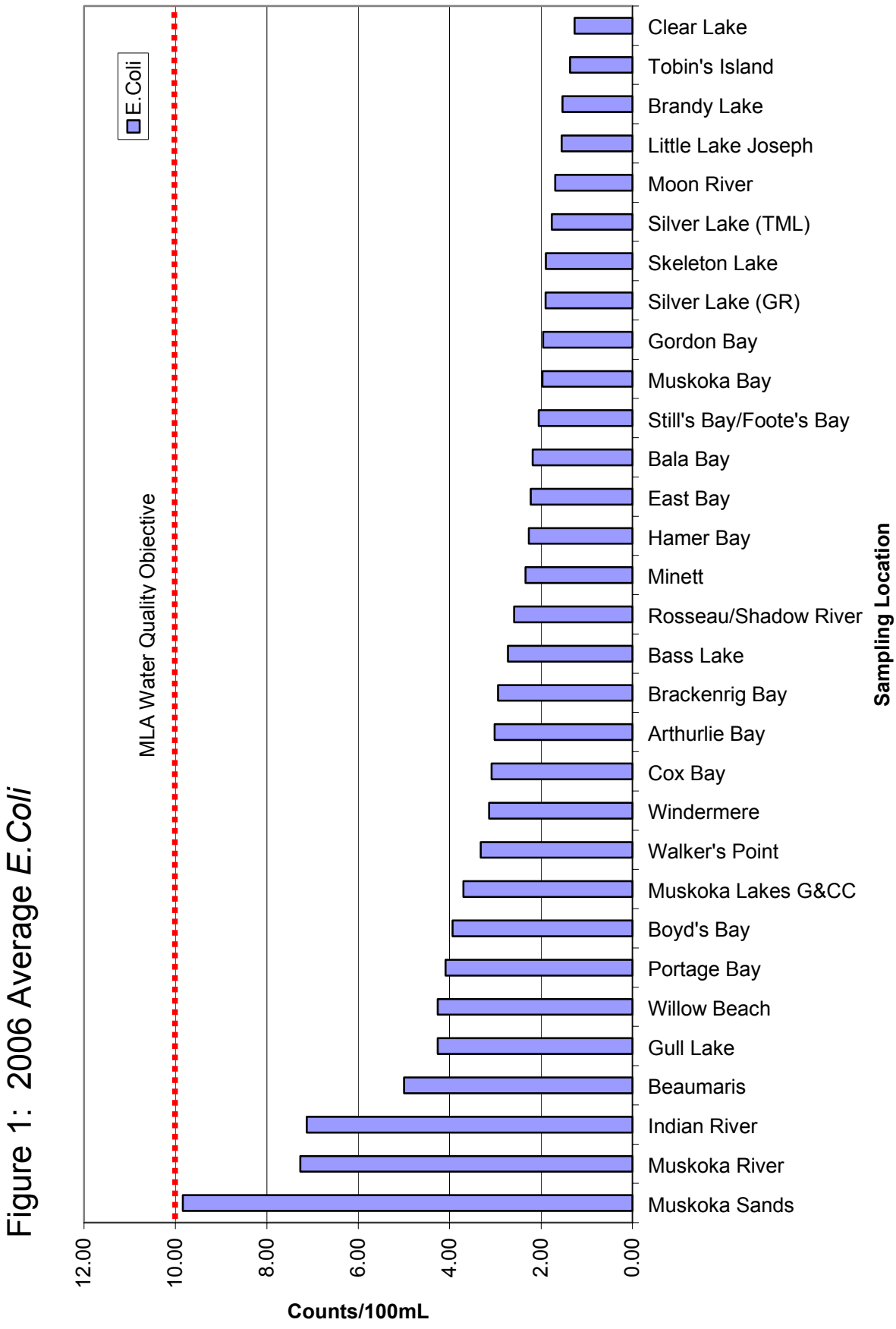



Figure 1: 2006 Average *E.Coli*

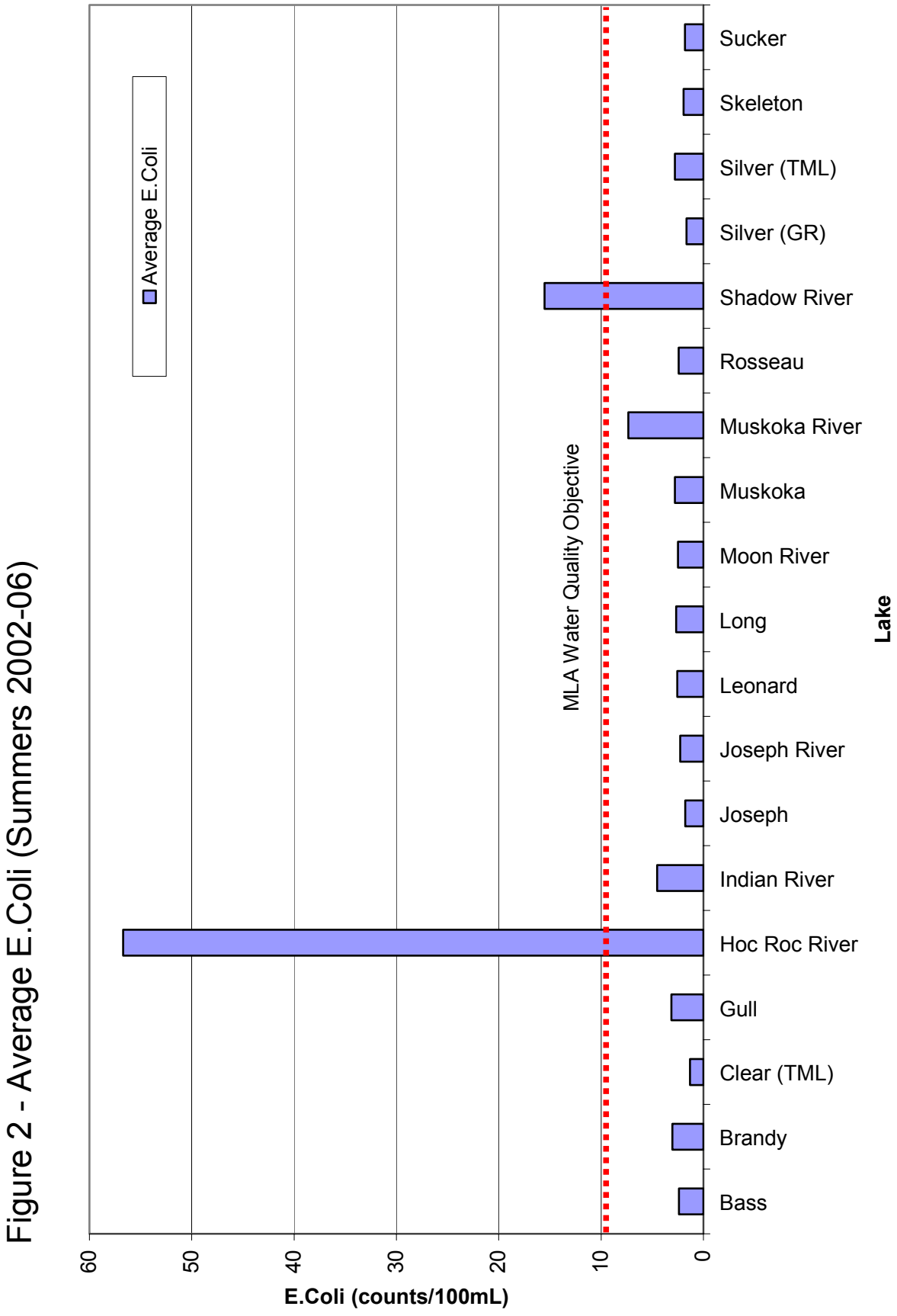
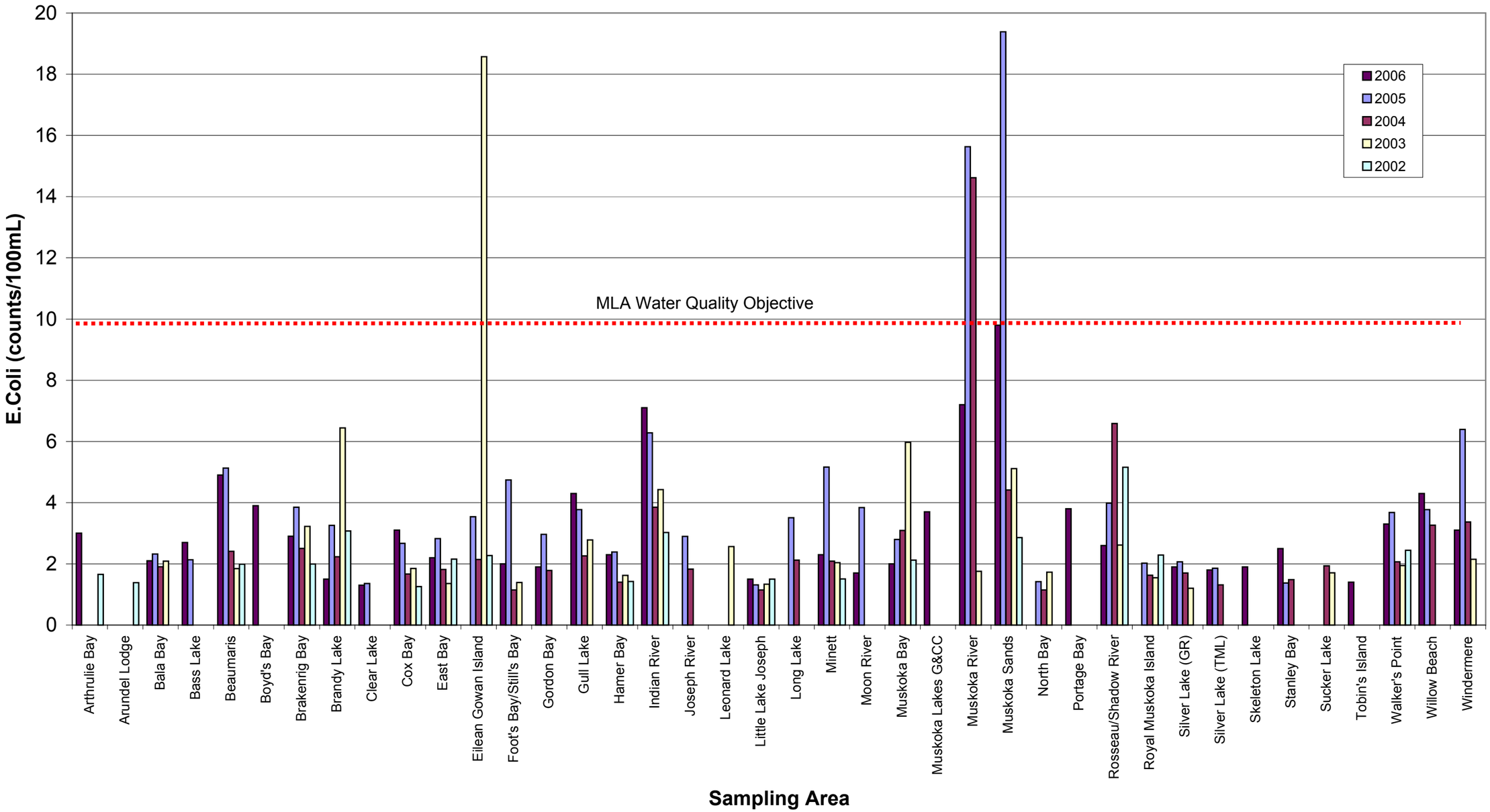



Figure 2 - Average E.Coli (Summers 2002-06)

Figure 3 - 2002-2006 Average *E.Coli*

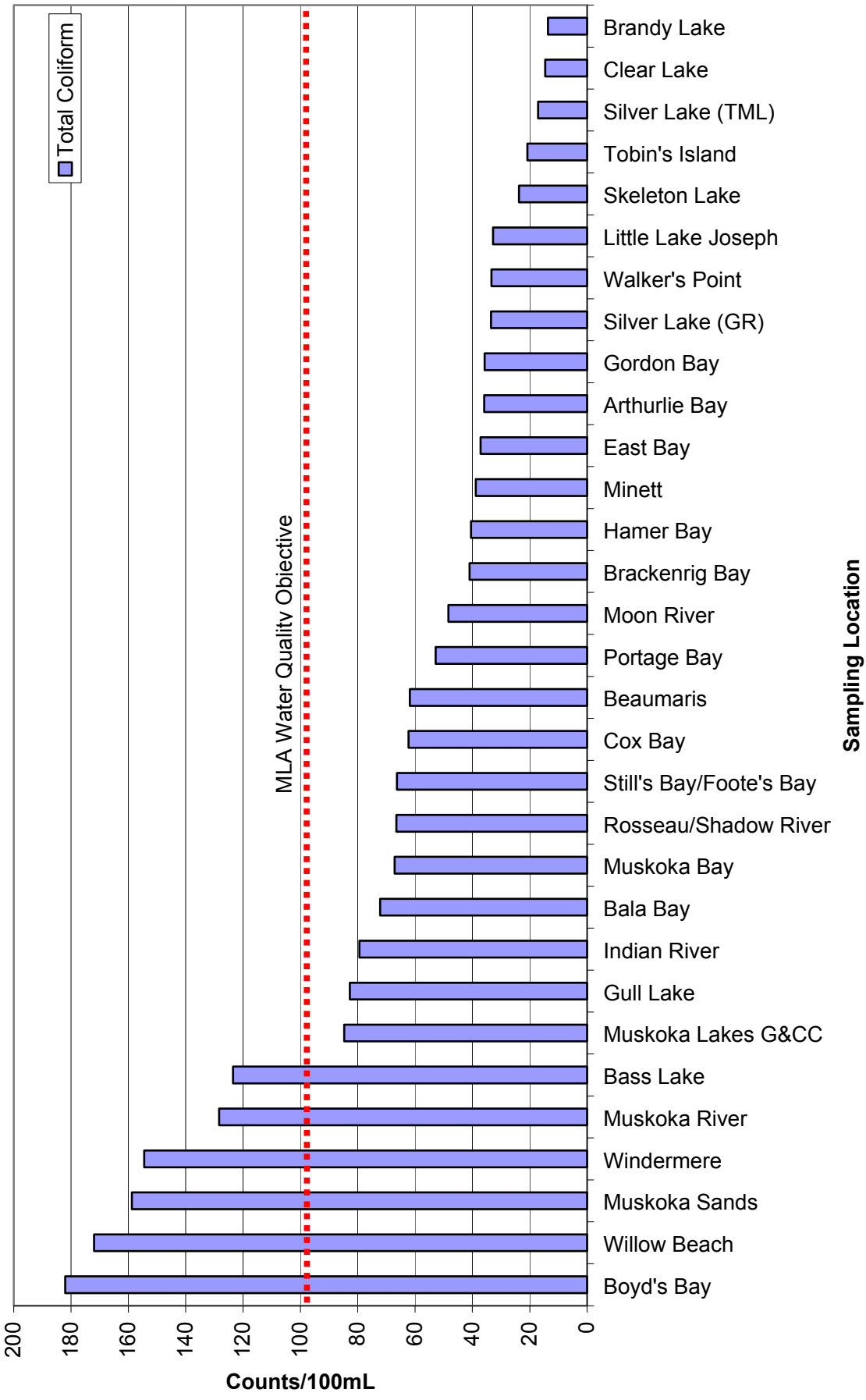


Average (geometric mean) total Coliforms in every area studied in 2006 are shown in Figure 4. Observed total Coliforms had increased dramatically (more than three-fold) between 2004 and 2005, and approximately half of the sampling areas exceeding the MLA Safe Water Objective on average. This increase in total Coliforms counts was attributed to higher than normal water temperatures observed in 2005. In 2006, average temperatures dropped approximately 1.5 degrees from 2006, but remained higher than previous years (likely due to a warm winter in 2005-06). As expected, counts of total Coliforms also decreased, by approximately 1/3, with six sites exceeding the MLA water quality objective on average. Where these readings are higher than in years prior to 2005, the results do show a close relationship between temperature and total Coliforms (this is explored in more depth in the 2006 Annual Report).

Average (geometric mean) total coliform observed over the five-year period of the program is shown in Figure 5. The figure shows that results are approximately ten times greater than average *E.Coli* measurements. Bass Lake's average total Coliforms remain high after two years of sampling, which is to be expected since the average water temperature reported by the volunteers on Bass Lake remained relatively constant and was one of the warmest temperatures in the sampling area (see Figure 13). Again, the Hoc Roc, Shadow and Muskoka Rivers are all high in total Coliforms. This is most likely because their catchments are relatively large and the mechanics of a watershed system work to concentrate contaminants in the rivers (and therefore at these sampling sites).

Figure 6 further illustrates the dramatic increase in total Coliforms in 2005. In many cases, 2006 readings are much lower than 2005 readings, comparable to 2003 readings.

Figure 4: 2006 Average Total Coliform



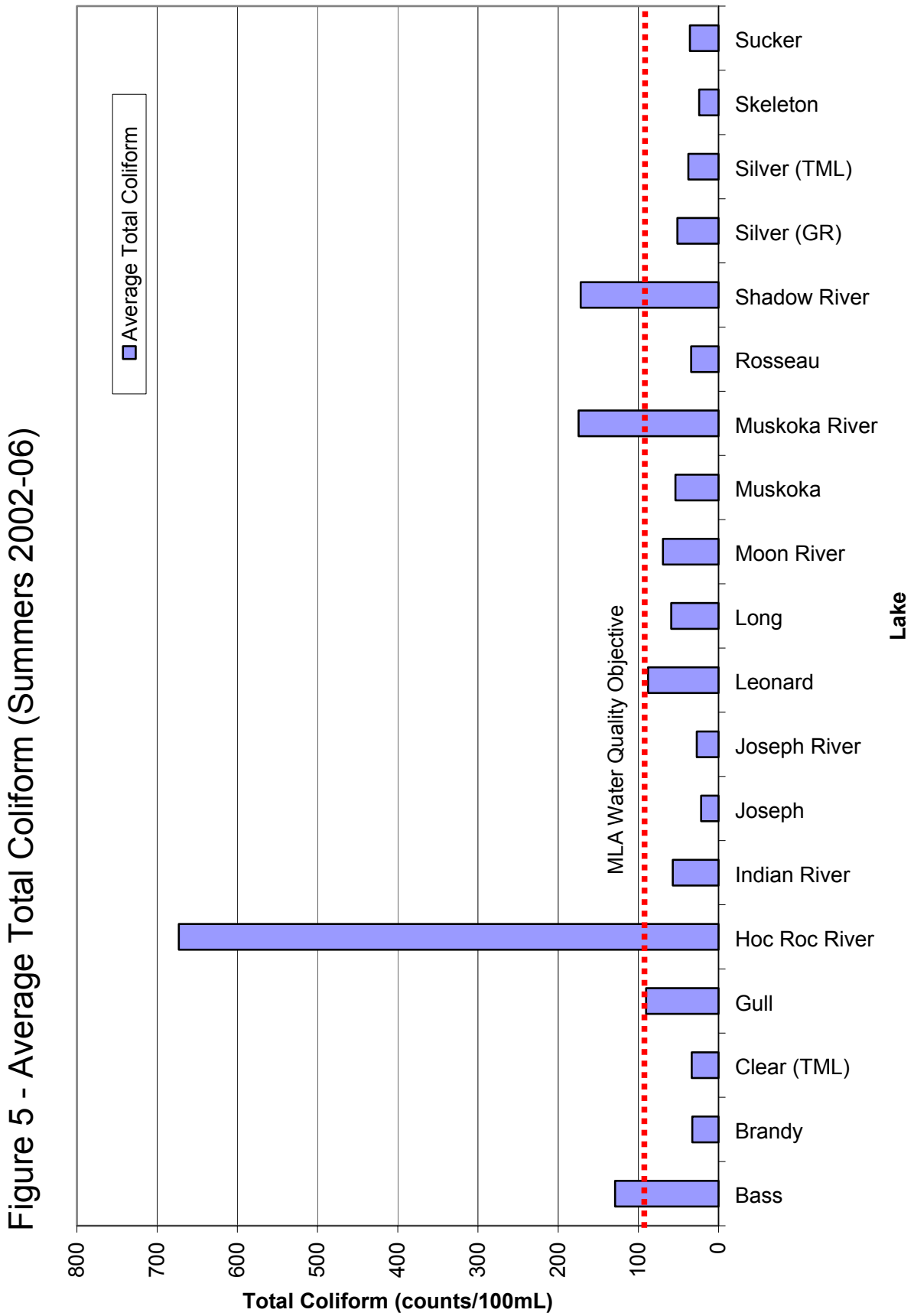
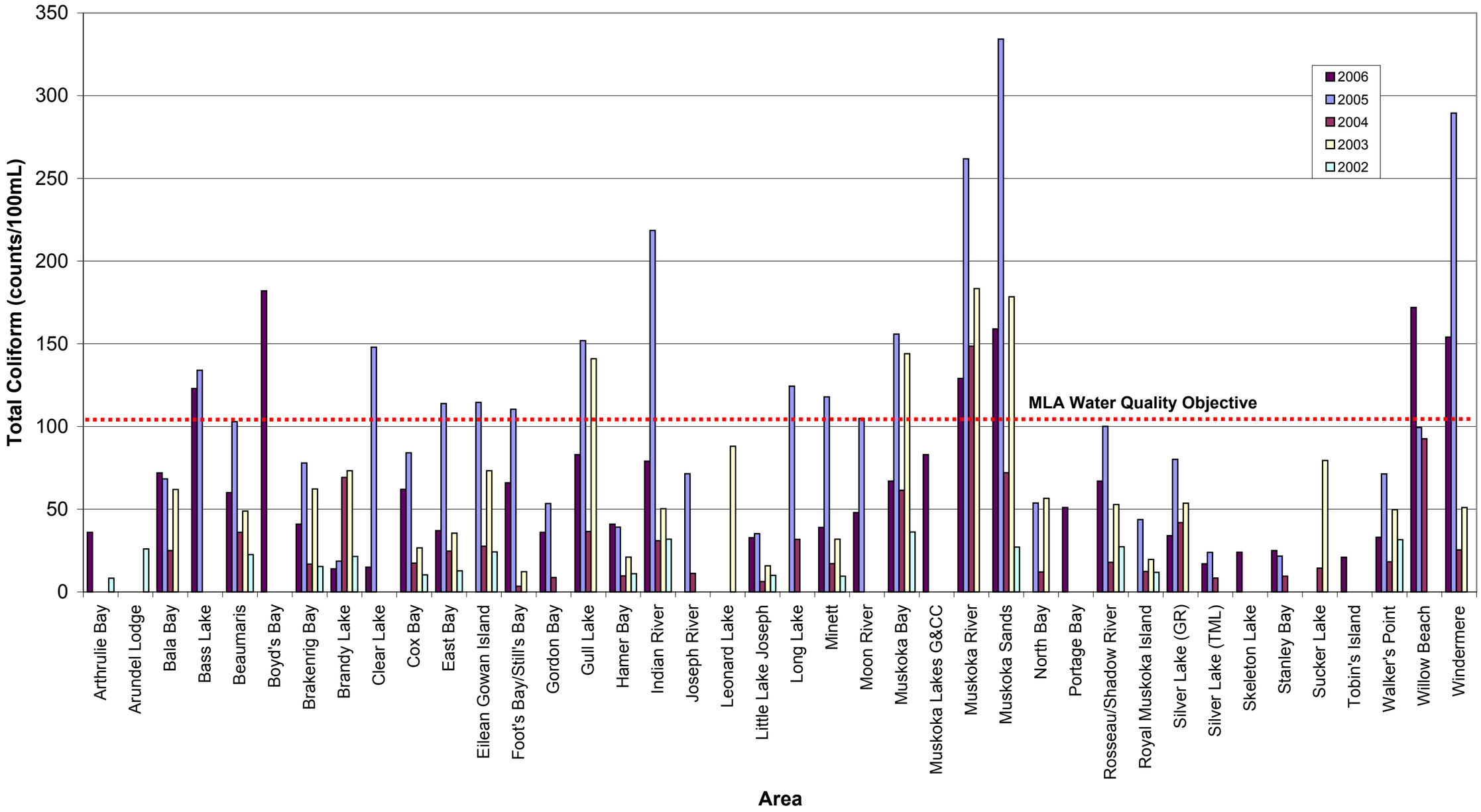



Figure 5 - Average Total Coliform (Summers 2002-06)

Figure 6 - 2002-2006 Average Total Coliform



## *Total Phosphorus*

**What it is:** Nutrient required for biological growth, typically the limiting nutrient in freshwater ecosystems. Phosphorus loading can be caused by human development, and usually brings algae blooms and unwanted plant growth to Muskoka's oligotrophic lakes, detrimentally affecting all parts of the ecosystem.

**Water Quality Objective:**

- Lake-specific thresholds defined by District of Muskoka's Lake System Health Program

In past years, the MLA water quality initiative has reported average total phosphorus concentrations across the program area, and classified lakes as either oligotrophic, mesotrophic or eutrophic. Placing lakes in these categories, directly related to their phosphorus concentration, is the traditional way of evaluating the human impacts on a lake ecosystem. After several years of research, monitoring and modelling, the District of Muskoka (DMM) has set specific phosphorus thresholds for all lakes (and some segments (e.g. bays) of larger lakes) within the District. This exercise was part of the Lake System Health Program (LSHP), a comprehensive planning policy that addresses development on and near lakes in Muskoka. More detail about how the development of this policy affects the MLA water quality initiative is found in the 2006 Annual Report. For more information about the Lake System Health Program, please contact the District of Muskoka directly.

The LSHP classifies lakes as over-threshold or under-threshold. If a lake or lake segment is classified as over-threshold, strict development controls and remedial actions to get the phosphorus concentration below the calculated threshold level are recommended by the LSHP for implementation by the area municipalities. The following is a list of lakes and lake segments in the MLA water quality initiative program area that are classified as over-threshold by the LSHP:

- Brackenrig Bay (Lake Rosseau)
- Clear Lake (Township of Muskoka Lakes)
- Cox Bay (Lake Joseph)
- Gull Lake
- Mirror Lake
- Muskoka Bay (Lake Muskoka)
- Portage Bay (Lake Rosseau)
- Silver Lake (Township of Muskoka Lakes)

There are two distinct ways that the MLA water quality initiative total phosphorus results can be used relative to the LSHP. First, deep water or "offshore" results can be used as a "second opinion"; that is, these results can be compared to DMM sample results and calculated threshold to confirm or dispute a lake or lake segment's classification. This comparison includes sampling areas that are not specifically modelled by the LSHP. This goal may be accomplished here. Second, nearshore total phosphorus results collected as part of the MLA water quality initiative can be used to determine differences in nutrient concentration and sources of phosphorus loading on a finer scale within a small lake or bay. The analysis of the data for this purpose is complex, and must be considered as part of a large-scale strategy such as the community planning process that the MLA is currently engaging. In fact, this more detailed knowledge is necessary for taking actions to remediate a local environment with a high phosphorus concentration and is not currently collected by any government agency or other research program.

Table 1 classifies the lakes and lake segments in the program area as either over-threshold or under-threshold, according to spring turnover total phosphorus ($TP_{so}$) data collected in the MLA water quality initiative in 2006. Note that these results do not change the classification given each lake and lake segment by the LSHP; the specific threshold calculated by the LSHP simply gives a benchmark for each sampling area in the MLA program. If a lake or segment is classified here as over-threshold but is not classified as such by the LSHP, there may still be cause for concern, especially if it is a lake or segment that the District of Muskoka does not sample or has not specifically considered within the LSHP.

**Table 1 - Classification of lakes using MLA data**

| Over-threshold | Under-threshold |
|---|---|
| • Bass Lake<br>• Brackenrig Bay<br>• Clear Lake<br>• Cox Bay<br>• East Bay<br>• Hamer Bay<br>• Hoc Roc River<br>• Joseph River<br>• Rosseau (Lake Rosseau, north basin) | • Arturlie Bay<br>• Bala Bay<br>• Brandy Lake<br>• Beaumaris (Lake Muskoka north basin)<br>• Boyd's Bay<br>• Dudley Bay<br>• Gull Lake<br>• Indian River<br>• Lake Joseph (main basin) |

| | |
|---|---|
| • Skeleton Lake<br>• Silver Lake (Muskoka Lakes)<br>• Still's Bay<br>• Willow Beach | • Lake Muskoka (south basin)<br>• Lake Rosseau (main basin)<br>• Little Lake Joseph<br>• Minett<br>• Moon River<br>• Muskoka Bay<br>• Muskoka Lakes G & CC<br>• Muskoka River<br>• Muskoka Sands<br>• Skeleton Bay<br>• Silver Lake (Gravenhurst)<br>• Tobin's Island<br>• Walker's Point<br>• Whiteside Bay<br>• Windermere |

Further analysis of total phosphorus measurements, including lake classifications and recommended measures, can be found in the 2006 Annual Report.

## *Turbidity*

**What it is:** Measurement of water clarity, mostly of concern for aesthetic purposes, but can have a significant impact on in-home water purification systems that use ultra-violet light to kill bacteria.

**Water Quality Objective:**
- None

Average turbidity is shown in Figure 7 (2006 arithmetic means), Figure 8 (five-year arithmetic mean, by lake) and 9 (five-year trend). While there is no water quality objective associated with turbidity, clearer water is usually considered to be aesthetically more pleasing and implies a healthy oligotrophic aquatic ecosystem. For reference, keep in mind that a commercially available bottle of drinking water (such as Aquafina) has a turbidity of approximately 0.3 NTU and normal black tea has a turbidity of approximately 25 NTU. Figure 9 shows that in most cases, water clarity has been relatively consistent since 2002. Brandy Lake had low turbidity in 2004 and again in 2006 since the typical late summer algal bloom did not occur.

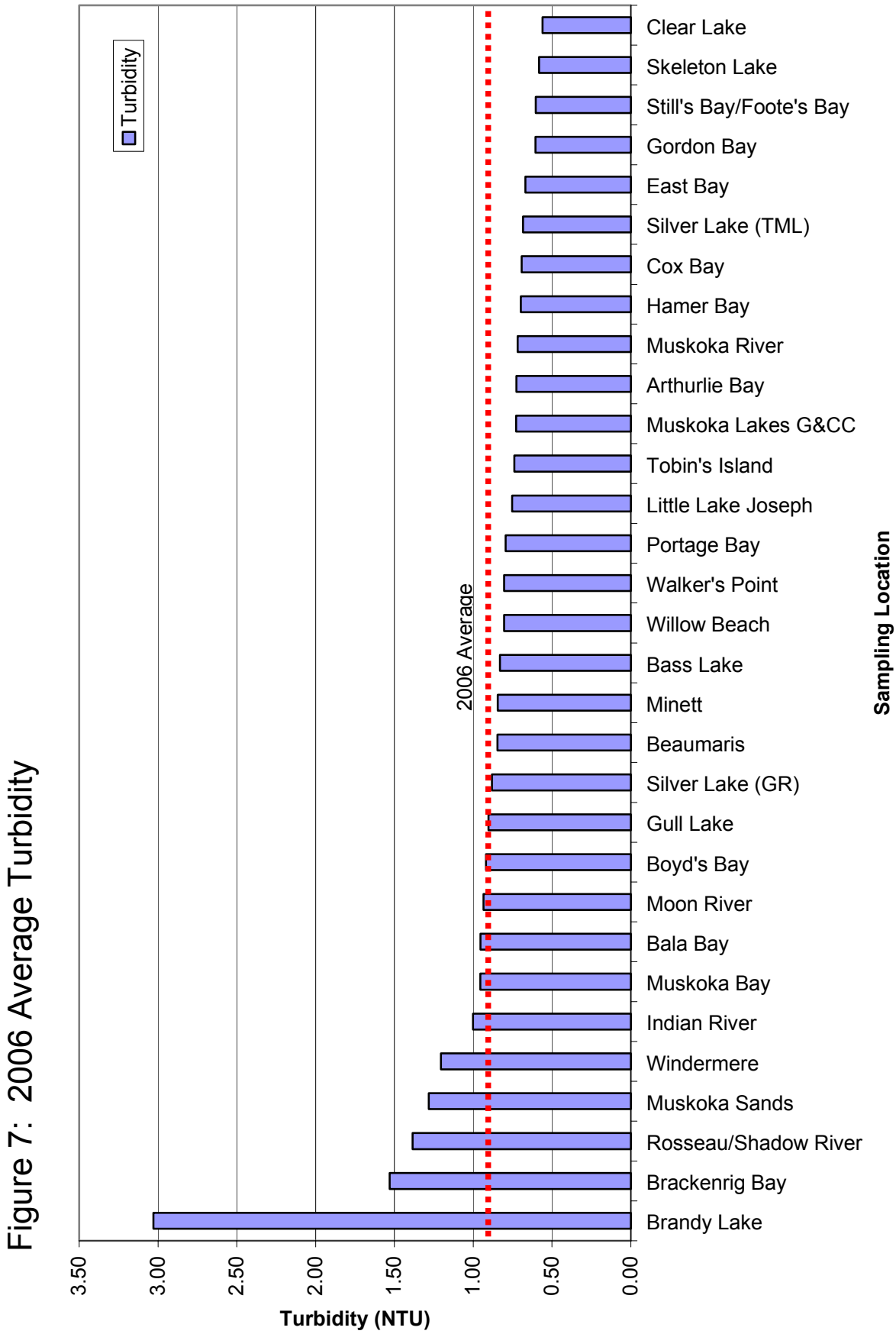



Figure 7: 2006 Average Turbidity

Figure 8 - Average Turbidity (Summers 2002-06)

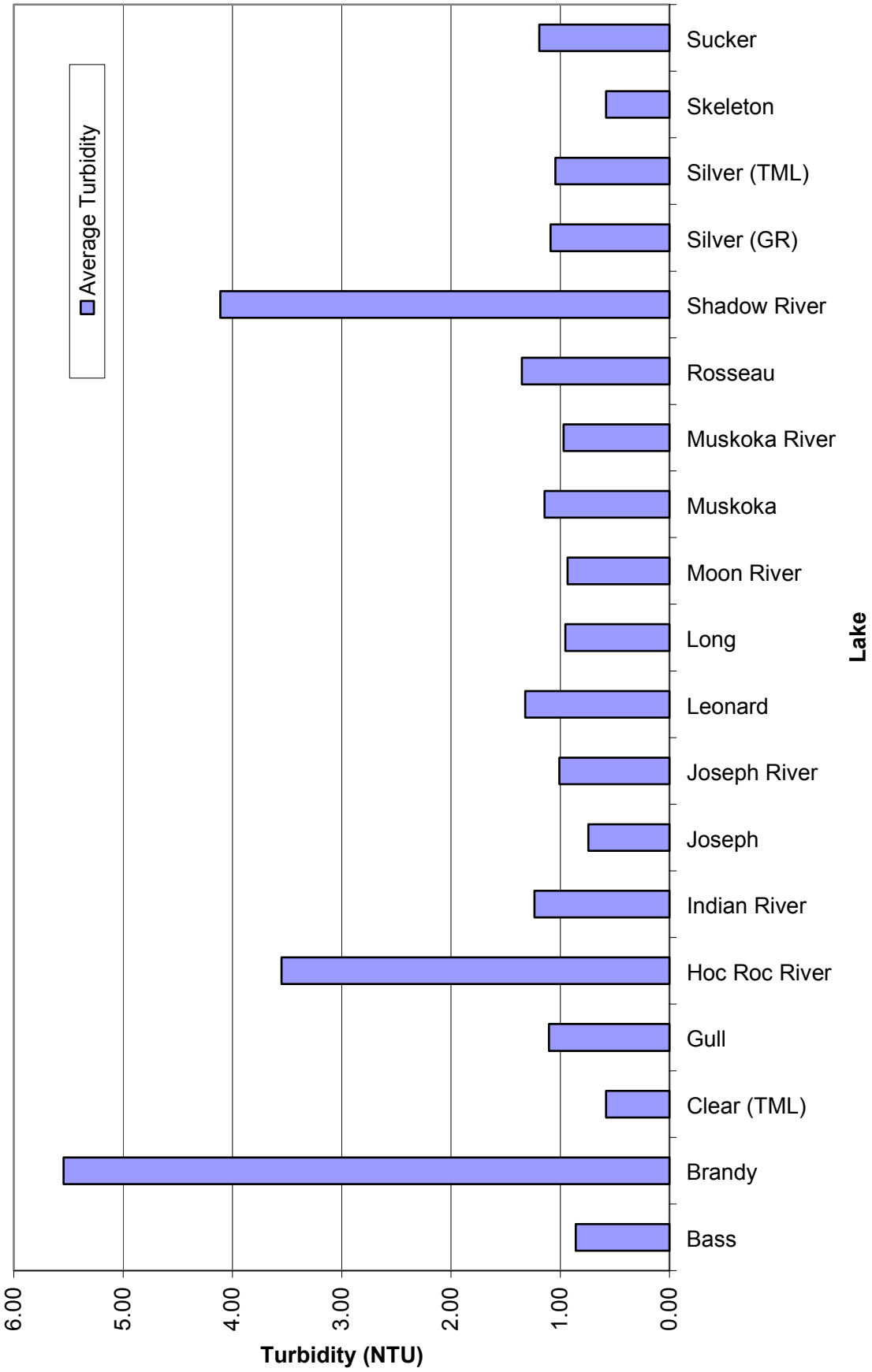
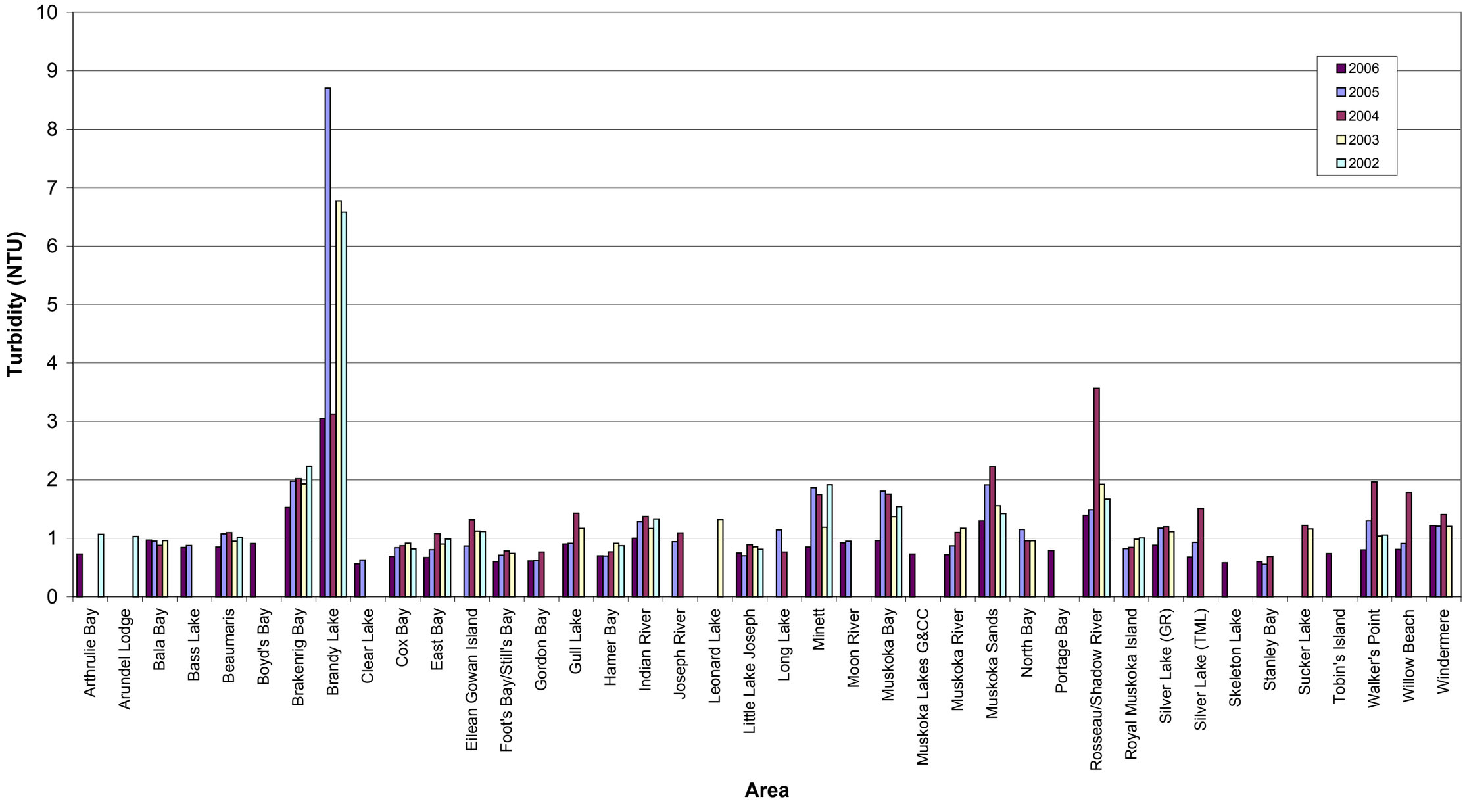


Figure 9 - 2002-2006 Average Turbidity



### *Temperature*

Average (arithmetic mean) temperature recorded at all sites in 2006 is shown in Figure 10. Average temperatures ranged from 17.2 degrees Celsius (at Tobin's Island) to 23.8 degrees Celsius (at the Indian River). There are no objectives for water temperature, and temperature has no effect on human health. However, water temperature can affect ecosystem productivity and other parameters, as evidenced by 2005 total coliform observations.

Figure 11 shows the long-term average temperature for each water body (since 2002). Note that the two highest readings, Clear Lake and Bass Lake, were only measured in 2005 and 2006, during two years when all temperatures were higher than average. This makes their total average temperature appear higher than other water bodies that have been part of the MLA initiative for a longer period.

The four-year trend in temperature is shown in Figure 12. The trends show that water temperature remained higher than average in 2006, but dropped by an average of 1.4 degrees Celsius from 2005. 2006 saw the second warmest water temperatures since 2002, 0.2 degrees Celsius warmer than those recorded in 2002.

## Conclusions

A review of program results show that between 2002 and 2004, bacteria levels (both *E.Coli* and total coliform) were typically well below the objectives set by the MLA. In 2005, counts of total Coliforms exceeded the MLA Safe Water Objective in 16 areas, but *E.Coli* counts remained typically low. In 2006, counts of total Coliforms decreased, but remained higher than years prior to 2005. The increase in total coliform, which is an indication of bacteria presence but does not have human health implications, is most likely due to the high water temperatures observed throughout the region primarily in 2005, and to a lesser extent in 2006. Note that these bacteria levels are still well below the safe water standard set by the Province of Ontario at all sites (except Site MSN-4 in 2005 where *E.Coli* averaged higher than is considered safe for recreational usage of water). In most areas, therefore, it remains highly unlikely that a recreational user of these areas would become stricken with a bacteriological

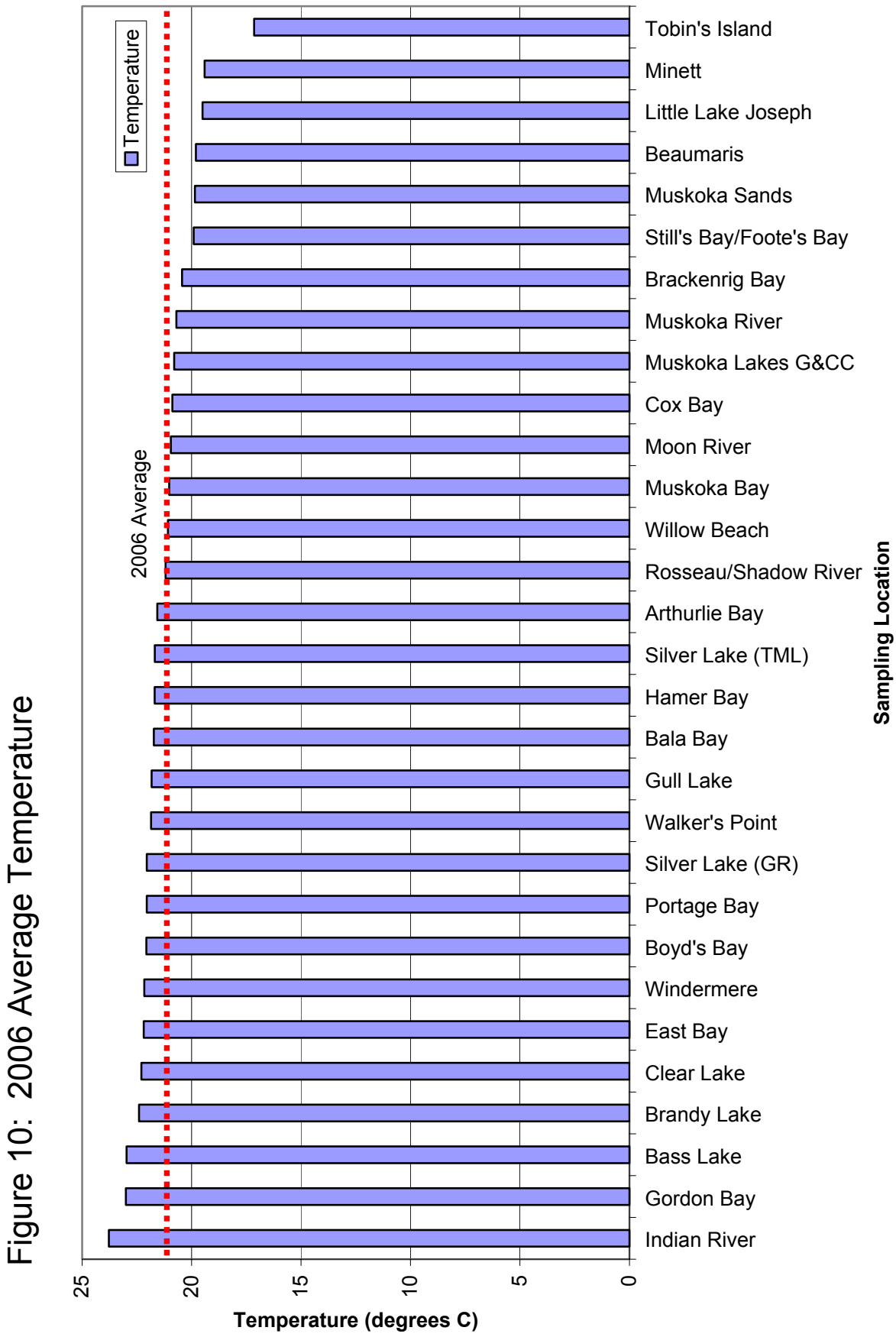



Figure 10: 2006 Average Temperature

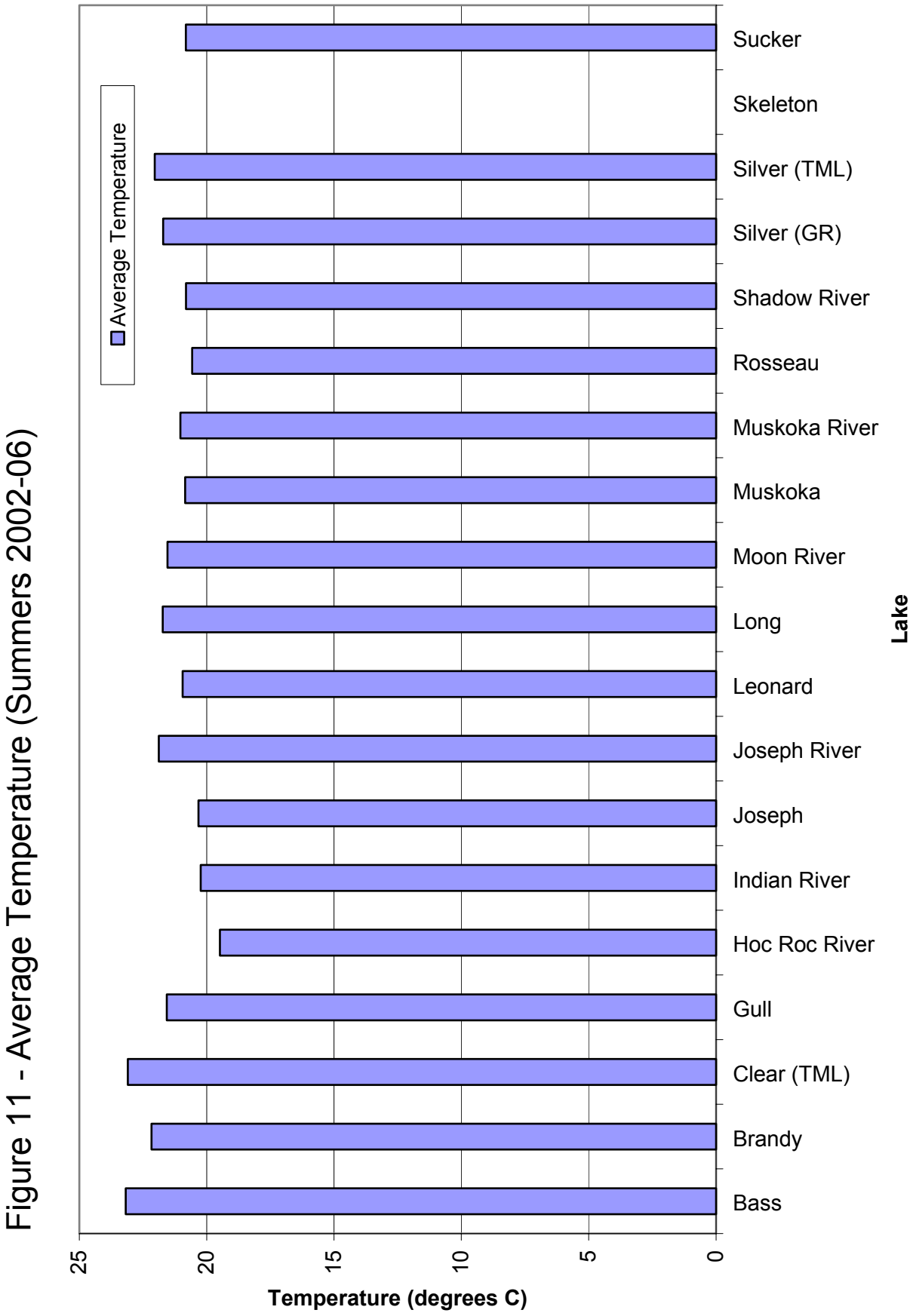
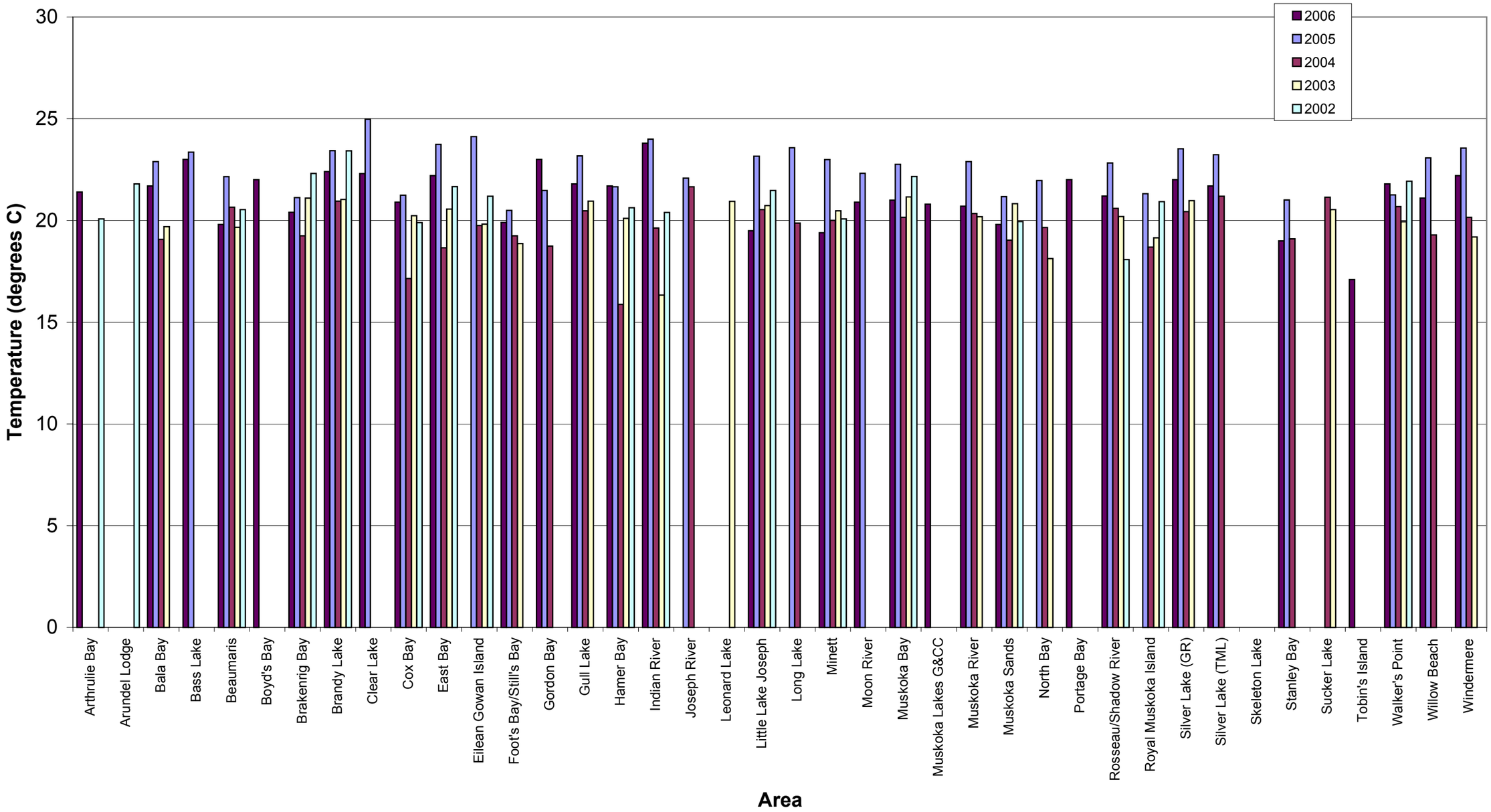



Figure 11 - Average Temperature (Summers 2002-06)

Figure 12 - 2002-2006 Average Temperature



infection. Long-term study of bacteria levels in the Muskoka Lakes indicate that water temperature has a significant impact on the counts of bacteria observed.

Total phosphorus results show that most lakes in the area remain below the threshold phosphorus level set by the District of Muskoka's Lake System Health Program. The MLA water quality initiative undertakes more thorough total phosphorus sampling at a greater number of sites and over a longer period of time. These results can be used to confirm or challenge classifications made in the LSHP, identify lake segments (bays) that may be over-threshold with respect to phosphorus concentration but are not specifically modeled or monitored by the District of Muskoka, and identify sources of phosphorus loading within small lakes and lake segments that are classified as over-threshold for the purpose of remedial measures.

There are important differences in water quality between one area and another on the same lake. Results from specific areas and sites show that some areas tend to have higher readings for all parameters. These include the Muskoka Sands area and the Willow Beach area. A new area added to the MLA program area in 2006, Boyd's Bay on Lake Muskoka, also showed signs of possible impairment. Likewise, specific areas consistently return the lowest readings across all parameters. These areas include Little Lake Joseph, Stanley Bay, Gordon Bay and Tobin's Island, a new area added in 2006.

**Report Prepared by:**

Michael Logan, BSc MASc MURP
President

26 October 2005

## Using the Website

Detailed results from all sites monitored are accessible in an interactive web-based application. To access the water quality initiative's online results, visit the MLA's website at http://www.mla.on.ca and click "Water Quality" on the main menu. Detailed background information including a glossary and references can be accessed by clicking on "About this Site". A more detailed step-by-step tutorial on using the website to access data is also available on this page.

Reports dating back to 2001 can be downloaded directly from the main water quality page. To get results using the interactive web-based tool, you will need to use Internet Explorer 6.0 or later with the downloadable Scalable Vector Graphics plug-in from Adobe (http://www.adobe.com/svg/viewer/install, or by following the link on the main water quality page). Other browsers such as Mozilla's Firefox (http://getfirefox.com) do not require a plug-in. The most up-to-date system requirements will be listed on the main page.

The results can be directly accessed by following the "Get Results" link. Once you click on this link, you are prompted to agree with a disclaimer that the MLA has written to protect itself, its volunteers, affiliates and contractors against any liability arising from the use of the results of the Water Quality Initiative. The use of this disclaimer allows the MLA to share its results with anyone who is interested in them. Once you agree to the disclaimer, you will have full access to all of the data from the Water Quality Initiative.

### *Searching*

You may now search for the results that you are specifically interested in. The first step is to select the time and place that the data was collected. You can then graph your selected results in a variety of ways to help you understand them. Keep in mind that neither bacteria nor total phosphorus are measured at all of the sites in the program, and that all sites have not been included in all years, so there may be some data gaps.

**Example:** View 2005 Brackenrig Bay results.

1. Select "Brackenrig Bay" from the *Location Name* drop down menu.
2. Select "2005" from the *Starting Year* drop down menu.
3. Select "2005" from the *Ending Year* drop down menu.
4. Click the "Search" button.

You may choose to search the data geographically, temporally or both. The temporal boundaries (the years of data you are interested in) can be defined using the drop-down menus entitled “Starting Year” and “Ending Year” (see Figure A). Information for both of these years and all of the years in between will be displayed. If you don’t select any years, results from all years will be displayed.

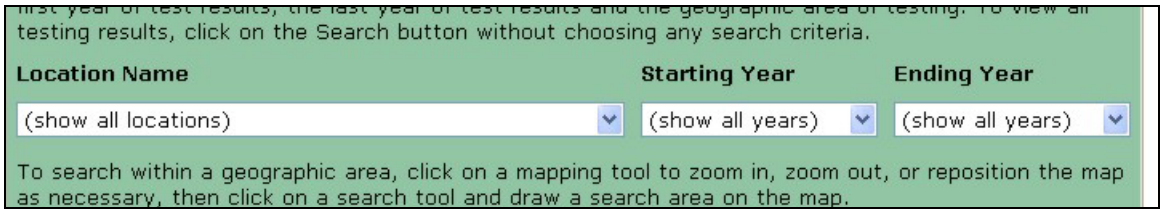



**Figure A**

Geographic boundaries of your search can be defined in two different ways. If you are only interested in data from one area, know that data exists for that area, and know the name of the area, you can select the area name from the drop-down menu called “Location Name” (see Figure A). If you would rather find the area on the map, you can do so by pointing at the area you are interested in. To do this, you will need to follow the following easy steps:

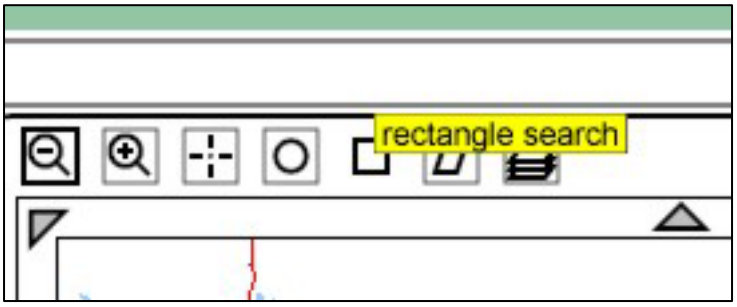



**Figure B**

1. Select one of the search tools in the map window. The search tools are identified when you use the mouse to move the pointer on top of one of the tools (see Figure B).
    - “Radius search” allows you to search a circular area on the map
    - “Rectangle search” allows you to search a rectangular area on the map
    - “Polygon search” allows you to search an irregular shaped area on the map – this allows for detailed searches, but you will need to define each corner of the polygon to search results in
2. After selecting the search tool you want to use, click on the map and drag the mouse until the shaded area includes the area you are interested in. If

you make a mistake, simply start again. The old shaded area will disappear and the new one will appear.

**Example:** View all results in South Lake Muskoka.

1. Select the *zoom in* tool.
2. Click on the map near Gravenhurst.
3. Select the *radius search* tool.
4. Click on the centre of the Lake Muskoka basin and drag the mouse until the shaded area encompasses all of South Lake Muskoka.
5. Click on the "Search" button.

3. If you need to see a more detailed map, use the zoom in tool in the map window to zoom in to a specific area. If you need to zoom out, switch to the zoom out tool and go back a step. When the map is showing enough detail for you to select the area you are interested in, switch to one of the search tools and make your boundary selection.

If you do not select a geographic location, information for all locations will be displayed.

After you have set both the parameters for your search (geographic, temporal or both) click on the "Search" button below the map to display the results that match your search criteria. If no data matches your criteria, or you wish to display different data, click on the "Get Results" link to restart the search process.

## *Viewing the Information*

### Sorting

Once the data you are interested in viewing is displayed on the screen, you can view it in a variety of ways. You can sort the data by any of the columns listed by clicking on the small, unshaded triangles next to the column heading (one triangle sorts the records in ascending order, the other sorts in descending order).

**Example:** Compare total phosphorus concentration at site BAL-0 between 2003 and 2005.

1. Search for all results from Bala Bay (as in preceding examples).
2. Click on upward facing triangle beside *Site Code* to list all BAL-0 results at the top of the display list.
3. Check the checkboxes beside BAL-0 2003, BAL-0 2004 and BAL-0 2005.
4. Go to the command line at the bottom of the display list.
5. Select "total phosphorus" in the first drop down menu and "descending year, alphabetical site name" in the second drop down menu.
6. Click the "Graph" button. The graph shows three bars, so you can see how the concentration has changed over time.

## Displaying sites on the map

Some or all of the sites in the display list can be shown on the map. Multiple sites can be selected from this list by checking the checkbox to the right side of each site you wish to show. If you wish to select all of the sites in the display list, click the "Select All" link at the bottom of the display list. To display, click on the "Show selected sites on map" link. The map, set to a scale appropriate for the area you have selected, will appear showing a yellow dot indicating the location of each site selected. The site code (corresponding to the record in the display list) for each site appears when you point to the dot with the mouse pointer. Clicking on a dot shows photographs of the site.

## Graphing

You may wish to graph the results. Check the checkbox to the right of each record in the display list you wish to graph. At the bottom of the display list, use the drop down menus to complete the command: "Graph [parameter] by [sort method]." Click the "Graph" button to display the results as requested.

**Example:** Compare how levels of *E.Coli* differed at all Hamer Bay sites in 2005.

1. Search for all results from Hamer Bay in 2005 (as in preceding examples).
2. Click on the "Select All" link at the bottom of the display list to check all of the checkboxes shown.
3. Go to the command line at the bottom of the display list.
4. Select "*E.Coli*" in the first drop down menu, and "descending year, alphabetical site name" in the second drop down menu.
5. Click the "Graph" button. The graph shows five bars (one for each site), so you can see how the concentration differed within the bay.

Completing this statement allows you to create a graph that shows any of the parameters measured (*E.Coli*, total coliform, total phosphorus, turbidity or temperature) sorted by year, location, or value.

Clicking on a bar of the graph shows a map and photographs of the site. If a question mark appears on the graph, you can point to it to show a note that will help you interpret the data.