2010 GEIGER REPORT
INTRODUCTION, CONCLUSIONS, & RECOMMENDATIONS

Introduction:

The objective of the 2010 GEIGER[1] Report is to update the "Detailed Technical Description of the Blue Sea Lake and Blue Sea Stream watersheds" produced in 2000. The territory covered by the present analysis focuses on the Blue Sea Lake watershed and partially covers the Blue Sea Stream watershed that flows between Blue Sea Lake and Lac Perreault. The major portion (ie, 84%) of these watersheds is located within the municipalities of Blue Sea and Messines; the watersheds extend beyond this area but this report concentrates on the activities that take place within the aforementioned municipalities.

The overall objective of this study is to highlight the principal environmental pressures exerted on the lake and, based on that information, produce an environmental frame of reference to assist in decision-making. The specific objectives include updating the data on the watershed's natural and man-made environmental/infrastructure activities and components, and estimating the amount of phosphorus feeding into Blue Sea Lake. The report will also include a characterization of Blue Sea Lake's shoreline and an evaluation of soil erosion.

To achieve its objectives, the report provides a technical description of the watershed, covering such subjects as soil use, soil composition, milfoil distribution, etc utilizing text, tables and maps. The report also includes the results of three sets of water samples taken during the summer of 2010, tables summarizing our estimates of phosphorous inputs and concentrations, as well as a characterization of Blue Sea Lake's shoreline using a standardized methodology.

At the end of our analysis of the watershed's natural and man-made environment/infrastructure, we will make several recommendations on land use and development.

Conclusions and Recommendations

The updating of the detailed technical description of the Blue Sea Lake and Blue Sea Stream watersheds not only allows us to establish the trophic[2] state of the lake, it also allows us to observe changes that have occurred during the past decade. In this section of the report, we first present the principal conclusions of the study and then detail recommendations regarding measures that should be taken to preserve and monitor the quality of Blue Sea Lake's water.

[1] GEIGER is a French acronym which in English means "Interdisciplinary Group of Regional Environmental and Geographic Studies"
[2] Trophic refers to the level of nutrients in the water.

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Conclusions:

State of the Watershed and Trophic State of the Lake:

- Two independent methods were used to evaluate the concentration of phosphorus in Blue Sea Lake. A model using export coefficients predicted a value of 7.8 µg/l, while an analysis of water samples gave a measure of 6.5 µg/l for 2010. The average annual value of this concentration since 2004 has never exceeded 8.2 µg/l. The strong convergence of these results lends great confidence to our modeling methodology. This clearly establishes that Blue Sea Lake is oligotrophic (ie, a lake with clear water, well under the 10 µg of phosphorus per litre limit set for this trophic designation).

- Septic tanks are the principal human source of phosphorus, providing one third of the phosphorus entering the lake. Agriculture only contributes around 12%. The remainder emanate from natural (vice human) sources, coming principally from the forest and the atmosphere. It should be noted that, unlike the majority of the lakes in the Outaouais, Blue Sea Lake rests on a limestone base which makes it more susceptible to phosphorous enrichment.

- From a location perspective, phosphorous concentrations across the lake vary from one time to the next and display no clear pattern. As a result, one cannot extrapolate the overall state of the lake based on an elevated level of phosphorus in one particular location. For example, the elevated level of phosphorus in Lac Laverdure is not matched by a similarly elevated level where Laverdure Stream enters Blue Sea Lake. This tends to confirm the phosphorous retention model we have used in estimating the impact of phosphorus in sub-watershed lakes on Blue Sea Lake (ie, we estimated that 77% of phosphorus fed into such a lake would be retained in that lake).

- The majority of Blue Sea Lake's shore area is inhabited but most of that land is covered by natural or ornamental vegetation. As a result, the shore area is in very good condition. Although the conversion of shoreline embankments is always desirable, it is not a priority given that such embankments make up only 3.4% of the entire length of the shoreline. The shore area of the islands is in excellent condition and is no cause for worry. The revegetation of the shore area is always desirable in order to maximize the retention of phosphorus in the riparian zone (i.e., the land closest to the shoreline).

- We did not encounter any blue-algae, but we did observe some green algae which is harmless. We also noted milfoil in numerous shallow locations around the lake. Although not desired, the proliferation of this invasive plant is normal and not was caused by the level of phosphorous concentration in the water.

Evolution of the Watershed and the Quality of Water in Blue Sea Lake between 2000 and 2010:

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- The changes observed in the watershed during the past decade are minor. There has been little change in land use, although the forest and fallow land have gained in area at the expense primarily of farmland. The number of industries and commercial enterprises, although small in 2000, was even smaller in 2010.

- There has been an increase in the total number of residences and a rise in the number of permanent residences due in part to the conversion of secondary residences to principal ones. This seems to correlate to the aging of the population noted in the two last censuses (2001 and 2006). The population grew significantly during this period, particularly in Messines which experienced a 22% increase, while the general rate of occupancy has increased due to the conversion of residences (from secondary to principal). This is significant because, if the rate of phosphorous retention in septic tanks had not changed between 2000 and 2010, the export of phosphorus from these tanks would have increased significantly. The municipalities have surveyed their septic systems and found the following: in Messines, a significant number of the systems surveyed were installed after 1990 while, in Blue Sea, the majority of the systems surveyed in the direct impact zone[3] are judged to be non-pollutant (in this municipality, the surveys did not include properties in the indirect impact zone).

- According to a model using export coefficients to calculate the concentration of phosphorus in the lake, that concentration has not changed between 2000 and 2010, even though there has been a change in land use and in the rate of residential occupancy. This seeming contradiction could be explained by the fact that one type of change offset another. For example, the increase in forest and fallow land at the expense of farmland would reduce the volume of phosphorus entering the lake while the increase in population and residential occupancy would increase said volume. At the level of the watershed, these opposing tendencies could cancel themselves out.

- The concentration of phosphorus in the lake varies considerably from place to place, summer month to summer month, and year to year. The average annual concentration of phosphorus from 2004 to 2010 has fluctuated between 4.3 and 8.2 µg/l. These fluctuations are due to the combined effect of the lake's dynamic hydraulics and the rate of sampling. No tendency can be discerned for the period in question. It would appear, therefore, the Blue Sea Lake has not experienced any change in its trophic condition over the medium term (ie, 5 to 10 Years), a fact confirmed both by predictions based on the estimated rates of exportation and the laboratory analysis of water samples.

- There has not been a significant change in soil erosion between 2000 and 2010.

- Simulations based on several development scenarios revealed that a modest increase in the number of watershed residences (ie, 25 and 50) would lead to a small but still significant increase in phosphorous concentration.

[3] The direct impact zone is that within 150 meters of the high water mark

Recommendations:

To Maintain or Improve the Quality of the Water:

1. Given that septic tanks continue to be the most important human source of phosphorus (contributing one third of the total), that the phosphorous retention rate of such tanks is relatively low, and that there is a strong likelihood that residency rates will continue to increase, more effort should be made to improve the retention of phosphorus emanating from this source by placing greater emphasis on the use of phosphate-free products, the upgrading of septic tanks and drainage fields, the revegetation of the shore area, etc.

2. There should be a systematic collection of information regarding the condition of septic tanks and their renovation (ie, place, date, type of renovation) as well as the type of septic systems installed at new residences. During this study, information on this subject was difficult to obtain which complicated the the evaluation of the effect of such renovations.

3. The conversion of farmland to forest or fallow land, both of which export less phosphorus, has helped to compensate for the rise in the amount of phosphorus generated through the increase in population and residency rates. It is important, therefore, to limit the reconversion of forest and fallow land to farmland, in particular in the direct impact zone. An increase in residential development combined with an increase in farming activities would generate a significant increase in phosphorous concentration in Blue Sea Lake. Accordingly, it would be worthwhile to track the annual statistics on land use available through the regional office of the Ministère de l'Agriculture, des P□cheries, et de l'Alimentation du Québec (Quebec Ministry of Agriculture, Fisheries, and Food).

4. Even though Blue Sea Lake does not show signs of eutrophication[4], the current concentration of phosphorus (the lake is not far from the mesotrophic state) combined with an increase in population could - in the absence of control measures - lead to a harmful increase in phosphorous levels. Accordingly, action should be taken to minimize the direct "inflow" of phosphorus; such actions include: the revegetation of the shoreline; a ban on fertilizers; the containment of ash generated by bonfires so that it does make its way into the lake; the use of phosphate-free products; the monitoring of farming activities; etc.

5. Preventative action should be focused on the direct impact zone as lakes within the sub-basin (ie, in the indirect impact zone) appear to retain a very significant portion of

[4] Eutrophication - "The process by which a body of water acquires a high concentration of nutrients, especially phosphates and nitrates. These typically promote excessive growth of algae. As the algae die and decompose, high levels of organic matter and the decomposing organisms deplete the water of available oxygen, causing the death of other organisms, such as fish. Eutrophication is a natural, slow-aging process for a water body, but human activity greatly speeds up the process."

phosphorus. That said, situations that are clearly problematic in that zone (such as that at Lac Laverdure) must be addressed.

6. Eurasian milfoil has spread throughout a large portion of the lake; this is probably more a function of the plant's adaptability than of the level of phosphorus in the lake. Its ability to reproduce by fragmentation likely accounts for its wide distribution. Many lakes across North America have been affected by this invasive plant and Blue Sea Lake is not a special case. Once it's been introduced into a lake, it is very difficult to eradicate milfoil. We recommend, therefore, that - as a first step - measures be taken to limit its proliferation. Such measures would include: avoid chopping the plant with boat propellers as milfoil reproduces by fragmentation, educate the users of the lake regarding the nature of this invasive species, and encourage everyone to take steps to prevent its reproduction. We also recommend that you contact organizations that want to test new control measures. Innovations such as the introduction of a species of weevil that eats the plant (ie, *Euhrychiopsis lecontei*) and the mechanical harvesting of the plant have to date had only limited and/or very short term effect. It is also very important to prevent the introduction of other invasive plants by demanding that boats be washed before they are put in the water.

7. Lac Laverdure has an elevated concentration of phosphorus. However, it was noted that this lake acts as a sort of retention basin given that a similar high concentration of phosphorus was not found at the point where the stream that drains Lac Laverdure empties into Blue Sea Lake. The golf course near Lac Laverdure is - without question - the principal cause of the eutrophication of the lake as there are very few cottages around the lake and no farming in the immediate area. To reduce the impact of the golf course on the lake, it is suggested that the construction of a buffer strip between the golf course and the stream that flows from the course to the lake be considered and/or that the owner of the golf course be asked to limit his use of fertilizers on the course, particularly in those areas that drain towards the aforementioned stream.

8. Based on our simulation of various residential development scenarios, a modest increase in the number of residences and in the rate of occupancy would not trigger a rapid eutrophication of Blue Sea Lake. However, it is most important that any increase in phosphorous input caused by such development be offset by tightening the quality control on septic systems. In addition, we recommend that the level of development be closely monitored and recorded, and that the impact of such development be compared with the scenarios we have developed. We also suggest that the Blue Sea Lake Watershed Association check the 2011 census results to track any changes.

9. Renewed and even greater effort should be made to sensitize the local population regarding the quality of the lake water. The efforts in this regard undertaken during the past decade have definitely had a positive effect in preventing an increase in the amount of phosphorus per person feeding into the lake (eg, by using phosphate-free

products) and in improving the rate of phosphorous retention in septic tanks and drainage fields.

To Closely Monitor Water Quality.

10. Phosphorous concentration found in water samples taken across Blue Sea Lake varied considerably from location to location and from month to month. Only systematic observation over a long period time will reveal any trends. Given the cost of such analysis, extensive sampling - such as that done in the summer of 2010 (ie, three series samples from 19 locations) would be cost prohibitive if done annually. Nevertheless, such sampling was very important to this study and demonstrated that the four locations used for sampling since 2004 provide excellent representative data. Accordingly, we recommend that - to determine the average level of phosphorous concentration, samples be taken at least three times a summer at these locations (ie, 72A, 72B, 72C, and 72D). Ideally, this should be done each year. If you wish to reduce costs, it is preferable that sampling be done less frequently (eg, once every two years) rather than reducing the number of samples taken each year. To offset this reduction in sampling, Secchi dish readings could be taken each year; these readings are much less expensive, but also much less reliable. The exact location at which samples are taken is not of great importance. Use of an inexpensive GPS is sufficient to ensure that the same locations are used each year. It is important to avoid taking samples when the weather conditions are atypical (eg, after several days of rain, after a storm, etc...).

11. The Blue Sea Lake Watershed Association should continue to record water test results on a methodical and systematic basis, recording the date, time, method, etc... The Association should ensure that these results are provided to the municipalities and other interested parties.