Bonnechere River Watershed Water Quality: A guide to water quality monitoring along the Bonnechere River for use by rural and urban community groups

Prepared by Holly Gardner
Project Coordinator
Bonnechere River Watershed Project
Feb. 2006

Water Quality Report 2006

Table of Contents

References

Appendix

1. Nitrate + Nitrite Raw Data
2. Total Phosphorus Raw Data
3. Soils Watershed Maps
5. E-Coli
6. Biochemical Oxygen Demand
7. Dissolved Oxygen
8. Forestry Watersheds Maps

History –

The BRWP water quality testing program was one of the first projects initiated by the Bonnechere River Watershed Project (BRWP). The program was made possible through a partnership between the BRWP, a professor at Kemptville College, who provided the analysis of results and the Ministry of Environment, which provided the testing equipment and initial analysis.

The program was rolled out in two phases. The first phase involved water quality testing throughout the entire length of the watershed and the results were presented at the BRWP 2003 Annual General Meeting. The results indicated that future testing should be focused on the section of the river between Douglas and the Castleford. The second phase of testing began in 2003 on a monthly basis and continued for two years. Results of the second phase of testing were presented by Professor Ben Hawkins of Kemptville College at the BRWP 2005 AGM. This set of results indicated that the water quality appears to be relatively good. However, there are signs of some nutrient loading from non-point sources and some concerns as the quality of water changes in the lower reaches of the river.

Goal –

The goal of the water quality testing program is to monitor water quality along the main body of the Bonnechere River, to identify areas of concern and to use results for the development of future water quality improvement projects.

Objective –

- Develop and maintain a partnership with the Ministry of the Environment and Kemptville College.
- Complete water testing at necessary intervals.
- Provide results to the public when they become available.
- Identify potential projects that would improve the overall water quality in the river.
- Continue monitoring to identify positive results of projects once implemented.

Test Site information

During the first phase of the water quality testing November 4, 1999 – July 4, 2001 water samples were taken from near the Highway 17 bridge, Renfrew Beach, Eganville Beach, Golden Lake Bridge, Tramore Bridge and Turners Camp Bridge.

During the second phase of water quality testing July 22, 2002 – July 5, 2004 water samples were taken from Castleford, Highway 17 bridge, Renfrew Beach, Butler Road Bridge, Bonnechere Road Bridge and Stone Road Bridge.

In the first phase, samples were taken quarterly whereas in the second phase samples were taken on a monthly basis. However, sampling was dependant on volunteer availability, accessibility of test sites and ice conditions.

Canadian Water Quality Guidelines (Environment Canada, 2002)

There are six types of voluntary guidelines for Canadian Water Quality that have been created through a collaboration between the federal, provincial and territorial governments in Canada. These six types of voluntary guidelines are:

1. Guidelines for Canadian Drinking Water Quality
2. Guidelines for Recreational Water Quality
3. Canadian Water Quality Guidelines for the Protection of Aquatic Life
4. Canadian Water Quality Guidelines for the Protection of Agricultural Water Uses
5. Canadian Sediment Quality Guidelines for the Protection of Aquatic Life, and,
6. Canadian Tissue Residue Guidelines for the Protection of Wildlife Consumers of Aquatic Biota

1. Guidelines for Canadian Drinking Water Quality

These guidelines relate directly to water quality for use as drinking water. They outline the maximum allowable concentrations of a number of different parameters including biological, physical and chemical indicators. These guidelines apply to all drinking water (public or private) in its finished form as it comes from the tap.

2. Guidelines for Recreational Water Quality

These guidelines relate directly to water quality for use with recreational purposes (canoeing, kayaking, swimming, diving, etc.). The parameters outlined under these guidelines generally relate to the potential for infection related to micro-organisms, general aesthetic conditions and visibility.

3. Canadian Water Quality Guidelines for the Protection of Aquatic Life

These guidelines relate directly to water quality for the purpose of maintaining healthy aquatic life. These guidelines look at indicators that can impact aquatic life including, temperature, acidity and toxic chemicals. The guidelines list the chemicals that if found within a particular range should not negatively impact aquatic life. They are based on sensitive species of plants and animals.

4. Canadian Water Quality Guidelines for the Protection of Agricultural Water Uses

These guidelines relate directly to water for use in irrigation of crops that may be sensitive to toxic substances (pesticides or herbicides) and water used for livestock. These guidelines outline limits for both crop safety and livestock safety (including toxic chemicals, water intake and potential for accumulation in their bodies).

Nitrates (Environment Canada, 2005)

Nitrates Sources and Movement

There are many different types of nitrogen in the environment and one form of nitrogen is nitrate. The type of nitrogen found in the environment depends heavily on a variety of parameters within the water including temperature, pH, oxygen availability and the biological community type. Nitrate is the most dominant form of nitrogen found in the environment, which also includes Nitrite and Nitrogen gas. Nitrate can be found in the natural environment but can also be released into the environment from sources such as agricultural operations (fertilizers) and industrial operations (oxidizing agents, pyrotechnics, matches, photography and glass making.).
When nitrate is released into the environment it moves very easily. Although it is readily taken up by plants it does not bind to water or soil molecules. Once the nitrate is released into the environment it can take a variety of pathways that depend on the types of conditions that exist in the water. It can move through the soils and enter the groundwater supply or it can enter the surface water system. If there is little oxygen available in the surface water then bacteria can convert the nitrate to nitrite and finally end up as nitrogen gas. When there is an abundance of oxygen in the surface water then the nitrate will be taken up by the aquatic plants and promote growth.

Impact

Having a general idea of what a nutrient does in the environment we can draw some conclusions around the impact of its presence. It is common knowledge that nitrates are necessary for plants. If found in high concentrations in surface water, plant growth will be excessive. Many different potential impacts will result. Algal blooms can reduce oxygen levels in the water, putting stress on aquatic animals, and some types of algae can produce toxins that are hazardous to other aquatic organisms. Excessive nitrates can also adversely affect aquatic animals and invertebrates by influencing their growth rate, maturity, and reproductive abilities. Extreme levels can be lethal to aquatic animals and invertebrates. These animals and invertebrates can also be more sensitive to high levels of nitrate during their early life (larval stages).

Safe limits

The Canadian Water Quality Guidelines (CWQG) have tentative limits set for concentrations of nitrates found in the environment. However, because of the limiting factors around the absorption of nitrates into the environment these limits are just a guide. Should the concentration of nitrate exceed the level outlined in the guideline it does not mean that the impacts discussed above will be expressed in the environment. These impacts are limited by many different outside factors including dissolved oxygen levels.

The CWQG to protect freshwater life should not exceed 13mg/l (CCREM,2005)

Typically, the majority of Canadian lakes and rivers studied do not exceed 4 mg/l. If greater concentrations are detected they are generally located in areas of intense agricultural, industrial or urban developments.

Results

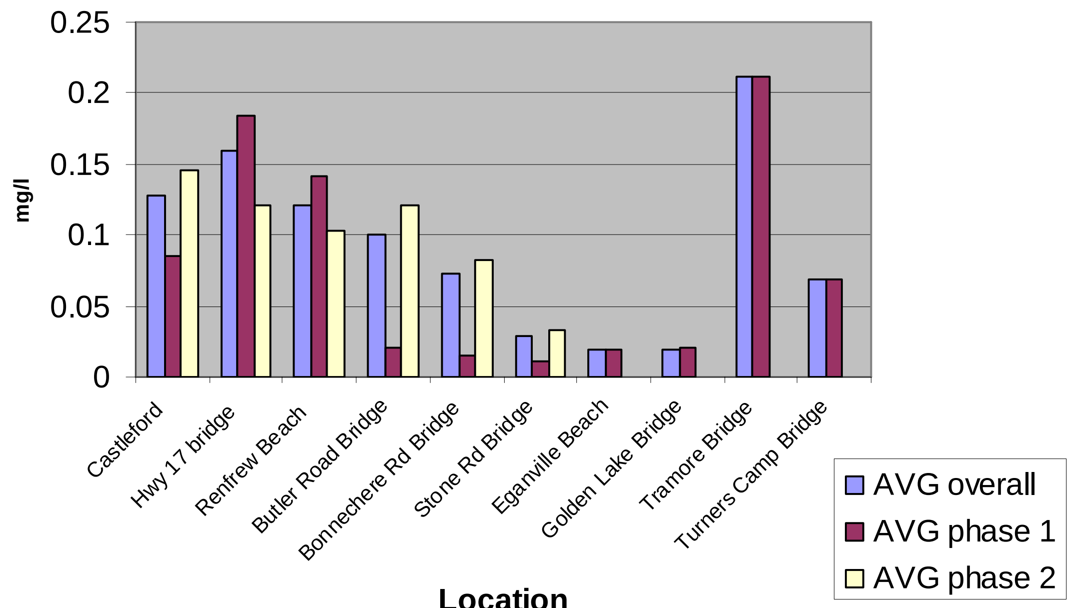

Figure 1. Nitrites +Nitrates concentrations sampled along the Bonnechere River during two phases of testing from 99-2004.

As expressed above in Figure 1. the values found at the test sites along the Bonnechere River during the two phases of testing undertaken are all well below the CWQG to protect aquatic life of 13 mg/l. All of the values are also well within the average Canadian nitrate concentration for freshwater of 4mg/l.

In Figure 1, the levels of nitrate fluctuate from station to station. There is some variation from site to site in the average concentration detected. The variation can be attributed to what would occur if there was a period of time with very little precipitation followed by a large rainfall event which would, in effect, flush the nitrates through the system. This type of result would also be consistent with spring melts.

Higher concentrations were found from the Renfrew Beach to Castleford. However, the concentrations found are all less then 0.5mg/l, well within the national average. The raw data is presented in Appendix 1 of this document.

Phosphorus (Environment Canada, 2005)

Phosphorus Sources and Movement

Phosphorus is a naturally occurring nutrient that originates in rocks and is released into the environment as they erode. Phosphorus can take a few main pathways to enter the surface water system;

1. The atmosphere
2. From sewage treatment plants and release from industrial development (point sources).
3. Run-off from cleared land, storm water and agriculture, shoreline erosion (non-point sources).

Just like nitrates, phosphorus has many factors influencing its occurrence in the environment that can vary based on land use types, human development, pollution, geology, etc. Phosphorus occurs in different states as organic, inorganic and dissolved organic within the water system. Inorganic phosphorus is consumed by aquatic plants for nutrition. Phosphorus is the limiting factor for growth of aquatic plants and alga. Of course, the demand or necessity of phosphorus for growth varies between different plant types and so the rate at which phosphorus is taken up can vary. This means that different concentrations of phosphorus will impact water systems differently.

Impact

Superfluous amounts of phosphorus leads to increased plant growth. A variety of impacts will ensue including, changes in plant or animal diversity, additional organic matter as a result of dead plants and animals and decreased oxygen levels. Anoxic conditions in the substrate leads to internal loading, which occurs when the anoxic condition allows additional phosphorus to be released from within the substrate leading to increased turbidity and phosphorus concentrations.

Increased amount of phosphorus and subsequent growth and decomposition use a large amount of oxygen for their processes. When this occurs in an already highly productive system, where oxygen may already be in short supply, it may result in fish kills.
In some rare instances, cyanobacteria (or blue-green algae), an alga that flourishes in high phosphorus conditions, may occur and result in fish kills, a decline in drinking water quality and odour and may lead to toxic conditions that can prove fatal to livestock and wildlife.

Safe Limits

As described above, “healthy” phosphorus levels can vary depending on several natural factors and productivity levels of each system. In order to determine the quality of this indicator based on the large number of influencing variables, a variety of ranges or “trigger ranges” of micrograms of phosphorus per litre of water have been identified: <4

ultra-oligotrophic, 4-10 (oligotrophic), 10-20 (mesotrophic), 20-35 (meso-eutrophic), 35-100 (eutrophic), and > 100 (hyper-eutrophic).
How do trigger ranges apply to different systems? It is reasonable to infer from the description of factors influencing different kinds of water systems whether the systems lean towards being oligotrophic or eutrophic. Water systems that are located on bedrock would likely naturally have less total phosphorus than water systems with a lot of organic matter.

Results

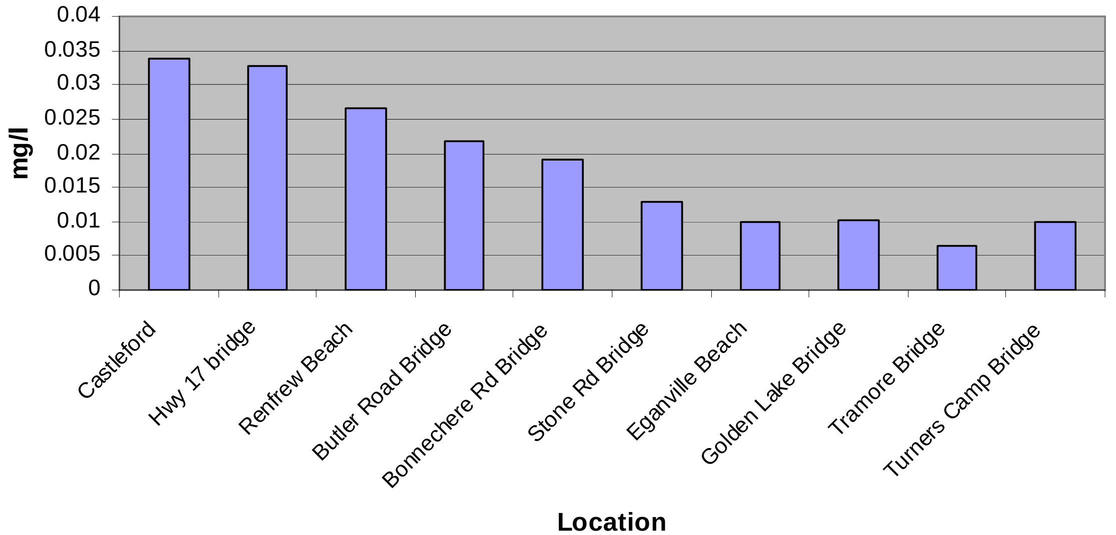

Figure 2. Average phosphorus concentrations from samples taken along the Bonnechere River in two phases from 1999-2004

Total phosphorus levels are relatively low for the majority of sample sites. The concentration of total phosphorus begin to increase at the Stone Road Bridge and continue to increase until the final test site at Castleford. The greater concentrations that begin at the Stone Road Bridge (AVG 0.019mg/l) are consistent with the change of geology from Canadian Shield to clay belt (Appendix 2 Soil Maps). Further increases in concentrations from the Renfrew Beach (AVG 0.027) sample site and beyond are consistent with greater phosphorus from anthropogenic sources, both point and non-point sources, from sewage and agricultural run-off. The raw data is presented in Appendix 3 of this document.

Suspended Solids

Sources and Movements

Suspended solids are an indicator of particulate material found to be floating in the water. This can include materials such as silt, sand, decomposing leaves and pieces of wood. The amount of suspended solids found in a system is dependent on the flow rate. Increased flow rates, depending on geology, can result in erosion of stream, river and lake banks and shorelines. A fast flow rate also inhibits suspended solids from settling to the bottom of the water system.

Impact

Suspended solids play an important role in water quality because they will diminish the amount of light that can penetrate the water and influence plant growth. Suspended solids can also actively transport chemicals in the environment. Pesticides or bacteria can bind to the solids and move through the system.
Alternatively, once the flow rate declines or reaches a pooling area in the water system, the suspended solids can settle out of the water. Once this occurs it can smother life found in the substrate of the water system due to a decline in available oxygen.

Safe Limits

Results

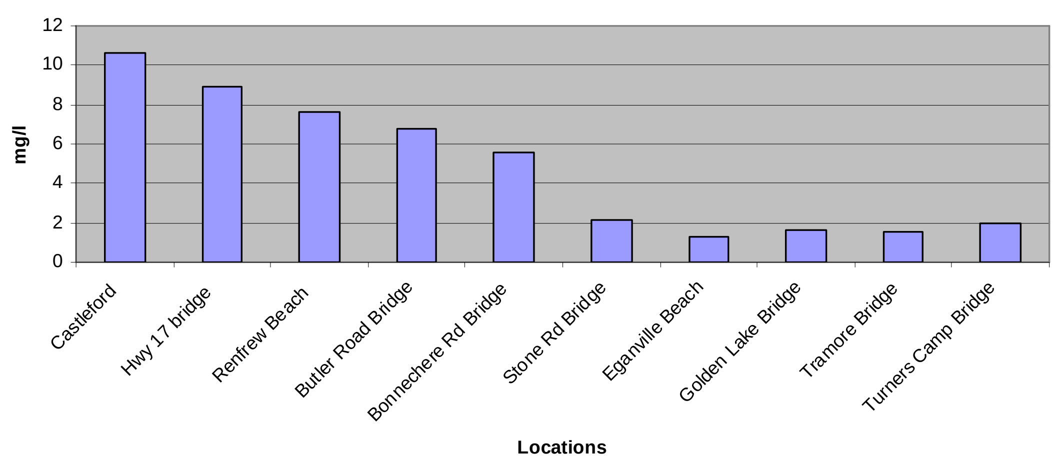

Figure 3. Total Suspended Solids found in samples taken along the Bonnechere River in two sampling phases between 1999-2004.

Figure 3 shows that test samples for the most part in the upper reaches of the river remain between 0-2 mg/l. Higher levels are found beginning at the Bonnechere Road Bridge. The highest average concentration was found at Castleford with an average concentration of over 10 mg/L. The greater concentrations found in the lower reaches of the river are consistent with a change in geology from a bedrock substrate in the upper reaches, moving to a clay belt in the lower reaches (see Appendix 2 map). Additional sources of suspended solids can be increased flow and erosion from destabilized or cleared shorelines. Appendix 4 details the raw data for total suspended solids.

E-Coli
(Guidelines for Canadian Recreational Water Quality, prepared by the Federal Provincial Working Group on Recreational Water Quality. Minister of Supply and Services Canada, 1992, Cat. H49-70/1991E ISBN 0-660-144239-2)

Sources and Movements

Fecal coliforms have all the properties of total coliforms plus they are able to ferment lactose with the production of gas within 24 hours, at an incubation temperature of 44.5C (Guidelines for Canadian Recreational Water Quality, 1992). Sources of e-coli contamination are not identified during standard testing but sources include humans, livestock and other warm blooded animal's fecal matter.

Impact

Measurable levels of e-coli are associated with many exposure related illnesses, including gastro-intestinal illnesses that can be introduced by consuming contaminated water or participating in recreational activities at contaminated sites.

Safe Limits (Guidelines for Canadian Recreational Water Quality, 1992)

Drinking Water – 0 count per 100ml
Recreational water 100 count per 100ml

Results

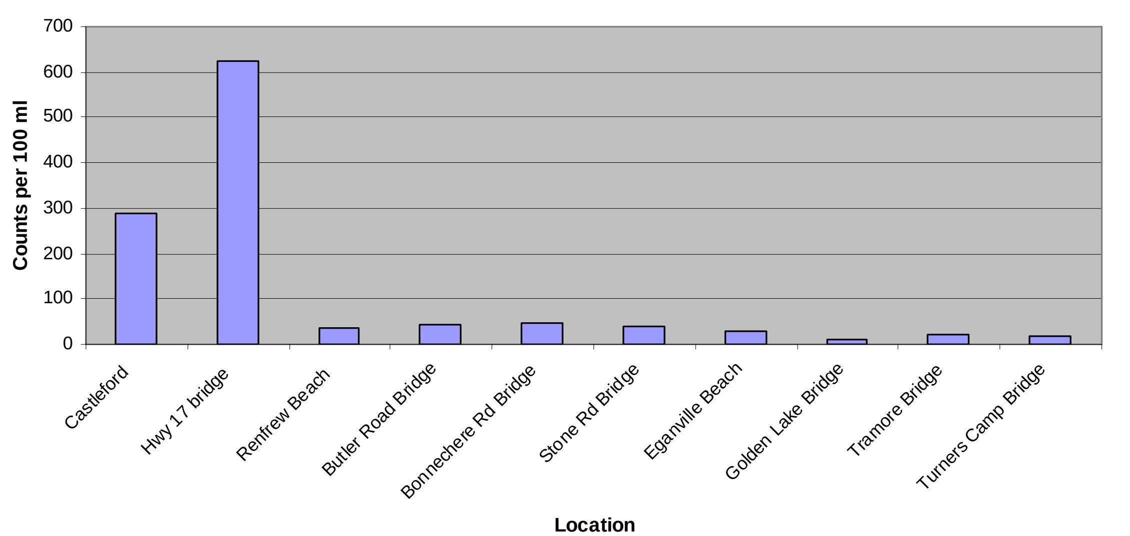

Figure 4. E-coli counts detected at various sample sites along the Bonnechere River during two sampling phases from 1999-2004

The results of sampling indicate that there were detectable levels of e-coli in all of the samples taken. The amounts detected up to and including the Renfrew Beach were below the 100 count per 100 ml of water, as described in the safe limits for recreational water. However, the levels increase exponentially below the Renfrew Beach location. Of the 15 samples taken during the two phases of sampling, 11 samples were found to be above the 100 count per 100 ml water and of those, six samples were above 1,000 counts per 100 ml of water. The higher levels found at these sampling sites can probably be attributed to fecal matter discharge from the Renfrew area. Appendix 5 details the raw data for total e-coli found in the sampling periods.

Biological Oxygen Demand

Sources and Movements

Biological Oxygen Demand (BOD) refers to the amount of oxygen that would be consumed if all the organics in one liter of water were oxidized by bacteria and protozoa The test measures the oxygen utilized during a specified incubation period for the biochemical degradation of organic materials.

Impact

Maintaining adequate levels of oxygen to sustain the life of aerobic organisms is vital to a healthy watershed. When oxygen levels reach an inadequate level they result in fish and other aquatic life mortality.

Safe Limits

Results

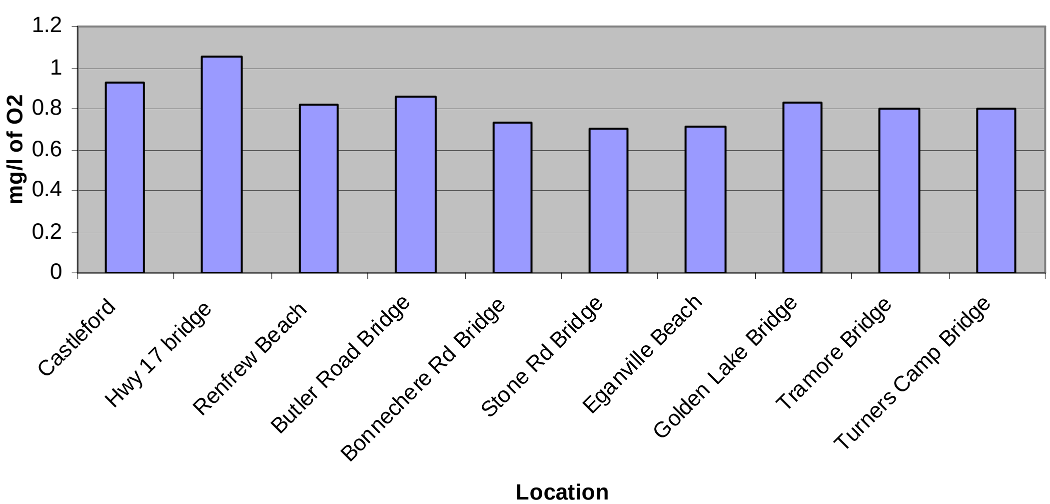

Figure 5. Biological Oxygen Demand (BOD) found at various sampling sites along the Bonnechere River during two sampling phases from 1999-2004

Figure 5 shows that the BOD found during the sampling phases remain relatively consistent with slightly higher levels found at the Highway 17 Bridge and Castleford test sites. This would be consistent with a greater oxygen requirement for the degrading of organic matter.

Dissolved Oxygen

Sources and Movements
Dissolved Oxygen is the measurement of the amount of oxygen freely available in the water sampled. Dissolved oxygen is also related to temperature. Oxygen becomes more soluble in water as temperatures decrease.

Impact
Adequate levels of dissolved oxygen are necessary for maintaining healthy aquatic ecosystems, which vary based on the type of biological community. When dissolved oxygen concentration fall below the required levels, it will result in suffocation of animals within that habitat.

Safe Limits (CCREM, 2005)

6.0mg/L protection of early life stages of warm water biota
5.0 mg/L protection of other life stages of warm water biota
9.5 mg/L protection of early life stages of cold water biota
6.5mg/L protection of other life stages of cold water biota

Results

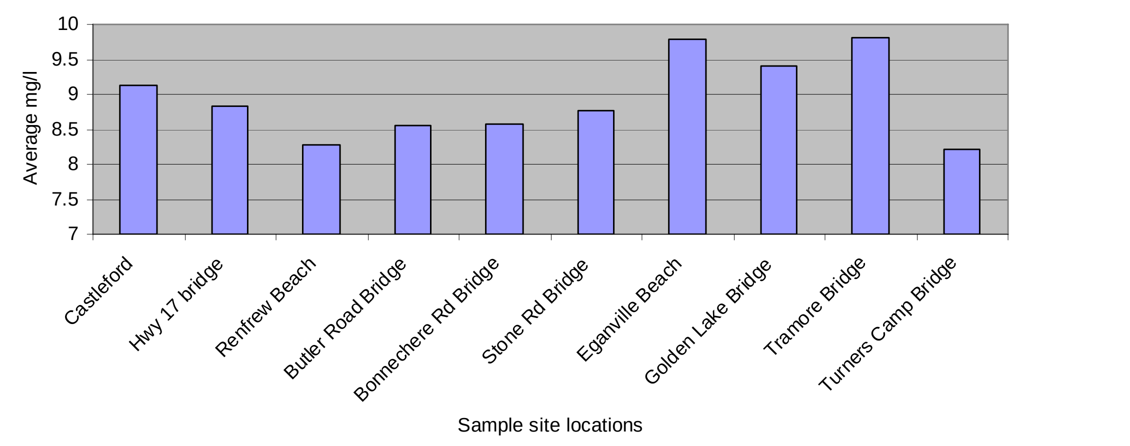

Figure 6. Average concentration of Dissolved Oxygen found at various test sites along the Bonnechere River in 22 sampling events from November 4, 1999 to July 4th, 2001.

Figure 6 shows that the concentrations found at the sample sites were between 8 and 10mg/l. Lower levels were detected between the Stone Road Bridge and Castleford, averaging between 8.76 and 9.121. All of the average values found in the sampling phases completed are between 8-10mg/L which is within the healthy range for all types of life expressed in the safe limits with exception to the protection of early life stage cold water biota. A closer examination of the raw data shows that lower concentrations were detected in the summer months, which is consistent with increased temperature and the oxygen solubility declining in the water. The safe limits vary based on the respective life stages of the aquatic life within the water system. A greater understanding of specific life cycle requirements for specific biota would be required to determine the impact of these fluctuations on the individual biotic types.

Sources of Errors

In any scientific study there are several possible sources of error that should be considered. The instruments used to determine the quality of water are extremely sensitive and samples may become contaminated during the sampling process. This can occur through improper handling of sampling equipment, during transportation of the samples, or, exposure of the samples to different temperatures and light conditions prior to analysis. In addition, there is potential interference in the consistency of samples related to the accessibility of sampling locations resulting from weather and ice conditions during the collection phase. This results in differing sample sizes for each sample site, which might distort the average concentration for the selected indicators.

What Has Been Done So Far

Introduction-
The promotion of good land stewardship was the driving force behind the creation of the Wetland, Woodland and Wildlife Program (W-3). This program was initiated in 2004 and was modeled after the Snake River W-3 project. The Renfrew County Rural Water Quality Enhancement Project is another example of a landowner based incentive program that was made available to landowners throughout Renfrew County.

The W-3 program provided a monetary incentive to agricultural landowners to implement best management practices on their property to improve overall water quality. Examples of the types of projects that have been undertaken include: fencing out livestock from waterways, solar and push pump watering systems, erosion protection and riparian enhancement and shoreline plantings.

The W-3 program provided support for 60% of the cost of implementing a variety of best management practices with the ultimate goal of improving water quality. W-3 is a project that works through leveraging funds from local partners. This included not only commodity groups but organizations and corporations from the local area. This was an ideal way for those local organizations and corporations to make an investment in the agricultural community.

Below are listed the financial partners who participated in the presentation of the 2004 W-3 projects:

Ontario Stewardship
Renfrew County Soil and Crop Improvement Association
Ontario Federation of Anglers and Hunters
Renfrew County Cattleman's Association
Town of Renfrew
Ontario Power Generation
Renfrew County Federation of Agriculture
County of Renfrew

Goals-
The W-3 program encourages the implementation of best management practices for water quality improvement on agricultural land within the Bonnechere River Watershed.

Steps –

- Obtain funding from both commodity and non-commodity groups.
- Develop a subcommittee that represents the agricultural community.
- Identify the appropriate proportion of funding to be provided and criteria for eligibility.
- Complete site visits to measure progress and the final completion of the project.
- Complete site visits one year following.

Recommendations

Throughout this report there have been numerous references to point and non-point sources of pollution entering the Bonnechere River watershed.

Non-point Sources

The introduction of non-point sources of pollution into a watershed occurs in both the rural and urban setting. In the urban setting, salt, oil (hydrocarbons) from roadways, accidents or spills, can enter waterways from roads near waterways. Pesticides and herbicides can be washed into waterways from cleared shorelines or from heavy, improper applications. Pollution can be washed into water systems during rainfall from storm drains, litter and improperly disposed refuse. Finally, inadequate or failing septic systems can be major source of non-point sources pollution.
The types of projects that can help to mitigate pollution entering the waterways vary in size, scale and cost.

1. Maintaining buffer zones: Buffer zones are an ideal way to reduce the flow of surface pollution into water systems and erosion control. Buffer zones can also act to attract a variety of birds, animals and insects, provide cover to water to help reduce temperature fluctuations and conserve water via reduced evaporation. The present forest cover in the watershed is shown in Appendix 8.
2. Fencing: Combining fencing with buffer zones is an ideal way to prevent livestock from moving into the water system creating additional erosion. The establishment of the buffer zone will also provide a cool place for livestock to keep cool.
3. Alternate Watering Systems: A valuable addition to a livestock fencing project is to provide an alternate watering system. There are numerous options for the implementation of these types of projects. Push pumps and solar pumping systems are the most common approaches.
4. Septic system: Malfunctioning septic systems are an additional source of nutrients being introduced into watersheds. The best defense against this source of pollution is education. Landowners who are familiar with the functioning of their septic system are less likely to allow them to fall into disrepair. There are many different types of septic technology available to landowners ranging from composting toilets to peat moss based systems. There is a lack of available funding for the implementation of these types of projects, especially in areas that lack conservation authorities. However, there is an enormous amount of information available via the internet or from a Landowner Resource Centre.

Funding

Sources of funding are always evolving to include new and different types of projects. For the purposes of this report some sources of funding that are presently available are listed below. More potential funding mechanisms are described in detail in the Fundraising Resource Package created by the BRWP in 2005.

BRWP Tree-Planting Incentive Program- this program provides a 50% contribution to landowners to plant trees and wildlife shrubs in the watershed. Larger plantings of 1000 or more trees are preferred. Applications can be filled out throughout the year but most applications for a Spring planting need to be received by the end of October in the year prior to the planting. For more information contact Alan Fox at 649-2677 or visit www.bonnechereriver.ca.

Environmental Cost-Share Opportunities for Ontario Farmers- Eligibility for this funding requires that applicants be Ontario farmers who are participating or willing to participate in the Environmental Farm Plan Program. Additional eligibility criteria also apply. Funds will be available until March 31, 2008 or until they are completely allocated, whichever occurs first. This program is delivered by Ontario Soil and Crop Improvement Association (OSCIA) through funding from the Federal and Provincial government. For more information call 1-800-265-9751, oscia@ontariosoilcrop.org, www.ontariosoilcrop.org.

Shell Environmental Fund - This fund provides money to community groups that would like to improve the natural environment in their area. They evaluate funding proposals received prior to February 28 and October 1st of each year. Applications can be downloaded from http://www.shell.ca/sef.

Point Sources of Pollution

The majority of land in the Bonnechere River Watershed is privately owned (Appendix 9 Landowner map). Point source pollution is limited to types of pollution with an identifiable source. Within the Bonnechere watershed there are few obvious point sources for pollution. Point source pollution in this area is primarily associated with inadequate sewage treatment facilities.
The results of the two phases of sampling completed on the watershed consistently indicated increased concentrations of most of the indicators in the lower reaches of the river.

Funding

Point sources of pollution can be associated with municipal activities and potential funding sources to address these concerns are:

Green Municipal Enabling Fund (GMEF) – Canadian municipality and their private and public sector partners are eligible for work to improve air, water or soil quality. The funds provides amounts $100,000 or greater with this funding mechanism providing up to 50% of the project costs including feasibility studies and field tests. Deadlines are year-round by invitation. Email greenfund@fcm.ca or visit http://www.fcm.ca for more information.

Green Municipal Fund (GMIF) – Canadian municipalities and their public or private-sector partners in support of the implementation of environmental infrastructure projects. This mechanism is focused on energy and energy services, water, solid waste management and sustainable transportation. The project must produce measurable results. Provides amounts $100,000 or greater. The application process is open year round following communications detailing intent to apply. Email greenfunds@fcm.ca or visit www.fcm.ca.

Glossary

Eutrophic - Eutrophication is a process whereby water bodies, such as lakes, estuaries, or slow-moving streams receive excess nutrients that stimulate excessive plant growth (algae, periphyton attached algae, and nuisance plants weeds). This enhanced plant growth, often called an algal bloom, reduces dissolved oxygen in the water when dead plant material decomposes and can cause other organisms to die.

Oligotrophic -Waters that are relatively low in nutrients and cannot support much plant life, such as the open oceans and some lakes.

Anthropogenic- Caused by humans.

Point sources- A source, especially of pollution or radiation, occupying a very small area and having a concentrated output.

Non-point sources – Pollution that does not have a concentrated or specific identifiable output site.

References

Environment Canada. 2002. Canadian Water Quality Guidelines. Her Majesty the Queen in Right of Canada. ISSN:0-662-65922-8

Environment Canada. 2005. Canadian Water Quality Guidelines: Nitrate. Prepared by the National Guidelines and Standards Office.

Environment Canada, 2005. Canadian Water Quality Guidelines: Phosphorus. Prepared by the National Guidelines and Standards Office.

CCREM (Canadian Council of Ministers of the Environment). 2005. Canadian Water Quality Guidelines for the Protection of Aquatic Life. Excerpt from publication No. 1299. ISBN 1-896997-34-1

Guidelines for Canadian Recreation Water Quality. 1992 Prepared by the Federal-Provincial Working Group on Recreation al Water Quality of the Federal-Provincial Advisory Committee on Environmental Occupational Health. Published by the Minister of National Health and Welfare.