Management Plan for the Main Bayfield River Watershed Draft 2012

Prepared for:
Ontario Ministry of the Environment
Lake Huron Southeast Shores Working Group

by
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Executive Summary

The Bayfield River watershed is one of the most remarkable natural features in Huron County. The smaller Main Bayfield subwatershed, which is the focus of this watershed management plan, boasts one of the largest percentages of forest cover in the Ausable Bayfield Conservation Authority (ABCA) jurisdiction, including a provincially designated Area of Natural and Scientific Interest (ANSI) and three Environmentally Significant Areas (ESAs). The extensive forest cover, which is concentrated along the main stem and its tributaries, provides excellent fish habitat. Furthermore, the Trick's Creek tributary is one of the few cold water streams in the area. Although the Main Bayfield watershed exhibits some exceptional natural features, areas still remain which could benefit from increased forest cover and wetland restoration. Water quality is also a concern and could be improved with reductions in sediment, nutrient and bacterial concentrations.

This project is part of a larger initiative termed the Lake Huron-Georgian Bay Watershed Canadian Framework for Community Action, which encourages the active participation of individuals, groups and communities, in identifying common issues, and the conservation and stewardship of natural resources. The Main Bayfield River Watershed Management Plan will respect the long-term sustainability of all water systems and the life that depends on them. The community vision is one of a healthy, resilient watershed where people, wildlife and habitat thrive. Taking pride in the quality of the Main Bayfield River watershed; continuing to protect and enhance the watershed resource.

The ABCA is excited to have this opportunity to work with the Main Bayfield watershed community in developing recommendations to protect and improve the resources on their land and in their watershed. Dialogue is currently on-going between the Main Bayfield watershed advisory committee and the community in order to generate specific, locally relevant actions to address their goal of improving water quality and quantity within Lake Huron, the Bayfield River and all tributaries. Specifically, the goal is to reduce total phosphorus and *Escherichia coli* (*E.coli)* values, while increasing and protecting forest cover, wetlands and streamside cover. In terms of meeting this goal, success will be measured using the indicator guidelines used in the ABCA Watershed Report Card (2006).

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The Main Bayfield Watershed Advisory Committee:
Marilyn Broadfoot, Main Bayfield landowner
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Thea & Bill Trick, Main Bayfield landower
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Thank you to all the landowners of the Main Bayfield Watershed for your interest and willingness to participate.

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Chapter 1 - Introduction

Main Bayfield River Watershed

Located in the village of Bayfield, Ontario, is the mouth of the Bayfield River which outlets into the southeast shore of Lake Huron. Great swimming, boating, fishing and recreational opportunities entice many day-trippers, cottagers, and permanent residents. However, nutrient, sediment and bacterial pollution can sometimes limit both the human uses and the ecological integrity of the shores of Lake Huron and the Bayfield River.

The Bayfield River drains 497km^2 in southwestern Ontario and has been divided in past studies into three distinct subwatersheds: Bayfield Headwaters, Bannockburn and the Main Bayfield. A watershed is an area of land that drains to a common waterway, such as a stream, wetland, or lake. The water in the Bayfield River watershed drains through the municipalities of Huron East, Central Huron and Bluewater where it ultimately enters Lake Huron. The Main Bayfield subwatershed, the focus of this watershed management plan, encompasses an area of 92km^2 and includes the main stem of the Bayfield River from Clinton to the village of Bayfield on Lake Huron. This subwatershed includes all tributaries draining to the main channel such as Trick's Creek and Middleton's Creek but excludes the Bannockburn River (Malone 2003).

Why Focus on Main Bayfield?

From past experiences it has been recognized that protecting and strengthening an area in good condition, such as the Main Bayfield watershed, is more effective than trying to build a good ecosystem from a degraded one. In the Ausable Bayfield Conservation Authority (ABCA) Watershed Report Card (2006), the Main Bayfield watershed was found to have good forest conditions as compared to the entire Ausable Bayfield watershed average. The Main Bayfield watershed includes an Area of Natural and Scientific Interest (ANSI) as well as diverse forest, which has singled it out as the best terrestrial functioning sub-watershed in the basin (Luinstra *et al*. 2008). Trick's Creek, a tributary of the Main Bayfield River, provides cold water fish habitat, which is rare within the ABCA area (Veliz 2001).

What is a Watershed Plan?

We all live in a watershed – the area that drains to a common waterbody, such as a stream, lake, estuary, wetland, or ultimately, an ocean (US EPA 2008). Recently there has been recognition of the importance of an ecosystem approach to land use planning. This approach requires that ecological goals be treated equally with economic and social goals. Under the ecosystem approach the boundaries for land use planning should be based on biophysical boundaries; the primary boundary for an ecosystem approach of land use planning should be the watershed (Ontario Ministry of the Environment and Energy and Ontario Ministry of Natural Resources 1993).

A watershed management plan is created co-operatively by the community and government agencies to manage the water, land/water interactions and aquatic resources within a particular watershed to protect (and enhance) the health of the ecosystem as land uses change (Ontario Ministry of the Environment and Energy and Ontario Ministry of Natural Resources 1993). The process of developing a community-based watershed plan has created an opportunity to ensure that as many local interests as possible are addressed. As a plan is developed by the community, the interests expressed are locally relevant.

A community-based watershed plan for the Main Bayfield River watershed will provide on-the-ground identification of community priority issues and sites for restoration and enhancement.

Watershed Planning Approach

The development of a watershed plan for the Main Bayfield watershed uses an approach prepared by partners from across the Lake Huron-Georgian Bay watershed, which is outlined in the Lake Huron-Georgian Bay Framework for Community Action.

The Lake Huron-Georgian Bay Framework for Community Action key steps include:
1) Build Awareness;
2) Support Community Involvement;
3) Implement Actions to Protect and Enhance; and
4) Evaluate the process.

The entire Framework can be found online at
http://www.lakehuroncommunityaction.ca/images/pdf/framework.pdf

Figure 1: Key strategies to encourage community involvement in the protection of Lake Huron (lakehuroncommunityaction.ca) (Anderson *et al*. 2007).

This community-led watershed plan for the Main Bayfield River has three components. The first component documents the current conditions within the Main Bayfield River watershed (Watershed Description). The second component identifies local issues and local approaches to environmental protection and enhancement. The third and most important component recommends actions that protect and enhance the Bayfield River. These actions, which have been developed in consultation with the community, relate directly to the strategies identified in Figure 1 and can be carried out over the next 10-15 years.

Relationship with Municipal Plan

Within the greater Huron County Official Plan are policies which deal with such issues as the protection of agricultural, mineral and environmental resources and the assurance that growth is coordinated with, and meets the needs of the community. Through extensive public consultation, a number of key directions for the natural environment policy were identified as:

- Ensuring that planning for the natural environment considers all components of an ecosystem and the recommended approach would be ecosystem based;
- Community-based and pro-active pursuit of a healthy ecosystem; and
- Protection and enhancement of the health of the environment while pursuing economic opportunity (County of Huron 1999).

The Huron County Official Plan also made the recommendation that a community-based approach to addressing ecosystem issues is needed to bring about positive change in the area (County of Huron 1999). A Management Plan for the Main Bayfield River watershed is an example of such community-based planning. Although this is 92km^2 of the 3397km^2 area of Huron County, it is through these focused efforts that community-based planning can take place. Watershed planning provides current and appropriate information about natural resources and the community's interests in using and protecting these resources. Thus, watershed planning will provide both a natural and community context to Official Plans, and helps to ensure that the county and member municipalities are creating appropriate policies concerning the natural environment.

Upon completion of the Main Bayfield Watershed Management Plan, the county of Huron and the municipalities of Bluewater, Huron East and Central Huron should consider the recommendations found in this document when they are updating their Official Plans.

Planning Process

In July of 2011, the Main Bayfield Watershed Management Plan process was introduced to local residents. A newsletter was mailed to residents of the Main Bayfield River watershed to generate interest, provide more information, and encourage community members to become involved. An advisory committee was formed in the fall of 2011 and has provided input into the planning process. Landowners within the watershed were approached on a one-to-one basis through a landowner survey (see Chapter 4) which provided invaluable information about current land use practices and approaches to address specific environmental issues.

Chapter 2 - Watershed Description

Landscape Features

Location and General Description

The Main Bayfield watershed encompasses 92km^2 of the 497km^2 area drained by the Bayfield River (19%). The downstream Main Bayfield subwatershed is located east of the village of Bayfield, west of the town of Clinton, and within the municipalities of

Bluewater, Huron East and Central Huron (Figure 2). Land use within the watershed area is predominantly agricultural (~70%) and natural area (~20%). The village of Bayfield, town of Clinton and communities of Varna and Vanastra, as well as some recreational and aggregate areas comprise the remaining land use activities.

There are numerous tributaries and municipal drains included in this watershed with seven main branches. Trick's Creek provides a significant amount of the baseflow to the Bayfield River and provides cold water fish habitat. Other significant tributaries are the Wise Drain, Steenstra Drain, Wiltse Creek, Johnston-Dowson Drain, Middleton's Creek, and Brant Creek (Figure 2).

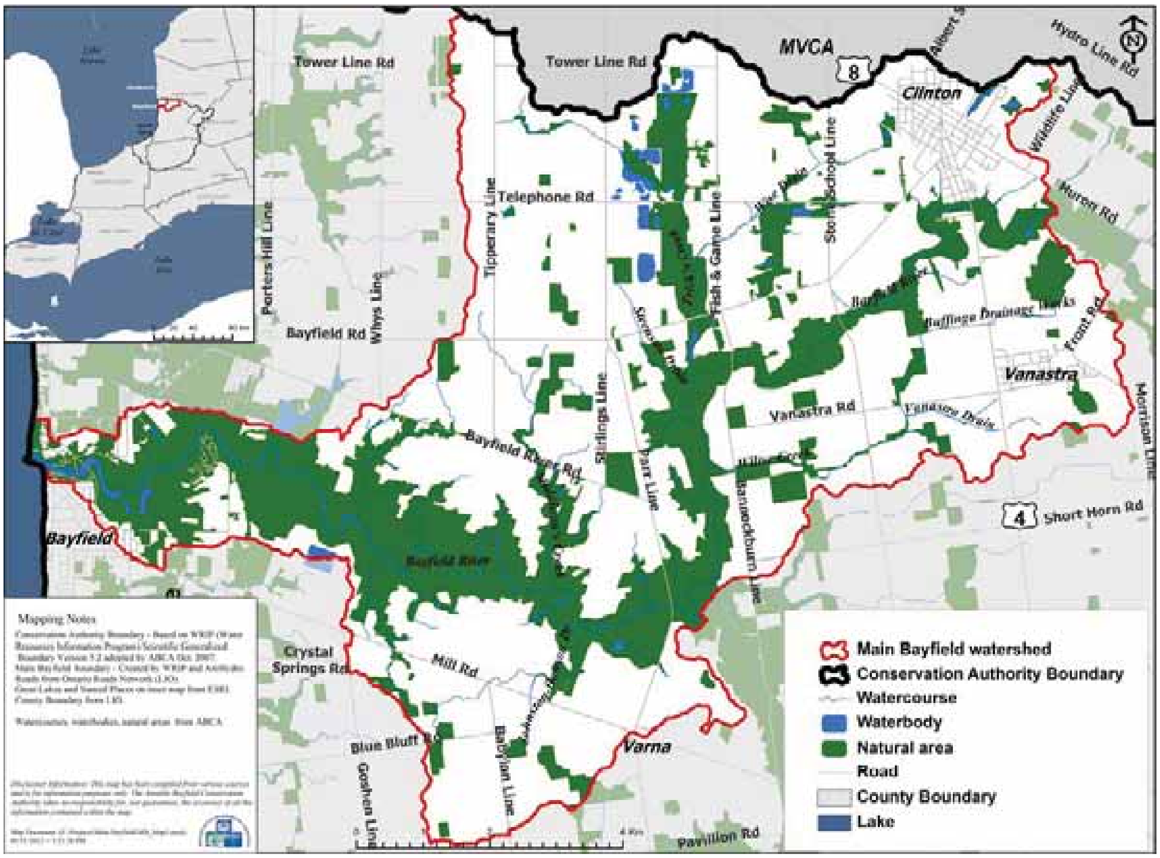


Figure 2: Landscape features of the Main Bayfield River watershed.

Topography

Generally the watershed is level with gently rolling hills along the moraines (Figure 3). The average gradient of the Bayfield River is 2.3m/km (Malone 2003); the slopes in the Bayfield watershed are less than 2% with the steeper slopes more predominant in the Main Bayfield River watershed (Giancola 1983).

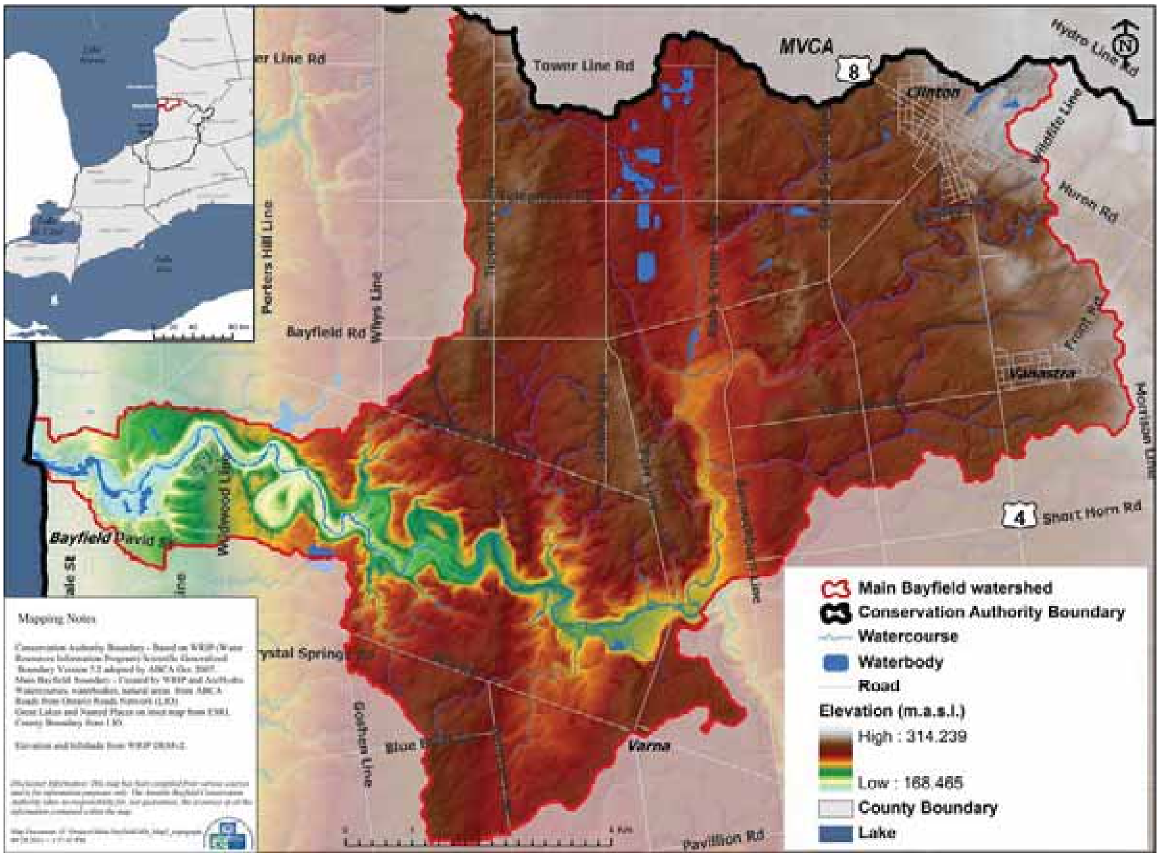


Figure 3: Topography of the Main Bayfield River watershed.

Physiography/Geology

The Main Bayfield River watershed is dominated by Wyoming moraine with sand plains towards Lake Huron, and till plains towards the east (Figure 4). The upper east portion of the watershed near Clinton originates as kame moraine. On the northwest of Clinton, the Trick's Creek watershed drains a portion of the Wyoming moraine and its connected spillway composed of a large deposit of sand and gravel (Chapman and Putnam 1984). The Trick's Creek watershed is the largest area of gravel compared to other subwatersheds, giving rise to the groundwater-fed nature of this stream. A portion of the Main Bayfield River watershed is made up of a large valley complex that is approximately 30m deep, and at many locations, up to 800m wide (Malone 2003), which resulted from the river cutting through the Wyoming moraine and its connected spillway. This large valley is home to high-level terraces, old oxbows and isolated meander cores giving the Bayfield River valley a striking resemblance to the Maitland River further north (Chapman and Putnam 1984).

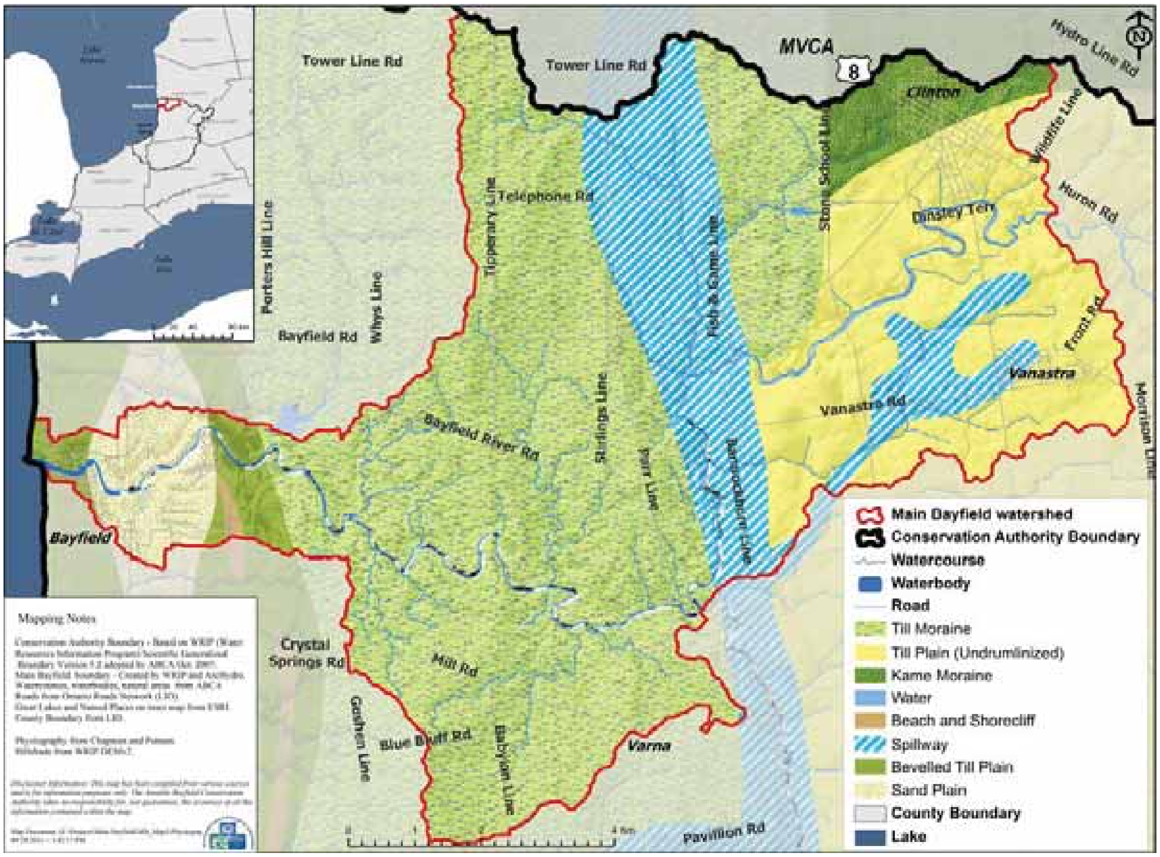


Figure 4: Physiography/Geology of the Main Bayfield River watershed.

Bedrock Geology & Soils

The bedrock of the Bayfield watershed is characteristic of the Devonian Period of the Paleozoic Era with the majority of the rock groups found being shale and limestone (Schaus 1982). The town of Clinton, a large area around and including the village of Bayfield, as well as the spillway associated with the Trick's Creek tributary are dominated by well-drained loam soils (Figure 5). Poorly-drained pockets of silty loam surround the community of Vanastra as well as a section east of the town of Clinton. Along several of the tributaries are bands of poorly drained clay loam, particularly near Middleton's Creek, Johnson-Dowson Drain, Wiltse Creek, and the headwaters of Trick's Creek and Wise Drain. There is a distinct pattern of increasing loam soils to the east and increasing silty soils moving towards Lake Huron with imperfectly draining silty loam right as Bayfield River outlets into Lake Huron.

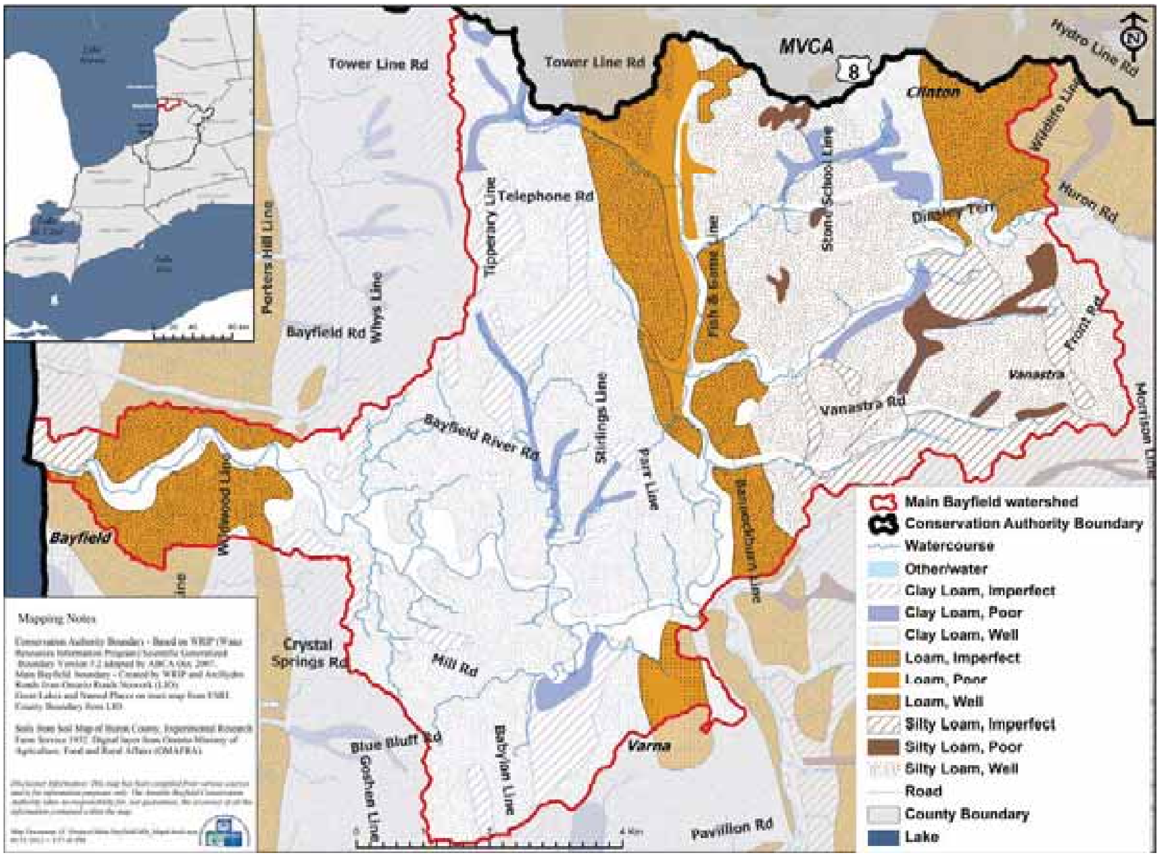


Figure 5: Soils of the Main Bayfield River watershed.

Aggregates

The subsurface geology in the Trick's Creek subwatershed is dominated by gravel deposits which provide opportunities for groundwater discharge and substrate suitable for spawning trout. Combined with the extensive forest conditions, Trick's Creek provides optimal cold water fish habitat (Veliz 2001). Gravel deposits and groundwater discharges are also often associated with aggregate resources.

A study completed in the Trick's Creek watershed determined that aggregate removal can impact the temperature of the groundwater discharging to nearby watercourses which can then negatively affect temperature-sensitive species, such as brook trout (Markle and Schincariol 2007). It was further determined that aggregate removal must not occur within 250m of adjacent watercourses since the thermal plumes emanating from aggregate pits are able to migrate this distance. Therefore, Markle and Schincariol (2007) suggest that aggregate removal should not occur within 250m of adjacent watercourses in order for temperature-sensitive fauna living within the watercourses to remain unaffected. While the extraction pit in the Trick's Creek study was approximately 750m from the creek, the authors cautioned that impacts may occur as the extraction proceeds closer towards the creek. As well, it is yet unknown what the cumulative effects of several aggregate operations within close vicinity can have (Markle and Schincariol 2007). These cautions are a relevant concern for all of the active pits located within the Trick's Creek watershed. Air photos of the Trick's Creek watershed taken in 2010 suggest that there is aggregate removal closer to Trick's Creek than the recommended 250m distance. The effects of the conversion from a moderately disturbed landscape to a pond created through aggregate removal are not known. Furthermore, it is unknown how evapotranspiration could be affecting flow rates within Trick's Creek and subsequently the Bayfield River.

The Socio-Economic Landscape

History

The town of Clinton, village of Bayfield and communities of Varna and Vanastra are the main urban centers within the Main Bayfield River watershed. The entire Main Bayfield River watershed exists within Huron County located on the eastern shores of Lake Huron. Even through it boasts close proximity to Lake Huron, it was the high quality agricultural land and not the lake that brought settlement to the area (Scott 1954). The Canada Company, which was formed in the early 1800s by a group of English businessmen in order to promote the settlement of Upper Canada, encouraged the raising of capital by providing settlers with land and employment. The Canada Company purchased the Huron Tract (the townships of Colborne, Goderich, Hullet, Mckillop, Tuckersmith, Stanley, Hay, Stephen and Usborne) in 1826, which in turn triggered the settlement of the Bayfield River watershed. When the settlers arrived, the land was stripped of trees and vegetation (Scott 1954). This is evident today in the forest cover patterns that exist in the watershed which are representative of the settlement patterns (Malone 2003).

The town of Bayfield is located on top of a bluff overlooking Lake Huron. In 1832 Carel Lodewijk, Baron van Tuyll van Serooskerken, a Dutch nobleman, purchased a large amount of property in the Huron Tract including 388 acres which he set aside for a settlement. This land became known as Bayfield, which was named after the nautical surveyor Henry Wolsey Bayfield, and it quickly developed into the main hub for the surrounding agricultural communities. The 1840s saw Bayfield become a major shipping port for locally produced grain, and the village itself prospered with many businesses. Once the railway came to Ontario however, this busy shipping port was no longer needed. As a result, Bayfield turned to the fishing industry, which still exists. Today, the Bayfield harbor has become the largest pleasure craft marina on the Canadian side of Lake Huron (Southern Ontario Tourism Organization 2006).

Clinton, which is the other larger urban centre within the Main Bayfield River watershed, was named after Sir Henry Clinton, an officer in the Peninsular War. Originally, the area was settled in 1834 by Peter Vanderburgh however, it was later known as Rattenbury's Corner, after William Rattenbury purchased corners of the main intersection. It was not until 1858 that the village actually became known as Clinton. This designation came in honour of Rattenbury's war hero friend (Southern Ontario Tourism Organization 2006).

Demographics

The Main Bayfield watershed extends into the municipalities of Bluewater, Huron East and Central Huron. For southern Ontario, the Main Bayfield watershed has a low population density, and according to Statistics Canada census data of 2011 the populations of Bluewater, Huron East and Central Huron have seen a slight decline, by 1.1 percent, 0.5 percent and 0.7 percent respectively (Table 1). Over half the population (54 percent) is over 45 years of age within both Bluewater and Central Huron, with 46 percent over 45 years of age residing within Huron East. The median age within these municipalities ranges from 41 to 48 years of age (Statistics Canada 2012).

Table 1: Demographic information for the municipalities of Bluewater, Huron East and Central Huron (Statistics Canada 2012).

Criteria	Municipality of Bluewater	Municipality of Huron East	Municipality of Central Huron
Population	**7,044**	**9,264**	**7,591**
Percent Population increase since 2006	**-1.1%**	**-0.5%**	**-0.7%**
Percentage of Population over age 45	**54%**	**46%**	**54%**
Median Age	**48**	**41**	**48**

Industry

The residents within the Main Bayfield watershed of Bluewater, Huron East, and Central Huron are involved in a wide variety of industry sectors (Figure 6). The largest percentage of population is involved within the diverse agricultural sector, such as livestock and cash crop, whereas 19 percent work in other resource-based industries. Although this is an average of the three municipalities, it does accurately reflect the percentage within each municipality individually. Manufacturing and other services industries are at 16 and 15 percent, respectively. Manufacturing is accurately reflected as an average for the three municipalities, but there is a higher percentage in other services within Bluewater and Central Huron. Business services, retail trade, construction, and health care and social services each contribute a significant percentage to the economy within each municipality with retail trade and health care services exhibiting a lower percentage for Huron East. Education service, finance and real estate also contribute to the economy within these municipalities (Statistics Canada 2006).

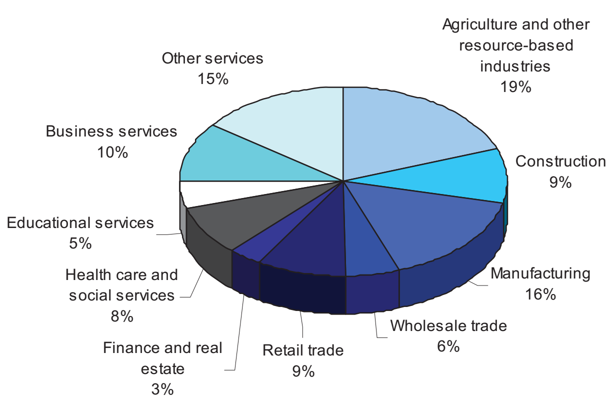


Figure 6: Industry sectors as an average for the municipalities of Bluewater, Huron East and Central Huron (Statistics Canada 2006).

Tourism

Approximately $15.1 billion in revenue was created by the tourism industry in 2008 (Ontario Ministry of Tourism and Culture 2009), and it has a particularly important economic impact for people and areas near lakes, such as those communities along Lake Huron (Dodds 2010). Over 550 surveys were completed as part of the Dodds (2010) study, which determined that the level of satisfaction beach visitors felt correlated with the health of the beach itself. Due to the fact that water quality was the most important concern as related to lake tourism, it was recommended that beaches obtain Blue Flag status to assist with water quality monitoring and informing the public regarding the health of the beach (Dodds 20010).

The health and quality of the water within the Bayfield River can pose a threat to the quality of the beaches along the southeast shore of Lake Huron, specifically the Bayfield Main Beach located within the Village of Bayfield. The Main Beach has had consistently low *Escherichia coli* (*E. coli*) concentrations over the past 11 years (Huron County Health Unit 2011) and has achieved Blue Flag status consistently, which most certainly keeps visitors coming and boosting the local economy. It is therefore critical that we continue to protect and improve upon this valuable resource.

Economic Development

Huron County has roughly 6,000 farms and businesses with a primary industry, such as farms, making up 35 percent of all businesses. This is followed in percentage by personal, business and other services at 21 percent, and retail and wholesale trade at 13 percent. As compared to other regions of Ontario, Huron County is unique in its large percentage of farming enterprises and comparative lack of retail and service sector businesses, however, over the past decade the number of businesses has grown at a steady pace. While still having a significant number of farms, the actual number of farms has decreased, possibly through farm consolidation. It is the mid-sized farms that are decreasing whereas the larger farms are now more common. Additionally, there was a positive movement seen in the growth of the number of businesses relative to the number of employees within each business. Companies with less than 5 employees declined, while businesses with 5 to 50 employees increased, which points to a maturing of businesses as they increase their customer base, their revenues and their labor force (County of Huron 2010).

Land Use

Land Use Planning

Land use planning establishes legislative principles and policies that guide a community toward a common vision for the future. It is the responsibility of the province and the local municipalities to create these principles and policies and update them as necessary. A municipality designates land for specific uses, and zoning by-laws assist in implementing the corresponding policies. Land use planning can become contentious, especially when changes occur to land use designations or policies.

Land Use

Agricultural land accounts for 65 percent of the land use in the Main Bayfield watershed (Figure 7). Information about the tillage practices, cover crops, livestock and crop rotations from windshield surveys collected as a part of the watershed study can help to explain watershed characteristics.

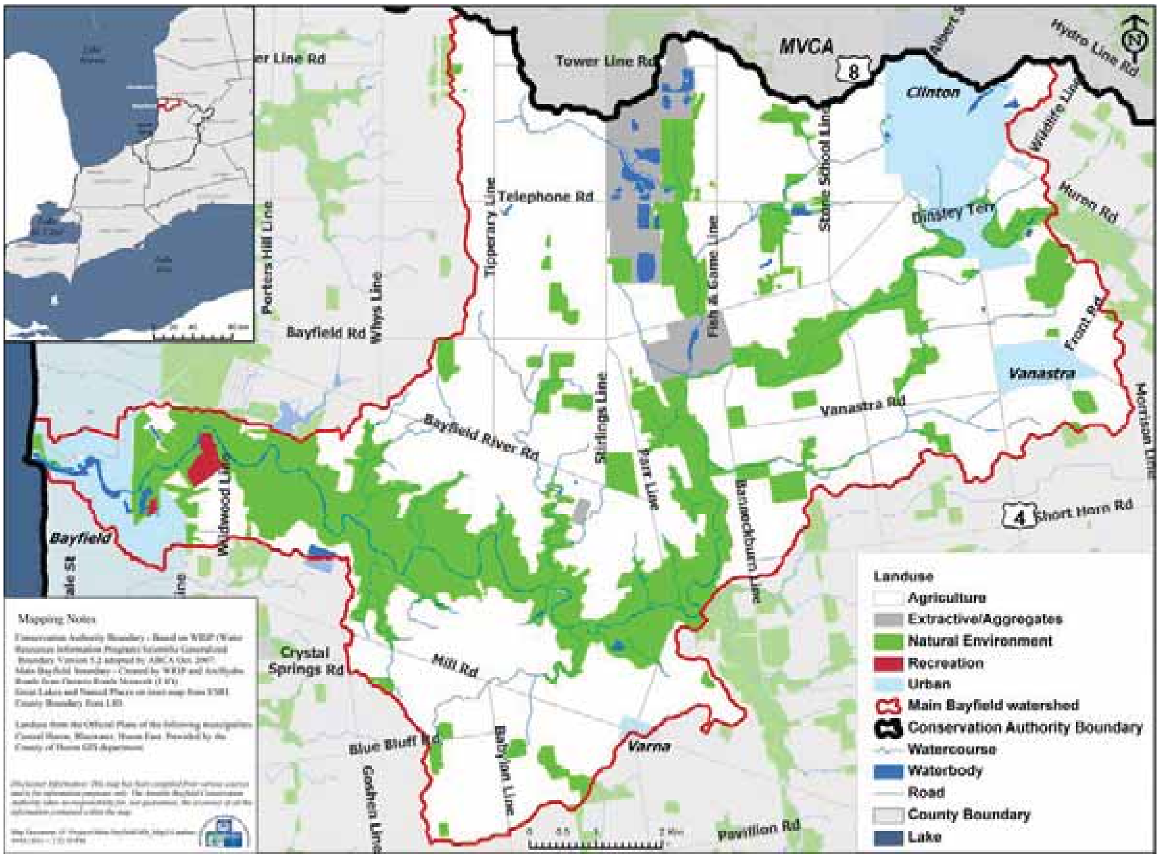


Figure 7: Land use in the Main Bayfield River watershed.

Natural environment encompasses 22 percent of the land use (Figure 8), with six percent of this being wetlands. According to the Huron County Official Plan a potential increase of wetlands by one percent exists within this watershed (Figure 9). Forest cover accounts for 20 percent of the natural environment designation, at times in combination with wetlands.

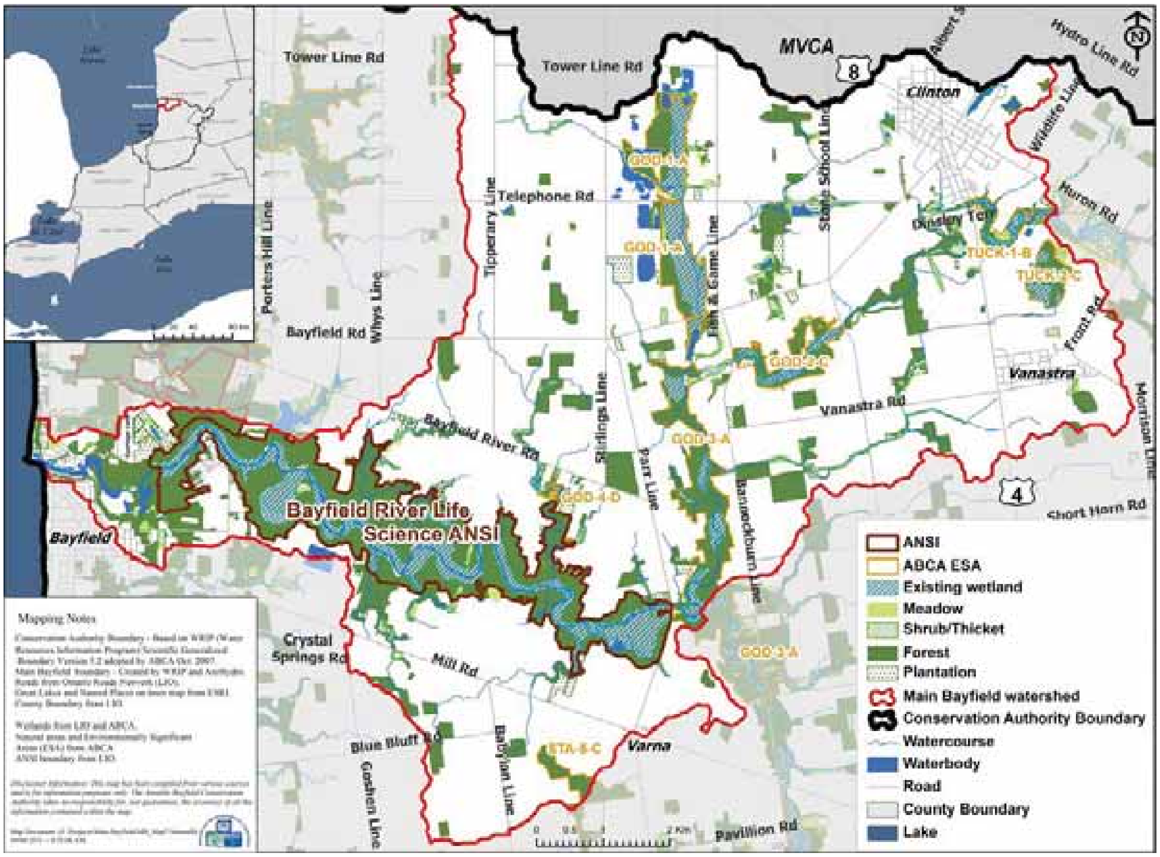


Figure 8: Natural areas of the Main Bayfield River watershed.

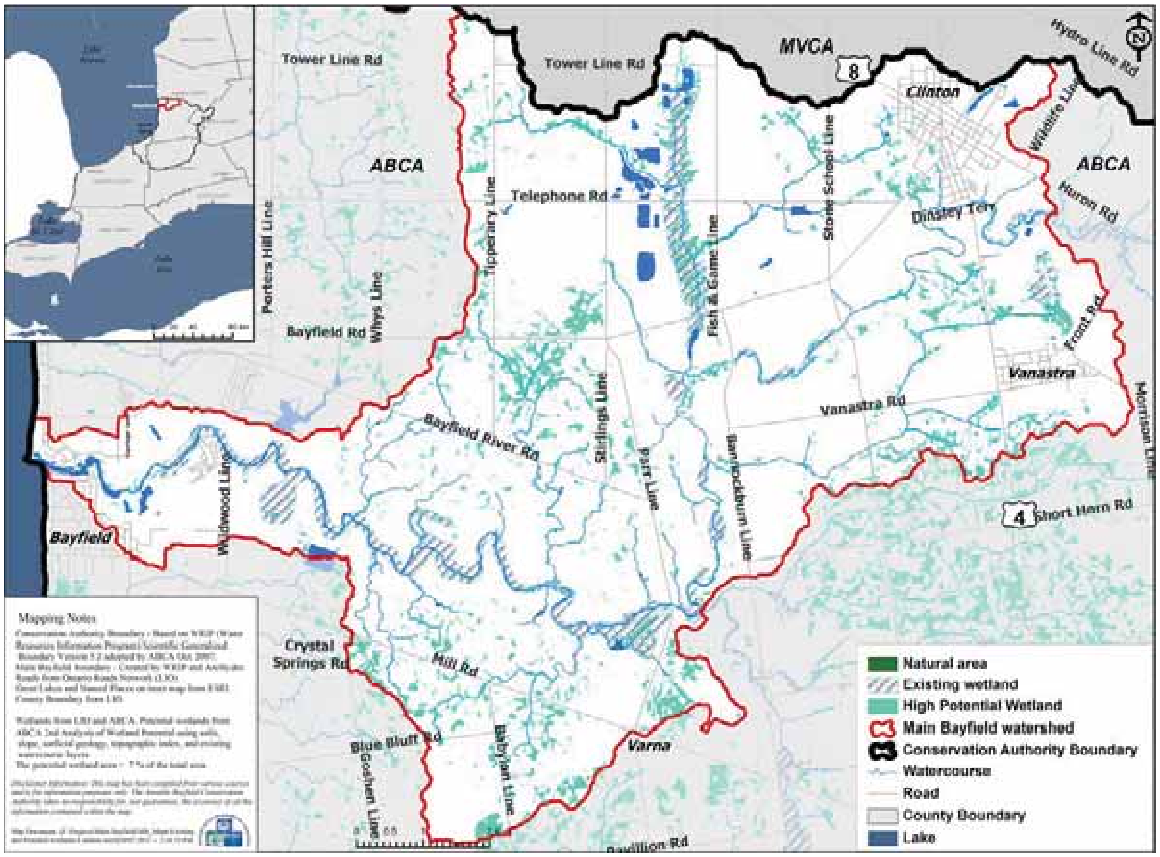


Figure 9: Existing and potential wetlands in the Main Bayfield watershed.

Urban land use accounts for eight percent and is attributed to the four main urban centres (*i.e.*, village of Bayfield, town of Clinton, community of Vanastra, village of Varna) (Figure 7). Recreation land use is less than one percent and relates to recreational trailer park communities. Aggregate/extractive accounts for four percent of land use and is heavily concentrated along the Trick's Creek tributary. There has been an emerging trend for green energy production with a number of solar panels constructed on private property, as well as a number of wind turbines proposed for the area.

Natural Areas

The Main Bayfield River Watershed includes significant natural areas, particularly forests and wetlands, which are primarily concentrated along the watercourses (Figures 8 and 9). According to the ABCA Watershed Report Card (Veliz *et al*. 2006), the Main Bayfield River watershed has more forest, wetland, and streamside natural cover than the average within the entire ABCA watershed jurisdiction (Table 2). Although these percentages are encouraging, they are still lower than those established by Environment Canada for healthy watersheds (Environment Canada 2005).

Table 2: Current percentage of the forest, wetland and vegetated riparian habitat for the Main Bayfield River watershed compared to recommended minimum percentages established by Environment Canada for healthy watersheds (Environment Canada 2005) and in the Ausable Bayfield Conservation Authority (ABCA) watershed jurisdiction.

Natural Feature Watershed**(%)	Current (%)	Environment Canada Recommended (%)	ABCA
Forests	20	30	13
Wetlands	6	10	2
Streamside Cover*	43	75	30

*The calculations used to determine the percentages of streamside over in the Main Bayfield Watershed differs slightly from that used by Environment Canada and therefore will not provide a direct comparison to their recommended percentage.
**The ABCA watershed jurisdiction is a roughly rectangular area of 2400km^2. This includes the area west of Mitchell and London to Lake Huron, and south of Goderich to south of Port Franks.

Area of Natural and Scientific Interest

The Bayfield River Area of Natural and Scientific Interest (ANSI) is a provincially significant area designated by the Ministry of Natural Resources (MNR) and chosen based on the representation of certain biological features. This area was also chosen due to its relatively low degree of disturbance and the doubtfulness that other valley systems will be found in this site district with the quality and quantity of representative and significant features (Crins 1983).

According to the Life Science Inventory and Vegetation Survey of the Bayfield River ANSI completed in 1983, the vegetation communities rather consistently follow the elevation levels. That is, each vegetation type or community can be found within an elevation band or strip along the narrow corridor which follows the Bayfield River (Crins 1983).

The upland areas which are situated on moderately moist, clay-based sites are characterized by hardwood forests dominated by sugar maple (*Acer saccharum*) and American beech (*Fagus grandifolia*). From the top of the valley along its slopes the moisture conditions range from a moderate to high moisture content. These sites are dominated with white cedar (*Thuja occidentalis*), eastern hemlock (*Tsuga canadensis*), and various hardwoods. Within the floodplains, the soil is mainly clay based, with localized areas of organic soil which overlays the clay where vegetation has decayed. The most notable assortment of communities can be found within these floodplains. The areas where the forests are well developed have been found to have limited anthropological disturbances. The significant tree species within this area include the butternut (*Juglans cinerea),* green ash (*Fraxinus pennsylvanica*), sugar maple (*Acer saccharum*), white cedar (*Thuja occidentalis*), and eastern hemlock (*Tsuga canadensis*) (Crins 1983).

Provincially Rare Plants

There are ten plant species designated as species at risk (SAR) present in the Bayfield River ANSI including: green dragon (*Arisaema dracontium*), tuberous indian-plantain (*Arnoglossum plantagineum*), Chinese hemlock parsley (*Conioselinum chinense*), eastern green-violet (*Hybanthus concolor*), butternut (*Juglans cinerea),* American gromwell *(Lithospermum latifolium),* scarlet beebalm *(Monarda didyma*), slim-flowered muhly (*Muhlenbergia tenuiflora*), large round-leaved orchid (*Platanthera macrophylla*), and hairy valerian (*Valeriana edulis*) (Crins 1983).

Significant Breeding Birds
Within the Bayfield River ANSI there are two species of birds which are designated as SAR, which are the Bobolink (*Dolichonyx oryzivorus*) and the Louisiana Waterthrush (*Seiurus motacilla*) (Crins 1983).

Molluscs, Reptiles and Fish
A total of six molluscs, reptiles and fish found within the Bayfield River ANSI are designated as SAR. These include black redhorse (*Moxostoma duquesnei*), snapping turtle (*Chelydra serpentina*), wood turtle (*Glyptemys insculpta*), queensnake (*Regina septemvittata*), mapleleaf mussel (*Quadrula quadrula*) and rainbow mussel (*Villosa iris*) (Crins 1983).

Environmentally Significant Areas
Environmentally Significant Areas (ESAs) are sites of environmental importance as they represent a variety of habitats, including upland forests, wetlands and river corridors. The ESAs are an integral part of Huron County's natural heritage system connecting valley lands, parks and other open spaces. For example, a wetland feature may support a rare plant or animal species or serve a hydrological function. Seven sites within the Main Bayfield River watershed have been designated as ESAs (Ausable Bayfield Conservation Authority 1995) (Table 3).

Table 3: Environmentally Significant Areas (ESAs) in the Main Bayfield River watershed (Ausable Bayfield Conservation Authority 1995).

ESA Name	Size in Main Bayfield River Watershed (ha)	Total Size (ha)	Wetland Size(ha)
STA-5-C	23	60	8.7
• South portion of this woodlot is a young upland forest made up primarily of sugar maple and dogwood. • Northern portion has two areas which could be designated as wetland. • Woodlot is fairly young and the vegetation is composed mainly of ash, beech and dogwood with a dense understory of sugar maple saplings. • The swamp areas are surrounded by silver maple and willow with ferns present on the ground. • The western area of the woodlot is more open, consisting of grasses, dogwood, silver maple and areas of standing water.			
GOD-4-D	31	31	0
• Named by the MNR as the Varna Deciduous Forest. • Maple-beech wet mesic forest. • Significant duck breeding marsh once occupied the site but now this site serves little significant hydrological function.			
GOD-3-A	166	283	42.0
• Includes a significant wetland and a high degree of diversity within community types. • Includes wet meadows, upland sugar maple-beech, lowland cedar, soft maple swamp, yellow birch-cedar and a variety of marsh communities. • Hemlock and yellow birch are abundant.			

• A sparrow hawk was sighted. • Cedar is common in the wetland and transitional areas with the latter areas associated with trembling aspen.			
GOD-1-A	168	168	18.0
• The entire drainage basin of Trick's Creek covered by natural vegetation. • Cold water stream with rainbow trout and bass fisheries. • Soft maple, ash, cedar are the dominant species. • Cedar swamp and cattail marsh. • Gravel pits with shallow aquifers which Ministry of Environment and Energy (MOEE) indicated may potentially impact Trick's Creek due to its proximity.			
GOD-2-C	77	77	25.36
• Lowland areas containing floodplain, cedars, willow and soft maple. • Upland area consists of mixed hardwood with sugar maple and beech being dominant and hemlock and cedar being secondary species. • Floodplains also contain wetland grasses, milkweeds and rushes. • Contains a white pine plantation.			
Tuck-1-B	35	100	27.5
• Approximately 27ha of this site lies within the Clinton Conservation Area. • A portion of this area west of the Bayfield River has been extensively developed as a picnic area. • A buffer strip has been retained adjacent to the river. • Many riverine marshes are present along the river channel, as well as several small ponds which lie adjacent to the watercourse, a result of spring flooding. • Another portion of this land contains extensive riverine wetlands along the Bayfield River floodplain and those of its tributaries. • Cedars have been planted beside a large cattail marsh bordering this area.			
Tuck-2-C	42	42	11.4
• Large woodlot consists of a maple, beech, ash and hickory upland community situated along a series of ridges and hills and is part of the kame moraine system. • Red and silver maple swamp communities lie within the depressions between these ridges, while pioneer species such as the popular and hawthorn occupy the ridge tops. • Some of the interior wetlands, possessing steep valley walls resembled isolated pristine natural areas which serve as headwaters for the small streams running throughout the area. • These wetlands provide some recharge to the groundwater and augment flows to the Bayfield River.			

Aquatics

Groundwater Resources

Groundwater resources for the Main Bayfield River watershed have been summarized by the provincial Drinking Water Source Protection initiative (Luinstra *et al*. 2007). The Main Bayfield watershed has areas of high sand and gravel deposits which indicate high permeability. This allows water to be infiltrated and stored in aquifers which will maintain more stable flow of water through streams and provide a cool water source through the year.

The data for groundwater in the Main Bayfield River is available from 2001 as part of the provincial *Safe Drinking Water Act* (2002), at which time wells servicing municipalities and large communities have been required to take regular samples of raw well water. In addition, the Provincial Groundwater Monitoring Network (PGMN) was initiated shortly after, in 2003, by the ABCA in partnership with the Ontario Ministry of the Environment (MOE).

Within Main Bayfield River watershed there are five municipal wells (Figure 10). The two within the village of Bayfield (Harbour Lights – Well 1 and Carriage Lane – Well 1) provide water to approximately 200 people. The other three wells serve the town of Clinton (Clinton 1, 2 & 3) and provide just over 3100 people (Luninstra *et al.* 2007). Note that these figures are not number of residences, but rather number of people. The remaining watershed population is fed by private wells and Lake Huron surface water, although there are plans to extend the Lake Huron pipeline to service the remainder of Bayfield still serviced by the two municipal wells.

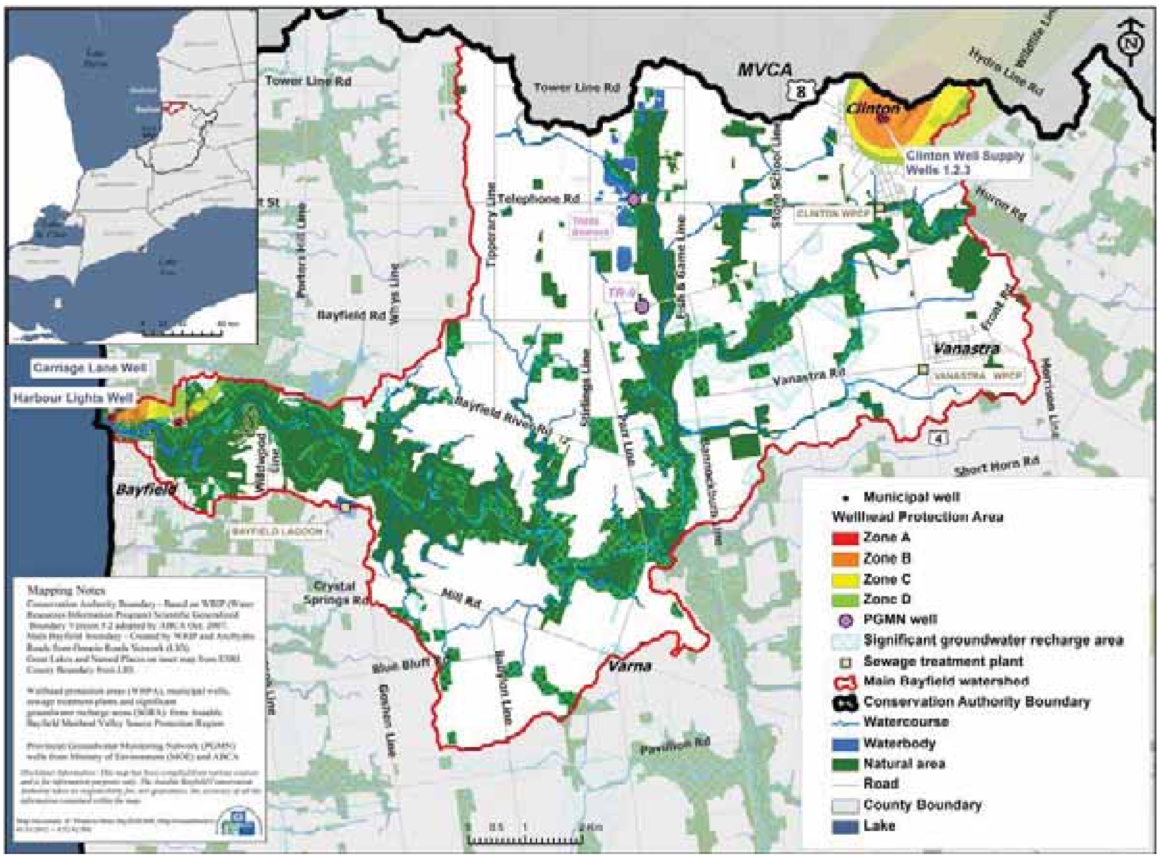


Figure 10: Significant groundwater recharge areas, municipal wells and wellhead protection areas of the Main Bayfield River watershed.

Baseflow Study

In 2007 the ABCA and the Maitland Valley Conservation Authority (MVCA) conducted a four year sub-basin baseflow study characterizing the percentages of baseflow contribution from each major tributary to the Ausable, Bayfield, Maitland, and Nine Mile Rivers. Baseflow measurements can be used to calculate regional scale water budgets and to define the areas within a watershed with higher amounts of groundwater discharge. These areas are considered to correlate to significant recharge areas, assuming no change in storage within the groundwater system (Figure 10).

Within the Main Bayfield River watershed there were two sites monitored for baseflow: Trick's Creek and the Bayfield River at the Lion's Club in Clinton. Over the four years of the study, Trick's Creek has had consistently higher baseflow contribution values than all of the sites in the Bayfield River. Due to the high gravel content of the soils within the Trick's Creek subwatershed, precipitation is easily absorbed and stored in the ground. Even during dry periods this stored groundwater allows Trick's Creek to continually flow. This indicates that the baseflow provided by Trick's Creek is highly significant in maintaining flow for the Bayfield River to Lake Huron. The site within Bayfield River at the Lion's Club in Clinton was not measured as often as the Trick's Creek site as it stops flowing during the monitoring season. Therefore, this site was found to provide medium baseflow contributions to the Bayfield River.

Surface Water Quality

What We Measure

Surface water quality indicators provide information about the state or condition of the water depending on its end use. Indicators of water quality for industrial purposes may differ from those used to determine quality for drinking. Under the current watershed report card process developed for Conservation Authorities in Ontario, there are three indicators for surface water quality: total phosphorus (TP), *Escherichia coli* (*E. coli*), and benthic invertebrates. Conservation Authorities are not limited to reporting on only these three indicators, but can also report on other, more locally-relevant indicators of surface water condition. For the purposes of this report, it is necessary to select a few key indicators to discuss water quality in order to develop a general understanding of major issues and pathways.

The United States Environmental Protection Agency (US EPA) has documented that for the water bodies listed as IMPAIRED in their National Water Quality Inventory, the three top pollutants causing problems are bacteria, suspended solids, and nutrients *(i.e.*, nitrate and total phosphorus) (US EPA 2012). Local reports such as the Ausable River Recovery Strategy (Ausable River Recovery Team 2005) and the Watershed Characterization for the Ausable Bayfield & Maitland Valley Source Protection Region (Luinstra *et al*. 2007) have also found that threats to local waterways are related to nutrient enrichment and erosion. These threats can be identified through our bacteria, suspended solids, and nutrient (nitrate and total phosphorus) concentrations.

Total Phosphorus

Total phosphorus (TP) includes phosphorus which is dissolved in water and which binds to organic and inorganic material in water. When there is an increase in phosphorus there is a correlated increase in plant growth. Once TP reaches a certain increased level it can cause over-enrichment and reduced oxygen concentrations for aquatic life called eutrophication. The Government of Ontario has established a Provincial Water Quality Objective (PWQO) for TP of 0.03 mg/L to prevent eutrophication from occurring.

Nitrates

Nitrate is the most stable form of inorganic nitrogen in streams and drains, and the primary source of nitrogen for algae and aquatic plants. Other forms of inorganic nitrogen (nitrite and ammonia) are less commonly found in streams and drains because they are quickly converted to nitrate by bacteria. Rising concentrations of inorganic nitrogen in aquatic systems increase the risk of algal blooms and eutrophication when accompanied by an increase in dissolved oxygen concentrations. The Canadian Council of Ministers of the Environment recommends a nitrate-N concentration of 2.93 mg/L as a draft Canadian Drinking Water Quality Guideline for protecting aquatic life from direct toxic effects (CCME 2007).

Total Suspended Solids
Total suspended solids (TSS) are a measure of the amount of material (*e.g.*, sediment and algae) that is suspended in the water of an aquatic system. High suspended solids concentrations can negatively impact feeding and respiration by aquatic animals, such as fish. Standards for suspended solids are difficult to develop because there are many site-specific conditions that affect the response of aquatic organisms to suspended material. As a result, a variety of standards have been set by different environmental agencies. According to the European Inland Fisheries Advisory Committee (EIFAC 1965 and Kerr 1995), good fisheries can be maintained with suspended solids concentrations up to 80 mg/L, and poor fisheries are likely to be associated with suspended solids concentrations greater than 400 mg/L.

Escherichia coli
Escherichia coli (*E. coli*) is a bacterium that is found in the intestinal tract of warm-blooded animals. Although *E. coli* is not typically a threat to the environment, its presence may indicate contamination by other harmful bacteria, viruses or parasites that are associated with fecal matter (*i.e.,* sewage or manure). The Ontario Ministry of Health and Long-term Care established a recreational guideline for *E. coli* of 100 colony forming units (cfu) per 100 mL (MOEE 1994).

Surface Water Quality Programs
In the Main Bayfield River watershed, there are currently three programs in place: the Provincial Water Quality Monitoring Network (PWQMN), the ABCA Enhanced Water Quality Monitoring Program and the Bayfield Ratepayers Association (BRA) Program. Historically, as part of a special ABCA water monitoring project, nutrient and bacterial concentrations were monitored at six stations within the Trick's Creek watershed from June to November in 1996 (Figure 11). In addition to the indicators described below for each program, temperature, pH, conductivity, dissolved oxygen, and total dissolved solids (TDS) were also measured using a YSI multi-parameter probe.

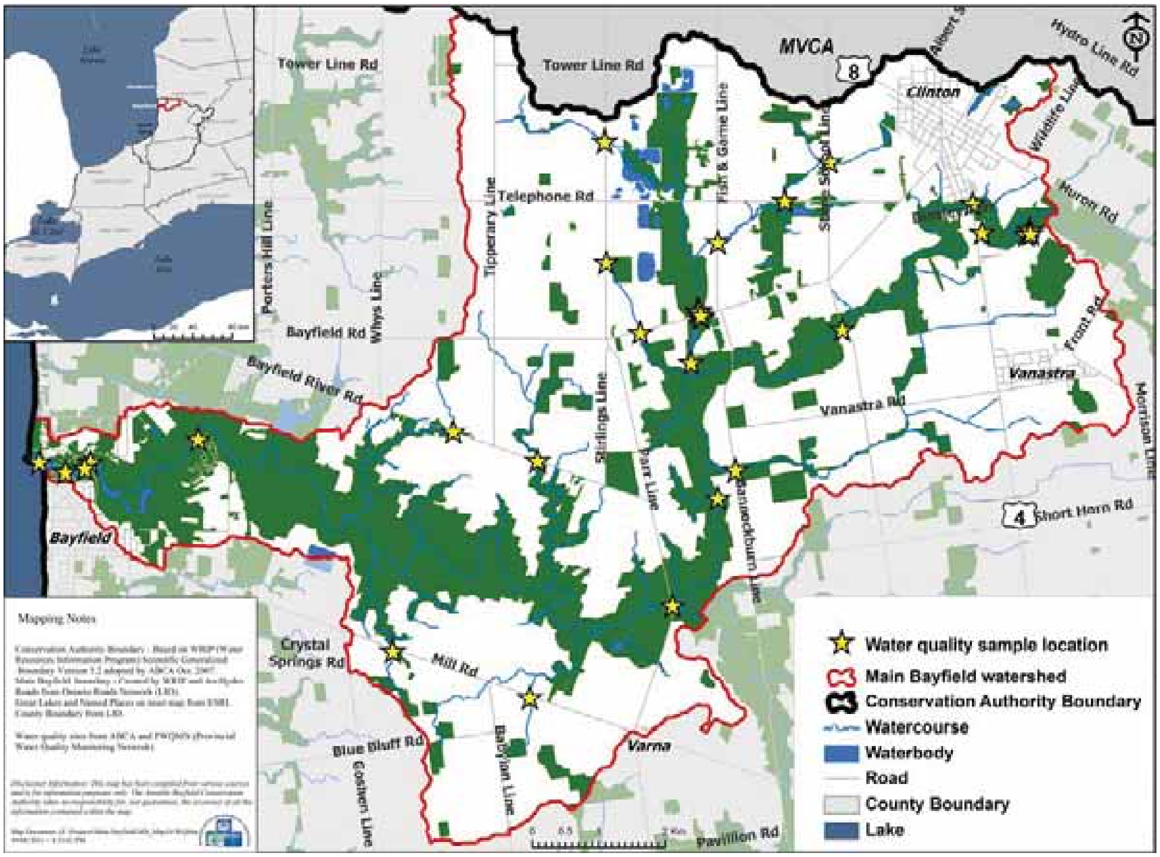


Figure 11: Water quality sampling sites in the Main Bayfield River watershed.

The PWQMN is a partnership between local agencies, often Conservation Authorities, and the MOE. The goal of this program is to collect long-term, site-specific water quality information for the province. The ABCA has been collecting surface water quality samples in our jurisdiction as part of this partnership since 1964. Sites are sampled monthly, from eight to twelve times a year, and consist of single grab samples. The indicators analyzed for this program include nutrients, suspended solids, common metals, bacteria (1970-1994) and heavy metals (since 1998). The MOE laboratory analyzes the samples for concentrations of these indicators. In the Main Bayfield watershed, one site (Bayfield River near Varna, Ontario) is monitored as part of the PWQMN program. However, this site has only been monitored since 1975.

The ABCA Enhanced program is focused on the collection of long-term, site-specific water quality information for sites that are not monitored as part of the PWQMN. This program has been running since 2003, collecting single grab samples monthly, nine times a year between March and November. The samples are sent to a private laboratory in London, Ontario, and analyzed for nutrients, suspended solids, and bacteria. There are two sites in the Main Bayfield watershed that are monitored as part of the ABCA enhanced program. Beginning in 2003, the Steenstra Drain Site 1 (Steenstra 1) was sampled to provide some information about smaller waterways in the Bayfield River Watersheds. In an attempt to document the effects of an off-line settling pond that was completed upstream of Steenstra 1 in the summer of 2006, a second site at Parr Line (Steenstra 2) was added.

Since 2008, the goal of the BRA water quality monitoring program has been to determine concentrations of *E.coli* within the watershed. Each year, nine sites have been monitored throughout the watershed; two sites located on the Bayfield River and seven sites located on tributaries. The ABCA collect single grab samples approximately twelve times a year, at a frequency of every two weeks, between June and November. The samples are sent to a private laboratory in London, Ontario, for analysis of *E. coli* concentrations.

Mean and 75th percentiles were used to summarize TP, nitrate and TSS concentrations in tributary waters. A mean is the average value while the 75th percentile is the concentration below which 75 percent of the samples for a given site occur. Geometric means were used to summarize *E. coli* concentrations in tributary waters. A geometric mean reduces the effect of uncommonly high or low concentrations on a mean.

In addition to the routine sampling undertaken by the ABCA, the Huron County Health Unit (HCHU) regularly samples 14 public lakeshore beaches during the months of June, July and August. In 2010, all of the shoreline locations were sampled on Tuesdays. The shoreline locations with previous adverse results and beaches with public washrooms were re-sampled on Thursdays. The London Public Health Lab was responsible for all lakeshore water sample analyses for the entire summer. Because swimming conditions can change rapidly, the HCHU posts beaches using seasonal averages (*i.e.*, historical five year geometric mean) in the form of blue signs (safe for swimming) and red signs (unsafe for swimming).

Data Analysis for Surface Water Quality

River Water Quality

Total Phosphorus

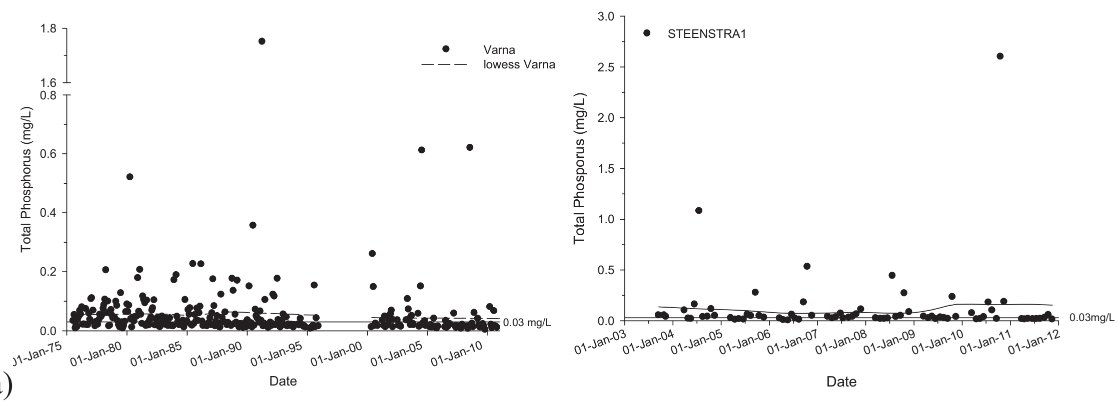
Total phosphorus (TP) concentrations for the Bayfield River and Steenstra Drain tributary typically exceed the guideline value (0.03 mg/L), however, concentrations are shown to be declining over time (Table 4 and Figure 11a) within the Bayfield River at Varna. TP concentrations tend to be higher in the Steenstra Drain tributary than the Bayfield River site at Varna.

Table 4: Mean and 75th percentile total phosphorus (TP) (mg/L), nitrate (NO_3) (mg/L), total suspended solids (TSS) (mg/L) and *Escherichia coli* (*E. coli*) (colony forming units (cfu) per 100mL) concentrations for the Bayfield River (1975-1995 and 2000-2011) and Steenstra Drain (2003-2011) water quality sites.

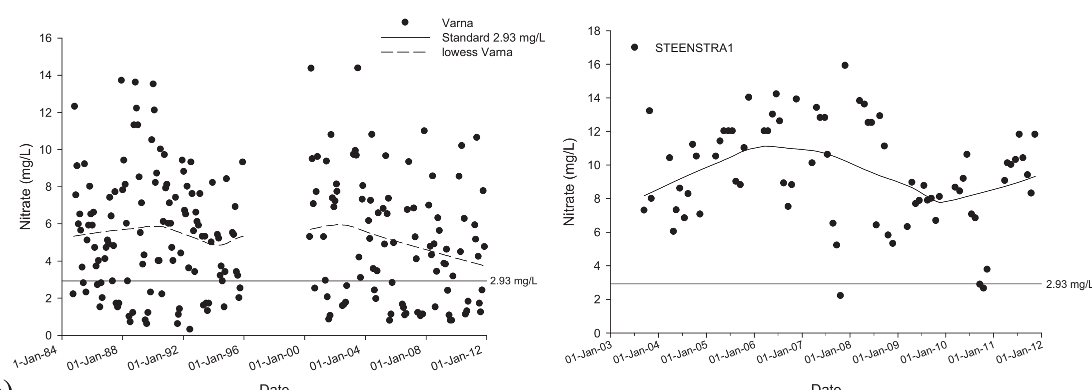
Program	TP (mg/L)	NO_3 (mg/L)	TSS (mg/L)	*E.coli* (cfu/100mL)
Guideline Value				
	0.03	2.93	80	100
Data from Individual Sites				
Bayfield River from 1975 to 1995 (Varna)				
n	232	120	229	9
Mean (Geometric mean for *E.coli*)	0.06	5.5	15	81
75th Percentile	0.06	7.7	11	143

Bayfield River from 2000 to 2011 (Varna)				
n	96	96	96	76
Mean (Geometric mean for *E.coli*)	0.04	5.1	15	100
75th Percentile	0.04	7.3	7	205
Steenstra Drain from 2003 to 2011 (Steenstra 1)				
n	75	75	75	74
Mean (Geometric mean for *E.coli*)	0.11	9.5	23	190
75th Percentile	0.06	12.0	14	1000
Steenstra Drain from 2003 to 2011 (Steenstra 2)				
n	-	-	56	55
Mean (Geometric mean for *E.coli*)	-	-	16	178
75th Percentile	-	-	13	588
Typical Value*				
	0.08			233

*Typical values represent the mean TP concentration (2000-2005) and the geometric mean for *E. coli* (2003-2005) for the entrie ABCA watershed (Veliz *et al*. 2006).



a)



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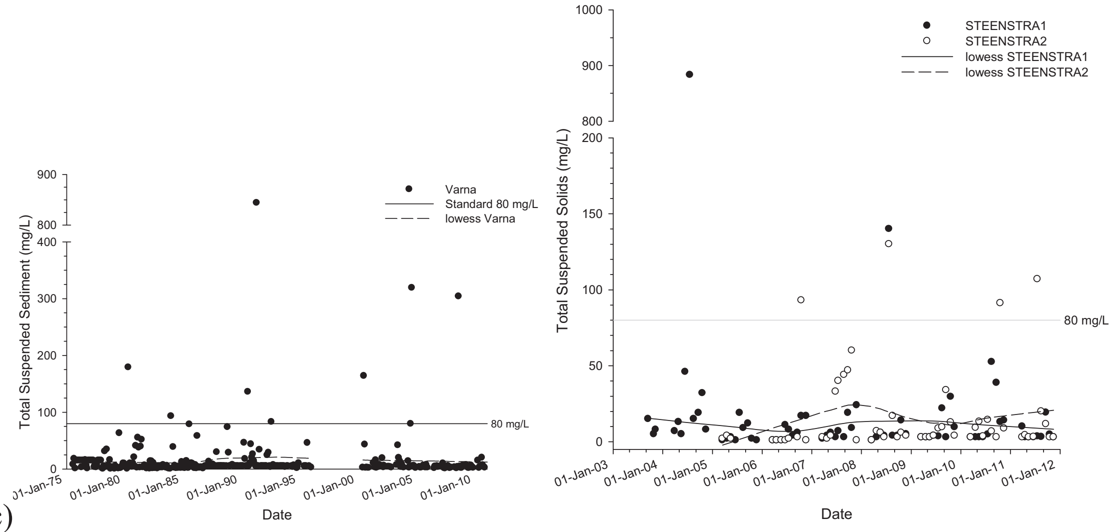

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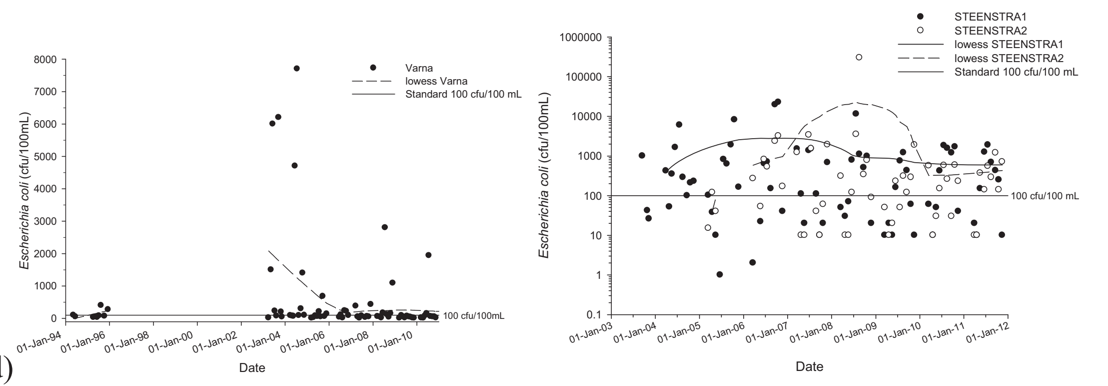

d)

Figure 12(a-d): Total phosphorus, nitrate, total suspended solids and *Escherichia coli* in the Bayfield River at Varna (1975-1995 and 2000-2011), Steenstra1 (2003-2011), and Steenstra2 (2003-2011). Lowess lines are interpolated from discrete samples to show trends. Period of record for these indicators vary.

Nitrates

Nitrate concentrations are consistently above the guideline (2.93mg/L), with values higher in the tributaries than the main branch (Table 4 and Figure 12b). There is an increase in the nitrate concentrations within the Steenstra Drain tributary from 2003 to the end of 2005, followed by a downward trend beginning in 2006. This downward trend continued until late 2009 before they began to increase once again in 2010. This rise and fall in the nitrate concentrations suggest that the collection of land use data may help to understand the land management implications on adjacent water quality values.

Total Suspended Solids

Total suspended solids (TSS) are consistently low, with the majority not exceeding the guideline value (<80 mg/L) (Table 4 and Figure 12c).

Escherichia coli

The geometric mean concentration of *Escherichia coli* (*E. coli)* does not exceed the guideline value for samples taken within the Bayfield River at Varna (Table 4). The values appear to be increasing over time, however, there is not enough data to confirm this, as only nine samples were collected for *E.coli* at Varna from 1975 to 1995 (Figure 12d). Following a similar trend found for TP and nitrate, increased concentrations of *E. coli* were found within the Steenstra Drain tributary as compared to the Bayfield River.

Samples collected to determine *E. coli* concentrations as part of the BRA and ABCA collaborative sampling program illustrate higher values collected within tributaries to the Bayfield River compared to values collected within the Bayfield River main branch (Figure 13). Samples collected from the Main Bayfield River tributaries are taken from six sites, and are more reflective of the geomean concentrations typically found in ABCA watersheds (Veliz *et al*. 2006). Data collected within Trick's Creek in 1996 however indicates that not all tributaries are similar. Variation exists between different tributary sites with some having high values and some with low values (Figure 14).

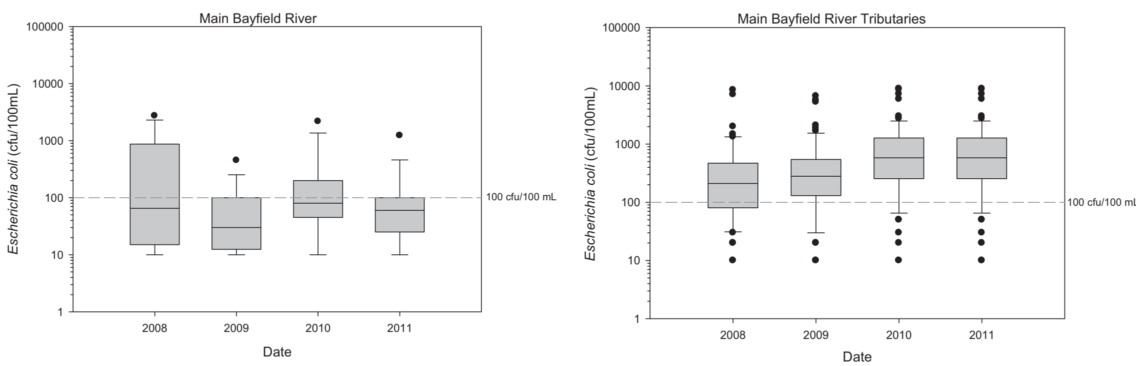

Figure 13: Median *Escherichia coli* concentrations, in colony forming units (cfu) per 100 mL, in the Main Bayfield River watershed and its tributaries in 2008 through 2011. Line through centre of box is median concentration. Box represents 50% of concentrations, while bars represent 80%. Circles show outliers (*i.e.*, concentrations that are much higher or lower than rest). Black horizontal dashed line marks 100 cfu/100 mL (Upsdell and Veliz 2009a; Upsdell and Veliz 2009b; Upsdell and Veliz 2011).

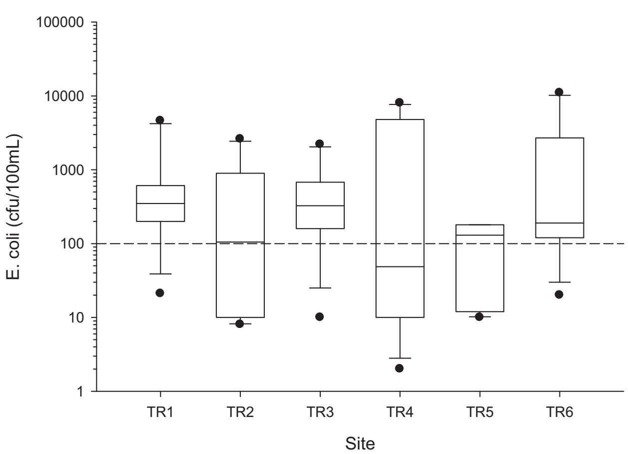

Figure 14: Median *Escherichia coli* (*E. coli*) concentrations, in colony forming units (cfu) per 100 mL, in the Trick's Creek watershed during 1996. Line through

centre of box is median concentration. Box represents 50% of concentrations, while bars represent 80%. Circles show outliers (*i.e.*, concentrations that are much higher or lower than rest). Black horizontal dashed line marks 100 cfu/100 mL (Brock, Upsdell and Veliz 2010).

Another way to summarize the water quality data is to use a grading scheme. Grade ranges of TP and *E.coli* concentrations have been developed under the 2011 Guide to Developing Conservation Authority Watershed Report Cards (2011) (Table 5). Grades for the Varna site are comparable for both time periods: C for TP and B for *E.coli* (Table 6). The grades for both indicators are one grade level below those for Varna with a D for TP and C for *E.coli* at the Steenstra1 site. Other studies (Nelson *et al*. 2003) have also noted that headwater tributaries seem to have greater concentrations of nutrients than main channel sites.

Table 5: Class range of total phosphorus (mg/L) and *Escherichia coli* (*E. coli*) (colony forming units (CFU) per 100mL) concentration under 2011 Conservation Ontario Guide to Developing Conservation Authority Watershed Report Cards (2011)

GRADE	CATEGORY	Total Phosphorus (mg/L)	E. coli (CFU/100mL)
A	EXCELLENT	<0.02	0 - 30
B	GOOD	0.02 - 0.03	31 - 100
C	FAIR	0.031 - 0.06	101 - 300
D	MARGINAL	0.061 - 0.18	301 - 1000
E	POOR	>0.18	>1000

Table 6: Scoring of Main Bayfield watershed indicators for Steenstra Drain site Streenstra1 (2003 to 2011) and for the Bayfield River at Varna (1975 to 1995 and 2000 to 2011), using Conservation Ontario scoring system.

Indicator	Steenstra Drain at Steenstra1 from 2003 to 2011		Bayfield River at Varna from 1975 to 1995		Bayfield River at Varna from 2000 to 2011	
	Concentration	Score	Concentration	Score	Concentration	Score
Total Phosphorus (75th Percentile, mg/L)	0.062	**D**	0.059	**C**	0.035	**C**
E. coli (Geometric mean, CFU/100mL)	190	**C**	81	**B**	100	**B**

Beach Water Quality

A recent report prepared by the MOE (Howell *et al*. 2005) analyzed the HCHU beach water data collected between 1993 and 2003. Over this period, the median *E.coli* concentration at the beaches sampled was between 50 and 100 cfu/100 mL. These findings are similar to current findings (Huron County Health Unit 2010) (Table 7). In the MOE report, the recreational water quality guideline of 100 cfu/100 mL was exceeded approximately 25 percent of the sampling opportunity.

Table 7: Five year (2006-2010) and one year (2010) geometric mean (GM) *Escherichia coli* (*E. coli*) concentrations (cfu/100mL) for Huron County public beach locations (Huron County Health Unit 2010).

Lakeshore Public Beach Locations	5 Year 2006 to 2010 *E. coli* GM	1 Year 2010 *E. coli* GM
Amberley Beach	54	97
Ashfield Township Park Beach	57	78
Bayfield Main Beach	33	27
Bayfield South Beach	36	26
Black's Point Beach	59	77
Goderich - Main Beach	77*	105
Goderich - Rotary Cove Beach	53	66
Goderich - St. Christopher's Beach	64*	79
Hay Township Park Beach	54	68
Houston Heights Beach	42	45
Port Albert Beach	69*	134
Port Blake Beach	35	53
St. Joseph's Beach	62*	90
Sunset Beach	25	23

Notes:
GM = Geometric Mean
* Site included at least one annual geometric mean greater than 100 *E. coli* per 100 mL water in the last 5 years.
5 Year E. coli Geometric Mean of 81 or greater
5 Year E. coli Geometric Mean between 61 and 80
5 Year E. coli Geometric Mean of 60 or lower

Benthic Sampling Locations
Aquatic water quality is commonly determined by sampling the benthic macroinvertebrates, which are bottom dwelling animals without backbones, present within a water body. Each benthic macroinvertebrate species has a different tolerance to environmental pollutants and/or stressors. The presence of species which are intolerant to pollution indicates healthy water quality, while the absence of these intolerant species can indicate that the water quality is impaired. Three sites within the Main Bayfield River watershed have been sampled in the past, with one site sampled on a more regular basis (Table 8 and Figure 15). In order to obtain a score for the surface water quality, a modified version of Hilsenhoff's (1998) Family Biotic Index (FBI) was employed (Table 9). Note that sites MBBAY1 and MBCLI1 have not been included in these results as they were both only sampled once in 2001, and the values for these sites did not affect the Main Bayfield average grade. The Main Bayfield average grade is slightly better than the ABCA average, with grades ranging from A to C over the seven years sampled (Table 10).

Table 8: Benthic sampling locations and years sampled within the Main Bayfield River watershed.

Site Name	Location	Sample Year(s)
MBBAY1	Bayfield River (Main)	2001
MBCLI1	Bayfield River (Main)	2001
MBVAR1	Bayfield River (Main)	2002, 2003, 2005, 2007, 2009-2011

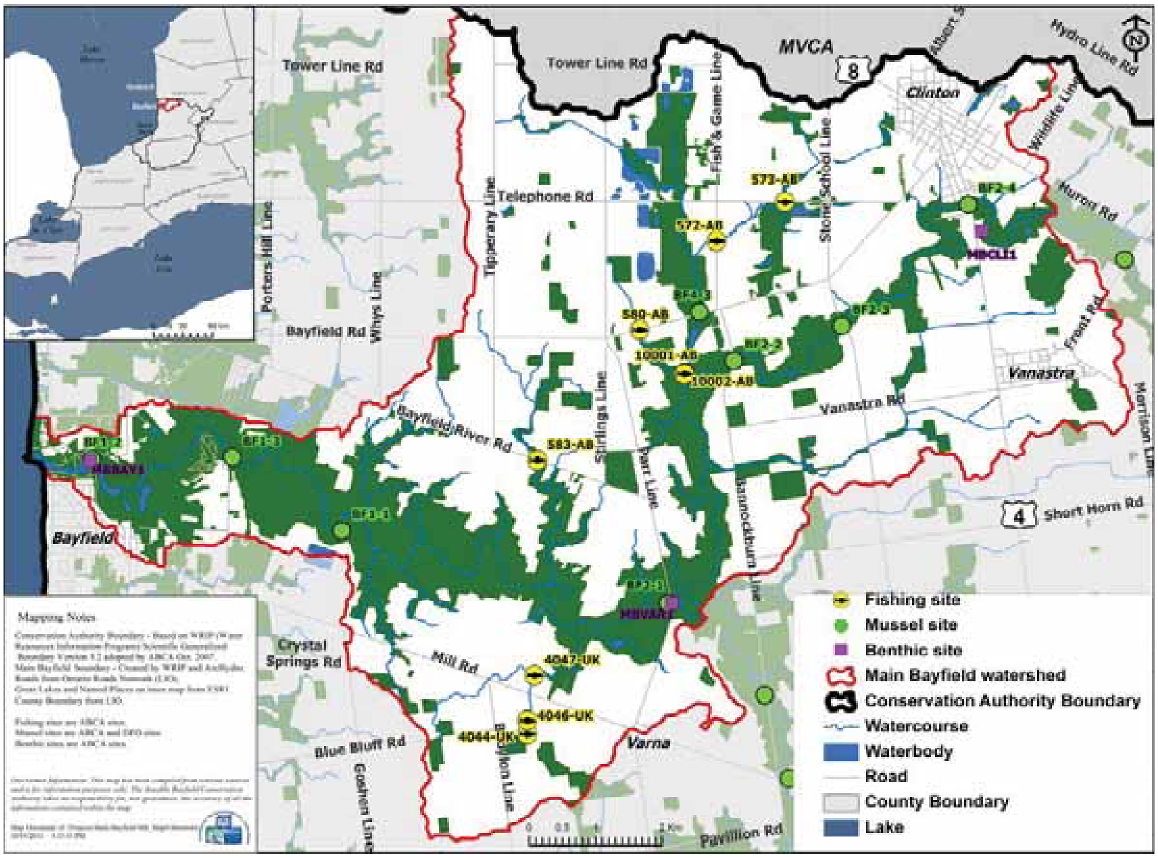

Figure 15: Benthic, fish and mussel sampling sites in the Main Bayfield watershed.

Table 9: Surface water quality scoring grid for benthic invertebrates.

Benthic Score (modified from Hilsenhoff 1988)	Grade
< 4.25	A
4.26-5.00	B
5.01-5.75	C
5.76-6.50	D
> 6.51	F

Table 10: Benthic invertebrate scores for the Main Bayfield River Watershed at site MBVAR1 (2002-2003, 2005, 2007, 2009-2011) and the average score from the entire ABCA watershed (2000-2005).

Year	Benthic Score	Grade
2002	5.59	C
2003	4.78	B
2005	4.75	B
2007	4.17	A
2009	3.82	A
2010	5.16	C
2011	5.15	C
Main Bayfield Average	4.77	B
ABCA Average	5.60	C

Fisheries and Fish Habitat

The *Fisheries Act* defines fish habitat as "spawning grounds and nursery, rearing, food supply, and migration areas on which fish depend directly or indirectly in order to carry out their life processes". The quality of aquatic habitat depends on water quantity (*i.e.*, water depth and velocity), water quality (most specifically water temperature and dissolved oxygen concentrations and to some extent turbidity, Nitrogen and Phosphorus concentrations), aquatic plants, in-stream substrate type and structure, and benthic invertebrates (which are an important fish food source). Activities that alter these characteristics may potentially alter fish habitat. Due to the inherent connectivity of watercourses the land use changes upstream can have significant impacts on the habitat downstream (Veliz 2001).

Fish surveys have been completed by various agencies at nine sites within the Main Bayfield River watershed (Figure 15). At least 45 species have been confirmed including the black redhorse (*Moxostoma duquesnei*), which is classified as a SAR (Table 11). A comprehensive fish sampling program does not exist within the Bayfield River and the information we have is from fish sampled for the purpose of different projects and purposes. Trick's Creek, which is one of the few cold water fisheries within the Ausable Bayfield jurisdiction, provides the majority of the habitat for cold water fish species such as the rainbow trout (*Oncorhynchus mykiss).*

Table 11: Fish species present in the Bayfield River watershed.

Common Name	Scientific Name	Most Recently Collected
Northern Brook Lamprey*	*Ichthyomyzon fossor*	
Gizzard Shad	*Dorosoma cepedianum*	1974
Alewife	*Alosa pseudoharengus*	1974
Pink Salmon	*Oncorhynchus gorbuscha*	
Coho Salmon	*Oncorhynchus kisutch*	
Chinook Salmon	*Oncorhynchus tshawytscha*	
Brown Trout	*Salmo trutta*	1974
Rainbow Trout	*Oncorhynchus mykiss*	1974
Brook Trout	*Salvelinus fontinalis*	1974
Atlantic Salmon	*Salmon salar*	1974
Rainbow Smelt	*Osemerus mordax*	1974
Central Mudminnow	*Umbra limi*	1974
Northern Pike	*Esox lucius*	1974
Horny head Chub	*Nocomis biguttatus*	2003
River Chub	*Nocomis micropogon*	1974, 2003
Common Shiner	*Notropis cornutus*	2003
Emerald Shiner	*Notropis atherinoides*	1974
Spottail Shiner	*Notropis hudsonias*	1974
Redfin Shiner	*Lythrurus umbratilis*	
Longnose Dace	*Rhynichthys cataractae*	
Creek Chub	*Semotilus atromaculatus*	2003
White Sucker	*Catostomas commerssoni*	1974, 2003
Northern Hog Sucker	*Hypentelium nigricans*	1974, 2003
Black Redhorse*	*Moxostoma duquesnei*	
Catfish	*Pylodictis olivaris*	1974
Brook Stickleback	*Culaea inconstans*	1974
Rock Bass	*Ambloplites rupestris*	1974, 2003
Smallmouth Bass	*Micropterus dolomieui*	1974
Yellow Perch	*Perca flavescens*	1974
Rainbow Darter	*Etheostoma caeruleum*	1974
Least Darter	*Etheostoma microperca*	1974
Johnny Darter	*Etheostoma nigrum*	1974, 2003
Blackside Darter	*Percina maculata*	1974
Mottled Sculpin	*Cottus bairdi*	1974
Largemouth Bass	*Micropterus salmoides*	2003
Brown Bullhead	*Ameiurus nebulosus*	2003
Channel Catfish	*Ictalurus punctatus*	2003
Round Goby	*Neogobius melanostomus*	2003
Striped Shiner	*Luxilus chrysocephalus*	2003
Bluntnose Minnow	*Pimephales notatus*	2003
Blacknose Dace	*Rhinichthys atratulus*	2003
Northern Redbelly Dace	*Phoxinus eos*	2003
Fathead Minnow	*Pimephales promelas*	2003
Black Bullhead	*Ameiurus melas*	2003
Common Carp	*Cyprinus carpio*	2003

*fish species found on the Index list of vulnerable, threatened, endangered, extirpated or extinct species of Ontario (Issued by Ontario Ministry of Natural Resources).

Mussel Habitat
In July of 2007, eight sites were monitored for mussels within the Main Bayfield River watershed, with seven sites on the main stem of the Bayfield River and one site on Trick's Creek (Figure 15). Each site was surveyed using the intensive time-search technique which included surveying the substrate at each site both visually and tactilely. Mussels were found at only four of the eight sites surveyed, with a total of 173 mussels collected representing 14 species (Table 12). Populations of pink heelsplitter (*Potamilus alatus)*, white heelsplitter (*Lasmigona complanata)*, fatmucket (*Lampsilis siliquoidea)* and fragile papershell (*Leptodea fragilis)* all appeared in the highest numbers. Fatmucket (*Lampsilis siliquoidea)* was found to be present at all four sites which contained mussel populations, with only one found at two of the sites. Two species of SAR were observed, which included the mapleleaf (*Quadrula quadrula*) and rainbow (*Villosa iris*) mussels; presence of these mussels indicates a need to continue to monitor mussel populations within the Bayfield River (Morris *et al*. 2012)

Table 12: Mussel species observed during the Morris *et al*. (2007) survey in the Bayfield River watershed.

Common Name	Scientific Name	Number Collected
Creeper	*Strophitus undulatus*	1
Cylindrical Papershell	*Anodontoides ferussacianus*	1
Deertoe	*Truncilla truncata*	1
Fatmucket	*Lampsilis siliquoidea*	29
Flutedshell	*Lasmigona costata*	14
Fragile Papershell	*Leptodea fragilis*	23
Giant Floater	*Pyganodon grandis*	16
Mapleleaf Mussel*	*Quadrula quadrula*	1
Paper Pondshell	*Utterbackia imbecillis*	1
Pink Heelsplitter	*Potamilus alatus*	39
Plain Pocketbook	*Lampsilis cardium*	12
Rainbow Mussel*	*Villosa iris*	3
Threeridge	*Amblema plicata*	8
White Heelsplitter	*Lasmigona complanata*	24

*mussel species found on the Index list of vulnerable, threatened, endangered, extirpated or extinct species of Ontario (Issued by Ontario Ministry of Natural Resources).

Rainbow (Villosa iris) (left) and mapleleaf (Quadrula quadrula) (right) mussels are two species at risk mussels found in the Bayfield River.

Municipal Drains

In rural Ontario many watercourses are Municipal Drains. These drains are either modified naturally occurring creeks or have been constructed. Drains have been constructed to provide an outlet for subsurface drainage or improve drainage from wet areas on farm properties. Periodically, deposited sediment and brush need to be cleaned out of the drain to help improve their function. As these drains provide potential habitat for desirable fish species they are protected under the *Fisheries Act*. The Act is comprised of three main areas of focus: management and monitoring of fisheries, conservation and protection of fish and fish habitat, and pollution prevention. The Act states in Section 35 that "no person shall carry on any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat" without receiving authorization by the Minister of Fisheries and Oceans Canada. To help determine the level of protection required for each drain, a Municipal Drain Classification system was created. This classification system is comprised of six drain types (A, B, C, D, E, and F), each type varying in the combination of flow, temperature, species present, and time since last clean out. As seen from Figure 16, a number of watercourses remain unclassified while there is a significant amount of cold and warm water habitat.

There have been recent upgrades to the Mary Street Drain, including a sedimentation pond.

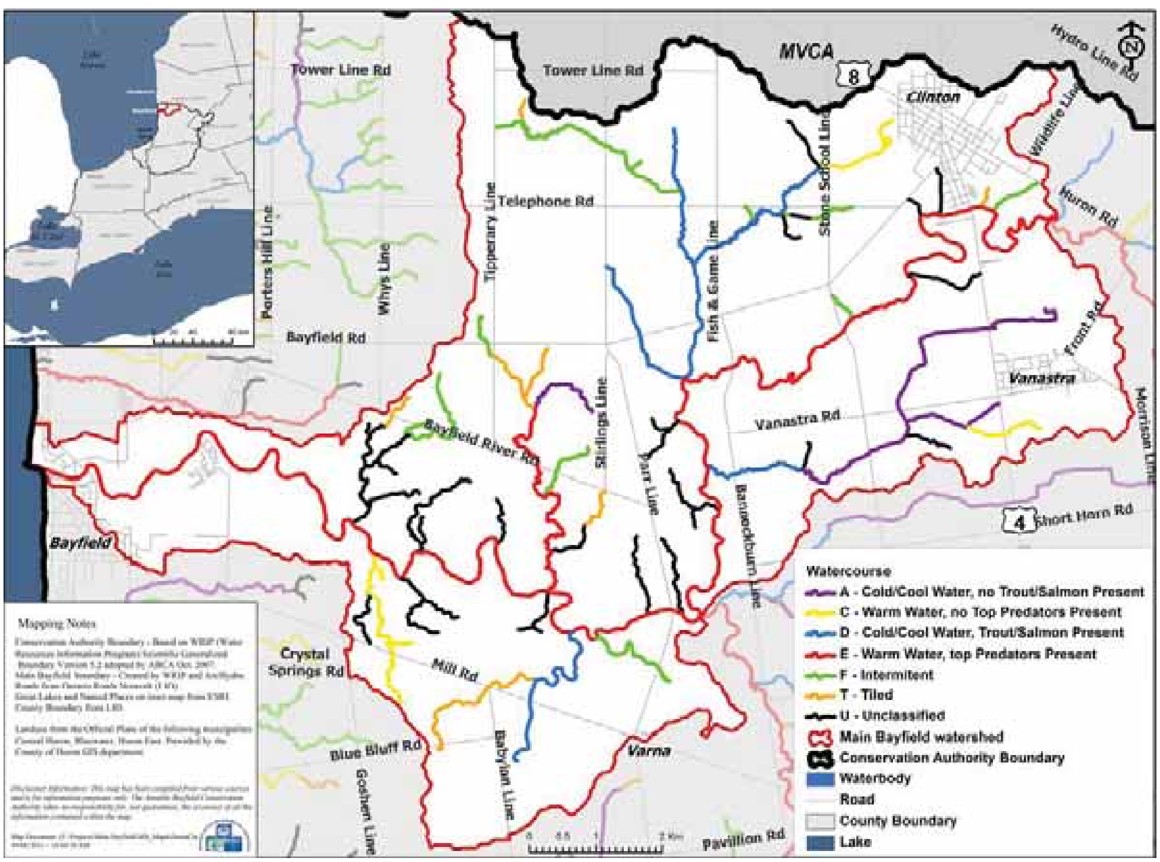

Figure 15: Municipal Drains of the Main Bayfield River watershed.

Chapter 3 - Community Goal

The advisory committee has created a vision, set a goal and decided on targets for assessing the goal.

Watershed Vision

Main Bayfield River Watershed Management Plan will respect the long-term sustainability of all water systems and the life that depends on them. Our community vision is one of a healthy, resilient watershed where people, wildlife and habitat thrive. Taking pride in the quality of the Main Bayfield River Watershed; continuing to protect and enhance the watershed resource.

Community Goal

Our goal is to improve the water quality and quantity within Lake Huron, the Bayfield River and all tributaries.

The Advisory Committee recommended working towards water quality and quantity improvements by using the values within the ABCA Watershed Report Card (Veliz *et al*. 2006) as a starting point to measure success. The Watershed Report Card for the Main Bayfield River has important water quality information which has already been collected and summarized for this area. Our goal is to improve the water quality and quantity within the Bayfield River by reducing total phosphorus (TP), *Escherichia coli* (*E. coli*) and total suspended solids (TSS) concentrations and to increase forest cover, wetlands, and streamside cover.

Chapter 4 - Taking Action

Survey

The landowner survey developed for The Main Bayfield River Watershed Management Plan incorporated the content and format from established surveys used in previous watershed plans (Durley 2006). The survey was then refined to best reflect the high percentage of agricultural land use within the Main Bayfield River watershed and then reviewed by the advisory committee. Members of the advisory committee then initiated contact with landowners within the Main Bayfield River watershed community to introduce the project and inquire if they would be open to completing a survey with ABCA staff. Information from the one-on-one landowner surveys were documented with identities kept confidential. The information gained from landowner surveys will help to identify priority areas for future action and implementation of environmental improvement projects, such as Best Management Practices (BMPs). Cropping information from the landowner surveys will additionally be used in our surface water quality information to obtain a better picture of the hydrology of the Main Bayfield.

We are working toward a goal of completing landowner surveys with 70% of the landowners within the Main Bayfield watershed community and then continue to complete surveys as an ongoing process. There are 175 agricultural landowners within the Main Bayfield watershed with surveys completed with 24 landowners to date. Crop surveys have been completed for the Main Bayfield River watershed for the Fall 2011, Spring 2012 growing seasons and will be an ongoing process of data collection. The information gathered as part of these surveys is used in the watershed characterization process and helps decipher water quality results.

Community-Based Actions

This information will be added in December 2012 pending community input.

Chapter 5 - Evaluation

Indicators Review

Successful environmental programming requires evaluation. The Lake Huron Framework Committee recognized the importance of identifying goals and measuring the program against targets and indicators as one of the four principles outlined in The Lake Huron Watershed Canadian Framework for Community Action (Anderson *et al*. 2007).

Evaluation of environmental programs requires performance measures that can range from how much money was spent to direct environmental indicators (*e.g.*, TSS or nutrient concentrations). The USEPA worked with the Florida State University to describe the hierarchy of environmental indicators that provide information on the efficacy of a program (Manale 2003) (Table 13). The most valued indicators are those that directly track changes in the health of humans, wildlife or the resource (*i.e.*, **direct environmental indicators**). The weakest indicators are those that do not reflect an actual ecological result, but track agency actions *(i.e.*, **program indicators;** *e.g.*, areas of land treated, dollars spent on conservation programs, number of clients served). The measurement of results (*i.e.*, **measurement indicators**; *e.g.*, miles of fences, acres of riparian buffers) may track the effort, but may not communicate what the public wants to know, which is, "*Is the water clean?*"

Table 13: Types of indicators that measure environmental programs and their hierarchy of efficacy in measuring success (Manale 2003).

Indicator Type	Hierarchy	Example
Environmental	1	Total Phosphorus concentration to measure eutrophication
Program	2	Number of clients attending a public meeting
Measurement	3	Number of acres retired
Social	4	Number of landowners requesting assistance to install management practices

The use of environmental indicators is a more complicated, and potentially expensive, approach; however, it is important to employ the use of all these indicators in some areas to provide a comprehensive understanding of a program's effectiveness.

Monitoring is a scientifically-designed system of long-term, standardized measurements, systematic observations, evaluation and reporting (Dowdeswell *et al.* 2010). Environmental programs often employ water monitoring as an evaluation tool. However, objectives usually differ between programs, resulting in various reasons for the collection of water quality data.

Although the ABCA Enhanced Water Quality Monitoring Program has two sites that are monitored for the purpose of evaluating an off-line sediment retention pond, the main focus of the monitoring programs in the Main Bayfield watershed has been devoted to providing long-term trends at different sites. To evaluate the effectiveness of the watershed plan with associated BMPs at the watershed scale, a different monitoring strategy is required.

Traditionally, there has been an assumption that a site at the outlet of a watershed may reflect overall watershed conditions. At a broad, Lake Huron scale, this is a reasonable assumption, but if we are trying to evaluate the effectiveness of site-scale BMPs at the watershed scale, the site specificity of water quality indicators creates at least two related problems:

1) We expect one site to represent an entire watershed area (typically 50 to $100km^2$), whereas the conditions at that site may reflect a factor that is more proximate. Water quality is determined by many factors, such as climate, land use, management practices, topography and soil composition. At the site scale, one or more of these factors may override other factors that are inherent throughout the watershed.
2) It would be difficult to use data from one location at the watershed outlet to measure specific, voluntary stewardship activities that occur within the basin as there may be multiple sources of the contaminant. In other words, relieving one source may not mean that other sources have been addressed.

The spatial specificity of water quality indicators may mean that additional monitoring sites, including monitoring sites at key locations that drain very small areas, may need to be considered. However, in most cases it is not feasible to monitor everywhere all of the time.

Changes to the Monitoring Program

There are at least two considerations when devising an evaluation framework with direct environmental indicators. The first consideration is related to time. Long-term monitoring stations, such as a site located at a watershed outlet, or sites that are part of the PWQMN or ABCA Enhanced Program are very useful over the longer term (*i.e.*, 10 to 20 years), as data analysis can address questions such as, "*Are the concentrations of nutrients trending up or down?*" While data from these locations may not provide reasons for changes in water quality, they can indicate whether conditions are improving or degrading.

The second consideration is that there needs to be some attempt to explain factors that determine water quality. If data collection and analysis are to explain causal changes, the building of scenarios may be necessary. Environmental models can help to synthesize observations, analyze interactions among processes and fill gaps in information (Dowdeswell *et al.* 2010). Models are built because it is impossible to collect sufficient monitoring data over the short-term to show changes in water quality.

If environmental models are to be integrated into an evaluation framework they need to accurately reflect what is happening in a watershed. Water quantity measurements need to be considered. Flowing water is the transport mechanism for water quality changes in the watershed. The water flow (or hydrology) in a watershed depends on climate (precipitation), land use, management practices, topography and soil composition, to name some of the main parameters. Water discharge records are needed to calibrate watershed parameters which will impact discharge as well as providing a means to create a continuous loading value for water quality indicators.

Information from the literature could be used to integrate the effectiveness of BMPs in improving water quality into an environmental model. Alternatively, if the opportunity exists,, it would be best to complete site-scale water quality monitoring of a BMP. Site-scale hypothesis testing would help to explain the impact of local climate, topography and soil conditions on water quality.

As mentioned previously, evaluation is an important component of any environmental program. The Main Bayfield Watershed Plan will incorporate the use of program and measurement indicators (*e.g.*, number of people attending events, number of landowner surveys completed, number of BMPs undertaken) and there are targets for these indicators (Table 14). However, through additional funding and collaboration with other partners, this program also provides the opportunity to use direct environmental indicators to track watershed plan success.

Table 14: Indicators to be used in the evaluation of the success of the Main Bayfield Watershed Plan.

Type of Indicator	Specific Indicator	Methodology
Environmental	Total Phosphorus, Total Suspended Solids Concentration	Direct water quality measurements
Environmental	Before and after pictures of areas where BMPs were implemented	Photographs
Environmental	Crop management changes	Windshield surveys; Landowner surveys
Program	Number of letters directly mailed to landowners	Mailing list
Program	Number of participants attending public and stakeholder meetings	Attendance lists
Program	Number of people attending demonstration site open house	Attendance lists
Program	Number of landowner surveys completed	Tracking database
Measurement	Number of restoration events held in collaboration with community groups	Tracking database
Measurement	Number of management practices completed	Tracking database
Social	Number of follow-up phone calls requesting information	Phone records
Social	Number of landowners requesting assistance to install management practices	Phone records
Social	Number of landowners aware of technical and financial assistance available for management practice installation	Landowner survey

A program that uses direct environmental indicators must integrate different scales of data collection. A more comprehensive program incorporates hypothesis-based experiments (likely conducted at the site scale) with long-term data collection.

To make better use of water quality data from a long-term site, collection of the following information should be considered:

1) a detailed water flow data set;
2) concentrations of the target indicator (*e.g.*, total phosphorus) at low, mid and high flow conditions); and
3) some land use information that details watershed cropping regimes and manure storage and application.

To include BMP evaluation in an environmental program, specific site-scale experiments that use Before, After, Control, Impact (BACI) designs would need to be integrated. Ideally, the same BMP (*e.g.*, berms) could be evaluated in different watersheds.

Chapter 6 - Recommendations

The Advisory Committee is planning consultation with community groups over the next few months to complete the recommendations section of this report. After these meetings are complete, this information will be added in December 2012.

Concerns taken from Advisory Committee Meetings

The advisory committee meetings there have produced some preliminary themes:

- Pride in protecting the natural areas in the community
- Nutrient management
- Silt and runoff needs to be held back
- Emphasis on the added value of BMPs to individual properties
- Set targets such as increased forest cover and increased wetlands
- Focus on marginal land
- Sewage treatment lagoon concerns
- Windmill concerns
- Aggregate concerns

Chapter 7 - Concluding Remarks

This information will be added in December 2012.

USEFUL LINKS

GLOSSARY

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