Nearshore Water Quality

A Preliminary Report on
Historical Nearshore
Water Quality
Information for
Southeastern Lake Huron

Sauble Beach to Sarnia

Prepared by

The Lake Huron Centre for Coastal Conservation

Nearshore Water Quality

This report was prepared under a Letter of Agreement between Environment Canada and the Coastal Centre.

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Executive Summary

This study was commissioned by Environment Canada in March, 2003 for use by the Lake Huron Southeast Shore Working Group, in support of priorities under the Lake Huron Binational Partnership. It was intended to compile and summarize water and beach quality data for southeastern Lake Huron's nearshore waters from an historical perspective. In addition, information was collected on public complaints to regulatory agencies about water quality, and information on land-use in tributary watersheds along the shoreline. The study area included the coastal area from Sarnia to Sauble Beach. An attempt was made to obtain information for the period 1984-2003.

A large body of information on southeastern Lake Huron's nearshore water quality exists, although it is fragmented, inconsistent and, in some cases, incomplete. Information was collected from area First Nations, local Health Units, community groups, Conservation Authorities, the Ontario Ministry of Natural Resources and Ontario Ministry of the Environment.

Bacterial pollution is a great concern all along the lakeshore in Lambton, Huron and the southern part of Bruce counties. Data showed high frequencies and duration of exceedences above the Provincial Water Quality Objectives set for *Escherichia coli* (*E. coli*). As a result, a number of public beaches have been posted for extended periods of time in recent years advising people against swimming. There is no formal system in place to track infections or illnesses related to exposures to polluted bathing areas along the southeastern shores of Lake Huron.

Nutrient data, specifically nitrates and total phosphorous, also show elevated concentrations in some watercourses flowing to the shoreline. Resulting algal blooms have been a problem in many areas south of Kincardine over the past 4-5 years, although historical accounts of algae problems suggest an ongoing problem in the Goderich area..

Sources of pollution were identified in past reports as including agriculture and faulty septic systems as the primary sources. A smaller, but important, source included by-passes from Waste Water Treatment Plants.

There is extensive development along the shoreline which relies on the use of septic systems for sewage disposal, and there are permeable soilsin some portions of the lakeshore area. These factors, in combination, suggest that septic systems may be a significant contributor to nearshore water quality impairments in some portions of the study area over the long term. This applies particularly in respect to nutrient enrichment.

Bacterial pollution tends to become elevated after precipitation events, suggesting that surface runoff is the primary conduit. Both agriculture, and the trend towards intensive agriculture in the study area, as well as waste water treatment plant by-passes, and urban stormwater runoff in some areas, were identified in past investigations as major contributors to wet-weather bacterial pollution.

Discussions were held with representatives from Saugeen, Chippewas of Nawash, and Kettle and Stony First Nations. All had concerns with the state of nearshore water quality particularly within their traditional waters.

Finally, information concerning recent outbreaks of Avian Botulism along southeastern Lake Huron is presented as a recent, albeit naturally occurring, impairment. An unresolved question is whether or not there is a connection between the rate and severity of outbreaks and the anaerobic environment created from decomposing algae.

1.0 Study Purpose

Impairments of nearshore water quality along portions of southeastern Lake Huron have been a major public concern in recent years. Beach postings and algae fouling have been frequent observations, and local media attention to the issue has raised the level of concern. The development of Intensive Livestock Operations near the lakeshore has heightened the level of concern in Saugeen Shores, Kincardine, Huron-Kinloss, Goderich, Grand Bend, and Sarnia. Concerned citizen groups have evolved in response to concerns that these types of intensive operations may be responsible for some of these impairments, and so there is an increased sensitivity about beach postings and algae fouling.

One of the specific objectives of the Great Lakes Water Quality Agreement is that "recreational waters should be substantially free from bacteria, fungi, and viruses that may produce enteric disorders or eye, ear, nose, throat and skin infections or other human diseases and infections." The public is becoming increasingly concerned with beaches exceeding Provincial recreational water quality objectives. Some local cottage associations have begun their own monitoring programs in an effort to better understand the magnitude of the problem in their own portion of the lakeshore.

In addition, public concerns have been raised about the regular occurrences of algal fouling along a number of beaches within the study area in recent years. Many of these fouling occurrences have produced a foul, "sewage" smell that has led some to infer that a manure spill has occurred. This has resulted in a number of complaints to the Ontario Ministry of the Environment who have been required to investigate each complaint.

A number of water quality reports have been prepared within the study area. Some have been *ad hoc* studies, while others have been watershed based and part of an ongoing planning process. From a coastal context, none of them seem to have been reviewed collectively to establish temporal or spatial trends.

As a preliminary step to better understand the extent of impairments along the southeastern Lake Huron shoreline, Environment Canada and the Lake Huron Centre for Coastal Conservation (Coastal Centre) have undertaken this review of information on water quality impairments in the area between Sauble Beach and Sarnia, particularly as they relate to nutrients and pathogens.

1.1 Study Outline

In this study the Coastal Centre has reviewed water quality reports from the County Health Units, from conservation authorities, from local organizations who have done water sampling, from First Nations, municipalities and the Ministry of Environment records.

The review also looks specifically at occurrences where beaches have been posted by the local health unit, or where a public complaint about water fouling has been registered with the Health Unit, municipality or the Ministry of Environment.

This information will assist a working group of federal and provincial research, monitoring and regulatory staff (the Lake Huron Southeast Shore Working Group) to:

- Monitor and assess the condition of nearshore and tributary water quality
- Study the limnological processes governing it,
- Determine the sources and relative concentrations of nonpoint source nutrient and bacterial pollution, and,
- Determine and coordinate appropriate management actions.

This work complements a detailed nearshore water quality monitoring program undertaken by the Ontario Ministry of the Environment in the Southampton, Goderich and Bayfield areas during the summer of 2003.

2.0 Overview of the Southeastern Coast of Lake Huron

The southeastern coast of Lake Huron between Sauble Beach and Sarnia is comprised of five primary watersheds that outlet into the lake. These include the Sauble River outletting at Sauble Beach, Saugeen River outletting at Southampton, Maitland emptying at Goderich, the Bayfield River flowing out at Bayfield and the Ausable River at Port Franks. Secondary watersheds include the Penetangore, Pine, Eighteen Mile and Nine Mile rivers. Tertiary watersheds include numerous creeks, gullies and drains flowing directly into Lake Huron.

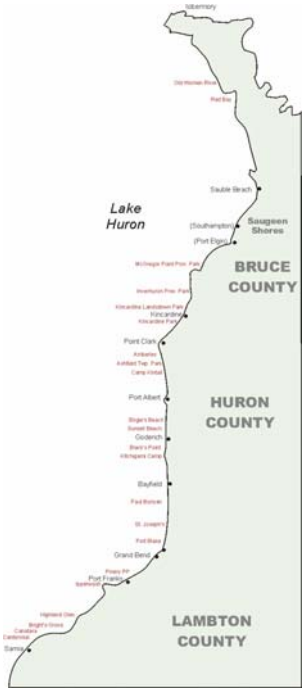


Figure 1—Location map of study area

Agriculture is the predominant land use throughout this region. Huron County, within the study area, has been identified as the most agriculturally productive county in Ontario. As part of the Maitland watershed, it also produces the greatest amount of manure in Canada at 7610 kilograms per hectare, with the Saugeen and eastern Lake Huron area (comprising the Penetangore and Pine River systems) within the top 10. The Maitland watershed also had the highest estimated concentrations

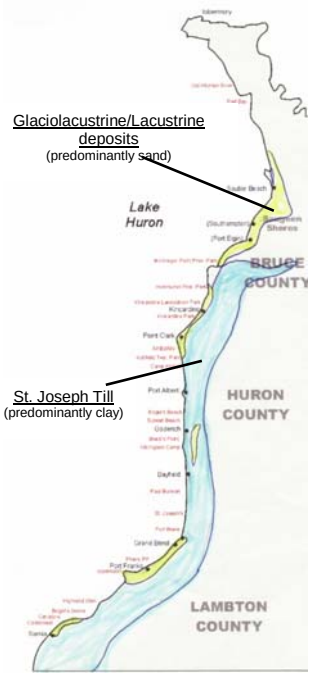
of Nitrogen, with the Saugeen and Ausable Bayfield watersheds within the nation's top ten (Statistics Canada, 2001).

Forest cover within the main watersheds is generally highest to the north and lowest to the south. The Saugeen watershed, for example, has a 30% forest cover overall, but the forest cover is greatest in the northern and eastern parts of the watershed and lower to the south and west. The Pine River watershed in the southwest corner of the Saugeen watershed has a total forest cover of only 6.6% (Smith, 2003). The Maitland watershed has a total forest cover of 15.5% (MWP, 2002). Moving south, forest cover continues to decrease, while the land used for agriculture increases.

Urban centres are scattered throughout these watersheds, but a concentration of urban and semi-urban (cottage) development occurs along the shoreline with the largest centres including the Town of South Bruce Peninsula (population 8,090), Saugeen Shores (pop. 12,500), Kincardine (pop. 12,000), Goderich (pop. 7500), Town of Bluewater (pop. 6920), Town of South Huron (pop. 10,020), municipality of Lambton Shores (pop. 11,000), Point Edward (pop. 2101), and Sarnia (pop. 70, 876). Between these centres are semi-urbanized strip developments along the coast. Development has been on an upward trend along the lakeshore over the past three decades. In a study of the Lake Huron coast, from Southampton to Point Clark, rapid urban and rural residential growth was attributed to a loss in the Huron Fringe forest cover from 58% in 1954 to 46% in 1990, although this figure does not reflect the amount of development in the understory. In the time period between 1954 and 1990, development increased from 8% to 17% of the total land use within the Huron Fringe in southern Bruce County (Lawrence and Nelson, 1992).

All of the coastal communities in the study area have an inextricable economic connection with Lake Huron. Area beaches are focal points for tourists and recreationists. For example, Grand Bend's 0.8 kilometre of beach attracts an average of 5-8,000 users per day with weekend numbers rising from 20,000 to 25,000 per day. It has been estimated that "on beach" there may be 10,000 to 15,000 at any moment. Pinery Provincial Park, to the south of Grand Bend, receives 8-10,000 bathers on peak holiday weekends, equal to approximately 1.25 bathers per metre of beach (ABCA, 1992). Similar numbers are prevalent at other public beaches in the study area. Port Elgin attracts an estimated 25,000 during a peak weekend, with a substantial number of these people believed to be using the beach (Benge, 2003). In 2002, Sauble Beach attracted an estimated 2,570,000 person-visits in July and August (Town of South Bruce Peninsula, 2003). In Lambton County, despite the fact that most beaches are private, some of the private beaches are reportedly more heavily utilized than the public beaches in the area (SCRCA, 1991).

The physiography of Lake Huron's coast has been shaped by a succession of post-glacial lakes, most notably Lakes Algonquin, Nipissing and Algoma, which formed what is known as the Huron Fringe. The Huron Fringe is defined as the narrow fringe of land along Lake Huron from Sarnia to Tobermory that is distinct from the clay plain adjacent and above it. It is comprised primarily of post-glacial lake deposits of sand dunes and gravel bars (Chapman and Putnam, 1973). These relic shorelines and beach deposits are evident north of Point Clark and south of Grand Bend. The large expanses of sand deposits have given rise to an extensive cottage industry in these areas. These relatively flat, well drained sandy soils with a shallow water table provide optimum conditions for the transport of nitrate and bacteria to groundwater, and in turn, enhance the preservation of nitrate once it reaches the groundwater (McLellan, 2000).



General physiography of the study area coast (Ministry of Northern Development and Mines, 1991)

Between Point Clark and Grand Bend the shoreline is composed of high clay till bluffs, reaching their highest point (25 metres) at Goderich. Occupying an area of about 1500 square kilometres along the eastern shore of Huron, the land slopes gently westward between the Wyoming moraine and the Algonquin bluff. This is known as the Huron Slope and is comprised primarily of the clay dominant St. Joseph Till. As water drains towards the lake a large 20 to 25 metre hydraulic head develops as the water reaches the shore bluff. Consequently, over 150 deep ravines have been incised into the till between Point Clark and Grand bend, creating direct drainage conduits to the lake. The heavy clay soils, typical of St. Josephs Till, can result in greater transport of nutrients (nitrate and phosphorous) and microbes (bacteria and protozoa) to surface water (McLellan, 2000).

The predominant wave direction on Lake Huron is from the northwest (Reinders, 1989). This sets up an alongshore current that moves nearshore sediments, on a net basis, from north to south. During summer months, when winds and waves tend to come from the southwest, the alongshore current can move sediments northward. Alongshore currents and the resulting sediment movement will have an influence on the movement of pollutants entering the nearshore waters of the lake, particularly those pollutants that become attached to sediment particles and move along the shoreline with the longshore drift. These alongshore currents can also form barrier beaches across the mouths of creeks and small watercourses causing a temporary stagnation of the estuary. Contaminants and algae blooms can accumulate in these areas until a rainfall event can breach the barrier and flush the estuary. These stillwater areas are an attraction to young children, particularly when high wave conditions make swimming in the lake undesirable. When flushing does occur, it sends a pulse of contaminants and other material into the lake.

There are a number of different authorities within the study area who have responsibilities for monitoring water quality. Within the study area there are the three counties of Bruce, Huron and Lambton with their respective Health Units that are responsible for testing the quality of public swimming beaches. Five Conservation Authorities, including the Grey Sauble, Saugeen, Maitland, Ausable Bayfield and St Clair Region, have done water testing as part of the former Clean Up Rural Beaches Program, as well as some *ad hoc* programs. Conservation Authorities also have an agreement with the province to maintain and take samples at Provincial Water Quality Monitoring Network stations within their watersheds. They send samples to the Ontario Ministry of the Environment, Environmental Monitoring and Reporting Branch for analysis and reporting. One municipality in the study area has undertaken some limited nearshore monitoring in response to community concerns of degraded nearshore water quality. Municipalities with sewage plants are responsible for ongoing monitoring of effluent. They are also mandated to monitor leachate from area landfills. The Ontario Ministry of the Environment Monitoring and Reporting Branch does an intensive nearshore monitoring program once every five years or so, as well as some *ad hoc* studies. The MOE has area offices in Sarnia and in Owen Sound which cover the study area. Staff from these offices deliver investigation and enforcement services, but do not carry out monitoring programs along Lake Huron. Periodically, MOE's Regional office in London has carried out *ad hoc* studies along the lakeshore. More recently, a number of local community groups have initiated monitoring programs in specific areas of the shoreline in response to concerns of deteriorating lake quality.

3.0 Availability of Water Quality Information

Generally, the water quality data for the study area is highly fragmented. A significant amount of historical surface water quality data has been collected by many different private and government organizations (see Appendix A p. A1 for a summary of past and current sampling programs along the southeastern shores of Lake Huron). The data is highly variable with respect to the types of parameters collected and the timing and locations of the samples. Some historical data have been lost. Some data was difficult to obtain due to staff shortages and the inability to respond in a timely manner, or because sensitivities in the information required engaging in a lengthy and costly process to access the data. Nutrient data was generally referenced in reports as nitrate and total phosphorous. Data now being collected at Provincial Water Quality Monitoring Stations report nitrate-nitrogen (the concentration of nitrogen present as nitrate).

Testing for bacterial pollution is regularly undertaken by county Health

Units during the summer season when recreational bathers are most likely to be exposed to pathogens in the nearshore (see map 1). This is a mandated responsibility under the Ministry of Health and Long Term Care, and a Beach Management Protocol has been developed to provide guidance for monitoring nearshore water quality. Routine beach surveillance is intended to consist of a minimum of one sample per week from each sampling site (minimum 5 sites per beach), over the course of the swimming season. Sampling frequency is permitted to be reduced to once per month if historical data indicates that water quality has consistently been within the limits set for recreational use (OMHLTC, 1998). This data is used to calculate running monthly (30 day) geometric means of bacterial concentrations.

Beach testing amongst Health Units in the study area was found to be inconsistent in terms of frequency of testing. In Huron and Lambton Counties, testing for *E. coli* at recreational beaches is done once each week. In Bruce County, testing for *E. coli* can vary from one station to another, with testing frequency either once every two weeks or once per month. While the Beach Management Protocol allows for a reduction in sampling frequency if historical data show consistently good results, the historical data for a number of Bruce County sample locations did not appear to support reduced sampling frequency. An unfortunate consequence of this reduced sampling frequency in Bruce County is less data to work with and, therefore, less statistical power to identify trends.

Large spatial voids exist in the Bruce County data between some sample stations. The Inverhuron sample station, for example, is about 15 kilometers from the next station to the south (Kincardine Landsdowne). The Point Clark station is about 15 kilometers from its closest station to the north (Kincardine Station Beach). Between these stations is a considerable population of beach users, many with public access. These large gaps between sampling stations is an unfortunate data hole. The Health Units use the Ministry of Health's definition of a public bathing beach as presented in the Beach Management Protocol to determine what beaches they will monitor. The sidebar is an excerpt from the Beach Management Protocol which describes the criteria for selecting beaches to be monitored. Based on this, it appears that additional private beaches between Point Clark and Kincardine would meet the definition of a public bathing beach based on public access and public use.

Health Unit data also varied in terms of its availability. In Lambton, the data went back to 1984 for most sampling locations. In Huron County, data prior to 1990 was inadvertently destroyed several years ago, and so their data set exists from 1990 to present. In Bruce, data was available from 1994 to present. There was also variability in the types of bacterial data collected. The bacterial indicator was changed throughout

Ministry of Health
Beach Management Protocol

Definition of a Public Beach:

- *A public bathing beach means a beach area, owned and operated by a municipality, which has a supervised aquatics program or is staffed by a lifeguard, and meets the requirements of the sampling protocol for sampling sites.*
- *The MOH may also monitor any other bathing area, except provincial parks, to which the public has access, and where the MOH has reason to believe that recreational use of the water may result in waterborne illness.*
- *The MOH is not responsible for routine monitoring of private residential beaches which are not used by and accessible to the public at large.*

Ontario in 1993-1994 from faecal coliform to *E. coli*. In all three counties, testing was done on a scheduled day and not based on lake or weather conditions.

There were also inconsistencies observed in how data was presented. For example, Lambton County identified the number of times that beaches were posted on an annual basis. Huron County, in addition to the annual number of postings, identified the numbers of days that each beach was designated as unfit for swimming. Bruce County did not present any summary of this kind.

Waste water treatment plants along the lakeshore include Southampton, Port Elgin, the Bruce Energy Centre, Bruce Nuclear Power Development, Kincardine, Goderich, Grand Bend, Forest and Sarnia. The Town of Bayfield constructed a plant in 1999. Goderich and Kincardine provided data on sewage by-pass events.

The Ministry of the Environment has information on public complaints about water quality impairments along the shoreline.

The Township of Huron-Kinloss was the only municipality found to be currently undertaking stream and lake water quality sampling (see map 4). Stream testing has been done in the Point Clark area as part of a Risk Assessment Study for continued development on septic systems in the lakeshore area since 1997. Testing has been done for *E. coli*, and *Pseudomonas aeruginosa*. In addition, the Township has been conducting river and lakeshore testing in the Pine River watershed as part of a community reaction to the construction of intensive livestock operations within the Township. This information is available for the last two years and consists of *E. coli*, nitrate and phosphorous data.

Information was obtained from area Conservation Authorities who undertook some testing during the 1990s as part of the Clean Up Rural Beaches (CURB) program. Faecal coliform was the indicator used in that program until 1993. The Maitland Valley Conservation Authority also undertook a two year monitoring program for pesticides/herbicides, heavy metals and persistent chlorinated organics in 2000 and 2001.

Saugeen First Nations north of Southampton have been collecting nearshore water quality data for a number of years. Beach monitoring occurs primarily in the south Sauble Beach area. Water quality has generally been poorest at the north end of the reserve lands, near the community of Sauble Beach. Sampling is conducted once per month during the summer season at 10 beach locations along south Sauble Beach. Records go back five years, as the band destroys files older than five years (Nawash, 2003). Kettle and Stony First Nations south of Port Franks

conduct sampling twice weekly. One set of samples is analysed by the London Public Health Laboratory, while the other is analysed by a private lab in London (GAP Environmental). Speaking with a member of their Environment Committee, and a staff person with their Environment Department, there were serious concerns about the quality of the water in the area of Kettle First Nation. High bacteria, as well as observed changes in the environment, such as algae blooms and fish morbidity, were some of the causes for concern (Bressette, 2003).

Finally, a number of local community groups have, through the use of volunteers, collected water samples for specific areas of the lakeshore (see map 3). The *Ashfield-Colborne Lakefront Association (ACLA)*, an umbrella group of about 20 cottage associations between Goderich and Amberley, is in its third year of water sampling of area streams that empty directly into Lake Huron. ACLA monitors 12 sites for *E. coli*, nitrates and phosphorous. ACLA members have been trained by the Maitland Valley Conservation Authority to collect water samples using standard protocols.

Friends of Bayfield River have tested for *E. coli* at the lower end of the Bayfield river. Recently, this group has changed its focus from monitoring to education and awareness building.

St. Joseph's Shores community group, north of Grand Bend, also monitor for *E. coli*. They monitor three sites including one gully site and two lakeshore sites—one north of the ravine mouth and one to the south. This group received training from the Ausable Bayfield C.A. Cost limits this group from sampling more sites. However, with the assistance of the Bluewater Shoreline Residents' Association, additional sites are being added in 2003.

Water quality information is widely available in Huron County. A comprehensive report on surface water quality data in Huron County was completed by researchers from the School of Engineering, University of Guelph (Bonte-Gelok and Joy, 1999). This study analyzed water quality data , land use, soils, waste treatment, human and livestock populations, landfills and precipitation data.

3.1 Water Quality Testing—1984 to 2003

3.1.1 Pathogens

Health Units

Ontario Ministry of Health switched bacterial indicators from Faecal Coliform to *E. Coli* effective April 1, 1993. Consequently, the Lambton County Health Unit's testing indicator changed from measuring for Faecal Coliform (1984-92), to measuring *E. coli* from 1993 on. For Huron County, and for Bruce County, *E. coli* data was available from 1990 and 1994 to present respectively. Graphs in the Appendix show the frequency in percent that *E. coli* was found to be above the Provincial Water Quality Objectives (PWQO) of 100/100 mL at each sampling location in each year. There are caveats to observe when trying to compare one county's results with another. As discussed previously, there are differences in the frequency that some sites are monitored. The data shortfall in some sampling locations makes it difficult to make direct comparisons between health unit data and makes it more difficult to take a regional outlook to nearshore water quality.

The data show that all three counties have stations with frequent and consistent exceedences above the PWQO for *E. coli*. Huron County shows the greatest impairment, with Amberley Beach, Ashfield Twp. Park, Goderich beaches, Black's Point and Port Albert having consistently poor readings. Huron County also had 32 postings in 2001 for a total of 354 beach-days posted with a "red" warning sign. That was up from 2000 with 6 postings and 260 beach-days with "red" warning signs. A red sign is posted if the geometric mean of two consecutive sets of sample readings exceed 100 *E. coli* per 100 mL of water.

Bonte-Gelok and Joy(1999), evaluated the Health Unit data for Huron County. The beach data were considered to be high in both reliability and quality. All of the beaches analyzed over the 1990 to 1997 period exceeded the PWQO for significant parts of the summer season. In Huron County, the three beaches with the highest average time exceeding the PWQO were: Amberley, Goderich Main beach and Port Albert (at the mouth of the Nine Mile River). All three had results that showed that the beaches exceed the PWQO over 40% of the time. While the highest Faecal Coliform concentrations occurred at the south end of the county, in the lakeshore gullies and Ausable River, Total Coliform loadings were highest in the Maitland and Bayfield Rivers.

Lambton County's poorest historical beach water quality was at Centennial Park in Sarnia (43% exceedences between 1984 and 1994), and at Grand Bend (47 % exceedences between 1984 and 1994), although all

beaches had some exceedences over the period of record. Lambton had 8 postings in both 2000 and 2001. It has had a total of 80 postings over the last 10 years. Data indicating how many days the beaches were posted in Lambton County are presented in Table 3.

Bruce County's poorest water quality over the past nine years appeared to occur at Point Clark and Kincardine's Station Beach with periodic exceedences at Sauble Beach. The only data for beach postings included an account of 13 days at Station Beach in Kincardine in 2002.

Rapid Detection Study

The Rapid Detection Study was a five year study undertaken in the late 1990s to test a faster method of determining *E.coli* at public bathing beaches. The study was undertaken between St. Joseph, north of Grand Bend, and Highland Glen. This was a local partnership initiative between, the Lambton County Health Unit, local municipalities, Ausable Bayfield CA, Pinery Provincial Park, Ministry of Environment and a water quality consultant. The motivation was a dissatisfaction by the local community with the conventional protocol of sampling that took too long (sometimes upwards of four days) to make a determination of whether or not to 'close' a beach. This was considered to be too much time from the initial sample period where conditions could be substantially improved at the time of posting or closing a beach. Rapid detection would theoretically allow sampling results to be analyzed and a public health decision made within a 24 hour period. Comparing the rapid detection test with the conventional test, it was found that the rapid test had an 85% accuracy relative to the conventional testing. This was an acceptable outcome to the Ministry of Health as it met their targets, however, until the study was replicated in another part of the Province, it would not be permitted to become a standard form of testing (Prout, 2003).

CURB Program

From the late 1980's to the mid-1990's, the Ministry of the Environment administered the "Clean Up Rural Beaches" (CURB) Program. This program was implemented by many conservation authorities in Ontario. Along Lake Huron, all five conservation authorities were involved in the CURB Program. CURB essentially had two components: (1) identify the relative impact of pollution sources of rural beaches by undertaking a monitoring program of targeted watersheds, and (2) administering grants to rural landowners for septic system upgrades, milkhouse washwater control, manure storage and livestock barriers to watercourses.

Similar to the county Health Unit beach monitoring, CURB monitoring switched from analyzing faecal coliform to *E. coli* in 1993. The CURB program's water monitoring included *E. coli*, *Faecal streptococci* and *Pseudomonas aeruginosa*. With this information, conservation authorities

determined the potential pollution sources and estimated the relative contribution of each of these sources to the water quality problem at area beaches.

In its 1994-95 Annual Report, the Saugeen Valley C.A.'s CURB Program identified that at many of their Lake Huron shoreline sampling locations, PWQO's were exceeded for *E. coli*, and concentrations were considered excessively high for *Pseudomonas aeruginosa*, Total Phosphorous and Nitrate. Similar results were obtained from the other conservation authorities. All identified faulty septic systems as a major source of bacterial pollution, although there is some controversy over whether the assumptions made had sufficient data to support this conclusion.

In its CURB report on the Penetangore watershed, the SVCA concluded that for the sources of faulty septic systems, livestock access, milkhouse washwater discharge and sewage treatment plant discharges, dry weather bacterial inputs were far greater than wet weather inputs. About 1.6% of the source contaminant bacteria was estimated to reach Lake Huron under high flow conditions. Three times as much, or 5.5% of the bacteria was estimated to be delivered to Lake Huron under low flow conditions (SVCA, 1992).

Figure 3—Location map of the Township of Huron-Kinloss in Bruce County.

Huron-Kinloss Township

The Township of Huron-Kinloss has two surface water quality monitoring programs in place. The Pine River water quality monitoring program was initiated in June 2001 at twenty-six locations throughout the Pine River watershed. Six lake sites were included in this program. The second program, the Point Clark water quality monitoring program, was initiated in 1998. The purpose of this program was to build a database of information that could be used to detect long-term trends in water quality, in relation to development using septic systems in the Point Clark area.

E. coli data from the Township of Huron-Kinloss' (see Figure 2) Pine River Water Quality Monitoring Program showed that the PWQO were exceeded 76% of the time in 2002. Results from the Township's 2002 Point Clark Water Quality Monitoring Program showed a 30% exceedence over Provincial objectives. Four of the seven sample stations at Point Clark are beach locations. For the purpose of this study, only data from the four beach stations were used.

Huron-Kinloss also monitored *Pseudomonas aeruginosa* in the Point Clark area in 1998 and 1999. Using <10 cfu/100mL as the acceptable limit of *P. aeruginosa* (B.M. Ross, 2000), 66% of samples in 1998 and 89% of samples in 1999, exceeded this limit. Due to questions concerning the sampling protocol, and the difficulty controlling the pathogen from multiplying between the time of sampling and laboratory analysis, this

indicator was discontinued in 2000. As was noted by the study, "Water sampling for PSA can be misleading, as the amount of bacteria evident at the source (e.g. human, animal waste) may be far less than is recorded by lab results. This could explain the elevated counts of PSA found in the past years of monitoring."

Ashfield-Colborne Lakefront Association

Local groups, like the Ashfield-Colborne Lakefront Association, have been getting similar results for *E. coli*. At their 12 monitoring sites between Point Clark and Goderich, 80% of samples exceeded PWQOs in 2001. Results in 2002 dropped slightly to 75% of samples exceeding PWQOs. ACLA takes samples once every two weeks from each of their sampling locations, from mid-May to early September. In September 2003, ACLA attempted to identify the source of E. coli in the area by having samples analyzed for DNA fingerprinting. Initial testing suggests the probable source of *E. coli* could be animal. Further tests using this technology are planned, depending on funding, to further isolate the source.

St. Joseph's Shores

At St. Joseph Shores Beach, north of Grand Bend, results over the past seven years of monitoring showing exceedences above PWQOs is presented in Table 1.

The St. Joseph Shores Association generally sample between mid-May and the end of August. In 2000, the Association sampled from late March to the end of October. The poorest water quality due to *E. coli* contamination was during the summer (see Appendix A).

Bonte-Gelok and Joy, (1999), concluded that based on the beach bacterial data analyzed for Huron County, there does not appear to be a clear trend as to whether or not water quality at beaches was getting better or worse over time for the duration over which data was available.

Table 1– *E. coli* exceedences at St Joseph Shores Beach

Year	Result
1996	58%
1997	57%
1998	61%
1999	50%
2000	88%
2001	33%
2002	70%

This conclusion appears to hold true for beaches in Bruce and Lambton Counties, as well.

MOE studies on Bacterial Pollution

Two studies were found where the Ministry of the Environment carried out monitoring and analysis of nearshore water quality along Lake Huron, as it related to bacterial pollution (see map 2). Both studies appeared to be in response to elevated bacterial concentrations and beach postings.

In 1984, an extensive monitoring program was undertaken at Grand Bend, Ipperwash Provincial Park and Goderich, with some supplemental work at Sauble Beach. A number of samples were taken at the mouths of gullies between Grand Bend and Goderich. Over 10,000 microbiological tests were carried out over a thirteen week study period, between June 13 and August 24. Samples were taken each day at specific time intervals (morning, afternoon and evening) over the course of the study period. The study found a high correlation between beach bacterial levels and lake roughness. On rough days when the beach waters were turbid, bacterial levels tended to be elevated. Under calm-water conditions, bacterial levels were normally low.

Besides water turbidity, runoff was another important factor in elevated bacterial levels as the bacterial load to Lake Huron increased significantly during major rainfall events (MOE, 1984). Other factors included: winds, which can result in the re-suspension of bacteria-rich bottom sediments; wind direction can direct contaminated river water onto beaches; sunny days can be significant as ultraviolet light can reduce bacterial levels — at times when bacterial levels were decreasing, daily hours of direct sunlight tended to be greater; and water temperature can affect the survival rates of various types of bacteria, as well as affect beach usage.

The conclusion that significant increases in the levels of pathogens in the water result from sediment re-suspension was linked to the slope geometry of the nearshore ramp. Ipperwash and Sauble Beach each have a very shallow nearshore slope (3%), while Grand Bend and Goderich had much steeper nearshore slopes (30% and 40% respectively). Gradual foreshore slopes at Ipperwash and Sauble Beach result in waves breaking further offshore, resulting in less re-suspension. However, the fine beach sands found at Ipperwash and Sauble Beach support higher concentrations of bacteria than the coarse sands found at Grand Bend and Goderich. This was suggested to be related to the difference in surface area available for adsorption by bacteria (MOE, 1984).

In 1990, the MOE conducted another nearshore water quality survey along Lake Huron between Canatara Beach (Sarnia) and Brights Grove.

The study of this fourteen kilometre reach of shoreline was undertaken at the request of the Abatement Section of the Sarnia District office of MOE, who were receiving queries from the Lambton County Health Unit, municipal officials and the local media regarding the sources of the bacterial contamination that was responsible for numerous beach postings in 1989.

In this study, bacterial results were generally poorer at the mouths of creeks and consequently the adjacent Lake Huron beach areas within the study area. Sampling runs were carried out between March 28 and August 28, 1990. Unlike previous summer months, Canatara Beach and Brights Grove Beach were not posted due to elevated bacterial counts in 1990. This complicated the results of this study to identify sources of pathogenic pollution (MOE, 1991).

3.1.2 Nutrients

In the environment, nitrate is the frequent form of inorganic nitrogen. For nitrate, 4 mg/L is the level that has been proposed by the National Guidelines and Standards Office (Environment Canada) as indicative of eutrophic conditions and tends to stimulate algal blooms. The Maitland Valley Conservation Authority typically uses this level in monitoring watershed health. This level has been used in this report as the target for nitrate levels for comparing testing results.

Phosphate is the most readily available form of phosphorous and, above a certain threshold can be harmful to aquatic systems. The interim PWQO for total phosphorous for lakes is generally 0.02 mg/L., and for rivers it is 0.03 mg/L. Algae blooms are associated with levels above 0.02 mg/L and so this is the target level used in this report for phosphorous levels and comparing testing results.

Nitrate and total phosphorous testing has occurred in specific locations along the study area. The Township of Huron-Kinloss has included these parameters in recent monitoring of the Pine River sub-watershed. In 2002, 20% of the nitrate samples taken (40 of 204) were above 4 mg/L. For total phosphorous, 76.5% of samples (130 of 170) exceeded 0.02 mg/L.. Data suggest that average nitrate concentrations in some monitoring locations relatively close to the lakeshore have been on an upward trend from 1965 to 2003 (Ross, B.M., 2004)

The Ashfield-Colborne Lakefront Association also carried out testing for nitrates and total phosphorous. In 2002, 38% of their samples (51 of 135) were over the 4 mg/L target. Total phosphorous levels were low at

Nitrate Facts

- *amphibians and invertebrates are particularly sensitive to high nitrate conditions.*
- *the interim guideline for nitrate for fresh water is 13 mg/L., although 4 mg/L is indicative of eutrophic conditions and tends to stimulate algal blooms.*
- *nitrate can be re-released into the water through plant decomposition.*
- *the interim guidelines do not protect against indirect toxic effects from excessive nutrient loading.*

Source: National Guidelines Standards Office, Environment Canada

only 6% (6 of 104) of samples taken exceeding 0.02 mg/L.

Bonte-Gelok and Joy (1999), ranked the data for Huron County to illustrate which areas of the county had the highest concentrations, and the highest loadings, of pollutants. In general, the highest concentrations of pollutants occur in the southern portion of the county. Nitrate concentrations were highest in the Bayfield River and lakeshore gullies. The highest loadings of nitrate to Lake Huron occurred on the Maitland and the Bayfield Rivers. Total phosphorous *concentrations* were highest at the south end of the county, particularly in the lakeshore gullies and the Ausable River. Total phosphorous *loadings* were highest on the Maitland River.

No citizens group appear to have been analyzing Nitrogen or Total Phosphorous levels in Bruce County or Lambton County.

3.1.3 Other Pollutants

PCBs

The Maitland Valley Conservation Authority commissioned a sediment and biological monitoring study on the Nine Mile and Maitland Rivers to see if there was a need for concern over metal, pesticide/herbicide and PCB bioavailability. Preliminary results of the 2000 study period suggested that mean PCB concentrations in minnows collected at Goderich and Port Albert were above the Great Lakes Water Quality Agreement's aquatic life protection guideline of 0.1 mg/kg. Follow-up monitoring in 2001 indicated that PCB concentrations were below the GLWQA guideline. However, other minnow species were used in the evaluation and the conclusions are based on the assumption that there were no species specific differences in PCB bioaccumulation.

Figure 4—Loader removing algae from the beach at Goderich (July 2001)

Tritium

The Grey-Bruce Health Unit began a sampling program in 1996 to monitor nearshore waters updrift and downdrift of the Bruce Nuclear Power Development (BNPD). The BNPD consists of two nuclear power stations containing a total of eight nuclear reactors. This monitoring was in response to growing public concern about tritium being released into the lake from the nuclear facilities at the BNPD (Paton and Wardell, 1997). Samples have been collected by Ontario Power Generation at each of the cooling water outfalls as a requirement by the Ministry of Labour. Until the Health Unit study, no tritium sampling had ever been taken of nearshore waters north or south of the plant. The Health Unit sampled nearshore waters between Kincardine and Southampton to determine tritium levels in drinking and recreational waters and to ensure that those

levels were safe for the public. The results of the study indicated that there was no current health risk to the public. Bruce Power continues to monitor the lakeshore stations between Southampton and Kincardine and submits the results to the Health Unit.

Algae

Concerns of nutrient enrichment and algal growth in the Great Lakes have been high for the past three decades. Between 1978 and 1981, the Ministry of Environment undertook a baseline investigation of *Cladophora* growth in the nearshore waters of Lake Huron to gain a better understanding of the sensitivity of Lake Huron to *Cladophora* in the presence of phosphorous inputs. The investigation focused on Goderich, south of the Maitland River mouth, and the Bruce Nuclear Power Development (BNPD) area, including Inverhuron. Another study area included the nearshore waters of southern Georgian Bay (Nottawasaga Bay). Much of the area was characterized by the presence of good substrate for the growth of the potentially nuisance aquatic algae, *Cladophora*. It was roughly estimated that over 70% of the nearshore area (within the 10 meter contour) of Lake Huron, from Sarnia to Tobermory, provides suitable substrate for *Cladophora* growth (MOE, 1982).

On one occasion in 1978, sloughed *Cladophora* fouled approximately 10 kilometers of Lake Huron shoreline in the vicinity of Goderich. During this time, average total phosphorous concentrations at 9 stations along the southeastern shores of Lake Huron were averaging 0.022 mg/L, slightly higher than the PWQO of 0.02 mg/L (MOE, 1982).

More recently, the Town of Goderich has been faced with removing truck loads of algae from its beaches (see Figure 3). In 2001 and 2002 in particular, the Town would routinely remove 4 to 6 gravel truck loads of algae 2 to 3 days a week for the entire summer period (June to September). Prior to 2001, algae on the beach had been a modest problem with removal of light amounts once per month or once every two weeks (P. Spain, 2003).

The algae was particularly problematic for the Town because of the foul odour it produced. Lab analysis of the algae was undertaken in 2001 and 2002 (late June each year) and found it to contain *Rhizoclonium* spp., a filamentous algae of the Cladophoraceae family (GAP, 2002).

4.0 Beach Postings and Public Complaints

Each of the three Health Units along Lake Huron approach beach posting differently. All three will generally post a beach if two consecutive sets of sample results exceed 100 E. coli/100 mL. Huron County differs somewhat, as it has a two-sign system. Permanent "Blue" signs are posted at all of the main beaches in the County. The Blue signs warn that pollution levels are elevated after a rainstorm and that high bacterial counts are possible for up to 3 days following rain or heavy wave action. When the geometric mean of two consecutive sets of sampling results exceed the acceptable limit, a "Red" sign replaces the Blue sign, indicating hazardous bathing conditions (see Figure 4). The Grey Bruce Health Unit has recently adopted a similar two-sign system. The Huron County Health Unit posts its weekly beach testing results on its website and also operates a water quality telephone hotline. From a public education and health protection standpoint, it would appear that the Huron County Health Unit has the most effective surveillance and public reporting system.

Figure 5— "Red" and "Blue" public notice signs used by Huron County Health Unit

Bruce County data has large spatial gaps between monitoring locations and less frequent monitoring than other health units in the study area (bi-weekly or monthly compared with weekly sampling). Water quality monitoring results in Huron-Kinloss Water Testing Program for Pine River and Point Clark appear to indicate that recreational water quality in that area might be poorer than the Health Unit data would suggest. More frequent monitoring (at least weekly), and the establishment of a greater number of stations between Point Clark and Kincardine would be worthy of consideration.

While the Huron County Health Unit had complete information on water impairments over its 12 years of data, it did not have complete information on beach postings or public complaints over this period. It did have information on the location and duration of when beaches were posted with red signs in 2000 and 2001. Information is presented here in beach-days (the sum total number of days that beaches were closed). 2001 was the worst year, in that Red signs were posted a total number of 354 beach-days at 18 locations. The most impaired beach was Black's Point (south of Goderich) with five postings totaling 49 beach-days. In 2000, Red signs were posted a total number of 260 beach-days at 6 locations. The most impaired was Ashfield Township Park (near Kintail) at 66 beach-days, closely followed by Black's Point at 64 beach-days. Table 2 shows the duration of postings (in days) for each beach sampled by the Health Unit for the two years of record.

Lambton County Health Unit recorded annual beach postings since 1991. Over that 11 year period, the Health Unit posted the beaches in that area

Table 2 - Huron County Health Unit
Duration of beach postings—2000-2001 (number of days)

Duration of Postings (Beach-Days)	**2000**	**2001**
Black's Point	64	49
Ashfield Twp. Park	66	35
Port Albert	53	35
Amberley	12	34
Goderich Main	28	32
Camp Kintail		29
Goderich St. Christophers		28
Driftwood Park		17
Goderich The Cove		16
St. Josephs		14
Paul Bunyan	37	13
Bayfield south		11
Houston Heights		11
Hay Twp Park		10
Port Blake		8
Bayfield Main		7
Huron Church Camp		3
Sunset Beach		2
TOTAL	**260**	**354**

Table 3 - Lambton County Health Unit—Duration of beach postings, 1990 to 2002 (number of days)

Duration of Postings (Beach-Days)	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**
Grand Bend	5		7	8	6	5				1	14	5	
Pinery			7	6		11					5	7	2
Ipperwash	29		7	7	7	17					9	8	2
Highland Glen												7	
Bright's Grove												7	
Canatara						16				5			10
Centennial Park						30				37	68	35	43
TOTAL	**31**		**21**	**21**	**13**	**79**				**43**	**96**	**69**	**57**

Table 4 - Grey Bruce Health Unit—public complaints

July 24, 1991	Point Clark beach water in general (lighthouse to Clark's Creek).
July 16, 1992	Huron Road south, Point Clark (between Clarks Creek and Pine River) - brown scum in water - scum was noted to have been algae, weeds, flotsam prevalent on the beaches in this area. Not sampled.
May 29, 2000	Inverhuron beachfront cottages - sewage smelling scum on beach
June 28, 2000	Inverhuron - sewage smelling scum on beach
June 29, 2000	Beach area near Point Clark (no location given) - algae on beach
June 30, 2000	Emmerton Beach, Huron Township (Pine St). Heavy amount of algae present on beach.
July 4, 2000	Inverhuron public beach
July 4, 2001	Bruce Beach (west end of 6th Concession). Foul smelling/looking beach. Green and black algae observed.
July 8, 2002	beach in Point Clark in general - black sludge/sewage smell
July 8, 2002	Black sludge/ sewage smell on beach outside of Kincardine (south). MOE indicated it was algae as seen in previous years.
Summer 2002	Complaints received about scum on the beach north of Kincardine. Also, Station Beach in Kincardine was posted due to high E. coli counts. There were many dead fish and birds on the beach in Kincardine. Tested negative for Type E botulism, but botulism was still suspected.

84 times. The greatest number of postings occurred in 1995 (12 postings) and 1991 (11 postings). The data showing the duration of each posting was available for 1990 to 1995 (ABCA, 1996) and 1999 to 2002 (Lambton County Health Unit, 2002). The duration of postings (in beach-days) for each beach sampled by the Health Unit is provided in Table 3.

The St. Clair Region Conservation Authority received some public complaints in 1995. At Port Franks, a cottager reported that his children developed ear infections during the July 15-16 period. Another cottager from the Highland Glen area reported that her children were swimming in the lake (August 12) and contracted serious eye infections. The children were taken to Sarnia General Hospital. The water was noted to have been rough and murky.

In Bruce County, the only record of beach posting in the study area was at Station Beach in Kincardine in 2002 for a duration of 13 days. The Grey Bruce Health Unit did have a record of public complaints received since 1991 and the information is presented in Table 4. While the Health Unit

Figure 6—Black, sewage-smelling material washed up on beach at Point Clark (rotting algae) August 2000.

Figure 7—Dead fish in area creek at Point Clark, where rotting algae was floating into the lake August 2000.

will investigate complaints received, they do not undertake testing of algae. The Health Unit relies on the Ministry of Environment to carry out such testing, and the Health Unit passes the information on to the public (Kestner, 2003).

In 2000, the Lake Huron Centre for Coastal Conservation summarized incidences and complaints of water quality impairments in Clarks Creek mouth, Pine River mouth and at Amberley Beach all in the Point Clark area. Black floating masses with a distinct sewage odour were observed in these locations in July and August (see Figure 6). In the case of the Clarks Creek incident, dead fish were noted (see Figure 7). Investigation and lab reports by MOE confirmed that the black masses consisted of decaying algae. No analysis was made to determine the nutrient status of the waters.

Most water quality related complaints by the public are directed to the Provincial Ministry of the Environment. The Ministry of Environment received a number of complaints within the Township of Huron in the period from 1989 to 2002. Four of these were directed to the Spills Action Centre in Toronto while the remainder where directed to the local MOE office in Owen Sound. Map 5 shows the geographic locations of complaints and the dates that complaints were received. Numerous letters of complaint were received by the MOE Minister's office for the Pine River and Clark Creek area over the period 2000 to 2002 (D. Boyd, pers. comm., 2003).

MOE's Owen Sound office received numerous public complaints during the years 2000 to 2002 along the Lake Huron shoreline. The complaints commonly referred to incidences of black, slimy material with a manure or sewage odour. The locations of these complaints was noted to have occurred from Amberley to Southampton. Samples taken on three occasions confirmed that the material was a combination of algae, diatoms and other organic material. Having confirmed the composition of the material, the public began to question where the nutrient enrichment was originating and why this problem was becoming more apparent over time.

The MOE also received calls regarding dead birds and fish on area beaches. These complaints were redirected to the Ministry of Natural Resources.

A significant number of complaints were also received by the Ministry of Environment in recent years concerning the construction of an intensive agricultural operation near Point Clark. Complaints related to the concern by the public that large livestock operations, often utilizing large quantities of liquid manure, may have a long-term impact on water quality.

5.0 Pollution Sources

5.1 Septic Systems

The Ministry of the Environment's Clean Up Rural Beaches program (CURB), implemented by local conservation authorities between 1988 and 1996, was intended to identify rural sources of surface water bacterial contamination and develop strategies to mitigate their impact on downstream beaches. Information on livestock waste management practices, household waste disposal and attitudes of farm operators towards water quality was collected through surveys. Bacterial and

nutrient water quality was monitored within the respective watersheds. The CURB Program reports, prepared by area conservation authorities, consistently identified septic systems as a major source of bacterial pollution to Lake Huron. For the Maitland River watershed, for example, the majority of the faecal coliform load to Lake Huron was faulty septic systems (65%), agricultural sources (31%) and urban sources (3%) (Fuller and Foran, 1990). The Ausable Bayfield watersheds were identified as having bacteria loads delivered by faulty septic systems (77.5%), agricultural (22%) and urban areas (0.5%) (ABCA, 1996). The Penetangore watershed, within the Saugeen Valley Conservation Authority watershed, estimated that 81.5% of the bacterial contamination in that watershed was from faulty septic systems, with 17.6% coming from agricultural sources (SVCA, 1991). Within the St. Clair Region C.A. watershed, bacterial loads varied between two lakeshore creeks that were analysed under the CURB Program. One, Perch Creek, had faecal coliform loadings attributed to septic systems (73%), agricultural (22%), and urban (3.6%) sources. The other, Highland Creek, had loadings from septic (37%), and agriculture (63%) sources (SCRCA, 1991).

The conservation authorities estimated the total annual faecal coliform load to a watercourse as a result of faulty septic systems. The algorithm used assumed a total volume of between 275 and 300 L/person/day, a failure rate of 30% for all septic systems, and that 50% of the total water consumption was reaching the watercourse. In the Saugeen V.C.A. 1992 CURB report, a failure rate of 10% was utilized for cottage septic systems. The caveat in using the CURB conclusions is that the algorithms used relied on a number of assumptions that may not have been thoroughly supported with data. Appendix A33 contains more specific information about algorithms used to calculate bacterial loads.

Municipal waste water treatment systems are confined to larger communities (Southampton, Port Elgin, Kincardine, Goderich, Bayfield, Grand Bend-Ipperwash, and Sarnia-Point Edward). Consequently, there are linear concentrations of lakeshore area development reliant on private septic systems. In Huron County, for example, there are 7,442 rural lakeshore residences, 5,641 (76%) of which are seasonal. Greater

Table 5 - Percent of permanent and seasonal development in Point Clark, 1977-96.

Year	Permanent (%)	Seasonal (%)
1977	20.4	79.6
1985	28.6	71.4
1988	26.8	73.2
1991	32.5	67.5
1996	35.5	64.5

concentrations can be found in Bruce and Lambton Counties.

5.1.1 Huron-Kinloss Case Study

With the high concentration of development along the shoreline, the high estimated rate of faulty septic systems is a concern for the majority of communities that do not have sewage treatment facilities. In Huron-Kinloss in southern Bruce County, for example, a significantly sized cottaging community has developed along the lakeshore. In the mid-1990's, because of concerns raised by the Ministries of Environment and Energy and Municipal Affairs about servicing any more development in the area, the township commissioned a "Risk Assessment Study for Continued Development on Septic Systems." This study took a comprehensive look at this area from the standpoint of past and future development. The lakeshore area was determined to have a population of 3041, with 680 being permanent. There were 2271 lots of record, with 1811 built on (80%), and 460 lots vacant.

With 1,027 septic systems having been installed since 1971, that means there are a total of 784 properties with septic systems older than 25 years old. The study assumed a life expectancy of a typical septic system to be 20-25 years. An average annual replacement rate of 4% to 5% was considered to be in the 'normal' range. In this area, however, the replacement rate has only been 1% per year.

The Huron-Kinloss lakeshore has been experiencing a trend in residency status from seasonal to permanent (see Table 5). This trend in Huron-Kinloss can be seen all along the lakeshore within the study area. Where these lakeshore communities have developed using private sewage disposal systems, the trends in occupancy suggest that these systems are increasingly being used for regular, year-round durations.

While the Ministry of Environment was generally satisfied with the results of the Risk Assessment report, they did not appear to be fully satisfied with the report as it related to the potential for beach contamination resulting from the discharge of bacteria from sewage systems (Armstrong, W., May 4, 1998). The Ministry supported the need for monitoring and proactive maintenance of septic systems. In addition, the Ministry recommended to the municipality that a contingency strategy be in place in the event that monitoring identifies a problem. Huron-Kinloss has responded by conducting an annual monitoring program in the Point Clark area.

5.1.2 Research on Septic Systems in Sandy Soils

In the Huron Fringe, the predominance of sandy soils and the concentration

of development (and septic systems) in this area has raised the question of the level of risk of continued development on private sewage disposal systems (B.M. Ross, 1997). Local groundwater flows tend to flow to the lake (see Figure 7). Much research has been undertaken in the past decade on the effects of septic systems on sandy soil environments, although it has tended to focus on chemical contaminants and not pathogens. Ptacek, et al, (1998), in a study at Point Pelee National Park, found that groundwater plumes emanating from sewage disposal systems typically contain elevated concentrations of nutrients. These nutrient plumes can discharge into surface water bodies, increasing the nutrient pool. Even after tile bed abandonment, the release of phosphorous and nitrates suggest the long term potential for nutrient persistence. Monitoring done after the cessation of the sewage disposal system indicated that there was a decline in the concentration of nitrates, but that phosphorous concentrations remained virtually unchanged. These nutrients can be released for decades, or longer, and will continue to contribute to the nutrient pool (Ptacek, *et al*, 1999). In this same study, it was found that these contaminants entering the groundwater flow system at the water table will move with the natural groundwater flow to the Lake Erie nearshore (Crowe, *et al*, 2002).

In other research, it has been found that with the continued application of effluent, the ability of the soil to treat the effluent may decline. Even with the soil absorption system working well, groundwater contamination was considered to be inevitable. With the passage of time, pollution values would increase as the soil loses much of its ability to retain pollutants as they pass through the soil before reaching the groundwater table (Viraraghavan, *et al*, 1976). Studies at Long Point have shown that the plume of septic impacted groundwater can extend from the tile bed area, following the water table gradient, to the Lake Erie shore (Robertson and Cherry, 1991).

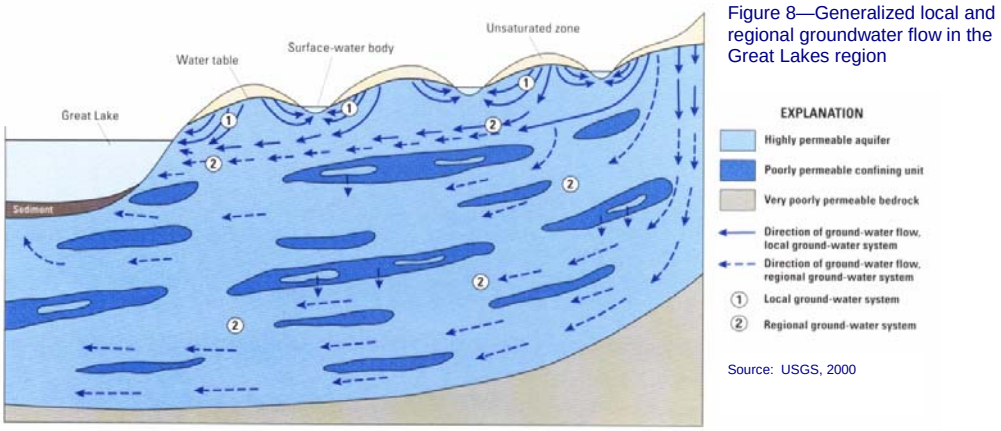


Figure 8—Generalized local and regional groundwater flow in the Great Lakes region

Cherry and Rapaport (1991), found that the plume of contaminated groundwater in an unconfined sand aquifer was found to be long, narrow and extending at least 130 meters from the tile bed. Over this distance, nitrate concentrations were greater than the maximum permissible limit of Canadian drinking water standards. The length of the nitrate plume continues to grow as long as the septic system remains in use. The lack of dilution from dispersion was found to be consistent with other North American studies of sand aquifers.

The implications for the Lake Huron shoreline are significant, and are of concern to the long term health of the lake's nearshore waters. The Huron Township study was one attempt to better understand the problem in that particular area. No other similar studies were uncovered within the study area, underscoring how little is known about this issue from a regional perspective.

5.2 Municipal Wastewater Treatment Systems

Sewage Plant discharges are another source of nearshore contamination. System discharges throughout the study area watersheds can ultimately impact on the nearshore waters of Lake Huron, but for the purposes of this study only systems adjacent to the lake were looked at in any detail. Waste Water Treatment Plants (WWTP) are located in Southampton, Port Elgin, the Bruce Energy Centre, BNPD, Kincardine, Goderich, Bayfield (new), and Grand Bend. Sarnia also has a WWTP, but its discharge enters the St. Clair River.

Goderich is the only WWTP in this area that still has some combined sewers (combined storm and sanitary). The Town is in the process of separating their sewer system. They are currently over 50% complete. The Goderich WWTP provided data from 1983 to 2001. The information contains the number of by-pass events where untreated or partially treated sewage was discharged into Lake Huron (Appendix A25). The sewage outfall is approximately 200 metres south of the St. Christophers Cove Beach. Amounts of sewage discharged was available from 1996 to 2001 (Appendix A26). It was not possible to correlate the by-pass data with Health Unit beach sampling because the by-pass data did not include the actual dates of by-passes. It can be safely assumed, though, that nearshore water impairment, and the potential for human health hazard, may occur during by-pass events.

Kincardine WWTP has a separated sewer system, and so by-pass events are not as frequent as Goderich. Data was available only from 1995. Since that time there have been eight by-pass events documented, with volumes not exceeding 1552 m^3.

In information dating back to 1979, WWTPs at Southampton, Port Elgin and the Bruce Information Centre have not recorded any by-passes (Russell, 2003).

5.3 Agriculture

The study area is predominantly agriculturally based. Studies including the CURB reports for the study area watersheds, agree that, along with septic systems, agricultural operations and manure management practices are the main sources of bacterial, nitrogen and phosphorous pollution.

Within the study area, the Maitland watershed has been identified as the largest producer of manure per hectare in Canada. The watershed also had the highest amount of nitrogen produced in Canada at an estimated 48 kilograms per hectare, while the Ausable-Bayfield and Saugeen watersheds (ranked 6 and 10 in Canada respectively) produced over 20 kg/ha. (Statistics Canada, 2001). Nitrate is highly soluble and can thus migrate easily through the soil where it is able to contaminate a groundwater or a tile drainage system (Fleming and Fraser, 1999).

For phosphorous, the Maitland (2nd highest in Canada), Ausable-Bayfield (7th) and Saugeen (9th) watersheds produced over 5 kilograms per hectare (Statistics Canada, 2001). Phosphorous tends to bind tightly to soils and therefore does not leach into water systems as easily as some nutrients. It can, however enter surface waters through suspended sediments from eroded soil (Fleming and Fraser, 1999).

Areas in Canada with the highest estimated concentrations of faecal coliform included the Maitland (2nd), Saugeen (7th) and eastern Lake Huron (8th) which includes the Kincardine-Pine River-Port Albert area (Statistics Canada, 2001). These statistics suggest that agriculture has a strong influence on the quality of surface waters in this region, particularly with respect to nutrient and pathogenic contributions. Other studies are underway to look more specifically at agricultural contributions in this region.

A recent report (Blackie and Tuininga, 2003 (a)), attempted to prioritize Ontario watersheds by their likelihood to be impaired by livestock and by manure mismanagement. Impacts were characterized as being either chronic or acute in nature. Chronic problems included persistent day-to-day discharges, such as runoff from manure storage, exercise areas or feed storage, unrestricted livestock access to watercourses, dairy farm milk-house wash-water discharges and domestic sewage (faulty septic systems). Acute problems would include manure spills, silo leachate following filling, on-site spills of other land applied materials.

Acute Problems

The Maitland Valley, Ausable-Bayfield and St. Clair Region watersheds were identified as having manure spill histories that exhibited large numbers of spills, and more consistent and persistent spills than other watersheds in the province. The Ausable River, Maitland River, East Lake Huron (which includes the Penetangore and Pine River watersheds), Bayfield River, Bear Creek (in Lambton County), and the Saugeen River were identified as being amongst the top twelve major tributaries having the highest number of manure spills between 1988 and 2001 (Blackie and Tuininga, 2003 (a)).

Analysis of spills data suggest that liquid manure is almost exclusively what is being spilled, and that this material is reaching open watercourses through overland runoff, or more frequently through sub-surface tile drainage (55% more frequently). The potential for these kinds of spills increases as larger operations with liquid manure operations become established. There is an expectation that other Lake Huron tributaries, like the Saugeen and Sauble River watersheds, may exhibit similar spill histories as liquid manure usage becomes more prevalent in those areas (Blackie and Tuininga, 2003 (a)).

Chronic Problems

Livestock access to watercourses is considered to be a chronic problem where this practice contributes to ongoing, and usually lower level, water impairment. All of the major tributaries along the southeastern shores of Lake Huron were considered to have potential cattle access and other chronic manure mismanagement impacts (Blackie and Tuininga, 2003 (b)).

5.4 Type E Botulism Outbreaks On Lake Huron

In recent years along Lake Huron, outbreaks of Type E Botulism *(Clostridium botulinum)* have left thousands of fish and waterbirds dead on area beaches. In 1998 and 1999, the outbreak appeared to be concentrated at the south end of the Lake between Goderich and Sarnia. In 2002 and 2003, outbreaks occurred in the Goderich to Port Elgin area. The occurrences began in late summer and continued through the fall season until late November. Historically, outbreaks of Type E Botulism occurred between 1960 and 1963 on Lakes Michigan and Huron.

The Lake Huron Fisheries Unit of the Ministry of Natural Resources in Owen Sound fielded most of the public calls and concerns raised about the dead animals on area beaches. Some of the public complaint information documented occurrences of brown, odourous 'sludge' collecting in embayments in the Kincardine area in the late summer. Information from the Ministry of the Environment confirmed that this was decomposing algae. This material produces the anaerobic conditions which may contribute to botulism

outbreaks. However, other environmental factors also need to be considered. These events on Lake Huron are being studied by researchers at the Canadian Wildlife Service, along with similar events on Lakes Erie and Ontario to determine what conditions lead to these events.

6.0 Discussion

Based on the information analysed for this report, it appears that the issue of bacterial pollution has been a problem for over twenty years at selected beaches within the study area. Data from Huron County and Lambton County both show a regularity of exceeding Provincial Water Quality Objectives at many of its beaches. The Bruce County data show regular exceedences at Point Clark and Kincardine in the southern portion of the county. There do not appear to be any definitive increasing or decreasing trends in the data. Rather, the frequency of exceedences appear to fluctuate over the time period studied. These fluctuations do not appear to be consistent between sample sites (see graphs in Appendix A).

The sampling stations with the greatest occurrences and durations of beach postings were those around Goderich (Goderich beaches, Black's Point) Amberley (Amberley beach, Ashfield Twp. Park) and Sarnia (Centennial Park). Algae blooms were most prevalent in the Goderich area, as well as the Point Clark/Amberley area.

The predominantly rural watersheds of southeastern Lake Huron are some of the most productive agricultural land in Canada. Studies indicate that these watersheds also produce some of the greatest amounts of manure, nitrogen and phosphorous in the nation. Agriculture is one of the main contributors of nutrients and pathogens to nearshore waters in the study area.

Another key contributor that has consistently been identified is faulty septic systems. A concentration of development exists along the lakeshore that relies on private septic system technology to dispose of human waste. As well as contributing pathogens, a review of literature suggests that failing septic systems have also contributed nitrates and phosphates to coastal ground and surface waters in other Great Lakes shorelines with permeable soils.

The delivery of bacteria and nutrients to Lake Huron may be aided by the physiography of the local landscape. The heavy clay soils of the Huron Slope provide a relatively impervious substrate over which nutrient and bacteria laden surface runoff can flow into Lake Huron. Direct surface flow to Lake Huron is supported by the numerous ravines and gullies incised into the clay till of the Huron Slope. Sandy soils, characteristic of the Huron Fringe, provide optimum conditions for the transport of nutrients and bacteria to groundwater. The pollutants can then follow the water table gradient to the

lake. While the soil conditions of these two physiographic areas are quite different, they both contribute to an increased risk of pathogen and nutrient impaired waters.

Once in the nearshore, pathogens and nutrients can be influenced by coastal geomorphological conditions. Alongshore currents, created by the prevailing wave climate, move sediments along the shore. Sediments move alongshore when waves hit obliquely onshore. Sediments will move in an onshore-offshore manner when waves approach parallel to the shore. It is assumed that pathogens and nutrients within the sediments will move accordingly. Phosphorous, in particular, moves through water bound tightly to soil particles. Since nitrate is water soluble, though, its impact is likely limited to the area where it enters the lake, and then begins to dissipate. However, since barrier bars frequently close off, or restrict the flow at the mouths of creeks and streams, nitrates may periodically concentrate in the estuary. This might become an aquatic habitat impairment issue if nitrate levels exceed 4 mg/L, and a toxicity issue if levels exceed 13 mg/L.

Beach and nearshore sediment size and nearshore gradient have been linked to the levels of pathogens in water. Gradual nearshore gradients (like those at Ipperwash and Sauble Beach) result in less re-suspension of sediments. Steeper nearshore gradients (like those at Goderich, Grand Bend and Kincardine) are more prone to re-suspension of nearshore sediments as more wave energy can penetrate the shore zone. Pathogens in steeper gradient nearshores, therefore, would also be prone to re-suspension. No research has been done to determine what influence bathers have on sediment re-suspension.

Gradual nearshore gradients are associated with fine-grained beach sands which support higher concentrations of bacteria than coarse sands. Steeper gradients are associated with coarser sands and therefore support lower concentrations of bacteria. No research has been done to determine the public health risk to small children who typically play in wet sands close to, or at, the shoreline.

Anecdotal information of people contracting ear, eye and throat infections or enteric disorders after swimming does not appear to have any corresponding medical data that tracks any linkages between beach exposures and medical treatment in the southeastern Lake Huron region. This is a data gap which makes it difficult to understand the magnitude of the health risk within the study area.

Kettle Point, Saugeen and Nawash First Nations were concerned about nearshore water quality in their traditional waters. While the Nawash First Nation had no historical nearshore water quality data, Kettle Point First Nation has collected nearshore samples twice per week, and Saugeen First Nation has collected once per month, during the summer months. Problems

that have been observed in the Kettle Point area range from occurrences of rashes, eye infections and enteric disorders, poor taste and smell of drinking water during times when nearshore quality is poor (due to excessive algae), and growths found on fish caught in their traditional waters (Bressette and Menagh, 2003). All of the First Nations are interested in more complete monitoring, including benthic sampling. There was a concern that past studies on water quality conducted by the federal, provincial and local governments have had a tendency to stop at First Nations boundaries. As a result, few historical records exist within First Nations territories. Nearshore water data collection is something that First Nations want involvement in, but research should include both traditional ecological knowledge and western science.

7.0 Conclusion

Based on the available historical information on the quality of nearshore waters within the study area, the data suggest that pathogenic pollution and nutrient enrichment are the primary nearshore impairments. Much of the public complaints data which was accessible related to concerns about bacterial pollution, illnesses allegedly caused by bacterial pollution and algae blooms resulting from excessive nutrients.

While there are substantial amounts of water quality data within the study area, this information shows inconsistencies, spatial and temporal gaps, and is fragmented amongst several agencies, municipalities and community groups. This study is the first attempt that has been made to assemble and review data of this kind on a regional basis. While no temporal trends of pathogenic pollution were apparent, it was clear that the scope of the problem is extensive (geographically) and enduring (temporally). The poorest water quality based on pathogens was in the Amberley, Goderich and Sarnia areas.

Based on previous studies, nutrient enrichment appears to be increasing, particularly in the area south of Kincardine. Benthic studies, particularly in estuaries would be helpful in understanding impacts to water ecology. The Ministry of the Environment undertook benthic monitoring in the Southampton, Goderich and Bayfield areas in the summer of 2003.

Inconsistent monitoring regimes by area Public Health Units make direct comparisons of the data difficult. Data from Bruce County has large spatial gaps between monitoring points, less frequent monitoring than other health units, and possible problems with sampling bias. A more consistent approach between the three Health Units in monitoring, data analysis and reporting would make regional tracking and comparisons easier.

Nearshore water quality monitoring along Lake Huron lacks coordination, lacks consistency and needs to be re-evaluated in terms of completeness. More and more community organizations appear to be willing, at least in the short-term, to undertake volunteer monitoring to fill in some of the data gaps. These organizations need assistance in training, using appropriate and consistent protocols, and data analysis. They will also need their work to be recognized seriously by public agencies as valid and useful information.

Basic information on septic systems in the study area is limited to isolated areas. Comprehensive regional information on septic systems (densities, age, maintenance history) has not been collected and analysed to provide essential information about impact potential.

No data seems to exist on the extent of the public health problem associated with impaired nearshore water. There is currently no program to track reports to doctors or hospitals that may be related to exposures at impaired beaches.

More research needs to be done to determine whether or not a link can be made between algal decay and Avian Botulism. Is this a water quality issue, a wildlife health issue, or a combination of both?

Finally, First Nations in the study area are currently not sufficiently engaged in nearshore monitoring and analysis of beach water quality, and related data sharing, and communications with health and environmental agencies. Greater efforts are needed to involve First Nations in issues related to nearshore ecosystem health, including nearshore monitoring.

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Maps

Appendices

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