12. NPSP AREA AND THE GREAT LAKES

The Niagara Peninsula Source Protection Area contains water that flows into the Great Lakes and is therefore required to consider the following agreements (MOE, 2007):

- The Canada-United States Great Lakes Water Quality Agreement (GLWQA);
- The Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem;
- Great Lakes – St. Lawrence River Basin Water Resources Compact; and
- The Great Lakes Charter.

The Great Lakes Water Quality Agreement (GLWQA) is a commitment between Canada and the United States to protect the natural health of shared water resources. It was first signed in 1972, reviewed six years later in 1978, and was signed nine years later in the 1987 Protocol. The Protocol focused on Remedial Action Plans (RAPs) and Lakewide Management Plans (LaMPS).

The RAPs are specific to Area's of Concern (AOCs) which are locations where environmental quality has been degraded compared to other areas in the Great Lakes and beneficial uses of the aquatic ecosystem is impaired. There are ten Canadian and five shared Canadian-United States AOCs. A designated AOC in the NPSP Area is the Niagara River, a major waterway interconnecting Lake Erie and Lake Ontario. The Niagara River has a poor overall water quality which began back in the early 1900s (Environment Canada, 2008).

The Canada Ontario Agreement (COA) is a pledge between the Canadian Federal and Ontario Provincial Governments that supports the restoration and protection of the Great Lakes Basin Ecosystem (Environment Canada, 2009). The Agreement outlines how the two Governments can coordinate efforts to achieve protection, restoration, and conservation of the Great Lakes basin. In addition, it will build on past Agreements while focusing on future priorities.

The Great Lakes – St. Lawrence River Basin Water Resources Compact (GLSLWRA) is a binding agreement between the eight Great Lakes States. The GLSLWRA was signed in 2005 by the governments of Ontario, Quebec, and the eight bordering Great Lakes states. In an effort to strengthen protection of the waters of the Great Lakes Basin, the Agreement establishes standards for new or increased water takings and places restrictions water diversions out of the basin (www.ecoissues.ca).

The Great Lakes Charter in a non-binding understanding between Ontario, Quebec, and the eight Great Lakes States that proposes broad principles for the joint management of the Great Lakes (Environment Canada, 2009). Agreements provide a framework for each province and state to pass laws for the purpose of protecting the Great Lakes and the St. Lawrence River Basin.

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12.1 Lake Erie

Lake Erie is the shallowest of the Great Lakes, with an average depth of approximately 19 m and a maximum depth of 64 m. The deepest section of the lake is in the eastern end while the western portion of the lake is generally much shallower. Lake Erie covers a surface area of approximately 25,745 sq km and is about 388 km long by 92 km wide. Lake Erie receives water from Lakes Superior, Michigan, and Huron as well as Lake St. Clair, via the Detroit River which discharges into the western end of Lake Erie. Other major rivers that contribute water to Lake Erie include Grand River, Huron River, and the Maumee River (in Ohio). (Environment Canada and U.S. EPA, 2008)

Water levels in Lake Erie typically fluctuate about 36 cm/yr, but in some years up to 50 cm (e.g., 2002). There has been a steep decline in levels from a 1997 peak to below average during recent years, with significant fluctuations due to climate and storm events. (Environment Canada and U.S. EPA, 2009b)

12.1.1 Water Quality

There are some disturbing trends in biota and system integrity that indicate an apparent deterioration of the physical, chemical, and biological regimes, for example:

- Geosmin and 2-MIB (see Section 2.3.3.2) are likely the cause of annual musty-muddy odour problems in drinking water supplied from the Western basin (e.g. Toledo). In addition, significant odour is produced by extensive rotting mats of shoreline attached algae which have been observed in the last few years to rival those of the 1970s. (Environment Canada and U.S. EPA, 2008) (Environment Canada and U.S. EPA, 2009b)
- Aquatic invasive species, such as zebra mussels, quagga mussels, round gobies and predatory zooplankton, are changing the food web, potentially affecting nearshore algae and the frequency of botulism outbreaks. (Environment Canada and U.S. EPA, 2009c)
- Hypoxia (inadequate dissolved oxygen) and anoxia (total depletion of dissolved oxygen) in the central basin are more extensive and occur over a longer period of time. In the central basin, the water may become devoid of oxygen by the end of the summer growing season. As the limiting macronutrient for aquatic plant growth, the increases in the amount of bioavailable phosphorus fertilize the growth of algae, thereby accelerating the rate of eutrophication in the lake. (Environment Canada and U.S. EPA, 2008)

These concerns and others are explained in more detail below.

12.1.2 Phosphorus

Historically, Lake Erie was considered to be very polluted in the 1960s and 1970s, with high levels of phosphorus and nitrogen. Efforts by the governments of Canadian and U.S.A. since then have resulted in improvements to the water quality in Lake Erie. However, nutrient management remains a top priority for improving the lake (Environment Canada and U.S. EPA, 2009c). This is because in the last decade, in-lake concentrations of total phosphorus have been on the rise and tributary loadings of dissolved phosphorus are increasing. Data from the last several years indicate that more phosphorus is leaving Lake Erie in the waters of the Niagara River than is entering the Lake from the major tributaries. (Environment Canada and U.S. EPA, 2008)

12.1.3 Exotic Species

Within the lake, benthic species composition, abundance, and distribution have become dramatically altered either because of, or together with the establishment of nonnative zebra and quagga mussels (*Dreissenidae*) beginning in the early 1990s. Dreissenids may be abundant enough in Lake Erie to regulate phytoplankton production, and they are becoming increasingly important in the diet of both sport fish (such as smallmouth bass) and invading species (round gobies). Dreissenids are also affecting the distribution of other benthic organisms, such as aquatic insects, crayfish, and other shallow-water (*Gammarus*) and deepwater (*Diporeia*) crustaceans. These changes are expected to influence the growth of both bottom-feeding and plankton-feeding fish populations.

In addition, the water quality models used to predict the amounts of nutrients and concentrations of oxygen in the water are becoming increasingly inaccurate. This may be due to the influence of non-native invasive species, climate change, or the need for better measurements of the way water circulates, mixes, and carries materials to different parts of the lake. (Environment Canada and U.S. EPA, 2008)

12.1.4 Nearshore Algae - Cladophora

Recent research has documented high concentrations and survival rates (>6 months at 5ºC) of *E. coli* within shoreline accumulations of *Cladophora*. This research indicates that *Cladophora* mats are a potential source of *E. coli* to recreational waters, potentially confusing the use of *E. coli* as an indicator organism for pathogens derived from fecal material. *Cladophora* filaments require hard surfaces such as rocky lake bottoms or man-made structures such as piers or breakwalls for attachment. Significant areas of shallow bedrock are restricted to the eastern basin, portions of the central basin's southern shoreline, and islands of the western basin. Man-made structures, however, are common to all basins.

The most recent systematic *Cladophora* surveys have been of the eastern basin. Across the northern shoreline of the east basin dense *Cladophora* mats were found over 96% of available rocky lake bottom and were not spatially limited to nutrient point sources such as the mouths of tributaries or sewage treatment outfalls. The standing biomass of *Cladophora* along this reach of shoreline was estimated to be 11,000 tonnes (dry weight). Shoreline accumulations of *Cladophora* were common during July and August, causing noxious odors and prompting numerous complaints from local homeowners. (Environment Canada and U.S. EPA, 2008)

12.1.5 Fish

Yellow perch stocks are recovering; however, the top predator species populations of walleye, lake trout, and lake whitefish are struggling. Contaminant levels, specifically PCBs and mercury continue to affect fish consumption. (Environment Canada and U.S. EPA, 2009c)

Consumption restrictions in Ontario on Lake Erie sport fish are caused by PCBs (82%) and mercury (18%). In 2002 these percentages were 70% and 30%, respectively. Other contaminants such as DDT and metabolites, hexachlorobenzene, octachlorostyrene, chlordane and lindane are often detected in Lake Erie sport fish, but do not cause consumption restrictions, and concentrations have declined over the years. In recent years, dioxins and furans have been monitored in species expected to have the highest concentrations (e.g. carp, lake whitefish), but have not caused consumption restrictions. Comparing data across the Canadian waters of the Great Lakes, Lake Erie has the lowest proportion of sport fish species with consumption restrictions at 15.7% (in 2002 that number was 17.4%). (Environment Canada and U.S. EPA, 2008)

12.1.6 Type E Botulism

Since 1999 there have been annual large scale die-off events of fish, fish-eating birds and mudpuppies (a native aquatic amphibian) observed in Lakes Erie, Huron and, in 2003, Lake Ontario. These events have occurred annually in Lake Erie and it is here where the largest toll of fish and wildlife has occurred. The type E botulism bacterium is believed to be the cause of the die-off events. (Environment Canada and U.S. EPA, 2008)

12.1.7 Emerging Chemicals of Concern

Over the past few decades, an increasing concern has developed about the potential and inadvertent contamination of water resources from the production, use, and disposal of the numerous chemicals used to improve industrial, agricultural, and medical processes. Analgesics, anti-inflammatory drugs, birth control chemicals, Prozac-like drugs, and cholesterol-lowering drugs have all been found in the effluent from water treatment plants discharging into the Detroit River, although at low concentrations. Even some commonly used household chemicals have raised concerns. Increased knowledge of the toxicological behavior of these chemicals raises the need to determine any potentially adverse effects on human health and the environment. For many of these contaminants, public health experts do not fully understand the toxicological significance, particularly the effects of long-term exposure at low levels. Further study needs to be done to determine the transport of these chemicals at trace levels through the environment and to determine any resulting adverse human health effects. (Environment Canada and U.S. EPA, 2008)

12.1.8 Climate Change

A number of climate changes have also been projected for the basin:

- further increases in air temperatures;
- a decrease in the daily temperature range;
- an increase in the intensity and frequency of extreme events (heat waves, drought, intense precipitation);
- more winter precipitation falling as rain and less as snow with a subsequent increase in winter runoff;
- earlier spring freshet with potentially less flow;
- increased evapotranspiration with warmer temperatures; and
- less ice cover.

While it is natural for Lake Erie's water level to fluctuate seasonally, annually and over decades, most impact assessments of climate change on the hydrology of the Great Lakes Basin project lower net basin supplies and increased frequency and duration of low water levels. (Environment Canada and U.S. EPA, 2008)

12.2 Organic Nitrogen Pollution in the Great Lakes and Water Treatment Plants

Niagara Region and the NPCA have identified that organic nitrogen is equally high at all WTPs in the Niagara Region. Available information does not clearly indicate a distinguishable source of organic nitrogen. Elevated levels of nitrogen can come from sewage outfalls, livestock sources and chemical fertilizers, but can also occur naturally in bedrock. The identification of potential contributors for organic nitrogen requires further investigation in future iterations of Source Protection Planning and perhaps Great Lakes targets.