Choices for Cleanup: Deciding the Future of a Great River

DRAFT
September 1993

"The environment is the business of everybody, development is the business of everybody, life and living is the business of everybody. I think the solution will be found in encouraging mass environmental literacy so that there can be democratic and literate decisions, because if decisions are taken by a few without the incorporation of the opinion of the masses, the NGOs [non-governmental organizations] especially included, the likelihood is that the situations will not succeed. They will be imposed from above, the people will not respond positively to them, and the project is lost before it is launched."

Joseph Ouma
Dean of School of Environmental Studies, Moi University
Nairobi, 23 September 1986

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Choices for Cleanup: Deciding the Future of a Great River

1. INTRODUCTION

The St. Lawrence River — one of the great rivers of the world — is suffering from decades of abuse and needs attention now. Not only does it receive pollutants flowing out of Lake Ontario, but many industries have located along its shores to take advantage of the huge volume of freshwater flowing by and convenient access to international shipping routes. Environmental quality in some sections of the river has been seriously degraded by the activities of clusters of industries and human population.

Efforts are being made to clean up the St. Lawrence River ecosystem in the stretch from Cornwall, Ontario to Valleyfield, Quebec. In a project called a *Remedial Action Plan*, local residents from various walks of life are working with representatives from government agencies to come up with the most appropriate and effective ways of taking action to address the environmental problems in the Cornwall area.

The purpose of this report is to involve as many local residents as possible in deciding which clean-up actions should be taken. The report gives some background on what the problems are and what has caused them, then describes proposed options for restoring the health of the river and discusses the environmental and economic implications of each option.

If you wish to have input into activities that will directly affect you and the community in which you live, we ask that you undertake your own review of the options proposed here. Tell us what you think of the options presented in Chapter 9 and whether you think other options should be included. Your comments will be given serious consideration in selecting a final set of clean-up actions.

History of RAP development

Remedial Action Plans — or RAPs — are part of an international effort to protect the Great Lakes environment that began almost ninety years ago. Back in 1909, Canada and the United States signed the *Boundary Waters Treaty*, recognizing that both countries must jointly care for boundary waters such as the Great Lakes. The Treaty established a binational organization called the *International Joint Commission* (IJC) — a group of Canadian and American representatives who advise the governments of both nations on activities that affect environmental quality in waters shared by the two countries.

Urged by the IJC for commitment and action to solve Great Lakes water quality problems, the governments of Canada and the United States signed a *Great Lakes Water Quality*

Agreement (1972, 1978). It legally obliges both countries to cooperate in specific efforts to improve and maintain water quality in the Great Lakes.

In the 1980s the IJC identified 43 of the most severely polluted areas in the Great Lakes as *"areas of concern"* (AOCs). Pollution in these areas has impaired water uses such as swimming, consumption of fish, drinking supply or the ability to support aquatic life. The IJC proposed that environmental quality be restored in each area of concern by developing a Remedial Action Plan (RAP) for the area.

The governments of Canada and the US are legally obliged to develop and carry out RAPs under the terms of the *Great Lakes Water Quality Agreement* as revised in 1987. The location of the 43 RAPs is shown in Figure 1 — seventeen are located in Canada and twenty-six are in the US.

Within Canada, the federal government and the Ontario provincial government initiated the RAP process through the *Canada-Ontario Agreement Respecting Water Quality in the Great Lakes*, or COA. It defined federal and provincial government responsibilities for protecting and improving water quality in the Great Lakes. It established a cooperative effort by the two levels of government to develop Remedial Action Plans for each of the 17 areas of concern in Canada, all of which are in Ontario.

How a RAP works

RAPs take a new approach to environmental problem solving in which citizens from many walks of life work with various government agencies to decide on how to clean up a specific environment. This gives local residents — the people who will be most directly affected by cleanup activities in the area of concern — direct input into environmental decisions affecting their community.

Each RAP is carried out in three stages. The first stage is a detailed assessment of environmental problems and their causes. In Stage 2, government agencies and citizens work together to examine options for addressing the problems identified in Stage 1 and decide which of these remedial options will be implemented. In the final stage of a RAP, the options selected in Stage 2 are carried out, or implemented, and environmental quality is monitored in order to confirm that the remedial actions have achieved their purpose.

People involved in the RAP use an ecosystem approach to environmental decision-making, recognizing that an ecosystem is an interacting network in which water, land and all forms of life including humans are linked. Actions affecting one part of the environment have an impact on the rest of the ecosystem, and this is true not only of polluting actions but also of cleanup actions. Each cleanup option is therefore evaluated on the basis of its potential effects on the entire ecosystem.

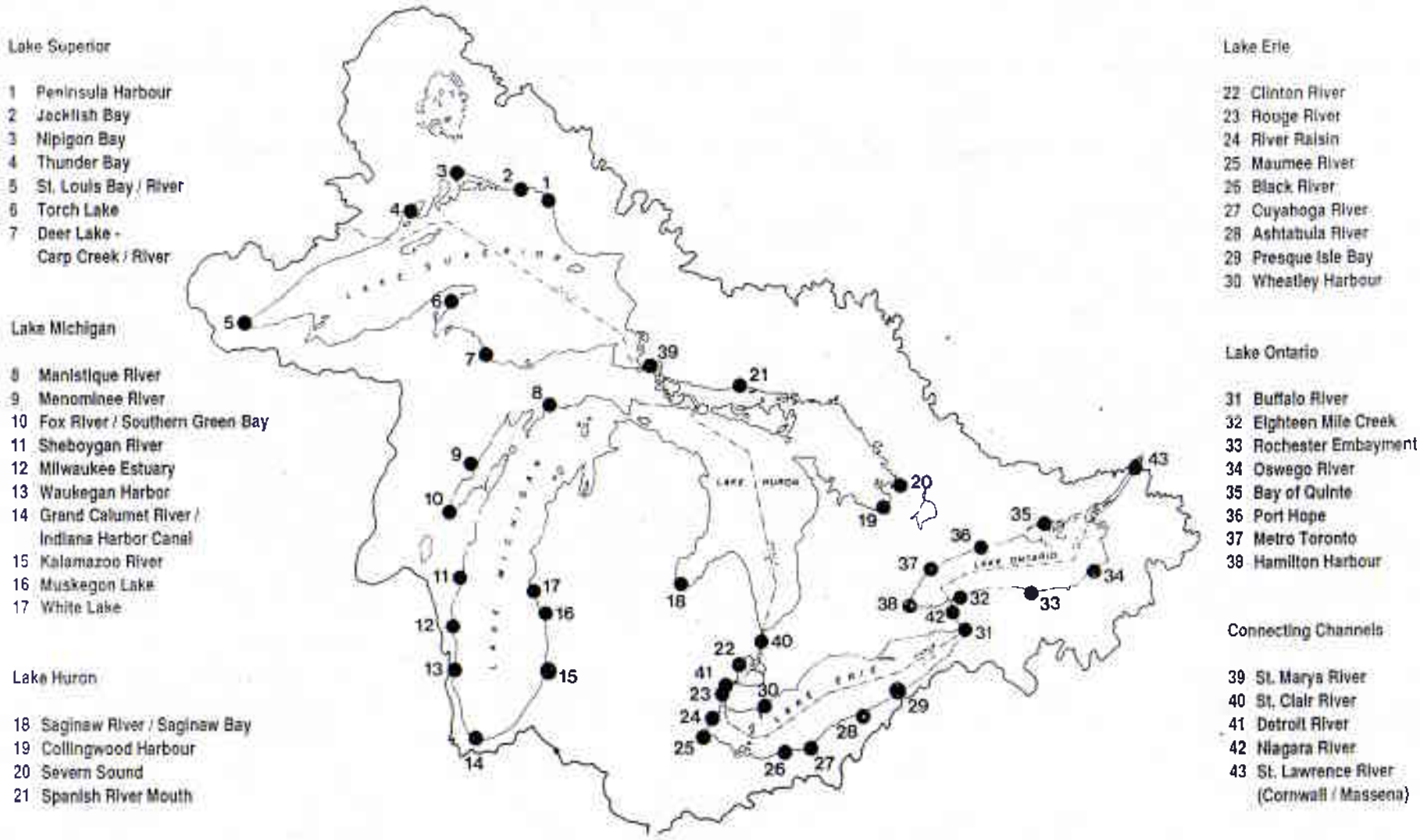


Figure 1. Location of forty-three areas of concern in the Great Lakes-St. Lawrence basin. A Remedial Action Plan is being developed for each area.

The Cornwall RAP

One of the Great Lakes areas of concern is the Cornwall-Lake St. Francis stretch of the St. Lawrence River. Here, Canada and the US are carrying out two separate RAPs as shown in Figure 2. The Cornwall RAP addresses environmental problems on the Canadian side of the river from the Moses-Saunders power dam in the west, to the outlet of Lake St. Francis in the east. The Massena RAP addresses problems on the US side of the river in the area of Massena, New York.

In 1986 a *RAP Team*, a team of federal and provincial government representatives, was formed to oversee the development of the Cornwall RAP. The RAP Team's job was to develop the RAP by means of both technical evaluation and public information, involvement and consultation.

Since 1988, the RAP Team has been working with a *Public Advisory Committee* — "the PAC" — which consists of stakeholders (people who have an interest in what happens to this section of the River) from various sectors of the public. The PAC or its subcommittees meet almost every week. Their activities have included the development of a set of goals for the Cornwall RAP (see Appendix II) and communication of RAP activities to the public through participation in trade shows, articles in local newspapers, and the production of brochures and flyers. The set of options presented in Chapter 9 of this report is the product of a process in which, with technical advice from the RAP team, the PAC undertook a comprehensive review of a wide range of remedial options for improving environmental quality in the area of concern.

Seven major environmental issues affect the Canadian portion of the St. Lawrence area of concern. These are: mercury contamination, PCB contamination, the presence of other persistent toxic contaminants, bacterial contamination, habitat degradation and destruction, excessive growth of aquatic plants, and invasion by exotic species. Chapters 2 to 8 of this report outline the seven issues. A detailed technical examination of the problems and their causes constituted the first stage of the Cornwall RAP and can be found in the Stage 1 Report of the Cornwall RAP, which is available upon request.

How to participate

The Cornwall RAP is reaching the end of Stage 2. It is now time to decide on a set of remedial actions for the St. Lawrence River in the Cornwall area. We encourage you to evaluate the information and proposed cleanup options discussed in this report and call, write or bring your comments to one of the upcoming open houses or public meetings. Your input will help to ensure that cleanup activities in the Cornwall area reflect the views and needs of the majority of local residents.

How to make your views known:

- Send written comments to: Cornwall RAP Public Advisory Committee
  c/o Ministry of Environment & Energy

newspapers and on the radio. If you would like to receive a notice of the location & date of the meetings please fill out the form enclosed with this report and send it to the address on the form.

(Form unavailable at time of printing).

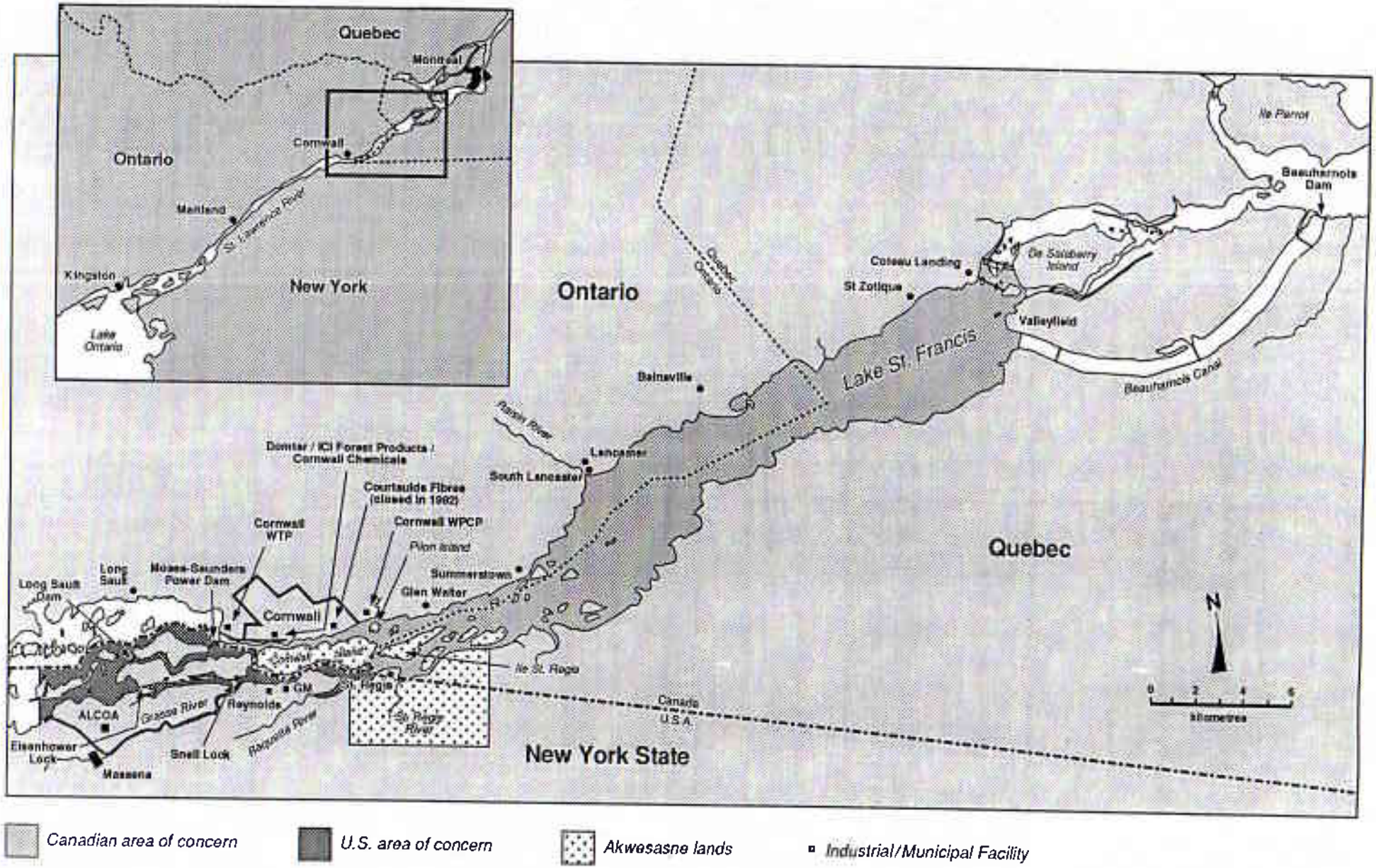


Figure 2. The St. Lawrence River area of concern and locations of the Cornwall RAP and Massena RAP.

2. ENVIRONMENTAL ISSUE: Mercury Contamination

Mercury contamination of the St. Lawrence River ecosystem between Cornwall, Ontario and Valleyfield, Quebec has been a concern since the late 1960s because it is a potential health risk for people who eat fish caught in the area. Mercury contamination has caused restrictions on fish and wildlife consumption, degradation of benthos (bottom dwelling organisms) and restrictions on dredging activities in this section of the river. In addition, high concentrations of mercury may degrade fish and wildlife populations and cause bird or animal deformities or reproduction problems.

This chapter describes the mercury problem and its causes. The final chapter (Chapter 9) of the report presents, for your review, remedial actions that the RAP Team and PAC are considering as ways to address the problem of persistent, toxic contaminants including mercury in the St. Lawrence area of concern.

2.1 Environmental and health effects of mercury

Mercury occurs naturally in the environment and will always be present to some extent. However, human activities over the past few decades have greatly increased the amount of this metal in industrialized areas. Concentrations in water used for drinking and swimming are generally too low to be a health hazard for humans, but because mercury concentrations tend to be much higher in sportfish, problems can arise when people eat fish caught in mercury-contaminated areas.

The way mercury moves through the food chain is not completely understood, but the high concentrations observed in sportfish are probably the result of *bioaccumulation*. Bioaccumulation, or biomagnification, is a process by which the concentration of a contaminant increases as it moves through the aquatic food chain from microscopic plants to top predators. The inset on page x describes this process in more detail.

Mercury exists in a variety of forms in the environment but is most toxic in the form called methyl mercury. Bacteria living in bottom sediment convert elemental mercury to methyl mercury. Methyl mercury can then move out of the sediment into the water column, where it is taken up by microscopic aquatic plants (algae) and passes through the food chain, from algae to zooplankton to forage fish to top predator fish, birds and mammals. The concentration of mercury increases at each level in the food chain. Because methyl mercury tends to be retained in body tissues for a long time, top predator fish such as walleye and northern pike can contain high concentrations of mercury. Concentrations will be highest in older (longer) fish as these fish have had more time to accumulate mercury.

Mercury can be quite toxic to humans if large amounts are consumed. For Cornwall area residents, there is no risk of mercury toxicity as long as fish consumption guidelines are followed. Guidelines specific for the St. Lawrence River at Cornwall and downstream into Lake St. Francis are shown in Figure 5 (from the *1993-1994 Guide to Eating Ontario Sport*

Movement of persistent, toxic contaminants through the aquatic food chain

Some of the chemical compounds released into waterways tend to *bioaccumulate* in the aquatic food chain. This happens because the compounds persist in the environment for a long time without breaking down to a harmless form, and they are very slow to leave a plant or animal once they get inside its cells and tissues.

In the aquatic ecosystem, microscopic plants (algae) absorb their nutrients from the water around them along with any contaminants in the water. When tiny aquatic animals known as zooplankton eat algae, they receive whatever contaminants are in the algae — as an individual zooplankton eats more and more algae, its load of contaminants gradually increases. As a result the concentration of contaminants in zooplankton may be much higher than in algae.

Zooplankton are eaten by small fish, which provide food for larger fish such as pike and walleye or pike. By the time the contaminant has worked its way up to the top of the food chain — to a top predator fish such as northern pike — it may have reached concentrations thousands of times higher than in algae inhabiting the same water as the pike. This process of bioaccumulation or biomagnification is illustrated below.

The longer a top predator fish lives, the more fish (and contaminants) it has consumed, which is why fish consumption guidelines for humans specify different lengths of fish. Large (old) fish are generally more contaminated than small ones.

Even though a toxic substance may be present at such low concentrations in the water that it can't be detected, a top predator fish living in that same water could contain quite high levels of the substance because of bioaccumulation. Water from an area can therefore be perfectly safe to drink even though fish from the same area are contaminated with toxic, persistent substances such as mercury and PCBs.

(This section will be included as a boxed, shaded inset.)

Fish).

Extreme cases of mercury poisoning occured in Minamata, Japan in the 1950s. Up until then, people weren't aware that toxic forms of mercury could accumulate in fish. Industrial discharges of mercury to water at Minamata had resulted in high levels of methyl mercury in fish. Minamata area residents ate so much fish (*i.e.*, daily) that they were exposed to very high doses of mercury. Mercury tends to accumulate in the human kidney, liver and brain, and at low levels may have adverse effects on fetal development. At very high levels in the brain — from doses as high as those received in Minimata — it causes convulsions and can be fatal. This kind of severe mercury poisoning became known as Minamata disease.

In Ontario, concentrations of mercury and other contaminants are regularly monitored in freshwater fish from a large number of lakes and rivers. The results are published in the *Guide to Eating Ontario Sport Fish*, which can be picked up at Ministry of Natural Resources or Ministry of Environment & Energy offices. The *Guide* lists Ontario waterbodies alphabetically, specifying how much fish caught in a given waterbody can safely be consumed according to the type and length of fish. An updated *Guide* is published every other year and should be consulted before eating sport fish.

The effects of mercury on other organisms are less well understood than its effects on humans.

2.2 The problem

Mercury in water

Because of the tremendous flow and dilution capacity of the St. Lawrence River, concentrations of mercury in water from the Cornwall-Massena portion of the river tend to be low except in the immediate vicinity of direct discharges. In Cornwall, these are the Domtar/ICI Forest Products/Cornwall Chemicals diffuser and the Courtaulds Fibres diffuser and shore-based sewers (before Courtaulds closed in November 1992).

The extent of mercury contamination becomes apparent only when other components of the ecosystem besides river water are sampled. For example, fish and sediment collected from the north channel of the Cornwall-Massena stretch of the river generally contain more mercury than samples from the south channel. (The north channel is the part of the river between the City of Cornwall and Cornwall and St. Regis Islands; the south channel is the section south of Cornwall Island and St. Regis Island.)

Mercury in suspended solids

Concentrations of mercury in solids suspended in the river water are generally much higher than concentrations in the water itself, because most mercury entering the river from industrial sources is either already associated with solid particles in the effluent or binds to particles in river water after it is discharged. Depending on their size, mercury-

contaminated particles will either be swept along in the current or settle to the bottom and become part of the bottom sediment.

In a 1988 survey, mercury content was determined for samples of: (1) mainstream river water, (2) solids suspended in mainstream water, and (3) solids suspended in industrial effluent. Whereas mercury was undetectable in most of the river water samples, solids suspended in river water at the same sites (which were not close to industrial discharges) contained significant amounts of mercury (0.11 to 0.25 μg mercury/g dry weight solids). Mercury content of suspended solids in the effluent of Cornwall industries was highest in Courtaulds Fibres' effluent.

Mercury in bottom sediment

Sediment on the bottom of the St. Lawrence River in the Cornwall area and downstream into Lake St. Francis is contaminated with mercury in some places. Since such areas may be releasing mercury to the food chain, they are a serious environmental concern.

In 1988 and 1991 surveys, mercury concentrations were highest in bottom sediment located downstream of the shared Domtar/ICI Forest Products/Cornwall Chemicals effluent diffuser and the Courtaulds discharges. Sediment at these locations contained less mercury than it had in 1970 and 1975, because less mercury was being discharged and because effluent was being discharged farther out into the river where it would diffuse into the fast moving, main current (offshore diffusers had replaced pipes that discharged effluent at the shoreline).

Mercury concentrations in 1991 still violated Ontario provincial sediment quality guidelines though and in some cases exceeded the *severe effect level* (the concentration detrimental to most species of organisms living in the sediment). Studies are under way to determine the stability of the sediment in severely contaminated areas and to see whether, over time, the active layer of sediment will be covered with less contaminated material or eroded and transported downstream because of the fast flow of the St. Lawrence River. These results will be used to help decide whether action should be taken to remove and treat the most severely contaminated portions of sediment.

Mercury in fish

Contamination by mercury and PCBs (Chapter 3) has caused restrictions on consumption of most sportfish species (other than yellow perch, bullhead and panfish) in the St. Lawrence area of concern. The federal department of Health & Welfare advises against consuming fish that contain more than 0.5 micrograms (μg) of mercury per gram of muscle tissue (wet weight).

Since 1970, advisories have recommended restricted consumption of sportfish, specifically walleye, northern pike and smallmouth bass. The commercial fishery for American eel,

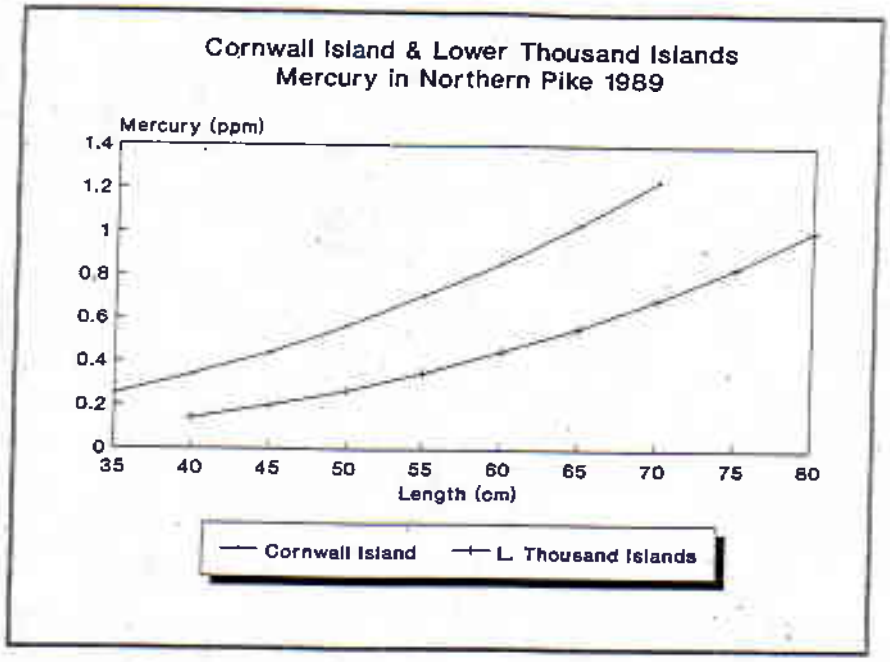
carp and white sucker has been closed sporadically or limits have been placed on the size of fish that can be sold. The Akwesasne fishery has been severely affected by consumption advisories based on mercury and PCB content. Since 1978 the Mohawk Governments of Akwesasne have advised women of child bearing age and children under the age of 15 not to consume any fish taken from the St. Lawrence River.

Figure 3 compares 1989 mercury concentrations in fish caught upstream of Cornwall in the lower Thousand Islands, with those caught off Cornwall Island. For both northern pike and brown bullhead, fish caught off Cornwall Island contained significantly more mercury than the same length (age) fish caught upstream of Cornwall away from industrial sources of mercury. This pattern reflects historical and ongoing mercury discharges to the area of concern. Fish in Lake St. Francis below Cornwall also have higher levels of mercury than fish in the upper St. Lawrence.

There is some good news, though. The amount of mercury in some sportfish has gradually declined since 1970 in response to decreases in local emissions of mercury. Concentrations of mercury in walleye (Figure 4) and northern pike have declined, although levels in older fish still exceed Health & Welfare Canada's consumption guideline of 0.5 μg/g, and the rate of decrease in walleye appears to be slowing. Restrictions on consumption of sportfish now apply only to larger fish.

According to the *1993-1994 Guide to Eating Ontario Sport Fish*, it is safe to eat unlimited amounts of walleye less than 45 cm (18 inches) long from Lake St. Francis or walleye less than 35 cm (14 inches) long caught off Cornwall Island. There are no restrictions on consumption of northern pike less than 45 cm long caught anywhere in the area of concern. Figure 5 (from the *1993-1994 Guide*) shows restrictions on consumption of other species of sport fish at various locations in the area of concern.

Some wildlife species (such as waterfowl) have been tested for mercury and levels are quite low.



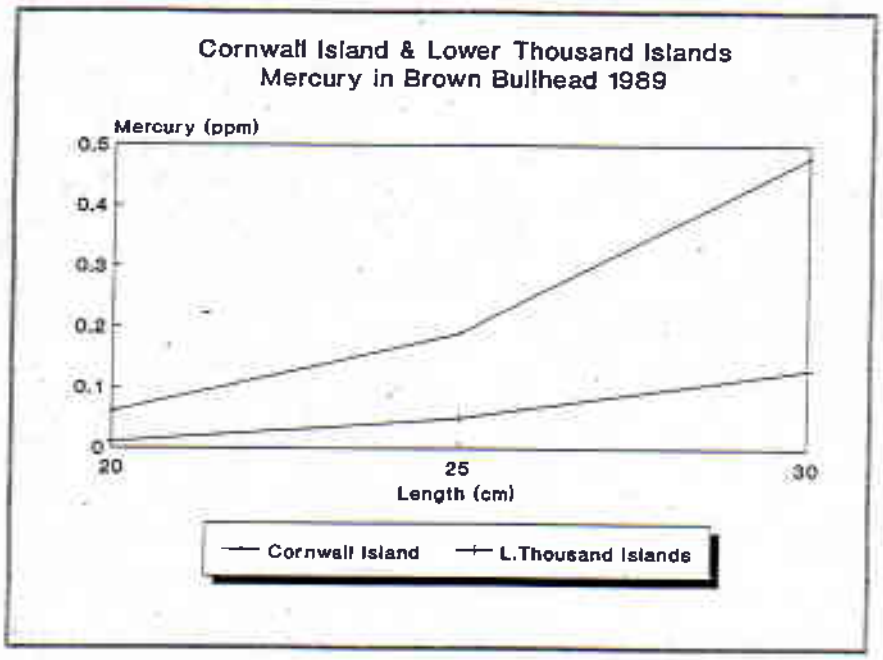


Figure 3. Comparison of mercury concentration in fish of the same length caught upstream and downstream of Cornwall.
For example, whereas a 50 cm (20 inch) northern pike caught in the Thousand Islands contained 0.2 μg of mercury per gram of muscle tissue, the same length pike caught off Cornwall Island contained three times as much mercury (0.6 μg/g).

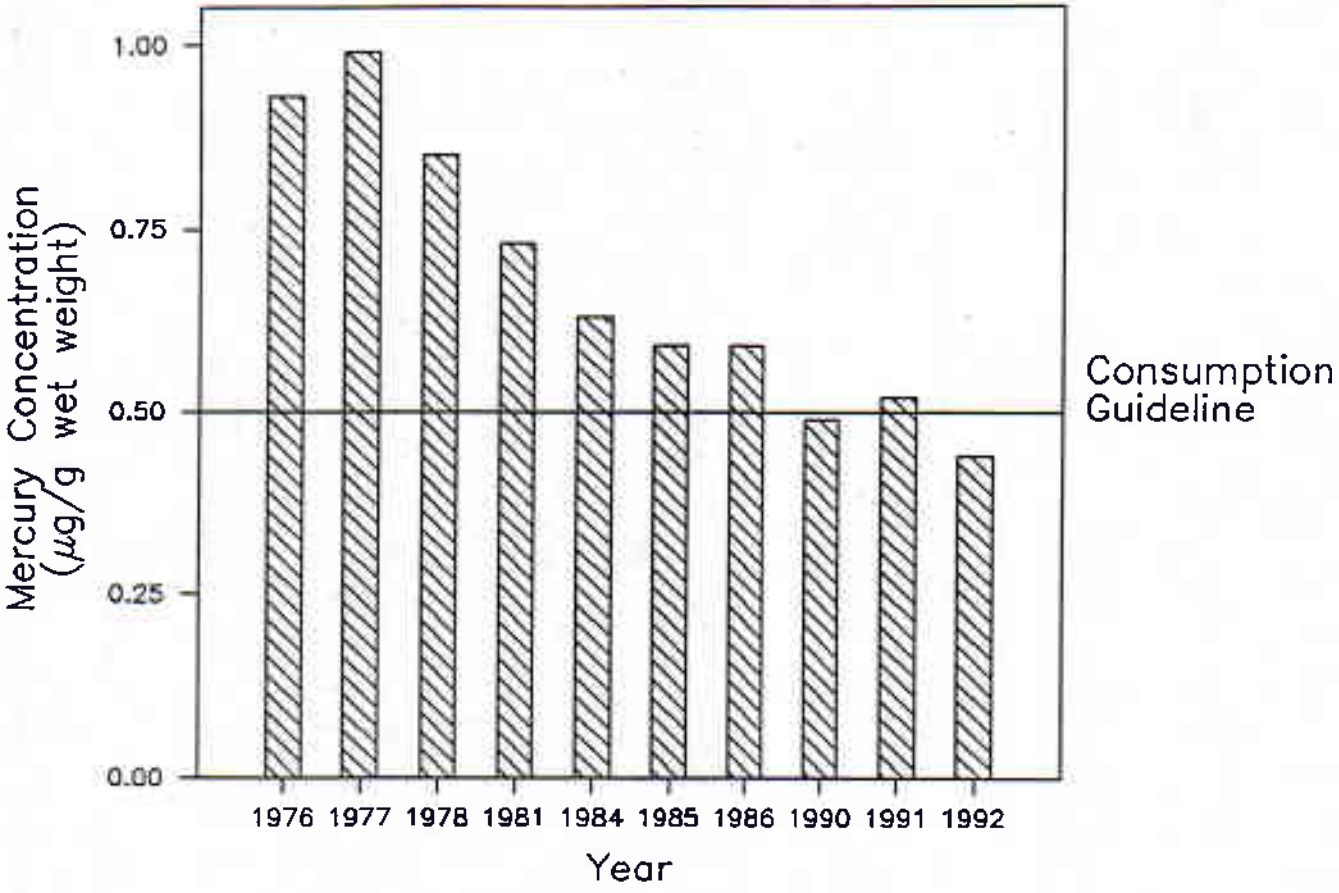
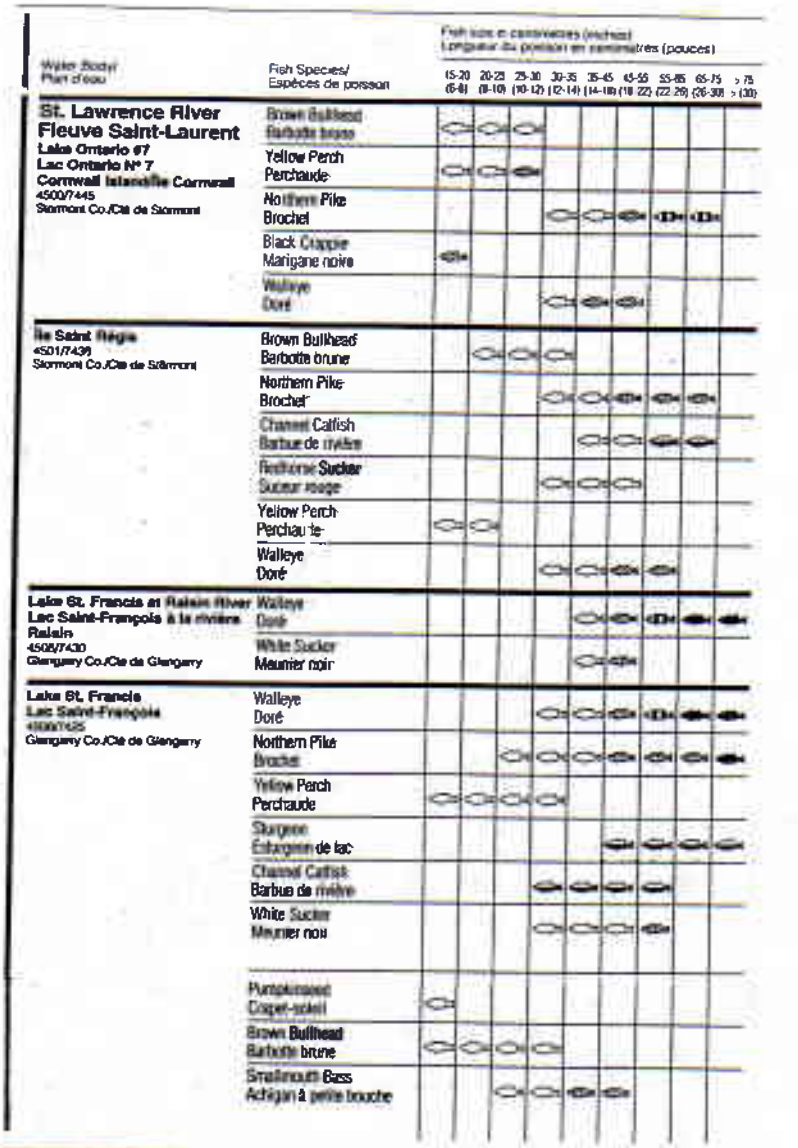


Figure 4. Average mercury concentration in 50 cm walleye from Lake St. Francis, 1971-1992.



Consumption guidelines for fish caught by anglers

Consumption Frequency					
Long-term consumption	No restrictions	0.2 kg/wk. (0.5 lb./wk.)	0.1 kg/wk. (0.3 lb./wk.)	1 or 2 meals per month 0.5 kg/mo (1 lb./mo.)	None
One-week vacation	No restrictions	10 meals 2.3 kg (5 lb.)	7 meals 1.5 kg (3 lb.)	1 or 2 meals 0.5 kg (1 lb.)	None
Two-week vacation	No restrictions	5 meals per wk. 1.3 kg/wk. (2.8 lb./wk.)	4 meals per wk. 0.8 kg/wk. (1.9 lb./wk.)	1 or 2 meals /wk. 0.5 kg/wk. (1 lb./wk.)	None
Three-week vacation	No restrictions	4 meals per wk. 1 kg/wk. (2.1 lb./wk.)	3 meals per wk. 0.6 kg/wk. (1.4 lb./wk.)	1 or 2 meals /wk. 0.5 kg/wk. (1 lb./wk.)	None

Children under 15 and women of childbearing age should eat only fish in category.

Figure 5. Restrictions on consumption of sport fish from various locations in the area of concern (from 1993-1994 Guide to Eating Ontario Sport Fish).

2.3 Causes of the mercury problem

A number of Cornwall industries release mercury directly to the river through discharge pipes or to the air through stacks. Courtaulds Fibres, which closed in 1992, discharged an average of 74 grams of mercury per day to the river in 1990. ICI Forest Products releases mercury both in its liquid effluent (24 g/day in 1991) and in emissions to the air (190 g/day in 1991). Domtar Fine Papers, Cornwall Chemicals and the Cornwall sewage treatment plant release much smaller amounts of mercury.

Figure 6 shows amounts of mercury discharged daily by each of the Cornwall point sources, based on 1990 and 1991 data. There are no significant US point sources of mercury in the area of Massena, NY.

ICI Forest Products in Cornwall is the only chlor-alkali plant in Ontario that still uses a mercury cell process. Other chlor-alkali plants have switched to non-mercury processes. ICI uses the mercury cell process to convert salt to sodium hydroxide (caustic) and chlorine by electrolysis. The plant discharges mercury in its liquid wastewater stream and from ventilation air outlets in the mercury cell rooms. It is not known how much of the mercury ICI releases into the air falls on land in the Cornwall area, or what proportion of the mercury falling on land ends up in the St. Lawrence River.

In the past, ICI discharged far more mercury to the river than it does today. The plant has been operating for almost sixty years, beginning in 1935. The earliest effluent monitoring done by the company and reported to the government was completed in 1970, with losses of about 410 grams of mercury per day reported. Losses were likely at least equal to or greater than that amount during the previous decades of operation. Prior to 1960, Ontario's industrial plants and municipalities did little to control their liquid waste discharges to the environment.

Domtar Fine Papers' pulp and paper mill releases its effluent through the same diffuser as Cornwall Chemicals and ICI Forest Products. Mercury loadings to the river are therefore often described as coming from Domtar/ICI/Cornwall Chemicals even though the bulk of the mercury is from ICI, with a much smaller proportion from Cornwall Chemicals and Domtar.

Pulp and paper mills used to use mercury as a slimicide to kill moulds growing on pulp fibres. This practice was halted in 1970 at Domtar in Cornwall, and the mill is now a minor discharger of mercury to the St. Lawrence River. The mercury it now discharges (an average of 2 grams per day) comes primarily from naturally-occurring mercury in tree bark and from low level contamination of chemicals used in the papermaking process.

Cornwall Chemicals is one of three operations on site at ICI (together with ICI Forest Products and the Stanchem packaging plant). Cornwall Chemicals manufactures a variety of chemicals using chlorine and sodium hydroxide produced at ICI Forest Products, and discharges about 3 grams of mercury per day, which makes it a minor source of mercury

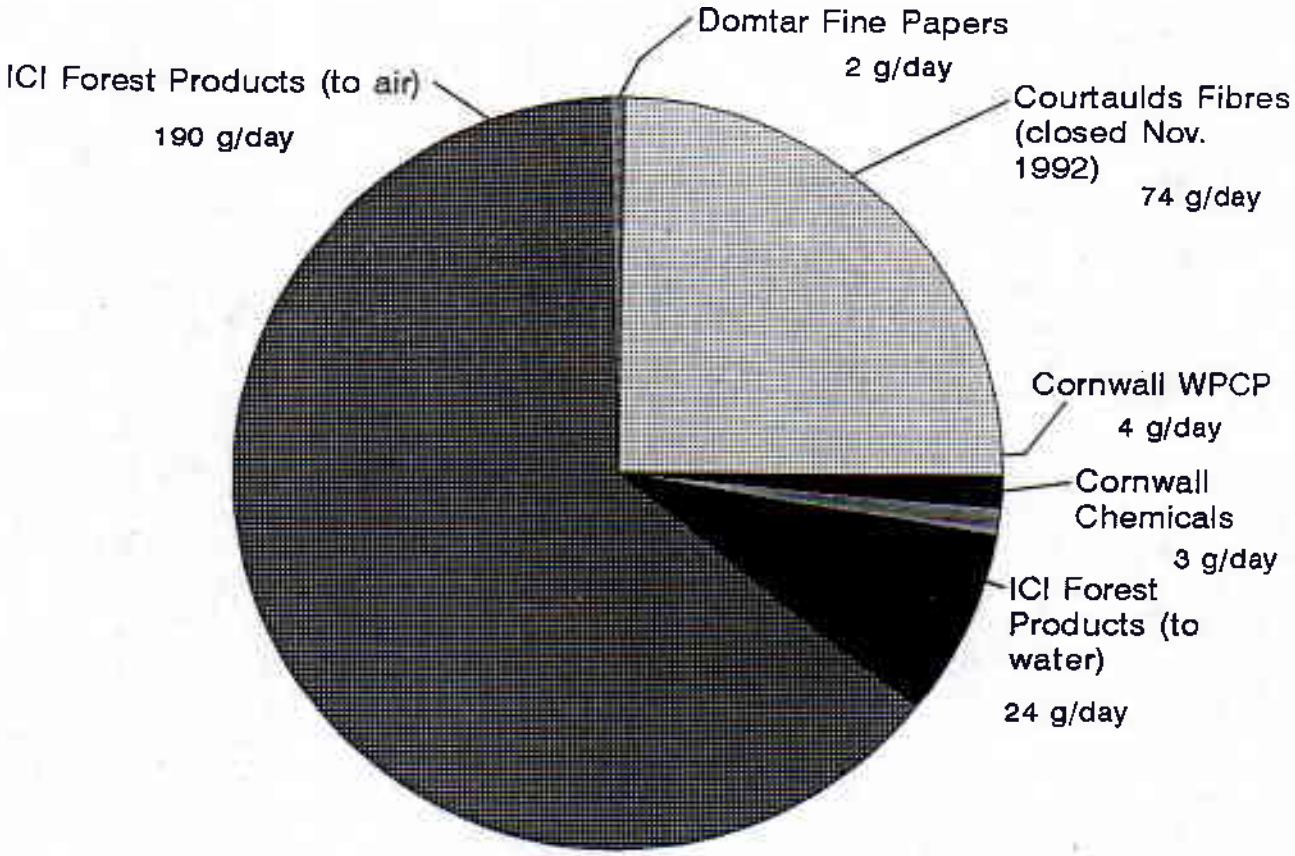


Figure 6. Comparison of mercury discharges by Cornwall point sources.
WPCP = Water Pollution Control Plant (City of Cornwall sewage treatment plant)

in the area of concern. The mercury comes from mercury-contaminated caustic used to neutralize effluent, and from ICI brine used to regenerate water softener for the boilers. The plant will soon be switching to uncontaminated brine, which will reduce mercury discharges by about two-thirds.

Effluent from Stanchem, a chemical packaging plant, is released with effluent from Cornwall Chemicals. Stanchem discharged an average of 0.1 grams of mercury per day in 1990.

The City of Cornwall Water Pollution Control Plant (sewage treatment plant) is also a minor source of mercury, discharging about 4 grams per day. Wastewater from dental offices and surface runoff containing atmospheric mercury fallout are possible sources of the mercury discharged from Cornwall's sewage treatment plant. The plant's system of primary sewage treatment removes most of the solids in a large settling chamber called a clarifier and most of the mercury is removed along with the solids.

In addition to direct discharges of mercury, severely contaminated areas of sediment in the Cornwall-Massena stretch of the St. Lawrence River themselves act as continuing sources of mercury, as bacteria living in the sediment convert mercury to the methyl mercury form that can enter the food chain.

Construction of the Beauharnois Dam and the flooding of Lake St. Francis probably resulted in a significant increase in levels of methyl mercury in the aquatic ecosystem of Lake St. Francis. This is a well-documented environmental effect of flooding but the exact reason for the mercury increase is not known. It is probably related to an increase in bacterial action in the flooded soil during which bacteria convert naturally occurring mercury in the soil to methyl mercury which is able to enter the food chain.

Mercury also enters the St. Lawrence River from upstream sources. An estimated 85.5 grams of mercury from Lake Ontario are contained in the water and suspended sediments flowing past Cornwall each day. Even though this mercury exists in the St. Lawrence River both upstream and downstream of Cornwall, fish caught upstream of Cornwall contain much less mercury than fish caught just downstream. This pattern reveals a locally created mercury problem in the Cornwall area which needs to be addressed while continuing to reduce mercury loadings into Lake Ontario as a whole.

2.4 General approaches for addressing the problem

Two overall approaches can be taken to reduce contamination by mercury and other toxic contaminants in the area of concern:
(1) First, and most important, action must be taken to stop or reduce the problem at its source. This means taking measures to eliminate or reduce industrial and urban discharges of mercury to the St. Lawrence River.
(2) Recognizing that existing contaminated sediment may contribute to the problem by continually releasing mercury into the food chain, measures to remediate (clean up)

severely contaminated sediment are being considered. Sediment remediation usually involves dredging (taking care to prevent resususpension of contaminants into the water column) followed by treatment and disposal of removed sediment. Before any such action is taken, the location and extent of severely contaminated sediment zones and the stability of that sediment (*i.e.*, how quickly it is either eroding or being covered over with new material) must be well understood.

The Cornwall Public Advisory Committee and RAP Team invite you to evaluate their preferred options for cleaning up contamination by mercury and other persistent, toxic chemical compounds. The options are listed and discussed in the final chapter of this discussion paper.

3. ENVIRONMENTAL ISSUE: PCB Contamination

Significant discharges of PCBs from three major industrial sites near Massena, NY affect the Canadian portion of the St. Lawrence River from Cornwall downstream into Lake St. Francis. Very high concentrations of PCBs have repeatedly been observed since 1979 in St. Lawrence River water, sediment and fish collected near the mouth and downstream of the Grasse River in New York State.

Although PCB contamination is a serious cross-border pollution issue in the Cornwall-Massena section of the St. Lawrence River, it is important to note that two separate RAPs are under way in Canada and the US, each with its own area of concern (Figure 2). The Cornwall RAP is being developed by the governments of Ontario and Canada, whereas the Massena RAP is being developed by New York State. This means that while the Cornwall RAP can make recommendations to American federal and state governments, it cannot initiate actual cleanup of PCB-contaminated sites on the New York State side of the River.

In the Canadian area of concern, PCB contamination has caused restrictions on dredging activities and consumption of fish and wildlife. Transboundary movement of PCBs has the potential to contaminate drinking water obtained from private intakes along the north shore of the St. Lawrence River. Elevated PCB concentrations may also degrade benthos (bottom dwelling organisms) and cause bird or animal deformities or reproduction problems.

3.1 Environmental and health effects of PCBs

PCBs are a family of over 200 similar chemical compounds that do not easily break down, are heat resistant, and do not dissolve easily in water but do mix readily with oil. Because of these qualities they were often used in transformers, hydraulic fluids, fire retardants, paints and inks.

During the 1950s and 60s PCBs were widely used industrially and commercially, but in the 1970s it was discovered that they persist and accumulate in the environment and may be toxic at high concentrations. Since 1978 the manufacture of PCBs has been banned in Canada and they can be used only in closed systems.

PCBs can persist for years in the environment and they readily bioaccumulate in the aquatic ecosystem (see inset, page x). As a result, top predator fish such as walleye accumulate PCBs to concentrations which can be a human health concern. In order to avoid consuming harmful quantities of PCBs, mercury or other persistent contaminants, the *Guide to Eating Ontario Sport Fish*, available at Ministry of Natural Resources or Ministry of Environment & Energy offices, should be consulted before eating sport fish. An updated *Guide* is published every other year.

At high concentrations in humans, PCBs may cause digestive disturbances and liver problems. There may be a link between low birthweights in children and women who are

exposed to high concentrations of PCBs in the workplace or women who are chronically exposed to PCBs through frequent consumption of PCB-contaminated fish. Some types of PCBs cause cancer in laboratory animals but it is not known whether they cause cancer in humans.

PCBs bioaccumulate in top predators such as walleye, channel catfish, fish-eating birds and snapping turtles, but their effects on the health and abundance of fish and wildlife are not well understood. The occurrence of bill deformities in cormorant and tern chicks may be related to PCB contamination.

3.2 The problem

PCB concentrations higher than anywhere in the St. Lawrence River upstream of Cornwall have been observed in river water (but not in treated drinking water), bottom sediment, forage fish and sport fish, waterfowl, snapping turtles and native mussels at various locations in the St. Lawrence River from Cornwall, Ontario to Valleyfield, Quebec.

PCBs in water

PCB concentrations are elevated in water from the Cornwall-Massena stretch of the St. Lawrence River. They are rarely below 1 nanogram per litre, the Provincial Water Quality Objective for the protection of freshwater life, and water from the south channel consistently has higher PCB concentrations than water from the north channel. Figure 7 shows the concentration of PCBs in river water at various locations around the area of concern.

The intake for the public water supply at Glen Walter, Ontario was fitted with carbon filters after modelling of river flow patterns showed that PCBs from American sources could reach the Glen Walter intake. This means that the public drinking water supply at Glen Walter does not contain PCBs, but shoreline residents who obtain their drinking water directly from the river through private intake pipes could be exposed to PCBs.

Drinking water for the City of Cornwall is obtained upstream of the industries in Cornwall and Massena and is therefore not susceptible to PCB contamination from those sources.

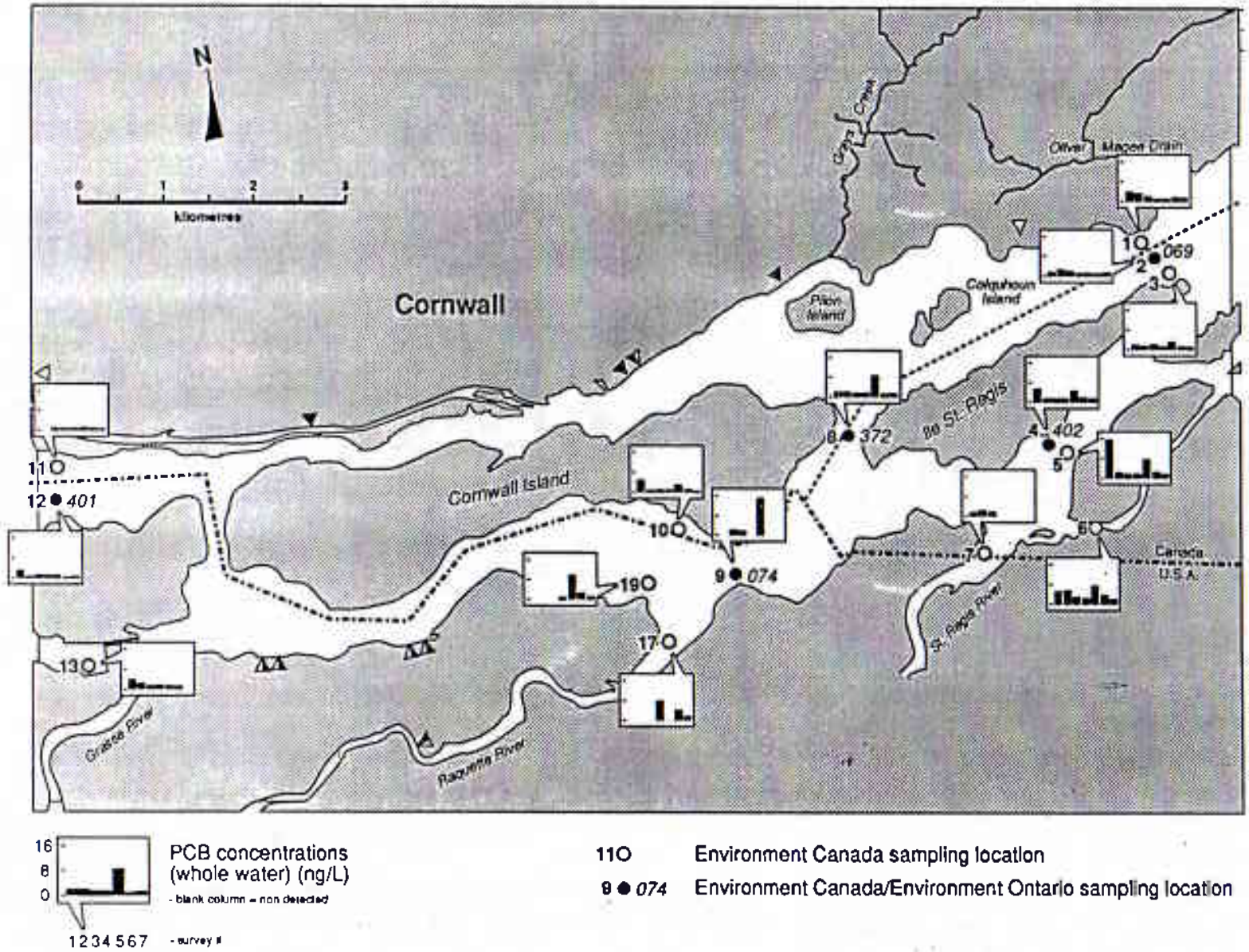


Figure 7. Total PCB concentrations in St. Lawrence River water, 1988.

PCBs in bottom sediment

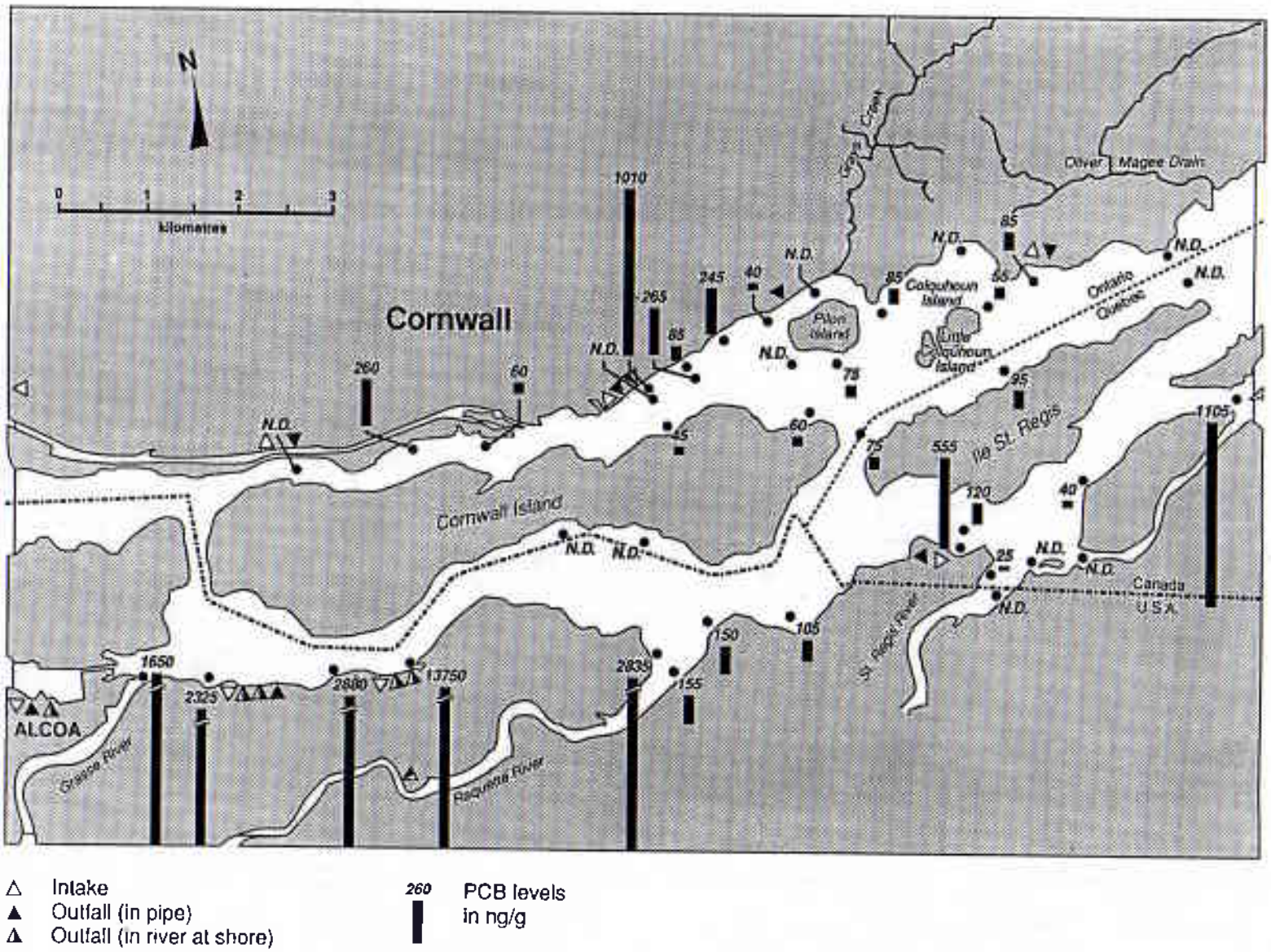
Although PCB concentrations are sometimes high in suspended sediment, they are highest in bottom sediment that is situated downstream of PCB sources. The St. Lawrence River flows very quickly in the Cornwall-Massena area, carrying suspended particles and their associated contaminants downstream where they are deposited in areas of slower moving water. As a result, bottom sediment at some locations in the area of concern has accumulated PCBs to high concentrations.

Bottom sediment that is severely contaminated acts as an ongoing source of PCBs, which can be transported out of the sediment in a number of ways. PCBs move downstream in sediment particles that have been resuspended by scouring of the river bottom, or they are passed along the food chain when PCB-contaminated bottom-dwelling organisms are eaten by fish or other animals. In addition, during routine maintenance dredging of St. Lawrence Seaway navigation channels, the dredged material is disposed of in the open water of the St. Lawrence River. If dredged sediment is contaminated, resuspended PCB-laden particles are swept downstream in the swift current and may be redeposited in the Canadian portion of the area of concern.

In 1985, Environment Ontario surveyed bottom sediment in the St. Lawrence River area of concern. As shown in Figure 8, the highest PCB concentrations were found at stations in the south channel of the St. Lawrence River and at one station in the north channel. The maximum PCB concentration observed on the US side of the river was over ten times higher than the maximum on the Canadian side — 13,750 ng of PCBs per gram of sediment near the GM plant compared with 1010 ng/g near the Courtaulds outfall.

PCBs in sediment from the US site near GM exceeded the *severe effect level* of 10,600 ng of PCBs per gram of sediment as specified by Ontario's Provincial Sediment Quality Guidelines. This is the concentration of PCBs that would be detrimental to the majority of bottom-dwelling species in sediment from this area. Sediment from the Courtaulds site contained PCBs at a concentration below the severe effect level but higher than the *lowest effect level* (the level of sediment contamination that can be tolerated by the majority of bottom-dwelling organisms).

The 1985 survey also showed that PCB concentrations in Lake St. Francis sediment are highest at the entrance to and along the south shore of the lake. Recent studies indicate that PCB concentrations decreased throughout Lake St. Francis over the decade from 1979 to 1989.



△ Intake
▲ Outfall (in pipe)
▲ Outfall (in river at shore)

260 PCB levels in ng/g

Figure 8. PCB concentrations (ng/g) in sediment from the Cornwall-Massena reach of the St. Lawrence River, 1985.

PCBs in fish

Contamination with PCBs and mercury has caused restrictions on consumption of a number of sport fish species in the area of concern. The federal department of Health & Welfare advises against consuming fish that contain more than 2 μg of PCBs per gram of muscle tissue (wet weight). Due to PCB concentrations that exceed this guideline, consumption restrictions exist for sturgeon and channel catfish in the Canadian area of concern. The commercial eel fishery is restricted to eels below a certain size and the carp fishery has been closed for several years.

The Akwesasne fishery has been severely affected by consumption advisories based on mercury and PCB content. Since 1978 the Mohawk Governments of Akwesasne have advised women of child bearing age and children under the age of 15 not to consume any fish species taken from the St. Lawrence River.

Figure 5 shows consumption restrictions on sport fish within the area of concern as indicated in the *1993-1994 Guide to Eating Ontario Sport Fish*. While there are other contaminants in fish, these consumption restrictions are the result of mercury and PCB contamination.

In surveys of young-of-the-year spottail shiners (a type of forage fish) carried out between 1979 and 1991, fish from New York waters contained more PCBs than fish from Ontario waters in the area of concern. Spottails collected from the mouths of the Grasse and Raquette Rivers and from sites near the GM and Reynolds Metals Co. plants contained higher concentrations of PCBs than spottails from anywhere else in the Great Lakes Basin. They contained PCBs at concentrations high enough to be considered a threat to the health of wildlife that preys on forage fish.

PCBs in other animals

PCB contamination of other animals besides fish has not been extensively studied. Three snapping turtles collected on Cornwall Island in 1988 by the Ontario Ministry of Natural Resources (MNR) contained high concentrations of PCBs and both MNR and the Mohawk Governments of Akwesasne have advised against eating snapping turtles from the area.

Lake St. Francis waterfowl contain significant levels of PCBs. There are no consumption guidelines for waterfowl, with respect to PCB content, but it is important to note that PCB levels in mallards (1988) and lesser scaup (1989) were amongst the highest from anywhere in the Great Lakes basin.

In 1985, two species of native mussel were collected at various sites along the St. Lawrence River, including sites in the Cornwall-Massena stretch. The highest concentration of PCBs occurred in mussels collected at the mouth of the Grasse River, and these mussels contained a number of additional types of PCBs compared with mussels from further upstream, indicating a local source of PCBs in the Cornwall-Massena area.

When native mussels in the Cornwall-Massena area were surveyed in 1988, PCBs were highest in mussels from New York waters and undetectable in mussels from Canadian waters. For example, mussels collected from the mouth of the Grasse River contained 700 nanograms of PCBs per gram of tissue (wet weight) whereas mussels collected from Cornwall Canal contained no detectable PCBs.

3.3 Causes of the PCB problem

The main sources of PCBs in the area of concern are three industrial sites near Massena, NY: ALCOA, General Motors Foundry and Reynolds Metals Co. They discharge wastewater containing PCBs directly to the St. Lawrence River or its tributaries and PCBs are suspected to be leaching from hazardous waste and landfill sites located on these industrial properties.

According to estimates by New York State's Department of Environmental Conservation, total annual (1989) discharges of PCBs by these three industries were: 12.45 kg/year from ALCOA, 1.16 kg/year from Reynolds Metals Co. and 0.02 kg/year from General Motors. These estimates include permitted discharges only. Runoff from the industrial sites and groundwater draining into the St. Lawrence River are not included although these amounts are likely significant.

The US Environmental Protection Agency and the State of New York have declared ALCOA, GM and Reynolds Metals Co. as Superfund sites designated for contaminant cleanup. All three industries have been required to conduct remedial investigations and propose measures for cleaning up their industrial sites and contaminated sediment in the St. Lawrence, Grasse and Raquette Rivers. This will include dredging, which has the potential to resuspend PCB-contaminated sediment that could then be swept downstream and deposited in Canadian waters. Canadian review and input has been invited for each of the Massena Superfund projects and a Canadian Review Panel is providing comments to the US via diplomatic channels.

In Canada, the manufacture and use of PCBs was banned in 1978. There are no known sources of PCBs on the Canadian side of the river, although in the past relatively small amounts of PCBs were discharged by Domtar (20 to 58 g/day in 1979) and the Cornwall sewage treatment plant (1 to 9 g/day in 1979; 5.5 mg/day in 1987). PCBs have been undetectable in more recent monitoring of these discharges but it is possible that Cornwall industrial and municipal effluent could contain trace amounts of PCBs at concentrations too low to detect.

Since the PCB ban, most PCB-containing equipment in the Cornwall area has been removed from service and placed in storage facilities. There are 6 such storage facilities in Cornwall, which are regulated by law and regularly inspected by Ontario Ministry of Environment & Energy staff.

PCBs also enter the St. Lawrence River from sources upstream of Cornwall (*i.e.*, Lake

Ontario), and PCBs may come into the area of concern in atmospheric deposits.

3.4 General approaches for addressing the problem

PCB contamination in the area of concern is an international problem. Although Canada and New York State are developing two separate RAPs for the Cornwall-Massena stretch of the St. Lawrence River, there is an ongoing exchange of information between the two RAPs. The Cornwall RAP can make recommendations to New York State and the US Environmental Protection Agency regarding their plans for cleaning up sediment on the American side of the river and a Canadian Review Panel is providing comments on proposed cleanup activities via diplomatic channels.

A number of the preferred options presented in Chapter 9 address the problem of contaminated sediment in both the US and Canada.

4. ENVIRONMENTAL ISSUE: Presence of Other Contaminants

The Cornwall-Massena section of the St. Lawrence River contains many other persistent, toxic contaminants in addition to mercury and PCBs. Some are discharged by local industries and others enter the St. Lawrence River in water from Lake Ontario.

This chapter deals with contaminants besides mercury and PCBs that have been found in the area of concern at concentrations higher than recommended guidelines. These include phenolics, oils and greases, dioxins and furans, polynuclear aromatic hydrocarbons (PAHs), zinc, lead, chromium and copper.

4.1 Environmental and health effects of persistent toxic contaminants

Persistent, toxic contaminants fall into two main groups: *organic compounds* and *metals*. The term "organic" is used in reference to compounds that contain carbon, because all living things are made of substances that contain carbon. Metals such as lead and zinc are called inorganic because they contain no carbon.

Even though they contain the basic building block of all life (carbon) organic compounds are not all harmless by any means. Some mushrooms, for instance, produce extremely poisonous organic compounds, as do many plants. Humans have created thousands of new organic chemicals for various purposes, sometimes with harmful environmental consequences. For example, certain toxic organic chemicals are useful for controlling insect pests. However, some pesticides such as DDT have turned out to be an environmental hazard. DDT is persistent (it takes a very long time to degrade or break down to a harmless chemical form) in the environment, bioaccumulates in the food chain, and has adverse effects on non-target organisms such as birds.

Environmental and human health effects of some of the main chemical contaminants in the Great Lakes-St. Lawrence basin are summarized in Appendix III for reference.

4.2 The problems and their causes

Phenolics and fish tainting

The Cornwall section of the St. Lawrence River was originally identified as an area of concern partly because a study in 1964 indicated that water from this part of the river imparted a taint or off-taste to the flesh of several types of fish including perch and walleye. Tainting occurred over a distance of at least 20 km downstream of Cornwall. Because the tainted flavour was similar to the odour of Domtar effluent, it was inferred that Domtar's discharges were responsible for the problem.

The subsequent installation of an effluent diffuser by Domtar in 1971 and shutdown of the sulphite mill and construction of a clarifier in 1972 helped reduce the size of the zone affected by tainting substances. In 1979, it was determined that certain phenols, resin acids

and sulphur compounds were potential tainting agents in Domtar effluent, and a study carried out in 1983 showed that Domtar effluent could cause tainting at concentrations of 0.25-0.40%.

It is not clear whether tainting is still a problem. A 1988 survey of 800 anglers on Lake St. Francis failed to find a significant number who thought fish flavour was tainted. Controlled taste tests of fish caught upstream and downstream of the Domtar diffuser in 1990 provided inconclusive results. However, since Domtar effluent had been demonstrated to cause fish tainting at certain concentrations, the pattern of effluent dispersion in the river was studied in order to map the concentration of Domtar effluent. This information was used to delineate the zone of potential fish tainting shown in Figure 9.

Oils and greases

Oils and greases consist of a variety of chemical compounds, some of which may be toxic, and thick deposits of oil and grease can harm or kill organisms that live in bottom sediment. In 1985, oils and greases exceeded Ontario's guideline for open water disposal of dredged material (1500 μg of oils and greases per gram of sediment) in 74% of sediment samples collected from the north shore and 33% of samples from the south shore of the St. Lawrence River in the area of Cornwall and Massena.

Concentrations of oils and greases were especially high at three areas along the north shore: (1) an area extending from the Domtar/ICI/Cornwall Chemicals diffuser to St. Regis Island; (2) just downstream of Courtaulds/BCL; and (3) in front of Universal Terminals at Cornwall Harbour. The highest concentration of oils and greases (1700 μg/g) was found in the area just downstream of Courtaulds, where metal concentrations were also very high and where the benthic (bottom-dwelling) community was degraded.

Sediment samples collected in front of Universal Terminals at the Cornwall waterfront contained an average of 300 μg of oils and greases per gram of sediment in 1985. Species richness (the number of different types of species) was poor in the sediment at this site and only pollution-tolerant species were common. The sediment was soaked with oil and tar, which would likely restrict bottom-dwelling animals to the upper layers of sediment where some oxygen would be available to them. More recent samples collected in 1993 from the area in front of Universal Terminals contained oils and greases at concentrations ranging from 180 to 6000 μg per gram of sediment.

The oil and grease deposits along the Cornwall waterfront have been described as thick, heavy and black, which means they may consist of heavy fuel oil known as Bunker C. In contrast, the kinds of oils and greases that are present at low concentrations in effluent from local industries and the Cornwall sewage treatment plant are light enough to remain afloat and would in time be broken down by bacteria. The source of the heavy oil and grease deposits is unknown; they may have come from historical spills of ship fuel.

A 1985 survey revealed that concentrations of zinc, lead, copper, chromium, nickel, arsenic and cadmium were higher than the Provincial Sediment Quality Guidelines *lowest effect level* at a number of sites around the area of concern. Only one site had sediment metal concentrations higher than the *severe effect level* (the concentration detrimental to the majority of benthic species). This was at the Courtaulds Fibres/Courtaulds Films discharger, where zinc, lead and copper were all present in the sediment at concentrations higher than the severe effect level.

In addition, concentrations of zinc and lead were higher in the effluent of Courtaulds Fibres than in their intake water, and the Provincial Water Quality Objective for zinc (20 μg of zinc per litre) was exceeded in 32% of water samples taken near the discharge. In 1988, suspended solids in Courtaulds' plant effluents were found to contain high concentrations of zinc, lead and copper. It was therefore concluded that Courtaulds Fibres/Courtaulds Films (now closed) was likely the source of metal contamination observed in the sediment near its discharges.

Zinc

Before it closed in November 1992, Courtaulds Fibres was the main source of zinc in the area of concern. Zinc improves the quality of rayon fibres and is therefore an integral component of the rayon-making process. It was a principal constituent of Courtaulds' liquid waste. Before it closed, Courtaulds Fibres discharged approximately 300 kilograms of zinc per day into the St. Lawrence River making it one of the highest dischargers of zinc in the Great Lakes basin.

Other Cornwall industries and the Cornwall Water Pollution Control Plant (sewage treatment plant) discharge measurable but acceptable amounts of zinc. In the period from January to June 1990, Cornwall industries discharged, on average, the following amounts of zinc: Domtar 5.7 kg/day; Cornwall WPCP 1.6 kg/day; Cornwall Chemicals 0.86 kg/day; ICI Forest Products 0.42 kg/day; and Stanchem 0.005 kg/day.

Lead

Courtaulds Fibres (closed 1992) was also the main source of lead in the area of concern. Because it is acid-resistant, lead was extensively used in the plant for lining tanks and piping that handled the large quantities of sulphuric acid required to manufacture rayon. Corrosion caused some lead to leave with the effluents (an average of 1.58 kg/day in 1990). Before it closed in November 1992, Courtaulds Fibres had replaced most of its lead piping and tank linings with plastic products.

Monitoring data collected from January to June 1990 indicates that none of the other industrial or municipal facilities in Cornwall are significant sources of lead.

Lead contamination is a problem for waterfowl in various parts of the Great Lakes basin because lead can be lethal to waterfowl. The main source of lead poisoning is probably the ingestion of lead shot discharged from shotguns rather than uptake of industrially or

municipally discharged lead. Almost 5% of mallard ducks sampled in the autumn in Lake St. Francis during the early 1980s had ingested lead shot. In the United States, an incidence greater than 5% triggers the establishment of a steel shot zone. There is likely mortality of Lake St. Francis waterfowl due to lead poisoning, although it has not been quantified.

Copper

In 1985, copper was found in sediment at the Courtaulds discharger at concentrations above the severe effect level. The source of the copper is unknown — it could come from corrosion of piping used in houses and industry.

Chromium, nickel, arsenic and cadmium

Stainless steel tanks and piping used in many industrial applications contain chromium, which is used to make the steel. Corrosion of this equipment can result in discharges of chromium by industrial or municipal facilities. Monitoring data from January to July 1990 showed that Cornwall industries and the Cornwall sewage treatment plant did not have significant concentrations of chromium in their effluent.

Concentrations of arsenic, cadmium, chromium and nickel were highest in sediment near or downstream of the Courtaulds outfall in 1985. However, the spatial distribution of these metals within the area of concern indicated no major local sources. These particular metals probably come from sources upstream in the Great Lakes.

4.3 General approaches for addressing the problem

The problems described in this chapter require approaches similar to those for mercury and PCBs. Contaminant inputs to the ecosystem must be reduced or stopped at their source, followed by remediation of severely contaminated areas of sediment if necessary. We invite you to carefully review the options for reducing or eliminating contamination by mercury, PCBs and other contaminants that are discussed in Chapter 9.

5. ENVIRONMENTAL ISSUE: Bacterial (Fecal) Contamination

Excessive amounts of fecal coliform bacteria in water of the Cornwall-Massena section of the St. Lawrence River contributed to the decision that this area of the Great Lakes basin required a Remedial Action Plan. Fecal contamination of water has resulted in periodic beach closings and has the potential to affect drinking water obtained from private intake pipes along the St. Lawrence River.

5.1 Health risks associated with bacteria in water

Bacteria are part of our natural environment and most types are beneficial. However, certain bacteria can cause serious human health problems or are associated with other types of microorganisms that cause disease.

Escherischia coli, a type of *fecal coliform bacteria*, is found in water only when it has been contaminated with animal feces. *E. coli* can therefore be used as an indicator — a warning that the water contains waste from humans or other animals. In fact, Ontario's government guidelines for drinking water and water at public beaches are based on the number of *E. coli* found in 100 millilitres of water.

Water that is contaminated with fecal matter (and therefore contains *E. coli*) is a human health concern because in addition to harmful bacteria, fecal matter may contain pathogenic organisms that cause serious illnesses such as typhoid, cholera or dysentery.

In the St. Lawrence area of concern, water is used for recreational activities as well as for drinking. If people swim or bathe in areas where fecal coliform densities are higher than 100 organisms per 100 mL of water, there is a risk of contracting diseases of the gastro-intestinal tract, eyes, ears, nose or throat. To protect human health, beaches are closed ("posted") when more than 100 *E. coli* are present in 100 millilitres of water from the swimming area.

Drinking water is considered unsafe if *any E. coli* are found in 100 millilitres of water, or when total coliform densities exceed 5 organisms per 100 millilitres of drinking water. Again, this is because the presence of *E. coli* indicates that the drinking water contains fecal matter which may contain harmful bacteria or other pathogenic organisms that can cause typhoid, cholera, dysentery or other ailments. Since animal droppings are always present in our environment, all water from lakes, ponds, rivers and streams must be considered unsafe to drink without some form of treatment.

5.2 Sources of bacteria

Bacteria in the Cornwall-Massena section of the St. Lawrence River come from a variety of sources such as municipal sewage systems (in Cornwall, Glen Walter, St. Regis and Massena), industrial wastewater discharges, faulty private septic systems, runoff from farming operations, and the droppings of birds and domestic pets.

Municipal sewage systems

Certain features of municipal sewage systems result in periodic discharges of untreated sewage, when volumes of flow are very high such as during periods of heavy rainfall or rapid snowmelt. In an ideal world, a sewer system would contain only sewage. In reality, sewage systems often contain large volumes of stormwater runoff (from rain and melted snow) as well as sewage.

The older sections of municipal sewer systems are built so that stormwater runoff drains into the same pipes that receive sewage water. These *combined sewers* take both domestic wastewater and surface runoff to the sewage treatment plant. Even where sewers are not combined, water other than sewage can get into the system from various sources — ground water seeps into leaky sewer pipes and stormwater (rainwater and snowmelt) gets into the sewer system via connections of roof drains and sump pumps to sewer pipes.

As a result, during periods of heavy rain or rapid snowmelt, the volume of water entering the sewage system greatly increases and sometimes exceeds the capacity of the system. Then water pressure can build up to such an extent that sewage backs up in sewer pipes or sub-stations equipped to pump sewage are in danger of being washed out. Sewage systems are designed to take this into account — when the volume of sewage gets too large a valve opens, rerouting excess volumes of sewage away from the system. This is called an *overflow* and results in discharges of raw, untreated sewage to the St. Lawrence River. In the case of combined sewers, the discharges are called *combined sewer overflows* or *CSOs*.

Similarly, when the volume of sewage arriving at a sewage treatment plant exceeds the plant's capacity to treat it, some of the sewage is rerouted around the facility. This is called *bypassing* and results in discharges of untreated or only partially treated (chlorinated) sewage to the river.

Ideally, storm and ground water should be kept out of sewers so that these releases of untreated sewage do not occur. A number of measures can be taken to decrease the frequency of bypassing and overflows. These are discussed in Chapter 9 of this report.

Stormwater can itself be highly contaminated. Domestic animal droppings are a significant source of bacterial contamination of surface runoff water in urban areas, and in some situations where birds congregate in large numbers around bodies of water, their droppings can be significant sources of surface water contamination. Unfortunately it is difficult and expensive to treat all stormwater runoff because of the huge volumes involved. Many innovative treatment methods are now showing some promise for effectively dealing with contaminated stormwater runoff, however.

Surface runoff from agricultural lands

Fecal contaminants also reach the St. Lawrence River in surface runoff from agricultural lands. Pathogenic (disease causing) bacteria or other microorganisms come from manure

piles located immediately beside waterways, milkhouse wash water that is allowed to mix with groundwater or surface water, and livestock that wade in waterways draining into the St. Lawrence. These sources contribute significantly to the problem of bacteria and other fecal contaminants in the St. Lawrence River near Cornwall.

5.3 Extent of the problem

From the Thousand Islands to Cornwall, the St. Lawrence River was contaminated with fecal coliform bacteria in some places as early as 1913. The bacteria originated in sewage discharged from boats and from communities along the river. Although fecal coliform densities are now typically low out in the mainstream water of the St. Lawrence, beaches in Lake St. Francis have been closed sporadically since the 1970s because of bacterial contamination. Localized contamination by bacteria and other fecal contaminants is a potential health hazard for residents who take their drinking water directly from the St. Lawrence River through their own private intake pipes.

Surveys in the 1970s and 80s revealed high densities of fecal coliform bacteria in the St. Lawrence River at the mouth of the Raisin River near South Lancaster, downstream of Courtaulds Fibres/Courtaulds Films, and downstream of the Domtar Fine Papers discharge. Bacterial contamination at the mouth of the Raisin River was attributed to agricultural runoff and faulty private septic systems. The bacteria near Courtaulds was attributed to stormwater runoff and combined sewer overflows.

The high levels of coliform bacteria associated with Domtar's effluent turned out to be *Klebsiella*. This is a type of coliform bacteria associated with pulp and paper mill discharges. A review of the problem led to the conclusion that *Klebsiella* in the environment is not a human health concern.

Stormwater runoff and sewage overflows and bypasses are potential sources of fecal contaminants from the City of Cornwall. Cornwall's Water Pollution Control Plant (WPCP) is a primary treatment plant — solids in the sewage are removed in a large settling chamber called a clarifier and the clarified effluent is chlorinated to reduce bacteria to acceptable levels before discharge to the river. The storage capacity of the Cornwall WPCP was increased in 1988, reducing the number of bypasses to the river. As well, combined sewer overflows at Pitt St. and Amelia St. were stopped, which further reduced inputs of fecal contaminants to the Cornwall waterfront. The City of Cornwall is now working with the Ontario Ministry of Environment & Energy and Environment Canada on a Water Pollution Control Plan — a comprehensive, integrated plan for dealing with sewage and stormwater in the City.

The Eastern Ontario Health Unit regularly monitors water quality at four beaches along the St. Lawrence River from Cornwall to the eastern border of Ontario. Charlottenburgh Park (now closed for economic reasons), Camerons Point, Lancaster Park and Lancaster Wharf are sampled weekly during the summer. In 1986, Charlottenburgh Park was closed because of bacterial contamination and it was closed again for the same reason from June

30 to August 2 in 1989. No beaches were closed in 1990, 1991 or 1992. In the Quebec portion of Lake St. Francis, no public beach closures have been reported since the Quebec environment ministry (MENVIQ) began monitoring beaches in 1984.

In 1990 and 1991, the Raisin Region Conservation Authority studied the problem of surface water quality in the vicinity of shoreline beaches in the Raisin Region. Background levels of fecal coliform in the St. Lawrence River were typically less than 10 organisms/100 mL of water, well below the Provincial Recreation Water Quality Guideline of 100 organisms/100 mL.

High fecal coliform densities were found at a number of locations in the Raisin River watershed. Fecal contamination in the nearshore area between Summerstown and Pilon Point and further downstream at South Lancaster near Lancaster wharf was attributed to faulty residential septic systems. Fecal contamination observed at the mouths of the Raisin River and Finney Creek near South Lancaster is the result of agricultural runoff from lands drained by these tributaries.

The Conservation Authority study concluded that a program should be implemented to reduce bacterial and phosphorus loadings into Finney Creek and the Raisin River. It also recommended that sewage disposal systems in Lancaster and Glengarry Parks be studied in order to determine their impact, if any, on beach water quality. These recommendations are being carried out and funded through the Clean Up Rural Beaches (CURB) program, with an emphasis on improving agricultural land management practices that adversely affect water quality.

The Cornwall RAP is proposing a number of options that will reduce fecal contamination of water in the St. Lawrence River and its tributaries. These are discussed in Chapter 9.

6. ENVIRONMENTAL ISSUE: Excessive Growth of Nuisance Aquatic Plants

Plants are a key part of the aquatic ecosystem, providing habitat and food for waterfowl, fish and other aquatic organisms, and influencing patterns of water flow and sediment deposition. At some places in the St. Lawrence area of concern, however, aquatic plant growth has become a nuisance and is far greater than the amount needed to sustain a healthy ecosystem. Prolific plant growth in Lake St. Francis hinders boating, fishing, swimming and other river recreation in late summer and aesthetically degrades the area. Blooms (periodic excessive growths) of algae have the potential to cause taste and odour problems in drinking water.

6.1 The problem

Thick growths of aquatic vegetation, including algae, occupy much of Lake St. Francis during the summer. Submerged, rooted plants such as tapegrass and Eurasian milfoil make boat access to marinas and shoreline residences increasingly difficult as the season progresses; dense plant beds and excessive growth of algae makes swimming unpleasant or impossible in some areas.

Plant masses occasionally break off and form thick, floating mats that accumulate near the shore. These have at times filled all or part of a bay with a weed mass over a hectare in area and up to a metre thick. As decaying plants and algae accumulate, they restrict water flow and the water around them becomes warm and stagnant. These conditions encourage bacteria to multiply, which aggravates the problem of bacteria and other fecal contaminants entering Lake St. Francis from agricultural sources and faulty septic systems. Proliferation of these pathogenic organisms is a health risk for swimmers, and rotting plant masses have an unpleasant odour.

In 1989, algae tainted the drinking water at Cornwall's Water Treatment Plant, which takes its water from the river upstream of Cornwall. This sort of impact could occur at municipal and private water intakes downstream in Lake St. Francis during periods of prolific algal growth.

6.2 Reasons for excessive plant growth

Excessive plant growth in Lake St. Francis is mainly due to the drastic changes in river flow imposed by construction of the Beauharnois Dam in the 1800s and the St. Lawrence Seaway in the 1950s. With the construction of the dam, lands were flooded and the river at Lake St. Francis became much shallower, wider and slower-flowing. Construction of the Seaway further changed flow patterns in Lake St. Francis by directing water down a deep, central navigation channel and reducing flow in nearshore areas.

These changes created conditions that encourage plant growth, namely greater light penetration, warmer water and increased deposition of nutrient-rich sediment. Nutrients released to the water from the flooded lands started a process of nutrient enrichment and

increased plant growth. Eurasian milfoil, a non-native (exotic) species of plant which was invading many southern Ontario water bodies during the 1960s, became established in Lake St. Francis. By 1973, it had become a dominant part of the ecosystem and was one of the two most abundant plant species in Lake St. Francis, along with a native aquatic plant called tape grass or ribbon grass. Milfoil plants are loosely rooted in the sediment and neighbouring plants are joined by an underground stem called a rhizome. Floating, broken pieces of milfoil can take root and grow in new areas, and thick beds of milfoil tend to crowd out other species of aquatic plants.

Almost three decades ago, nutrient enrichment was recognized as a serious problem in the Great Lakes basin, particularly Lake Erie. The nutrient phosphorus acts as a plant food that stimulates plant growth, and unnaturally high inputs of phosphorus to water can cause an overproduction of plant life in a process known as *eutrophication*.

When Lake Erie showed signs of eutrophication (fish kills and excessive plant growth) in the 1960s and 70s, the Canadian and US governments adopted phosphorus control as the primary method of reversing or preventing this process. Phosphorus removal from municipal and industrial discharges and the introduction of low-phosphate detergents have significantly reduced inputs of phosphorus to all of the Great Lakes since the early 1970s. In response, phosphorus concentrations in Lake Ontario water entering the St. Lawrence River at Wolfe Island, Kingston have declined since the mid-1970s, as shown in Figure 10.

Ontario government guidelines state that a total phosphorus concentration below 0.03 mg/L is necessary in order to avoid excessive plant growth in rivers and streams. The guidelines are slightly different for lakes: 0.02 mg/L for the avoidance of nuisance algae and 0.01 mg/L to protect against aesthetic deterioration. Although Lake St. Francis is part of the St. Lawrence River it has many of the same characteristics as a lake, yet its phosphorus content exceeds the guidelines for lakes, with concentrations rarely below 0.01 mg/L in 1988.

Nutrients (phosphorus and nitrogen) enter the St. Lawrence River in water from Lake Ontario and from point and non-point sources in the Cornwall-Massena area (*i.e.*, from specific discharge pipes and from general surface runoff). Point sources include sewage treatment plants at Cornwall, Glen Walter, Massena and St. Regis, and industrial wastewater discharges in Cornwall and Massena. Non-point sources of nutrients include urban runoff, erosion and rural surface runoff. The nutrients in rural runoff come from fertilizers, improperly handled manure and milkhouse wash water, waste from livestock that wade in rivers and streams, and faulty shoreline septic systems.

The *Great Lakes Water Quality Agreement* calls for all sewage treatment plants in the Great Lakes basin with a capacity of 1 million gallons or more to limit the phosphorus content of their discharge to a maximum of 1 mg/L. Ontario interprets this phosphorus removal requirement as applying to sewage treatment plants in the St. Lawrence River as well as the Great Lakes. New York State interprets it as applying only to sewage treatment plants in the Great Lakes themselves and not to any plants downstream of Lake Ontario. Hence,

New York State sets no guideline for phosphorus discharges from its sewage treatment plants discharging to the St. Lawrence River and does not monitor phosphorus in effluent from those plants.

The Cornwall Water Pollution Control Plant removes some of the phosphorus from its effluent, which meets the current total phosphorus requirement of 1 mg/L for effluent discharged by plants treating over 1 million gallons per day of sewage. The Glen Walter sewage treatment plant treats much less water and does not currently require phosphorus removal.

Inputs from rural non-point sources mean that nutrient concentrations are generally higher at the mouth of tributaries draining agricultural lands. Although tributary flows are low compared to the main river and therefore contribute a relatively small amount of nutrients to the river as a whole, local impacts (increased growth of algae and submerged, rooted plants) can be observed at tributary mouths. The impacts of increased nutrient levels where tributaries such as Finney Creek, Gunn Woods Creek, Sutherland Creek and the Raisin River discharge into the St. Lawrence River can be decreased by reducing phosphorus inputs to these waterways.

Rooted aquatic plants (aquatic macrophytes) obtain their nutrients from the sediment through their roots. Since the St. Lawrence Seaway was built there has been so much phosphorus available in the sediment of Lake St. Francis that the growth of rooted plants is limited only by the amount of available space, not by the amount of available phosphorus. For this reason, reducing the phosphorus content in the water (by reducing phosphorus inputs to Lake St. Francis) will have no effect on the growth of rooted plants in Lake St. Francis.

Algae, on the other hand, are aquatic plants that have no roots or stems and absorb their nutrients from the surrounding water. Reducing phosphorus inputs to the water of Lake St. Francis could help to reduce the growth of algae in this part of the St. Lawrence River.

A number of measures can be taken to control plant growth in Lake St. Francis. These are discussed in the final chapter of this report.

Figure unavailable at time of printing.

Figure 10. Total phosphorus loadings in St. Lawrence River water at Wolfe Island, Lake Ontario (1977-1985).

7. ENVIRONMENTAL ISSUE: Habitat Destruction and Degradation

Destruction and degradation of fish and wildlife habitat in the St. Lawrence area of concern occurs in three main ways: wetland degradation or loss; physical alteration, disruption and destruction of aquatic habitat; and shoreline erosion along the St. Lawrence River and its tributaries.

5.1 Wetlands

Over three-quarters of the wetlands in southern Ontario south of the Canadian Shield have been lost since European settlement began, but it is only in the last decade that resource management agencies and environmental groups have started to focus on protecting wetlands. Once thought of as useless land, wetlands are now recognized as important ecological components of ecosystems, providing food and habitat for a wide variety of animals, maintaining and improving water quality, aiding in flood control, and protecting shorelines from erosion.

Present-day wetland management consists of three main elements: evaluation, protection and restoration. In Ontario, wetlands are classified using an evaluation system that takes into account four groups of wetland *values* or *functions* — biological, socioeconomic, hydrological and special features. All of the values have been assigned numeric scores so that they can be used to rate and classify wetlands into one of seven classes.

Efforts to protect wetland areas are related to wetland classifications. Class 1, 2 and 3 wetlands are designated *provincially significant wetlands* that should be protected in official plans, zoning by-laws and other development decisions, according to Ontario's Wetlands Policy Statement of 1992. However, because application of the Policy is left to the discretion of individual municipalities, even provincially significant wetlands are not entirely free from development pressures.

The third main component of wetland management, in addition to evaluation and protection, is restoration. This is the creation of new wetland habitats using a variety of techniques as described in Chapter 9.

Location of wetlands in the area of concern

Only two major wetland complexes remain in Ontario waters of the St. Lawrence area of concern. These are the marshes at Bainsville Bay and Charlottenburgh — provincially significant wetlands that are threatened by various development pressures.

Other important wetland habitats in the Ontario portion of the area of concern include aquatic plant beds such as those located along the Lancaster Bar. Although these aren't classified as wetlands, they provide significant staging habitat for a variety of migrating waterfowl. Lake St. Francis is a major staging area for waterfowl in the Atlantic flyway. The largest of the Lake St. Francis wetlands lie along the south shore, in and adjacent to

lands of the Mohawks of Akwesasne. They have not been formally evaluated but are significant wetland habitats.

In addition, there are a number of inland wetlands in the watersheds draining into the Cornwall-Massena section of the St. Lawrence River, ranging in size from several hectares (one hectare equals approximately two and a half acres) to several hundred hectares and from the highest (Class 1) to the lowest (Class 7) value.

Causes of wetland destruction

Wetland destruction occurs as either direct loss or degradation. Direct loss results from development that eliminates wetland habitat; degradation results from changes that reduce the wetland values of an area even though the area may still meet the definition of a wetland.

Wetlands are lost when they are filled in or dredged for residential, industrial, recreational or agricultural purposes. The major threat to the Bainsville Bay and Charlottenburgh marshes is development for recreational and permanent housing. Wetlands further inland from the St. Lawrence River are under pressure from agricultural drainage and development interests, permanent housing developments and, in some cases, industrial development.

There are many ways that wetlands are degraded without a loss of overall area. The construction and maintenance of roads, pipelines and hydro transmission corridors has fragmented wetland habitats, increased human disturbances and altered vegetation communities, water levels and water movement in wetlands. Construction and maintenance of agricultural drains has substantially altered the natural hydrology of inland wetlands by reducing seasonal water levels, which reduces flood retention capability, water quality, and habitat and species diversity.

The wetlands in Lake St. Francis have been most severely damaged by alterations in the natural hydraulic cycle of the St. Lawrence River brought about by construction of the Beauharnois Dam and the St. Lawrence Seaway. Lake St. Francis was changed from a flowing river habitat with seasonally fluctuating water levels into a reservoir with stable water levels.

The Beauharnois Dam impounded Lake St. Francis, reducing the magnitude and frequency of water level fluctuations. The St. Lawrence Seaway further dampened natural water level fluctuations by changing flow patterns in Lake St. Francis — construction of the navigation channel diverted water away from nearshore areas, forcing more flow down the shipping channel in the middle of the river.

Velocities and flows in Lake St. Francis still vary to some extent, but water levels are controlled within a range of ± 30 cm. In its natural state, the St. Lawrence River would have flooded substantially during late spring, water levels would have receded over the

summer, increased slightly during the fall and declined substantially over the winter. This regime recharged and refreshed wetlands, maintaining habitat diversity. In the absence of changing water levels, the wetlands of Lake St. Francis have become extensive monocultures of cattails with very little open water. The reduction in habitat diversity has severely reduced wetland values, particularly for fish and wildlife species.

Increased flow in the navigation channel and reduced flow in nearshore areas have contributed to the establishment of dense beds of submerged aquatic plants in much of Lake St. Francis, a problem discussed in detail in Chapter 6. The extent of offshore bulrush beds, which provide valuable habitat for yellow perch and waterfowl, may have been reduced as a result of increased competition from submerged plants and wave wash effects from Seaway traffic.

In summary, the extent and quality of wetlands in the area of concern has been greatly reduced, beginning with construction of the St. Lawrence Seaway and the Beauharnois Dam. Residential, commercial and industrial development continue to degrade and destroy the few wetland areas that remain, pushing waterfowl, fish and other animals out of the area in the process.

5.2 Physical alteration, destruction or disruption of aquatic habitats

Although fish and wildlife habitat is affected by a wide range of factors, this section focuses only on physical aspects such as shelter, substrates (bottom surfaces), depths and currents. The effects of contaminated water and sediment on fish and wildlife are extensively discussed in earlier chapters.

Seaway and dam construction

Aquatic habitats in the St. Lawrence area of concern have been physically altered in two main ways: by Seaway and dam construction and by a variety of smaller scale development pressures. Extensive channel modification during Seaway construction altered the natural locations of substrates. Dredging (deepening) to build the navigation channel eliminated many of the in-river reefs and shoals that had provided good fish habitat and it allowed more of the flow to move down the centre of the river, reducing velocities in the nearshore areas. This in turn allowed more sediment deposition to occur in these areas and submerged aquatic plant beds developed which further reduced flow in the nearshore area.

River habitats are by nature more diverse and more biologically productive (more plants and animals live there) than lake environments. The diversity of habitats was reduced when Lake St. Francis was impounded, mainly at the expense of shallow-water riffle areas (where water flows quickly over rocks) and wetlands. On the plus side, the nearshore, quiescent habitats have been enhanced.

While the full impact of large-scale modifications to the river may not be realized for a century, it is apparent that the system is moving towards some degree of stability 30 years

after the last major project. From an ecosystem point of view, most of the major disruption and adjustment associated with Seaway and dam construction has occurred, although dredging activities continue in order to maintain the navigation channel.

Residential, commercial and industrial development

The second type of physical habitat alteration is more insidious, more incremental and still occurring. Small scale dredging, filling and other habitat modifications are driven by a variety of development pressures. Landowners along the waterfront and on inland streams put constant pressure on the nearshore (littoral) zone by straightening shorelines, removing rocks and logs, removing aquatic plants, deepening the area next to shore or filling it in, removing shoreline terrestrial vegetation, channelizing small streams, placing new developments on undeveloped shoreline and by failing to recognize that many of the things they value about Lake St. Francis are jeopardized by their actions.

Inland streams provide important habitat for fish and wildlife, but they have been physically altered by humans. Agricultural land use practices and channel modifications for flood control have increased erosion and sedimentation and destroyed or degraded river bank (riparian) habitats.

5.3 Shoreline erosion

Erosion occurs naturally in all aquatic systems but is more pronounced in rivers. Uncontrolled, natural rivers erode during peak discharge periods and the river slowly carves a natural channel for itself. Over geologic periods of time, this generally results in the upper reaches of a river containing little sediment and the lower reaches or deltas being rich in sediment deposits.

The St. Lawrence River no longer has a natural erosion-deposition cycle because peak flows and water levels have been attenuated by means of control structures. Because it has been impounded, the river now has a series of sediment traps such as Lake St. Francis along its length. Although there were substantial changes in erosion patterns associated with Seaway construction, none of these were adequately documented.

Present-day erosion problems are confined to four main places in the area of concern: inland tributaries, shorelines adjacent to shipping channels, the shoreline of Pointe Mouillee adjacent to Bainsville Bay and shorelines in the Cornwall Island-St. Regis section of the north channel.

A variety of human activities cause erosion in tributaries. Channel modifications associated with drainage projects increase erosion, as does the loss of floodplain storage (including wetlands). Removal of vegetation along tributary banks and in the floodplain due to development or agricultural practices increases erosion of tributary banks. Hardening of shorelines (by construction of concrete retaining walls, for example) increases the downstream energy of the river or stream, promoting erosion.

Erosion affects aquatic habitats in tributaries by increasing siltation on fish spawning beds and deposits of eroded material reduce water velocities, especially during low flow periods. All of the tributaries to Lake St. Francis share these problems, and there is an overall impact on the fish community because the tributaries are key spawning and nursery habitats for many of the fish species in Lake St. Francis.

The shorelines adjacent to the shipping channel are also being eroded, due to increased wave action associated with freighter traffic. Erosion problems have been identified and corrected on Hamilton, Stanley, Clark, Renshaw and Jacobs Islands to date. This issue is being addressed by Transport Canada, which has implemented a multi-year shoreline protection program that involves placing continuous stone barriers along the affected areas.

The third area affected by erosion is the Bainsville Bay-Pointe Mouillee area. This provincially significant wetland complex and key fish production area covers about four kilometres of shoreline on Lake St. Francis just west of the Ontario-Quebec border. The area has a long point (Pointe Mouillee) extending into the lake, which creates a shallow, protected and relatively productive (lots of plants and animals live there) bay to the east. Pointe Mouillee is eroding along its face at a rate of 3 metres per year. The cause of the erosion has been identified as normal wave wash from wind and storm generated waves.

Erosion of Pointe Mouillee is threatening a privately held wetland that provides habitat for waterfowl, and the eroded material is being deposited as an underwater sandbar across the mouth of Bainsville Bay. As the sandbar grows, it increasingly restricts flow in the Bay and the resulting excess of submerged aquatic plants is reducing the quality of yellow perch habitat in Bainsville Bay.

The fourth affected area is the Cornwall Island-St. Regis Island section of the north channel. Shorelines here are not adjacent to the shipping channel, yet they show signs of continuing erosion. It may be related to the channel modifications associated with Seaway construction but this has not been confirmed.

In addition, many small areas of the shoreline have erosion problems associated with recreational and residential developments. Erosion occurs when landowners destabilize the shoreline by removing vegetation or by changing the micro flow patterns along the shoreline through construction of docks or boathouses. Shoreline protection works have been undertaken in many of these areas and the magnitude of the problem is gradually being reduced.

5.4 Conclusion

The St. Lawrence River is one of the great rivers of the world, yet it is often taken for granted, even though many thousands of people, birds, and aquatic animals depend upon it. The ecosystem in the St. Lawrence River area of concern is as severely affected by habitat destruction and degradation as it is by discharges of toxic contaminants to the river. Every portion of habitat that disappears takes with it numerous plants and animals and disrupts

the balance of life in the ecosystem.

There are many options for preventing, controlling or in some cases even reversing habitat loss. These are discussed in the final chapter of this report.

8. ENVIRONMENTAL ISSUE: Exotic Species Invasions

Exotic species are plants or animals that have been accidentally or intentionally introduced to an area they did not previously inhabit. They often cause problems as they become established, disrupting ecosystems by competing with or replacing native species.

Once introduced, an exotic species usually spreads rapidly in a population explosion brought about by a lack of natural predators and diseases. Eventually the ecosystem structure changes to accommodate the new species. Removal of an exotic species from a system as large as the Great Lakes basin or the St. Lawrence River is impossible — since the 1800s over 130 exotic plants and animals have settled in the Great Lakes basin.

8.1 The problem

A number of exotic species live in the Cornwall-Massena section of the St. Lawrence River. These include exotic mussels (zebra and quagga mussels), the wetland plant purple loosestrife and the aquatic plant Eurasian milfoil. Pacific salmon were intentionally introduced into Lake Ontario for sport fishing and have now moved downstream into parts of the St. Lawrence River. The common carp was intentionally introduced in North America in the 1800s. The river ruffe, an accidentally introduced European fish, now inhabits Lake Superior and may well spread through the Great Lakes basin into the St. Lawrence River.

The exotic species of most concern to the Cornwall RAP are zebra mussels (*Dreissena polymorpha*), a new exotic mussel the quagga mussel (*Dreissena sp.*) and purple loosestrife (*Lythrum salicaria*). Other species such as Eurasian milfoil and carp are firmly established and have become integrated into the aquatic ecosystem. Pacific salmon do not threaten the river ecosystem in the Cornwall-Lake St. Francis area, although they could pose a threat to Atlantic salmon stocks on the East coast.

Zebra mussels

It is believed that zebra mussels entered the Great Lakes in ballast water discharged to Lake St. Clair by a European ship. These small, striped clam-like mussels were first discovered in the Great Lakes basin in 1988. They can live for as long as five years, grow up to 5 cm (2 inches) long and each female can produce tens of thousands of eggs. Their ability to travel attached to boat hulls, their high fertility and movement of the larvae (veligers) on water currents have helped zebra mussels to spread rapidly throughout the Great Lakes basin. Figure 11 depicts the life cycle of zebra mussels.

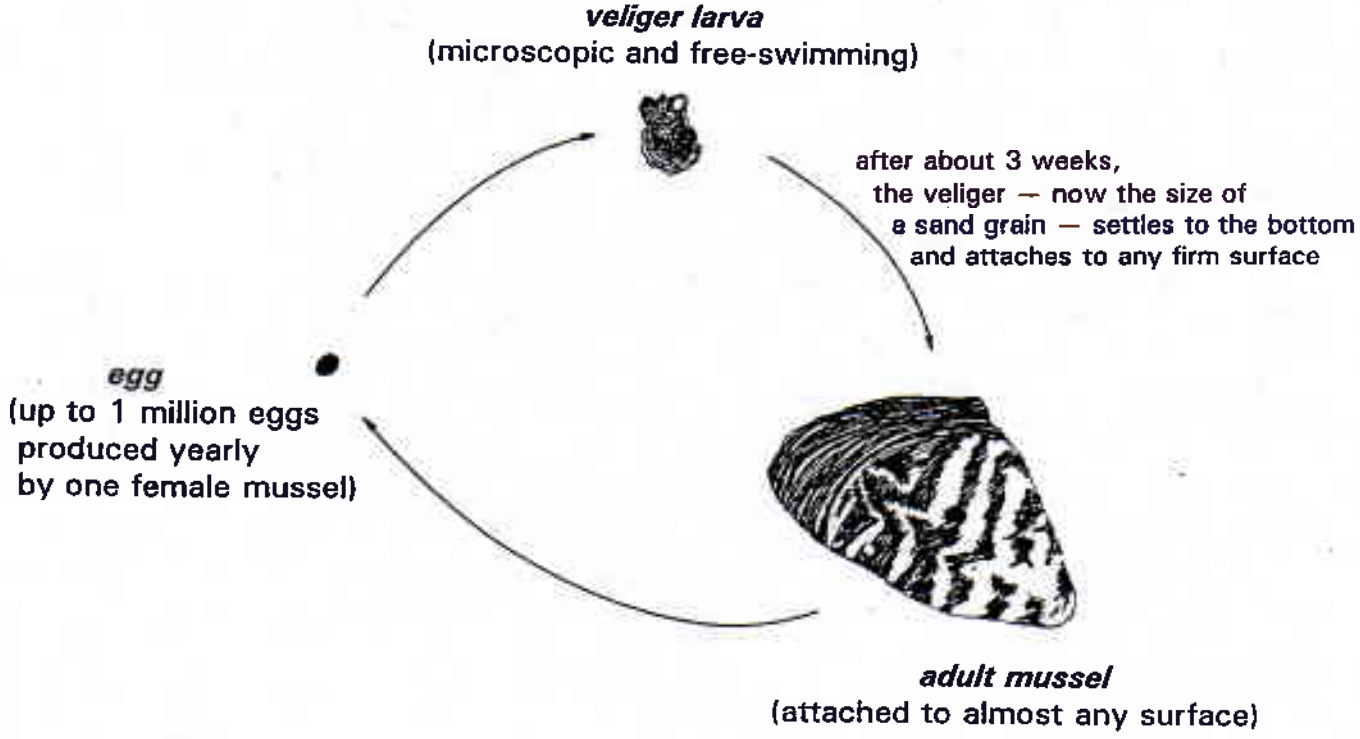


Figure 11. Life cycle of a zebra mussel.

Zebra mussels will likely invade smaller inland lakes and rivers; they have already been seen in the Ottawa River and as far south as Tennessee. Because adult zebra mussels attach to boat hulls and can survive for several days out of water, recreational boaters unknowingly transport them to new watercourses. Time-consuming boat maintenance is required to prevent or control the spread of zebra mussels.

These small mussels have the potential to profoundly alter the structure of aquatic ecosystems. Because of their great numbers, they can filter huge volumes of water, consuming substantial amounts of algae in the process. Zooplankton, tiny aquatic animals that feed on algae, can be greatly reduced in number because there is less algae to eat, and this in turn may affect young fish that feed on zooplankton. Increased clarity of nearshore waters that have been filtered by zebra mussels may cause light-sensitive fish such as walleye to move to deeper, non-traditional feeding grounds. Zebra mussels can ruin spawning shoals for sport fish by covering substrates suitable for spawning.

As well as threatening Great Lakes fisheries, zebra mussels are an expensive nuisance because they attach themselves to solid surfaces and can build up colonies several layers thick, clogging industrial and municipal intake pipes. The removal of mussels and prevention of further buildup on intake pipes is estimated to have cost hundreds of millions of dollars in Lake Erie alone. This tendency to cover solid surfaces such as boat hulls and docks means greater maintenance costs for boaters and shoreline property owners. Zebra mussels also have sharp edges that can cut the feet of people walking in swimming areas.

Zebra mussels were first reported in the Cornwall-Massena section of the St. Lawrence River in 1989. In 1990 they were found only at Cornwall and Prescott but by 1991 they had spread throughout the St. Lawrence River in the area of concern. A new exotic species of mussel, the quagga mussel, has also been collected from the area of concern.

Purple loosestrife

Purple loosestrife is an attractive wetland plant that has invaded wetlands along much of the Great Lakes shoreline, making it less favourable for waterfowl and replacing native plant species. Low-lying, marshy areas carpeted with purple are a common sight where purple loosestrife crowds out native species of wetland plants. The plant has been invading wetlands in North America since the 1800s, when it was introduced from Europe. Since then it has spread across the continent from the Atlantic regions to British Columbia, Washington, and Oregon, and from southern Manitoba to the northern reaches of the Mississippi basin.

Each purple loosestrife plant has a tremendous capacity to reproduce, producing as many as 50 stems and 2 million seeds in a season. Its dense root mat crowds out native plant species and traps sediment, accelerating the natural tendency of wetlands to slowly evolve into dry land ecosystems. The overall effect of purple loosestrife colonization is a decrease in the variety of plants and animals — as different types of food and habitat disappear, the

structure of the ecosystem gradually changes.

Once established, purple loosestrife is almost impossible to eradicate. Cutting or mowing stimulates new shoots to grow from the base of the plant, and pulling up large numbers of plants creates ideal conditions for colonization by more loosestrife, because it tends to invade disturbed sites rather than areas in which the soil and native vegetation are undisturbed.

Although the distribution of purple loosestrife in the area of concern has not been surveyed, the plant has been noted in all of the wetlands along the north shore of Lake St. Francis. It is not a dominant component of these areas now, and there are no data on how quickly it is spreading, but it is expected to become more abundant and methods of controlling its spread are being examined.

Other exotic species in the area of concern

Other exotic species in the area of concern have either become a part of the aquatic system (milfoil, carp), have not yet arrived (river ruffe) or do not present a problem (Pacific salmon) in the area of concern. Eurasian milfoil is a problem in Lake St. Francis; excessive growth of milfoil and other nuisance aquatic plants is discussed at length in Chapter 6.

Some of the proposed remedial options for dealing with exotic species (Chapter 9) are broad actions that apply to all exotic species whereas other options are designed to control zebra mussels or purple loosestrife specifically.

(Options marked *** were still under review at time of printing.)

9. PROPOSED REMEDIAL OPTIONS

The Cornwall RAP Team and Public Advisory Committee (PAC) propose the following seventy-nine options as a plan for combatting the environmental problems outlined in the first section of this report. A range of approaches is discussed with an explanation of why some options were preferred over others.

The options are arranged in five main groups: general recommendations, pollution abatement measures, options to control the growth of nuisance aquatic plants, options for preserving or improving habitat in the area of concern and options for controlling the spread of exotic species.

In order for the Cornwall RAP to properly reflect the needs of communities in the area of concern, we need input from members of the public who did not sit on the PAC. We invite you to examine these options and their alternatives carefully and tell us whether or not you agree with our choices and why. Public responses to this report and input from upcoming public meetings and openhouses will help the Cornwall RAP make a final decision on the most appropriate set of remedial options for the Cornwall-Massena section of the St. Lawrence River.

9.1 General Recommendations

Some of the issues affecting the St. Lawrence area of concern are broad-based environmental concerns that can only be addressed by taking action to correct the problem throughout the Great Lakes-St. Lawrence basin. For example, many persistent toxic contaminants enter the St. Lawrence River from sources outside the Cornwall-Massena area and measures need to be taken to control or eliminate these inputs at their source. The Cornwall RAP therefore proposes the following general options for addressing basin-wide environmental issues.

 # 1 Ask the federal and provincial governments to show more tangible evidence of their commitment to the goal of virtual elimination of persistent toxic contaminants by using their legislative authorities to ban the use of mercury and production of persistent toxic compounds like dioxins and furans.

The governments of Canada and the United States have agreed (as set out in the *Great Lakes Water Quality Agreement*) to adopt a policy of virtual elimination of inputs of persistent toxic substances to the environment. The *Agreement* states that "the philosophy adopted for control of inputs of persistent toxic substances shall be zero discharge".

The government of Canada has reaffirmed this policy by adopting virtual elimination as a national goal in its Green Plan, a six year funding initiative launched at the end of 1990. The provincial government of Ontario has established a Municipal-Industrial Strategy for Abatement (MISA) program, the purpose of which is to regulate discharges of persistent toxic substances and conventional pollutants in effluent to the point where they are

virtually eliminated from the environment.

The two levels of government should implement concrete actions that will show evidence of their commitment to the goal of virtual elimination and zero discharge of persistent toxic substances such as mercury, dioxins and furans.

 # 2 Recommend that parties to the Great Lakes Water Quality Agreement develop and implement a policy regarding long-range transport of airborne mercury and PCBs into the area of concern.

Mercury and PCBs enter the St. Lawrence area of concern in atmospheric depositions from worldwide sources, as well as in local industrial and municipal discharges. The issue of long-range transport of airborne pollutants (LRTAP) into the St. Lawrence area of concern can be dealt with only at the level of international negotiations.

 # 3 Recommend that the governments of New York State, Ontario, the United States and Canada develop and implement the Niagara River and Lake Ontario Toxics Management Plans and the Lakewide Management Plans and recommend that these plans call for elimination of the production, use and release of mercury, mirex and other persistent toxic substances like dioxins and furans.

Development and implementation of these plans would reduce inputs of contaminants to the area of concern from upstream sources. An estimated 85.5 grams of mercury, for example, now enters the St. Lawrence River daily from upstream sources.

These Management Plans represent an international effort to reduce concentrations of persistent, toxic contaminants in the Niagara River and each of the Great Lakes. Under the terms of the *Great Lakes Water Quality Agreement*, Canada and the United States are legally obliged to develop and implement a Lakewide Management Plan (LAMP) for each of the Great Lakes.

The Niagara River Toxics Management Plan Declaration of Intent was signed by the governments of Canada, the US, Ontario and New York State on February 4, 1987 and includes a commitment to develop a Lake Ontario Toxics Management Plan. The Niagara River Toxics Management Plan commits the four governments to achieve, by 1996, a 50 percent reduction in loadings of ten priority persistent toxic chemicals from point and non-point source discharges.

The Lake Ontario Toxics Management Plan calls for the development of load reduction targets by 1994, with the long-term goal of making the water and fish of Lake Ontario safe for unlimited human consumption and suitable for natural reproduction of the most sensitive native species of fish.

 # 4 Recommend that legislation be enacted to protect wetlands (to the same extent, for example, that fish habitat is protected).

Ontario's Provincial Wetlands Policy Statement of 1992 is not legally binding and therefore provides inadequate protection for wetlands. Whereas fish habitat is protected by law under the federal *Fisheries Act*, no legislation protects wetlands. The Wetlands Policy merely asks municipalities and planning boards to "have regard to" the Policy Statement in their planning decisions.

The Cornwall RAP therefore recommends that legislation be enacted (*i.e.*, a Wetlands Act) to protect wetlands to the same extent, for example, that the federal *Fisheries Act* protects fish habitat.

 # 5 ***Establish federal and provincial regulations banning the manufacture and sale of all detergents containing phosphates.***

In the 1960s and 70s, the Canadian and US governments adopted phosphorus control as the primary way of reversing the process of eutrophication, which was causing fish kills and excessive growth of plants in Lake Erie. Low-phosphate detergents were introduced and phosphorus discharges from industries and sewage treatment plants were reduced.

These phosphorus control measures were effective. Since the mid-1970s there has been a significant decrease in phosphorus concentration in water leaving the Great Lakes (near Kingston, where Lake Ontario empties into the St. Lawrence River).

Human inputs of phosphorus to the Great Lakes should be reduced further by banning the manufacture and sale of all detergents containing phosphates. This will reduce phosphorus inputs from rural residences on private septic systems and in urban areas sewage treatment plants will more easily be able to reach their phosphorus discharge limit. Phosphate-free detergents are already available in supermarkets.

9.2 Overcoming the River's Pollution Problems

Earlier chapters of this report describe the wide range of pollutants affecting the St. Lawrence River at Cornwall. Toxic contaminants, fecal contaminants and nutrients such as phosphorus generally come from industrial, municipal or rural sources. Toxic contaminants can also come from areas of contaminated sediment that may be releasing toxic substances to the food chain or the water column.

Options for overcoming the river's pollution problems are presented here in four groups, based on where the pollution comes from rather than which pollution issue the option addresses. In many cases, a single option will effectively reduce or eliminate more than one type of pollutant at once. Appendix I lists the environmental issues each option addresses.

Industrial pollution sources

Pollutants from industrial sources in the area of concern include mercury, PCBs, other contaminants (*e.g.*, PAHs, phenolics, dioxins and furans, oils and greases, metals), bacteria,

and nutrients such as phosphorus. The main industrial sources of pollution in the Cornwall area are Cornwall Chemicals, Domtar Fine Papers Inc., ICI Forest Products and Stanchem. Courtaulds Fibres in Cornwall has been closed since November 1992. The major industries in the area of Massena, NY are ALCOA, General Motors Foundry and Reynolds Metals Co.

 # 6 Require ICI Forest Products to replace its mercury cell chlor-alkali process with a mercury-free process.

This is the only way to completely eliminate mercury discharges from ICI Forest Products. ICI estimates that it would cost them $40 million to convert their plant to a membrane cell process that does not require mercury. ICI's Cornwall operation is the only chlor-alkali plant in Ontario still using the mercury-cell process.

The option of converting to a new process was favoured over the following options that would reduce, but not eliminate, mercury discharges from ICI:
(a) Rely on federal government chlor-alkali regulations or Ontario's MISA program to control mercury discharges. This option leaves the decision up to somebody else rather than taking a proactive approach to the problem in Cornwall.
(b) Stay with the mercury cell process but change certain in-plant processes to reduce mercury discharges to 15 g/day from the 22 grams now discharged daily. This would cost ICI an estimated $25,000 plus an unknown amount to upgrade the plant's effluent treatment capability, and sludge disposal costs would increase. This option does nothing to address ICI's significant atmospheric discharges of mercury (190 g/day emitted from ventilation stacks in 1991).
(c) Use evaporation and distillation to reduce the mercury in ICI's liquid effluent to 2-3 g/day. This would generate an increased amount of sludge that would require disposal as a hazardous waste. ICI's atmospheric discharges of mercury would not be addressed by this action.
(d) Retrofit ventilation system with emission controls. This could remove 99% of the mercury in ICI's air emissions. The cost is unknown but it is estimated at around $2-3 million. This action would be taken in conjunction with either (b) or (c), above.

After much consideration, the option to eliminate mercury from ICI's chlor-alkali process was preferred over all others. It would eliminate both liquid and atmospheric discharges of mercury and it takes into account the federal government's intention of gradually phasing out industrial uses of mercury in the Great Lakes basin.

*# 7 *** Apply BATEA to new ICI Forest Products process to control discharges of persistent, toxic contaminants.*

In order to control potential discharges of persistent toxic contaminants, the best available technology economically achievable (BATEA) should be applied to any new mercury-free process used by ICI Forest Products.

 # 8 Upgrade wastewater treatment at Domtar to secondary treatment with phosphorus removal to 1 mg/L through implementation of MISA.

Ontario's Municipal-Industrial Strategy for Abatement (MISA) is a regulatory program of the Ministry of Environment & Energy. Its ultimate goal is virtual elimination of toxic contaminants from municipal and industrial discharges to Ontario's waterways. MISA consists of two phases: intensive monitoring of effluent quality over a twelve month period, followed by implementation of specific recommendations for using the best available technology economically feasible (BATEA) to improve effluent quality.

The effluent of all Ontario pulp and paper mills was monitored in 1990 and it is likely that new Federal Pulp and Paper Regulations will require Domtar (Cornwall) to provide secondary treatment of its effluent. Further improvements may be required when MISA regulations are passed.

The initial cost of upgrading to secondary treatment would be about $60 million, with annual operating costs of about $6 million. Secondary treatment will remove about 90% of oxygen-demanding organic contaminants with the suspended solids. It will remove 50-98% of phenolic compounds in the effluent and reduce mercury discharges by about one-half.

With phosphorus removal, secondary treatment will produce effluent containing one milligram of phosphorus per litre. Domtar currently discharges phosphorus at a concentration of approximately 2.5 milligrams per litre (1989-90 MISA data).

 # 9 Install state-of-the-art technologies at Domtar that reduce or concentrate effluent.

The long term goal of zero discharge of toxic contaminants can be achieved by implementing this option. Chlorine can be eliminated from the process by means of extended delignification with oxygen-bleaching. Eventually, the application of emerging state-of-the-art technologies such as ozone/peroxide/hydrosulphite bleaching could eliminate chlorine, reduce non-persistent contaminants by 95% and reduce persistent contaminants by 98%. Ozone bleaching facilities would cost approximately $130 million.

*# 10 *** Identify sources of PAHs in Domtar effluent and take steps to control or eliminate them.*

MISA monitoring in 1990 revealed that the effluent from Domtar's Cornwall plant contained higher levels of PAHs than any other pulp and paper mill in Ontario. Domtar frequently reports small oil spills and leaks; these likely contain PAHs. It should be possible to reduce PAH discharges by instituting better housekeeping practices in the Domtar plant once the sources of PAHs have been identified.

 # 11 Upgrade wastewater treatment at Cornwall Chemicals to secondary treatment with phosphorus removal to 1 mg/L through implementation of MISA.

Cornwall Chemicals discharges about 3 grams of mercury per day as well as carbon tetrachloride (11.361 kg/day in 1989/90) and chloroform (0.056 kg/day in 1989/90). The plant manufactures carbon tetrachloride, a chemical used mainly in the production of chlorofluorocarbons (CFCs), which are being phased out in Canada and many other countries.

MISA will require Cornwall Chemicals to install secondary wastewater treatment, which will involve steam stripping, possibly done in conjunction with carbon filtration. Steam stripping takes out volatiles such as carbon tetrachloride and chloroform, which are then condensed and recycled. Secondary treatment will remove about 90% of oxygen-demanding organic contaminants with the suspended solids. It will remove 50-98% of phenolic compounds in the effluent and reduce mercury discharges by about one-half. The capital cost to Cornwall Chemicals is estimated at $1.5 million to install a secondary treatment facility.

An alternative option is for Cornwall Chemicals to totally eliminate its liquid effluent by evaporation. While this approach would be effective for removing mercury, it has been rejected by the RAP Team and the PAC because carbon tetrachloride and chloroform are volatile organic compounds, some of which would be released to the air during evaporation.

 # 12 Change process materials at Cornwall Chemicals to reduce amount of mercury in effluent.

Mercury in the effluent of Cornwall Chemicals comes from mercury contaminated caustic used to neutralize effluent, and from ICI brine used to regenerate water softener for the boilers. The plant will soon be switching to uncontaminated brine, which will reduce mercury discharges by about two-thirds. It should also switch to mercury-free caustic.

 # 13 Track decommissioning of Courtaulds Fibres via participation of RAP Team through MOEE and public consultation with PAC.

Courtaulds Fibres closed its Cornwall operation in November 1992. Although all discharges of effluent have been stopped, the site likely has some residual contamination. Decommissioning must follow a set procedure overseen by the Ontario Ministry of Environment and Energy. Decommissioning of the Courtaulds site began in 1993 and is expected to take about two years.

*# 14 *** Recommend that current and all future industries in the area of concern operate plants to achieve a compliance limit of 1 mg/L total phosphorus and an objective of 0.5 mg/L.*

Two types of nuisance plant growths occur in Lake St. Francis. The rooted type is not controllable by pollution abatement measures. These plants receive their nourishment from the abundant supply of nutrients stored in Lake St. Francis sediment.

The second type of plant growth is algae. These microscopic plants obtain their nourishment by extracting nutrients from the water. Some algae are free-floating and when abundant can impart an undesirable taste and odour to drinking water. Others form long, flowing strands that attach to and get tangled in rooted aquatic plants. When this happens they take on a slimy and unattractive appearance. Since algae abundance in Lake St. Francis is controlled by the amount of phosphorus in the water, measures to reduce the discharge of phosphorus from industrial and municipal sources will reduce this nuisance plant growth problem.

A consistent maximum phosphorus concentration of 1 mg/L should be set for effluent from all current and future industries in the area of concern.

 # 15 Encourage, through education, the use of phosphate-free cleaning agents at commercial establishments and light industries in the area of concern.

It is not practical to remove phosphorus by treating discharges from light industries and commercial establishments in the area of concern. However, phosphorus use can be reduced. Phosphate-free cleaning agents are available and offer an environmentally friendly alternative to super-phosphates.

Contaminated sediment

Areas of contaminated sediment in the US and Canadian portions of the St. Lawrence River can act as ongoing sources of pollution, releasing contaminants into the aquatic food chain or directly into the water itself. Although plans are under way to remediate some of the most severely contaminated US sediment, the cleanup activities have the potential to cause contamination of Canadian sediment further down the river. The following options address this concern as well as specifying procedures for dealing with contaminated sediment on the Canadian side of the river.

 # 16 Implement a Canada/US monitoring program to track site-specific and AOC-wide impacts of American sediment remediation efforts.

Sediment cleanup operations in the St. Lawrence River at the Reynolds Metals Co., GM and ALCOA sites will likely begin within the next year. Cleanup will include dredging (removal) of sediment, which can cause resuspension of contaminated sediment that may then be swept downstream and deposited in other parts of the area of concern. Because modelling of river flow patterns indicates that resuspended contaminants are likely to be deposited within the Canadian area of concern, cleanup activities on the US side of the river should be monitored carefully.

 # 17 Develop appropriate federal/provincial positions on remediation of the Reynolds Metals, ALCOA and GM sites by means of the Canadian Review Panel, which reviews the various cleanup plans for PCBs, PAHs, dioxins and furans.

This process is ongoing.

 # 18 As a last resort, take legal action in US courts regarding contaminated US sediment.

It is anticipated that Canadian concerns identified by the Canadian Review Panel will be dealt with. Should this not occur satisfactorily, the Canadian concerns should be pursued by other available means.

 # 19 For Canadian hot spots influenced by US remediation efforts, hold decision on Canadian cleanup until cleanup is completed on American side.

Areas of severely contaminated sediment ("hotspots") in Canadian waters may require remediation. However, if monitoring shows that US sediment remediation efforts are in fact introducing additional contaminants to Canadian hotspots, it would be premature to remove or treat any Canadian sediment before the US cleanup has been completed.

 # 20 In areas where contaminant levels in sediment are below the severe effect level but above the lowest effect level, implement source control measures to prevent further contamination of sediment and allow remediation of contaminated sediment to occur by means of burial by the natural sedimentation process.

Removal or treatment of moderately contaminated sediment is not justifiable in terms of cost and the potential for contaminated particles of sediment to be resuspended and transported downstream while sediment is being removed.

The Cornwall RAP therefore recommends that for sediment with contaminant concentrations below the severe effect level but above the lowest effect level, further contamination should be prevented by controlling or stopping contamination at its source. The sediment should be left in place so that it can gradually be buried by new, uncontaminated sediment once the source of contamination has been controlled.

 # 21 In areas where contaminant levels in sediment exceed the severe effect level for mercury, PCBs or other persistent toxic contaminants or where there is demonstrable toxicity (i.e., the "hot spots") prevent further contamination by implementing source control measures and remediate sediment by the most appropriate state-of-the-art technology (e.g., dredging, capping, in situ treatment).

In areas where sediment is severely contaminated, steps should be taken to control all sources of contamination and then the contaminated site should be assessed to determine whether sediment should be left alone to recover by natural sedimentation processes or whether some sort of remedial action should be taken. If contaminated sediment is constantly being eroded and moving downstream to contaminate new areas, the sediment should be removed or treated using the most appropriate state-of-the-art technology.

*# 22 *** If investigations in the vicinity of Universal Terminals reveal contamination of*

river sediment, remediation should be done in accordance with options C9 and C10.

Sampling of sediment at the Cornwall waterfront near Universal Terminals in the late 1980s and early 1990s indicated a problem of contamination with oils and greases, and metals including mercury. Additional samples taken in 1992 and 1993 have indicated that the degree and extent of contamination is not as severe as originally thought. Further studies are required to accurately assess whether or not there is a zone of severely contaminated sediment in this area.

Transport Canada, who owns the site, is working with Environment Canada's National Contaminated Sites Program to investigate remedial measures for both the land and the water portion of the Universal Terminals site. If a zone of severely contaminated sediment is found, the Cornwall RAP recommends that sediment remediation follow the procedure outlined in options 20 and 21.

Municipal pollution sources

Municipal areas contribute pollutants to the St. Lawrence River in effluent from sewage treatment plants and in stormwater runoff. Both of these sources may be contaminated with bacteria and other fecal contaminants, phosphorus and persistent toxic substances such as mercury.

There are two sewage treatment plants in the Canadian area of concern: the Cornwall Water Pollution Control Plant and the Glen Walter Pollution Control Plant. New York State has a number of sewage treatment plants discharging to the St. Lawrence River or its tributaries in or upstream of the St. Lawrence area of concern. The St. Regis Village Sewage Treatment Plant is located on lands of the Mohawks of Akwesasne.

 # 23 Upgrade Cornwall sewage treatment plant to secondary treatment.

The Cornwall sewage treatment plant discharges 2-5 grams of mercury per day and potentially discharges small amounts of PCBs (based on PCBs detected in its effluent in 1987). Phosphorus concentration in its effluent is in the order of 0.9 mg/L (1988). The plant currently provides primary treatment of sewage — solids are removed from the sewage in a large settling chamber called a clarifier and the clarified effluent is chlorinated to reduce bacteria to acceptable levels before discharge to the river.

Ontario's MISA program may require an upgrade to secondary treatment. In secondary treatment, solids in the sewage are not just allowed to settle out, but are treated by providing conditions that encourage bacterial decomposition of organic solid matter. Secondary treatment would reduce phosphorus discharges to 0.5 mg/L, cut the amount of mercury discharged by about one-half and increase the efficiency of removal of other toxic contaminants.

The cost of providing secondary treatment of sewage at the Cornwall sewage treatment

plant is estimated at $30 million capital cost and an annual operating cost of $3 million.

 # 24 ***Prevent mercury discharges into the sewer system (industries, dentists, pharmacies, laboratories, paint shops etc.) through public education and enforcement of sewer use by-laws.***

Mercury enters the municipal sewage system from dental offices, pharmacies, laboratories, paint shops and industry. These inputs can be reduced by informing workers of the environmental consequences of dumping mercury-containing substances down the drain, as well as by increasing the enforcement of sewer use by-laws.

 # 25 ***Implement an education program for the general public and industrial sectors where such a program does not exist, about the handling and disposal of hazardous wastes including spill prevention and cleanup.***

This program would emphasize the prevention of discharges of hazardous wastes into the sewer collection system and subsequently to the sewage treatment plant and the river.

 # 26 ***Find and eliminate the source of PCBs in spottail shiners collected from the Cornwall waterfront.***

There are no known PCB sources on the north shore of the St. Lawrence River in the area of concern — PCBs have almost always been undetectable in Cornwall industrial and municipal effluent. However, spottails collected from the Cornwall waterfront have contained PCBs and some PCBs were detected in the suspended solids of Cornwall industrial effluents in the late 1980s. Suspended solids in Cornwall industrial and municipal effluent should be monitored for PCBs in order to determine where the PCBs in the spottail shiners are coming from. Secondary treatment of industrial and municipal effluents would reduce PCB discharges if they exist, but additional steps may be required to eliminate PCB discharges if a local PCB source is found.

 # 27 ***Track development of the City of Cornwall's Pollution Control Planning Study (PCPS) and ensure that the outcome of the study is an action plan that will eliminate the City's sewer systems as sources of pollution.***

The Cornwall RAP identified a number of potential options that would overcome pollution problems associated with the City of Cornwall's sewer systems. The RAP is recommending that evaluation of these options be deferred to the City of Cornwall Pollution Control Planning Study, a comprehensive study currently in progress. A PCPS is the best means for evaluating ways of dealing with sewer system problems.

The main concern is that stormwater inputs periodically overload the sewer system, causing overflows that result in releases of raw, untreated sewage to the river. This sewage can contain bacteria and phosphorus from domestic wastewater plus persistent, toxic contaminants and phosphorus from stormwater. These problems can be addressed through

options such as separating sanitary and storm sewers where they are now combined, instituting a street sweeping program to reduce contaminant levels in surface runoff entering storm sewers, or storing and treating stormwater from combined sewers, for example.

The Cornwall RAP proposes to monitor the development of the PCPS to ensure that it addresses the RAP's concerns.

 # 28 Encourage careful use of water by implementing a volume-based water pricing system.

 # 29 Require new dwellings to use water-saving devices such as low volume toilets and shower heads and institute a program of retrofitting old houses for water conservation.

 # 30 Establish a public education program about ways of conserving water and the environmental and economic benefits of using less water.

Water conservation is an effective way to avoid the high costs (hence, taxes) associated with trying to treat ever-increasing volumes of sewage at the Cornwall Water Pollution Control Plant. Less water used means less sewage entering the system and reaching the sewage treatment plant. As a result the sewage plant is less likely to be overloaded, so sewage bypasses to the river occur less frequently. Water pricing has been shown to be a very cost-effective measure and is in place in a number of cities and towns in Ontario.

 # 31 Recommend that the City of Cornwall modify the snow dump site to contain surface runoff, and that they undertake a feasibility study to find a more acceptable long term solution to the problem.

Meltwater from the Cornwall snowdump site at the foot of Brookdale Avenue runs directly into the St. Lawrence River. Snow from city streets is likely to contain hydrocarbons, mercury and other metals, as well as salt, and the snow dump site could be considered a problem from an aesthetic point of view. The site should therefore be bermed or otherwise modified to minimize runoff while investigating the feasibility of using an alternate location for dumping snow.

 # 32 Request that in its Official Plan, the City of Cornwall delineate zones of coal tar contamination and define development constraints for those zones and that a Notice on Title be registered for all of the affected properties.

Historical coal tar deposits between the Water Street arena and parking lot and at 7th and Cumberland Streets are benign as long as they remain undisturbed. Activities that would result in movement of the deposits should therefore be restricted. This can be achieved by defining development constraints on these lands in the City of Cornwall's Official Plan and by ensuring that future owners of the affected properties are made aware of the problem by a notice placed on the title of the property (a Notice on Title).

 # 33 Upgrade Glen Walter sewage treatment plant to achieve 1 mg/L total phosphorus.

In order to reduce the growth of algae in Lake St. Francis (see discussion of option # 14), the Cornwall RAP recommends that all municipal and industrial dischargers limit the phosphorus content of their effluent to a maximum of 1 mg/L.

 # 34 Recommend phosphorus removal to 1 mg/L at all wastewater treatment systems along the St. Lawrence River upstream of Cornwall.

The rationale for option # 34 is the same as for option # 33.

 # 35 Recommend that New York State install treatment facilities for phosphorus removal at its sewage treatment plants discharging into the St. Lawrence River and its tributaries.

The *Great Lakes Water Quality Agreement* (GLWQA) calls for all sewage treatment plants in the Great Lakes basin with a capacity of 1 million gallons or more to limit the phosphorus content of their effluent to a maximum of 1 mg/L. New York State interprets this as applying only to sewage treatment plants in the Great Lakes themselves and not to any plants downstream from Lake Ontario. The State therefore sets no guideline for phosphorus discharges from its sewage treatment plants discharging to the St. Lawrence River and does not monitor phosphorus in effluent from those plants.

Since the Cornwall and Massena RAPs are being carried out under the conditions of the GLWQA, it is reasonable to interpret the *Agreement* as applying to the St. Lawrence River as well as the Great Lakes proper. For this reason, the Cornwall RAP recommends that all sewage treatment plants draining into the St. Lawrence River in the area of concern and upstream to the outlet of Lake Ontario limit their phosphorus discharge to a maximum concentration of 1 mg/L and monitor their effluent to ensure compliance with this limit.

 # 36 Establish a public education program to encourage the use of phosphorus-free products.

This is a low-cost option that encourages individual environmental responsibility and will help to reduce localized effects (increased growth of algae) near phosphorus inputs. It is part of an overall effort to heighten general awareness and personal involvement in environmental improvement efforts.

Rural pollution sources

Pollution from rural areas enters the St. Lawrence River in surface runoff that gets into tributaries draining into the St. Lawrence. Surface runoff in agricultural areas contains bacteria and other fecal contaminants from livestock feces; nutrients such as phosphorus and nitrogen from fertilizers, livestock waste and faulty (leaking) septic systems; and pesticides. In Lake St. Francis, lead contamination is a problem for waterfowl that inadvertently consume lead shotgun pellets.

 # 37 Control stormwater discharges from municipalities other than Cornwall, particularly roads and communities along the Raisin and St. Lawrence Rivers, by collecting and treating stormwater.

Stormwater in built up areas can be highly contaminated with bacteria or other fecal contaminants, as well as phosphorus, from the droppings of birds and domestic pets. Inputs of these pollutants can be controlled by collecting and treating stormwater in communities along the Raisin and St. Lawrence Rivers.

 # 38 Install proper septic systems where land is sufficient and can meet existing regulations; carry out inspections to ensure compliance.

Faulty septic systems on private shoreline properties release nutrients (*e.g.*, phosphorus), fecal coliform bacteria and associated pathogenic microorganisms to the St. Lawrence River. Phosphorus stimulates plant growth and can cause algal blooms which have the potential to cause taste and odour problems in drinking water. Fecal microorganisms from faulty septic systems are a potential health risk for people who draw private drinking water from or swim in the St. Lawrence River.

 # 39 Where land is not sufficient, install holding tanks and institute municipal or other regulatory collection to the sewage treatment plant, with costs included in annual property tax assessments.

Some shoreline properties along the St. Lawrence River are not large enough to accommodate a septic system and may be discharging sewage directly to the river. These properties should be equipped with holding tanks for the short-term but eventually they should be connected to a municipal sewage collection and treatment system.

 # 40 As a long-term plan, install sewage treatment plants for river communities, including Summerstown, South Lancaster, Pilon and Cornwall Islands and Bainsville.

This option ties in with option # 39, which deals with the problem of shoreline properties that are too small to accommodate a septic system. It will also overcome the problem of septic systems that leak because they are poorly maintained.

 # 41 Educate the public about bacterial levels in private discharges of sewage.

If they fully understand the health risks involved, property owners are more likely to ensure that fecal matter and associated disease-causing organisms do not reach the St. Lawrence River or its tributaries in private discharges of sewage.

 # 42 Increase flow at beaches and other public swimming areas by removing breakwaters and harvesting weeds.

Increasing the flow at public swimming areas reduces bacterial contamination by

eliminating the warm, stagnant waters that provide ideal conditions for bacterial growth, as well as by creating conditions in which bacteria are washed out of the swimming area. Engineered flow alterations have improved water quality at beaches on the Rideau and Thames Rivers and in Toronto.

Because the removal of breakwaters may increase erosion and does not stop bacterial inputs to beach areas, the Cornwall RAP finds this option acceptable only if it occurs as a by-product of other options.

 # 43 Inspect park and campground sewage disposal systems and correct deficient systems.

At some beaches, fecal contaminants come from leaking sewage disposal systems located in a park or campground near the beach. The problem can be corrected by repairing these systems. The cost of implementing this option would be low to moderate and it would take some time to carry out inspections and make the necessary repairs.

 # 44 Encourage education and posting of signs at parks and campgrounds, regarding the importance of poop and scoop, personal hygiene at beaches, not feeding gulls, and proper garbage control and collection.

Beaches littered with garbage attract seagulls; droppings from pets and seagulls contain fecal contaminants and nutrients (phosphorus and nitrogen) that are transferred to swimming areas in stormwater runoff. This option is a low cost way to improve the quality of stormwater at beaches, which will improve water quality for swimming.

 # 45 Where feasible, collect and treat stormwater and discharge at downstream end of beach.

Stormwater containing nutrients and fecal contaminants can be effectively treated by means of a stormwater retention pond or wetland, with the treated water discharged downstream of the public beach. Site visits would be required to assess whether the construction of a retention pond or wetland is feasible at a particular beach area.

 # 46 Eliminate livestock access to surface waters by providing education and financial incentives to farmers and by enforcing existing regulations.

When livestock have direct access to surface water draining into the St. Lawrence River, they contaminate it with bacteria and other fecal microorganisms as well as nutrients such as phosphorus and nitrogen. These contaminants make their way to the St. Lawrence River and contribute to the problem of contaminated public and private swimming areas and excessive growth of plants and algae in tributaries and around their mouths.

The environmental effects of allowing livestock to wade in waterways should be made known and financial incentives provided to help farmers make alternative watering arrangements and build fences to block access to waterways.

 # 47 Inspect manure piles and milkhouse waste disposal systems which have the potential to be sources of surface water contamination, and correct by:

(1) providing education to farmers;
(2) providing financial incentives to farmers;
(3) enforcing existing regulations;
(4) incorporating into municipal zoning by-laws, the Agricultural Code of Practice regarding manure/milkhouse wastes;
(5) establishing a bioconversion facility for production of fertilizer from manure and other organic sludges pending feasibility study (to determine available manure supply, interest in participation etc.)

Nutrients and bacteria get into surface waters from manure piles located close to waterways and milkhouse wash water that is allowed to run directly into waterways via surface runoff or groundwater. The pollutants eventually drain into the St. Lawrence River. Contamination from these rural sources can be reduced using the combination of approaches specified by this option.

 # 48 Endorse the Farm Environmental Plan program described in Our Farm Environmental Agenda *as part of the development of an agricultural land stewardship program.*

In 1992, the Ontario Federation of Agriculture (OFA), the Christian Farmers Federation of Ontario (CFFO), AGCare (Agricultural Groups Concerned About Resources and the Environment) and the Ontario Farm Animal Council (OFAC) published a report called *Our Farm Environmental Agenda.*

Over 50 farming organizations participated in developing the report, which describes the factors that farmers see as the main environmental concerns in Ontario agriculture. The report proposes a farm-specific approach to solving these problems. The goal is to have each farmer in Ontario develop an environmental farm plan for their enterprise. The plan would identify key opportunities for environmental enhancement and define an implementation strategy.

This is a farmer-initiated approach to addressing environmental problems associated with running an agricultural operation. The Cornwall RAP recommends that the Farm Environmental Plan program be incorporated into the development of an agricultural land stewardship program.

 # 49 Regulate discharges of grey water from new boats.

An Ontario Ministry of the Environment study of "grey water" (household waste from sinks and showers) on pleasure boats in the late 1980s showed that it contains significant amounts of fecal and potentially pathogenic microorganisms as well as "conventional" pollutants (nutrients, solids, and oxygen-demanding substances). Measures should therefore be taken to control discharges of grey water from boats into waterways.

Since it is physically impossible to retrofit many older boats, this recommendation should apply only to new boats.

 # 50 Increase enforcement of existing regulation for discharge of black water.

"Black water" (toilet waste) on boats contains bacteria and other fecal contaminants and should never be discharged untreated into waterways. Enforcement of the existing regulation that prohibits the discharge into surface waters of sewage from pleasure boats should be stepped up. The Ontario Ministry of Environment & Energy is responsible for enforcement for pleasure craft; the federal Department of Transport is responsible for sea-going ships.

*# 51 *** Recommend that lead shot be banned from, at a minimum, Lake St. Francis and replaced by a non-toxic, non-bioaccumulating type of shot.*

As described in Chapter 7, ingestion of lead shot is lethal to waterfowl, and lead has been detected in 5% of Lake St. Francis waterfowl sampled. In the US, this percentage triggers the establishment of a steel shot zone. Steel shot has different ballistic properties than lead shot and there is a debate about whether the use of steel shot increases the frequency of waterfowl wounding. However, increased wounding rates observed in one study may have occurred because the hunters did not know they were using a different type of shot and were therefore unable to adjust their technique accordingly.

A bismuth alloy shot has been developed which has the favourable ballistic properties of lead shot but has been shown to be non-toxic to waterfowl. Bismuth shot is undergoing a formal environmental assessment in Canada. It has been tentatively approved by the Canadian Wildlife Service and may receive final approval by 1994.

9.3 Controlling the Growth of Nuisance Aquatic Plants

Pollution control options to reduce inputs of phosphorus to the St. Lawrence River will not help to control the growth of rooted aquatic plants, for reasons which are discussed in Chapter 6. Controlled physical removal of plants (under permit) is therefore the most effective way to control nuisance aquatic plants, as reflected in the following four options.

 # 52 Support managed mechanical harvesting as a continued option for controlling nuisance aquatic macrophytes in selected areas of Lake St. Francis.

The Lake St. Francis sediment in which aquatic plants such as milfoil and tapegrass are rooted will continue to provide enough phosphorus to support excessive plant growth, regardless of the phosphorus content in the water column. The most effective way to control plant growth is therefore to mechanically harvest aquatic plants in selected areas of Lake St. Francis.

Until 1992, the Raisin Region Conservation Authority managed the harvesting of about 80

hectares of weed beds each year. A harvesting machine (the Limnos Aquatic Plant Harvesting system) cut, ground and returned the plants to the river in the form of a slurry. This was an effective way of providing boating access points and channels.

A study to determine the effects on water quality of returning cut and ground plant material to the water showed that in flowing areas, water quality returned to background levels within 2 minutes or 50 metres downstream of the harvested area. Along shorelines and in low flow areas, or where tape grass is the main species harvested, the cut, grind and return method should include barging the slurry to deep water channels. When researchers investigated the ability of plant fragments to take root in the sediment, they found that no viable material was returned to the river in the slurry.

The RRCA has discontinued its harvesting program due to lack of funds. The program, which cost $50,000 to $100,000 annually, was very effective and should be reinstated in selected areas of Lake St. Francis.

 # 53 Prohibit the use of chemical herbicides by individuals to provide access lanes for boating adjacent to their shoreline.

Application of chemical herbicides to control aquatic plants does not work in flowing systems like the St. Lawrence River because the chemicals are rapidly diluted and moved downstream. Such unnecessary releases of toxic organic chemicals into the river should be prohibited.

 # 54 Continue to allow individuals to physically remove (under permit) a pre-determined and limited amount of aquatic vegetation from the water in front of their property.

Small scale physical removal (hand pulling) is an effective method for controlling nuisance aquatic plants. Individual property owners can obtain a permit from the Ontario Ministry of Natural Resources to remove and dispose of vegetation for this purpose as long as their actions will not destroy fish spawning beds.

 # 55 Mechanically harvest several hectares of Bainsville Bay to improve water circulation and flow in the Bay and increase dissolved oxygen levels.

This option ties in with options # 69 and # 73 as part of a three-pronged approach of the Point Mouillee-Bainsville Bay erosion control project. In order for this option to be effective over the long term, the basic reason for excessive plant growth in Bainsville Bay (*i.e.*, erosion of Pointe Mouillee and deposition of a sandbar in the mouth of the Bay) must first be addressed. Once measures have been taken to control the erosion (option # 73) and remove the sandbar, then aquatic plants in the Bay can be mechanically harvested to further improve water circulation and flow.

9.4 Controlling or Reversing Habitat Degradation and Destruction

The ecosystem in the St. Lawrence River area of concern is as seriously affected by habitat destruction and degradation as it is by discharges of toxic contaminants to the river. Each piece of habitat that disappears takes with it many plants and animals. Habitat destruction and degradation can be controlled or reversed by implementing the following options.

 # 56 As a first priority, acquire all wetlands on Lake St. Francis presently in private ownership.

This should be done as a first priority before carrying out option # 57, below. The three wetlands in question are Charlottenburgh, Bainsville and Wesley's. Charlottenburgh is now protected by public ownership and controlled by the Raisin Region Conservation Authority but Bainsville and Wesley's are unprotected. Acquisition of these wetlands would require willingness on the part of about ten property owners.

 # 57 After acquiring all private wetlands on Lake St. Francis, then secure all additional Class 1, 2 and 3 wetlands in the watershed.

Once the wetlands on Lake St. Francis have been protected through public ownership, action can be taken to acquire additional provincially significant (Class 1, 2 and 3) wetlands further inland in the watershed.

 # 58 Encourage municipalities to continue to implement the Provincial Wetlands Policy (June 1992) which requires all planning agencies to have regard for provincially significant wetlands in their planning decisions. The Policy prohibits development on Class 1, 2 and 3 wetlands.

Municipalities can now protect Class 1, 2 and 3 wetlands through Official Plan by-laws that reflect the Provincial Wetlands Policy. Municipalities should be encouraged to implement the Wetlands Policy by enforcing appropriate by-laws.

 # 59 Encourage municipalities to protect less significant wetlands (Class 4, 5, 6 & 7) by requesting that they include development constraints and buffer zones around these areas.

Wetlands that are not designated provincially significant should also be protected from eradication or encroachment by development. The Cornwall RAP should request that municipalities recognize the importance of all wetland areas and establish, in their Official Plans, development constraints and buffer zones around Class 4, 5, 6 and 7 wetlands.

 # 60 Increase public education regarding the value of wetlands, particularly those provincially significant wetlands in the watershed.

Historically, over 70 percent of the wetlands in Southern Ontario have been damaged or destroyed by dredging, draining or filling projects. These alterations have been made because wetlands have a perceived lack of societal value. Wetlands do have tangible societal

benefits though and they are a necessary component of a healthy aquatic ecosystem. Greater effort is necessary to communicate information on wetland values to the public and ensure that these values are recognized in the decision making process.

 # 61 Establish a joint Quebec/Ontario/Mohawks of Akwesasne committee to coordinate the protection and management of wetlands in Lake St. Francis.

There is a need for an overall stratgey for protecting and managing the wetlands of Lake St. Francis. IN order for this to happen, a joint committee representing all of the lake's political jurisdictions needs to be established.

 # 62 Continue to use existing legislation (including the federal Fisheries Act, Public Lands Act, Lakes and Rivers Improvement Act, Conservation Authorities Act and Environmental Protection Act) to protect aquatic habitats (including fish habitat and wetlands) where this legislation applies. Continue to require a minimum compensation of 1:1 (new habitat created : habitat altered) for fish habitat altered by development activities.

Using existing legislation, the Ontario Ministry of Natural Resources advises the Department of Fisheries and Oceans whether to accept or reject a development proposal and whether or not acceptance should include modifications of the proposal in order to protect fish habitat. The *Fisheries Act* requirement of a minimum 1:1 compensation of new habitat created:habitat altered refers not only to geographic area, but also to fish production. Fish production after development must equal fish production prior to development. Part of this option would be to ensure that new development proposals not only provide the appropriate habitat compensation but that, where appropriate, habitat enhancement is included in the development process.

 # 63 Change the existing provincial work permit system, to prevent any dredging or filling in any shoreline wetland unless that activity would directly enhance the function or value of the wetland.

Under existing legislation, physical alterations to the aquatic environment can be regulated to prevent damage to fish habitat. Existing legislation does not, however, afford comparable protection of wetlands. New or amended legislation would be required to provide this regulatory control.

 # 64 Develop and implement a program to identify the causes of wetland and aquatic habitat degradation in the area of concern, identify appropriate remedies and ensure their implementation.

This program would target issues such as drainage of wetlands, degradation of water quality in tributaries, and development activities along shorelines. Government agencies and non-government organizations would cooperate in a stewardship and education program that could tap into existing programs such as Land Stewardship and Clean Up Rural Beaches

(CURB) programs. Actions would include the reestablishment of wetland fringes along creeks and of fish habitat structure in creeks, erosion control, management of vegetation along creek banks, and other changes in land use practices.

 # 65 Restore and enhance wetlands by using, where appropriate and pending the EA and EARP processes, techniques such as controlled water level impoundments, construction of open water habitats (level ditching) and shoreline reconstruction.

Bainsville Bay and Charlottenburgh Marsh are the two key target areas for this activity. These actions would include works in existing wetlands as well as the establishment of new wetlands in appropriate locations.

 # 66 Through a combination of stewardship and education initiatives, encourage landowners to protect wetlands they own by means of conservation easements or management agreements. Encourage landowners to implement small enhancement projects (nesting boxes, habitat management) and to undertake wetland creation, especially in small headwater areas.

A substantial percentage of the wetlands in the area of concern are privately owned. It is possible, through a partnership involving land owners and resource agencies, to establish mutually beneficial management agreements for these wetlands.

 # 67 Develop an integrated planning approach for shoreline development based on resource management information which would be collected and managed in a collective GIS-based database. This would include information on fish & wildlife species in the affected area, habitat type and degree of expected alteration, impacts on nearshore water currents and potential erosion impacts, and potential impacts on water quality.

This is the first step necessary to establish an integrated approach to development planning along the shoreline. It would give agencies involved in decision-making access to a common pool of the most comprehensive information available.

 # 68 Inform municipalities, landowners and other agencies involved in shoreline development about fish and wildlife habitat concerns along the waterfront to ensure that these concerns are considered in the planning process.

This would include the development and application of a variety of environment-friendly development and construction techniques, the development of an education package (kit) and program to deliver, and a request to municipalities to support this activity through by-laws designed to protect key shoreline aquatic habitats.

 # 69 Restore shallow-water reef habitat by constructing artificial reefs at various locations including Bainsville Bay-Pointe Mouillee and the Cornwall waterfront, giving priority to areas closer to the power dam.

Habitat suitable for fish has disappeared or been greatly reduced in built-up areas of the St. Lawrence River such as the Cornwall waterfront. Habitat diversity can be restored by building a series of structures such as artificial reefs, embayments, wetlands and substrates along the shoreline. By reducing the impact of fast current in localized areas, these structures will help to create warmer, slow moving areas where vegetation and substrates appropriate for some of the fish species that used to inhabit the area (walleye, bass, perch, muskellunge and sturgeon) can be established.

An in-depth study done in 1992 concluded that a series of artificial reefs and islands could be used to control erosion and enhance fish habitat in Bainsville Bay as well as along Pointe Mouillee itself (this ties in with erosion control option # 73).

*# 70 ***Work with the Mohawks of Akwesasne to protect fish habitat and prevent shoreline degradation.*

Protection of Lake St. Francis fish habitat is a responsibility shared by several political jurisdictions. Negotiations between the Province of Ontario and the Mohawks of Akwesasne are in progress to establish a closer working relationship for the betterment of this shared resource.

Erosion control

 # 71 Using the present regulatory system, continue to permit small, privately-owned shoreline properties to be stabilized on a site-by-site basis (includes shorelines of Lake St. Francis and tributaries) using erosion control techniques such as rip-rapping, revegetation, natural revetments and construction of offshore wave barriers and reefs.

Small scale erosion along shorelines occurs when individual landowners remove vegetation and construct unstable slopes. Erosion in these areas causes localized sediment deposition which destroys fish habitat. Shorelines can be stabilized using a variety of techniques including rip-rapping (covering eroding shorelines with small boulder-sized rocks), revegetation of shorelines, revetments and construction of offshore wave barriers and reefs. Using a site-by-site approach, these actions will reduce erosion and protect or restore fish habitat in localized areas.

 # 72 For specific problem areas, design the appropriate stabilization technique and implement the work as a government initiative either with public funding only or on a cost-shared basis with the landowner.

Some of the erosion problems in Lake St. Francis are minor and can be easily overcome. In other areas, the problems are such that properly engineered solutions will require public funds.

 # 73 Design a shoreline stabilization project for Pointe Mouillee, based on the completed feasibility study, which incorporates the appropriate wetland and fish habitat protection

and enhancement measures.

A study to investigate the feasibility of habitat restoration and erosion control in the area of Pointe Mouillee-Bainsville Bay has been completed and is now being reviewed by various government agencies. Preliminary results indicate that construction of a series of artificial reefs and islands would be an effective way to control erosion and enhance habitat along Pointe Mouillee. This approach would control erosion without hardening the wetland shoreline, and would establish significant habitat diversity in an area that is currently a shifting sand plain created by ongoing erosion.

This remedial action would also help to restore fish habitat in Bainsville Bay (see option # 73), because material now eroding from Point Mouillee is deposited as a sandbar that has significantly reduced water circulation in the Bay, degrading the quality of fish habitat there.

The cost of implementing this option would probably be in the $2-3 million range for construction of the reefs and islands.

 # 74 Research, and if applicable, establish boating speed limits for specific areas in the St. Lawrence River.

While speed limits already apply to commercial navigation on Lake St. Francis, there is a concern that these limits might be too high and that there are no established speed limits for power boats operating on the lake. Further study is required to determine if boat wakes are contributing to the bank erosion problems in Lake St. Francis.

9.5 Controlling Exotic Species

The best protection against exotic species is to prevent new introductions, because an exotic species is pretty well impossible to remove once it has become established in a new area. The following actions can be taken to prevent further introductions of new exotic species and to deal with the effects of exotic species that are already here and causing problems.

 # 75 Recommend that all regulatory agencies ensure that no accidental introductions of exotic species occur in the area of concern and that any planned introductions are subject to the appropriate level of provincial and federal environmental assessment.

Although it is virtually impossible to remove an exotic species once it becomes established, regulatory and educational measures can be taken to prevent the accidental introduction of new exotic species to the Great Lakes-St. Lawrence River basin.

 # 76 Recommend mandatory regulation requiring treatment or exchange (or some other technique) to ensure that ballast water cannot be a vector for the introduction of exotic species into the area of concern.

Ballast water is a common vector for the transport of exotic aquatic species into the St. Lawrence River and the Great Lakes. Zebra mussels, for example, probably arrived in freshwater brought from Europe in the ballast of a European ship.

Although the federal government now asks ships to exchange freshwater ballast with seawater before entering the St. Lawrence Seaway, the program is entirely voluntary and some ships still enter the Seaway with foreign freshwater and its associated freshwater organisms intact. Even when ballast water is exchanged, some foreign organisms may survive a mid-ocean exchange, or foreign organisms may be released at the mouth of the St. Lawrence River if exchange takes place there rather than in the open seas.

A mandatory program of ballast water exchange or some form of ballast water treatment to kill exotic species should therefore be instituted in order to ensure that exotic species are no longer brought into Canada's inland waters in this manner.

 # 77 Discontinue chlorination as a control measure for exotic mussels as soon as a more environmentally sound method becomes available.

At the moment, chlorination is the most effective way of controlling zebra mussel infestations in municipal and industrial intake pipes. Although chlorine used for this purpose moves towards the facility in the direction of water intake flow rather than being released into waterways, it is environmentally undesirable to use a toxic contaminant such as chlorine to control zebra mussels. As soon as a more environmentally sound control method is available, the use of chlorine for this purpose should be discontinued in the area of concern.

 # 78 Increase public awareness about purple loosestrife by providing information on how to control small, accessible populations by hand pulling.

As discussed in Chapter 6, large populations of purple loosestrife cannot be controlled by physical removal (pulling or digging), partly because it would cost too much and partly because the plant thrives on disturbed ground and would therefore quickly reinvade excavated areas.

It is feasible, however, to control small populations in accessible areas if loosestrife is properly removed. The plant must be dug up, root and all, removed from the area and destroyed, with care taken to ensure that no seeds are dispersed in the process and no vegetative parts of the plant (shoot or root) remain behind. Removal should be done early in the growing season before seeds have formed.

 # 79 Regulate purple loosestrife as a noxious weed under federal and provincial legislation.

Designation of purple loosestrife as a noxious weed would allow municipalities to establish by-laws that incorporate control measures for the plant. Municipalities could then require property owners to remove purple loosestrife from their property.

APPENDIX I. Issues Addressed by Each Remedial Option

Option	Issues addressed						
	Mercury	PCBs	Other Contam.	Bacteria	Nuisance Aquatic Plants	Habitat	Exotic Species
1	✓	✓	✓				
2	✓	✓					
3	✓	✓	✓				
4						✓	
5					✓		
6	✓						
7			✓				
8	✓		✓		✓		
9	✓		✓		✓		
10			✓				
11	✓		✓		✓		
12	✓						
13	✓	✓	✓				
14					✓		
15					✓		
16		✓	✓			✓	
17		✓	✓			✓	
18		✓	✓			✓	
19	✓	✓	✓			✓	
20	✓	✓	✓			✓	
21	✓	✓	✓			✓	
22	✓	✓	✓			✓	
23	✓	✓	✓	✓	✓		

Option	Issues addressed						
	Mercury	PCBs	Other Contam.	Bacteria	Nuisance Aquatic Plants	Habitat	Exotic Species
24	✓						
25	✓	✓	✓				
26		✓					
27	✓	✓	✓	✓	✓		
28				✓			
29				✓			
30				✓			
31	✓	✓	✓				
32			✓				
33					✓		
34					✓		
35					✓		
36					✓		
37			✓	✓	✓		
38				✓	✓		
39				✓	✓		
40			✓	✓	✓		
41				✓	✓		
42				✓			
43				✓	✓		
44				✓	✓		
45				✓	✓		
46				✓	✓	✓	
47				✓	✓		
48			✓	✓	✓	✓	

Option	Issues addressed						
	Mercury	PCBs	Other Contam.	Bacteria	Nuisance Aquatic Plants	Habitat	Exotic Species
49				✓	✓		
50				✓	✓		
51			✓				
52					✓		
53					✓		
54					✓		
55					✓	✓	
56						✓	
57						✓	
58						✓	
59						✓	
60						✓	
61						✓	
62						✓	
63						✓	
64						✓	
65						✓	
66						✓	
67						✓	
68						✓	
69						✓	
70						✓	
71						✓	
72						✓	
73						✓	

Option	Issues addressed						
	Mercury	PCBs	Other Contam.	Bacteria	Nuisance Aquatic Plants	Habitat	Exotic Species
74						✓	
75							✓
76							✓
77							✓
78							✓
79							✓

APPENDIX II. Goals of the Cornwall Public Advisory Committee

USE GOALS

Ecosystem Health

Restore the ecosystem in the area of concern such that populations of flora and fauna including humans be robust and self-sustaining in a balanced community, by:

- rehabilitating and protecting required habitats;
- ensuring that the reproduction and health of individuals is not impaired by toxic and other potentially hazardous substances and effects;
- preventing adverse impacts resulting from the introduction of non-native species.

Municipal Use of Water

Have an unlimited quantity of aesthetically pleasing water for municipal use, free from toxic or other potentially hazardous substances and effects.

Consumption of Fish and Wildlife

Improve the quality of fish and wildlife for sustained human consumption, by:

- eliminating persistent toxic substances in fish and wildlife;
- reducing the level of naturally occurring metals to background (natural) levels; and
- ensuring that the odour and taste of fish and wildlife are not impaired by water quality.

Swimming

Ensure that swimming or other water contact sports are not impeded by water quality.

Boating

Improve recreational boating in current areas of use, principally by improving the usefulness of existing channels.

Recreational

Increase the enjoyment provided by other recreational uses such as wildlife viewing, hunting and sport fishing by:

- restoring the required flora and fauna;
- improving the aesthetics of the river and the shore; and
- maintaining access to these resources.

Industrial Use of Water

Ensure an adequate quantity and quality of water for industrial use.

Navigation

Maintain sufficient water depth for legitimate and safe seaway operation.

Power Generation

Maintain the use of St. Lawrence River water resources for the production of electricity in conjunction with environmental considerations.

SOURCE GOALS

Municipal Discharge

Municipalities shall provide proper treatment of sewage and stormwater before discharge to the river. The treatment should ensure that municipal effluent is free from toxic and other potentially hazardous substances and effects.

Industrial Discharge

Industries shall provide proper treatment for their effluent and, where necessary, modify their processes to ensure their effluents will be free from toxic and other potentially hazardous substances and effects.

Other Sources

Control the impacts from other sources by eliminating toxic and other potentially hazardous substances and effects.

Other sources include, but are not limited to, dredging, dumping, filling, landfill leachate, spills from shipping and bilging.

Activities for achieving this goal include:

- controlling erosion into tributaries and along shorelines;
- reducing nutrient inputs;
- preventing ground water contamination;
- eliminating atmospheric deposition of toxic and other potentially hazardous substances in the watershed;
- reducing bacterial inputs;
- controlling the impacts of sediment resuspension.

APPENDIX III. Persistent Toxic Contaminants

I. Organic Compounds

chloroform
- a chlorine-containing organic chemical commonly used as an industrial solvent
- suspected human carcinogen

carbon tetrachloride
- a chlorine-containing organic chemical used in drycleaning, as a fire extinguisher, and in the manufacture of many organic compounds including chlorofluorocarbons (CFCs)
- suspected human carcinogen

dioxins and furans
- a group of chemicals that contain chlorine, are highly persistent in the environment and bioaccumulate in the food chain
- they enter the environment as byproducts of industrial processes such as chlorine bleaching of paper and the production of some herbicides
- also released during combustion in incinerators and from vehicles using leaded fuel
- suspected human carcinogens; disrupt hormones; cause developmental problems
- one of the dioxins (2,3,7,8-TCDD) is among the most toxic synthetic chemicals known
- potential health risk for people who consume large amounts of Great Lakes fish (consult the *Guide to Eating Ontario Sport Fish*)

oils and greases
- oils and greases consist of a variety of organic chemicals, some of which may be toxic (e.g., PAHs)

PAHs (polyaromatic hydrocarbons)
- a group of compounds formed by incomplete combustion of fossil fuels, wood and tobacco
- byproducts of garbage incineration and coke and steel production
- high concentrations of PAHs exist in sediment of certain industrialized areas in the Great Lakes (e.g., Hamilton Harbour)
- presence of PAHs in sediment is associated with malignant liver tumours in fish
- main risk to humans is an occupational hazard of cancer caused by inhaling large amounts of PAHs in the workplace

PCBs (polychlorinated biphenyls)
- a group of stable, heat resistant chemicals that were widely used in electrical equipment and as lubricants
- highly persistent in the environment and bioaccumulate in the food chain
- manufacture and use banned in Canada in 1978; manufacture banned in US in 1976
- can cause liver toxicity and digestive problems and may be carcinogenic
- health risk in some areas for people who consume large amounts of Great Lakes fish (consult the *Guide to Eating Ontario Sport Fish*)

pesticides

mirex
- an extremely persistent insecticide never used agriculturally in Canada but manufactured in Niagara Falls, NY and Oswego, NY
- banned in US and Canada in 1978
- mirex concentrations in Great Lakes lake trout and coho salmon have decreased since the 1970s
- not a threat to human health at present levels as long as fish consumption advisories are followed

(see the *Guide to Eating Ontario Sport Fish*)

HCB (hexachlorobenzene)

- generated as a byproduct of pesticide manufacture
- used as a fungicide for cereal crops
- use restricted in Canada in 1971
- current levels not a threat to human health

dieldrin

- used mainly as a soil insecticide
- persistent in the environment
- highly toxic and readily absorbed through skin
- no longer manufactured in the US or Canada (manufacture banned in Canada in 1969)
- continues to enter Great Lakes as leachate from soils, so environmental levels haven't decreased as much for dieldrin as for other pesticides
- current dieldrin concentrations in fish are not a threat to human health

DDT

- introduced into North America in 1946 as an insecticide
- use restricted in Canada in 1974 and banned in 1989
- DDE, a metabolite of DDT, tends to be stored in fatty tissues and causes eggshell thinning in many birds
- environmental concentrations have significantly decreased but have now levelled off. This may be due to atmospheric depositions, because DDT is still used in many parts of the world
- current DDT concentrations in fish are not a hazard to human health

phenols (phenolics)

- a large group of compounds, some of which are found in the effluent of pulp and paper mills
- poisonous; possible carcinogens
- chlorinated phenols can cause fish tainting (*i.e.*, impart an "off" flavour)

II. Metals

chromium

- used as an alloy to manufacture stainless steel
- skin irritant; suspected human carcinogen

lead

- used to be added to gasoline in the form of tetraethyl lead
- environmental concentrations of lead have decreased since 1981 due to introduction of unleaded gasoline
- not a human health risk as long as fish consumption guidelines are followed (see the *Guide to Eating Ontario Sport Fish*)
- poison; suspected human carcinogen

mercury

- found naturally in environment
- was widely used as a slimicide in pulp and paper manufacture
- used in one type of process for manufacturing chlorine and caustic soda
- persistent and bioaccumulates in the food chain
- mercury concentrations in Great Lakes fish have decreased due to industrial reductions but there are still many sport fish advisories (consult the *Guide to Eating Ontario Sport Fish* before eating fish from the Great Lakes or St. Lawrence River)
- poisonous substance

zinc

- used in rayon manufacturing to improve quality of rayon fibres
- moderately toxic when ingested or when fumes are inhaled

APPENDIX IV. Units of Measurement

Weight

kg kilogram (1000 grams) = 2.2 lb

g gram (one thousandth of a kilogram = 0.001 kg)

mg milligram (one thousandth of a gram = 0.001 g)

μg microgram (one millionth of a gram = 0.000001 g)

ng nanogram (one billionth of a gram = 0.000000001 g)

pg picogram (one trillionth of a gram = 0.000000000001 g)

Volume

L litre (1000 millilitres) = 0.22 Canadian gallons

mL millilitre (one thousandth of a litre = 0.001 L)

μL microlitre (one millionth of a litre = 0.000001 L)

Concentrations

1 mg/kg = 1 μg/g = 1 part per million (ppm)*

1 μg/kg = 1 ng/g = 1 part per billion (ppb)**

1 ng/kg = 1 pg/g = 1 part per trillion (ppt)

1 mg/L = 1 μg/mL = 1 part per million (ppm)

1 μg/L = 1 ng/mL = 1 part per billion (ppm)

* One part per million is one inch in two miles or one minute in two years.
** One part per billion is one inch in 16,000 miles or one second in 32 years.

TERMS & ACRONYMS USED IN THE REPORT

AOC Area of Concern

ALCOA Aluminum Company of America

BATEA best available technology economically achievable

benthic living at the bottom of a lake, river or ocean

benthos the organisms that live on the bottom of a water body

bioaccumulation the process by which the concentration of a toxic contaminant increases as it passes up through the food chain from algae to top predators (see page x)

biomagnification see **bioaccumulation**

bypass rerouting of sewage around a facility such as a sewage treatment plant during periods of high flow. Bypassing is done to prevent a washout of the facility, but it results in the release of raw, untreated sewage to the receiving body of water (lake, river or ocean).

carcinogen any substance that causes cancer

coliform bacteria rod-shaped bacteria, most of which live in the intestines of warm-blooded animals

combined sewers pipes that take both domestic wastewater and surface runoff to the sewage treatment plant. They are usually located in the older parts of municipal sewage systems.

combined sewer overflow
a valve that opens to allow the contents of an overfilled combined sewer pipe to overflow into another pipe that takes the excess sewage directly to the river or other receiving water body, without being treated at the sewage plant

conventional pollutant
before persistent toxic substances became an environmental concern, a number of other types of substances were known to pollute waters. These are now referred to as conventional pollutants and include phosphorus and nitrogen (nutrients); chemical oxygen demand and biological oxygen demand (*i.e.*, substances that decompose using oxygen in the process); oils

and greases; volatile solids; total and fecal coliform bacteria; and chlorides.

DDT the pesticide dichlorodiphenyltricloroethane

EA Environmental Assessment. An EA is required by law under the Province's Environmental Assessment Act for designated provincial and municipal projects.

EARP Environmental Assessment Review Process. An environmental assessment screening process required for all federally funded projects.

effluent the liquid waste that is discharged from an industrial facility or municipal sewage treatment plant. Industries discharge effluent either directly to surface waters or to wastewater sewers that take it to a sewage treatment plant. Sewage treatment plants discharge their effluent (treated sewage) to surface waters.

eutrophication a process of excess plant growth and oxygen depletion in an aquatic ecosystem. Unnaturally high inputs of nutrients such as phosphorus stimulate excessive growth of aquatic plants, which means an increased amount of dead plants being decayed by bacteria. The bacteria, which use oxygen to live, deplete oxygen dissolved in the water and the lack of dissolved oxygen kills fish.

exotic species plants or animals that have been accidentally or intentionally introduced to an area they did not previously inhabit

fecal coliform rod-shaped bacteria that inhabit the intestines of warm-blooded animals including humans and are used to indicate the presence of animal waste (fecal matter) in water

flow amount (volume) of water or wastewater running out of a pipe or through an area in a given length of time (*e.g.*, number of gallons per day or number of cubic metres per day)

food chain a series of organisms (beginning with plants and ending with the largest carnivores) each dependent on the next for food

GLWQA Great Lakes Water Quality Agreement

Great Lakes Water Quality Agreement
a joint agreement between Canada and the United States, which legally commits the two countries to develop then implement plans to restore and maintain the many desirable uses of the water in the Great Lakes Basin

ground water water located underground (as opposed to surface waters such as lakes, rivers and oceans).

guideline a suggested (not legally binding) maximum acceptable concentration of a pollutant in surface water, drinking water, sediment, fish and wildlife, effluent

ICI ICI Forest Products

leachate water that percolates through solids such as soils, solid wastes and rock layers and may contain dissolved or suspended contaminants

load(ing) the total amount of a pollutant entering a water body over a specific time (*e.g.*, grams per day of mercury). Loadings give a clear picture of how much of a given contaminant is being discharged because they take into account the volume of effluent being discharged over time. In contrast, concentrations (*e.g.*, milligrams of mercury per litre of effluent discharged) can be misleading because even though the concentration of a pollutant may be low, if a large enough volume of effluent is being discharged the total load to the environment is high.

lowest effect level the contaminant concentration that would be detrimental to some of the species of organisms living in the sediment

MISA Municipal-Industrial Strategy for Abatement — an Ontario Ministry of Environment & Energy regulatory program. The ultimate goal of MISA is to regulate municipal and industrial discharges of toxic substances and conventional pollutants to the point where they are virtually eliminated from the environment.

MNR Ontario Ministry of Natural Resources

MOEE Ontario Ministry of Environment & Energy

non-point source a source of pollution that spreads pollutants over a wide area (*e.g.*, rural runoff or atmospheric emissions from a smoke stack) rather than to a distinct, identifiable location.

nutrient a chemical that is an essential raw material for the growth and development of organisms. In speaking of the aquatic environment, the term nutrient generally refers to the substances that act as plant food (phosphorus, nitrogen).

Ontario's Drinking Water Objectives
a set of maximum acceptable concentrations of substances which could

affect people's health if present in drinking water

overflow a sewage overflow occurs when excess sewage and stormwater cause a valve to opens so that the excess volume can be rerouted away from the regular sewage collection system that leads to the sewage treatment plant. Overflows result in discharges of untreated sewage to surface waters such as the St. Lawrence River.

PAC Public Advisory Committee

PAH polynuclear aromatic hydrocarbon / polyaromatic hydrocarbon

PCB polychlorinated biphenyl

persistent toxic substance
any toxic substance that is difficult to destroy or degrades slowly (*i.e.*, has a half-life in water greater than eight weeks).

point source a source of pollution that is distinct and identifiable (*e.g.*, a liquid effluent discharge pipe)

primary treatment a process of sewage treatment in which sewage is held temporarily in a large settling chamber where solids settle to the bottom. The clarified liquid is then chlorinated to kill pathogenic microorganisms and discharged to a river, lake or ocean.

Provincial Sediment Quality Guidelines
a set of guidelines that specify maximum acceptable levels of various pollutants in sediment. The Guidelines were released in 1992 by the Ontario's Ministry of Environment & Energy.

Provincial Water Quality Objectives
a set of maximum acceptable concentrations of pollutants designed for the protection of aquatic life and recreation in and on the water

RAP Remedial Action Plan

resuspension the remixing of sediment particles and pollutants back into the water by storms, currents, organisms and human activities such as dredging

revetment a retaining wall or facing

RRCA Raisin Region Conservation Authority

secondary treatment
primary sewage treatment combined with a period of bacterial action to remove (decompose) organic matter in the waste

sediment solid particles that settle to the bottom of a liquid

severe effect level
the contaminant concentration that would be detrimental to most species of organisms living in the sediment

solubility ability of a substance to dissolve in a liquid

surface waters water located on the earth's surface (*i.e.*, rivers, streams, lakes, oceans)

suspended sediment
particles of solid matter within the water column (somewhere between the surface and the bottom sediment)

toxic substance a substance that can cause illness, death, birth defects, genetic mutations or reproductive impairment in any organism or its offspring

water pollution control plant
facility that receives municipal sewage, treats it and discharges it to a river, lake or ocean.

water treatment plant
facility that provides safe drinking water for a municipality. The plant takes in raw fresh water and treats it (usually by chlorination or filtration) so that it is suitable for drinking. (A water treatment plant is a different facility than a sewage treatment plant.) Cornwall's water treatment plant intake is located upstream of Cornwall industries and the Cornwall sewage treatment plant.

WPCP Water Pollution Control Plant (=sewage treatment plant)