

FORWARD

Preparation of the Stage 2 Remedial Action Plan (RAP) for the St. Clair River has involved the dedication and expertise of many individuals, particularly volunteers, from both within and outside of the St. Clair River Area of Concern (AoC). Stage 2 marked the establishment of a new working relationship between members of the Binational Public Advisory Council (BPAC) and Government Agency members on the RAP team. The process, involving facilitated task teams and strategically timed workshops was successful in identifying goals, priorities and recommended actions to correct environmental problems outlined in Stage 1 of the RAP.

Stage 2 has followed a locally prescribed "ecosystem approach" recognizing the St. Clair River and its watershed as an entity without regard for geo-political borders and establishing priorities based on environmental quality needs. This "binational" RAP has been a model of cooperation largely the result of a forward thinking and active BPAC who have, on several occasions, overcome international borders and roadblocks to maintain a productive process. BPAC and the RAP team have communicated successes and failures to other binational RAPs through numerous engagements hosted or attended by members including an IJC sponsored binational RAP roundtable. The participants learned from difficulties and delays encountered during the development of Stage 1 and have through diligence kept on time despite an ambitious schedule. In addition, there have been many examples of partnerships established to secure grants, private or agency funding for work which could have otherwise not been completed.

The following BPAC and RAP team members, invited experts, facilitators and technical writers have enabled the completion of a Stage 2 report which is challenging yet achievable and supported by all involved:

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EXECUTIVE SUMMARY

INTRODUCTION

The St. Clair River Stage 1 Remedial Action Plan (RAP), defining environmental problems ("impairments to beneficial uses") affecting the St. Clair River was released in 1991. The Stage 1 RAP identified current environmental conditions including trends through time. Impairments were identified, however, one of the more significant findings was the substantial improvements in environmental quality which had occurred over the last decade. These improvements have largely been the result of regulatory or voluntary initiatives on the part of local industries and municipalities in Ontario and Michigan and, in particular, petrochemical facilities located in the Sarnia/Lambton area. Since release of the Stage 1 report, RAP efforts have been focused on finding solutions to the remaining problems and prioritizing actions in order to restore beneficial uses. This document, which represents the findings from the Stage 2 RAP, presents the framework for restoring the environmental integrity of the St. Clair River and recommended remedial and preventive actions to reach these goals. In some cases, the remedial and preventative actions are not fully developed in this document. In those instances, the next steps that will be taken to develop the preferred remedial actions are outlined in the report.

Where conclusive information is lacking, actions listed in this document will be further evaluated for their linkages with identified impairments and prioritized in light of competing environmental initiatives and expected benefits to the St. Clair River and surrounding environment.

The next step in the RAP process will focus on:

- prioritizing actions that will clearly lead to removal of impairments;
- obtaining commitments (including funding) from those responsible and proceed with carrying out the priority actions listed in this document; and
- further refining plans for those areas where the remedial actions have not yet been fully developed.

RAP participants have attempted to prescribe actions for delisting of the St. Clair River as an Area of Concern. Some actions may yield greater environmental benefits and would receive a higher priority in committing limited resources. The RAP is principally concerned with restoring impairments to beneficial uses and, as such, will prioritize these actions while promoting other actions which will further improve environmental conditions in the area.

To more comprehensively address the environmental problems defined in the Stage 1 RAP, the scope of the RAP has been broadened to encompass the immediate drainage basin of the St. Clair River. The eastern watershed draining from Ontario consists of several small tributaries encompassing an area of about 20,976 ha (51,832 acres). The Michigan watershed, encompassing the Black, Belle and Pine Rivers, is significantly larger at 315,900 ha (780,589 acres). Consideration of the entire watershed is essential for the RAP as activities anywhere within the drainage basin can lead to downstream impacts.

The watershed defined does not incorporate upstream sources contributing to the head of the St. Clair River from Lake Huron. As Lake Huron contributes by far the greatest amount of water to the river, pollutant contributions from the lake can not be ignored. In particular, loadings of pesticides, mercury, total PCBs, phosphorus, chloride, hexachlorobenzene and suspended solids from Lake Huron are known to be significant. This RAP cannot directly address minimization or elimination of these sources, but does commit to continued monitoring of these and other inputs to the St. Clair River. It is also recommended that reductions of contaminants of concern within the St. Clair Area of Concern (AOC) be a priority for the proposed Lake Huron Lakewide Management Plan (LaMP).

Atmospheric inputs may also be contributing to contamination of the St. Clair River via direct deposition, its tributaries and Lake Huron; however, insufficient data exist for a full evaluation of the presence and distribution of atmospherically derived contaminants. This RAP strongly supports further investigations to ascertain the extent of the problem.

The Stage 2 RAP document summarizes the results of the Stage 1 report and addendum report which outline the nature and extent of environmental problems in the St. Clair River AOC. Chapter 3 outlines the process undertaken to complete Stage 2, goals and objectives of the RAP and appropriate delisting criteria for those beneficial uses assessed as impaired. The remainder of the report provides specific recommended actions for implementation (Stage 3) relating to point sources (Chapter 4), non-point sources (Chapter 5), sediments (Chapter 6), habitat (Chapter 7), public outreach and education (Chapter 8), required monitoring leading to delisting and research needs to fully evaluate the status of certain other beneficial uses (Chapter 9), and the strategy for RAP Implementation (Chapter 10). The actions identified and time frame for their implementation are summarized at the end of this executive summary (Section 1.11).

IMPAIRMENT OF BENEFICIAL USES AND DELISTING CRITERIA

Table 1.1 lists the impairments to beneficial uses (9 of 14 beneficial uses as defined by the IJC) determined in the Stage 1 report and subsequent Update report. The delisting criteria, as defined by the RAP Team and Binational Public Advisory Committee (BPAC), for each impairment is also indicated.

PUBLIC CONSULTATION PROCESS

This Stage 2 document has been created as the result of extensive public consultation and input to derive a community-based consensus report. It is largely the product of four Task Teams consisting of members of the BPAC and RAP Team with some additional agency support. As such, it attempts to accurately portray the collective interests and will of the local community. This document has been reviewed on several occasions by task team members through facilitated workshops, meetings and individual review. It is the product of a joint effort involving local interested citizens within and outside of BPAC as well as Agency representatives. The implementation of recommended actions thus is supported by all stakeholders which will certainly enhance the success of the remediation and cleanup of the St. Clair River AOC.

The Stage 2 process involved a series of facilitated workshops and the creation of four Task Teams. Point sources and non-point sources of contamination were evaluated and assessed by the Point Source and Non-Point Source Task Teams, respectively. A Sediment and Habitat Task Team addressed issues relating to contaminated sediments and the loss of wildlife habitat. A Common Issues Task Team was struck to fill any gaps among the other Task Teams and address cross-cutting concerns; their primary focus dealt with public awareness and education.

GOALS AND OBJECTIVES

One of the first tasks of the Stage 2 process was the development of specific water use goals and objectives to direct the work of the Task Teams and, eventually, result in delisting of the impairments to beneficial uses (Table 1.1). The goals and objectives were developed jointly by the RAP Team and BPAC.

A series of six qualitative goals were defined as follows:

Aesthetics:

Achieve and maintain an aesthetically pleasing clean "blue water" and an appropriate balance of natural shoreline and human uses. There should be sufficient public access to the river for recreation, enjoyment and cultural activities;

Consumption of Fish and Wildlife:

Eliminate the need for restrictions on human consumption of fish and wildlife for reasons of health;

Ecosystem Health:

Attain and maintain healthy, diverse and self-sustaining biological communities and habitats. Ensure that there are no negative impacts on the health of local populations due to water quality. Ensure no net loss of fish and wildlife habitat and reclaim, rehabilitate and enhance habitat where possible;

Recreation and Shipping:

Ensure that the water quality is safe for body contact at all times. Eliminate adverse effects caused by recreational and shipping activities;

Sources of Contamination:

Ensure that no source (point or non-point) impairs water quality. Eliminate ; and

Water Supply:

Ensure that an adequate and affordable water supply, in quality and quantity, is available from the St. Clair River for users at all times.

Specific objectives for each goal have also been defined all of which have a target for achievement by the year 2000. Because use impairments reflect many decades of ecosystem abuse, it may take many years to totally restore environmental integrity, however, the delisting criteria reflect goals for substantial improvement within a reasonable short time frame.

In addition to the goals and objectives and delisting criteria, the RAP Team and BPAC also developed an AOC-specific set of water, sediment and biota quality guidelines referred to as "yardsticks". These yardsticks are presented in Chapter 3. They were derived from several jurisdictions and represent the most stringent criteria available for each contaminant. These yardsticks are proposed as the values required to be achieved as a result of RAP implementation.

The St. Clair RAP is aware of the connections between human health and the environment. Many of the remedial activities underway or proposed will make the AOC a healthier place to live by reducing levels of contaminants in the water, sediment, food and air.

POINT SOURCE

A point source was defined as "Any discrete, quantifiable discharge (air and/or water), e.g., outfall, pipe, conduit, lined ditch/channel, tunnel, which discharges directly to the St. Clair River or its tributaries from sources including industrial/municipal discharges". These discharges include: storm water runoff from developed areas of industrial sites/activities; urban storm runoff; spills; CSOs; residential discharges; and landfill leachate systems.

Early in the Stage 2 process, the RAP team commissioned a study to evaluate technical options for remediation of use impairments. This report (Beak 1993) outlined detailed, site-specific technical options and approximate costs for addressing source controls as well as sediment and habitat remediation. The Beak (1993) report has been included in its entirety as Appendix 4.3 to

this Stage 2 document. Following extensive discussions with BPAC and RAP team members, it was agreed that with respect to point sources, a more effective approach would be to identify performance expectations or a "yardstick" necessary to achieve RAP goals and objectives and to rely on individual sources to comply. This was felt to be the approach most likely to succeed given the complex technical, economic and social issues at hand for each facility. The RAP will pursue the achievement of these "yardsticks" through ongoing monitoring and iterative discussions with both municipal and industrial dischargers.

The Point Source Task Team developed an evaluation and ranking system for contaminants and sources based on scoring the impact to each media (based on yardstick values) from individual parameters. The formula for determining individual media scores is as follows:

Parameter Impact Score = No. Uses Impaired
X (100/(parameter yardstick/mercury yardstick))
X total loading

The highest priority sources (sum of media impact scores greater than or equal to 1.9), based on this ranking process were determined to be:

Cole Drain Hexachlorobenzene; Hexachlorobutadiene; Pentachlorobenzene; Octachlorostyrene; Nickel

Dow Chemical Copper; Zinc; Hexachlorobenzene

Esso Petroleum Arsenic; Phosphorus, Ethyl Lead; Mercury; 1,2-Dichloroethane; 1,1-Dichloroethane; Carbon Tetrachloride; 1,1,2-Trichloroethane; Tetrachloroethylene; Trichloroethylene; PAHs; Toluene

Marysville WWTP Phosphorus

Novacor Petroleum Arsenic

Polysar Benzene; Oil & Grease; Phosphorus

Port Huron WWTP Cadmium; Phosphorus

Sarnia WPCP Zinc; Cadmium; Iron; Mercury Phosphorus; Copper; Nickel; Lead;

Suncor Arsenic

In addition, selected contaminants were modelled using the KETOX fate and effects model for sediment and water. Four different loading scenarios were employed to determine the contributions of individual sources to contaminant levels in the water and river sediment. Where contaminant concentrations exceeded yardstick values the water or sediment was considered impaired. Modelling scenarios include:

1. Contaminant levels in water from the Stage 1 RAP (1991);
2. Contaminant levels in water and sediment from the Stage 1 RAP Addendum (1993);
3. Contaminant levels in water and sediment from current information (industrial discharges 1994); and
4. Projected contaminant levels in water and sediment.

Parameters modelled include: hexachlorobenzene; lead; mercury; tetrachloroethylene; benzene; carbon tetrachloride; cadmium; and zinc. The selection of these parameters was not based on the final ranking but on the availability of complete data. As a result of the modelling, those sources which were found to contribute to exceedences of yardstick values, based on the Stage 1 Update loading scenario, are:

Cole Drain Hexachlorobenzene

Dow Zinc, Mercury, Hexachlorobenzene

Polysar Benzene

St. Clair WWTP Mercury

The Cities of Sarnia WPCP, Port Huron, Marysville have submitted Pollution Control plans in order to abate their sewage treatment, CSO (combined sewer overflow) and stormwater problems. The cities of Yale, St. Clair and Marine City will complete sewer separation (sanitary and storm sewers) before the end of 1994.

NON-POINT SOURCE

The general nature of this topic, non-point sources, has resulted in Chapter 5 being less complete than other chapters hence, non-point source generalizations make it difficult to be specific about recommendations and responsibilities.

Available data indicates that non-point sources and Lake Huron contribute at least ten percent of the total loadings to the St. Clair River for the following parameters: copper, iron, lead, mercury, nickel, cadmium, cobalt, PAHs and PCBs. For substances such as mercury and PCBs, the majority enters from Lake Huron resulting from airborne deposition to the lake. In addition, non-point phosphorus and zinc contributions are close to ten percent of the total loadings.

The Non-Point Source Task Team identified and focused on six non-point sources of contaminants in the St. Clair River watershed, exclusive of Lake Huron. These sources include:

- (1) urban storm runoff (excluding storm runoff from industrial sites and CSOs);
- (2) rural storm runoff;
- (3) waste sites without leachate and runoff collection;
- (4) malfunctioning septic systems;
- (5) all domestic sources not connected to municipal treatment facilities; and
- (6) generation of household hazardous waste (HHW).

Evaluation of Ontario landfill and waste disposal sites identified two potential problem sites, the Ladney Waste Disposal Site and the Canatara Landfill (Chapter 5). In addition, it was revealed that there is not enough information available to make an assessment for the Dow LaSalle Road, Dupont, and Shell Canada waste disposal sites and the Walpole Island, Moore Township, and Sombra Township landfills.

In St. Clair County, Michigan, nine inactive 307 sites (contaminated site identified for remediation under the *Michigan Environmental Response Act* and the *Comprehensive Environmental Response, Compensation and Liability Act*) along with 4 leaking underground storage tanks have been identified however, none of the sites are on the list 307 Highest Ranking Sites requiring immediate clean-up. There are no documented effects to the St. Clair River or its tributaries from these sites.

A number of ongoing programs focusing on the reduction and eventual elimination of contaminants to the St. Clair River through agricultural practices are identified in Chapter 5. Several sewer construction projects are also described in Chapter 5. Local non-point source control activities and the importance of watershed assessment have accelerated as a result of the RAP (e.g. CURB Program).

SEDIMENT

Parameters of concern in St. Clair River sediment include: total Kjeldahl nitrogen, total phosphorus, arsenic, mercury, cadmium, copper, chromium, iron, lead, nickel, zinc, manganese, oil and grease, PCBs, hexachlorobenzene and total PAHs.

The Sediment and Habitat Task Team developed a "Sediment Remediation Decision Tree" to determine the most suitable option for contaminated sediment remediation in the St. Clair River.

Results from the OMOEE 1990 sediment study were used to characterize and prioritize sediment impact zones. Prioritization was based on the following criteria:

Priority 1 zones are characterized by Severe Effect Level (SEL) exceedences, degraded benthos and sediment toxicity.

Priority 2 zones are less impacted with SEL exceedences, and impaired benthos.

Priority 3 zones are identified with SEL exceedences.

As a result of this process three Priority 1, four Priority 2, and four Priority 3 sediment impact zones were identified. All impact zones are located in the upper St. Clair River along the Chemical Valley with Priority 1 zones located at and immediately downstream of Polysar Rubber Corp. and Novacor Chemicals (Sarnia); Suncor Inc.; and Ethyl Canada Inc., DuPont Canada and Novacor Chemicals (Corunna).

Sediment characterization studies are outlined in Chapter 6 and will be conducted on the Priority 1 zones. Results from these studies will be used to develop remedial measures for these areas.

HABITAT

Loss of habitat has been identified as an impaired beneficial use in the St. Clair River AOC Stage 1 RAP. The protection of wildlife habitat involves the application of legislation and regulatory programs. Federal, Provincial and State legislation are reviewed and procedures for habitat protection discussed.

The Sediment and Habitat task team have defined a set of principles that are to be adhered to in all existing and planned remedial actions for habitat protection, restoration and enhancement in the St. Clair River watershed. These principles are as follows:

- (1) no further losses of current wildlife habitat;
- (2) gain in wetland and aquatic habitat wherever and whenever possible;
- (3) focus on areas of contiguous habitat, with a minimization of habitat fragmentation;
- (4) make provisions for diverse habitats and communities (*i.e.* an ecological approach); and
- (5) set a high priority for endemic species, communities and habitats.

Numerous habitat restoration and enhancement programs are ongoing in both Ontario and Michigan and are outlined in Chapter 7. The majority of these projects are focused in the St. Clair River delta region. Thirty-five candidate sites, located along the entire length of the St. Clair River and its delta, have been identified by OMNR and MDNR for potential habitat rehabilitation and/or enhancement. Both organizations are currently exploring funding mechanisms for habitat restoration and enhancement.

The OMNR (1994) candidate site report evaluates and prioritizes areas based on a complex scheme involving cost/benefits; design; partnerships and sustainability as well as a number of other critical factors. It also provides a comprehensive evaluation of technologies and feasibility

for specific remedial actions at Candidate Sites. Perhaps the single most important factor lies in "opportunities" that present themselves either through concerted efforts to gain interest from land owners and potential partners or unsolicited interest. As a consequence, priorities may be altered to reflect "opportunities" which offer a more streamlined means to move towards RAP goals and objectives.

Ongoing actions pertaining to habitat protection, restoration and enhancement were itemized into three categories: protection; rehabilitation and enhancement; and education and communication. Actions relating to exotic species are also outlined.

PUBLIC OUTREACH & EDUCATION

The primary goals of the public outreach and education activities undertaken by the RAP Team and BPAC are:

- develop and implement an environmental education program for local schools;
- increase public awareness of the RAP, its Goals and Objectives;
- develop and implement educational programs for the general public; and
- encourage and enhance public involvement in all phases of RAP implementation.

Thirteen educational and public outreach programs undertaken within the St. Clair River AOC are described and recommendations for continued/additional programs are outlined.

MONITORING & RESEARCH

The Stage 2 RAP identifies monitoring programs required to determine progress toward meeting the RAP goals and objectives. Additional research to further evaluate those use impairments which have not been adequately assessed is also identified. Monitoring requirements are noted for each of the nine impaired uses. Many on-going agency and industry monitoring programs will be sufficient to meet the requirements of the RAP. However, some programs require adjustments to sampling locations, frequency of sampling, and parameters to be measured/estimated.

Twelve proposed or on-going non-point source monitoring programs are described. These programs include air monitoring programs, tributary monitoring (Sydenham and Black Rivers), CSO and urban runoff monitoring, nearshore bacteriological surveys and detailed watershed surveys in both Michigan and Ontario. Investigations are currently under way to determine the cost, timing and feasibility for mass balance and/or St. Clair River head and mouth surveys.

Current point source monitoring includes industry self-monitoring requirements in Ontario and Michigan. In addition, new monitoring requirements will be specified in the MISA effluent regulations once they are promulgated. Additional monitoring may be required at certain facilities to ensure priority contaminant loadings reflect actions identified by the Point Source Task Team.

RAP IMPLEMENTATION

Implementation of the RAP involves the commitments on behalf of responsible parties; a management and co-ordination structure; tools and procedures to track implementation; evaluation of the success of remedial activities; appropriate funding to undertake actions; and the identification of additional actions, as needed.

A formal implementation structure is proposed which consists of a RAP Implementation Committee and a RAP Accountability Committee. The first consists of representatives of those agencies responsible to ensure implementation. Its responsibilities relate to overall co-ordination of RAP implementation activities, including tracking and evaluation of recommended actions, tracking and assessment of monitoring activities and the assessment of impaired use status. This

committee will be responsible for developing detailed workplans relating to the implementation of recommended actions and to monitoring and research activities. The Accountability Committee is an arms-length committee with representation from each of the stakeholders groups. It will serve an auditing, review and reporting function which will maintain regular contact with the public.

The strategy for implementation is based on assigning responsibility for recommended actions and ensuring that the funding is in place. Written commitments regarding loading reductions have already been obtained and these are outlined in the report. To date commitments have been obtained from Dow Chemical Canada, DuPont Canada, Imperial Oil Chemicals Division, Imperial Oil Refinery Division, Novacor Chemicals (Mooretown), Polysar Rubber, and St. Clair Wastewater Treatment Plant (WWTP). Each facility and agency will be responsible for implementing assigned actions through consensus but when necessary employing appropriate regulations. Several of the actions, particularly those relating to public and business community education are to be undertaken by the RAP Implementation Committee.

Targets for restoration of degraded areas and the conservation and protection of human and ecosystem health have been established under the Canada-Ontario Agreement (COA). The remedial actions outlined in this document are largely consistent with these targets and indeed some (those under the jurisdiction of Canada/Ontario) may benefit from priorities established as part of the Agreement.

In addition to the expertise and resources available through government and private sector activities, the RAP will where possible utilize the resources and expertise available locally through Community Colleges. Of particular benefit to the RAP will be those programs responsible for training students in the fields of resource management, environmental technology and engineering.

ACTIONS

Table 1.2 summarizes the main recommended actions according to the agencies with primary responsibility for implementation.

ENVIRONMENTAL CONDITIONS & PROBLEM DEFINITION

AREA OF CONCERN CHARACTERISTICS

In Ontario, 78% of the immediate drainage area of the St. Clair AOC is agricultural and in Michigan, 68% is dedicated to agriculture. While urban areas such as Sarnia and Port Huron are home to a large number of people, a significant portion of the population remains in rural areas. A relatively small portion of the land bordering the St. Clair River is forested. There is a concentration of industry in the upper portion of the river between Lake Huron and Fawn Island, including petroleum refineries, organic and inorganic chemical manufacturers, paper companies, salt producers and thermal electric generating facilities. The Stage 2 RAP identifies 40 sites of environmental contamination (23 industrial waste sites; 4 municipal landfills; 9 Michigan waste sites; and 4 leaking underground storage tanks) in the watershed that require further assessment and/or clean-up. Two native Indian reserves are situated along the Canadian shore - the Chippewa of Sarnia Band Reserve and the Walpole Island First Nation Reserve.

The St. Clair River serves as a shipping channel for a number of industries and the broader Great Lakes Seaway system. It is also a source of cooling and process water for industry and thermal generating stations. It serves as drinking water for a population of approximately 170,000. The wetlands and associated open waters of the lower St. Clair River and Lake St. Clair comprise one of the most important wetland areas in the Great Lakes Region (Figure 2.2). They provide an important habitat for ducks, geese and swans. The AOC supports 91 fish species, 20 species of amphibians, 25 species of reptiles, 250 species of birds and 60 mammal species. Currently, commercial fishing within the St. Clair River is considered negligible. Sport fishing, however, is popular on the St. Clair River, and hunting and trapping are significant uses, particularly for the native people living on the River. The River also supports a number of parks and areas affording opportunities including swimming, boating and naturalist activities.

IMPAIRMENT OF BENEFICIAL USES

The St. Clair River was identified as an AOC because of exceedences of general or specific objectives of the Great Lakes Water Agreement, responsible for impairment of 9 of the 14 beneficial uses recognized under the Great Lakes Water Quality Agreement (GLWQA). These beneficial uses are impaired as the result of physical disruption of habitat and/or elevated contaminant levels in the water, sediment and biota of the St. Clair River. Table 2.1 summarizes the status of beneficial uses.

Contaminants of concern which have exceeded Ontario, Michigan or GLWQA objectives/standards for water, sediment or biota include:

Metals

Arsenic
Cadmium
Copper
Chromium
Iron
Lead
Manganese
Mercury
Nickel
Zinc

Conventional Pollutants

oil and grease
TKN

total phosphorus
bacteria
chloride
phenols

Organic Contaminants

octachlorostyrene
hexachlorobenzene
hexachlorobutadiene
tetrachloroethylene
carbon tetrachloride
dieldrin
polychlorinated biphenyls (PCBs)
polycyclic aromatic, hydrocarbons (PAHs)
polychlorinated dioxins and furans

In addition to the contaminants of concern noted above, several additional parameters known to occur in the St. Clair River have been identified in Ontario's Effluent Monitoring Priority Pollutants List (EMPPL) as having one or more of the following characteristics: persistence, potential to bioaccumulate, and potential acute and sublethal toxicity to biological organisms including humans. These include:

Benzene
Pentachlorobenzene
Toluene
Chlorophenols
Xylene
1,1- and 1,2-Dichloroethane
Trichloroethylene
Hexachloroethane
2,4,5-Trichlorotoluene
1,1,1- and 1,1,2-Trichloroethane

The primary sources of contaminants to the St. Clair River are industrial and municipal point sources and urban and rural non-point sources.

NON-POINT SOURCES & RELATED IMPACTS

Urban Stormwater

Urban areas represent a significant non-point source of contaminant loading to the St. Clair River. Loadings from Ontario urban areas generally account for greater than 10% of the total contaminant loading. Contaminants associated with the Ontario urban areas and which may result in use impairments include iron, lead, zinc, oil and grease, hexachlorobenzene, total PAHs and total PCBs.

The largest Ontario and Michigan urban areas within the St. Clair River AOC, including size and population, are listed below:

	Area (Ha)	Population
Moore Township	31,781	10,432
Village of Point Edward	352	2,323
City of Sarnia	16,406	72,684
Sombra Township	29,932	4,053
Town of Wallaceburg	1,068	11,684
Walpole Island First Nation	15,891	1,658

Chippewas of Sarnia	1,315	487
Port Huron	33,670	33,694
Marysville	20,720	8,515
St. Clair	7,252	5,116
Marine City	5,568	4,556
Algonac	14,763	4,551

Contamination from urban areas can be attributed primarily to urban stormwater discharges, combined sewer overflows, and malfunctioning septic systems. Discharges from storm sewers can be a major source of pollutant loadings due to washoff of accumulated contaminants. Sources of these contaminants include nutrients and pesticides spread on lawns, heavy metals and exhaust emissions from automobiles, sediment from construction sites, petroleum and chemical spills in industrial areas, bacterial contamination from fecal droppings of domestic pets and birds, atmospheric deposition, and direct or indirect connections with sanitary sewers. Connections from the sanitary sewer systems contribute to contaminant flows not only during wet weather, but also during dry weather conditions.

Overflows which include sanitary and combined sewage overflows within the system, as well as pumping station overflows, are generally caused by larger rainfall events. The City of Sarnia is the only Ontario municipality within the St. Clair watershed with combined sewer overflows. Based on 1987 monitoring, there are approximately 108 combined sewer overflows per year for the four Sarnia CSOs discharging directly to the St. Clair River.

The Cities of Port Huron, Yale, and Marysville all currently have combined sewer overflows. From January 1993 through April 1994, Port Huron reported 8 overflows; Yale 3 overflows; and Marysville estimates 12 overflows per year. Yale sewer separation is scheduled to be completed by the end of 1994, Marysville by 2001, and Port Huron's CSO control plan has yet to be reviewed by MDNR. St. Clair and Marine City combined sewers have been separated and are undergoing final testing and certification and overflows have not been reported in 1993 and 1994.

Septic systems release untreated contaminants into the groundwater system. The primary concern is the infiltration of the septic waters into the storm sewer system, groundwater and/or surface water.

Rural Runoff

Rural non-point pollution due to agricultural operations include nutrients (manure and commercial fertilizers), sediment from land erosion, and inputs of insecticides, herbicides and fungicides. Pesticides entering the tributaries are a contaminant of concern and agricultural drainage is a source of disruption to habitat and to wetland size and integrity.

Agricultural operations in Ontario focus on cash cropping, beef and swine operations. The area's long growing season and fertile soils easily support the principal cash crops of soybeans, corn, wheat, hay and cereals. In Michigan, agricultural operations consist primarily of cash cropping, dairy and beef operations. Soils on both sides of the river are typically fine grained (silts and clays) which tend to adsorb contaminants and can be transported long distances.

Ontario tributaries have been found to contribute pesticides including atrazine, alpha-BHC, gamma-BHC, dieldrin, alpha-endosulphan, p,p'DDE, p,p'DDD, p,p'DDT, endrin and methoxychlor. Dieldrin is the only pesticide which has been found to exceed water quality guidelines in the AOC. The total loading of dieldrin from Ontario tributaries, based on instantaneous loadings is 0.000118 kg/d. Contamination by dieldrin is widespread and likely includes upstream sources since it is detected in all tributaries. It does not degrade quickly and, thus, may be more representative of historical usage. In Canada dieldrin registration under the *Pest Control Products Act* was discontinued in 1990. Manufacture and importation was not permitted but existing stocks could be

used. In practice, little has been used since the mid 1970s. Ontario announced a ban on the use of dieldrin in 1993.

Waste Disposal Sites

Contaminants from waste disposal sites may be transported to the St. Clair River through groundwater pathways and/or surface water runoff. Contaminant loads from waste sites have not been measured and therefore impacts on the St. Clair River are unknown. There are twenty-three industrial and four municipal waste sites within the Ontario portion of the AOC. There are nine known waste sites and four known leaking underground storage tanks in the Michigan watershed which require further assessment and possible cleanup. These sites have some potential for surface water contamination and are listed on the Priority List for EVALUATION AND INTERIM RESPONSE under Act 307.

HABITAT

The loss of wetland resources and other fish and wildlife habitat is considered a major concern within the AOC. Wetlands have been lost by drainage of land for agricultural purposes; dredging or filling for navigation, marina and housing developments; and hydrologically separating the wetland from the main channel. Quantitative estimates of wetland loss indicate that, on the Michigan side, a 72% decrease in aerial extent between 1873 and 1973 occurred while in Ontario 2,630 acres (1,064.36 ha) were lost between 1965 and 1984 from the mouth of the Thames River to Chenal Ecarte, including channels of the Walpole Island Indian Reserve. Agricultural drainage accounted for 92% of the losses. Marine and cottage development has accounted for the remaining portion (8%) of the loss of wetland.

Industrial, agricultural and urban development, involving extensive bulkheading and infilling, have altered shoreline configurations and minimized spawning, rearing and feeding sites of many fish species. The delta area has seen increased use by waterfowl species in general (between 1968-1982) but a decrease in use by diving ducks specifically during the fall season. Spring use of the area has seen little change in terms of peak number of waterfowl, but a decrease of 79% for dabbling ducks is documented as occurring between 1968 and 1982. Peak counts of migrating waterfowl in U.S. waters of Lake St. Clair averaged less than 50,000 ducks with a high peak count of 51,130 in autumn of 1988 and a low of 32,000 in 1986. Waterfowl counts have been on the increase since 1989. Peak counts range from a low in 1989 of 52,630 to a high in 1991 of 209,000. Peak counts from 1989 through 1993 averaged just under 100,000.

Reduction in waterfowl in the 1960s, 1970s and early 1980s may be attributed to drainage and the subsequent loss of wetlands, boat traffic, hunting and local or continental population declines of certain species.

GOALS, OBJECTIVES & EVALUATION CRITERIA

RAP WATER USE GOALS & OBJECTIVES

The goals and objectives were prepared following the release of the Stage 1 report in December, 1991. They were prepared in response to the specific environmental problems defined in the Stage 1 document and are consistent with the provisions of Annex 2 of the GLWQA. The goals and objectives were developed so as to be consistent with the standards, objectives, criteria, regulations and policies of OMOEE and MDNR. They were developed jointly between the Binational Public Advisory Committee (BPAC) and Remedial Action Plan (RAP) Team through a series of workshops. The first was a one day Water Use Goals workshop held in January, 1992. This was followed by a series of Objectives Setting workshops. Draft water use goals and specific objectives were then reviewed, prioritized and ratified at a combined workshop in November, 1992. These were revised following public review and the final water use goals and objectives were formally released on January 14, 1993.

The specific time frame for achieving the goals varies and will be determined by the work required. The goals are consistent with the intent of the Great Lakes Water Quality Agreement (GLWQA), to restore, protect and maintain beneficial water uses, as well as the chemical, physical and biological integrity of the St. Clair River and delta. In addition to the specific RAP goals, the St. Clair River RAP recognizes the obligations under the GLWQA to strive for virtual elimination within a philosophy of zero discharge of persistent toxic substances.

The water use goals and objectives defined by the RAP Team and BPAC are as follows:

Aesthetics

Achieve and maintain an aesthetically pleasing clean "blue water" and an appropriate balance of natural shoreline and human uses.

There should be sufficient public access to the river for recreation, enjoyment and cultural activities.

Consumption of Fish and Wildlife

Eliminate the need for restrictions on human consumption of fish and wildlife for reasons of health.

Objective A.

Human Consumption: By the year 2000, levels of contaminants in fish and wildlife attributable to sources in the AOC will not pose a health hazard to humans based on consumption guidelines.

Ecosystem Health

Attain and maintain healthy, diverse and self-sustaining biological communities and habitats.

Ensure there are no negative impacts on the health of local populations due to water quality.

Ensure no net loss of fish and wildlife habitat and reclaim, rehabilitate and enhance habitat where possible.

Objective B

Wetland & Aquatic Habitats: By the year 2000, protection of existing (1992) habitat and enhancement and appropriate increase of sustainable, viable wetland and aquatic habitats will be achieved.

Objective C

Ecosystem Improvements: By the year 2000, we will demonstrate improvements in ecosystem health through:

- reductions in body burdens of persistent bioaccumulative substances to a level below established effect levels;
- enhancement of abundance and species diversity;
- establishing that no exceptional incidents of tumours or deformities are evident in fish and wildlife populations; and
- achievement of environmental yardsticks, e.g., water and sediment.

Recreation and Shipping

Ensure that the water quality is safe for body contact at all times.

Eliminate adverse environmental effects caused by recreational and shipping activities.

Objective D

Recreation: By the year 2000, consistently acceptable water quality and access for recreational uses such as swimming, fishing, boating and aesthetic enjoyment will be provided.

Sources of Contaminants

Ensure that no source (point or non-point) impairs water quality.

Eliminate spills.

Objective E

Point Sources (including shipping): By the year 2000, there will be top quality river water as measured against ambient water quality objectives in the AOC through pollution prevention activities and effective control of industrial, municipal, shipping, air and water discharges.

Objective F

Non-Point Sources: By the year 2000, all urban and rural non-point sources (e.g., sources of herbicides/insecticides, soil, nutrients [fertilizers/animal & human waste], bacteria, and input to storm sewers, lawn runoff, septic systems, storm runoff) will be controlled to achieve the overall goals of the RAP.

Objective G

Sediments: By the year 2000, river sediments and associated contaminants will not impair identified beneficial uses.

Objective H

Exotic Species: By the year 2000, the introduction of nuisance exotic species will have been prevented and their expansion will have been controlled.

Water Supply

Ensure that an adequate and affordable water supply, in quality and quantity, is available from the St. Clair River for users at all times.

Objective I

Water Quality and Quantity: By the year 2000, river water meeting quality criteria for municipal, industrial, agricultural and residential non-drinking uses and as a drinking water source using normal treatment processes will be available without interruption.

POINT SOURCE

The Point Source Task Team formally defined 'Point Source' as follows:

Any discrete, quantifiable discharge (air and/or water), e.g., outfall, pipe, conduit, lined ditch/channel, tunnel, which discharges directly to the St. Clair River or its tributaries from industrial/municipal discharges including:

- storm water runoff from developed areas of industrial sites/activities;
- urban storm runoff;
- spills;
- CSOs;
- residential discharges;
- landfill leachate systems.

POINT SOURCE REGULATORY PROGRAMS: MICHIGAN & US

Effluent requirements for wastewater discharged to Michigan surface waters are established in National Pollutant Discharge Elimination System (NPDES) permits. NPDES permits are required for all municipal and industrial point source discharges and are issued under the U.S. *Clean Water Act* and the *Michigan Water Resources Commission Act*. Effluent limits are required to be as stringent as the national effluent guidelines.

In November 1990, based on 1987 amendments to the *Clean Water Act*, the U.S. EPA passed new regulations requiring certain commercial and industrial facilities to apply for NPDES permits for storm water discharges from point sources. Municipalities with populations over 100,000 and served by separate storm sewers were also required to apply for an NPDES permit.

Several state and federal regulations are all used to address spill prevention and response. The *Michigan Water Resources Act* has been the most significant regulation used to reduce the impact, number and severity of spills. This act regulates storage and shipping for all "polluting materials" and acts as a mechanism for the establishment of spill prevention, notification and clean-up procedures.

Non-domestic users which discharge to municipal WWTPs, come under the Industrial Pretreatment Program (IPP) of the NPDES permitting program. The IPP contains details as to how the industrial wastewater will be treated prior to discharge to the municipal collection system, establishes local limits, and outlines monitoring, compliance and enforcement requirements.

Air pollution control is addressed through a permitting process similar to the NPDES process, under the authority of the federal *Clean Air Act* and the *Michigan Air Pollution Act*. The *Clean Air Act* also includes specific provisions for the protection of the Great Lakes from toxic air pollutants.

ACTIONS IN PROGRESS RELATED TO USE IMPAIRMENTS

Remediation and Prevention Approaches

In general, measures available for any point source may involve one or more of the following five major categories:

- change in process resulting in an elimination or reduction in the use of or production of chemicals of concern;
- change in process to closed system whereby no discharge to ambient environment occurs;
- elimination of process entirely;

- improved and/or optimized water collection and treatment technology; and/or
- institution of best management practices relating to storage, handling, containment, training, and so on.

Given the wide range of industrial and municipal sources, including stormwater and CSOs, and the large number of facilities discharging to the St. Clair River AOC, it is not possible in the context of this document to review all remediation approaches available. Many of these have been described in the Beak (1993, Part B - Appendix 4.3) report on industrial and municipal sources. Rather than recommend specific technologies for each point source in the AOC, the Task Team has focused on the determination of required loadings to meet yardsticks (KETOX model, Section 4.3.3) and a quantitative ranking of individual sources of specific contaminants. Required reductions at each facility will be evaluated by responsible agencies against their planned and ongoing remedial programs and, if further reductions are required to meet ambient yardstick values, then these will be negotiated by responsible agencies with each facility affected.

Ontario industrial and municipal facilities have provided current and projected contaminant loadings to the St. Clair River for modelling. These projections are presented in Appendix 4.2 and all facilities are striving to meet these projections by the year 2000.

Ongoing Programs

Ontario Municipal

Corunna WPCP: This WPCP is operated by the Ontario Clean Water Agency and is an extended aeration secondary treatment facility with continuous phosphorus removal and chlorination. There have not been any upgrades since 1990 and none are anticipated. The option identified for this plant is optimization to improve the removal efficiency of pollutants.

Courtright WPCP: This WPCP is also operated by the Ontario Clean Water Agency. It is an extended aeration secondary treatment facility with continuous phosphorus removal and chlorination. It underwent a major study in 1992 and 1993 to optimize plant performance. Improvements have been realized as a result of this study. No additional improvements are planned.

Point Edward Water Pollution Control Plant (WPCP): This plant is operated by the municipality. It was upgraded to secondary treatment and ultraviolet disinfection in October 1992. This has resulted in major improvements to effluent quality. The only technical option identified for this plant is process optimization to ensure maximum efficiency. Optimization of the new secondary treatment facility is presently being undertaken.

Sarnia WPCP: The Sarnia WPCP is operated by the municipality. It is currently a primary treatment facility with continuous phosphorus removal and seasonal effluent chlorination. The City of Sarnia is in the final stages of a consultant selection process for an Environmental Study Report and Design for upgrading the plant to secondary treatment. This upgrade has a projected cost of \$30 million and is expected to result in loading reductions of 50% for total suspended solids, 70% for BOD, 100% for fecal coliforms and 0% for total phosphorus. The secondary treatment upgrade is expected to be completed and operating by 1997. This upgrade is part of the recommendations identified in a Pollution Control Plan which was completed for the municipality in March 1993 by UMA Engineering Ltd. The preparation of the Pollution Control Plan was cost shared by the municipality, OMOEE and Environment Canada's Great Lakes Cleanup Fund. Funding for the Pollution Control Plan was prompted in large part because Sarnia is situated within the St. Clair River AOC.

The proposed upgrade design for the Sarnia WPCP will also increase plant capacity and significantly reduce combined sewer overflows while providing primary treatment and disinfection

(likely ultraviolet method) to any which occur. The Pollution Control Plan has been formally adopted as City Policy and includes the installation of CSO storage tanks and a treatment pond system for the storm sewers that are contaminated with CSOs. The total cost of CSO controls is projected at \$12.7 million. Installation of off-line storage tanks has begun and completion dates are as follows: Devine St. (the largest) will be 85% complete by March 1996 and cost approximately \$5.4 million; Cromwell St. - 1997 (\$4 million); Exmouth St. - 1999 (\$2.5 million); Wellington St. - 2001 (\$0.8 million); and the retention pond system will be completed in 2003 (\$6.7 million). Upon completion of the CSO project, only 3 to 5 CSO events per year are expected however, these CSO events will be disinfected before discharge using the ultraviolet method. The CSO control project is being funded by the federal/provincial infrastructure program.

The City of Sarnia instituted a program over the past several years to install water meters in homes which were previously not metered. This action, in addition to an environmental surtax based on water consumption, has had the effect of lowering water consumption and establishing a fund to defray infrastructure costs.

There are no ongoing or planned upgrades/studies for either the Sombra or Port Lambton Lagoons. The use of physical-chemical treatment and an aerated and/or facultative lagoon and a multi-cell intermittent sand filter has been suggested for upgrading these lagoons.

Ontario Industrial

AKZO Chemicals Ltd. (Sarnia): This facility has been shut down since 1992 and decommissioning programs are nearing completion. Decommissioning programs include: removal of equipment; removal and appropriate disposal of wastes such as organic amines, ammonia, methyl chloride and hydrogenated tallow fatty acids; removal and remediation of historic ethyl benzene contaminated soil; and soil and groundwater surveys.

AMOCO Canada Resources Ltd. (Sarnia): A waste audit study was undertaken in 1993 to identify contaminant sources for evaluating various treatment options available. A leak abatement program is also underway to minimize contamination of surface runoff by leaking process stream valves.

BASF Canada Inc. (Sarnia): Recently completed and ongoing remedial measures at this facility include: new primary treatment facility for removal of rubber from process effluent; further treatment of effluent at Polysar's biological treatment plant; water conservation programs have reduced consumption by about 50% since 1990 and further reductions are planned; process related improvements to non-contact cooling water to reduce acrylonitrile concentrations; installation of new vertical condenser (1992) to pressurize cooling water above that of process water.

Cabot Canada Ltd. (Sarnia): Cabot has examined using treated effluent in the process to achieve zero discharge, however, this was determined not to be feasible. The company may re-evaluate this option.

Chinook Chemicals Company (Sombra): Process and storm sewer effluents are treated for odour (peroxide treatment) in a holding pond then spray irrigated during summer and discharged to the river during winter. Recently completed and ongoing remedial measures at Chinook Chemicals include: improved aeration of collected rainfall water holding pond; toxicity source investigation/evaluation; ultraviolet/ ozone treatment for organics removal; groundwater and soil surveys; revision of the dimethylformamide process to reduce contaminants in final discharge; implementation of new methylamine production technology.

Cole Drain (Cut-Off Drain): Although not an industrial facility, this drain contributes significant loadings of contaminants from both point sources (industrial site runoff and landfill leachate) and non-point sources (urban and rural runoff). The Cole Drain is an open ditch system servicing an

area south of Sarnia's residential and business core. It also receives inputs from the Scott Road Ditch prior to entering the St. Clair River.

Four waste disposal sites located on Scott Road include the Fiberglas and Dow waste sites and Polysar and Esso Petroleum landfills. The Fiberglas and Dow sites are closed. Leachate from both sites pass through activated carbon beds however only leachate from Fiberglas is treated off site. Leachate from Dow is released to the Cole Drain. The Esso Petroleum and Polysar landfills on Scott Road are still in operation. Both have berms to contain surface runoff and only the Esso Landfill has leachate collection and off site treatment. Both sites however, have runoff and leachate entering the Cole Drain. Polysar is currently developing a long range strategy and remedial action plan for the site.

Dow Chemical Canada Inc. (Sarnia): All chlorine chemistry operations at Dow Chemical in Sarnia have been shut down since mid 1993. As a result, the plant no longer produces chlorine, sodium hydroxide, ethylene dichloride, vinyl chloride, propylene oxide, nor styrene/butadiene latex. Dow is currently implementing a multi-million dollar River Separation Project which will ultimately remove the plant from direct contact with the St. Clair River - key components include: separation of non-contact cooling water from storm water collected inside the battery limits of each processing unit (to allow process unit drainage to be captured and tested before release); piping of non-contact cooling water to combined sewer collecting storm water outside of process area; assessment of spill risk from water cooled heat exchanger; reduction of process wastewater by recycling and reuse.

Dow Chemical formerly operated a waste disposal site (Scott Road) with a leachate collection system. Leachate is passed through carbon filters prior to discharge. The adequacy of the existing collection system has not been proven and there is a potential for some leachate to pass through the existing sheet pile wall and discharge to the river via the Cole Drain. Surveys are currently underway to determine the extent of hydrocarbon contamination at this waste site.

Dow Chemical operates a non-hazardous waste site on LaSalle Road. Stormwater runoff is collected in a pond where it is tested for contamination. If treatment is not required, stormwater is released to Talfourd Creek. If treatment is required, stormwater is sent to Dow's biox treatment plant.

DuPont Canada Ltd. (Corunna): Recently completed and ongoing remedial measures at this facility include: internal water recycling; high frequency testing and on-line analyzers for detection of leaks; studies to determine sources of dioxin and suspended solids; in-place spill response plan; dyking of all hydrocarbon storage areas; staff training.

Ethyl Canada Inc. (Corunna): As of May, 1993 the ethyl chloride production unit shut down and as of April 1994, all tetraethyl lead and tetramethyl lead production was halted. Continuing production at the plant consists only of mixing, blending and repackaging of industrial chemicals and the Diesel ignition improvers (DII) manufacturing. The rail tankcar/refinery cleaning and sludge recycling operations will also continue. As a result of these production shut downs, major sources of lead, ethylene dibromide, ethylene dichloride, and ethyl chloride will be removed from wastewater discharges. The DII wastewater stream will continue and the rail tankcar/refinery washings as well as out-of-spec stormwater will continue to be treated by the wastewater treatment plant to ensure the plant meets its outfall criteria.

Fiberglas Canada Inc. (Sarnia): This facility ceased production in 1992. Decommissioning procedures included: removal and off site disposal of contaminated stormwater and stored process water; removal and cleaning of process equipment, tanks and pipes; constructed new PCB waste storage site and properly stored all PCB capacitors; removed wastewater settling lagoon and surrounding contaminated soil; and demolished maintenance garage, #4 warehouse, waste water treatment building, furnace hall and batch silos. Where possible all metals, steel, wood and concrete have been recycled.

Fiberglas formerly operated a waste disposal site on Scott Road. The site was closed and capped in 1983. Leachate is collected, passed through activated carbon beds and treated off site.

ICI Canada Inc. (Courtright): ICI operates a stormwater collection system, which can be discharged through its outfall. A covered gypsum stack pondwater treatment system is also operated by ICI.

Imperial Oil Chemicals Division (Sarnia): Recently completed and ongoing remediation measures at this facility include: recycling of river water through three operating unit cooling systems; increased reliability of the wastewater treatment plant; improvements to wastewater treatment plant early detection systems; spill contingency plan including response team, containment measures and investigations; staff training; provision of training manuals and formal program.

Imperial Oil Limited (Sarnia) Refinery: Recently completed and ongoing remediation activities at this facility include: increasing steam condensate collection; reduction of cooling water usage; segregation of once-through cooling water from process streams; change to organic chemicals from metals to reduce toxicity of cooling water tower blowdown; on-line analyzers installed on once-through cooling water discharges; dechlorination of cooling water; reduction of contaminants from activated sludge plant; staff training; and development of a spill reduction strategy including a spill source control program and on-site spill response team.

Lambton Thermal Generating Station (Courtright): Recently completed an ongoing remediation measures at this facility include: retrofitting of flue gas desulphurization technology designed to minimize water use and to produce a marketable by-product; dyking of storage tanks; improvement of coal and ash drainage area; construction of oil/water separators in new buildings; staff training; emergency response team trained in spill response; and a spill response plan. Other measures include a spill risk assessment, plans for installation of outfall channel booms and oil detection equipment, and studies of on-site wetlands.

Liquid Carbonic Inc. (Courtright): Recent initiatives undertaken at this facility include: installation of a berm at the outfall; 40% reduction in water use since 1989; installation of high/low alarms on the oil recovery drum.

Novacor Chemicals (Canada) Ltd. (Corunna): Recently completed and ongoing remediation activities include: reduction of cooling tower blow down; water conservation studies; elimination of metals as cooling water treatment chemicals; removal of zinc contaminated sludges and installation of easy-to-clean membranes in ponds; improved pilot plant performance (filtration and BIOX); sewer segregation; baseline benthic studies; staff training; wastewater plant operating targets and dedicated laboratory; spill response equipment.

Novacor Chemicals (Canada) Ltd. (Mooretown): Recently completed and ongoing remedial measures at Novacor Chemical's Mooretown facility include: installation of a geomembrane of fibre webbing and gravel in the process wastewater pond and retention ponds; regular testing of sumps within process units prior to entering wastewater treatment system - if too highly contaminated, it is removed and disposed by a private contractor; computer program to systemize the maintenance program and equipment; spill control measures; staff training and procedural documentation. The facility is currently undertaking a total survey of its waste water streams and systems by an outside consultant. Recommendations for improvement to the waste water management system are expected toward the end of 1994.

Novacor Chemicals (Canada) Ltd. (Sarnia): Recently completed and ongoing remedial measures at Novacor Chemical's Styrene II facility include: conversion of closed Styrene I ditch to use as a storm or spill retention system; evaluation of treatment technology relating to oil

removal, filtration and carbon adsorption; new process technology which significantly reduces/eliminates process wastewater; spill prevention strategy.

Partek Insulations Ltd. (Sarnia): The non-contact cooling water effluent is scheduled to be eliminated with the installation of a cooling tower and complete recycling of cooling water. This will virtually eliminate emissions from Partek.

Polysar Rubber Corporation (Sarnia): Recently completed and ongoing remedial measures at this facility include: spill prevention strategy; installation of a closed-loop cooling system on one major unit in 1993 with a second unit scheduled for 1994, to eliminate possible discharges of contaminated cooling water to the river; containment and testing of storm water and fire water; re-routing of two effluent streams through the BIOX plant; installation of dechlorination facilities; partial replacement of benzene with cyclohexane; staff training; equalization basin to stabilize flows to BIOX plant being considered; engineering studies relating to optimization of the BIOX plant, sludge dewatering and unit containment.

Polysar also operates a landfill and flyash lagoon (Scott Road) with a surface water collection system. The collected surface water is pumped via pipeline to the Polysar BIOX Plant where it is treated prior to discharge to the river. Leachate springs have been observed on the east berm and the containment of surface runoff on the eastern portion of the landfill may be inadequate. Contaminants within the Polysar perimeter drain as well as any which may reach the Scott Road Drain will eventually discharge to the St. Clair River via the Cole Drain. Polysar is currently developing a long range strategy and remedial action plan for the site.

Praxair Canada Inc. (Moore Township and Sarnia): The following practices are in-place at both these facilities to reduce opportunity for discharge of toxic compounds: floor drains are covered; spill response plans; chemical storage areas are dyked; and residual chlorine and bromine have been reduced in the cooling water. The Sarnia plant also has oil/water separators on all floor drains. In addition, a study has been undertaken to determine feasibility of substituting chlorine and bromine with ozone for cooling water treatment.

Shell Canada Products Ltd. (Sarnia): Recently completed and ongoing remedial measures at this facility include: installation of a third clarifier for improved TSS removal; installation of an oil/water separator to treat cooling water having potential of contamination; sewer separation program; water use reduction programs; process control of the BIOX unit; on-line leak detection; elimination of zinc and chromate from cooling tower; dechlorination of cooling water; staff training; on-site spill response equipment; spill containment measures; wastewater treatment plant optimization studies.

Suncor Inc. (Sarnia): Recently completed and ongoing remedial measures include: ongoing program to reduce water use; sour water recover system to reduce intake requirements; collection of steam condensate for re-use; pressurization of once-through cooling water to prevent contamination with hydrocarbons; treatment of recirculated cooling water; on-line sensor on influent of API separator to detect oil emissions to once-through cooling water; on-site spill response equipment; staff training. Suncor has also installed an in-stream GC analyzer to monitor river water intake, once-through cooling water discharge, and process water discharges for benzene, toluene, xylenes, ethyl benzene, and other chemicals in trace quantities.

Terra International Canada Inc. (Courtright - formerly ICI Nitrogen Products): Recently completed and ongoing remedial measures at Terra include: spill prevention programs including collection and recycling of process waters; elimination of chromium and chlorine in cooling tower water treatment; staff training; reduced once-through cooling water use; upgrade of air scrubber in urea granulation process. Upgrades to process equipment nitrogen solutions have resulted in a recycling of previously discharged product.

Welland Chemical Ltd. (Sarnia): Recently completed remedial measures at this facility include: new wastewater treatment system (1992) and changes in lagoon operations have significantly reduced phenols, cadmium, aluminum, trace metals, sulphide and chlorinated organics; conversion of water cooled compressors with air cooled compressors has greatly reduced water consumption and toxicity related to residual chlorine in intake water.

Michigan Municipal

In 1989 the MDNR implemented a CSO Control Program, to be implemented through the NPDES permit system, to eliminate or adequately treat all CSOs in Michigan. In the interim, all facilities are also required to notify the MDNR, the MDPH and the local daily newspaper whenever there is an overflow. Progress on the CSO Control Program (as of March, 1994) and other Waste Water Treatment Plant (WWTP) remedial measures undertaken or planned since 1990 are documented below.

Capac Waste Water Sludge Lagoons (WWSL): Capac has a three lagoon treatment system which discharges to the Belle River via Lemon Drain. The city has completed separation of combined sewers and is conducting the final flow tests for certification.

St. Clair River Sewer Authority (East China Township WWTP): The WWTP has secondary treatment with phosphorus removal. There are no CSOs associated with this facility.

Marine City WWTP: This facility was converted to an activated sludge process in 1993. Grit and sludge handling, chemical addition and the feedback system were improved. Also, two final clarifiers and a new laboratory/office were added.

The process of sanitary and storm sewer separation will be completed in 1994.

Marysville WWTP: Marysville WWTP is a trickling filter secondary plant with chemical phosphorus removal and effluent chlorination.

One CSO has been discontinued and two remain with approximately 12 discharges to the river per year. The City of Marysville has recently completed a program to separate all storm and sanitary lines comprising one CSO. The second outfall must be separated by 2001, based on a long range plan approved by the MDNR. In addition, to separation, the City has installed monitoring stations on each outfall to the river which record volume of flow and sample discharges for certain water quality parameters.

Port Huron WWTP: The Port Huron WWTP is an activated sludge secondary treatment plant with chemical phosphorus removal and effluent chlorination. A new outfall structure has recently been constructed for the Port Huron WWTP and the diffuser was raised from the bottom of the river to eliminate impacts to benthic fauna.

The WWTP submitted a CSO abatement plan to MDNR in December, 1992 and is awaiting approval. The plan includes a combination of sewer separation and containment basins to eliminate 20 CSO points including 10 on the Black River and 10 on the St. Clair River. The plan is to be implemented over the next 30 years.

St. Clair WWTP: This facility is a trickling filter secondary treatment plant with chemical phosphorus removal and effluent chlorination. Sewer separation was completed in 1994. Two lift stations have been replaced with newer units having increased capacity and an additional lift station has been added. The remaining older unit was replaced in 1994. One additional lift station is relatively new and will require only modifications to the flow monitoring equipment.

St. Clair - Algonac WWTP: The St. Clair County - Algonac WWTP is a rotating biological contactors secondary treatment plant with chemical phosphorus removal and effluent

chlorination. A 480,000 gallon (1.817 millionÉL) sludge storage facility was constructed at the plant. In addition, new sludge valves were installed in the primary tanks and one rotating biological contactor was replaced.

There are no CSOs associated with this facility.

Memphis Waste Water Sludge Lagoons (WWSL): The City has a two lagoon treatment system, which discharges to the Belle River. In 1994, to increase treatment capacity, the City removed 20 years of sludge that had accumulated in the lagoons.

Yale WWSL: This facility discharges to the Black River via Mill Creek. The City constructed a third stabilization lagoon in 1993. The two original lagoons were desludged in 1994. Separation of combined sewers was also completed in 1994.

Michigan Industrial

AKZO Salt (St. Clair): This facility has developed a PIPP and pollution control manual. Spill prevention includes containment measures, daily inspections, pressure sensors to detect leaks, and best management practices relating to storage and handling of chemicals. Planned remedial measures include an additional storage tank for the wastewater treatment system to reduce the number of process wastewater overflows of brine to near zero.

Detroit Edison Company (Belle River, St. Clair and Marysville): Facility specific PIPP and Emergency Control Plans have been developed detailing spill notification and response procedures. The plans incorporate the requirements of the federal Spill Prevention, Control, and Countermeasure Plan, the hazardous waste (RCRA and Act 64) Contingency Plan, the *Toxic Substances Control Act* and the *Superfund Amendments and Reauthorization Act*. Spill containment measures have also been constructed.

E B Eddy Paper (Port Huron): This facility has a PIPP which includes spill notification and response procedures. Materials stored and the containment provided are nearly identical to that at James River (see below). This facility added an equalization tank to the wastewater treatment system in 1992.

James River Corporation (Port Huron): Remedial measures undertaken since 1990 include: isolation of process chemicals from waste streams; installation of alarm systems to warn of potential problems; reduction in amount of chemical handling reducing opportunity for spills and reduction in solid waste; new lamella settler to be installed in 1994 to reduce TSS content of process wastewater discharge; development of a Pollution Incident Prevention Plan (PIPP) relating to spill prevention, notifications and response and including the construction of containment measures.

Mueller Brass: This facility is currently discharging all dry weather flows from the property to the City of Port Huron sanitary sewer system. The company is in the process of constructing a storm water collection system. All wet weather flow will be contained, treated and used as process cooling water. All surface water discharges will be eliminated by the end of 1994. It has developed a PIPP relating to spill notification and response.

NON-POINT SOURCE

OVERVIEW

Contaminants from non-point sources may have contributed to 5 of 9 beneficial use impairments. The impairments and associated contaminants are as follows:

- restrictions on fish consumption (mercury, PCB);
- chironomid mouthpart anomalies (through water and sediment contamination);
- degradation of benthos (through sediment contaminated with copper, iron, lead, mercury, nickel, cadmium, zinc, total phosphorus and PCBs);
- restrictions on dredging (copper, iron, lead, mercury, nickel, cadmium, zinc, total phosphorus, PAHs and PCBs); and
- beach closings (bacteria from urban and rural runoff, domestic sanitary sources).

Based on available data, non-point sources including Lake Huron contribute at least ten percent of the total loadings to the St. Clair River for the following parameters: copper, iron, lead, mercury, nickel, cadmium, cobalt, PAHs and PCBs. In addition, non-point phosphorus and zinc contributions are close to ten percent of the total loadings. Additional parameters of concern are also suspected to be associated with non-point source loadings, but require additional investigation.

Six major non-point sources of contaminants in the watershed were identified and include:

- urban storm runoff (point source task team responsible for storm runoff from industrial sites);
- rural storm runoff;
- waste sites without leachate and runoff collection (waste sites with leachate collections systems addressed by point source task team);
- malfunctioning septic systems;
- all domestic sources not connected to municipal treatment facilities; and
- generation and disposal of household hazardous waste (HHW).

A complete Non-Point Source Work Plan is provided in Appendix 3.2. This work plan represents actions taken by the Non-Point Source Task Team for the development of the Stage 2 RAP. It is comprised of four components which are summarized below. These tasks do not represent recommended actions resulting from task team deliberations. Recommendations (actions) are summarized at the end of this chapter. Work Plan components include:

Urban and Rural Storm Runoff

Identify and monitor sources contributing to storm runoff;

- Assess types and causes of "controllable" pollutants (chemicals, nutrients, bacteria, sediments, road salt);
- Identify measures to control urban and rural storm runoff;
- Implement control measures; and
- Evaluate the environmental effectiveness of prevention measures.

Waste Disposal Sites

- Compile and evaluate waste site information;
- Recommend action where an identified concern exists;
- Ongoing monitoring of all sites;
- Implement control measures; and
- Evaluate the environmental effectiveness of prevention measures.

Domestic Sanitary Sources

- Identify and document conditions in the St. Clair River, its tributaries and beaches;
- Identify problem areas;
- Document municipal initiatives;
- Mandate ongoing maintenance of private sewage disposal systems;
- Develop and implement remedial actions; and
- Evaluate the environmental effectiveness of prevention measures.

Household Hazardous Waste

- Promote public education and awareness to minimize waste production and to encourage proper disposal and handling.

REGULATORY PROGRAMS: MICHIGAN & U.S.

Urban stormwater and/or snow melt induced runoff is controlled through the Non-point Source Control Program (NPS) and the Stormwater Control Program (SCP). The NPS program address both urban and rural/agricultural non-discreet runoff sources and provides funds for the design and implementation of control measures. The SCP program addresses runoff associated with discreet point sources such as storm sewers. It regulates runoff from construction sites that disturb five acres (2 ha) or more of land and have a point source discharge of storm water into a municipal separate storm sewer or waters of the state. Small and large industrial sites are mostly regulated through general storm water permits, with some requiring individual permits. Municipalities with a population of 100,000 or more that discharge to a municipal separate storm sewer system require a municipal storm water permit.

Agricultural runoff is principally addressed through the U.S. Department of Agriculture (USDA) Natural Resource Conservation Service - NRCS (formerly Soil Conservation Service - SCS) and the Cooperative Extension Services (CES). Both agencies provide education and expertise to farmers regarding soil erosion and management practices as well as animal waste control and use of pesticides. The USDA, Natural Resource Conservation Service (Soil Conservation Service) has also implemented several agricultural programs in portions of the St. Clair watershed that are used to apply conservation practices to highly erodible land. The Integrated Crop Management Program ensures that nutrients and pesticides are applied to cropland in an efficient and environmentally sound manner.

The *Michigan Hazardous Waste Management Act*, Act 64, Public Acts of 1979, as amended, regulates the generation, use, transport, storage, and disposal of hazardous wastes within Michigan. The *Michigan Environmental Response Act*, Public Act 307 of 1982, as amended (MERA), and its administrative rules, provide for the identification, risk assessment, evaluation and clean up of sites of environmental contamination in the State.

Pesticide use in Michigan is regulated by the *Pesticide Control Act*, Michigan Act 171 of 1976 as amended. The Michigan Department of Agriculture "Clean Sweep" program allows farmers and chemical distributors to turn in out of date chemicals for proper disposal.

Installation and operation of septic tank/tile field disposal facilities are regulated through a cooperative program involving the MDNR and the local County Health Department under the provisions of Act 245, Public Acts of 1929, as amended.

REMEDIATION & PREVENTION APPROACHES

Non-point source problems will be addressed through comprehensive watershed management planning. Remedial and preventative measures for each non-point source are summarized as follows:

Urban and Rural Storm Runoff

Identify and monitor sources contributing to storm runoff;

- Assess types and causes of "controllable" pollutants (chemicals, nutrients, bacteria, sediments, road salt);
- Identify measures to control urban and rural storm runoff;
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REMEDICATION & PREVENTION APPROACHES

Non-point source problems will be addressed through comprehensive watershed management planning. Remedial and preventative measures for each non-point source are summarized as follows:

Urban Runoff

Schroeter and Associates (1992) conducted an Ontario, Great Lakes basin wide study which provided estimates of annual loadings for 26 toxic contaminants in urban stormwater runoff, combined sewer overflows and sewage treatment plant effluents. Results, in terms of total solids loadings, showed that surface runoff generated 49 to 96% of the total; overflows and combined sewers accounted for 1.5 to 20%; and sewage treatment plant effluents contributed 4 to 39% of the total (Schroeter and Associates 1992).

There are three general remediation approaches:

- pollution prevention;
- pollution control; and
- land use policy/planning.

Rural Areas

Tributaries subject to rural runoff have been identified as a contaminant source in the St. Clair River watershed; remedial options include:

- control soil loss;
- proper storage and handling procedures for manure; and
- reduction in, and proper use of, pesticides.

Waste Disposal Sites

Options related to problems encountered with industrial and municipal landfill sites include:

- landfill design;
- construct leachate collection and treatment systems;
- regular monitoring programs for problem detection;
- alternative treatments such as removal or solidification of liquid waste;
- decrease the quantity of waste sent to landfills, reduce, reuse and recycle;
- retrofitting existing landfills to meet current standards; and
- mitigation and remediation of contaminated shallow groundwater.

Waste disposal sites and landfills are potential sources of groundwater and surface water contamination. The non-point source task team was responsible for evaluating waste disposal sites without leachate and runoff collections systems. Waste disposal sites with leachate and surface water collections systems are the responsibility of the Point Source Task Team.

The non-point source task team used the Stage 1 document and Technical Options report (Beak 1993; Part A, Section 3.5 in Appendix 4.3) in order to identify all sites not having leachate and collection treatment systems. The Ontario site list was submitted to the OMOEE Senior Environmental Officer at the OMOEE district office who provided the non-point source task team with the most recent available information. These data were used to evaluate each site

Results for Ontario sites revealed that there is not enough information available to make an assessment for three waste disposal sites and three landfill sites. Two potential problem sites were identified, the Ladney Waste Disposal Site and the Canatara Landfill.

The Ladney Waste Disposal Site operated in the late 1950s and early 1960s receiving a variety of industrial wastes both as bulk waste and in drums. Upon closure, actions to cover exposed tar and open pits was unsatisfactory. In 1979 OMOEE issued a Control Order to solidify and cap two lagoons containing styrene tar. Work required by this order was completed in 1981. In the spring of 1990 an oil like substance was observed seeping from the Ladney site into a drainage ditch that eventually drains into Baby and Talfourd Creeks. During the summer of 1990 an attempt was made by the owner to stop the flow of liquid waste and clean up the accumulated material in the ditch. This work was completed, however oil/tar has since been observed moving up through the lagoon clay caps to the surface. Remedial actions are pending.

The Ladney Waste Disposal Site was inspected on February 22, 1994. During this inspection 177 electrical capacitors were found. Subsequent tests confirmed that each capacitor contained 5 to 10 litres (1.32 to 2.64 U.S. gal) of almost pure PCBs. The capacitors and some PCB contaminated soil have been secured in 45 gallon (54 U.S. gal) drums which in turn have been put in a locked container, approved for PCB storage, that remains on the site. An investigation is ongoing to determine the source of the capacitors. In June, 1994 Golder and Associates commenced a hydrogeologic investigation and assessment of only the PCB contaminated area on the Ladney site. Study objectives include:

- (1) Determine if additional capacitors are buried in the vicinity of those already found at the site;
- (2) Determine the lateral and vertical extent of PCB contamination in the soil; and
- (3) Determine the most appropriate clean up measures for the contaminated soil.

The Canatara Landfill Site is a closed and covered landfill site that is part of Canatara Park in Point Edward. During the 1930s and 1940s chemicals and other wastes were disposed of at the site. A pollution survey in 1992 revealed that the site was generating hazardous levels of methane gas at its perimeter. Floating oil products were observed in surface water at several

locations, and benzo(a)pyrene was detected in the shallow groundwater zone, however impacts on the St. Clair River have not been documented. The report identifies several areas where follow up investigations should be done in order to determine the area, extent and intensity of contaminants. A follow up study will be used to determine remedial options for the site.

Studies will be conducted in order to properly assess the waste disposal sites and landfills for which there is limited or no information

Michigan waste disposal site information was provided by MDNR to the non-point source task team. Since the 1991 Stage I RAP was published many additional contaminated sites have been identified in Michigan and cleanup procedures have been initiated for some. Currently identified are 153 contaminated waste sites (307 sites) and Leaking Underground Storage Tank (LUST) sites in St. Clair County. Assessment and cleanup responses have been initiated for 140 of these sites. Of the remaining 13 sites, 9 are designated 307 sites, the other 4 are sites with leaking underground storage tanks.

Currently, none of the sites in St. Clair County are on the list 307 Highest Ranking Sites requiring immediate clean-up. There are no documented effects to the St. Clair River or its tributaries from these sites.

Migration of contaminants from deep injection wells to the freshwater aquifer, and subsequently to the St. Clair River may be the result of several factors that promote potential contamination. These include: (1) numerous bore holes, drilled for oil and gas exploration, if improperly closed will act as channels through bedrock to the aquifer, especially if the lower formations are under excessive pressure; (2) poorly constructed injection wells may allow waste to leak through casings; (3) pressurized waste may travel along faults in the bedrock; and/or (4) pressurized waste may migrate through permeable limestone and shale to the freshwater aquifer. Figure 5.2 shows the location of waste disposal wells in Ontario and Michigan.

Because deep well injection is no longer used for the disposal of industrial wastes, technical options are limited to:

- proper closing of bore holes and existing injection wells;
- regular monitoring of groundwater; and
- mitigation and remediation of contaminated groundwater.

Domestic Sanitary Sources

Sanitary waste disposal practices of individual households and recreational boats in the St. Clair River watershed contribute to water quality problems; control options include:

- maintain septic systems;
- correct direct discharges of untreated sewage; and
- prevent pollution from pleasure boats.

Non-domestic Discharges to Sanitary Systems

Non-domestic sanitary sources contribute to loadings discharged by way of the water pollution control plants/wastewater treatment plants; control options include:

- pollution prevention initiatives; and
- treatment of non-domestic waste prior to discharge to the sanitary system

Household Hazardous Waste

Persistent toxic chemicals are contained in such common household products as: household cleaners, pool chemicals, paint, solvents, pesticides and herbicides, fertilizers, wood

preservatives, metal and furniture polishes, some medications, chemicals in pet collars and insect sprays/powders, photographic chemicals, antifreeze, batteries and used motor oil. Control of household hazardous waste is best achieved through public education and awareness to minimize waste production and encourage proper handling and disposal.

Beak (1993; Part A, Section 3.1 in Appendix 4.3) identified technical/remedial options for each category through a review of relevant literature, discussions with experts and questionnaires distributed to the general public and interest groups.

ONGOING PROGRESS

Ontario Rural Runoff

There are a number of programs in place in the St. Clair River watershed, available to those concerned with ongoing and potential contamination of the river and its tributaries as a result of rural practices. The local Ontario Ministry of Agriculture and Food and Rural Affairs (OMAFRA) District Office in Lambton, Agriculture and Agri-Food Canada, the St. Clair Conservation Authority, and the Soil and Crop Improvement Association (OSCIA) have been active in devising and implementing farm conservation practices. Each program is geared toward the ultimate goal of preserving farmland over the long-term and initiating practices that promote conservation tillage and address pollution at the source. These programs are summarized below and information is provided in more detail in Beak (1993; Part A, Section 3.4 in Appendix 4.3) and in Appendix 5.1.

Clean Up Rural Beaches (CURB) Program: CURB is a province wide program with a mandate to identify agricultural sources of contamination of rural beaches. It is administered through local conservation authorities. Cooperative work involving OMOEE, Lambton Health Unit and St. Clair Region Conservation Authority has permitted an evaluation of water quality at beaches and tributary outflows to the St. Clair River. As a result of studies undertaken in 1993 and at the urging of BPAC, CURB funding has been approved for Clay Creek and Baby Creek watersheds.

Permanent Cover II Program: The Permanent Cover II program is a federal initiative started in September, 1992. The focus of the program is the permanent retirement, protection and maintenance of fragile agricultural land on a farm in exchange for 15 years rent from Agriculture Canada. Benefits of this program result in reduced erosion on lands adjacent to water courses and reduced risks to farmers.

High Crop Residue Program: This is a federal initiative targeted at taking erodible slopes out of production and reducing the amount of sedimentation in nearby water courses by utilizing high crop residue management. The program allocates per acre grants (up to \$10,000) to farmers willing to leave more residue from previous crops on their fields than traditionally practised.

Michigan Runoff

Urban stormwater and/or snow melt induced runoff is controlled through the Non-point Source Control Program (NPS) and the Stormwater Control Program (SCP). These programs are administered by the Michigan Department of Natural Resources (MDNR). The NPS program addresses both urban and rural/agricultural runoff from non-discreet sources such as overland sheet flow and groundwater seepage. The program provides grants for locally sponsored projects for design and implementation of non-point source control measures based on Best Management Practices (BMPs) that have been developed through the NPS program. The program is primarily voluntary rather than being permit/enforcement oriented. Programs that are part of the NPS include:

Clean Sweep Program allows farmers and chemical distributors to turn in out of date chemicals for proper disposal. Several, one day collection sites were set up over a one week period in 1993 for St. Clair County. Another is planned for 1994;

Clean Stream Program which samples rivers and educates landowners specifically for pesticides and nutrients in rivers and streams; and

Animal Waste Control Program assists and educates livestock owners with less than 400 animals in waste management practices.

Agricultural runoff is principally addressed through the Natural Resource Conservation Service (Soil Conservation Service) and the Cooperative Extension Services (CES). Michigan Cooperative Extension Services are institutions that facilitate outreach and education/informational exchange between researchers at land grant universities and the growers. The United States Department of Agriculture (USDA) Natural Resource Conservation Service (Soil Conservation Service) provides technical expertise to farmers on soil management. The Farm Service Agency - FSA (Agricultural Stabilization and Conservation Service - ASCS) of the USDA provides direct federal payments to growers/farmers who participate in programs administered by SCS under the 1985 and 1990 "Farm Bills".

The USDA Natural Resource Conservation Service (Soil Conservation Service) has also implemented several agricultural programs in portions of the St. Clair watershed. SCS has set forth policy on "Highly Erodible Land" where approved conservation techniques must be applied to all highly erodible land used to produce an agricultural commodity. In St. Clair County 3,500 acres (1,416 ha) have been designated as highly erodible and are practising approved conservation techniques.

The Agricultural Cost Share Program uses a variety of approved practices that can be implemented on cropland; such as no-till, tree planting, permanent hay cover, grass waterways, animal waste systems, etc. The Soil and Water Conservation Service in St. Clair, Lapeer and Sanilac counties cost shares with each landowner for up to 3 years. Seventy-five to eighty percent of landowners who have been involved in the cost share program continue to maintain conservation practices used in the program.

The Integrated Crop Management Program is a new program to St. Clair County which ensures that nutrients and pesticides are applied to cropland in an efficient and environmentally sound manner.

Commencing October 1994, the U.S. Department of Agriculture through the Soil and Water Conservation Districts will prepare a Southeast Michigan River Basin Study and Environmental Action Plan. This study includes St. Clair County and will follow through with county resource plans by 1996. This project will culminate in the development of a plan addressing non-point source issues. Several federal state and local agencies, organizations and other interested parties will participate in the project.

ACTIONS

The following actions are to be completed in accordance with the principles and priorities as outlined in the implementation strategy described in Section 10.2.

Watershed action:

1. Preparation of Watershed/Subwatershed Management Plans. Draft watershed management plans focusing, in part, on contaminant reduction measures will be developed within existing regulations, policies and programs by 1997

Urban storm runoff actions include:

1. For areas under development, attempt to maintain the pre-development hydrography through maintenance of natural infiltration pathways for stormwater and hence minimize surface runoff and peak flows during storm events by 2000
2. All new developments will be designed in order to maximize (protect, enhance and/or restore) existing natural features 1995 and ongoing
3. Construct on site controls to remove pollutants at existing sites by 2000
4. Bylaws/subdivision agreements will be enforced to ensure developments incorporate on-site pollution control 1994 and ongoing
5. Educate the development industry and municipalities 1995 and ongoing
6. Monitor to quantify the effectiveness of various treatments 1993 and ongoing
7. Urban and rural stormwater management should be linked through common watershed management plans 1994 and ongoing
8. Reduce the use of road salt, and explore the use of alternative de-icing products 1994 and ongoing
9. Reduce excessive use and application of fertilizers and pesticides for lawn care maintenance and, wherever possible, employ the use of alternative products and different lawn care methods 1994 and ongoing

Rural storm runoff actions include:

(1) Agricultural practices

- Promote the utilization of current programs, i.e. land stewardship ongoing since 1993
- Promote the uptake of new technology and management practices i.e. minimum till, no till, manure injection, etc. ongoing since 1993
- Monitor test results (i.e. sampling of milk house wastes, sediment loading) 1994 and ongoing
- Reduction in the use of pesticides and fertilizers 1994 and ongoing

(2) Land Use Management

- Promote maintenance of existing wetlands and forest 1993 and ongoing
- Incorporate stormwater management and watershed or subwatershed planning into the Official Plans for individual municipalities Check status and promote 1995 and ongoing
- Implement remedial and preventative measures, as appropriate, for Clay Creek and Baby Creek watersheds under approved funding from the "Clean Up Rural Beaches" (CURB) Program in Ontario 1993 and ongoing

Waste site remedial actions identified by the non-point source task team include:

1. Create incentives and increased opportunities for proper disposal of wastes Phase-in 5 years
2. Improve accountability of waste disposal practices by 1995
3. All new waste disposal sites and landfills to use only best available technology (BAT) 1994 and ongoing
4. Determine the extent of contamination with existing sites and implement plans to deal with the problem (i.e. collect and treat) 1995 and ongoing
5. Properly cap closed sites in order to minimize leachate by 1995
6. Keep an up-to-date inventory of sites and site condition 1994 and ongoing
7. Use only licensed/insured/bonded haulers 1994 and ongoing
8. Sites will only accept waste they were designed to handle 1993 and ongoing
9. Implement pollution prevention measures in order to minimize wastes Phase-in 5 years
10. Secure monies (bond) to avoid abandonments 1993 and ongoing
11. Monitor site conditions and shallow groundwater zone to assess improvements 1995 and ongoing

12. Ensure proper closing of all bore holes and wells 1993 and ongoing
13. Mitigate and remediate contaminated groundwater.

Ongoing domestic sanitary sources actions include:

1. Identify problem areas.
2. Enable County Health departments to identify public health risks and report related diseases such that actions can be enforced.
3. Require home owners to either repair the existing system, construct a new system or require the municipality to investigate long-term solutions such as connection to the municipal sewer system.
4. Check and maintain septic tank systems.
5. Correct direct discharges of untreated sewage and "grey water".
6. Adopt and implement recommended changes to Ontario's Planning Act (December 1993) based on Sewell Commission recommendations (Appendix 5.2).

Household Hazardous Waste

Ongoing household Hazardous waste educational actions include:

1. Use less of the products.
2. Use reusable products such as rechargeable batteries.
3. Use substitute products that contain fewer or no toxic chemicals.
4. Proper use and disposal of household toxic waste.
5. Proper disposal of non-toxic wastes.
6. Reuse non-biodegradable products.
7. Educate the public on the use and disposal of household hazardous materials and the use of alternative products.

Other Initiatives

1. Compost household organic wastes.
2. Control pets (feces).
3. Reduce atmospheric emissions (i.e. automobiles).

SEDIMENTS

OVERVIEW

Contaminated sediment may have contributed to 5 of 9 beneficial use impairments as follows:

- restrictions on fish consumption (mercury, PCB, dioxins, furans);
- chironomid mouthpart anomalies (through water and sediment contamination);
- degradation of benthos (through sediment contaminated with arsenic, mercury, cadmium, copper, chromium, iron, lead, nickel, zinc, oil and grease, PCBs, hexachlorobenzene and total PAHs);
- restrictions on dredging (total Kjeldahl nitrogen, total phosphorus, arsenic, mercury, cadmium, copper, chromium, iron, lead, nickel, zinc, manganese, oil and grease, PCBs, hexachlorobenzene and total PAHs); and
- added cost to agriculture or industry.

Contaminants in bottom sediments are derived from point and non-point sources. In turn, elevated contaminant levels in bottom sediment act as a contaminant source through dissolution, resuspension and bioaccumulation. Parameters of concern in St. Clair River sediment are: total Kjeldahl nitrogen, total phosphorus, arsenic, mercury, cadmium, copper, chromium, iron, lead, nickel, zinc, manganese, oil and grease, PCBs, hexachlorobenzene and total PAHs.

Results of bottom sediment surveys in the St. Clair River reveal the most heavily contaminated portion of the river, as identified by: most frequent exceedences of dredged material disposal guidelines; exceedences of the lowest effect level of the Provincial Sediment Quality Guidelines; and by sediment toxicity. This area is within 100 metres of the Ontario shore from the Cole Drain to downstream of Suncor.

The Sediment and Habitat Task Team developed a Sediment Work Plan that outlines actions undertaken by the Sediment and Habitat Task Team for the development of the Stage 2 RAP. A complete Sediment Work Plan is provided in Appendix 3.2 and is summarized below. This work plan does not represent recommended actions resulting from task team deliberations. Recommendations (actions) are summarized at the end of this chapter. Work Plan components include:

- Agree to a uniform approach where international sampling protocols, sediment quality standards, sediment quality management, long and short term goals and decision making processes are defined;
- Identify impacted areas and characterize impact zones;
- Explore remedial technologies and compile information;
- Develop a sediment model and verify in the field;
- Prioritize areas for remediation;
- Implement remediation steps; and
- Develop monitoring and reporting systems.

HABITAT

OVERVIEW

The Stage 1 RAP has identified "Loss of Habitat" as an impaired beneficial use in the St. Clair River AOC. Habitat loss is one of the most serious of the use impairments because it is the most difficult to reverse. Habitat loss and wetland degradation and loss, also affects four other use impairments which include:

- degradation of fish and wildlife populations;
- restrictions on fish and wildlife consumption;
- bird or animal deformities or reproductive problems; and
- degradation of benthos.

Fish populations have dramatically changed from earlier times but they are presently diverse and appear relatively stable and healthy; the populations are probably impaired to the degree that preferred littoral and wetland habitat continues to be lost and fish community goals, once available will be used to re-evaluate impairment status.

The Sediment and Habitat Task Team developed a Habitat Work Plan that outlines actions undertaken by the Sediment and Habitat Task Team for the development of the Stage 2 RAP. A complete Habitat Work Plan is provided in Appendix 3.2 and is summarized below. This work plan does not represent recommended actions resulting from task team deliberations. Recommendations (actions) are summarized at the end of this chapter. Work Plan components include:

- Establish baseline information, including:
- compilation of historic and current wetland information into a GIS database for the St. Clair River AOC;
- review and compile all land use information including zoning status;
- review restoration techniques; and
- review regulations;
- Develop specific long term goals and delisting criteria; and
- Protect, enhance and restore habitat.

HABITAT PROTECTION: MICHIGAN & U.S.

Section 404, Clean Water Act: requires a permit for the discharge of dredged or fill material to waters of the United States, including wetlands. Federal reviews are conducted for the following: major discharges of dredged or fill material; discharges into critical areas established under state or federal law (natural areas, wildlife refuges, historic sites); placement of fill which may impact the waters of another state; placement of fill material which contains known or suspected toxic pollutants or hazardous substances.

Michigan's Goemaere-Anderson Wetland Protection Act: establishes regulations to preserve, manage, and protect wetland resources in the light of extensive historic losses and ongoing impacts due to human use and development. The MDNR may not issue a permit authorizing a loss of wetland unless certain stringent tests are met. The proposed project must be found to be in the public interest; must not unacceptably disrupt the state's aquatic resources; and impacts to wetlands must be unavoidable. The Wetland Protection Act applies to all wetlands in Michigan except for non-contiguous wetlands less than five acres (2 ha) in size, unless the MDNR determines that the particular wetland is essential to the preservation of the natural resources of the state. Although this act provides comprehensive protection of wetlands, most normal agricultural and silvicultural activities are exempted from permit requirements.

Michigan's Inland Lakes and Streams Act: regulates construction activities below the Ordinary High Water Mark of inland lakes and streams. This act is used in combination with the Wetland Protection Act to regulate activities in wetlands.

Michigan's Great Lakes Submerged Lands Act: provides for the protection of coastal wetlands below the ordinary high water mark of the Great Lakes. Activities impacting on the remaining coastal wetlands are not allowed. Projects proposed in or near coastal wetlands are usually denied a permit unless the activity is necessary to exercise a riparian right of access, such as an open pile dock.

Michigan's Shoreland Protection and Management Act: provides for the designation of Environmental Areas (EAs), defined as shoreland areas necessary for the preservation and maintenance of fish and wildlife.

Water Quality Standards for Wetlands: are in draft form. Through the promulgation of wetland-specific water quality standards, wetlands will be included in the definition of "waters of the state". By this process, the quality and functions of wetlands will receive additional protection.

Michigan's Comprehensive Wetland Conservation Plan: is currently under development and expected to be complete by the end of 1994. This plan will provide a mechanism for multi-agency involvement and input into wetlands management and protection.

Habitat Acquisition Programs: Wetlands are purchased by MDNR through funds from the Michigan Natural Resources Trust Fund. MDNR also purchases development rights on lands identified as unique or critical to habitat preservation. Wetlands are sometimes also acquired through tax reversion.

REMEDATION APPROACHES

Habitat degradation and loss has resulted from a multitude of human activities in the St. Clair River watershed. Remediation principals related to habitat protection, restoration and enhancement include:

- no further losses of current wildlife habitat;
- gain in wetland and aquatic habitat wherever and whenever possible;
- focus on areas of contiguous habitat, with a minimization of habitat fragmentation;
- provisions for diverse habitats and communities (i.e. an ecological approach); and
- high priority for endemic species, communities and habitats.

HABITAT RESTORATION & ENHANCEMENT

Michigan and the United States

STATE LAND:

Algonac State Park

A management plan for Algonac State Park and lakeplain prairie restoration is being undertaken by the Natural Heritage Program in MDNR's Wildlife Division, with funding assistance from the Coastal Management Program (to be completed by December 31, 1994).

St. Clair Flats Wildlife Area

The islands, marshes, bays and channels at the mouth of the St. Clair River are collectively known as St. Clair Flats. Much of Dickinson Island, Harsens Island, St. Johns Marsh, the adjacent marshes and bays are in public ownership. State managed wildlife areas are located on Harsens Island and at St. Johns Marsh.

A portion of a U.S. Fish and Wildlife Service grant, administered by the MDNR Land and Water Management Division, has been set aside for wetlands restoration in the Flats area. The

estimated cost for removal of old seawalls and dilapidated structures is \$20,000 (U.S) for two lots that have reverted back to state ownership.

In April 1981, Michigan's Natural Resources Commission approved the St. Clair Flats Management Plan developed by the MDNR. This plan covers the platted lots south and west of the main portion of Harsens Island and recommends that MDNR acquire submerged, undeveloped leased lots whenever possible through reversion to State for non-payment of taxes or by offering of the lot as a gift to the State. Approximately 25 residential lots have reverted back to the state in the last several years.

Seawall installation, dredging, filling and other construction permit applications are reviewed carefully to minimize adverse impacts to wetlands, bottom lands, open water areas etc. The Plan also indicates that the State shall not lease or deed existing unleased State owned property as most of these parcels are submerged or are undeveloped marsh. When a deed is issued for a parcel, only the existing "upland" area of the lot is included in the legal description. The balance of the lot that is generally submerged and/or marsh is retained by the State.

Dickinson Island

Dickinson Island, at the heart of the St. Clair Flats Wildlife Area, represents a major portion of the remaining coastal wetland habitat in the U.S. Lake St. Clair. This area remains as one of the largest natural undeveloped and functioning wetland complexes along Lake St. Clair, and is an important biological study area. Wildlife management practices are limited to periodic controlled burns and placement of nesting structures. Special concern, rare and endangered species and habitats have been identified. A Great Blue Heron rookery is located on the island.

Harsens Island

An updated management plan for Harsens Island is being drafted. Some minor work is being done on existing state land; habitat changes proposed at Harsens Island include enhancing 73 acres (30 ha) for waterfowl nesting and brood rearing by construction of small ponds and nesting islands. Agricultural units and U.S. Army Corps disposal sites have been converted to wet meadows and emergent marsh habitat. Future work includes development of small ponds, meadows and nesting islands. Improved access is also proposed by elimination of some dike pullovers and level ditching to allow hunters to float their boats to hunting areas. This will also improve fish access to critical habitat.

New land acquisition (approximately 400 acres (162 ha)) has been proposed; much of the site is wetland and is being offered to the state following permit denial for a very large marina development. This parcel has been nominated for funding through the Land Trust Fund. There is a question of who will manage the site as there are several buildings that were used as dorms. The suggested use is for an environmental education centre.

St. Johns Marsh Wildlife Area

Currently, the area encompasses approximately 2,300 acres (931 ha), and is being managed to increase biodiversity. Because of the areas size and diversity of habitat, wildlife development and maintenance activity is directed towards preserving, protecting and enhancing existing marsh and upland habitats to meet the needs of breeding and migratory waterfowl, and other wildlife species. Practices for managed areas include: dyking for water level management, establishment of waterfowl production areas (including creation of approximately 15 acres (6 ha) of wetlands), controlled burns, mechanical and chemical control of purple loosestrife and brush, artificial nest structure placement, and maintenance and preservation of prairie habitat. Michigan Department of Transportation mitigation site will add to existing habitat; the plan has not been finalized. A management plan for St. Johns Marsh is in draft form and the interested parties are working out a plan that will increase wetland area while avoiding flooding of existing lakeplain prairie, a rare natural habitat.

ACTIONS

Sources of Funding

State Policy in Michigan places emphasis on wetland protection and acquisition in Lake St. Clair and Lake Erie. The Michigan Department of Natural Resources (MDNR) Wildlife Division is developing a catalogue of funding sources for wetland restoration work. The OMNR Chatham office is currently exploring funding mechanisms for restoration of habitat in Ontario; possible funding sources which have been identified include the GLCUF and the North American Waterfowl Management Plan (NAWMP). Land owner cooperative programs are also being investigated.

Ongoing Actions

Ongoing actions pertaining to habitat protection, restoration and enhancement are itemized into three categories:

- * Protection;
- * Rehabilitation and Enhancement; and
- * Education and Communication.

The following actions are to be completed in accordance with the principles and priorities outlined in the implementation strategy described in Section 10.2.

Education and Communication Actions:

1. Develop and implement a strong comprehensive education and communications program to deal with habitat issues (e.g. draft "St. Clair RAP Communication of Protection and Enhancement Measures for Wildlife Habitat"). Responsible party: RAP Implementation Committee.
2. Develop detailed habitat/aquatic guidelines outlining regulatory requirements, review procedures, and best management techniques to assist landowners, developers, consultants and municipalities. Educate municipal, county and township officials on regulations affecting habitat (e.g. workshops). Develop mechanism of coordination of agencies responsible for disseminating information and enforcing regulations. MDNR Land & Water Management Division programs may serve as a model for RAP programs. Responsible party: St. Clair River RAP Implementation Committee.
3. Public education programs will include information programs (i.e. Sea Grant, Great Lakes Fisheries Commission) which attempt to prevent further spread of exotic species.

Actions for Habitat Protection:

1. Strengthen wetland protection regulations in Ontario, to provide specific regulatory authority for protection of all types of wetlands, and provide penalties for violators. Strengthen wetland protection in Michigan through application of voluntary and regulatory programs that address silvicultural and agricultural activities currently exempted from wetland permitting requirements. Responsible parties: Ontario and Michigan legislative bodies (with lobbying by many parties).
2. Reduce ship wakes and surges. Responsible parties: U.S. Coast Guard and Canadian Coast Guard.
3. Minimize shoreline and benthic habitat damage attributable to winter shipping. Responsible parties: MDNR, U.S. Corps of Engineers, U.S. Coast Guard, U.S. Fish and Wildlife Service, Canadian Coast Guard.
4. Control shoreline erosion to improve benthic habitat. Responsible parties: MDNR Surface Water Quality Division Non-point Source Program; USDA Natural Resource Conservation Service (Soil Conservation Service).
5. Contact landowners for "candidate sites" and other sites about proposed habitat protection and enhancement activities. Responsible parties: OMNR, Lambton Wildlife, The Nature Conservancy.
6. Work with the Walpole Island Heritage Centre and First Nation peoples to identify candidate sites on the St. Clair Delta. Responsible party: OMNR

7. Integrate shoreline erosion, shoreline development (or redevelopment) projects with environmentally friendly habitat approaches (like buffer strips and spawning channels) that take hydraulic impacts into account. Improved inter-agency communications and the need to be proactive and opportunistic is key to this approach. Responsible parties: all agencies.
8. Recognize the St. Clair AOC as a priority area within each agency to increase enforcement focus. This could be a combination of increased funding, focused training for aquatic habitat protection, or a shift in enforcement focus (geographically). Responsible parties: OMOEE, OMNR, MDNR.
9. Encourage conservation easements as a mechanism for habitat protection.
10. Impose strict regulations on use of small watercraft i.e. wave runners etc. within shallow water marshes of the St. Clair River Delta for habitat protection.
11. Complete a GAP Analysis in order to determine the difference between habitat that is currently protected and habitat that needs to be protected in order to maintain wildlife diversity and integrity.

Actions for Habitat Rehabilitation and Enhancement:

1. Pursue Stag Island restoration. Responsible party: Ontario Ministry of Natural Resources.
2. Maximize fish use of wetland areas in the Delta; provide fish access to wetlands. Responsible party: Michigan Department of Natural Resources Fisheries Division.
3. Develop compatible mapping data base between U.S. and Canada areas of concern. Responsible parties: Michigan Department of Natural Resources, Ontario Ministry of Environment and Energy.
4. Encourage maintenance or restoration of riparian vegetated zones. However, where this vegetation has already been removed, and cannot be restored, use rip-rap instead of seawalls, or a combination of rip-rap and seawalls to mitigate the effects of ship wakes, enhance fish habitat, and increase shore stabilization. Where seawalls are already installed, place rip-rap at the base of the walls. Replace old seawalls with rip-rap. Responsible parties: MDNR Land and Water Management Division, Fisheries Division; OMNR; RAP Team education programs.
5. Implement projects identified in OMNR Candidate Sites Report as opportunities arise. Responsible party: Ontario Ministry of Natural Resources.
6. Integrate concepts and techniques of 1994 MNR Candidate Sites Report where possible in other areas of the St. Clair AOC which were not specifically identified in this report.
7. Expand candidate sites inland in Ontario. Develop a "candidate sites" list for wetland and aquatic habitat restoration projects in the Michigan portion of the AOC, similar to that developed for Ontario. Responsible parties: OMNR, MDNR, U.S.FWS, U.S. National Biological Survey, Nature Conservancy Great Lakes Program.
8. Acquire proposed Harsens Island Land. Responsible party: MDNR.
9. Explore opportunities for joint projects between all of the agencies within the AOC, for restoration of wetland and aquatic habitat. Compare lists of special status species for the AOC, and set priorities for habitat restoration based on those species that: 1) have binational special status, 2) historically occur or potentially could occur in the AOC, 3) depend on aquatic and/or wetland habitat, and 4) have decreased populations due to habitat destruction or degradation. Responsible parties: RAP Implementation Committee, MDNR, OMNR, OMOEE.
10. Include invertebrates, plants, unique plant communities and other special features in addition to mammals, birds, fish, reptiles and amphibians in the "special status species" lists. Special features would include, but is not limited to: Great Lakes Marsh, Lake Plain Prairies, Southern Swamp, Great Blue Heron Rookery. Responsible party: RAP Implementation Committee.
11. A long-term habitat management plan for both Michigan and Ontario, including an assessment of needs relating to wildlife diversity and integrity will be completed. Responsible Parties: MDNR, OMNR, USFWS, NBS, Environment Canada.

Actions Related to Exotic Species:

1. Where habitat is being restored, enhanced, or in any way altered, care will be taken to avoid the creation of "incidental" habitat favourable to exotic species.
2. Control mechanisms for exotics in the AOC will take into consideration water quality objectives. For example, physical or biological controls for zebra mussels may be preferable to chlorination

of intakes, or dechlorination must occur before discharge, since chlorine is a contaminant of concern.

3. The RAP will consider future local endorsement and implementation of control measures for exotics if and when they become feasible.

GLOSSARY & ACRONYMS

ABSORPTION Penetration of one substance into the body of another.

ACCLIMATION Physiological and behavioural adjustments of an organism in response to a change in environment. See also Adaptation.

ACCUMULATION Storage of a chemical or substance in tissue. May also apply to the storage and concentration of a chemical in aquatic sediments to levels above those that are present in the water column.

ACUTE Involving a brief exposure to a stimulus. In toxicity tests, a duration of 96 hours is typically considered acute.

ACUTE TOXICITY Mortality or other toxic effects that are produced within a short period of time, usually 24 to 96 hours.

ADAPTATION Change, often genetically based, in the structure, forms or behaviour of an organism to accommodate changing environmental conditions. See also Acclimation.

ADIPOSE Of, like, or containing animal fat: Fat in the connective tissue of an animal's body.

ADSORPTION The taking up of one substance onto the surface of another.

AEROBIC The condition associated with the presence of free oxygen in the environment.

ALGA (E) Simple one-celled or many-celled micro-organisms, usually free-floating, capable of carrying on photosynthesis in aquatic ecosystems; a form of aquatic plant.

ALGICIDE A specific chemical, highly toxic to algae. Algicides are often applied to water to control nuisance algal blooms and may contain harmful contaminants such as heavy metals.

ALKALINITY A measurement of acid neutralization or buffering capability of a solution (see pH).

ALKYLATED LEAD A contaminant in the environment, resulting mainly from burning leaded gasoline, but also found in some industrial emissions. Lead concentrates in the skeleton, causing cumulative poisoning, especially in young children.

AMBIENT An encompassing surrounding.

AMBIENT STANDARDS The concentration of a toxic substance in the water, which based on available data, will not result in significant risks of adverse effects to biota or human health.

AMBIENT WATER The water column or surface water (lake, river, etc.) as opposed to groundwaters or sediment pore water.

ANADROMOUS Species which migrate from salt water to freshwater to breed.

ANAEROBE An organism for whose life processes a complete or nearly complete absence of oxygen is essential.

ANOXIA The absence of oxygen. In aquatic ecosystems this refers to the absence of dissolved oxygen in water, a situation which cannot be tolerated by most aquatic organisms.

ANTAGONISM Reduction of the effect of one substance because of the introduction or presence of another substance; e.g. one substance may hinder, or counteract, the toxic influence of another. See also Synergism.

ANTHROPOGENIC Origin a consequence of human-related activities.

AQUATIC Living in water.

ASSIMILATION The absorption, incorporation and metabolism of substances. For example nutrients can be absorbed and processed, or assimilated, by an organism or ecosystem.

ASSIMILATIVE CAPACITY The ability of a waterbody to transform and/or incorporate substances (e.g. nutrients) by the ecosystem, such that the water quality does not degrade.

ATMOSPHERIC DEPOSITION Pollution from the atmosphere associated with dry deposition in the form of dust, wet deposition in the form of rain and snow, or as a result of vapour exchanges.

BENTHIC Of or living on or in the bottom of a water body; benthic region, benthos.

BENTHOS Bottom dwelling organisms, the benthos comprise: 1) stationary animals such as sponges, some worm species and attached algae; 2) creeping forms such as snails and flatworms; and 3) burrowing forms which include most clams, worms, freshwater shrimp, mayflies and midges and other insect larvae.

BENZO(A)PYRENE A PAH (polycyclic aromatic hydrocarbon) which is a suspected carcinogen found in cigarette smoke. It is a byproduct of combustion and is released to the aquatic environment from industrial processes such as steel and aluminum making.

BIOACCUMULATION Uptake and retention of substances, including nutrients and contaminants, by an organism from both its environment (i.e. directly from the water) and its food.

BIOASSAY A biological assessment of water or sediment designed to evaluate toxicity of to an organism.

BIOAVAILABILITY The portion of the total chemical(s) in the surrounding environs, i.e. water, sediment, which is available for uptake by organisms (plant, animal). The biologically reactive amount of a substance in the environment.

BIOCHEMICAL OXYGEN DEMAND The amount of dissolved oxygen required for the bacterial decomposition of organic waste in water.

BIOCONCENTRATION The ability of an organism to concentrate substances within its body at concentrations greater than in its surrounding environment or food.

BIOCONCENTRATION FACTOR The ratio of the measured residue within an organism compared to the residue of the substance in the ambient air, water or soil environment of the organism.

BIODEGRADATION The chemical breakdown/decomposition of a compound by bacteria/micro-organisms.

BIOMAGNIFICATION The increasing concentrations of a chemical in biota, moving up the food chain. Trace organic contaminants tend to be at greater concentrations in top predators than in lower levels of the food web.

BIOMASS Total weight of all or specific organisms usually expressed for a given area or volume of water or sediment.

BIOMONITORING The use of organisms to test the toxic effects of substances in effluent discharges or the surrounding environment as well as the chronic toxicity of low-level pollutants in the aquatic environment.

BIOTA Plants and animals.

BIOTRANSFORMATION Enzymatic conversion of a compound to another compound within a living organism. Can result in less toxic or in more toxic substances.

BIOTURBATION Biological mixing of sediment by benthic organisms which results in physical, chemical and/or biological changes in sediment to a depth generally not greater than 10 cm. Can result in the transport of contaminants from sediment into the water column.

CARCINOGEN Cancer-causing chemical or substance.

CHIRONOMID Any of a family of midges that lack piercing mouth parts as adults. Larval forms are sediment dwelling burrowing invertebrates that are an important food source for bottom feeding species such as fish.

CHRONIC Duration of exposure to an environmental stress that is prolonged.

CHRONIC TOXICITY Toxicity observed following a long duration of exposure, that produces an adverse effect on organisms. The end result of chronic toxicity can be death although the usual effects are sublethal; e.g. reproduction or growth inhibition. These effects can be reflected by change in the productivity and structure of the population and community. See also Acute Toxicity.

COMMUNITY Group of populations of plants and animals interacting in given place; ecological unit used in a broad sense to include groups of various sizes and degrees of integration.

CONGENER A member of the same taxonomic genus as another plant or animal: Also, a different configuration or mixture of a specific chemical usually having different toxicological properties.

CONSUMPTIVE USE Permanent removal of water from a water body. Consumptive use may be due to evaporation, agricultural use, or incorporation of water into a manufactured product.

CONTAMINANT A substance foreign to a natural system or present at unnatural concentrations in air, water, soil or food, causing use of those things to be limited. A naturally occurring substance may be found to exceed government guidelines, or objectives and be called a contaminant, e.g. metals.

CONTAMINATION The introduction of pathogenic or undesirable micro-organisms, toxic and other deleterious substances which can render water, air soils or biota unfit for use or unhealthy.

CONTROL ORDER Enforceable orders in Ontario, often applied to industrial facilities.

CONVENTIONAL A term used to describe substances which consume oxygen upon

POLLUTANT decomposition, materials which produce an oily sludge deposit, and bacteria. Conventional pollutants include phosphorus, nitrogen, chemical oxygen demand, biochemical oxygen demand, oil and grease, volatile solids, and total and fecal coliform, chlorides, etc.

CRITERIA Numerical limits of pollutants typically established to protect the aquatic ecosystem and human use of the ecosystem.

CRITERIA, WATER QUALITY Designated concentrations water quality constituents based on scientific evidence and judgement, that, when not exceeded will protect an organism, a community of organisms, or a prescribed water use with an adequate degree of assurance.

CUMULATIVE Brought about or increased in strength by successive additions, i.e. effects produced by simultaneous dose of two or more chemicals, or repetitive dose effects of more than one chemical may occur in three ways: additive effects - sum of the individual effects; antagonistic effects - effect of one chemical is reduced by the present of another chemical(s); synergistic effects - presence of one or more chemicals produces effects greater than the sum of individual effects.

CUMULATIVE ACTION Increasingly severe effects due to either storage or concentration of a substance within the organism.

DENSITY Number of individuals in a given space.

DETRITUS Organic residue of plant and animal origin that has undergone decomposition.

DIATOM Any of a class of minute planktonic unicellular or colonial algae with skeletons of high silica content.

DIELDRIN A chlorinated pesticide that is persistent and bioaccumulates in all living organisms; causes reproductive disorders in wildlife and is a known carcinogen.

DIOXIN A group of approximately 75 chemicals of the chlorinated dibenzodioxin family, including 2,3,7,8 - tetrachlorodibenzo-para- dioxin (2,3,7,8 - TCDD) which is generally considered the most toxic form. Can be formed when naturally occurring organic molecules come in contact with chlorine introduced into the environment.

DIFFUSE SOURCE A source of pollution that is not distinct and is widely distributed, such as atmospheric deposition and agricultural or urban runoff.

DISSOLVED OXYGEN The amount of oxygen dissolved in water.

DRAINAGE BASIN A body of water and the land area drained into it.

DREDGE SPOILS The material removed from the river, lake or harbour bottom during dredging operations.

DREDGING GUIDELINES Numerical guidelines with primary emphasis on the concentrations of toxic materials in sediment to be dredged, with directions designed to minimize the adverse effects of sediment disposal.

DYNAMIC EQUILIBRIUM The result of fluctuations of the biological, chemical and physical components of the ecosystem within well defined bounds.

ECOSYSTEM The interacting complex of living organisms and their non-living environment; the biotic community and its abiotic environment.

EFFLUENT Waters discharged from facilities to either wastewater sewers or to surface waters.

EPHEMEROPTERA Invertebrates (e.g. mayflies) that live as adults only a very short time, but can dwell for several years as nymphs in sediment. Some species are indicative of relatively clean environmental conditions.

EPIIMNION The warm, upper layer of water in a lake that occurs during summer stratification, or layering of the open waters.

EROSION The wearing away and transportation of soils, rocks and dissolved minerals from the land surface shorelines or river bottom by rainfall, running water, wave or current action.

EUTROPHICATION The process of nutrient enrichment that causes high productivity and biomass in an aquatic ecosystem. Eutrophication can be a natural process or it can be a cultural process accelerated by an increase of nutrient loading to a waterbody by human activity.

EXOTIC SPECIES Species that are not native to the Great Lakes and have been intentionally or inadvertently introduced into the system, such as zebra mussel and purple loosestrife.

FATE As in the fate of a contaminant: the result of material deposition via transport, bioaccumulation, transformation and degradation, i.e. sediment, water column, air or biota.

FOOD CHAIN The organization of biota in which organisms in higher trophic levels gain energy by consuming organisms at lower trophic levels; the dependence for food of organisms upon others in a series, beginning with bacteria and plants and ending with carnivores.

GOAL An ideal, aim or objective towards which to strive; it may represent an ideal condition that is difficult, if not impossible to attain technically, sociologically, environmentally, or economically.

GREAT LAKES BASIN COSYSTEMThe interacting components of air, land, water and living organisms, including humans, within the drainage basin of the St. Lawrence River at or upstream from the point at which this river becomes the international boundary between Canada and the United States (from Article 1 of the 1978 GLWQA).

GREAT LAKES WATER QUALITY AGREEMENT (GLWQA) A joint agreement between Canada and the United States which commits the two countries to restore and maintain the chemical, physical and biological integrity of the waters of the Great Lakes Basin Ecosystem (from Article 2 of the 1978 GLWQA). Originally signed in 1972 the Agreement was amended in 1978 and 1987.

GROUNDWATER Water entrained and flowing below the surface which may supply water to wells and springs.

GUIDELINES Any suggestion or rule that guides or directs; i.e. suggested criteria for programs or effluent limitations.

HALF-LIFE The period of time in which a substance loses half of its active characteristics (used specifically in radiological work); the amount of time required for the concentration of a pollutant to decrease to half of the original value through natural decay or decomposition.

HAZARDOUS SUBSTANCES Chemicals considered to be a threat to humans in the environment, including substances which (individually or in combination with other substances) can cause death, disease (including cancer), behavioural abnormalities, genetic mutations, physiological malfunctions or physical deformities.

HEPATIC Of the liver.

HEXACHLOROBENZENE A by-product of the chemical industry, created during the production of solvents and some pesticides. It is a persistent carcinogen.

HYDROLOGIC CYCLE The natural cycle of water on earth, including precipitation as rain and snow, runoff from land, storage in groundwaters, lakes, streams, and oceans, and evaporation and transpiration (from plants) into the atmosphere.

HYPOLIMNIONThe cold, dense, lower layer of water in a lake that occurs during summer layering or stratification.

INSECTICIDE Substances or a mixture of substances intended to destroy or repel insects.

IN SITUIn place; occurring in nature.

INTERSTITIAL Of, forming, or occurring in interstices or pores between sediment particles; situated between the cellular components of an organ or structure.

INSTANTANEOUS LOADING A loading value calculated using either a single or a mean of concentration values multiplied by a single flow measurement (instantaneous flow). There is no attempt to calculate the total or mean loading which would require both concentration and flow measurements representing a full range of flow regimes.

LACUSTRINE Formed in, or growing in lakes.

LEACHATEMaterials that percolated through solids, soils, solid wastes and rock layers, that can enter the water column.

LETHAL Causing death.

LIPOPHILIC Having a chemical affinity for fats, oils or other lipids, such as many trace organic contaminants.

LITTORAL ZONE Productive shallow-water zone of lakes with light usually penetrating to the bottom; often occupied by rooted aquatic plants.

LOADINGS Total mass of a substance added to a water body over a specified time; e.g. kilograms per year of phosphorus.

MACROPHYTEMacroscopic plant life, larger than algae, found in bodies of water.

MACROZOO-BENTHOS Visible bottom dwelling animals, invertebrates. The distribution of macrozoobenthos in an aquatic ecosystem is often used as an index of the impacts of contamination on the system.

MASS BALANCE An approach to evaluating the sources, transport and fate of contaminants entering a water system, as well as their effects on water quality. In a mass balance budget, the

amounts of a substance entering the system less the quantity stored, transformed or degraded must equal the amount leaving the system. If inputs exceed outputs, substances, often pollutants, are accumulating and contaminant levels can rise. Once a mass balance budget has been established for a pollutant of concern, the long-term effects on water quality can be simulated by mathematical modelling and priorities can be set for research and remedial action.

MERCURY Recognized as a dangerous substance for many years because it bioaccumulates and biomagnifies through the food chain, and can affect the central nervous system. It has entered the Great Lakes from a variety of industrial processes and natural sources.

METABOLITES Biodegraded chemical end products - the product of a bio-transformation process. Pollutants or natural substance produced from metabolic activity.

MIREX A pesticide which has been found in significant quantities in Lake Ontario. It accumulates in the food chain, causes reproductive problems and cancer.

MIXING ZONE An area of water contiguous to a point source, where exceptions to water quality objectives and conditions otherwise applicable to the receiving water may be granted (OMOE 1984). For the purpose of point source recommendations: For non-persistent, non-bioaccumulative substances, the lesser of: 75 meters downstream from the discharge, or the distance to the nearest downstream intake or point source discharge. For persistent, bioaccumulative substances, zero (0) distance from the discharge.

MODELLING Mathematical simulation of actual conditions often used to predict the fate of nutrients, bacteria, or other chemicals in the ecosystem.

MUTAGEN Any substance or effect which alters genetic characteristics or produces an inheritable change in the genetic material.

MUTAGENICITY The ability of a substance to induce a change in genetic material which can be transmitted to progeny, or from one cell generation to another within an individual.

NON-POINT SOURCE Source of pollution in which pollutants are discharged over a widespread area or from a number of small inputs rather than from distinct, identifiable sources. See also diffuse source.

NONPOLAR/ HYDROPHOBIC Having an affinity for lipids rather than water. Having extremely low solubility in water, such as oil, grease, and many trace organic substances.

NUTRIENT A chemical that is essential for the growth and development of organisms.

ORGANOCHLORINE Chlorinated hydrocarbons.

OXIC-ANOXIC Oxidic - oxygen present Anoxic - no oxygen present

PATHOGEN A disease - causing agent such as bacteria, viruses, and parasites.

PERIPHYTON Plants that live attached to underwater surfaces.

PERSISTENT TOXIC Any toxic substance with a long half-life in water or sediment. Can be defined as persisting for more than eight weeks.

PESTICIDE Any substance used to kill plants, insects, fungi or other organisms; include herbicides, insecticides, algicides, fungicides.

PHENOLICS Any of a number of compounds with the basic structure of phenol. Phenolics are produced during the coking of coal, the distillation of wood, the operation of gas works and oil refineries, from human and animal wastes, and the microbiological decomposition of organic matter. Phenols can cause tainting in fish.

PHOTOSYNTHESIS A process occurring in the cells of green plants and some micro-organisms in which solar energy is transformed into stored chemical energy.

PHYTOPLANKTON Minute, microscopic aquatic vegetative life; plant portion of the plankton (free floating aquatic plants); the plant community in marine and freshwater situations which floats free in the water and contains many species of algae and diatoms.

POINT SOURCE A source of pollution that is distinct and identifiable, such as an outfall pipe from an industrial plant.

POLAR/HYDROPHILIC Having an affinity for aqueous environment. Soluble in water.

POLLUTION (WATER) Anything causing or inducing objectionable conditions in any watercourse and adversely affecting the environment and use or uses to which the water thereof may be put.

POLLUTION PREVENTION The use of processes, practices or products that reduce or eliminate the generation of pollutants and waste at the source, including those that protect natural resources through conservation or more efficient utilization.

POLYCYCLIC Organic compound having three (3) or more ring structures may be the same or different; e.g. anthracene, naphthalene.

POTABLE WATER Water suitable, on the basis of both health and aesthetic considerations, for drinking or cooking purposes.

PRIMARY TREATMENT Mechanical removal of floating or settleable solids from wastewater.

PUBLIC Any person, group, or organization.

RADIONUCLIDE A radioactive substances.

RAW WATER Surface or groundwater that is available as a source of drinking water, but has not received any treatment.

RESUSPENSION (of sediment) The remixing of sediment particles and pollutants back into the water by storms, currents, organisms and human activities such as dredging and shipping.

RISK ASSESSMENT Process for estimating the likelihood that toxic response could take place if people or animals were exposed to certain concentrations of toxic chemical(s) over a given period of time.

SECONDARY TREATMENT Bacterial action on the waste remaining from primary treatment of sewage to decompose organic components of the waste.

SEDIMENT The fines or soils on the bottom of the river or lake.

SEICHE An oscillation in water level from one end of a lake to another due to winds or atmospheric pressure. Most dramatic after an intense but local weather disturbance passes over one end of a large lake.

SESSILE An animal that is attached to an object or is fixed in place (e.g. barnacles).

SEWER, SANITARY A municipal sewer for the collection and transmission of domestic, commercial and industrial wastes to treatment plants; not including land drainage or storm water runoff.

SEWER, STORM A municipal sewer for the collection and transmission of storm water runoff, land surface water and water from soil drainage not including any industrial wastes other than unpolluted cooling waters.

SLUDGE Solids produced by wastewater (sewage) treatment facilities and some industrial processes.

SOLUBILITY Degree to which a substance can be dissolved.

STABILITY Absence of or predictable fluctuations in populations; ability to withstand perturbations without large changes in community composition or function.

STANDARD (Water Quality) Regulatory limits concerning the concentration of chemical(s)/substance(s) permitted in effluent discharges and/or waterway(s). Standards are generally dependant on designated use(s).

STEADY STATE State in which rates of uptake and elimination of chemical/substance are equal - bioconcentration factors can be measured at steady state.

STRATIFICATION (or layering) The tendency in deep lakes for distinct layers of water to form as a result of vertical change in temperature and therefore, in the density of water.

SUBACUTE Involving a stimulus whose duration is between acute and chronic.

SUB-LETHAL Involving a response to a stimulus below the level that causes death.

SUSPENDED SEDIMENT Particulate matter suspended in water.

SYNERGISM The joint action of two or more substances, which is greater than the sum of the action of each of the individual substances. See also Antagonism.

SYNERGISTIC Interactions of two or more substances or organisms producing a result such that the total effect is greater than the sum of the individual effects.

SYNTHESIS The production of a substance by the union of elements or simpler compounds.

TAXA A group of similar organisms.

TAXONOMY The process of identifying an organism by its structure.

TERATOGEN A substance that increases the incidence of birth defects.

TERATOGENICITY The ability of a substance to produce irreversible birth defects, or anatomical or functional disorders as a result of an effect on the developing embryo.

THERMOCLINE A layer of water in lakes separating cool hypolimnion (lower layer) from the epilimnion (surface layer).

THRESHOLD The chemical concentration or dose that must be reached before a given reaction occurs.

TOXAPHENE An insecticide which was banned in 1983. It has been shown to be a carcinogen.

TOXIC SUBSTANCE As defined in the Great Lakes Agreement, any substance that can cause death, disease, behavioural abnormalities cancer, genetic mutations, physiological or reproductive malfunction or physical deformities in any organism or its off-spring, or which can become poisonous after concentration in the food chain or in combination with other substances.

TOXICANT Substance capable of producing adverse effect(s) in the ecosystem, resulting in injury, disfunction or even death.

TOXICITY The quality of being toxic or poisonous.

TROPHIC ACCUMULATION Passing of a substance through a food chain such that each organisms retain all or a portion of the amount in its food and eventually acquires a higher concentration in its flesh than in its food. See also Biomagnification.

TROPHIC LEVEL Functional classification of organisms in a community according to feeding relationships; the first trophic level includes green plants, the second level includes herbivores; etc.

TROPHIC STATUS A measure of the biological productivity in a body of water. Aquatic ecosystems are characterized as oligotrophic (low productivity), mesotrophic (medium productivity) or eutrophic (high productivity).

TUBIFICID An aquatic oligochaete or sludge worm which is tolerant to organically enriched sediment and low oxygen concentration.

TURBIDITY A measure of clarity in water.

UBIQUITOUS Present, or seeming to be present, everywhere at the same time.

UPTAKE The transfer of a substance into an organism.

VIRTUAL ELIMINATION Cannot be measured (net loading) and does not have any bioaccumulative effect. For persistent, bioaccumulative toxics, no mixing zone will be recognized. No cross-media transfer is acceptable.

WATER QUALITY OBJECTIVES Under the Great Lakes Water Quality Agreement, goals set by the Governments of Canada and the United States for protection of the uses of the Great Lakes.

WATER QUALITY STANDARD A criterion or objective for a specific water use that is incorporated into enforceable regulations.

XENOBIOTIC Chemical not normally found in nature; i.e. manufactured chemical.

ZERO DISCHARGE Total elimination of the parameter from the discharge (net loading).

AOC Area of Concern

ASCS Agricultural Stabilization and Conservation Service

BAT Best Available Technology/Treatment

BATEA Best Available Technology/Treatment Economically Available

BMP Best Management Practices

BPAC Binational Public Advisory Committee (tentatively used for RAP Accountability Committee as well)

BTX/BTEX Benzene, toluene, ethylbenzene, xylene

CEPA Canadian Environmental Protection Act

COA Canada-Ontario Agreement Respecting Water Quality in the Great Lakes

CDF Confined Disposal Facility

CES Cooperative Extension Services

CSO Combined Sewer Overflow; combined storm and sanitary sewers

CURB Clean Up Rural Beaches

CWA Clean Water Act

CWS Canadian Wildlife Service

EA Environmental Area

EMPPL Environmental Ontario Effluent Monitoring Priority Pollutants List

EPA (United States) Environmental Protection Agency
Environmental Protection Act (Ontario)

EROD Ethoxyresorufin-o-deethylase (Enzyme determination in fish)

FPAC Farm Pollution Advisory Committee

FSA Farm Service Agency
GLPF Great Lakes Protection Fund
GLCUF Great Lakes Clean Up Fund
GLNPO Great Lakes National Programs Office (EPA Region V)
GLWQA Great Lakes Water Quality Agreement
HCB Hexachlorobenzene
HHW Household Hazardous Waste
IJC International Joint Commission
ILC Interactive Learning Centre
IADN Integrated Atmospheric Deposition Network
IPP Industrial Pretreatment Program
KETOX A model consisting of a hydrodynamic and dispersion subprogram and contaminant mass transport and fate subprogram
LEL Lowest Effect Level
LIS Lambton Industrial Society
LUST Leaking Underground Storage Tank
MDNR Michigan Department of Natural Resources
MDPH Michigan Department of Public Health
MERA Michigan Environmental Response Act
MRIS Michigan Resources Information System
MWHF Michigan Wildlife Habitat Foundation
MDA Michigan Department of Agriculture
MISA Municipal-Industrial Strategy for Abatement
MDL Minimum Detection Limit
NPDES National Pollutant Discharge Elimination System
NHL Natural Heritage League
NAWMP North American Waterfowl Management Plan
NPS Non Point Source Control Program
NRCS Natural Resource Conservation Service
OMOEE Ontario Ministry of the Environment and Energy
OMNR Ontario Ministry of Natural Resources
ODMP Ontario Drainage Management Program
OMAF Ontario Ministry of Agriculture and Food
OMAFRA Ontario Ministry of Agriculture and Food and Rural Affairs
OSCIA Ontario Soil and Crop Improvement Program
OWRA Ontario Water Resources Act
ORBBO Ontario Rare Bird Breeding Program
OCS Octachlorostyrene
PAH Polycyclic Aromatic Hydrocarbons
PCB Polychlorinated biphenyls
PCE Perchloroethylene, tetrachloroethylene
PERC Tetrachloroethylene
PSQG Provincial Sediment Quality Guidelines
PIPP Spill Notification Response Program
PCP Pollution Control Planning Program
ppb parts per billion
ppm parts per million
ppt parts per trillion
ppq parts per quadrillion
PEAS Pollution Emergency Alert System
RAP Remedial Action Plan
RICRAP Implementation Committee
SEL Severe Effect Level
SCS Soil Conservation Service
SCP Stormwater Control Program
SDMP Storm Drain Marking Program

SAC Spills Action Centre
TKN Total Kjeldahl Nitrogen
TSS Total Suspended Solids
TCE Trichloroethylene
TEQ Toxic Equivalents
U.S. EPA United States Environmental Protection Agency
USDA United States Department of Agriculture
USACOE United States Army Corps of Engineers
USFWS United States Fish and Wildlife Service
WPCP Water Pollution Control Plant
WWTP Waste Water Treatment Plant
WWSL Waste Water Sludge Lagoon
WRITAR Waste Reduction Institute for Training and Research