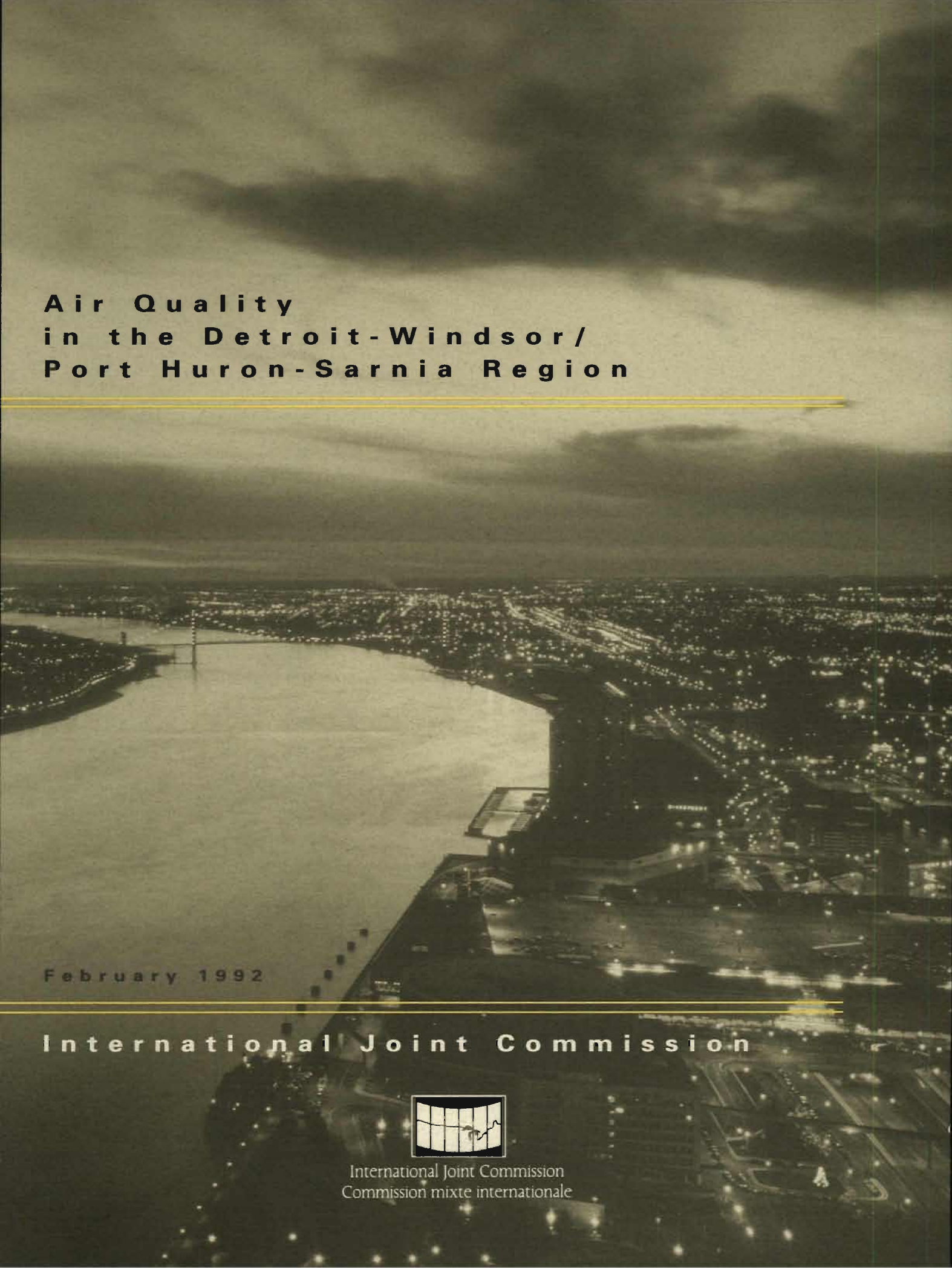

Air Quality in the Detroit-Windsor/ Port Huron-Sarnia Region

February 1992

International Joint Commission

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Air Quality in the Detroit-Windsor/ Port Huron-Sarnia Region

A Report to the Governments
of Canada and the United States
Pursuant to the Reference of July 8, 1975
and letters from the Governments
of September 30, 1988

by the

International Joint Commission

February 1992

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February 12, 1992

The Hon. Barbara McDougall,
Secretary of State for External Affairs
Ottawa, Ontario

The Hon. James A. Baker, III
Secretary of State
Department of State
Washington, D.C.

We have the pleasure of submitting to you the International Joint Commission's first report under the renewed 1975 Reference on air quality in the Detroit-Windsor and Port Huron-Sarnia areas pursuant to letters from the governments of September 30, 1988.

The report highlights the need for governments to implement pollution prevention programs to eliminate or phase out the emissions of air toxics in the region and recommends that priority attention be focused on fifteen known carcinogens that are present in the ambient air. The Commission's recommendations are based on studies undertaken by its advisory board which reviewed available information and assessed human exposure to chemical substances through direct inhalation.

In keeping with the governments' commitment under the Great Lakes Water Quality Agreement (Agreement), the Commission emphasizes the need to prohibit the emission or release to the atmosphere of toxic substances in toxic amounts and to eliminate the release of persistent toxics based on the philosophy of zero discharge from anthropogenic sources. The geographic area of study under this Reference falls within the geographic scope of the Great Lakes Water Quality Agreement, and the reduction or control of atmospheric emissions is required to meet the goals of the Agreement as they relate to the atmospheric pathway as a source of Great Lakes contamination.

The Commission alerts governments to the fact that in the reference region, as well as in other areas, data and information on the human health effects of toxic contaminants are extremely sparse. While further studies and research are essential to advance overall understanding of the adverse human health effects of toxic chemicals, its lack should not be a deterrent to immediate action to prevent the emissions of known carcinogens or persistent toxic substances which are present in the region.

The Commission plans to pursue additional studies in the reference region and will provide advice to governments on matters related to the Reference.

Yours sincerely,

Gordon K. Durnil
Chairman
United States Section

E.D. Fulton
Chairman
Canadian Section

TABLE OF CONTENTS

Executive Summary and Recommendations vii

Introduction 1

Recommencement of the 1975 Reference 2

Evaluation of Air Pollutants of Concern 3
- Data Availability 3
- Assessment of Risk 4
- Airborne Carcinogens 6
- Noncancer Health Risks Posed by Airborne Pollutants 9
- Chemical Mixtures 10

Incinerators 11

Air Quality Trends in the Detroit-Windsor / Port Huron-Sarnia Region 13
- Particulate and Sulphur Dioxide 13
- Carbon Monoxide 14
- Nitrogen Dioxide 15
- Ozone and Volatile Organic Compounds 15

Future Activities Under the Reference 17

Appendix A -
Letters of Reference 19

Appendix B -
A History of International Joint Commission Studies of Air Quality in the Detroit-Windsor / Port Huron-Sarnia Region 23

Appendix C -
Membership of the Commission's International Air Pollution Advisory Board for the Detroit-Windsor / Port Huron-Sarnia Region 25

Appendix D -
Summary of Views Expressed at Public Meetings 26

Appendix E -
Air Quality Trends in the Detroit-Windsor/Port Huron-Sarnia Region 28

EXECUTIVE SUMMARY and RECOMMENDATIONS

By letters dated September 30, 1988, the Governments of Canada and the United States requested the International Joint Commission (Commission) to recommence work under the 1975 Reference on the state of air quality in the Detroit-Windsor and Port Huron-Sarnia areas. In particular, the Commission was asked to examine and report on the actual and potential hazards posed to human health and the environment from airborne emissions in the Detroit-Windsor area.

The task assigned to the Commission is challenging and complicated when one considers the limited data base available on toxic chemicals and the current state of knowledge with respect to their effects on humans and the environment. To initiate studies under the Reference, the Commission appointed an advisory board of federal, state, provincial and academic experts. The board completed a preliminary screening of available information on a list of 125 chemicals known to be present in the ambient air of the region, and reported its conclusions and recommendations to the Commission on December 11, 1990. The report was released to the public on February 4, 1991, and the Commission held two public meetings, in Port Huron and Windsor, in March-April 1991 to obtain citizen comment and reaction to the board's report. It also provided a period for written submissions.

Following consideration of the board's report and the public's comments and written submissions, the Commission presents this first report to Governments under the Reference. Based on the studies and other evidence received, the Commission arrives at the following conclusions:

1. Sufficient information exists on airborne toxic chemicals in the region to conclude that there is a significant public health issue which requires the immediate implementation of additional air emission abatement and preventive measures.

2. While many data and information deficiencies on the presence of airborne toxic chemicals in the region and their effects have been identified, these deficiences should not be a deterrent to immediate action to prevent the emissions of the 15 chemicals identified by the Board as having the highest level of concern relative to direct inhalation exposure.

3. The board's analysis focused on the direct inhalation route of exposure. Before an assessment of the total risk of the burden of toxic chemicals on human health can be undertaken, analyses of multiple routes of exposure must be completed.

4. The ambient concentrations of airborne toxics in the region are similar to other urban areas of comparable size and industrial development.

5. Insufficient information is available to conclude whether or not excess disease or deaths are attributable to exposure to airborne toxics in the region.

6. Noncarcinogenic or more subtle health effects must be considered in addition to carcinogenic effects in analyzing the extent of toxic chemical impacts.

7. A lack of ambient air monitoring data, emission inventories and health-related studies on potentially important toxic substances make it difficult to analyze the potential human health and environmental effects of many toxic chemicals.

8. The commitment by the Governments -- in Annex 15 of the Canada-United States Great Lakes Water Quality Agreement -- to reduce atmospheric deposition of toxic substances, particularly persistent toxic substances, to the Great Lakes basin is directly related to the concerns addressed in this Reference. To alleviate problems related to airborne contaminants in the Detroit-Windsor/Port Huron-Sarnia region, programs must be accelerated to meet the commitments under this international agreement.

Recommendations

Based on studies and information received to date, the Commission makes the following recommendations to Governments on air quality in the Detroit-Windsor and Port Huron-Sarnia region:

1) A comprehensive air toxics monitoring program be developed and implemented in the Detroit-Windsor and Port Huron-Sarnia corridor to address the following:

   a) measurement of the 15 Group I chemicals identified by the board. These are: benzene, chromium compounds, formaldehyde, 1,3-butadiene, 1,4-dichlorobenzene, nickel compounds, benzo(a)pyrene, cadmium, chloroform, carbon tetrachloride, arsenic compounds, trichloroethylene, beryllium, 1,2-dichloroethane (ethylene dichloride) and perchloroethylene (tetrachloroethylene).

   b) measurement of other chemicals identified by the board as present in the region following an assessment of their potential to cause adverse effects on human health or the environment. Emphasis should be placed on carcinogens listed in Categories 1 and 2 by the International Association for Research on Cancer.

   c) characterization of long-term trends in air toxics data.

   d) determination of quality assurance protocols to assure network compatibility and intercomparison.

   e) identification of toxic hot spots where concentrations of chemicals and human exposure may be higher than generally measured in the region.

   (f) deposition of the chemicals of concern onto land and water, especially those that enter the food chain and bioaccumulate.

   (g) transport of air toxics into the region.

2) Governments update emission inventory data on toxic air contaminants to provide a basis from which to assess potential health impacts, monitoring needs and development of emission reduction strategies.

3) Risk assessment tools be developed and refined to determine the risk to human health from exposure to toxic substances.

4) Governments develop and pursue other decision-making tools to avoid total reliance on risk assessment in the control of air toxics.

5) Procedures be developed to assess the relative and cumulative importance of various pathways by which humans are exposed to toxic chemicals.

6) Governments initiate and implement pollution prevention programs to reduce emissions of airborne toxics in the region, with priority attention given to the 15 known carcinogens in the board's Group I listing, especially benzene, 1,3-butadiene and formaldehyde.

7) Governments assess the potential health and environmental impacts of air toxics found on the board's list to identify those chemicals, in addition to the board's Group I chemicals, that require immediate abatement and preventive measures.

8) Governments ensure that the filling of data gaps for known carcinogens which appear on the International Agency for Research on Cancer (IARC) 1 and 2 lists and the U.S. EPA cancer classifications be given high priority to enable more precise risk assessments to be undertaken.

9) A more extensive assessment of the actual and potential reproductive and teratogenic effects of the airborne chemicals styrene, chloroform, nickel compounds, xylene, benzene and formaldehyde, identified by the Board as having an inadequate margin of safety, be undertaken.

10) More attention be devoted to developing data bases and compiling information on non-cancer endpoints as a result of human exposure to airborne toxic chemicals.

11) Research be undertaken on the subtle effects of toxic chemicals to suppress immune, endocrine and nervous systems as a basis for appropriate risk decisions.

12) Additivity concepts be incorporated routinely into risk assessment models.

13) Incineration facilities in the region be phased out of use or required to eliminate the production and emission of dioxins, furans, PCBs and inorganic materials, especially mercury and hydrochloric acid.

14) Uniform state and provincial requirements be established for incineration facilities in the Reference region based on the principle of zero discharge of persistent toxic substances.

15) Governments monitor incinerator emissions for phosgene gas when chlorinated organic materials are being incinerated and institute effective controls to prevent the production of this gas.

16) The Governments review current air quality objectives for sulphur dioxide and particulate matter in the region and provide the Commission with updated objectives for compliance assessment.

17) Consideration be given to modifying the particulate objective to include PM_{10}.

18) The Governments, in consultation with the State of Michigan and the Province of Ontario, develop a joint regional ozone control strategy that includes emission controls for mobile and stationary sources, including coke ovens.

19) The Governments, in consultation with the State of Michigan and the Province of Ontario, adopt a common ozone standard for the Reference region.

Air Quality in the Detroit-Windsor/ Port Huron-Sarnia Region

INTRODUCTION

Air quality in the Detroit-Windsor and Port Huron-Sarnia region has concerned local citizens, governments and the International Joint Commission (Commission) for several decades. In addition to monitoring and studies undertaken by the state, provincial and federal governments, regional air quality was the subject of three references to the Commission. While substantial progress has been made in controlling emissions of the more conventional pollutants (i.e. airborne particles, sulphur dioxide, odours and smoke from vessels on the Detroit River), more attention must be focused on a wider range of pollutants, particularly toxic and hazardous substances. These pollutants originate from sources both inside and outside the region, the latter brought into the region by atmospheric transport.

In its report to the Governments of Canada and the United States in 1983, the Commission concluded that the air quality objectives of the 1975 Reference had essentially been met. It also noted that very little additional progress could be made under the Reference as it was framed and that attention needed to be focused on toxic and hazardous substances.

In 1988, the City of Detroit completed construction of a municipal solid waste and energy recovery facility, one of the largest incinerators of its type in the world. Local residents, environmental groups and government agencies expressed concerns that the facility lacked adequate environmental control systems and posed serious health risks to people of the area, including residents on the Canadian side of the international boundary. Because of these and other concerns, including several other proposals to commercially destruct hazardous chemicals in the Detroit-Windsor area, the Governments requested, by letters of September 30, 1988 (see Appendix A), that the Commission recommence its work under the July 1975 Reference. Specifically, the Commission was asked to investigate the actual and potential hazards posed to human health and the environment from airborne emissions in the region, and to assist the Governments in dealing more effectively with air quality concerns. This request continues a long history of Commission involvement in air quality issues in the region. A summary of earlier Commission studies appears in Appendix B.

This report highlights the studies undertaken by the Commission in response to the reactivated Reference and presents recommendations for government action. The recommendations focus on pollution prevention initiatives, research, and enhancement of monitoring and inventory activities to gain a better understanding of the potential health effects of airborne toxic contaminants.

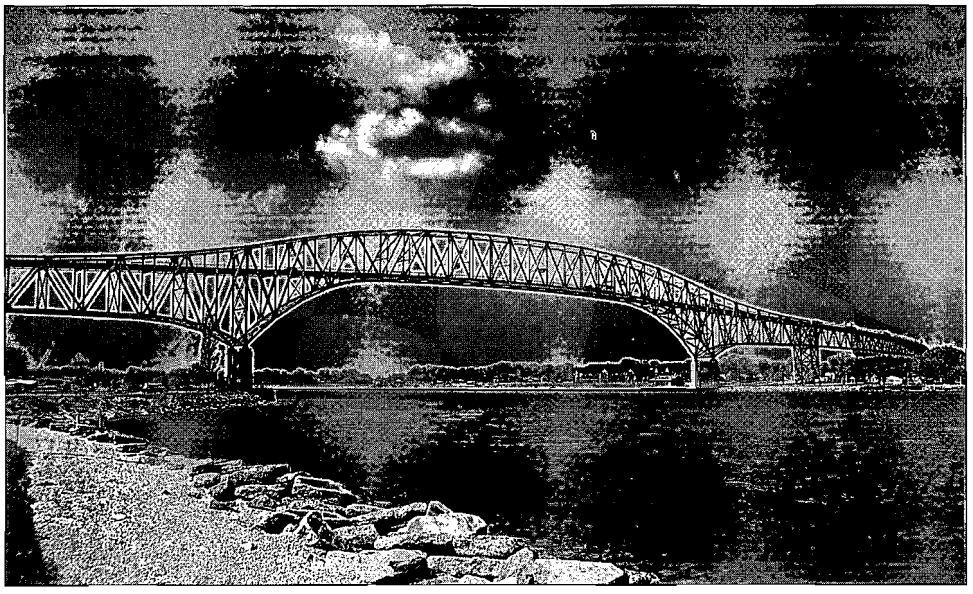
RECOMMENCEMENT OF THE 1975 REFERENCE

The Commission, in recommencing work under the Reference, appointed members to the International Air Pollution Advisory Board for the Detroit-Windsor/Port Huron-Sarnia Region. The membership of the board is provided in Appendix C. The board was directed to review existing information on emissions, to study trends in ambient air quality and problems of airborne toxic chemical pollutants in the region, and to provide a preliminary assessment of the adequacy of information to address the requirements of the Reference.

The board, in reviewing available information, emphasized human health implications of airborne toxic pollutants. The board submitted its report to the Commission on December 11, 1990. The Commission released the board's report in early February 1991 and convened public meetings in Port Huron, Michigan on March 18, 1991 and in Windsor, Ontario on March 19, 1991 to receive citizen comments on the board's report prior to preparing this first report to Governments under the Reference. A summary of views expressed at the public meetings appears in Appendix D.

The Commission acknowledges the significant contribution of its International Air Pollution Advisory Board in analyzing existing information and formulating conclusions and recommendations to guide pollution prevention and remediation initiatives. Further, the Commission endorses the recommendations of the board. In preparing this report to Governments, the Commission has considered the board's report, comments received at the public meetings, written submissions, and information from other sources.

The Commission has only begun to address the matters referred to it under the Reference through the efforts of the advisory board, and intends to undertake additional studies to provide advice and guidance to Governments pursuant to the Reference. The Commission's plans in this regard appear in the last section of this report.



The Bluewater Bridge between Port Huron and Sarnia

EVALUATION OF AIR POLLUTANTS OF CONCERN

Data Availability

Not every chemical substance found in the air poses a health or environmental hazard. Therefore, it is essential that techniques be established to identify chemicals that do pose a risk, and to establish priorities for their monitoring, assessment and control. Many domestic and international agencies have developed lists of chemicals for priority attention based on known or suspected harmful effects on human health and/or the environment. The board reviewed several such lists and compiled a list free of redundancies and synonymies (chemicals which appear more than once because they have more than one technical or trade name). These chemicals were then checked against data from a regional emissions inventory, supplied by the U.S. Environmental Protection Agency, to produce a final list of chemicals with a known regional presence. The board's final list contained 125 chemicals and formed the basis for the board's analysis of environmental monitoring and an initial screening of the potential for human health concerns in the region.

The Commission notes that the chemicals on the board's list are on the list of hazardous air pollutants found in Title III of the United States Clean Air Act. Several are also candidates for priority assessment under the Canadian Environmental Protection Act. Thus, the Commission recognizes that many of these chemicals are priority concerns within current Governments' programs.

Of the 125 chemicals on the list, there is monitoring data for only 58. These data are neither complete nor fully representative of the presence or distribution of air toxics in the region. The board concluded, however, that the available data were scientifically sound and could be used for initial screening purposes to provide a basis to initiate control actions and develop future program directions.

The relatively limited amount of data available for the chemicals of concern raises the question of the adequacy of current monitoring efforts in the region. The monitoring of air toxics in the Detroit-Windsor area has expanded greatly over the last three years, but remains more limited for the Port Huron-Sarnia area. Inconsistencies and incompatibilities in data and reporting between and among jurisdictions occur because of differences in sampling and analytical protocols used. These differences become significant when data sets developed for specific purposes are utilized on a broader basis or for purposes other than the ones for which they were collected.

The Commission needs the most current and reliable information on emissions and ambient air quality to review chemicals for their potential effects on the environment and human health. Governments must update emissions inventories to include data on new chemicals found in the region and to specify, for all chemicals in the inventory, their local sources as well as those sources external to the region. Information currently available does not differentiate between chemicals originating from sources within the region and those originating outside the region, which are transported into the region by atmospheric pathways.

On the basis of the board's analysis of monitoring programs and data availability,

the Commission recommends that:

1) a comprehensive air toxics monitoring program be developed and implemented in the Detroit-Windsor and Port Huron-Sarnia corridor to address the following:

   a) measurement of the 15 Group I chemicals identified by the board. These are: benzene, chromium compounds, formaldehyde, 1,3-butadiene, 1,4-dichlorobenzene, nickel compounds, benzo(a)pyrene, cadmium, chloroform, carbon tetrachloride, arsenic compounds, trichloroethylene, beryllium, 1,2-dichloroethane (ethylene dichloride) and perchloroethylene (tetrachloroethylene).

   b) measurement of other chemicals identified by the board as present in the region following an assessment of their potential to cause adverse effects on human health or the environment. Emphasis should be placed on carcinogens listed in Categories 1 and 2 by the International Association for Research on Cancer.

   c) characterization of long-term trends in air toxics data.

   d) determination of quality assurance protocols to assure network compatibility and intercomparison.

   e) identification of toxic hot spots where concentrations of chemicals and human exposure may be higher than generally measured in the region.

   (f) deposition of the chemicals of concern onto land and water, especially those that enter the food chain and bioaccumulate.

   (g) transport of air toxics into the region, and

2) the Governments update emission inventory data on toxic air contaminants to provide a basis from which to assess potential health impacts, monitoring needs and development of emission reduction strategies.

Assessment of Risk

Because the actual risk posed by exposure to most chemicals is unknown, health authorities generally use some form of risk assessment technique to propose an acceptable dose associated with exposure. That dose usually corresponds either to one causing no adverse risk of effects from noncarcinogens, or one causing very small risk for carcinogens.

To assist in determining the significance of each chemical on its list, the board reviewed risk assessment techniques. It concluded that the use of standard risk assessment procedures to estimate the incidences of cancer, and then relating this to population distribution to predict the probable incidence of cancer for a specific demographic area, improperly conveys a sense of accuracy of the risk estimate that is not logically consistent. While the quantitative risk estimation process -- with its inherent uncertainties and conservatism -- is widely used in preventive regulatory programs, the Commission supports the board's conclusion that the risk

assessment techniques in use are inappropriate for the type of evaluation undertaken in this study. Assumptions in the risk assessment process may lead to significant overestimates of the real risks posed by air toxics to residents of the region and, thus, cause undue concern.

The board developed a more limited assessment based on a "Levels of Concern Algorithm" which is a screening technique to identify the chemicals of most concern from a human health perspective, based on the direct inhalation route of exposure. The risk to human health is based on knowledge of the severity of toxic effects (Toxicity Rating), the population of the region exposed to the chemical (Exposure Index), and whether the levels of the chemical in the air exceed screening levels used by government agencies (Level of Exposure). The algorithm also identifies data gaps and monitoring needs in the region.

Consistent with the board's caution about the confidence that should be placed in the screening process, the Commission supports the procedure and conclusions reached as sufficient evidence of the need to take abatement and preventive actions for the identified chemicals. The algorithm also might be useful in assessing the potential risks that chemicals pose to the environment. The Commission will pursue this aspect in future work under the Reference.

Risk assessment techniques are controversial because of the lack of public understanding of the methods used as well as scientific disputes over the basic theories and the interpretation of results. The Commission supports the use of risk assessment **in conjunction** with other decision-making tools. Sufficient confidence in the methods appears to be lacking for general acceptance as sole decision-making tools to assess environmental and human health effects.

With respect to risk assessment,

the **Commission recommends that:**

3) **risk assessment tools be developed and refined to determine the risk to human health from exposure to toxic substances, and**

4) **governments develop and pursue other decision-making tools to avoid total reliance on risk assessment in the control of air toxics.**

While the Reference to the Commission pertains to the Detroit-Windsor/Port Huron-Sarnia region, concerns were expressed at the Commission's public meetings and in written submissions that air quality in the region should be studied by subregions: the Sarnia-Port Huron airshed and the Windsor-Detroit airshed. It was suggested that unique sources and air patterns in the areas created a non-uniform distribution of risks to human health and the environment and that more stringent pollution controls may be required in one subregion than in the other.

From a review of the available data, it appears that the air pollution plumes from the two urban subregions have limited interaction. However, many toxic air pollutants have elevated levels throughout the Reference region. Thus, despite the merits of studying air pollution problems on a subregion level, the lack of monitoring sites and consistent, comparable data do not presently allow such a refinement in the analyses. Improvements in monitoring programs should enable characterization of pollutant impacts in each subregion.

It is important to note that the board's recommendations to the Commission depend on an analysis of the risks that airborne pollutants pose to human health from exposure through direct inhalation. This limited analysis requires additional analyses of exposure from other pathways such as indoor air, food, water, and other site and occupation-specific exposures. Without a total exposure assessment, the relative importance of each route of exposure remains in question. This should not justify delays, however, in implementing appropriate programs to control air toxics in the region.

As toxic chemicals enter the environment from a number of sources and humans are exposed to them through numerous pathways,

the Commission recommends that:

5) **procedures be developed to assess the relative and cumulative importance of various pathways by which humans are exposed to toxic chemicals.**

Airborne Carcinogens

Existing data bases on the toxicity of chemicals were used to identify those chemicals on the board's list that have carcinogenic potential. Sufficient data existed to apply the board's algorithm to 20 known carcinogens. This analysis led to categorizing of the chemicals into two groups, the first group of 15 having a higher level of concern in the Reference region based on their potential for direct inhalation than those in the second group of five. The specific chemicals in each group are listed in Table 1.

TABLE 1: Chemicals of Concern

Group I:		
Arsenic compounds	Chloroform	Benzene
1,4-dichlorobenzene	Benzo(a)pyrene	Beryllium
1,2-dichloroethane	Formaldehyde	1,3-Butadiene
Carbon tetrachloride	Cadmium	Nickel compounds
Perchloroethylene	Chromium compounds	
Trichloroethylene		

Group II:	
Acetaldehyde	Chlorinated dioxins (2,3,7,8-TCDD equivalents)
Methylene chloride	Polychlorinated biphenyls (PCBs)
Vinyl chloride	

The algorithm analysis provides useful results but does not imply that other chemicals on the board's list do not merit attention. The fact that chemical carcinogens are present at measurable levels in the reference region gives sufficient cause for concern.

Of the 125 chemicals on the board's list, only 73 have been reviewed by the International Agency for Research on Cancer (IARC) and/or the U.S. Environmental Protection Agency (U.S. EPA). Nine chemicals have sufficient data on human carcinogenicity classified as IARC 1 or U.S. EPA A carcinogens. A description of these classifications appears in Table 2.

Table 2: A Summary of the Evidence Required by the International Agency for Research on Cancer (IARC) and the U.S. Environmental Protection Agency (EPA) to Classify Carcinogens

IARC		U.S. EPA	
1	THE AGENT IS CARCINOGENIC TO HUMANS - used only when there is sufficient evidence of carcinogenicity in humans.	A	Sufficient human data to show carcinogenicity
2A	THE AGENT IS PROBABLY CARCINOGENIC TO HUMANS - limited evidence in humans and sufficient evidence in experimental animals. - in exceptional cases, an agent may be placed in this category based solely on limited evidence in humans or on sufficient evidence in experimental animals strengthened by supporting evidence from other relevant data.	B1	Limited human data to show carcinogenicity
2B	THE AGENT IS POSSIBLY CARCINOGENIC TO HUMANS - limited evidence in humans in the absence of sufficient evidence in experimental animals - may also be used when there is inadequate evidence in humans (or when human data is nonexistent) but when there is sufficient evidence in experimental animals.	B2	Sufficient experimental data to show carcinogenicity
		C	Human data are inadequate or nonexistent, but limited experimental animal data to show carcinogenicity
3	THE AGENT IS NOT CLASSIFIED AS TO ITS CARCINOGENICITY TO HUMANS - agents are placed in this category when they do not fall into any other group.	D	Data to assess carcinogenicity are inadequate or nonexistent
4	THE AGENT IS PROBABLY NOT CARCINOGENIC TO HUMANS - used when there is evidence suggesting lack of carcinogenicity in humans together with evidence suggesting lack of carcinogenicity in experimental animals	E	Well designed studies suggest that the pollutant is noncarcinogenic

Thirty-seven were classified as IARC 2A, 2B or U.S. EPA B1 or B2 carcinogens. Twenty-two had an inadequate data base to allow classification and five are currently under review by U.S. EPA. Annual mean air concentrations in the region were available for only 27 of the 46 chemicals ranked as carcinogens. Inventory information existed for 43 of these.

The Commission is particularly concerned about the lack of monitoring data for the four chemicals with IARC 1 classifications -- coke oven emissions, asbestos, chloromethyl methyl ether and (bis)chloromethylether -- and for six IARC 2A carcinogens because of their presence in the region and their potential carcinogenic effects. Improved monitoring and emission inventories are required to assess actual ambient levels and the potential for exposure to many known chemical carcinogens known to be present in the region. This lack of monitoring data and emission inventories seriously hinders regulatory decisions to control these known chemical carcinogens.

The Commission supports the board's conclusion that existing information justifies targeted pollution prevention initiatives for the 15 Group I chemicals with priority attention given to benzene, formaldehyde and 1,3-butadiene because of their elevated levels in the ambient air and the strong evidence of their carcinogenicity.

The Commission recommends that the Governments:

6) **initiate and implement pollution prevention programs to reduce emissions of airborne toxics in the region, with priority attention given to the 15 known carcinogens in the board's Group I listing, especially benzene, 1,3-butadiene and formaldehyde, and**

7) **assess the potential health and environmental impacts of air toxics found on the board's list to identify those chemicals, in addition to the board's Group I chemicals, that require immediate abatement and preventive measures, and**

8) **ensure that the filling of data gaps for known carcinogens which appear on the IARC 1 and 2 lists and the U.S. EPA cancer classifications be given high priority to enable more precise risk assessments to be undertaken.**

Based on a review of several recent health risk studies dealing with multiple pathway exposures, the inhalation pathway dominates the cancer risk for most chemicals in Group I and three chemicals in Group II. On the other hand, for polychlorinated biphenyls (PCBs) and chlorinated dioxins (2,3,7,8-TCDD and equivalents), human exposure from food and water ingestion generally exceeds exposure from inhalation. A recent Government of Canada report, *Toxic Chemicals in the Great Lakes and Associated Effects* (March 1991), estimated that for people in the Great Lakes basin, the majority (80 to 90 percent) of their intake of chlorinated organic chemicals comes from food, a lesser amount from air (5 to 10 percent) and less than one percent from water.

Many chlorinated organic pesticides also have carcinogenic properties. The board noted that while these chemicals may be of concern from the perspective of atmospheric deposition and impact on aquatic and terrestrial life, they are not a high priority for the region when compared to other chemicals studied and to widespread exposure in the ambient air. The U.S. EPA's study of toxics in the transboundary region included two chlorinated organic pesticides, chlordane and heptachlor. The estimated cancer risk of these two chemicals via inhalation was found to be extremely small.

Noncancer Health Risks Posed by Airborne Pollutants

Many of the 125 chemicals on the board's list cause a variety of serious effects other than carcinogenicity. Data availability on these effects, however, is extremely limited. Recent developments in data bases for noncarcinogenic effects emphasize reproductive, teratogenic and neurological effects. Because neither the data nor the structure of these data bases have received peer review comparable to those for carcinogenicity, the analyses for noncancer health risks are extremely limited.

Of the 56 chemicals on the board's list that had data related to reproductive or teratogenic toxicity, monitoring data were available for only 25. Analysis of these data based on the "Margin of Safety Approach" outlined in the board's report indicated that ambient air concentrations in the region for styrene, chloroform, nickel compounds, xylene, benzene and formaldehyde occur at concentrations which suggest an inadequate margin of safety for human exposure. More detailed analyses of these chemicals should be undertaken to determine the potential for reproductive and teratogenic effects due to exposure in the region. The chemicals xylene and 1,1,2-trichloroethane have large inventory values, suggesting the possibility for widespread exposure.

Some sectors of the scientific community have suggested that for chemicals which are carcinogenic and cause reproductive and/or teratogenic effects, ambient air concentrations sufficient to protect against carcinogenic effects would also protect against reproductive or teratogenic effects. The Commission cautions against this extrapolation, for the following reasons:

a) Cancer risk assessment assumes a lifetime exposure while risk assessment for teratogenicity and reproductive impairment must recognize the danger of a single exposure or a few exposures at a critical period in development.

b) The cellular mechanisms of tumor production differ from those producing birth defects or reproductive impairments, and risk assessment models do not always mathematically accommodate those mechanistic differences.

c) Monitoring reproductive problems and teratogenic impairments has not yet confirmed the validity of this assumption.

Based on the Board's analysis of teratogenic and reproductive endpoints of toxic air contaminants in the region,

the Commission recommends that:

9) a more extensive assessment of the actual and potential reproductive and teratogenic effects of the airborne chemicals styrene, chloroform, nickel compounds, xylene, benzene and formaldehyde, identified by the Board as having an inadequate margin of safety, be undertaken, and

10) more attention be devoted to developing data bases and compiling information on noncancer endpoints as a result of human exposure to airborne toxic chemicals.

There is growing concern within the scientific community about the possible effects of low levels of toxic chemicals on suppression of immune, endocrine and nervous systems. Two of the most important chemical pollutants on the board's list, mercury and lead compounds, are known neurotoxins and are regulated by Governments on this basis. For most other chemicals, very little information is available to assess these subtle effects.

The Commission recommends that:

11) **research be undertaken on the subtle effects of toxic chemicals to suppress immune, endocrine and nervous systems as a basis for appropriate risk decisions.**

Chemical Mixtures

Because air is a chemical mixture, people are not normally exposed to single pollutants through inhalation. Many interactions among constituents of the air occur both internally and externally to the human body. Therefore, a single pollutant assessment of risk for cancer or other effects does not necessarily reflect the true or total chemical exposure.

Screening levels for a few chemicals used in the board's analysis incorporated information on background levels of other pollutants with potential interactions. For those specific pollutants, the additive effects of several chemicals were implicit in the analysis. Such a broader, additive analysis of the impact on humans should be extended to the broader list of chemicals to improve the overall risk assessment.

Mathematical techniques are available to incorporate this concept into risk assessment models. However, analyses of the effects of toxic air contaminants to date have not included synergistic effects of chemical combinations because current risk assessment models do not have the theoretical basis or sophistication to accommodate such factors. The current information on the effects of chemical combinations indicate that very few are known to produce synergistic effects. Most studies of the effects of combinations of chemicals indicate additivity rather than synergism. Incorporating additivity into risk assessment models significantly improves the quality of those models.

Since chemical reactions occur between and among components of a pollution mixture to produce secondary pollutants that may present hazards to human health,

the Commission recommends that:

12) **additivity concepts be incorporated routinely into risk assessment models.**

INCINERATORS

With the move away from landfills for the disposal of municipal and industrial waste, incinerators have frequently been used as an alternate means of waste disposal. The operation of these facilities and, in some cases, their lack of adequate pollution prevention technology have been of major concern to environmental and local citizens groups in recent years.

From a transboundary pollution perspective, one main concern in the Reference region is the construction and operation of the Detroit Solid Waste Recovery Facility in Detroit, Michigan. Public concern about emissions from this facility -- because of what some consider inadequate and ineffective pollution control systems -- and about other proposals to incinerate hazardous wastes in the area were among the principal reasons for the current Reference to the Commission.

The board compiled a survey of incinerators in the Reference region by type, waste burning capacity, and type of pollution control systems employed as of 1989. Over the past decade in the four-county region in Michigan (Macomb, Oakland, St. Clair and Wayne Counties), a shift has occurred from small incinerator units to larger, regional units. The trend continues as several small incinerators (mainly apartment building types) are decommissioned, forcing more solid waste into regional handling systems. This regionalization process offers great opportunity for waste minimization through reuse, recycling and resource recovery, thus minimizing the need for incineration.

The survey identified 1,678 incinerators in the four Michigan counties, the majority of which are smaller units with capacities less than 500 lb/hr (227 kg/hr.). Ninety-four handle over 500 lb/hr (227 kg/hr.) and five handle more than 39,650 lb/hr.(18,000 kg/hr.). In the Ontario portion of the region there are nine operating incinerators. Six are relatively small biomedical waste facilities, while the other three handle liquid and industrial waste. The largest facility, in Moore Township, has a capacity of 39,650 lb/hr.(18,000 kg/hr).

Among the most serious toxic pollutants emitted by incinerators are dioxins, furans, PCBs, hydrochloric acid, mercury and other metals. Incineration of contaminated municipal sludges are quite often a source of PCBs; however, because levels of PCBs in the sludges are below those regulated as hazardous waste, treatment technology to control emissions of PCBs is not usually present. The large volumes of sludges being incinerated can result in potentially dangerous levels of PCBs emitted into the atmosphere.

Incinerators clearly emit pollutants of concern. Data are not available to determine the relative percentage of contaminants contributed by incinerator emissions or other sources in the region, but the technology exists to significantly reduce these emissions.

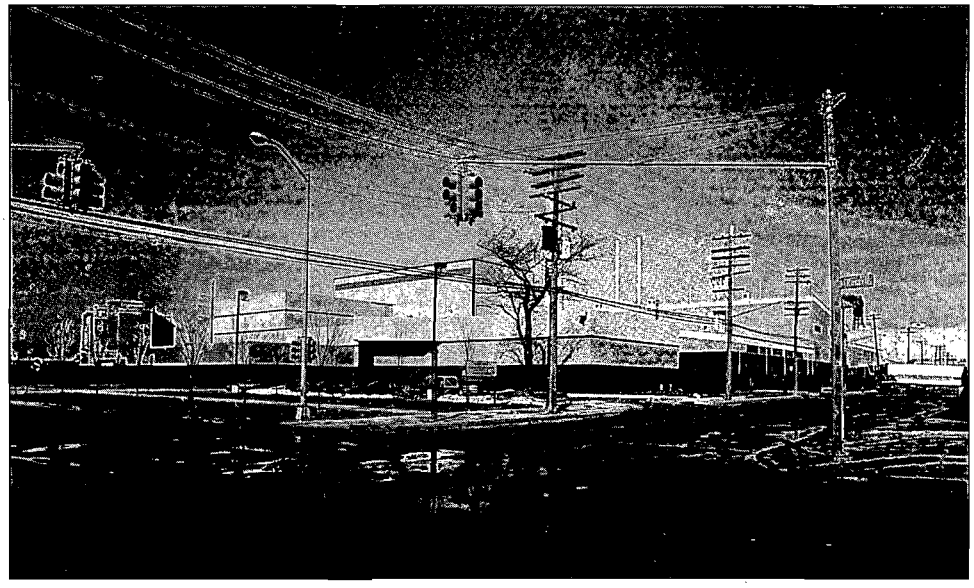
In addition to the above pollutants, the Commission recognizes the increasing concern over the production and emission of phosgene, a highly toxic compound that can result from high temperature reaction between carbon monoxide and hydrochloric acid during the combustion of chlorinated organics. The presence of phosgene warns of technical problems with the incinerator process.

The Commission recommends that:

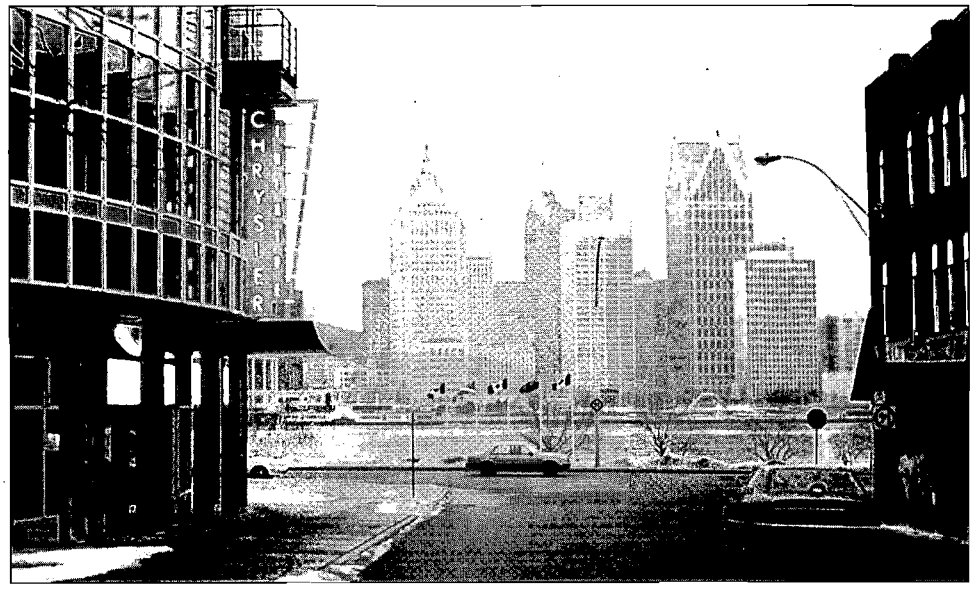
13) incineration facilities in the region be phased out of use or required to eliminate the production and emission of dioxins, furans, PCBs and inorganic materials, especially mercury and hydrochloric acid, and

14) uniform state and provincial requirements be established for incineration facilities in the Reference region based on the principle of zero discharge of persistent toxic substances, and

15) governments monitor incinerator emissions for phosgene gas when chlorinated organic materials are being incinerated and institute effective controls to prevent the production of this gas.



The Detroit Solid Waste Recovery Facility *Credit: Saida Malarney*



Part of downton Detroit as seen from Windsor *Credit: Bruce Jamieson*

AIR QUALITY TRENDS IN THE DETROIT-WINDSOR/ PORT HURON-SARNIA REGION

From 1975 to 1983 the Commission reported annually to the Governments of Canada and the United States on specific air pollution concerns and associated activities in the Detroit-Windsor/Port Huron-Sarnia region. The 1975 Reference referred to only three pollutants for which firm commitments had been made by federal, state and provincial authorities to achieve air quality compatible with the air quality objectives proposed by the Commission in its 1972 report to Governments: total suspended particulate (TSP) matter, sulphur oxides and odours. The board appointed by the Commission under the 1975 Reference also reported, to a limited degree, on ambient levels and control information for carbon monoxide, nitrogen dioxide and photochemical oxidents.

In its final report to Governments in 1983, the Commission reported that from 1976 to 1983 control strategies and technical works had been implemented to bring particulates, sulphur dioxide and odours under control. It reported that more than 90 percent of the geographical region complied with the objective for control of sulphur oxides. The problem of odours was only occasional, and control of particulates in stationary sources had been accomplished.

The ambient air quality objectives in place during this earlier reference period were:

1. Sulphur dioxide (SO_2) concentration for:
   a. 1 hour is less than 0.25 ppm (655 ug/m^3) of air; and for
   b. 24 hours is less than 0.10 ppm (260 ug/m^3) of air
2. Total Suspended Particulate (TSP) concentration
   as determined by high volume samplers and at 1 atmosphere and 70°F for:
   a. 24 hours is less than 120 ug/m^3, and for
   b. 1 year the annual geometric mean is less than 60ug/m^3.
3. Offensive odours were absent.

Particulate and Sulphur Dioxide

Since 1983, the United States and Canada have amended their particulate matter and sulphur dioxide standards and objectives. The United States particulate standard includes monitoring of and reporting on fine particulates, which are very small particles that can be inhaled and thus reach the lungs. The United States no longer reports on emergency one-hour exceedance for sulphur dioxide, but has retained a 24-hour mean of 365 ug/m^3 (micrograms per cubic metre), and reports against an annual average limit of 80 ug/m^3. Canada reports against an annual average limit for sulphur dioxide of 53 ug/m^3.

Data archiving of air quality information for the region no longer accommodates analysis based on the objectives established for the 1975 Reference. In order to report trend data on sulphur dioxide and total suspended particulates, the Commission seeks clarification from Governments on the regulatory objectives in effect in the region. It is assumed that these replace the earlier bilateral objectives against which the Commission reported until 1983.

Analysis of air quality trends for total suspended particulate and sulphur dioxide from 1983 to 1990 appear in Appendix E. The Commission concludes that the region has generally met the total suspended particulate and sulphur dioxide objectives established for the 1975 Reference. Exceedances of the TSP objective occurred on several occasions from 1983 to 1986, mainly in Wayne County (Detroit area), but data indicate that all stations have met the objective since 1986. In addition, air quality at all stations met the sulphur dioxide objective from 1983 to 1990.

Improvements in sulphur dioxide emissions in the region are a major success story, but ameliorations in total suspended particulates are less conclusive. As a parameter, TSP alone is not a good indicator of how air quality affects human health because its measurement only considers the number and not the size of particles. Very small particles, or fine particulates measured as PM_{10}, are respirable and can cause adverse health effects. A few monitoring sites in the region no longer report on TSP but only report for PM_{10}. This is a significant change in monitoring protocols, which should be reviewed on a regional basis to ensure that appropriate monitoring is in place to correlate the observed presence of particulate matter with emission sources since some pollutants that correlate with TSP do not always correlate with PM_{10}. The Commission requires both TSP and PM_{10} data to advise Governments on the health and environmental implications of particulate matter.

Accordingly,

the Commission recommends that:

16) the Governments review current air quality objectives for sulphur dioxide and particulate matter in the region and provide the Commission with updated objectives for compliance assessment; and

17) consideration be given to modifying the particulate objective to include PM_{10}.

The United States and Canada have national ambient air quality standards or objectives for carbon monoxide, nitrogen dioxide, volatile organic compounds (VOCs), and ozone. Analysis of the available monitoring data for these parameters in the Reference region is presented in Appendix E.

Carbon Monoxide

Motor vehicles are the main source of carbon monoxide. Current control strategies, by the states and provinces, are aimed at vehicle maintenance and inspection programs to assure that engines and catalytic converters operate to emit less carbon monoxide. Although each new

class of vehicles emits less carbon monoxide than its predecessors, the impact of the increased number of vehicles in service has exceeded the impact of emission improvements per vehicle. Ambient air quality standards for carbon monoxide include a short-term event level of 35 ppm (40 mg/m^3) expressed as a one-hour mean, and a long-term standard of 9 ppm (20 mg/m^3) expressed as an eight-hour mean.

Available monitoring data for carbon monoxide are difficult to interpret. Very few sites monitor this parameter and most data are too ambiguous to judge compliance, because monitoring sites are generally located in heavy traffic areas and thus do not represent regional trends. It was not possible to determine the significance of carbon monoxide to human health or as an air pollutant with transboundary significance.

Nitrogen Dioxide

Nitrogen dioxide has received considerable attention in recent years because it is a precursor to ozone and acid precipitation. Since regional authorities rarely monitor nitrogen dioxide, very little monitoring data is available in the Reference region. What limited data is available appears to indicate that the region meets national ambient air quality standards for this pollutant.

Ozone and Volatile Organic Compounds (VOCs)

The United States and Canada have different national standards or objectives for ozone and automobile emission standards for volatile organic compounds. The United States ozone standard is 120 parts per billion (ppb) based on a 24-hour mean and the Canadian objective is 80 ppb for the same time average. Both countries had identical ozone requirements of 80 ppb until the late 1970s and early 1980s, when the United States increased its ozone standard to 120 ppb.

The warmer summers of recent years have increased the number of ozone-related air pollution incidents in the Reference region and across the entire Canada-United States transboundary region. Neither country has consistently achieved even the more lenient United States ozone standard in the Reference region and it can only be assumed that neither country will consistently achieve its own respective ozone standard or objective within the next few years. Ozone data are presented in Appendix E.

Since 1980, several studies have shown relationships between ozone and acid rain and ozone and toxic air pollution. Governments have not articulated persuasive arguments that current ozone control programs have a technical, philosophical and legal basis to retain different standards on each side of the international boundary.

As the Reference region is classed a major non-attainment area for ground-level ozone by both Governments, the Commission encourages Governments to develop a binational ozone control strategy for the Reference region. Although initiatives are underway in both countries to deal with the problem, the Commission is concerned that these do not appear to be leading to effective and timely action to alleviate the current ozone exposure.

The United States Clean Air Act Amendments (1990) authorize control measures for ozone according to the severity of a regional ozone problem, and also has separate provisions for coke oven emissions. Coke ovens have historically been the largest single stationary sources of toxic volatile organic compounds in the United States portion of the Reference region. These organics can react with other air pollutants to generate ozone, and also react with ozone to form other toxic air pollutants.

The Commission is aware of recent closures of coking facilities in the region and the anticipated improvements this should have on local air quality. Although the Commission understands that there are currently no active coke oven operations in the region, the United States Environmental Protection Agency, in designating ozone controls required for the region, is encouraged to ensure that emissions from any new or reactivated coke oven facilities are considered.

On the Canadian side, federal and provincial officials have not reached consensus on implementation strategies and time frames for the the Federal NO_x-VOC (Nitrogen Oxide/ Volatile Organic Compound) Management Strategy, and thus the Commission cannot determine its impact and potential effectiveness in the Reference region. Further, local Canadian guidelines on acceptable airborne levels for many unregulated toxic organic chemicals emitted from Canadian industrial sources and for ozone precursors are numerically comparable to levels authorized for these chemicals under occupational exposure (workplace) conditions, which tend to be considerably higher than those health authorities would accept for the general population.

Thus, a regional ozone control strategy must address stationary and mobile sources of volatile organics, with particular emphasis on emissions from new or reactivated coke oven facilities in the Reference region. Since ozone is clearly a transboundary pollutant and not strictly a locally generated domestic pollution problem in the Reference region,

the Commission recommends that:

18) the Governments, in consultation with the State of Michigan and the Province of Ontario, develop a joint regional ozone control strategy that includes emission controls for mobile and stationary sources, including coke ovens, and

19) the Governments, in consultation with the State of Michigan and the Province of Ontario, adopt a common ozone standard for the Reference region.

FUTURE ACTIVITIES UNDER THE REFERENCE

In future work under the Reference, the Commission will continue tracking and reporting on air quality trends in the region and will monitor government regulatory and other initiatives aimed at reducing the emission of air toxics. Specific activities under the U.S. Clean Air Act, as they affect the Reference region, as well as state regulatory initiatives and Canadian initiatives under the Canadian Environmental Protection Act, Ontario's MISA program and motor vehicle emission controls will be assessed for their impact on air quality in the Reference region.

An important task will be to investigate certain aspects of the environmental effects of airborne emissions, including an analysis of where the pollutants originate. The Commission also intends to continue its assessment of health risks posed by airborne chemicals, with more intensive analysis of the impact of those chemicals identified in this study as well as others for which data gaps precluded further analysis at this time.

The Commission will submit progress reports periodically to Governments on its activities under the Reference.

Signed this 12th day of February, 1992, at Ottawa, Ontario.

Gordon K. Durnil
Co-Chairman

E. Davie Fulton
Co-Chairman

Hilary Cleveland
Commissioner

Robert S. K. Welch
Commissioner

Robert F. Goodwin
Commissioner

Claude Lanthier
Commissioner

United States Department of State

Washington, D.C. 20520

September 30, 1988

Mr. David LaRoche
Secretary, United States Section
International Joint Commission
2001 S Street, N.W.
Washington, D.C. 20440

Dear Mr. LaRoche:

I am writing to you regarding issues of air quality in the Detroit-Windsor area. As you know, concerns have been expressed on a number of occasions over the potential consequences of emissions from the Detroit municipal solid waste combustion facility currently under construction. In recent months we have also learned of several other proposals for facilities in the Detroit-Windsor area, to burn hazardous chemicals in their production processes, or for commercial waste destruction.

We have pursued our concerns over the potential effects on health and environment in the Detroit-Windsor area from such sources on a case-by-case basis. We believe however that there is a larger question involved. We are concerned at the potential, cumulative effects of emissions of toxic and hazardous substances from incineration facilities, large or small, in the Windsor-Detroit area on air quality on both sides of the international border. The International Joint Commission has had a long and successful history of monitoring and reporting upon air quality in the Detroit-Windsor area and I believe it would be most helpful if the Commission could again play a role in this regard.

I understand that further to the IJC's Final Report Pursuant to the July 8, 1975 Reference on the State of Air Quality in the Detroit-Windsor and Port Huron-Sarnia Areas, in 1983, the Commission disbanded the International Michigan-Ontario Air Pollution Board, but that the International Air Pollution Advisory Board (now called the International Air Quality Advisory Board) was continued. While the latter has reported on the Detroit incinerator, for example, it seems to have such a broad range of activities that it would not be able to give detailed attention to a regional problem. The former performed a very useful function, and many of the questions posed in the July 1975 reference which led to its creation are still relevant to the current situation.

I would ask, therefore that the IJC re-commence its work pursuant to the July 1975 reference. In particular, I would wish to see the Commission examine and report upon the actual and potential hazards posed to human health and the environment from airborne emissions in the Detroit-Windsor area. The Government of Canada supports this proposal; I understand that a letter will shortly go forward to the Canadian Section of the IJC on it.

It is, of course, the prerogative of the IJC to establish an appropriate mechanism to carry out this task. I would however ask the Commission to take into account the resource constraints currently facing Governments. Indeed, the Commission may wish to consider a structure similar to the board which carried out the work of the 1975 reference, which proved to be quite effective.

I look forward to the IJC's further contributions to our knowledge of this problem, which will help governments deal more effectively with them.

Sincerely,

Robert O. Homme

Robert O. Homme, Acting
Deputy Assistant Secretary
European and Canadian Affairs

The Rt. Hon. Joe Clark, P.C., M.P.
Secretary of State for External Affairs

Canada

Le très hon. Joe Clark, C.P., député
Secrétaire d'État aux Affaires extérieures

OTTAWA, ONTARIO
K1A OG2

September 30, 1988

Dear Mr. Koop:

I am writing to you regarding issues of air quality in the Windsor-Detroit area. As you know, the Government of Canada has expressed its concerns on a number of occasions over the potential consequences for Canadians of emissions of toxic chemicals from the Detroit municipal solid waste incinerator currently under construction. In recent months we have also learned of several other proposals for facilities in the Detroit area, (for example, St. Mary's Peerless Cement) to burn hazardous chemicals in their production processes, or for commercial waste destruction.

We have pursued our concerns over the potential effects on the health and environment of Canadians in the Windsor area from such sources on a case-by-case basis. We believe however that there is a larger question involved. We are concerned at the potential, cumulative effects of emissions of toxic and hazardous substances from incineration facilities, large or small, in the Windsor-Detroit area on air quality on both sides of the international border. The International Joint Commission has had a long and successful history of monitoring and reporting upon air quality in the Windsor-Detroit area. I believe it would be most helpful if the Commission could again play a role in this regard.

. . . /2

Mr. Rudy Koop
Acting Secretary
Canadian Section
International Joint Commission
100 Metcalfe Street, 18th floor
Ottawa, Ontario
K1P 5M1

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I would ask, therefore that the IJC re-commence its work pursuant to the July 1975 reference. In particular, I would wish to see the Commission examine and report upon the actual and potential hazards posed to human health and the environment from airborne emissions in the Windsor-Detroit area. The Government of the United States supports this proposal; I understand that a letter will shortly go forward to the US Section of the IJC on it.

It is, of course, the prerogative of the IJC to establish an appropriate mechanism to carry out this task. I would however ask the Commission to take into account the resource constraints currently facing Governments. Indeed, the Commission may wish to consider a structure similar to the board which carried out the work of the 1975 reference, which proved to be quite effective.

I look forward to the IJC's further contributions to our knowledge of this problem, which will help governments deal more effectively with them.

Yours sincerely,

APPENDIX B

A History of International Joint Commission Studies of Air Quality in the Detroit-Windsor/Port Huron-Sarnia Region

Transboundary air pollution is not a new problem in the Detroit River area. The International Joint Commission (Commission) was requested by the Governments of Canada and the United States to undertake studies of air pollution in 1949, 1966 and 1975. A brief summary of these studies is presented in this Appendix.

The 1949 Reference

By 1949, expanding industrial and other activities along the Detroit and St. Clair Rivers had led residents to express their concerns to Governments that property in the Detroit-Windsor and Port Huron-Sarnia vicinities were being subjected to detrimental quantities of air pollutants that were crossing the boundary. The Commission was asked to report whether the air over or in the vicinity of Detroit and Windsor was being polluted by smoke, soot, fly ash or other impurities in quantities detrimental to the public health, safety or general welfare of citizens or property on either side of the boundary. The Commission also was asked to indicate the extent to which vessels on the Detroit River were contributing to the problem.

In its final report to Governments in 1960, the Commission replied to the first question in the affirmative and indicated that industrial, domestic and transportation activities on land were largely responsible. Smoke emission objectives for vessels plying the Detroit River were set annually by the Commission from 1952 to 1957. Each progressive year's objective was made more stringent until the Commission was satisfied that an appropriate level of control had been achieved. In its 1960 report, the Commission recommended that Governments adopt the objectives and take appropriate action to ensure that they were met. Governments responded positively and, in 1966, the Commission concluded that its recommendations under the 1949 Reference on air pollution had been implemented effectively. The Governments concurred and the Commission's surveillance of vessel smoke emissions ended.

The 1966 Reference

In responding to the 1949 Reference, the Commission identified various sources contributing to air quality concerns in the region but did not make specific recommendations with

regard to these sources, since its terms of reference dealt only with vessel emissions. Because of the growing seriousness of the region's air quality problem, the Governments in September 1966 asked the Commission to report on whether air pollution over and in the vicinity of Port Huron-Sarnia and Detroit-Windsor was affecting public health, safety or the general welfare of citizens or property on either side of the international boundary. The Commission was to identify sources, if any, contributing to the problem and to recommend preventive or remedial measures.

In its final report under the Reference in 1972, the Commission recommended air quality objectives to be adopted by the federal, state and provincial governments. It also recommended that preventive and remedial measures be implemented at the earliest practicable date to achieve the objectives and that compatible methods be adopted to assess air quality on both sides of the international boundary. The Governments also were encouraged to expand their research programs to reduce emissions; ascertain with more certainty the effects of airborne contaminants on health, property, vegetation and aesthetics; and enhance understanding of the formulation, control, movement, transformation, ultimate accumulation and dispersion patterns of all airborne pollutants.

The 1975 Reference

Although Governments recognized that significant progress was being made to remedy problems identified in the Commission's report of 1972 and to improve air quality in the areas, they acknowledged the need for regular monitoring and review of efforts to ensure that meaningful improvement continued to occur. The Commission was requested on July 8, 1975 to report on a continuing basis on the state of air quality in the Detroit-Windsor and Port Huron-Sarnia areas. Specific emphasis was to be placed on ambient air quality trends and emissions of sulphur dioxide, suspended particulates and odours. The extent and adequacy of air quality surveillance and the adequacy of steps being taken to prevent, abate and control air pollution were also to be assessed.

The Commission reported annually to the Governments on achievement of the specific objectives and other air quality concerns in the area from 1975 to 1983. In 1983, the Commission noted that domestic regulatory programs and control strategies in the Reference region -- combined with decommissioning some older industrial facilities and upgrading pollution control systems at others -- had resulted in significant improvements in emission levels of sulphur dioxide (SO_2), particulates and odours from 1976 to 1983. Reduced emission levels had been sustained for several years and there was no reason to expect a reversal in this trend.

As the objectives of the Reference had essentially been met, the Commission, on January 19, 1984, notified Governments of the effective completion of the Reference. However, the Commission noted that reporting on trends and programs for the three pollutants in the Reference region did not represent an adequate picture of the atmospheric environment in the Michigan-Ontario transboundary region. It also pointed out that more attention needed to be focused on a wider range of air pollutants, particularly toxic and hazardous substances.

APPENDIX C

Membership of the Commission's International Air Pollution Advisory Board for the Detroit-Windsor/ Port Huron-Sarnia Region

Canadian Section

Mr. Edward W. Piché, Co-Chair
Ontario Ministry of the Environment
Toronto, Ontario

Dr. Clair A. Franklin
Health and Welfare Canada
Ottawa, Ontario

Mr. Kim Shikaze
Environment Canada
Toronto, Ontario

United States Section

Mr. Delbert Rector, Co-Chair
Michigan Department of Natural Resources

Dr. Ralph Kummler
Wayne State University
Detroit, Michigan

Dr. Warren P. Porter
University of Wisconsin
Madison, Wisconsin

For information on the Board's study,
contact one of the following at the International Joint Commission:

Mr. E.A.Bailey
100 Metcalfe Street
Ottawa, Ontario
K1P 5M1

(613) 995-2984

Dr. J. Fisher
1250-23rd St N.W., Ste 100
Washington, DC
20440

(202) 736-9000

APPENDIX D

Summary of Views Expressed at Public Meetings

The Commission convened two public meetings, one in Port Huron, Michigan on March 18, 1991 and the other in Windsor, Ontario on March 19, 1991, to obtain public comment on the December 1990 Report of the International Air Pollution Advisory Board for the Detroit-Windsor/Port Huron-Sarnia Region. In addition to receiving oral presentations at the meetings, written submissions were accepted until April 30, 1991.

A couple of main themes dominated the oral presentations. Some citizens felt sufficient evidence exists that toxic chemicals are causing adverse health and environmental effects in the Reference region and governments (federal, provincial and state) need to enforce and expand air emission regulations, permits and control orders. The board's report was generally viewed as a good beginning to address the problem of airborne toxic chemicals, but followup by governments to target specific sources for emission reductions was strongly supported. Governments were also encouraged to pursue further cooperative efforts across the boundary to alleviate the confusion and uncertainty resulting from different environmental standards, emission control regulations and risk assessment techniques in the United States and Canadian portions of the region.

Concern also was expressed that the aggregation of data for the Detroit-Windsor/Port Huron-Sarnia region had a "smoothing effect" and tended to lower the estimates of pollutants to which individuals are exposed in many areas of the region, since the two areas are distinct and separate within the region. There are differences not only in the types of industries in the areas but also in the pollution produced and emitted.

The Commission was criticized for the lack of adequate advance notice for the public meetings. The Lambton Industrial Society presented the Commission with a report on volatile organic compound monitoring data for the Sarnia area that had not been available to the board. Following the meetings, the board reviewed this data and confirmed that it did not alter the conclusions and recommendations as presented in its report.

With respect to the human health issue, presenters indicated that area residents generally had trusted government agencies and industries to ensure that appropriate technology was in place to provide an adequate level of protection. Instead, facilities such as the Detroit incinerator were allowed to operate with less than acceptable pollution control equipment and without regard for alternative waste handling techniques, such as reduction, reuse and recycling. By aggressively promoting reduction, reuse and recycling techniques, citizens felt significant reductions in the amount of waste to be landfilled or incinerated could be achieved.

The need for further investigation into the impacts of atmospheric toxics on the environ-

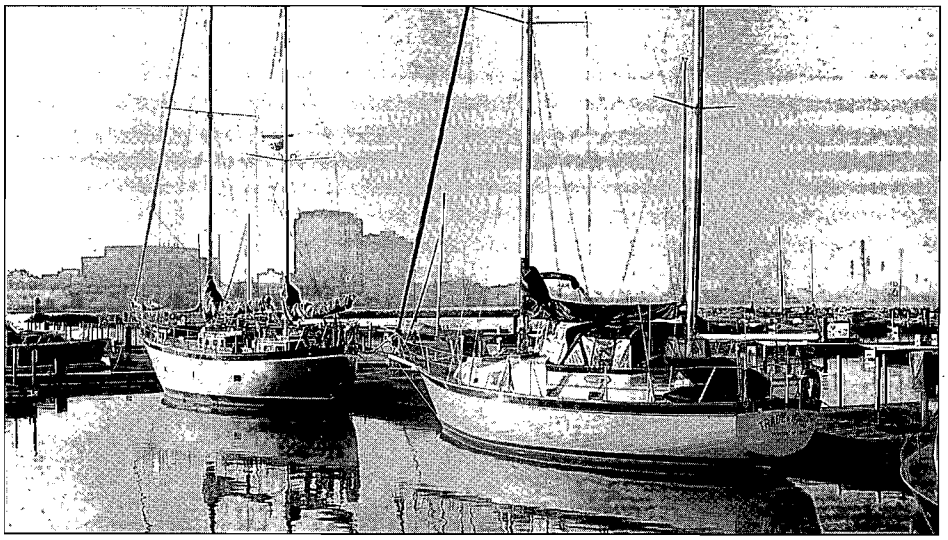
ment, particularly on smaller life forms that are precursors to potential impacts on human populations, was also emphasized.

Concern was also expressed about the operation of the Detroit wastewater treatment plant and its toxic loadings to the Detroit River, and about the fate of polychlorinated biphenyls (PCBs) from incinerated sludge. While presenters recognized that the facility does not produce PCBs, it is a conduit for these and other toxic chemicals from local industries discharging to the municipal sewer system, and from illegal dumping into the system.

Although it was generally recognized by local residents that there is sufficient evidence of human health effects from exposure to contaminants in the air and water, there was strong support for better data collection and interpretation. Other specific calls for action included:

- identify specific sources of toxic emissions and develop specific time lines for action.
- determine the specific impacts of toxic chemicals on the environment and on human health in the Reference region.
- control emissions from incinerators. Consideration should be given to shutting down all single-source incinerators.
- develop similar standards for atmospheric emissions in Canada and the United States.
- standardize risk assessment data and methodologies, since human risks are the same regardless of which side of the Detroit River they live on.

It was also made clear to the Commission that the public wishes to provide input to the process of dealing with air quality concerns in the region. They are not satisfied with reacting to proposals after they are developed and they seek to be full participants in a multi-stakeholder setting similar to that which has emerged in many Areas of Concern for the development of Remedial Actions Plans (RAPs). It was suggested that a multi-stakeholder forum for air quality in the transboundary area along the Detroit River be established to advise and work together with governments on air quality concerns in the area.



Recreational activity in the Sarnia - Port Huron area

Credit (page 2 and here): Sarnia/Lambton Economic Development Commission

APPENDIX E

Air Quality Trends in the Detroit-Windsor/ Port Huron-Sarnia Region

POST-1983 TRENDS FOR TOTAL SUSPENDED PARTICULATES AND SULFUR DIOXIDE

From 1975 to 1983 the Commission reported to the Governments on trends in total suspended particulates (TSP) and sulfur dioxide (SO_2). The Commission received air quality data suitable to estimate the one-hour and 24-hour means for the two air quality parameters to compare with the established objectives which the Governments had agreed upon and incorporated into the 1975 Reference. The objectives were:

- a 24-hour average for particulates of 120 ug/m^3;
- a one-hour emergency objective for sulfur dioxide of 0.25ppm (655 ug/m^3);
- a 24-hour objective for sulphur dioxide of 0.10ppm (260 ug/m^3).

In response to the Commission's request for post-1983 data to continue this reporting, the United States Environmental Protection Agency (U.S. EPA) provided the Commission with extensive air quality data for Michigan, summarized by counties, for the years 1965 to 1983. The Atmospheric Environment Service of Environment Canada (AES) and the Ontario Ministry of Environment provided annual reports of air quality monitoring for 1980 to 1990. The provided data indicated major changes had occurred in air quality monitoring and data activities after 1983. The form and format of archived air quality data no longer suited the specific calculations previously performed by the Commission. Air quality monitoring ceased at some stations in the Reference area, while other stations had name changes or changes in the numerical identifiers used in various data banks. Many analytical methods used in air quality monitoring also changed, and data network managers instituted new or additional quality control procedures consistent with the new analytical methods and the need to maintain high quality data reporting and archiving.

Because these factors affect the analysis and interpretation of data for air quality trends, data base managers were consulted to determine the best way to ensure consistency with past reporting as well as provide an accurate assessment of new reporting. They suggested the assembly of a subset of data and some changes in statistical methodology to retain the historical continuity of stations and parameters. Some methodologies appear in Table 1.

The data for total suspended particulates (TSP) appear in Table 2. The data for sulfur dioxide appear in Table 3.

The analysis of trend data from Table 2 shows the following:

1. All Canadian stations meet the objective for TSP. For United States stations, most meet the TSP objective.
2. Where the objective is not met, the critical inequality between the 24-hour mean and arithmetic annual mean is violated in only two out of 175 applicable entries, at a single monitoring station in Wayne County. The air quality index test is violated for TSP in 21 out of 175 applicable entries, with occurrences at stations in Wayne, Monroe and Oakland Counties. These violations were not negated by the paired data test for trend extrapolation.
3. An overview of TSP monitoring for the seven Michigan counties of the transboundary region (Lapeer, Macomb, Monroe, Oakland, St. Clair Washtenaw and Wayne), shows that Wayne County's urban industrialized zone and adjacent Monroe County have the greatest air quality problems for TSP. Still, every station in Wayne County trends downward in ambient air levels of TSP over the period. The inconsistent trend at one Monroe County station implies the need for additional remedial measures for certain sources.

The analysis indicates that the region has generally continued to meet its TSP objective. From 1983 to 1986, some air quality stations indicated exceedances of the objective, mainly in Wayne County (Detroit area), but all stations indicate the objective has been met after 1986.

The analysis of data from Table 3 on SO_2 trends shows the following:

1. All stations meet the arithmetic annual average limit adopted by Ontario of 53 ug/m^3, a more stringent requirement than the United States standard of 80 ug/m^3. The Commission concludes that the region has continuously met the SO_2 objective.
2. Where violations appear to have occurred, further analysis reveals statistical anomalies. For example, violations of the air quality index (AQI) for SO_2 occurred in 4 of 63 applicable cases, all in St. Clair County (Port Huron area), but the data from the air quality monitoring station met the paired data test for trend extrapolation. Those data trend downward and show the objective was achieved by 1987.
3. The Commission questions the reduced level of monitoring SO_2 in the region. A consistent pattern emerges after 1984 of deleting SO_2 monitoring stations from the networks, and raises questions about the soundness of the monitoring activity.

OTHER AIR QUALITY PARAMETERS

The Commission reported periodically on the following air quality parameters in its reports to Governments from 1975 to 1983. Common standards have not been established for the Reference region.

Carbon Monoxide

Ambient air quality standards for carbon monoxide include a short-term event level of 35ppm or 40,000 ug/m^3 (40 mg/m^3), expressed as one-hour mean, and long term standard of 9ppm or 10,000 ug/m^3 (10 mg/m^3), expressed as an eight-hour mean. Table 4 presents carbon monoxide trends for the period 1973 to 1990.

Trends in carbon monoxide are unclear from the data. For the few sites -- less than 3% of station entries -- at which the maximum observed level is less than the United States ambient air quality standard, carbon monoxide is not a problem. But this observation occurs in too few cases to use as a basis for a broader judgment. Very few stations in the Reference region report on carbon monoxide.

Nitrogen Dioxide

The United States ambient air quality standard for nitrogen dioxide is 0.053ppm or 100 ug/m^3, expressed as an annual arithmetic mean. Table 5 presents some of the reported but limited nitrogen dioxide data for the Reference region.

All stations listing nitrogen dioxide data show that the annual arithmetic mean limitation is achieved for the United States ambient standard.

Ozone

The ambient air quality ozone standards of the United States and Canada differ. The United States ozone standard is 120 ppb based on a 24-hour mean, and the Canadian ambient air standard for ozone is 80 ppb, also expressed as a 24-hour mean. On some days, the differences in the two ozone standards would enable the United States to meet its standard while Canada does not meet its standard. On fairly poor air quality days neither country meets its own ozone standard. Table 6 presents some of the ozone data for the 1973 to 1990 period.

The data provide only limited clues about ozone trends. For 1990, the last year reported in the summary herein, all Michigan areas in the transboundary region except Macomb County met the United States ozone standard. Only two sites that met the United States standard also met the Canadian standard. This information comes from inspection of the maximum observed values for ozone in the Table 6 entries.

TABLE 1

Selected Tests Used to Analyze Air Quality Data for the Period of 1983-1990

1. *Available data*	For air quality monitoring stations, the usual data for a given parameter are the annual arithmetic mean, maximum observed value, and number of observations used to estimate the annual mean.
2. *The annual arithmetic mean*	If the annual arithmetic mean estimated from air quality monitoring data numerically exceeds the objective, the objective is not achieved. The reverse situation is not automatically true, but requires other information.
3. *The maximum observed parameter value*	The objective is achieved if it numerically exceeds this statistic. (If no observed datum exceeds the objective, then no mean based on observed data can exceed the objective.)
4. *The annual arithmetic mean and maximum observed value for parameter as an ordered pair*	The objectives place upper limits on post-1983 data. Regional air quality meets the objectives if both the annual arithmetic mean and maximum observed value of a parameter, as an ordered pair, numerically equal or are less than the ordered pair associated with year 1983. This test a overcounts ordered pairs in which the maximum observed value is below the 24-hour mean, and thus requires correction.
5. *Air Quality Index (AQI)*	A widely used air quality index assigns a value of 100 to the United States ambient air standard of 260 ug/m^3 for TSP and 80 ug/m^3 for SO_2 as 24-hour means. Air quality is good below AQI of 100 and worsens above an AQI of 100. The objectives have AQI values of 46 for TSPand 72 for SO_2 for the 24-hour means, and 179 for SO_2 for the one-hour mean. The index ignores parameter interaction. Unless the Commission has other information, the Commission would question whether a region can achieve the objective if data for the parameter indicate undesirable AQI values.
6. *Air quality network design*	Some stations measure many parameters very often while others measure only a few and less often. A study of the trends in number of stations and their pattern of distribution, parameters measured, operational life times, and related factors can provide other important information on how a region meets objectives for air quality.
7. *Outliers*	When a parameter's maximum observed value far exceeds other observed values, it might imply an outlier. By combining the maximum observed value, the annual arithmetic mean and the number of observations used to calculate the mean, an analyst can estimate a new annual mean that excludes the maximum observed value from the data. Suspicion of an outlier is reinforced when the new mean is much smaller than the original annual mean, and one might argue that the new mean is the appropriate one to use in previously described statistical tests. As this method may cause errors, its use requires great care.

TABLE 2

Air Quality Trends for Total Suspended Particulates (ug/m³)

WAYNE COUNTY (26163) Stations

Year		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0001	ann. mean	83.5	79.0	67.4	61.3	63.7	64.4	61.9	65.6	61.5	68.1	58.0
	max value	247	210	191	134	153	257	198	210	128	136	123
0002	ann. mean	151	129	124	111	118	123	113	104	124	99.6	86.2
	max value	279	287	341	241	307*	341*	248	298*	280*	211	171
0003	ann. mean	54.8	50.3	49.6	50.1	51.3	46.2	43.2	44.3	50.9		
	max value	113	143	129	141	123	391*	128	115	93		
0004	ann. mean	54.2	54.4	46.6	51.5	51.4	50.4	40.8	50.5	54.5	49.6	
	max value	126	132	115	133	203	300*	74**	282*	287*	105	
0014	ann. mean	49.9	49.4	49.4	48.7	48.7	43.6	41.4	45.8	45.1	45.2	45.5
	max value	97	97	134	173	116	110	85	114	126	93	98
0015	ann. mean	121	105	96.1	95.9	106	98.8	86.1	86.8	94.8	87.5	84.8
	max value	272	277	403	266*	334*	289*	165	202	212	221	208
0016	ann. mean	96.5	73.5	74.9	68.7	65.7	60.5	54.8	56.8	54.7	56.4	55.1
	max value	339	204	236	165	140	163	103	145	141	171	119
0019	ann. mean	61.0	64.7	58.8	57.9	57.7	44.5	49.1	50.5	52.5	51.9	48.4
	max value	122	178	153	147	137	149	94	168	152	134	111
0029	ann. mean							74.6	64.0	61.5	60.5	63.8
	max value							133	146	166	134	161
Annual average of stations					68.1	70.3	66.4	62.8	63.1	66.6	65.0	63.1
Annual average of maximums					171	189	250	136	181	176	151	142

TABLE 2 (continued)

Air Quality Trends for Total Suspended Particulates (ug/m³)

MONROE COUNTY (26115) Stations

Year		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0003	ann. mean			67.1	59.8	52.2	50.3	46.2	45.3	44.8	45.4	59.7
	max value			180	129	158	136	151	90	79	105	115
0004	ann. mean			82.5	79.1	79.8	68.7	56.1	81.8	70.1	70.4	90.9
	max value			245	163	216	193	79**	783*	271*	166	236
0023	ann. mean			87.9	77.6	71.5	78.6	67.4	63.9	77.5	68.3	
	max value			154	141	190	172	175	146	191	157	
0951	ann. mean				67.9	60.6	72.9	48.7	61.0	73.4	60.6	61.6
	max value				339*	398*	1077*	169	1300*	616*	210	304*
Annual average of stations					71.1	66.0	67.6	54.6	63	66.5	61.2	70.7
Annual average of maximums					193	241	395	143	580	289	160	218

SAINT CLAIR COUNTY (26147) Stations

Year		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0005	ann. mean		54.7	47.9	44.0	45.1	41.4	43.8	44.5	46.5	53.7	38.0
	max value		108	135	112	125	158	92	117	127	136	85
0910	ann. mean	62.9	46.5	55.2	50.5	55.2	58.1	54.5	49.6	52.1	56.5	52.1
	max value	179	115	125	120	212	110	114	171	235	123	119
0912	ann. mean	53.5	52.1	50.2	57.3	49.4	54.2	49.8	48.7	46.7	47.9	46.4
	max value	157	169	142	167	115	245	105	125	134	122	142
1001	ann. mean			87.0	72.9	71.3	67.6	63.8	59.9	57.0	60.6	66.3
	max value			175	180	240	175	139	245	139	157	154
Annual average of stations				60.1	56.2	55.3	68.4	53.0	50.7	50.6	54.7	50.7
Annual average of maximums				144	145	173	172	113	165	159	135	125

TABLE 2 (continued)

Air Quality Trends for Total Suspended Particulates (ug/m³)

LAPEER COUNTY (26087) Station

Year		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0001	ann. mean			86.0	57.0	59.3	81.3	64.3	59.5	57.5	81.5	54.9
	max value			271	109	157	197	144	241	117	226	143

WASHTENAW COUNTY (26161) Station

Year		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0002	ann. mean	49.1	49.5	49.4	46.4	48.5	50.7	49.3	50.3	43.1	43.7	40.9
	max value	88	92	102	95	138	169	91	139	84	75	95

MACOMB COUNTY (26099) Stations

Year		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0001	ann. mean					66.6	57.6	57.4	53.1	53.8	59.1	
	max value					144	155	120	257	114	131	
0008	ann. mean			77.2	66.9	66.8	57.0	56.1	50.0	53.8	60.2	
	max value			176	157	271	130	118	127	136	168	
6001	ann. mean			63.1	56.0	53.9	52.6	51.6	49.5	46.8	48.8	
	max value			128	115	119	140	117	214	89	107	
8001	ann. mean			69.3	61.8	55.2	53.2	56.5	50.9	51.4	53.8	59.7
	max value			143	115	123	128	118	105	107	98	134
Annual average of stations						60.6	55.1	55.4	50.9	51.5	55.5	
Annual average of maximums						164	138	118	175	112	126	

TABLE 2 (continued)

Air Quality Trends for Total Suspended Particulates (ug/m³)

OAKLAND COUNTY (26125) Stations

Year		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0003	ann. mean			67.0	59.6	57.0	54.5	52.3	51.1	47.4	60.4	
	max value			111	123	153	111	124	260*	92	141	
0005	ann. mean				57.4	51.8	54.8	56.7	59.3	50.5	64.1	
	max value				115	132	130	152	255	129	132	
1001	ann. mean			76.1	63.3	50.1	52.1	55.6	52.1	47.7	57.5	
	max value			209	128	124	129	125	151	84	133	
3001	ann. mean			58.6	50.6	50.7	48.8	50.6	43.8	47.8	57.1	
	max value			105	103	134	126	125	90	89	112	
Annual average of stations						52.4	52.6	53.8	51.6	48.4	59.8	
Annual average of maximums						136	124	132	189	98.5	130	

LAMBTON COUNTY (SARNIA)

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AES 061004R											
ann. mean				66.5	64.5	48.4	51.8	49.8	46.5	48.4	42.0
max value				175	131	94	181	109	158	20.8	88

TABLE 2 (continued)

Air Quality Trends for Total Suspended Particulates (ug/m³)

ESSEX COUNTY (WINDSOR) Stations

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AES 060203R											
ann. mean			50.7	40.8	42.0	48.8	48.3	53.7	42.8	51.6	
max value			140	98	83	207	109	144	126	94	
AES 060204C											
ann. mean			62.0	67.9	61.0	65.3	73.0	67.8	67.6	63.4	
max value			136	149	130	174	152	187	147	178	
AES 060212I											
ann. mean							83.5	77.0	63.4	84.4	59.3
max value							342	154	154	175	178
Annual average of stations			56.3	59.3	51.5	57.1	64.9	64.8	57.9	66.3	
Annual average of maximums			138	124	106	191	201	161	142	149	

Notes:

"Ann. mean" is the annual arithmetic mean; "Max value" is the largest recorded datum. Underlined entries indicate that the objective was not achieved. An asterisk (*) indicates that the maximum value exceeds the United States TSP standard of 260 ug/m³ because at least one datum exceeded the TSP standard that year. Two asterisks (**) indicate that there are quality assurance problems with the entries, but that the numbers are reported for completeness. All stations except Wayne County 0029, Monroe County 0951 and Oakland County 0005 report data back to 1980.

TABLE 3

Air Quality Trends for Sulfur Dioxide (ug/m³)

WAYNE COUNTY (26163) Stations

Year		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0001	ann. mean	19.6	24.0	26.1	18.2	19.9	13.0	14.5	16.4	22.6	19.4	18.7
	max value	461	461	445	225	320	246	215	241	485	236	280
0002	ann. mean		34.3	40.6	35.6	25.6	28.3	25.1	20.5	28.4	27.1	28.3
	max value		267	694	608	322	236	309	335	587	312	283
0005	ann. mean	22.4	29.8	25.8	27.3	23.4	23.8	25.0	24.9	25.3	23.7	21.1
	max value	338	477	380	553	359	348	288	629	396	430	246
0015	ann. mean	45.6	45.0	46.1	37.0	31.8	37.4	38.8	39.6	40.2	37.0	32.8
	max value	791	681	529	498	461	532	741*	356	458	354	383
0016	ann. mean	25.9	35.2	38.9	15.5	26.1	17.2	21.8	27.6	24.2	25.9	24.8
	max value	456	398	514	427	469	217	270	254	301	390	307
0019	ann. mean	24.5	29.7	24.6	27.0		19.3	18.5	19.0	19.9	18.0	17.3
	max value	524	409	338	618		241	262	385	278	215	197
0029	ann. mean						26.5	21.5	23.7	26.6	21.0	
	max value						424	354	238	312	204	
Annual average of stations					26.8	25.4	23.6	23.6	24.5	26.7	24.6	23.8
Annual average of maximums					488	387	320	348	316	402	305	283

TABLE 3 (continued)

Air Quality Trends for Sulfur Dioxide (ug/m³)

MONROE COUNTY (26115) Stations

No reported sulfur dioxide monitoring after 1984 in data base

SAINT CLAIR COUNTY (26147) Stations

Year		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0005	ann. mean	24.6	37.7	27.3	28.0	24.0	22.6	21.4	20.3	22.0	19.8	
	max value	377	587	1153*	798*	748*	862*	603	783*	493	574	

LAPEER COUNTY (26087) Station

No reported sulfur dioxide monitoring after 1984 in data base

WASHTENAW COUNTY (26161) Station

No reported sulfur dioxide monitoring after 1984 in data base

MACOMB COUNTY (26161) Stations

Year		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1003	ann. mean	14.7	23.4	36.4	38.8	36.4	20.3	19.5	16.5	16.4	15.9	16.3
	max value	269	446	343	724*	403	582	202	390	278	210	244

OAKLAND COUNTY (26125) Stations

0902	ann. mean		10.8	25.0			10.5	7.8	5.0			
	max value		209	487			236	288	131			

TABLE 3 (continued)

Air Quality Trends for Sulfur Dioxide (ug/m³)

ESSEX COUNTY (WINDSOR) Stations											
Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AES 060204C											
ann. mean				---	---	---	18.2	20.8	20.8	28.6	20.8
max value				390	390	520	260	520	286	338	286
AES 060211R											
ann. mean				---	---	26	23.4	15.6	13	20.8	23.4
max value				338	572	520	338	364	286	364	286
AES 060212I											
ann. mean						23.4	26	18.2	20.8	18.2	
max value						468	338	338	338	364	
Annual average of stations				---	---	24.7	22.5	18.2	18.2	22.5	22.1
Annual average of maximums				364	481	502	312	407	303	346	286
LAMBTON COUNTY (SARNIA) Stations											
AES 061004R											
ann. mean				31.2	---	---	28.6	20.8	18.2	23.4	20.8
max value				650	546	832	494	728	520	624	624

Notes:

"Ann. mean" is the annual arithmetic mean; "Max value" is the largest recorded observation. All stations except Oakland County 0902 report data back to 1980. A notation about reported data not being in the data base does not mean that no monitoring for sulfur dioxide occurred, only that the data base did not contain that information. An asterisk (*) indicates a maximum observed value which exceeds the one-hour objective for sulfur dioxide of 655 ug/m³ and thus assures at least one exceedance of the objective within the reporting period. Dashed lines (---) indicate that the parameter was reported as less than .01ppm or less than 2.6ug/m³.

TABLE 4

Air Quality Trends for Carbon Monoxide (ppm)

WAYNE COUNTY (26163) Stations

Year		1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0001	ann. mean	1.38	1.38	1.18	1.35	1.38	1.11	1.03	0.97	0.93	0.86
	max value	18.1	12.5	10.8	12.7	17.8	16.3	10.1	8.9	15.0	16.8
0014	ann. mean	1.32	1.31	1.28	1.22	1.31	1.24	1.08	1.02	1.03	0.97
	max value	17.7	18.2	17.8	20.5	15.8	17.2	16.3	10.2	22.3	17.4
0016	ann. mean	1.87	1.84	1.69	1.69	2.05	2.21	1.43	1.09	1.05	1.06
	max value	17.1	12.7	16.5	13.1	17.7	16.3	13.4	10.3	10.9	11.4
2002	ann. mean	1.25	1.04	0.87	0.58	0.92	0.93	0.98	0.78	0.79	0.86
	max value	12.9	12.8	7.6	15.4	8.0	9.2	13.9	9.4	15.3	17.5

Year		1983	1984	1985	1986	1987	1988	1989	1990
0001	ann. mean	0.86	0.85	1.14	0.76	0.8	0.84	0.79	0.7
	max value	13.9	14.9	6.1	17.4	12.0	7.8	11.0	7.8
0014	ann. mean	1.07	1.07	1.01	0.99	0.86	0.82	0.82	0.69
	max value	15.7	21.7	14.6	20.6	15.0	12.1	9.5	9.7
0016	ann. mean	0.99	1.02	0.96	1.04	0.86	0.9	0.84	0.74
	max value	9.4	6.5	8.1	12.0	11.6	8.3	11.4	7.8
2002	ann. mean	0.87	0.84	0.75	0.88	0.81	0.7	0.68	0.61
	max value	11.4	14.0	9.7	19.5	23.4	8.1	8.5	7.4

MONROE COUNTY (26115) Stations

No reported carbon dioxide monitoring for the 1973-1990 period.

TABLE 4 (continued)

Air Quality Trends for Carbon Monoxide (ppm)

SAINT CLAIR COUNTY (26147) Stations

Year		1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0003	ann. mean	3.08	10.3*		2.53	2.63	3.73	2.23	1.41	3.21	
	max value	13.5	308*		10.0	14.7	10.8	9.3	14.5	8.3	

No carbon monoxide monitoring reported after 1981.

LAPEER COUNTY (26087) Station

No reported carbon dioxide monitoring for the 1973-1990 period.

WASHTENAW COUNTY (26161) Station

No reported carbon dioxide monitoring for the 1973-1990 period.

MACOMB COUNTY (26099) Stations

Year		1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1003	ann. mean				1.76	1.09	1.1	1.18	1.23	1.04	1.33
	max value				16.5	24.9	20.1	22.7	23.7	12.3	13.3

Year		1983	1984	1985	1986	1987	1988	1989	1990
1003	ann. mean	0.92	1.08	0.77	0.87	0.8	0.69	0.81	0.63
	max value	13.0	20.7	10.6	25.4	20.7	9.3	11.0	9.5

OAKLAND COUNTY (26125) Stations

Year		1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0001	ann. mean								0.82	0.85	
	max value								19.0	17.0	

Year		1983	1984	1985	1986	1987	1988	1989	1990
0001	ann. mean	0.9	0.83	0.7	0.78	0.76	0.75	0.88	0.39
	max value	14.0	19.0	11.1	15.4	11.1	8.4	10.6	7.1

TABLE 4 (continued)

Air Quality Trends for Carbon Monoxide (ppm)

ESSEX COUNTY (WINDSOR) Stations								
Year	1983	1984	1985	1986	1987	1988	1989	1990
AES 060204C								
ann. mean			---	---	0.5	0.7	0.9	1.0
max value			10	11	8	9	9	12.0
LAMBTON COUNTY (SARNIA) Stations								
AES 061004R								
ann. mean			---	---	0.2	0.2	0.3	0.3
max value			8	6.0	10	9	11	6.0

Notes:

"Ann. mean" is the annual arithmetic mean; "Max value" is the largest recorded observation. An asterisk (*) indicates that there are data quality problem notations associated with this reported statistic. Dashed lines (---) indicate that the reported mean is below 0.005ppm.

TABLE 5

Air Quality Trends for Nitrogen Dioxide (ppm)

WAYNE COUNTY (26163) Stations

Year		1973	1974	1975	1976	1977	1978	1979	1980	1981
0019	ann. mean								0.022	0.021
	max value								0.082	0.107

Year		1982	1983	1984	1985	1986	1987	1988	1989	1990
0019	ann. mean	0.019	0.022	0.019	0.021	0.018	0.024	0.021	0.018	
	max value	0.132	0.137	0.114	0.114	0.093	0.108	0.09	0.045	

WASHTENAW COUNTY (26161) Stations

No nitrogen dioxide monitoring reported for the period 1973-1990.

LAPEER COUNTY (26087) Station

No nitrogen dioxide monitoring reported for the 1973-1990 period.

ST. CLAIR COUNTY (26147) Stations

Year		1973	1974	1975	1976	1977	1978	1979	1980	1981
0003	ann. mean	0.031	0.031	0.039	0.039	0.051	0.014	0.018		
	max value	0.18	0.4	0.18	0.44	0.28	0.1	0.19		
0904	ann. mean						0.02	0.013	0.011	0.013
	max value						0.352	0.066	0.122	0.129

No nitrogen dioxide monitoring reported after 1982.

MACOMB COUNTY (26099) Stations

1003	ann. mean				0.026	0.028				0.021
	max value				0.04	0.055				0.116

No nitrogen dioxide monitoring reported after 1981.

TABLE 5 (continued)

Air Quality Trends for Nitrogen Dioxide (ppm)

OAKLAND COUNTY (26125) Stations

Year		1973	1974	1975	1976	1977	1978	1979	1980	1981
0001	ann. mean									0.038
	max value									0.48
0002	ann. mean			0.017		0.001				
	max value			0.032		0.027				
0902	ann. mean							0.01	0.012	
	max value							0.064	0.07	

Year		1982	1983	1984	1985	1986	1987	1988	1989	1990
0902	ann. mean			0.009	0.01	0.008				
	max value			0.07	0.1	0.05				

MONROE COUNTY (26115) Stations

Year		1973	1974	1975	1976	1977	1978	1979	1980	1981
0008	ann. mean			0.018		0.017				
	max value			0.036		0.028				
0020	ann. mean	0.039		0.025		0.018				
	max value	0.18		0.057		0.028				

No nitrogen dioxide monitoring reported after 1977.

ESSEX COUNTY (WINDSOR) Stations

Year		1982	1983	1984	1985	1986	1987	1988	1989	1990
AES 060204C										
	ann. mean		2.9	2.6	2.7	2.6	2.5	2.7	0.9	0.028
	max value		14	12	12	10	14	10	9	0.16

LAMBTON COUNTY (SARNIA) Stations

AES 061004R										
	ann. mean		2.2	2.0	2.3	1.9	2.1	1.2	0.3	0.019
	max value		25	17	12	13	12	8	11	0.09

Notes:"Ann. mean" is the annual arithmetic mean; "Max value" is the largest recorded observation. An asterisk (*) indicates that there are data quality problem notations associated with this reported statistic.

Table 6

Air Quality Trends for Ozone (ppb)

WAYNE COUNTY (26163) Stations

Year		1973	1974	1975	1976	1977	1978	1979	1980	1981
0001	ann. mean								51.5	49.2
	max value								133	123
0016	ann. mean								55	50.7
	max value								129	118
0019	ann. mean					56.4	63.2	39.4	56.1	56.7
	max value					137	217	116	139	158
0020	ann. mean		43.7	35.9	48.8	53.5	38.7	44.5	29.5	
	max value		107	86	287	210	149	170	72	
2002	ann. mean					50.5	42.9	57	49	
	max value					188	110	122	121	
2003	ann. mean					48.7	55.5	36.3		
	max value					127	146	100		

Year		1982	1983	1984	1985	1986	1987	1988	1989	1990
0001	ann. mean	48.0	47.2	38.7	37.7	39.3	39.7	52.1	45.4	45.3
	max value	151	117	97	94	118	98	138	110	92
0016	ann. mean	51.4	50.1	44.3	42.5	41.8	49.4	52.8	53.5	46.8
	max value	150	148	98	99	88	117	168	112	95
0019	ann. mean	51.1	54.2	50.3	47.7	50.8	54.7	49.0	50.2	50
	max value	109	155	115	97	112	150	145	144	113
2002	ann. mean	52.2	53.8	51.3	50.3	43.5	50.7	57.2	50.8	44.7
	max value	136	116	109	106	109	110	141	106	93

TABLE 6 (continued)

Air Quality Trends for Ozone (ppb)

WASHTENAW COUNTY (26161) Stations

Year		1973	1974	1975	1976	1977	1978	1979	1980	1981
1001	ann. mean							57.7	51.6	42
	max value							123	105	99

Year		1982	1983	1984	1985	1986	1987	1988	1989	1990
1001	ann. mean	54.7	51.4	49.6	47.2	47.7	50.2	61.6	55.6	48.1
	max value	105	95	95	101	110	120	125	107	89
0005	ann. mean						56.1	58.4	52.5	47.8
	max value						145	135	99	94

ST. CLAIR COUNTY (26147) Stations

Year		1982	1983	1984	1985	1986	1987	1988	1989	1990
0005	ann. mean	57	56.6	52.4	52.7	47.2	55.0	54.7	55.2	50
	max value	196	141	127	117	134	130	145	147	123
0030	ann. mean								42.1	52.0
	max value								108	118

MONROE COUNTY (26115) Stations

No ozone monitoring reported for the period 1973-1980.

LAPEER COUNTY (26087) Stations

No ozone monitoring reported for the period 1973-1980.

TABLE 6 (continued)

Air Quality Trends for Ozone (ppb)

OAKLAND COUNTY (26125) Stations

Year		1973	1974	1975	1976	1977	1978	1979	1980	1981
0001	ann. mean									51.4
	max value									122
0902	ann. mean								59.2	43.4
	max value								152	84
1002	ann. mean					56.0	41.3	40.5	33.9	34.0
	max value					218	162	179	98	82

Year		1982	1983	1984	1985	1986	1987	1988	1989	1990
0001	ann. mean	53.2	55.4	48.9	49	48.4	48	56.9	53.9	44.2
	max value	153	142	143	104	114	124	155	125	109
0902	ann. mean		45.5	30.1	12.3					
	max value		111	70	60					

MACOMB COUNTY (26099) Stations

Year		1973	1974	1975	1976	1977	1978	1979	1980	1981
0009	ann. mean								62	52.9
	max value								151	180
1003	ann. mean					58.6	71.3	50.2	45.7	49.2
	max value					227	195	127	111	155

Year		1982	1983	1984	1985	1986	1987	1988	1989	1990
0009	ann. mean	53.4	52.3	40.4	47.4	44.9	50.5	55.9	55.7	53.7
	max value	165	170	96	130	150	131	204	171	134
1003	ann. mean	52.3	52.4	50.5	50.5	47.1	50.2	53.8	50.9	47.4
	max value	123	127	111	117	101	148	172	115	128

TABLE 6 (continued)

Air Quality Trends for Ozone (ppb)

ESSEX COUNTY (WINDSOR) Stations									
Year	1982	1983	1984	1985	1986	1987	1988	1989	1990
AES 060204C									
ann. mean		18	19	19	20	17	18	22	21
max value		120	140	140	120	100	110	160	140
LAMBTON COUNTY (SARNIA) Stations									
AES 061004R									
ann. mean		23	23	23	23	21	22	23	25
max value		130	140	130	110	110	170	130	160

Footnotes:

"Ann. mean" is the annual arithmetic mean; "Max value" is the largest recorded observation. An asterisk (*) indicates a data quality problem associated with the reported statistic.