

1. Introduction

Inventory Objective

This 1999 inventory, the fourth inventory of the Great Lakes Regional Air Toxic Emissions Inventory Project, presents a multi-jurisdictional inventory of point, area and mobile sources of toxic air emissions that have the potential to impact environmental quality in the Great Lakes region. This ongoing initiative was undertaken through an intergovernmental partnership involving the air regulatory agencies of the Great Lakes states and province of Ontario, and the U.S. Environmental Protection Agency (U.S. EPA). The objective of this ongoing initiative is to present researchers, policy makers and the general public with detailed, region wide data on the source and emission levels of air toxic contaminants.

The development and release of the inventory is an important step in meeting the goals of the 1986 Great Lakes Toxic Substances Control Agreement (signed by the Great Lakes governors and Premier of Ontario), and sections 112 of the 1990 U.S. Clean Air Act Amendments (see <http://www.cglg.org/pub/toxics/index.html> and <http://earth1.epa.gov/oar/caa.html> for further details).

The inventory project presents a compilation of the best available data for calendar year 1999 point, area and mobile source emissions. Great Lakes jurisdictions believe this work provides a strong foundation for building national and binational strategies to reduce toxic air emissions affecting the Great Lakes basin.

This inventory effort focused on the identification of point, area and mobile source categories that contribute to the total emissions of toxic contaminants listed in Table 1-1. This list of **213** contaminants was compiled using the Great Lakes Water Quality Agreement, International Joint Commission's list of Great Lakes critical pollutants, U.S. EPA's list of targeted toxic chemicals and compounds defined in the U.S. Clean Air Act Amendments of 1990, section 112(b), and those pollutants suggested by the Great Lakes states and Province of Ontario.

The inventory project is strengthening decision making capabilities in the region by promoting inter-jurisdictional consistency in data collection and analysis, establishing standard procedures and protocols, developing and testing an automated emission estimation and inventory system, and demonstrating the value of client/server technology via the Internet to transmit and exchange environmental data among the Great Lakes jurisdictions and inform the larger Great Lakes community.

Inventory Scope

The Great Lakes Toxic Air Emissions Inventory effort began in 1989 with primary funding provided by the Great Lakes Protection Fund and subsequently by the U.S. EPA

and the Great Lakes states. Development of a Protocol document to estimate emissions, the *Regional Air Pollutant Inventory Development System* (RAPIDS), and an inventory for Southwest Lake Michigan counties launched this regional effort. To date we have released full inventories for the years 1993, 1996, 1997 and 1998. The 1993 inventory consisted of point and area sources for 49 pollutants of concern. The subsequent inventories include emissions information from point, area, and mobile sources for 82 toxic air pollutants. The present inventory for 1999 consists of 213 HAP, presents an overview of the regional mercury emissions, identifies gaps in the information, and suggests areas of improvements for the inventory.

Inventory Methodology

The 1999 Regional Toxic Air Emissions Inventory effort focuses on significant sources of air emissions of **213** toxic air pollutants in the jurisdictions bordering the Great Lakes. Working cooperatively through the Great Lakes Commission, inventory work is undertaken by the air quality departments of the state and provincial governments in the region. Each agency follows the *Regional Toxic Air Emissions Inventory Protocol* (online at <http://www.glc.org/air/protocol/prototoc.html>). The protocol provides guidelines to accomplish the regional inventory development effort so the inventory is as complete, accurate, and consistent as possible from one jurisdiction to the next. The protocol:

- Assigns responsibilities and procedures to the states, Great Lakes Commission, U.S. EPA, and the Great Lakes National Program Office (GLNPO);
- Outlines procedures to identify and locate emission sources of target compounds;
- Guides selection of specific emission estimation techniques;
- Instructs states on compiling and updating the regional repository at GLNPO;
- Outlines quality assurance/quality control procedures for emission data and estimates; and
- Identifies and explains the full suite of automated tools available for developing the regional inventory.

Two important issues for the inventory development effort are the appropriate level of detail and the use of facility versus area approach for calculating emissions. For the inventory, the protocol defines the following level of detail as being appropriate for meeting the goals of the project:

- **Emissions include:** All target compounds listed in Table 1-1;
- **Spatial resolution:** By county for area and mobile sources, and to the nearest 100 meters for facility sources and associated devices;
- **Temporal resolution:** Annual emissions estimates and annual activity data; and
- **Source/device/process categorization:** By the most detailed source/device/process as identified in U.S. EPA's Source Classification Codes (SCC) and Area and Mobile Source (AMS) coding systems of process codes plus a further breakdown by Standard Industrial Classification (SIC), as appropriate, to better categorize a given source (required to prevent the problem of inconsistent aggregation of sources/devices/processes among the participating states).

The protocol describes the two emission calculation approaches as follows:

- **Facility source approach:** Separately identify each device/process at each facility source and calculate its emissions (often referred to as a facility/point source approach); and
- **Area source approach:** Aggregate all similar or identical device/processes within a defined area and calculate their total emissions directly using the appropriate surrogate activity data (the source in this case is the area in which all of the devices are found, usually an entire county). It should be noted here that, a mobile source is a specific type of area source category.

The area source approach is generally used for sources that are small and numerous, such as gasoline stations and dry cleaning establishments. They are not included as facility sources because the effort required to gather and estimate emissions for each individual facility is beyond the resources available for inventory development efforts. Some area sources, such as consumer products, have no analog as a facility source.

The protocol refers to certain software tools (e.g. the Regional Air Pollutant Inventory Development System (RAPIDS), discussed below) that can be used to prepare a state or province's portion of the regional inventory. However, the protocol procedures, if followed, will result in emissions data and estimates that are compatible and consistent, whether or not these software tools are used. Each state report in the appendix indicates the specific methodology used to produce the emissions data result.

RAPIDS Development

The RAPIDS Steering Committee is composed of representatives from each of the air management programs from the eight Great Lakes states and province of Ontario and observers from U.S. EPA. A complete list of members with contact information can be found in Appendix HH. For further information on Steering Committee functions see <http://www.glc.org/air/>.

The Steering Committee worked closely with the project software development contractor, Windsor Technologies Inc., to enhance emissions estimation and reporting capabilities in RAPIDS. RAPIDS is a client/server system, developed in PowerBuilder® with an ORACLE® back-end database. The software takes full advantage of Internet/Great Lakes Information Network (GLIN) connections between the states, the Great Lakes Commission and the U.S. EPA GLNPO office in Chicago. Three software enhancements were developed for this release:

1. Point and area emissions data export capability from RAPIDS to EPA's National Emissions Inventory (NEI), format NIF 2.0.
2. Capability of using facility specific data at three levels. Apply data for the whole state, for the whole facility, or for individual devices.
3. Improved reporting capabilities by adding an easily queried Datamart.

Quality Assurance/Quality Control

Quality Assurance/Quality Control (QA/QC) of the inventory was performed. The RAPIDS software provides feedback on missing data during emission calculation and “out of range” errors when importing or entering data via the input screens. Regional checks included items such as:

- Comparing emissions of the states to each other
 - state emissions by pollutant
 - state emissions by pollutant and source category (point, area, mobile, etc.)
- Comparing emissions of a state to its emissions from the 1998 inventory
- Ranking emissions by county for each pollutant and looking for outliers
- Identifying the individual source types for area sources that were not inventoried by a state
- For each SCC/AMS, identified which pollutants each state inventoried and indicated which pollutants were missing or were additional
- For the mercury review
 - checked for SCCs that were in FIRE 6.23 that had a mercury emission factor where the state indicated it had that SCC but did not report mercury emissions
 - checked for SCCs in FIRE 6.23 that seemed they should have had a mercury emission factor (e.g., coal combustion) and indicated this to states who had that SCC
 - identified readily available area source categories that had mercury emission but were not reported by the state (i.e. lamp recycling, lamp breakage)

These checks, and other minor ones, ensured that this report provided an accurate and useful summary of toxic air emissions at the regional level. Responses to specific QA/QC issues are covered in the individual state sections of the report.

Future Directions

For future inventories, the Steering Committee will continue all 213 hazardous air pollutants identified in the Project, and will focus on emerging pollutants of concern (e.g., PBTs).

Ongoing inventory efforts will provide for various studies, analyzing the regional impact and trends of air toxic emissions with emphasis of emerging pollutants of concerns. By producing an annual inventory, the RAPIDS Steering Committee provides quality data as a basis for trend analysis.

The RAPIDS software will be enhanced to improve its RAPIDS/NEI export utility for area and mobile sources and the capability to import point, area and mobile sources data in NEI format. To accommodate the changes in industrial source classifications, NAICS codes will be added to RAPIDS reference tables. In addition, RAPIDS' mobile source import capabilities will be modified to import MOBILE 6.2 output data for estimating mobile source emissions. Furthermore, the RAPIDS' Datamart will enhance the reporting functionality of RAPIDS through an Internet interface to its data. This approach will use roll-up tables to store summary information and roll-up tables to expedite access to emission data.

The Steering Committee will continue enhancing the inventory with emerging pollutants of concern and will examine previously reported data where there might be significant changes in specific emission estimation methods. These studies bridge the gap between the science of inventorying toxic air emissions and the public policy debate concerning how these emissions affect human health and the environment and how they should be addressed. Follow-up by state, provincial and federal environmental protection agencies is necessary to make further progress toward these goals. The Steering Committee recommends that regulatory decisions not be based on this data alone.

The air emissions inventory project is funded primarily by the U.S. EPA from the Great Lakes Air Deposition program grant funds designated for regional and multi-jurisdictional projects that address air toxics and the Great Lakes states.

The eight states and the Province of Ontario will continue to work collaboratively to improve and refine the toxics inventory and strengthen its ability to support sound regulatory decisions at all levels of government.

Table 1 – List of 213 targeted toxic pollutant

Code	CAS	Pollutant Name
TCE,111	71-55-6	1,1,1-Trichloroethane
TETCLET,1122	79-34-5	1,1,2,2-Tetrachloroethane
TRICLETH,112	79-00-5	1,1,2-Trichloroethane
DICLETH,11-	75-34-3	1,1-Dichloroethane
DIMETH HY,11	57-14-7	1,1-Dimethyl hydrazine
HEXACL-1,3-C	77-47-4	1,2,3,4,5,5-Hexachloro-1,3-cyclopentadiene
TRICLBNZ,124	120-82-1	1,2,4-Trichlorobenzene
DIBROMO3,12	96-12-8	1,2-Dibromo-3-chloropropane
DIBROMOET,12	106-93-4	1,2-Dibromoethane
DICHLORETH12	107-06-2	1,2-Dichloroethane
DIPHENHYD,12	122-66-7	1,2-Diphenylhydrazine
EPOXYBUT,12	106-88-7	1,2-Epoxybutane
PROP IM, 12	75-55-8	1,2-Propylenimine
BUTADIENE,13	106-99-0	1,3-Butadiene
DICLPROPE,13	542-75-6	1,3-Dichloropropene
PROPANESU,13	1120-71-4	1,3-Propane sultone
DICLBENZ,14	106-46-7	1,4-Dichlorobenzene
DIOXANE	123-91-1	1,4-Dioxane
TRIME-PENTAN	540-84-1	2,2,4-Trimethylpentane
TCDD,2378	1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin
TCDF,2378	51207-31-9	2,3,7,8-Tetrachlorodibenzofuran
TRICLPHN,245	95-95-4	2,4,5-Trichlorophenol
TRICLPHN,246	88-06-2	2,4,6-Trichlorophenol
D,2,4	94-75-7	2,4-D, Salts And Esters
TOL DIAMIN24	95-80-7	2,4-Diaminotoluene
DINITROPH,24	51-28-5	2,4-Dinitrophenol
DINITRTOL,24	121-14-2	2,4-Dinitrotoluene
ACETYLAMIN,2	53-96-3	2-Acetylaminofluorene
CLACETOPHE,2	532-27-4	2-Chloroacetophenone
NITROPROPA,2	79-46-9	2-Nitropropane
DICLBENZD,33	91-94-1	3,3-Dichlorobenzidene
DIMETHOXY,33	119-90-4	3,3-Dimethoxybenzidine
DIMETHBNZ,33	119-93-7	3,3-Dimethylbenzidine
METEN BIS,44	101-14-4	4,4-Methylene bis(2-chloroaniline)
METHENE(B)4-	101-68-8	4,4-Methylenediphenyl diisocyanate
METHENE DIAN	101-77-9	4,4-Mmethylene dianiline
DINITRO-O-CR	534-52-1	4,6-Dinitro-o-cresol (including Salts)
AMINOBIPE,4	92-67-1	4-Aminobiphenyl
NITRBIPHEN,4	92-93-3	4-Nitrobiphenyl
NITROPHENL,4	100-02-7	4-Nitrophenol
ACENAPHTHEN	83-32-9	Acenaphthene
ACENAPHTHYL	208-96-8	Acenaphthylene
ACETALDEHYDE	75-07-0	Acetaldehyde
ACETAMIDE	60-35-5	Acetamide
ACETONITRILE	75-05-8	Acetonitrile
ACETOPHENONE	98-86-2	Acetophenone
ACROLEIN	107-02-8	Acrolein
ACRYLAMIDE	79-06-1	Acrylamide
ACRYLIC ACID	79-10-7	Acrylic acid
ACRYLONITRIL	107-13-1	Acrylonitrile
LEAD,ALK		Alkylated lead

Code	CAS	Pollutant Name
ALLYL CHLORI	107-05-1	Allyl chloride
ANILINE	62-53-3	Aniline
ANTHRACENE	120-12-7	Anthracene
ANTIMONY	7440-36-0	Antimony
ARSENIC	7440-38-2	Arsenic (and compounds)
ASBESTOS	1332-21-4	Asbestos
ATRAZINE	1912-24-9	Atrazine
BENZ(A)ANTHR	56-55-3	Benz(a)anthracene
BENZENE	71-43-2	Benzene
BENZIDINE	92-87-5	Benzidine
BENZO(A)PYRE	50-32-8	Benzo(a)pyrene
BENZO(B)FLUO	205-99-2	Benzo(b)fluoranthene
BENZ(GHI)PE	191-24-2	Benzo(g,h,i)perylene
BENZO(K)FLUO	207-08-9	Benzo(k)fluoranthene
BENZOTRICHLO	98-07-7	Benzotrichloride
BENZYL CHLOR	100-44-7	Benzyl chloride
BERYLLIUM	7440-41-7	Beryllium (and compounds)
BETA-PROPRIO	57-57-8	Beta-propiolactone
BIPHENYL	92-52-4	Biphenyl
BIS(2-CLETH)	111-44-4	Bis (2-chloroethyl) ether
BIS(CLMETH)	542-88-1	Bis(chloromethyl)ether
BROMOFORM	75-25-2	Bromoform
BROMOMETH	74-83-9	Bromomethane
CADMIUM	7440-43-9	Cadmium (and compounds)
CALCIUM CYAN	156-62-7	Calcium cyanamide
CAPTAN	133-06-2	Captan
CARBARYL	63-25-2	Carbaryl
CARBON DISUL	75-15-0	Carbon disulfide
CARBON TETRA	56-23-5	Carbon tetrachloride
CARBONYL SUL	463-58-1	Carbonyl sulfide
CATECHOL	120-80-9	Catechol
CHLORAMBEN	133-90-4	Chloramben
CHLORDANE	57-74-9	Chlordane
CHLORINE	7782-50-5	Chlorine
CHLOROACETIC	79-11-8	Chloroacetic acid
CHLOROBENZ	108-90-7	Chlorobenzene
CLBENZILATE	510-15-6	Chlorobenzilate
CHLOROETHANE	75-00-3	Chloroethane
CHLOROFORM	67-66-3	Chloroform
CLMETH METH	107-30-2	Chloromethyl methyl ether
CHLOROPRENE	126-99-8	Chloroprene
CHROMIUM	11115-74-5	Chromium (and compounds)
CHROMIUM VI	18540-29-9	Chromium VI
CHRYSENE	218-01-9	Chrysene
COBALT	7440-48-4	Cobalt (and compounds)
COKE OVEN GS		Coke oven emissions
COPPER	7440-50-8	Copper (and compounds)
CU CYANIDE	544-92-3	Copper cyanide
CRESOL MX IS	1319-77-3	Cresol (mixed isomers)
CUMENE	98-82-8	Cumene
CYANIDE	57-12-5	Cyanide
DIAZOMETHANE	334-88-3	Diazomethane
DIBENZAHAN	53-70-3	Dibenzo(a,h)anthracene

Code	CAS	Pollutant Name
DIBENZOFURAN	132-64-9	Dibenzofuran
DIBUTYL PHTH	84-74-2	Dibutyl phthalate
DICHLORVOS	62-73-7	Dichlorvos
DIETHANOLAMI	111-42-2	Diethanolamine
DIETH SULFAT	64-67-5	Diethyl sulfate
DIEYLHEX PHT	117-81-7	Diethylhexyl phthalate
DIMETH AMINO	60-11-7	Dimethyl aminoazobenzene
DIMETH PHTHA	131-11-3	Dimethyl phthalate
DIMETH SULFA	77-78-1	Dimethyl sulfate
DIMETHYLANIL	121-69-7	Dimethylaniline (N,N-Dimethylaniline)
DIOCTYL PHTH	117-84-0	Dioctyl phthalate
EPICLHYDRIN	106-89-8	Epichlorohydrin
ETH ACRYLATE	140-88-5	Ethyl acrylate
ETHYL CARBAM	51-79-6	Ethyl carbamate
ETHYLBENZENE	100-41-4	Ethylbenzene
ETHYLENE GLY	107-21-1	Ethylene glycol
ETHYLENE IMI	151-56-4	Ethylene imine
ETHYLENE OXI	75-21-8	Ethylene oxide
ETHYLENE THI	96-45-7	Ethylene thiourea
FINE MNRLFIB		Fine mineral fibers
FLUORANTHENE	206-44-0	Fluoranthene
FLUORENE	86-73-7	Fluorene
FORMALDEHYDE	50-00-0	Formaldehyde
GLYCOL ETRS		Glycol ethers
HEPTACHLOR	76-44-8	Heptachlor
HEXCL-13-BUT	87-68-3	Hexachloro-1,3-butadiene
HEXCLBENZENE	118-74-1	Hexachlorobenzene
HEXCHLORETH	67-72-1	Hexachloroethane
HXMETH PHOSP	680-31-9	Hexamethyl phosphoramidate
HEXAMETHYL16	822-06-0	Hexamethylene-1,6-diisocyanate
HYDRAZINE	302-01-2	Hydrazine
HCL	7647-01-0	Hydrochloric acid
HYDROGEN CYA	74-90-8	Hydrogen cyanide
HF	7664-39-3	Hydrogen fluoride
HYDROGEN SUL	7783-06-4	Hydrogen sulfide
HYDROQUINONE	123-31-9	Hydroquinone
INDN(123CDPY	193-39-5	Indeno(1,2,3-c,d)pyrene
ISOPHORONE	78-59-1	Isophorone
LEAD	7439-92-1	Lead (and compounds)
LINDANE ISO	58-89-9	Lindane (all Isomers)
CRESOL,M	108-39-4	m-Cresol
XYLENE,M	108-38-3	m-Xylene
MALEIC ANHYD	108-31-6	Maleic anhydride
MANGANESE	7439-96-5	Manganese (and compounds)
MERCURY	7439-97-6	Mercury (and compounds)
MERCURY,ORG	22967-92-6	Mercury (organic)
METHANOL	67-56-1	Methanol
METHOXYCHLOR	72-43-5	Methoxychlor
METHYL CHLOR	74-87-3	Methyl chloride
METH ETH KET	78-93-3	Methyl ethyl ketone
METH HYDRAZI	60-34-4	Methyl hydrazine
METH IODIDE	74-88-4	Methyl iodide
METH ISOBUT	108-10-1	Methyl isobutyl ketone

Code	CAS	Pollutant Name
METH ISOCYAN	624-83-9	Methyl isocyanate
METH METHACR	80-62-6	Methyl methacrylate
METH TERT BU	1634-04-4	Methyl tert butyl ether
METHYLENE CL	75-09-2	Methylene chloride
NDIMETH CARB	79-44-7	N,N-Dimethyl carbamoyl chloride
DIMETHFORMAM	68-12-2	N,N-Dimethylformamide
HEXANE	110-54-3	n-Hexane
NITROSO-N,N	684-93-5	N-Nitroso-n-methylurea
NITROSODIMET	62-75-9	N-Nitrosodimethylamine
NITROSOMORPH	59-89-2	N-Nitrosomorpholine
NAPHTHALENE	91-20-3	Naphthalene
NICKEL	7440-02-0	Nickel (and compounds)
NITROBENZ	98-95-3	Nitrobenzene
ANISIDINE,O-	90-04-0	o-Anisidine
CRESOL,O	95-48-7	o-Cresol
TOLUIDINE,O-	95-53-4	o-Toluidine
XYLENE,O	95-47-6	o-Xylene
CRESOL,P	106-44-5	p-Cresol
PHENYLENED,P	106-50-3	p-Phenylenediamine
XYLENE,P	106-42-3	p-Xylene
PARATHION	56-38-2	Parathion
PENTCLNITBEN	82-68-8	Pentachloronitrobenzene
PCP	87-86-5	Pentachlorophenol
PHENANTHRENE	85-01-8	Phenanthrene
PHENOL	108-95-2	Phenol
PHOSGENE	75-44-5	Phosgene
PHOSPHINE	7803-51-2	Phosphine
PHOSPHORUS	7723-14-0	Phosphorus
PHTHALIC ANH	85-44-9	Phthalic anhydride
PCBS	1336-36-3	Polychlorinated biphenyls (PCBS)
PCDD		Polychlorinated dibenzodioxins, Total
PCDF		Polychlorinated dibenzofurans, Total
PROPIIONALDEH	123-38-6	Propionaldehyde
PROPOXUR	114-26-1	Propoxur
PRPLENE DICH	78-87-5	Propylene dichloride
PRPLENE OXID	75-56-9	Propylene oxide
PYRENE	129-00-0	Pyrene
QUINOLINE	91-22-5	Quinoline
QUINONE	106-51-4	Quinone
RADIONUCLIDE		Radionuclides
SELENIUM	7782-49-2	Selenium (and compounds)
STYRENE	100-42-5	Styrene
STYRENE OXID	96-09-3	Styrene oxide
PERC	127-18-4	Tetrachloroethylene
TITAN TETCL	7550-45-0	Titanium tetrachloride
TOLUENE	108-88-3	Toluene
TOLUENE24DII	584-84-9	Toluene-2,4-diisocyanate
TOXAPHENE	8001-35-2	Toxaphene
TRICHLORETHY	79-01-6	Trichloroethylene
TRIETHAMINE	121-44-8	Triethylamine
TRIFLURALIN	1582-09-8	Trifluralin
VINYL ACETAT	108-05-4	Vinyl acetate
VINYL BROMID	593-60-2	Vinyl bromide

Code	CAS	Pollutant Name
VINYL CHLOR	75-01-4	Vinyl chloride
VINYLIDENE CL	75-35-4	Vinylidene chloride
XYLENES ISO	1330-20-7	Xylene (mixed isomers)