The Great Lakes Regional Air Toxic Emissions Inventory: Point and Area Sources and Assessment of Mercury Emissions for 1999.

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ABSTRACT

The eight Great Lakes states and the province of Ontario, with the coordination of the Great Lakes Commission, have developed an air toxic emissions inventory of point and area sources for calendar year 1999. This is the 4th inventory completed for the Great Lakes Region. It includes emission estimates for 197 out of 213 target pollutants, with emphasis on mercury. This paper presents the inventory results and an assessment of mercury emission estimates in the region.

The regional emission inventory includes emissions from 675 distinct source categories and 1592 distinct source classification codes (SCC). Point sources are responsible for emissions of 196 pollutants while area sources are associated with emissions of 133 pollutants. Area sources dominate the emissions for 14 PAH, and 40 non-metal compounds, with a contribution of more than 50% to the total emissions. Point sources are responsible for more than 80% of emissions for all metal compounds with the exception of chromium VI, for which about 45% emissions are from area sources, mainly chromium electroplating. Point sources also contribute more than 50% of total emissions for 2 PAH, and 129 non-metal compounds.

Mercury emissions from Great Lakes' states and the province of Ontario totaled 47,198 lb. in 1999. These emissions are associated with 556 industrial and area source categories, 327 distinct process codes (SCC), and 107 process categories. About 95 percent of the mercury emissions come from industrial point sources, while 5 percent come from non-point area sources. The majority of the emissions result from the combustion of coal. The mercury inventory assessment identified forty-seven reported process codes (SCC), included in the emissions inventory, that should associate with mercury emissions, having no available emission factors for mercury in FIRE. Emissions from these processes could result in significant mercury emissions in the region.

INTRODUCTION

This 1999 inventory, the fourth inventory of the Great Lakes Regional Air Toxic Emissions Inventory Project, presents a multi-jurisdictional inventory of point and area 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(c)(6), 112(k) and 112(m) of the 1990 U.S. Clean Air Act Amendments.

The inventory project presents a compilation of the best available data for calendar year 1999 point and area source emissions. 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 and area source categories that contribute to the total emissions of toxic contaminants affecting the environment of the Great Lakes region. The present inventory consists of 213 HAP, with an emphasis on mercury. The 1999 inventory effort includes an overview of the regional mercury inventory, identifies gaps in the information, and suggests areas of improvements for the inventory.

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 (c)(6), 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 interjurisdictional 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.

Data summaries and a report of the 1999 inventory and all previous inventories are available at the Great Lakes Commission (http://www.glc.org) and the Great Lakes Information Network (http://www.great-lakes.net) web sites. Additional information, including background documents, the emission protocol document and lists of products for the project, is located on the emission inventory project's web site (http://www.glc.org/air).

INVENTORY METHODOLOGY

Working cooperatively through the Great Lakes Commission, inventory work is undertaken by the air quality programs of the state and provincial governments in the region. Each agency follows the *Regional Toxic Air Emissions Inventory Protocol*. 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 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:

- Emittants included;
- Spatial resolution**:** By county for area 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).

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.

Quality Assurance/Quality Control

Quality Assurance/Quality Control (QA/QC) of the inventory was performed by the Great Lakes Regional Air Toxic Emissions Inventory Technical Steering Committee. 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, 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, 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 didn't 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)

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. These checks, and other minor ones, ensured that this report provided an accurate and useful summary of toxic air emissions at the regional level.

RESULTS

The following results represent emissions from point and area sources in the Great Lakes region for calendar year 1999. The regional emission inventory includes emissions from 674 distinct source categories and 1597 distinct source classification codes (SCC). Definitions of point and area sources are dependent on data collection methods, as reporting requirements for air toxic emissions are different from state to state, one emission source defined as an area source in one state may be covered as a point source in other states. Although these categories are covered by all states, some states and the province of Ontario may not estimate emissions for some area source categories due to the coverage of point sources and resource restrictions. For example, Hospital Sterilization category is covered in point sources for Wisconsin, but in area sources for Minnesota.

Emissions from All Sources

The 1999 emissions were estimated for 213 target compounds, however, data were only available to obtain emissions for 197 air toxins, including 16 polycyclic aromatic hydrocarbons (PAHs), 13 metal compounds, and 168 non-metal compounds. Table 1 shows pollutant names and estimated emissions from point and area sources.

Point sources emitted 196 pollutants while area sources emitted 133 pollutants. Area sources dominated the total emissions for 14 PAHs and 40 non-metal compounds, with a contribution more than

50% of the total emissions. Point sources were responsible for more than 80% of total emissions for all metal compounds with an exception of chromium VI and alkylated lead. About 45% emissions of chromium VI were from area sources, mainly chromium electroplating. A total of 0.68 pounds of alkylated lead were reported from petroleum storage. Point sources also contributed more than 50% of total emissions for 2 PAH, and 129 non-metal compounds. Among the 197 pollutants, toluene was estimated to have the highest emissions at 340,684,671 pounds, while chloroacetic acid emissions were the lowest recorded at about 0.22 pounds.

Specific Pollutants

A closer look was taken at the top five non-metal compounds and the top five metal compounds according to the emission totals. The source contribution to emissions for the selected 10 pollutants was analyzed by category for area sources, and the first two digits of the SIC codes for point sources. The most significant source categories and their contributions are shown in Tables 2 and 3. The selected pollutants are toluene, xylenes (includes o, m, and p), hydrochloric acid, 1,1,1-trichloroethane, trichloroethylene, manganese, copper, lead, nickel, and chromium.

With the exception of hydrochloric acid emissions, area sources account for more than 86% of total emissions of four out of the five top non-metal compounds. Industrial Surface Coating category alone contributes more than 35 percent of the regional emissions of toluene, and xylenes (isomers and mixture). More than three quarters of the emissions of 1,1,1-trichloroethane and trichloroethylene are from Degreasing Equipment. On the other hand, almost all emissions of hydrochloric acid are from point sources. Electric, Gas, and Sanitary Services (SIC code 49xx) contribute a substantial fraction of hydrochloric acid emissions, 89.7%.

In contrast with the top five non-metal compounds, point sources dominate the emissions of the top five metal compounds, accounting for more than 97.8% total regional emissions. As shown in Table 3, the most significant source category for these metal compounds is Primary Metal Industries (SIC code 33xx). More than one-half of emissions of manganese, copper, lead and nickel and 41.4% of chromium emissions are attributed to Primary Metal Industries.

Progressive Emission Changes

The 1999 inventory is the fourth one since the 1996 inventory. Eighty two pollutants were included in the regional emission inventories in 1996 - 1998 while 213 pollutants are included for 1999. The overall regional emissions from point and area sources for 1996 - 1999 are summarized in Table 4. The emission differences among years are mainly due to the following factors:

1. increased number of pollutants in the emission inventories,
2. an expansion of area sources, and
3. improvements of emission estimation methods, emission factors, and activity data.

For example, the chromium emission factor for residential natural gas combustion used in the 1996 inventory is 45 times higher than the revised one used in the 1997-99 inventories. The sum of emission factors for 16 PAHs in the 1999 inventory is 35% of the value in the 1997 and 1998 inventories for residential wood burning - certified, catalytic stoves. Also, the 1999 inventory contains emissions from 24 more distinct source categories and 384 more SCCs than the 1998 inventory.

Therefore, the results should not be viewed as a trend analysis. A back-calculation using the 1999 approaches for 1996 to 1998 could provide emission trends, however, this is a resource intensive effort.

Figures 1 to 3 show emissions of three groups of pollutants estimated from 1996 to 1999. The pollutants in PAH and metal compound groups have not changed with calendar years, so that the difference among calendar years reflects factors 2 and 3 listed above. Factors 2 and 3 also influenced emissions of non-metal compound (excluding PAHs) group. However, the primary cause of the increase of total regional emissions of non-metal compounds in 1999 is due to addition of pollutants. Some of

new inventoried pollutants showing high emissions are hydrochloric acid, methanol, methyl ethyl ketone, and hexane. These pollutants are ranked in the top ten with regard to the total emissions in 1999.

Mercury Emissions

An area of focus in developing the 1999 Great Lakes regional inventory consisted of improving the quality of our current mercury emission estimates. The work involved: 1) the addition of area source categories associated with mercury emissions, 2) the identification of source categories and processes from which mercury emissions were likely (e.g., coal combustion), but where no emission factors were available for calculating emissions, 3) identification of sources with processes associated with mercury, but for which emissions were not estimated, 4) corrections to previously reported data based on new information and assessments, and 5) the identification of improvements in reporting requirements. Some of these efforts varied from state to state, depending on reporting requirements and resources.

The first step in identifying mercury sources in the region was to compare each of the state and province reported source/process with mercury emissions, to sources with like processes, having mercury emission factors in FIRE, but with no reported mercury emissions. Fifty-one process codes (SCC) were identified in this category, and submitted for corrections. The corrections resulted in significant changes in the total emissions from some states, but not for others. For example, the emission estimation from these sources in Wisconsin resulted in only 19 pounds from 107 facilities.

Forty-seven reported process codes (SCC), associated with mercury emissions and included in the states' inventories, were identified as having no emission factors for mercury in FIRE. Although there were no mercury emission factors for these processes, some states already had emission estimates based on stack tests and other state/facility specific information. The mercury emissions from these processes could be significant, and an effort should be made to provide adequate emission factor information for these processes. For example, Illinois estimated the mercury emissions from processes lacking emission factors by applying state specific emission factors from similar sources. The emissions resulted in an additional 1,376 pounds.

Mercury emissions from the eight Great Lakes states and the province of Ontario totaled 47,198 pounds in 1999. These emissions are associated with 556 industrial and area source categories, 327 distinct process codes (SCC), and 107 process categories. About 95 percent of the mercury emissions come from industrial point sources, while 5 percent come from non-point area sources (Table 1).

Table 5 presents a summary of total mercury emissions from the Great Lakes region by source category (SIC). Of the 556 source categories inventoried, 12 categories account for 88 percent of the emissions while the remaining 544 account for 12 percent.

Of the four top categories, the Electric Services sector account for approximately 55 percent of the total emissions. The majority of the emissions result from the combustion of coal. The other top categories are Refuse Systems, Chloride Alkali manufacturing facilities, and Hospitals. The emissions from Refuse Systems result from the incineration of solid waste, while those from hospitals are mainly from the incineration of medical waste. The Electric, Refuse Systems and Hospital sectors also dominated the regional emissions of mercury in 1998.

A summary of mercury emissions by process category is presented in Table 6. Of the 107 process categories inventoried in the Great Lakes region, 9 account for 90 percent of the emissions. Consistent with the emissions by source category, coal combustion, incineration and Chloro-Alkali facilities account for the bulk of the emissions.

About 7 percent of the emissions come from unidentified processes. This could be the result of the lack of appropriate SCC to describe a process, confidential facility information, voluntary reporting, or oversight. Emissions from Fluorescent Lamp Breakage and recycling are two categories that were added to the inventory effort. The emissions from lamp breakage totaled 657.64 pounds, or close to 1.4 percent of the regional total. Although the contribution to the regional total is small, the emission estimates are higher than other point sources. Fluorescent Lamp Recycling amounted to only 0.05 pounds.

Regional mercury emissions from point and area sources in 1999 are 26,027 pounds lower than those reported in 1998. Point source emissions decreased by 18,173 pounds, while area sources decreased by 7,854 pounds. The changes in emissions from point sources were driven by emission reductions in the Refuse Systems and in the General Medical and Surgical Hospital sectors. The decrease in emissions from area sources was driven by Residential Oil Combustion. This source category was one of the most significant in 1998.

Table 7 presents a comparison of the mercury emissions from the main source categories in the Great Lakes region for 1999 and 1998. Emissions from the new categories of Fluorescent Lamp Breakage and Fluorescent Lamp Recycling were added to the list for comparison purposes.

The increase in mercury emissions in the Chloride-Alkali category results from the inclusion of another manufacturing facility missing in the 1998 regional inventory. There are only two facilities of this sort in the Great Lakes region. The decrease in emissions from hospital incineration result from corrections to the emission estimates from 1998. The decrease in emissions from residential oil combustion is due to a change in emission factors used by some states.

The mercury emission estimates presented above are based on the best available data and on the efforts by the Great Lakes states and the province of Ontario to improve the regional emission inventory. Because of reporting requirements, some states are not able to gather all the information needed to obtain a more complete account of the regional mercury emissions. Some states still depend on the information reported by facilities to the TRI database to collect some of the toxic emissions estimates. The TRI only includes a limited number of industries, allows the reporting of emission ranges, and has a higher reporting threshold than other states. For the year 1999, the mercury-reporting threshold was 25,000 pounds for manufacturing facilities, and 10,000 pounds for industries using mercury-containing materials. Electric Utilities is one of the categories affected by the reporting threshold. The TRI reporting threshold for mercury was lowered to 10 pounds in the year 2000; therefore, we could expect more complete information from a number of states in the next regional inventory update. In addition, the emissions of mercury from a number of processes could not be estimated due to a lack of generic emission factors in FIRE. These emissions could be significant, and it is recommended to include those process categories in the next FIRE update.

CONCLUSION

The air regulatory agencies from the states of Minnesota, Wisconsin, Illinois, Indiana, Michigan, Ohio, Pennsylvania and New York, along with the province of Ontario, continued the collaborative effort to successfully develop an annual inventory of airborne toxic pollutant emissions for the Great Lakes region.

The 1999 toxic emissions inventory for point and area sources in the Great Lakes region includes emissions from 674 distinct source categories and 1597 distinct source classification codes. This inventory includes improved mercury emissions estimates through the addition of area sources associated with mercury emissions, and corrections to existing data. It also identifies source categories where no mercury emission factors were available.

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 1999 toxic emissions inventory is intended to assist in the successful implementation of key provisions of the Great Lakes Toxic Substances Control Agreement, signed by the Great Lakes governors and premiers in 1986. In addition, this work is consistent with the state activities for the implementation of the Urban Area Source Program required under sections 112(c) and 112(k) under the Clean Air Act Amendments of 1990 and the assessment of atmospheric deposition to the Great Lakes under the efforts of the U.S. EPA's Great Waters Program.

The emphasis of this project was to prepare an accurate inventory of emissions for **213** target compounds in the Great Lakes region and to develop an enhanced mercury emissions inventory. As a regional effort, a high level of coordination was necessary to ensure consistency. The project team utilized Quality Assurance/Quality Control (QA/QC) criteria to develop an accurate regional summary of toxic air emissions. Having a quality controlled and quality assured emissions inventory allows scientists, researchers and policy makers to define and regulate sources; evaluate control technology; establish guidelines for siting new facilities; and reduce airborne deposition of persistent toxic chemicals to the Great Lakes.

The ultimate benefit of developing a regional annual inventory of air toxic emissions belongs to organizations that use the data. The project will offer online access to the compiled inventory of toxic emissions from point and area sources via the Great Lakes Information Network and enhanced data access from the Regional Air Pollutant Inventory Development System (RAPIDS). Future enhancements to RAPIDS will enable raw emissions data to be exported in formats compatible to a variety of analytical programs. With these access tools, decision-makers and the general public will be able to make better-informed decisions that help reduce toxic pollution, protect and restore habitats and support intergovernmental partnerships. Timely access to a comprehensive inventory provides the foundation for sound public policy decisions.

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 basin.

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.

REFERENCES

Great Lakes Commission. 1999 Inventory of Toxic Air Emissions: Point and Area Sources, November 2002. http://www.glc.org/air/inventory/1999/99fullreport.pdf.

Factor Information Retrieval System (FIRE),*Version 6.2*3; U.S. Environmental Protection Agency: Research Triangle Park, NC, October 2000.

Great Lakes Commission; *Air Toxics Emissions Inventory Protocol for the Great Lakes States*; June 1994. **http://www.glc.org/air/protocol/protocol.html**

Table 1. Summary of the 1999 air toxic emissions from the Great Lakes Region.

	Emissions (lb)			Percent (%)	
Pollutant Code	**Point**	**Area**	**Total**	**Point**	**Area**
PAHs					
ACENAPHTHEN	76,435.93	53,310.50	129,746.43	58.91	41.09
ACENAPHTHYL	612.79	807,742.68	808,355.47	0.08	99.92
ANTHRACENE	54,644.17	74,981.33	129,625.50	42.16	57.84
BENZ(A)ANTHR	207,934.59	92,868.99	300,803.58	69.13	30.87
BENZ(GHI)PE	753.44	53,673.99	54,427.44	1.38	98.62
BENZO(A)PYRE	18,430.12	28,048.80	46,478.92	39.65	60.35
BENZO(B)FLUO	29.25	28,912.26	28,941.51	0.10	99.90
BENZO(K)FLUO	6.76	13,800.79	13,807.55	0.05	99.95
CHRYSENE	24,797.58	73,540.34	98,337.92	25.22	74.78
DIBENZAHAN	19.42	11,560.92	11,580.34	0.17	99.83
FLUORANTHENE	65,517.07	99,962.78	165,479.85	39.59	60.41
FLUORENE	12,526.59	111,602.01	124,128.60	10.09	89.91

	Emissions (lb)			Percent (%)	
Pollutant Code	**Point**	**Area**	**Total**	**Point**	**Area**
INDN(123CDPY	12.90	39,778.96	39,791.87	0.03	99.97
NAPHTHALENE	1,149,207.53	9,844,209.09	10,993,416.62	10.45	89.55
PHENANTHRENE	147,590.07	692,057.62	839,647.69	17.58	82.42
PYRENE	2,767.46	115,822.35	118,589.81	2.33	97.67

Metal Compounds

ANTIMONY	75,078.28	438.11	75,516.39	99.42	0.58
ARSENIC	286,480.80	3,178.76	289,659.57	98.90	1.10
BERYLLIUM	10,204.82	744.18	10,949.00	93.20	6.80
CADMIUM	76,861.35	19,827.98	96,689.33	79.49	20.51
CHROMIUM	435,749.35	5,084.17	440,833.52	98.85	1.15
CHROMIUM VI	9,704.87	7,902.40	17,607.27	55.12	44.88
COBALT	93,157.35	1,476.44	94,633.79	98.44	1.56
COPPER	1,335,648.64	4,235.63	1,339,884.27	99.68	0.32
LEAD	1,106,121.04	13,932.16	1,120,053.21	98.76	1.24
LEAD,ALK		0.68	0.68		100.00
MANGANESE	1,752,673.77	10,146.27	1,762,820.04	99.42	0.58
MERCURY	44,953.88	2,244.84	47,198.72	95.24	4.76
NICKEL	899,286.12	19,866.37	919,152.49	97.84	2.16
Non-Metal Compounds (Excluding PAHs)					
ACETALDEHYDE	1,713,117.90	1,500,357.10	3,213,475.00	53.31	46.69
ACETAMIDE	21.00	7.32	28.32	74.15	25.85
ACETONITRILE	326,989.67	2,085.30	329,074.97	99.37	0.63
ACETOPHENONE	34,313.80	1,697.94	36,011.74	95.29	4.71
ACETYLAMIN,2	2.00		2.00	100.00	
ACROLEIN	118,614.11	1,419,478.73	1,538,092.85	7.71	92.29
ACRYLAMIDE	4,689.40		4,689.40	100.00	
ACRYLIC ACID	59,450.99	18.85	59,469.84	99.97	0.03
ACRYLONITRIL	457,425.78	35,689.20	493,114.97	92.76	7.24
ALLYL CHLORI	69.47	111.22	180.69	38.45	61.55
AMINOBIPHE,4	3.22		3.22	100.00	
ANILINE	38,732.15		38,732.15	100.00	
ANISIDINE,O-	1.27		1.27	100.00	
ASBESTOS	1,902.60		1,902.60	100.00	
ATRAZINE	314.00	7,064,291.70	7,064,605.70	0.00	100.00
BENZENE	4,688,131.80	33,916,580.25	38,604,712.05	12.14	87.86
BENZIDINE	11.22		11.22	100.00	
BENZOTRICHLO	1,645.00		1,645.00	100.00	
BENZYL CHLOR	96,777.04	53.06	96,830.10	99.95	0.05
BIPHENYL	125,578.20	30,203.95	155,782.15	80.61	19.39
BIS(2-CLETH)	115.30		115.30	100.00	
BROMOFORM	9,072.99	0.17	9,073.16	100.00	0.00
BROMOMETH	142,463.22	9,757,010.91	9,899,474.13	1.44	98.56
BUTADIENE,13	368,056.12	8,384,604.45	8,752,660.57	4.21	95.79
CALCIUM CYAN	499.00		499.00	100.00	
CAPTAN	3,730.27		3,730.27	100.00	
CARBARYL	940.00		940.00	100.00	
CARBON DISUL	5,194,056.05	28,203.21	5,222,259.26	99.46	0.54
CARBON TETRA	44,759.15	35,478.51	80,237.66	55.78	44.22

	Emissions (lb)			Percent (%)	
Pollutant Code	**Point**	**Area**	**Total**	**Point**	**Area**
CARBONYL SUL	8,210,547.50	1,852.42	8,212,399.92	99.98	0.02
CATECHOL	907.57		907.57	100.00	
CHLORDANE	2.47		2.47	100.00	
CHLORINE	1,981,991.01	3,445,070.44	5,427,061.45	36.52	63.48
CHLOROACETIC	0.22		0.22	100.00	
CHLOROBENZ	236,789.93	3,105,176.47	3,341,966.40	7.09	92.91
CHLOROETHANE	650,530.16	376,805.13	1,027,335.28	63.32	36.68
CHLOROFORM	490,122.69	238,730.34	728,853.04	67.25	32.75
CHLOROPRENE	78.70	147.50	226.20	34.79	65.21
CLACETOPHE,2	611.74	0.03	611.77	100.00	0.00
CLBENZILATE	2.00		2.00	100.00	
CLMETH METH	65.00		65.00	100.00	
COKE OVEN GS	1,022,445.91		1,022,445.91	100.00	
CRESOL MX IS	340,556.23	10.67	340,566.90	100.00	0.00
CRESOL,M	24,288.60		24,288.60	100.00	
CRESOL,O	10,444.00		10,444.00	100.00	
CRESOL,P	24,795.94		24,795.94	100.00	
CUMENE	494,746.60	81,901.13	576,647.74	85.80	14.20
CYANIDE	372,512.04	10.87	372,522.91	100.00	0.00
D,2,4	3,957.09	3,463,450.00	3,467,407.09	0.11	99.89
DIBENZOFURAN	4,909.81	316.42	5,226.23	93.95	6.05
DIBROMO3,12	9.82		9.82	100.00	
DIBROMOET,12	2,747.03	508.88	3,255.91	84.37	15.63
DIBUTYL PHTH	52,966.69	2,151,488.33	2,204,455.02	2.40	97.60
DICHLORETH12	67,073.83	30,538.10	97,611.93	68.71	31.29
DICHLORVOS	27.78		27.78	100.00	
DICLBENZ,14	102,662.24	3,837,075.13	3,939,737.37	2.61	97.39
DICLBENZD,33	1.00		1.00	100.00	
DICLETH,11-	17,430.70	1,230.10	18,660.81	93.41	6.59
DICLPROPE,13	242.87	9,687,715.12	9,687,957.99	0.00	100.00
DIETH SULFAT	14.22		14.22	100.00	
DIETHANOLAMI	62,806.15	33.53	62,839.68	99.95	0.05
DIEYLHEX PHT	34,257.19		34,257.19	100.00	
DIMETH HY,11	8.00		8.00	100.00	
DIMETH PHTHA	57,489.52	21.29	57,510.81	99.96	0.04
DIMETH SULFA	9,549.66	8.21	9,557.87	99.91	0.09
DIMETHBNZ,33	2.00		2.00	100.00	
DIMETHFORMAM	328,771.34	375,634.73	704,406.07	46.67	53.33
DIMETHOXY,33	1.54		1.54	100.00	
DIMETHYLANIL	4,226.24	1,974.66	6,200.90	68.16	31.84
DINITRO-O-CR	5.00		5.00	100.00	
DINITROPH,24	159.29		159.29	100.00	
DINITRTOL,24	44.36	294.25	338.61	13.10	86.90
DIOCTYL PHTH	13,051.55	49.64	13,101.19	99.62	0.38
DIOXANE	35,911.57	1,123.74	37,035.31	96.97	3.03
DIPHENHYD,12	2.00		2.00	100.00	
EPICLHYDRIN	80,716.43	29.35	80,745.78	99.96	0.04
EPOXYBUT,12	653.90		653.90	100.00	
ETH ACRYLATE	18,511.49	15.91	18,527.40	99.91	0.09
ETHYL CARBAM	79.10		79.10	100.00	
ETHYLBENZENE	4,153,267.60	12,546,529.97	16,699,797.57	24.87	75.13
ETHYLENE GLY	583,571.25	9,205,772.74	9,789,343.99	5.96	94.04

	Emissions (lb)			Percent (%)	
Pollutant Code	Point	Area	Total	Point	Area
ETHYLENE OXI	194,346.89	1,272,818.92	1,467,165.81	13.25	86.75
ETHYLENE THI	10.00		10.00	100.00	
FORMALDEHYDE	9,205,903.59	8,569,225.82	17,775,129.41	51.79	48.21
GLYCOL ETHRS	11,659,727.46	14,300,408.39	25,960,135.85	44.91	55.09
HCL	246,429,839.56	1,393,438.36	247,823,277.92	99.44	0.56
HEPTACHLOR	2.00		2.00	100.00	
HEXACL-1,3-C	81.36	3.56	84.92	95.81	4.19
HEXAMETHYL16	8,632.01	0.32	8,632.33	100.00	0.00
HEXANE	20,438,212.03	25,155,348.37	45,593,560.41	44.83	55.17
HEXCHLORETH	40,489.94		40,489.94	100.00	
HEXCL-13-BUT	270.98	4.45	275.43	98.39	1.61
HEXCLBENZENE	2.00	1.34	3.34	59.99	40.01
HF	25,519,107.85	1,226.00	25,520,333.85	100.00	0.00
HYDRAZINE	485.70		485.70	100.00	
HYDROGEN CYA	180,302.94	1,501,407.27	1,681,710.21	10.72	89.28
HYDROGEN SUL	7,200,675.39		7,200,675.39	100.00	
HYDROQUINONE	9,064.31	15,983.00	25,047.32	36.19	63.81
ISOPHORONE	119,437.36	68,189.87	187,627.23	63.66	36.34
LINDANE ISO	5.16		5.16	100.00	
MALEIC ANHYD	225,963.75		225,963.75	100.00	
METEN BIS,44	4,185.00		4,185.00	100.00	
METH ETH KET	23,229,112.08	44,039,154.02	67,268,266.10	34.53	65.47
METH HYDRAZI	20,857.46	0.74	20,858.20	100.00	0.00
METH IODIDE	349.38		349.38	100.00	
METH ISOBUT	6,539,600.15	25,764,633.79	32,304,233.93	20.24	79.76
METH ISOCYAN	34.00		34.00	100.00	
METH METHACR	639,654.04	15,106.89	654,760.93	97.69	2.31
METH TERT BU	237,106.27	101,576.02	338,682.29	70.01	29.99
METHANOL	31,693,872.64	39,249,798.87	70,943,671.51	44.67	55.33
METHENE DIAN	4,101.05		4,101.05	100.00	
METHENE(B)4-	254,183.78	554.89	254,738.67	99.78	0.22
METHOXYCHLOR	320.00		320.00	100.00	
METHYL CHLOR	1,286,071.20	494,077.10	1,780,148.30	72.25	27.75
METHYLENE CL	15,944,333.70	27,136,580.10	43,080,913.80	37.01	62.99
NDIMETH CARB	4.00		4.00	100.00	
NITRBIPHEN,4	0.77		0.77	100.00	
NITROBENZ	509.84	41.81	551.65	92.42	7.58
NITROPHENL,4	615.09		615.09	100.00	
NITROPROPA,2	91.79	119.63	211.42	43.42	56.58
NITROSODIMET	1.98		1.98	100.00	
NITROSOMORPH	1.22		1.22	100.00	
PCBS	153.18	0.11	153.30	99.93	0.07
PCDD	5.73	1.03	6.76	84.79	15.21
PCDF	6.61	5.62	12.23	54.05	45.95
PCP	5.30		5.30	100.00	
PENTCLNITBEN	8.86		8.86	100.00	
PERC	2,779,654.04	55,466,184.82	58,245,838.87	4.77	95.23
PHENOL	3,445,371.73	1,553.14	3,446,924.87	99.95	0.05
PHENYLENED,P	1,200.00		1,200.00	100.00	
PHOSGENE	244.00	1.08	245.08	99.56	0.44
PHOSPHINE	766.10	419.70	1,185.80	64.61	35.39
PHOSPHORUS	142,832.71	34,377.30	177,210.02	80.60	19.40

	Emissions (lb)			Percent (%)	
Pollutant Code	Point	Area	Total	Point	Area
PHTHALIC ANH	163,161.76		163,161.76	100.00	
PROP IM, 12	6.22		6.22	100.00	
PROPIONALDEH	64,609.79	30.73	64,640.52	99.95	0.05
PROPOXUR	108.20		108.20	100.00	
PRPLENE DICH	1,957.19	439.10	2,396.28	81.68	18.32
PRPLENE OXID	69,901.06	35,204.30	105,105.36	66.51	33.49
QUINOLINE	7,479.48		7,479.48	100.00	
QUINONE	3,259.94		3,259.94	100.00	
SELENIUM	233,297.85	1,762.13	235,059.98	99.25	0.75
STYRENE	16,888,081.55	427,806.88	17,315,888.43	97.53	2.47
TCDD,2378	3.11	0.01	3.12	99.69	0.31
TCDF,2378	0.53	0.56	1.09	48.61	51.39
TCE,111	393,957.32	132,260,596.57	132,654,553.89	0.30	99.70
TETCLET,1122	14,932.83	5,189.75	20,122.57	74.21	25.79
TITAN TETCL	262.00		262.00	100.00	
TOL DIAMIN24	12.00		12.00	100.00	
TOLUENE	46,298,147.67	294,386,523.51	340,684,671.18	13.59	86.41
TOLUENE24DII	14,639.06	4,473.74	19,112.80	76.59	23.41
TOLUIDINE,O-	1,821.21	11.56	1,832.78	99.37	0.63
TOXAPHENE	15.00		15.00	100.00	
TRICHLORETHY	7,396,994.22	95,719,937.60	103,116,931.81	7.17	92.83
TRICLBNZ,124	19,480.03	526.41	20,006.44	97.37	2.63
TRICLETH,112	3,925.74	187.95	4,113.69	95.43	4.57
TRICLPHN,245	9.26		9.26	100.00	
TRICLPHN,246	908.53		908.53	100.00	
TRIETHAMINE	1,442,750.41	50,799.98	1,493,550.39	96.60	3.40
TRIFLURALIN	3,111.45	759,312.69	762,424.14	0.41	99.59
TRIME-PENTAN	60,782.94	1,578,671.96	1,639,454.91	3.71	96.29
VINLIDENE CL	30,387.91	14,701.50	45,089.41	67.39	32.61
VINYL ACETAT	412,662.55	12,963.22	425,625.77	96.95	3.05
VINYL CHLOR	356,996.05	410,668.17	767,664.22	46.50	53.50
XYLENE,M	93,636.87	1,192,122.45	1,285,759.32	7.28	92.72
XYLENE,O	849,317.73	17,972,427.83	18,821,745.56	4.51	95.49
XYLENE,P	12,643.37	864,077.63	876,721.01	1.44	98.56
XYLENES ISO	33,419,152.31	231,833,449.16	265,252,601.47	12.60	87.40

Table 2. The most significant source categories for the top five non-metal compounds.

Pollutant Name	Emissions (lb)	Most Significant Source Category	Percent of Contribution
Toluene	340,684,671.18	Industrial Surface Coating	36.91
Xylenes (includes o, m, and p)	265,317,635.47	Industrial Surface Coating	35.11
Hydrochloric acid	247,823,277.92	Electric, Gas, and Sanitary Services (SIC code 49xx)	89.72
1,1,1-Trichloroethane	132,654,553.89	Degreasing Equipment	76.27
Trichloroethylene	103,116,931.81	Degreasing Equipment	91.73

Table 3. The most significant source categories for the top five metal compounds.

Pollutant Name	Emissions (lb)	Most Significant Source Category	Percent of Contribution
Manganese	1,762,820.04	Primary Metal Industries (SIC code 33xx)	56.79
Copper	1,339,884.27	Primary Metal Industries (SIC code 33xx)	85.18
Lead	1,120,053.21	Primary Metal Industries (SIC code 33xx)	63.43
Nickel	919,152.49	Primary Metal Industries (SIC code 33xx)	59.30
Chromium	440,833.52	Primary Metal Industries (SIC code 33xx)	41.43

Table 4. Summary of regional air toxic emissions from point and area sources (1996-1999, expressed in pounds).

Calendar Year	1996	1997	1998	1999
PAHs	29,072,422	12,888,310	14,404,640	13,903,159
Non-Metal Compounds (Excluding PAHs)	845,813,767	662,217,430	718,624,462	1,681,552,825
Metal Compounds	7,622,696	5,373,067	5,472,034	6,214,998
Total	882,510,881	680,480,803	738,503,134	1,701,672,982

Table 5. 1999 Great Lakes States Mercury Emission Summary by Source Category.

SIC	Category Name	Emissions (pounds)	Percentage (%)
4911	Electric services	25796.48	54.66
4953	Refuse systems	4975.25	10.54
2812	Alkalies and chlorine	2742.63	5.81
8062	General medical & surgical hospitals	2571.78	5.45
4931	Electric and other services combined	879.45	1.86
1011	Iron ores	859.93	1.82
2046	Wet corn milling	835.41	1.77
3241	Cement, hydraulic	735.86	1.56
4952	Sewerage systems	711.54	1.51
LAMP BREAKAGE	Lamp Breakage	657.64	1.39
3321	Gray and ductile iron foundries	643.31	1.36
Others	Sum of other categories that have emissions less than 1% of total	5789.44	12.26
TOTAL		**47198.72**	**100.00**

Table 6. 1999 Great Lakes States Mercury Emission Summary by Process Category.

Process Category	Emissions (pounds)	Percentage (%)
COAL COMBUSTION	27163.06	57.55
INCINERATION	6814.83	14.44
UNSPECIFIED	3523.27	7.46
CHLORO-ALKALI	1081.71	2.29
SITE REMEDIATION	946.00	2.00
SOLID WASTE COMBUSTION	800.62	1.70
CEMENT MFG	733.97	1.56
LAMP BREAKAGE	657.64	1.39
GRAY IRON FOUNDRY	643.51	1.36
Others	4834.12	10.24
TOTAL	**47198.72**	**100.00**

Table 7. 1998-1999 Emissions of Mercury Comparison by Top SIC Category.

SIC	Category Name	1998 Emissions (pounds)	1999 Emissions (pounds)	Percent Change
4911	Electric services	21158.63	25796.48	22%
4953	Refuse systems	9453.6	4975.25	-47%
2812	Alkalies and chlorine	1083.75	2742.63	153%
8062	General medical & surgical hospitals	12765.54	2571.78	-80%
4931	Electric and other services combined	404.17	879.45	118%
1011	Iron ores	2179.86	859.93	-61%
2046	Wet corn milling	52.97	835.41	1477%
3241	Cement, hydraulic	3547.2	735.86	-79%
4952	Sewerage systems	201.15	711.54	254%
---	Lamp Breakage	0.00	657.64	---
---	Fluorescent Lamp Recycling	0.00	0.05	---
---	Residential Oil Combustion	9006.58	248.69	-97%
3321	Gray and ductile iron foundries	469.33	643.31	37%
TOTAL		**60322.79**	**41658.02**	

Figure 1. Emissions of PAHs from point and area sources (1996-1999).

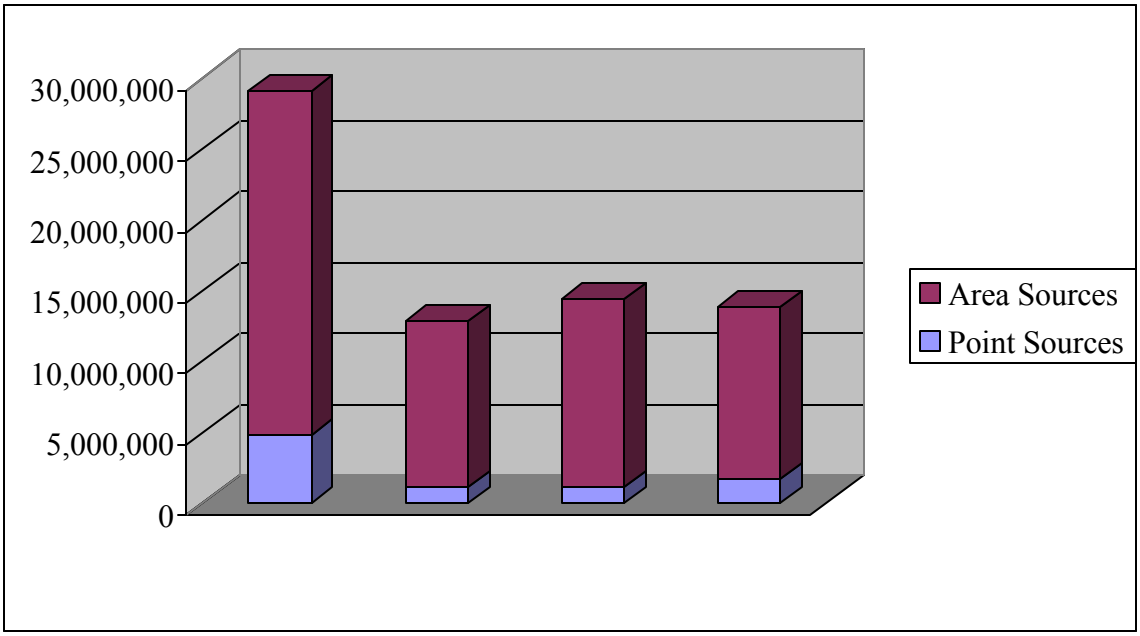

Figure 2. Emissions of non-metal compounds (excluding PAHs) from point and area sources (1996-1999).

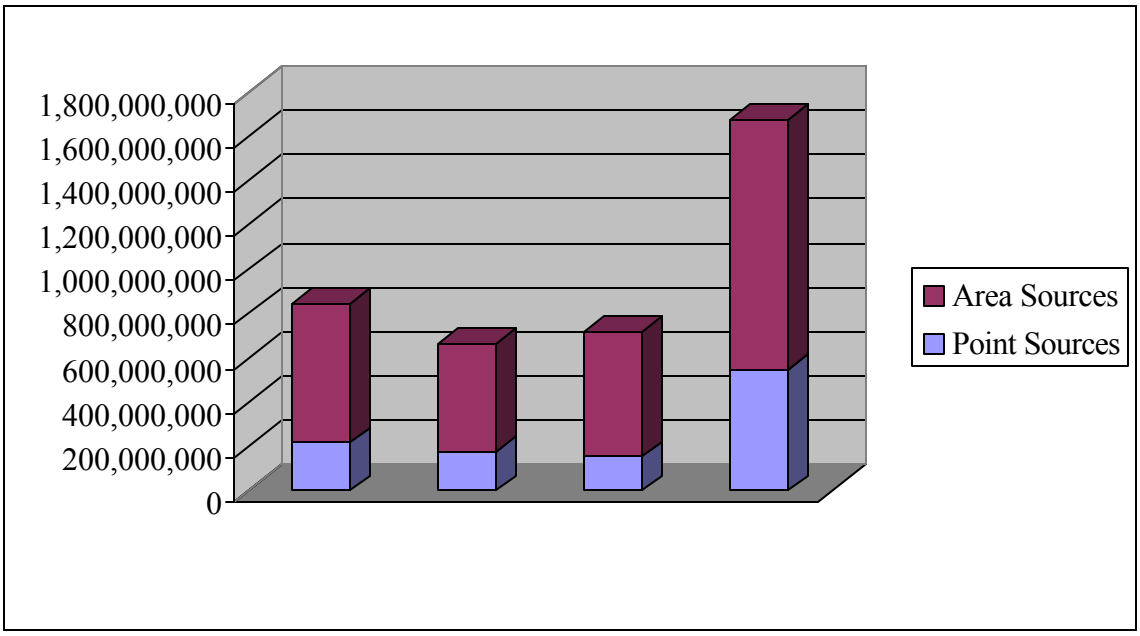

Figure 3. Emissions of metal compounds from point and area sources (1996-1999).