Analysis of Emission Sources for Air Toxic Pollutants

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ABSTRACT

Air toxics emission inventories play an important role in various air quality issues. However, the emission information was limited to point and area sources for the State of Minnesota in previous years. The majority of emissions were estimated based on generic emission factors and speciation profiles, therefore, the inventory had a low level of reliability.

Recently, Minnesota Pollution Control Agency (MPCA) staff has compiled a comprehensive air toxics emission inventory for calendar year 1996, which includes not only point and area sources but also mobile sources. The work for point sources has focused on gathering source-specific emission information for large emitters.

This paper presents a brief description of the methodology used in the inventory development. It also analyzes the emission sources for 109 air toxic pollutants in Minnesota. The emission contributions to the state total are quantified by source categories. However, due to some technical problems, estimating emissions of mobile sources is still in progress. The results will be presented at a later time.

INTRODUCTION

The Minnesota air toxics emission inventory is a part of the Great Lakes Regional Emission Inventory project which was initiated in 1986 foster cooperation among the Great Lakes states in quantifying the loadings of toxic substances originating from all sources. The inventory is also mandated by Minnesota Statutes Chapter 115D.15 for a biannual Legislative Report updating a prioritized and categorized list of facilities that emit toxic air contaminants.

In previous years, the emission information was limited to point and area sources for the State of Minnesota. The majority of emissions were estimated based on generic emission factors and speciation profiles, therefore, the inventory had a low level of reliability.

A reliable air toxics emission inventory becomes more important for the Minnesota Pollution Control Agency (MPCA), especially, since last year Woodruff, et al, suggested that concentrations of certain air toxics were above levels of concern in many areas across the United States in 1990, including Minnesota.[1] To determine the current status of air toxics problems in Minnesota, MPCA staff is working on collecting and analyzing air toxics data. Much effort has been made to compile a more accurate air toxics emission inventory for calendar year 1996.

The 1996 Minnesota air toxics emission inventory includes 109 chemicals: 16 polycyclic aromatic hydrocarbons (PAHs), 80 non-metal compounds (excluding PAHs), and 13 metal compounds. These pollutants are selected based on criteria from two projects: the 1996 Great Lakes Regional Air Toxics Emission Inventory and the MPCA Urban Air Toxics Study. The 1996 Great Lakes Regional Inventory includes 82 pollutants which are the compounds identified as significant contributors to the contamination of the Great Lakes and the compounds requested by the U. S. EPA for the National Toxics Inventory. The MPCA Urban Air Toxics Study was funded by the EPA in February 1997. It is notable that 20 out of the 109 pollutants are not in the 1990 Clean Air Act Amendment 112(b) list (Hazardous Air Pollutant list).

METHODOLOGY

The 1996 Minnesota air toxics emission inventory includes three principal source categories: point, area, and mobile sources. The following sections give separate discussions on emission data acquisition for point and area source categories.

POINT SOURCES

Minnesota does not have air toxic emission inventory reporting requirements for industrial point sources. However, emission data for point sources are collected for the Minnesota criteria pollutant emission inventory. Therefore, for the purpose of the Minnesota air toxics emission inventory, point sources are identified as facilities that are required to submit their annual inventories of criteria pollutants (carbon monoxide, nitrogen oxides, particulate matter [PM], particulate matter smaller than 10 microns, lead, sulfur dioxide, and volatile organic compounds) to the MPCA. According to this definition, there were a total of 2586 point sources in Minnesota in calendar year 1996. The available emission estimation methods and their prioritization for use in the emission inventory are described below.

1. Direct reporting values

   Although Minnesota does not have a rule mandating that point sources report air toxics emissions, the MPCA sent a letter in October 1997 to facilities requesting them voluntarily provide emission information. The facilities contacted were the top emitters based on the sum of PM and VOC emissions. Some facilities responded, including refineries and other manufacturing facilities. The reported information was examined and appropriate emissions were used.

   Also, lead emissions were available in the emission inventory for criteria pollutants and reviewed by facilities. These values were adapted to the air toxics emission inventory in order to maintain the consistency in these two MPCA inventories.

2. Emission factors

   An emission factor is defined as “a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant.”[2] Emission factors can be either source-specific or generic. In the 1996 MN inventory, the emission factors from the EPA Factor Information Retrieval (FIRE) Data System, version 6.0, are used as generic emission factors.[3] In most cases, these emission factors are derived from actual measurements of the emissions from representative sources/processes, and are assumed to be the long-term averages for all facilities in the source category. The source-specific emission factors are derived from source-specific emission testing, mass balance, or chemical analysis, therefore, they are preferred for estimating emissions from a source. Some source-specific emission factors were developed based on the information in facility permit applications. Air toxics emissions are calculated by multiplying an emission factor by activity data. The activity data are always source-specific regardless of the type of emission factors because they are reported by each facility in the Minnesota criteria pollutant emission inventory.

MPCA staff focused on developing source-specific emission factors in the emission inventory compilation. Some source-specific emission factors were developed based on the information in facility permit applications and stack testing reports. Metal Mining/Iron Ores Process and Electric Services/Coal Burning Facilities were selected for this special effort. These two industrial sectors are not covered by the Toxic Release Inventory (TRI) report but contributed almost 50% of PM emissions from point sources in 1996. A detailed discussion on the development of emission factors and the emission inventory for these two industrial sectors was presented in two papers.[4,5] The estimated emissions were reviewed by the industries and permit engineers for the data validation.

In addition, the MPCA also developed source-specific emission factors for municipal solid waste incinerators, chromium electroplating facilities, some paper mills, and some facilities manufacturing wood products. However, only selected facilities reviewed their emission estimates.

3. TRI data

The TRI report is prepared by the Minnesota Department of Public Safety for manufacturing point sources with certain reporting thresholds. The emission data are facility-based and of unknown accuracy. For many facilities reporting to the TRI, the emission estimates appear to be incomplete in terms of the number of pollutants included. However, when the source-specific or generic emission factors were not available, TRI emissions were used for some facilities.

AREA SOURCES

Area sources are stationary sources that are not required to submit criteria pollutant data to the MPCA. The categories of area sources have been determined by the Great Lakes States after reviewing the Emission Inventory Improvement Program (EIIP) documents and other available information.[6] The emission data for area sources were obtained from surveys, literature, and the submittals for the National Emission Standards for Hazardous Air Pollutants. There are 16 source categories included in Minnesota emission inventory: Agricultural Pesticide Applications, Architectural Surface Coatings, Auto Body Refinishing, Chromium Electroplating, Consumer and Commercial Products, Commercial Dry Cleaning, Gasoline Marketing, Graphic Arts, Industrial Surface Coating, Marine Vessel Loading, Municipal Solid Waste Landfills, Public-Owned Treatment Works, Residential Fuel Combustion, Residential Wood Burning, Solvent Cleaners, and Traffic Marking.

For area sources, the activity data were pre-treated to a county-level. Then, toxics emission estimates were calculated by using the emission factor method and speciation method. In the speciation method, emissions of particulate matter (PM) or total organic gases (TOG) were speciated to individual air toxic compounds using speciation profiles. Since EPA FIRE version 6.01 and SPECIATE version 1.5 only contain scarce emission factors and speciation profiles for area sources, source-specific emission factors and speciation profiles were developed for the area sources.[3, 6] These emission factors and speciation profiles were compiled from a review of available literature. EPA publications or studies, such as Emission Inventory Improvement Program (EIIP) documents, were given first preference.[7] Information from the California Air Resource Board and other resources were also incorporated. If information was not available for a source category, emission factors for similar processes or sources were used as surrogates. For example, emission factors for commercial/institution combustion were used to estimate emissions from residential fuel combustion.

There are different levels of source activity data available for different categories of area sources. Source activities are any parameters associated with the source that are surrogates for emissions, such as fuel throughput, solvent usage, or population. Some source categories, including Dry Cleaning, Chromium Electroplating, and Halogenated Solvent Cleaners, need to comply with NESHAPs, and the source-level or process-level activity data are available from the initial notification forms. In this case, emission data were aggregated for all similar or identical device/processes within each county. For example, county total perchloroethylene consumption values were calculated for all dry-to-dry machines with control, all dry-to-dry machines without control, all transfer machines with control, and all transfer machines without control, using perchloroethylene consumption data from each individual dry cleaner within the county.

However, for some area sources direct activity data are not available at the county level. In these cases, statewide activity data were apportioned to each county based on appropriate activity indicators. For example, fuel consumption data for Residential Fuel Combustion were calculated from the state fuel consumption by using population data. If state-level activity data were not available, appropriate surrogate activity data were used. For example, county-based population data were used as the most appropriate or applicable activity data for commercial and consumer solvent products and architectural surface coating.

MOBILE SOURCES

The mobile source category includes those sources that do not exist as stationary emission points. Mobile sources are divided into four categories in the Minnesota air toxics inventory: on-road vehicles, non-road mobile sources, locomotives, and aircraft. Each category contains sub-categories with similar data collection and emission estimation methods. Emission data for mobile sources were obtained from state and federal government reports, personal communication with affected parties, and emission inventory literature.

For on-road vehicles, emission factors based on vehicle miles traveled (VMT) were calculated using the EPA Mobile5b and Part5 models.[8,9] For the Mobile5b model, the state of Minnesota was divided into four 'temperature zones' to account for differences in climate. We have identified the four regions as northeast, northwest, central, and metro. Temperatures in the metro region were similar to the central region, but in the Twin Cities metro area, vehicles were subject to an inspection and maintenance program, while out-state vehicles were not. Temperature did not play a significant role in particulate emissions, so the Part5 model used two scenarios: metro and out-state.

Emission factors from the EPA models were combined with Minnesota VMT data to calculate emission estimates of TOG and PM10, but not for air toxics. TOG and PM10 emissions along with VMT data were broken down by county, season, and road type (functional class). Air toxics emissions were then estimated with appropriate emission factors and speciation profiles extracted from the 1996 National Toxics Inventory. [8] Speciation factors from EPA SPECIATE version 1.5 were also used when information was not available in the 1996 National Toxics Inventory.

Minnesota used default activity data and TOG and PM emission factors for non-road mobile sources in the EPA NONROAD model.[10] Due to a lack of emission factors for non-road mobile sources, the speciation method was used to estimate air toxics emissions. Speciation profiles were obtained from the 1996 National Toxics Inventory supplemented with EPA SPECIATE version 1.5 .[11,6]

Locomotive emission estimates were broken up into two parts: line haul and yard haul. Line haul emissions occur when locomotives are in operation hauling cargo between destinations. 'Yard operations' refers to locomotives in use to transfer trains between tracks in the train yard. Emissions from locomotives were estimated by collecting activity data from individual railroads with operations within Minnesota. The activity data were combined with EPA emission factors to estimate emissions of VOC and PM.[12] Air toxics emissions were estimated by using the same methods as for the non-road mobile sources.

Four types of air traffic are included in the aircraft category for mobile sources: general aviation, air taxis, commercial, and military aircraft. Activity data were collected for each airport. While general aviation and air taxi estimates used a default fleet breakdown, the actual commercial fleet description was available which improved emission estimates for this sub-source category. TOG and PM emissions were estimated with emission factors from the Federal Aviation Administration Aircraft Engine Emission Database.[13] The speciation method was used to estimate county-level air toxics emissions. The speciation profiles were obtained from the same information sources as for non-road mobile sources.

To assess the reasonableness of estimated emission results for point, area, and mobile sources, emissions for each pollutant were examined. The extraordinary emission values were re-calculated. The activity data and emission factors that led to the extraordinary emissions were verified. Minnesota emissions were also compared with emissions from other Great Lakes States to check for consistency.

RESULTS AND DISCUSSIONS

Because estimating emissions of mobile sources is still in process, the results presented here are for point and area sources. It was estimated that 827 out of 2586 point sources emitted one or more inventoried pollutants. Emissions from area sources were calculated for the 16 categories mentioned in the previous section.

OVERALL

The 1996 emissions were estimated for the 109 target compounds, however, data were only available to obtain emissions for 84 air toxics, including 16 PAHs, 56 non-metal compounds and 12 metal compounds. Table 1 shows pollutant names and estimated emissions from point and/or area sources. Among the 84 pollutants, 80 pollutants are emitted from point sources, and 75 pollutants are emitted from area sources. Area sources are responsible for almost all emissions (more than 75% of total emissions) for 15 PAHs, 36 non-metal compounds, and 1 metal compound. Point sources contribute more than 75% of emissions to the total for 14 non-metal compounds and 9 metal compounds. in Minnesota, toluene was estimated to have the highest emissions at 15,402,143 pounds, while 2,3,7,8-tetrachlorodibenzo-p-dioxin emissions are the lowest recorded at about 0.013 pounds. Point and area source emissions are from 193 distinct standard industrial classification (SIC) codes and 238 distinct source classification codes (SCC).

SPECIFIC POLLUTANTS

To understand the problem of air toxics in Minnesota, a close look was taken at 10 pollutants that exceed inhalation health benchmarks either based on environmental monitoring data, modeling data, or both. The selected pollutants are acrolein, benzene, 1,3-butadiene, carbon tetrachloride, chloroform, ethylene dibromide, formaldehyde, arsenic, chromium, and nickel.

First, a geographic distribution of emissions was analyzed for the Minneapolis/St. Paul metropolitan area and for the entire state. The Minneapolis/St. Paul metropolitan areas include 7 counties out of 87 counties in the state. Table 2 presents point and area source emissions in the metropolitan areas and compares these emissions with state-wide emissions. For 1,3-butadiene, carbon tetrachloride, ethylene dibromide, and nickel, emissions from the metropolitan areas account for more than 50% of state total emissions. Emissions of chromium, benzene, and chloroform also have significant portions from the metro area, in a range of 23% to 46%. However, acrolein, arsenic, and formaldehyde are emitted mainly (more than 90%) from outside the metro area. In the metro area, the contributions from point and area sources are similar as those observed in the entire state for 8 out of 10 pollutants, but changed significantly for chloroform and formaldehyde. Area source contributions increased from insignificant to about 100% for chloroform and 54% for formaldehyde. This is because the predominant point sources are located outside the metro area.

Please note that the above analysis is based on point and area source emissions only. Mobile sources have been identified as significant sources for acrolein and as primary sources for benzene, 1,3-butadiene, and formaldehyde. Therefore, the weight of emissions from the metro area is expected to increase for these pollutants when mobile source emissions become available for the analysis.

Second, the source contribution of emissions was analyzed by category for area sources and the first two digits of the SIC codes for point sources. The source categories and their contributions are shown in Table 3. Emissions of three pollutants are linked to specific source categories; acrolein to manufacturing lumber and wood products, 1,3-butadiene to gasoline marketing, and ethylene dibromide to industrial surface coating, are dominated by one single source category. These sources contribute more than 96% of emissions of the three pollutants. Figure 1 shows source contributions for 7 other pollutants. More than two thirds of emissions for 4 pollutants are associated with specific source categories; arsenic with metal mining, benzene with residential wood burning, carbon tetrachloride with public owned treatment works, and chloroform with manufacturing paper and allied products. Source contributions of chromium, formaldehyde, and nickel emissions are more scattered. Details are shown in Figure 1.

DATA LIMITATIONS

Although QA/QC plans were established to ensure the best results, there are acknowledged uncertainties with the methodology used to compile the Minnesota air toxics emission inventory. Source specific information was only collected for certain pollutants in selected facilities. Generic emission factors and control efficiencies were used for many facilities. These generic values may lead to good estimates of national total emissions, but may not represent the real situation for individual facilities in Minnesota. Even source-specific emission factors may yield inaccurate results. This is because some source-specific emission factors were developed with data from stack testing for permit purposes, which may be based on testing under a worst case operating scenario. In addition, generic emission factors are not adequate for a variety of processes and pollutants. The area source categories covered in this emission inventory are not comprehensive. Many other area sources need to be explored in the future.

CONCLUSION

The 1996 Minnesota air toxics emission inventory includes 109 pollutants and three principal source categories: point, area, and mobile sources. The results available at this time are for point and area sources, mobile source emissions will be added soon. Emissions were obtained for 84 pollutants with the highest emissions for toluene and lowest emissions for 2,3,7,8-tetrachlorodibenzo-p-dioxin. Area sources are responsible for more than 75% of total emissions for 52 pollutants. Point sources contribute more than 75% of the emissions to the total for 23 pollutants.

For the 10 pollutants that exceed inhalation health benchmarks in Minnesota, emissions from the Minneapolis/St. Paul metropolitan areas account for more than 50% of the total for 4 pollutants, but less than 10% of the total for 3 other pollutants. Point and area source contributions to 8 out of 10 pollutants in the metro area are similar as the entire state, but area sources account more contributions for chloroform and formaldehyde. One corresponding primary source category dominate emissions for each of 7 pollutants, while the source contribution to emissions for the other 3 pollutants is more scattered.

Further work is needed to improve the reliability of the Minnesota air toxics emissions inventory to support regulatory activities in the MPCA, the Great Lakes region, and the EPA, but the 1996 inventory represents important milestones towards development of a comprehensive and reliable emission inventory in Minnesota.

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Table 1. Summary of Minnesota 1996 air toxics emissions from point and area sources.

Pollutant Name	Cas No.	Point (lb)	Area (lb)	Total (lb)	Point (%)	Area (%)
PAHs						
Acenaphthene	83329	5.23	14397.90	14403.13	0.04	99.96
Acenaphthylene	208968	58.86	305235.51	305294.37	0.02	99.98
Anthracene	120127	76.99	20157.06	20234.05	0.38	99.62
Benz(a)anthracene	56553	153.19	28815.60	28968.80	0.53	99.47
Benzo(a)pyrene	50328	4109.37	5759.16	9868.53	41.64	58.36
Benzo(b)fluoranthene	205992	10.77	8638.74	8649.51	0.12	99.88
Benzo(ghi))perylene	191242	0.41	5759.16	5759.57	0.01	99.99
Benzo(k)fluoranthene	207089	0.09	2879.58	2879.67	0.00	100.00
Chrysene	218019	19.10	17277.52	17296.63	0.11	99.89
Dibenz(a,h)anthracene	53703	0.35	5759.16	5759.51	0.01	99.99
Fluoranthene	206440	76.18	28797.26	28873.44	0.26	99.74
Fluorene	86737	18.48	34554.96	34573.44	0.05	99.95
Indeno(1,2,3-cd)pyrene	193395	0.26	28795.80	28796.06	0.00	100.00
Naphthalene	91203	28935.72	1012826.80	1041762.53	2.78	97.22
Phenanthrene	85018	23.31	112303.63	112326.94	0.02	99.98
Pyrene	129000	4.41	34554.96	34559.38	0.01	99.99
Non-Metal Compounds (Excluding PAHs)						
Acetaldehyde	75070	62048.35	0.00	62048.35	100.00	0.00
Acetone	67641	49129.12	1668444.10	1717573.23	2.86	97.14
Acrolein	107028	98267.57	0.00	98267.57	100.00	0.00
Acrylonitrile	107131	86.15	8282.94	8369.09	1.03	98.97
Atrazine	1912249	0.00	679138.67	679138.67	0.00	100.00
Benzaldehyde	100527	15.21	6856.51	6871.72	0.22	99.78
Benzene	71432	132710.45	3718053.56	3850764.01	3.45	96.55
1,3-Butadiene	106990	3081.94	3552011.65	3555093.59	0.09	99.91
Carbon tetrachloride	56235	805.84	9498.20	10304.04	7.82	92.18
Chlorobenzene	108907	142.12	336838.93	336981.05	0.04	99.96
Chloroform	67663	42742.42	20861.59	63604.01	67.20	32.80
1,2-Dichlorobenzene(o)	95501	0.27	42557.23	42557.50	0.00	100.00
1,3-Dichlorobenzene(m)	541731	0.00	2722.92	2722.92	0.00	100.00
1,4-Dichlorobenzene(para)	106467	3.90	389136.36	389140.26	0.00	100.00
Diethylhexyl phthalate (DEHP)	117817	2688.89	0.00	2688.89	100.00	0.00
Di-n-butyl phthalate	84742	148.55	889.72	1038.27	14.31	85.69
Ethylbenzene	100414	211158.08	659771.56	870929.65	24.25	75.75
Ethylene dibromide (Dibromoethane)	106934	0.15	7126.79	7126.94	0.00	100.00
Ethylene dichloride (1,2-Dichloroethane)	107062	30.72	9512.92	9543.65	0.32	99.68
Ethylene oxide	75218	68.50	831781.59	831850.09	0.01	99.99
Ethylidene dichloride (1,1-Dichloroethane)	75343	0.00	2017.04	2017.04	0.00	100.00
Formaldehyde	50000	1287258.19	113565.31	1400823.51	91.89	8.11
Glycol ethers		847479.45	212506.31	1059985.76	79.95	20.05
Hexachlorobenzene	118741	1.05	0.18	1.23	85.23	14.77
Methyl bromide (Bromomethane)	74839	39448.78	1039570.06	1079018.84	3.66	96.34
Methyl chloroform (1,1,1-Trichloroethane)	71556	117081.53	1834672.74	1951754.27	6.00	94.00
Methyl chloride	74873	83767.68	36117.98	119885.65	69.87	30.13
Methylene chloride (Dichloromethane)	75092	382693.37	630618.09	1013311.46	37.77	62.23
Methylene diphenyl diisocyanate (MDI)	101688	1529.55	0.00	1529.55	100.00	0.00
Phenol	108952	228908.67	1439.79	230348.46	99.37	0.63
Propionaldehyde	123386	4487.91	0.00	4487.91	100.00	0.00

Table 1. Summary of Minnesota 1996 air toxics emissions from point and area sources (continued).

Pollutant Name	Cas No.	Point (lb)	Area (lb)	Total (lb)	Point (%)	Area (%)
Propylene dichloride (1,2-Dichloropropane)	78875	0.24	396.63	396.87	0.06	99.94
Styrene	100425	1147511.72	2499.57	1150011.29	99.78	0.22
2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)	1746016	0.0025	0.0107	0.01	18.95	81.05
2,3,7,8-tetrachlorodibenzo-furan (TCDF)	51207319	1.28	0.64	1.92	66.86	33.14
1,1,2,2-Tetrachloroethane	79345	100.02	2221.78	2321.80	4.31	95.69
Tetrachloroethylene (Perchloroethylene)	127184	160841.47	691412.19	852253.66	18.87	81.13
Toluene	108883	2894741.36	12507401.36	15402142.73	18.79	81.21
2,4-Toluene diisocyanate	584849	4.30	0.00	4.30	100.00	0.00
Total polychlorinated biphenyls (PCBs)	1336363	5.35	0.09	5.43	98.40	1.60
Total polychlorinated dibenzodioxins (PCDDs)		0.33	4.15	4.48	7.36	92.64
Total polychlorinated dibenzofurans (PCDFs)		4.44	22.91	27.34	16.22	83.78
1,1,2-Trichloroethane	79005	177.23	275.50	452.73	39.15	60.85
Trichloroethylene	79016	391834.55	189526.88	581361.43	67.40	32.60
Trichlorofluoromethane (CFC-11)	75694	5.00	450948.63	450953.63	0.00	100.00
Trifluralin	1582098	0.00	42489.88	42489.88	0.00	100.00
1,2,4-Trimethylbenzene	95636	108398.44	0.00	108398.44	100.00	0.00
1,3,5-Trimethylbenzene	108678	3386.22	0.00	3386.22	100.00	0.00
Trimethylbenzene	2551137	15665.00	244704.05	260369.05	6.02	93.98
Vinylidene chloride (1,1-Dichloroethylene)	75354	0.53	5253.55	5254.08	0.01	99.99
Vinyl chloride	75014	272.57	29819.90	30092.47	0.91	99.09
m/p-Xylenes		113.06	47925.17	48038.23	0.24	99.76
m-Xylenes	108383	353.87	191266.05	191619.92	0.18	99.82
o-Xylenes	95476	173826.99	569181.60	743008.59	23.40	76.60
p-Xylenes	106423	0.08	109303.06	109303.14	0.00	100.00
Xylenes (Isomers and mixture)	1330207	1889483.70	6600880.52	8490364.22	22.25	77.75
Metal Compounds						
Antimony	7440360	1414.93	0.00	1414.93	100.00	0.00
Arsenic	7440382	10991.74	171.73	11163.47	98.46	1.54
Beryllium	7440417	205.63	47.30	252.92	81.30	18.70
Cadmium	7440439	2131.14	244.83	2375.97	89.70	10.30
Chromium	7440473	19395.44	12544.67	31940.11	60.72	39.28
Chromium (6)	18540299	1042.40	1977.38	3019.78	34.52	65.48
Cobalt	7440484	3372.88	33191.00	36563.88	9.22	90.78
Copper	7440508	18121.96	1329.30	19451.26	93.17	6.83
Lead	7439921	150118.14	1368.60	151486.74	99.10	0.90
Manganese	7439965	84854.86	1984.61	86839.46	97.71	2.29
Mercury	7439976	2715.10	238.38	2953.48	91.93	8.07
Nickel	7440020	33398.65	9660.53	43059.18	77.56	22.44

Table 2. 1996 air toxics emissions from point and area sources in Minneapolis/St. Paul metropolitan. areas.

Pollutant	Metropolitan Area					State	Metro/State
	Point (lb)	Area (lb)	Total (lb)	Point (%)	Area (%)	Total (lb)	(%)
Acrolein	21.55		21.55	100.00	0.00	98,267.57	0.02
Arsenic	579.98	95.73	675.71	85.83	14.17	11,163.47	6.05
Benzene	77,233.10	1,242,799.77	1,320,032.86	5.85	94.15	3,850,764.01	34.28
1,3-Butadiene	3,067.25	1,789,437.98	1,792,505.23	0.17	99.83	3,555,093.59	50.42
Carbon tetrachloride	6.91	7,912.18	7,919.09	0.09	99.91	10,304.04	76.85
Chloroform	13.03	14,345.91	14,358.93	0.09	99.91	63,604.01	22.58
Chromium	7,108.69	7,689.20	14,797.89	48.04	51.96	31,940.11	46.33
Ethylene dibromide	0.15	3,963.07	3,963.22	0.00	100.00	7,126.94	55.61
Formaldehyde	54,787.21	65,130.86	119,918.07	45.69	54.31	1,400,823.51	8.56
Nickel	19,882.64	5,379.47	25,262.10	78.71	21.29	43,059.18	58.67

Table 3. 1996 air toxics emissions of selected pollutants by source category (data are from point and area sources).

Pollutant	Source Description	Emissions (lb)	% of Total
Acrolein	Lumber and Wood Products	97,689.78	99.41
1,3-Butadiene	Gasoline Marketing	3,552,011.65	99.91
Ethylene dibromide	Industrial Surface Coating	6,856.51	96.21

Figure 1. 1996 air toxics emissions of selected pollutants by source category (data are from point and area sources).