A Comprehensive Model for Multi-Pathway Risks from Air Pollution: Emission Inventory Preparation

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ABSTRACT

The Minnesota Pollution Control Agency (MPCA) together with Lakes Environmental, Inc. developed a tool (MNRiskS for Minnesota Risk Screening) to evaluate the potential health risks from all inventoried sources of air pollution in the state. The tool is used not only as a means for adding context to the facility-specific risk assessment process, but is also broadly useful in air quality programs for identifying pollutants, exposure pathways, geographic areas, sources, and receptors of potential concern. In the preliminary study, issues were identified regarding the emission inventory data, including stack parameters for point sources, methods for allocating county-based non-point source emissions to census tracts, and the possible occurrence of double counting for grouped pollutants. To resolve these issues, the 2005 emission inventory data were extensively reviewed, enhanced and corrected as necessary. Point sources with problematic data were identified and contacted for corrections. For nonpoint sources, new activity data were collected, and methods for allocating emissions were developed. Pollutant groups were assigned to specific species where data were available, and in other cases duplicative data were removed. The accuracy and completeness of the updated version of the 2005 emission inventory was improved greatly. The data will be incorporated into an updated version of MNRiskS.

This paper discusses the data issues addressed during the process of preparing the 2005 emission inventory for MNRiskS. Detailed methods for allocating nonpoint source emissions and treating grouped pollutants are provided. This paper also summarizes the improvements in the emissions inventory and the expected effects on risk assessment results.

INTRODUCTION

Air toxics are known or suspected to cause cancer or other serious health effects, or adverse environmental effects. In order to better understand risks from air toxic emissions, the U.S. Environment Protection Agency (EPA) developed a tool, the National-Scale Air Toxics Assessment (NATA). However, NATA assessments use general information about sources and consider only inhalation exposure.[1] The NATA results are estimated at census tract (2002) or census block (2005) centroids and cannot be used to identify exposures and risks to individuals who may have higher exposures due to their proximity to emissions sources.

To evaluate air toxics in a systematic and objective way, the Minnesota Pollution Control Agency (MPCA) together with Lakes Environmental, Inc. developed a tool, called MNRiskS (for Minnesota Risk Screening).[2] MNRiskS estimates risks via inhalation and ingestion exposure pathways. The spatial resolution of MNRiskS is at the neighborhood level, i.e., on the order of hundreds of meters to a few kilometers, but results can also be viewed statewide on a scale of approximately 400 km by 600 km. To reach the designed spatial resolution, statewide emission data developed for reporting to EPA national emission inventory (NEI) must be refined.

The most common concern is the representativeness of emission values. Besides inaccurate emission estimates, there is a possibly double counting for grouped pollutants, such as metal compounds, PAHs, and dioxins. According to the MNRiskS preliminary study and reviews of NATA assessments, additional issues regarding the emission data include geographic coordinates and stack parameters for point sources and methods for allocating county-based non-point source emissions to census tracts. Details on resolving these issues are discussed in the following sections.

OVERVIEW OF THE 2005 STATEWIDE EMISSION INVENTORY

The most current statewide emission inventory is available for emission year 2005. The 2005 emission inventory covers emissions of 286 individual air toxics (including diesel PM) from three principal source categories: point, nonpoint, and mobile sources. Emissions from biogenic sources are not considered.

Point source emissions were from 1286 facilities that are typically large and have emission permits. MPCA staff compiled the emissions estimates for point sources based on voluntary reports from 599 facilities, data in toxics release reports (TRI) from 51 facilities, and emission factor calculations. Generic emission factors from EPA Factor Information REtrieval (FIRE) Data System, version 6.25, as well as augmented emission factors for combustion processes, were used in the 2005 emission inventory.[3] The reported data and TRI emissions provided the coverage for majority of processes that with site-specific emission information or lack of generic emission factors, such as power plants, refineries, ethanol production plants, taconite ore process facilities, printing processes, surface coating operations, solvent cleaning processes, and solid waste incinerations.

Nonpoint source emissions were estimated from 37 categories and 86 sub-categories that are generally smaller sources of emissions than point sources (Table 1).

Table 1. 2005 Nonpoint source categories and surrogates for apportioning county-level emissions to census tract.

Category Name	Data Source	EI Level	Surrogates for Tract Apportioning	Surrogate Source
Agricultural Pesticide Use	MPCA	County	Rural	MPCA GIS land cover database
Animal Cremation	MPCA	County	Industrial Land Use	MPCA GIS land use data for metro counties (vector data converted to raster and apportioned to tracts) population data for outstate
Asphalt Paving	MPCA	County	Lane Miles	MNDOT GIS roadway data
Autobody Refinishing	MPCA	County	Commercial Land Use	MPCA GIS land use data for metro counties (vector data converted to raster and apportioned to tracts) population data for outstate

Category Name	Data Source	EI Level	Surrogates for Tract Apportioning	Surrogate Source
Commercial and Consumer Products Usage	MPCA	County	Population	US Census 2000 data updated to 2005
Commercial Cooking	EPA	County	Commercial Land Use	MPCA GIS land use data for metro counties (vector data converted to raster and apportioned to tracts) population data for outstate
Degreasing	MPCA	County	Population	US Census 2000 data updated to 2005
Dental Preparations	MPCA	County	Commercial Land Use	MPCA GIS land use data for metro counties (vector data converted to raster and apportioned to tracts) population data for outstate
Dry Cleaners	MPCA	Individual		
Fluorescent Lamp Recycling	MPCA	Individual		
Fluorescent Lamp Breakage	MPCA	Individual	Population	US Census 2000 data updated to 2005
Forest Wildfires	EPA	County	Wildfires	DNR wildfire database
Gasoline Service Stations	MPCA	County	Gas Station Locations	US Census economic survey database (zipcode data apportioned to census tracts)
Gasoline Trucks in Transit	MPCA	County	All Fuel Use	US Census economic survey database (zipcode data apportioned to census tracts)
General Laboratory Activities	MPCA	County	Population	US Census 2000 data updated to 2005
Grain Elevators	MPCA	County	Commercial Land Use	MPCA GIS land use data for metro counties (vector data converted to raster and apportioned to tracts) population data for outstate
Graphic Arts	MPCA	County	Commercial Land Use	MPCA GIS land use data for metro counties (vector data converted to raster and apportioned to tracts) population data for outstate
Hospital Sterilization	MPCA	County	Hospital Beds	MDH hospital bed database (street addresses of hospitals geocoded)
Human Cremation	MPCA	Individual		
Industrial Surface Coating	MPCA	County	Industrial Land Use	MPCA GIS land use data for metro counties (vector data converted to raster and apportioned to tracts) population data for outstate

Category Name	Data Source	EI Level	Surrogates for Tract Apportioning	Surrogate Source
Mercury Volatilization	MPCA	County	Population	US Census 2000 data updated to 2005
Mineral Processes	MPCA	County	Extractive Industries	MPCA GIS land use data for metro counties (vector data converted to raster and apportioned to tracts) facilities data for outstate
Municipal Solid Waste Landfills	MPCA	Individual		
On-site Incineration	EPA	County	Rural	MPCA GIS land cover database
Prescribed Burning for Forest Management	EPA	County	Prescribed Burns	DNR prescribed burn database
Prescribed Burning of Rangeland	EPA	County	Prescribed Burns	DNR prescribed burn database
Public Owned Treatment Works (POTWs)	MPCA	Individual		
Residential Fossil Fuel Combustion	MPCA	County	Population	US Census 2000 data updated to 2005
Residential Wood Burning	MPCA	County	Population	US Census 2000 data updated to 2005
Stationary Source Fuel Combustion - Commercial/Institutional	MPCA	County	Commercial Land Use	MPCA GIS land use data for metro counties (vector data converted to raster and apportioned to tracts) population data for outstate
Stationary Source Fuel Combustion - Industrial	MPCA	County	Industrial Land Use	MPCA GIS land use data for metro counties (vector data converted to raster and apportioned to tracts) population data for outstate
Structure Fires	MPCA	County	Population	US Census 2000 data updated to 2005
Surface Coating - Architectural	MPCA	County	Population	US Census 2000 data updated to 2005
Swimming Pools	EPA	County	Population	US Census 2000 data updated to 2005
DRUM AND BARREL RECLAMATION	MPCA	Individual		
Traffic Markings	MPCA	County	Lane Miles	MNDOT GIS roadway data
Waste Disposal - Open Burning, Household Waste	MPCA	County	Rural	MPCA GIS land cover database

The categories of nonpoint sources selected for inventorying were based on their importance to the state after reviewing the EPA's documentation for the final 2002 NEI, Emission Inventory Improvement Program (EIIP) documents, and other available information.[4,5] The activity data were obtained from surveys, literature, and the submittals for the National Emission Standards

for Hazardous Air Pollutants (NESHAP). MPCA staff compiled the emissions estimates for the majority of nonpoint sources in the 2005 inventory. However, emissions for certain categories of nonpoint sources were obtained from EPA. Details on activity data information sources and emission estimation methods for each sub-category are shown online at MPCA's website.[6]

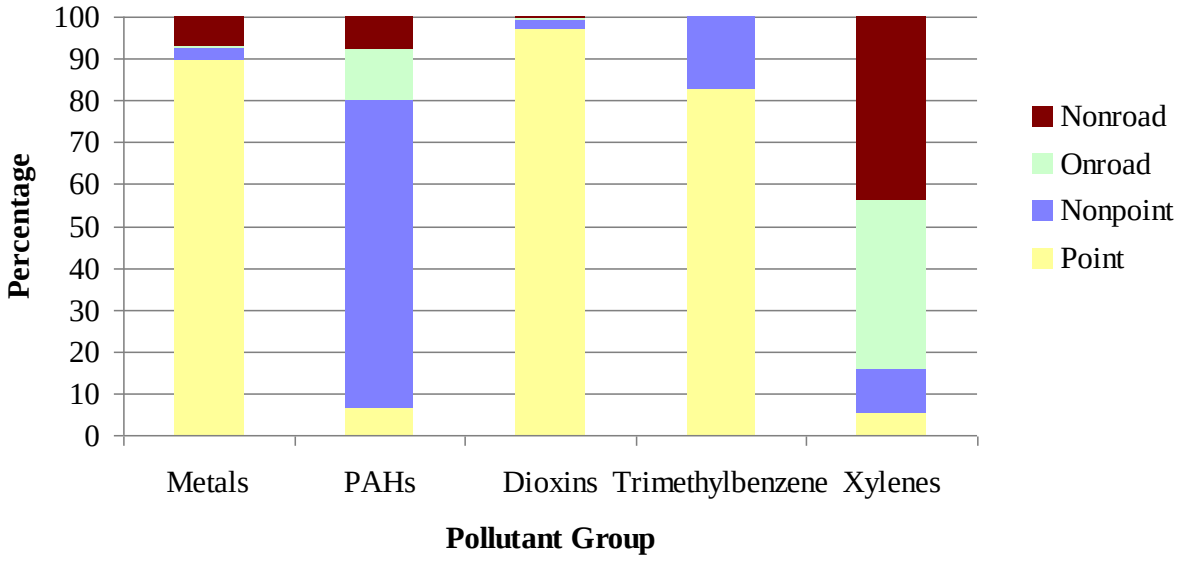
Mobile source emissions were from five subcategories: on-road sources, non-road equipment, aircraft, commercial marine vessels, and locomotives. The emissions estimations in the 2005 NEI for on-road mobile sources and non-road equipment other than airport ground support equipment were used in the MN statewide emission inventory.[7] MPCA staff collected state-specific data to calculate emissions estimates for aircraft, airport ground support equipment, and locomotives. The 2005 emissions for commercial marine vessels were estimated based on the 2002 emissions with an adjustment of port activities in 2005 vs. 2002. The 2002 commercial marine vessel emissions were prepared by CENtral States Regional Air Partnership (CENRAP) using state-specific data.

EMISSION DATA ISSUES AND RESOLUTIONS

Metal Emissions from Point Sources

The preliminary run of the MNRisks model using 2002 emission data showed potentially high risks associated with sources emitting metal compounds. Figure 1 shows 90% of total emissions of metals were from point sources.

Figure 1. Emissions by principal source categories for selected pollutant groups.



Several possible factors contributed to the overestimation of metal emissions from point sources during the preparation of the 2005 emission data for MNRiskS.

Double Counting

Metals are specific groups of compounds in the 2005 emission inventory. Recommended strategies for reporting emissions for those groups were made using the following hierarchy:

1. Report emissions and associated CAS numbers of all individual metal compounds, such as arsenic trioxide (CAS No. 1327-53-3) and cadmium chloride (CAS No. 10108-64-2).
2. If individual metal compounds cannot be reported, a less preferred method for chromium, lead, mercury, and nickel is to separately report two forms of widely varying toxicity: trivalent and hexavalent chromium, organic and inorganic lead, organic and inorganic mercury, and into nickel subsulfide and other nickel.
3. For all other metal groups, report total emissions of the group in terms of the mass of the metal alone, accounting for the molecular weight of the metal portion of the compound.
4. Alternatively, but far less preferred, report total emissions of the group in terms of mass of total compounds, not just the metal within the compounds.

Also, only one reporting strategy per group per source should be used to avoid the possibility of double counting emissions. However, in reality, some point sources reported metal emissions using more than one strategy. The emission estimation tool, Regional Air Pollution Inventory Development System (RAPIDS), was set to calculate emissions for all possible pollutants.[8] As a result, RAPIDS calculated emissions for the mass of total compounds in a group when a facility reported emissions using reporting strategies 1, 2, or 3., or vice versa.

In addition to possible double counting from reporting, the generic emission factors from FIRE double counted some mass of total compounds in a group and mass of metal within the group. For example, FIRE has emission factors for both total chromium and hexavalent chromium for wood residue combustion, emission factors for both nickel and nickel (II) oxide for carbon steel electric arc furnace.

The 2005 metal emissions were from 5,057 individual processes and 1,139 facilities. To resolve the double counting issue, emissions from each individual processes were first analyzed to determine where double counting occurred. Then, MPCA staff made corrections for known errors and contacted facilities for errors in question. Final corrections were made based on feedback from reporting facilities.

Over Estimates for Surface Coating Operations

Review and analysis of metal emission data for point sources revealed suspiciously high emissions from surface coating operations. Evaluation of the reporting basis uncovered a mistake in the calculation method used by many facilities. The method was prepared to help small businesses determine if they need an air emissions permit and/or to track compliance with their current air emissions permit.[9] Although metals emitted from coating processes are in a particulate form, transfer efficiency (ranging from 30% to 100%) and control efficiency (ranging from 0 to 99.8%) were not considered in calculating metal emissions.

There were metal emissions from 100 individual surface coating processes at 32 facilities. To correct the errors caused by the wrong emission calculation, each facility with single metal/metal compound emissions greater than 20 lbs from surface coating operations were contacted. The

instructions for estimating actual emissions were provided. New reported values were examined and replaced the old values.

Results and Discussion

The above efforts resulted in a reduction of 25,175 lbs in metal emissions from point sources (Table 2).

Table 2. Results of refining the 2005 metal emissions (lbs).

	Emission Mass (lb)			Equivalent Emissions of Metal Element (lb)		
Pollutant Name	**Before Refining**	**After Refining**	**Difference (Before - After)**	**Before Refining**	**After Refining**	**Difference (Before - After)**
Antimony	2,414	2,381	33	2,353	2,311	42
Arsenic	15,858	15,866	-8	15,857	15,866	-8
Beryllium	545	546	-1	545	546	-1
Cadmium	2,389	2,243	146	2,389	2,243	146
Chromium	13,600	15,301	-1,701	13,576	15,162	-1,587
Chromium VI	3,848	2,075	1,773	3,707	1,886	1,821
Cobalt	5,617	5,108	509	5,538	5,024	514
Copper	16,049	16,051	-2	16,049	16,051	-2
Lead	77,184	54,334	22,849	77,125	54,329	22,796
Manganese	92,390	91,270	1,120	86,069	84,582	1,488
Mercury	3,616	3,617	-1	3,616	3,617	-1
Nickel	37,731	37,270	461	37,555	34,516	3,038
Selenium	7,830	7,832	-2	7,830	7,832	-2
Metal Total	279,071	**253,896**	**25,175**	272,209	**243,965**	**28,244**

The largest reduction was obtained for lead. Lead emissions are included in both the emission inventory for criteria pollutants and the emission inventory for air toxics. Annual report to the emission inventory for criteria pollutants is under a mandatory requirement and emissions are the mass of lead alone. Triennial report to air toxics emissions inventory is voluntary, and in many cases, facilities reported emissions under lead compounds. Therefore, double counting problems were observed mostly for lead emissions. Promulgating the National Ambient Air Quality Standard for Lead Final Rule facilitated the review of lead emissions.[10] More attention was paid to derive accurate lead emissions by facilities and MPCA.

Besides the changes in emissions for metal groups, detailed information was also collected to specify emissions of individual metal compound instead of total emissions of the group. It allowed expressing emissions for elemental metal within the compound. Table 2 provides changes in equivalent emissions of metal elements that will be used in MNRisks modeling. The

refining process collected additional emissions for metals that were originally ignored by reporting facilities.

Although the emission inventory was improved greatly, problems still exist due to time restriction and inability to respond by some facilities. Therefore, the following general steps were taken to avoid double-counting for emissions that will be used as MNRiskS input.

1. Where emissions data were only available for the metal compound, those values were used as emissions of metal elements.
2. Chromium was speciated into hexavalent and trivalent forms using EPA's 2005 Emissions Inventory Chromium Speciation Multipliers.[11]
3. Emissions of an individual metal compound were converted to emissions of metal elements with a ratio of the metal element to the molecular weight of the compound.

Recommendation for Future Emission Inventory

To collect metal emissions for use in risk assessment, the recommendations for reporting emissions must be revised. In reporting metals, facilities should be required to report specific metal compounds when that information is available. When specific compound information is not available, reporting should be in terms of the mass of the metal.

The generic emission factors from FIRE need to be analyzed and recompiled to have mutually exclusive emission factors for compounds included in the emission inventory.

Lead emissions from the criteria pollutant emission inventory and the air toxics emission inventory need to be reconciled to avoid double counting.

Emissions for Other Grouped Compounds

Double counting issues were also associated with emissions for other grouped compounds. The pollutant groups include dioxins, polycyclic aromatic hydrocarbons (PAHs), trimethylbenzenes, and xylenes. The general resolution and future work are similar to metal compounds. However, each type of group compounds has unique features. Figure 1 provides emissions by principal source categories for those pollutant groups too.

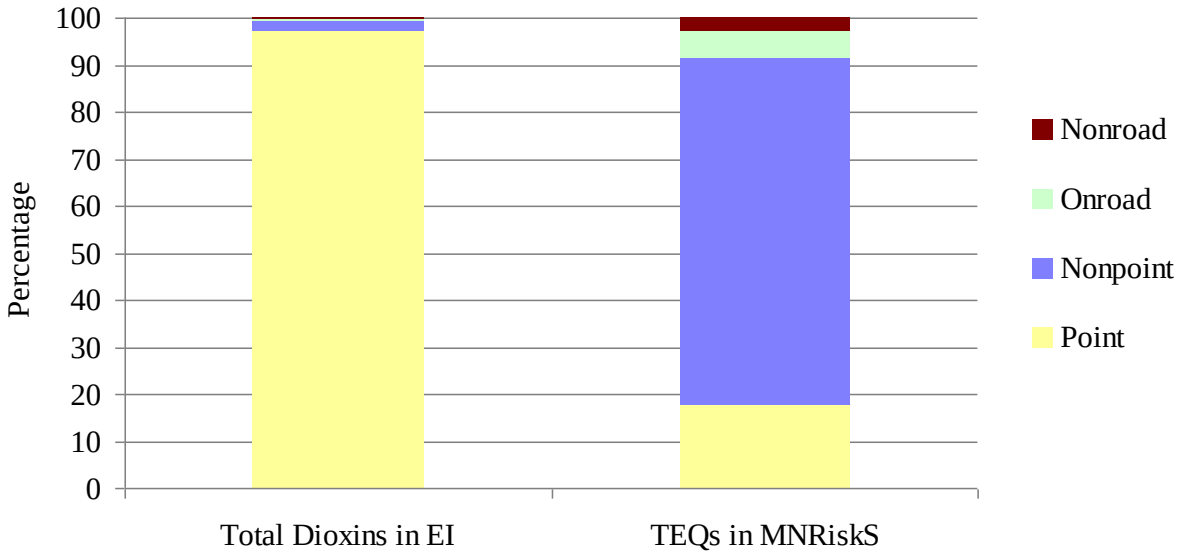
Dioxin Emissions

Dioxins consist of 210 possible congeners. Emissions of dioxins involved the same issues as emissions for metal compounds as well as additional issues caused by the existences of emissions for 20 congener groups. Those congener groups are distinguished by chlorine substitution. Toxicity values for compounds within a congener group could be totally different. Therefore, emission formation for individual congeners is needed for MNRiskS modeling.

Although dioxin emissions were mainly from point sources (see Figure 1), majority emissions for groups were from generic emission factors in FIRE. To resolve the issues related to group emissions, dioxin/furan apportioning factors were taken from the EPA's dioxin emissions report.[12] The 2,3,7,8-TCDD equivalents (TEQs) were calculated for MNRiskS input. Results

show after double-counting was removed and group apportionment to individual congeners was made, nonpoint sources became by far the majority source categories (69% of TEQs, mostly open burning). Point sources only contributed to about 17% of TEQs (Figure 2).

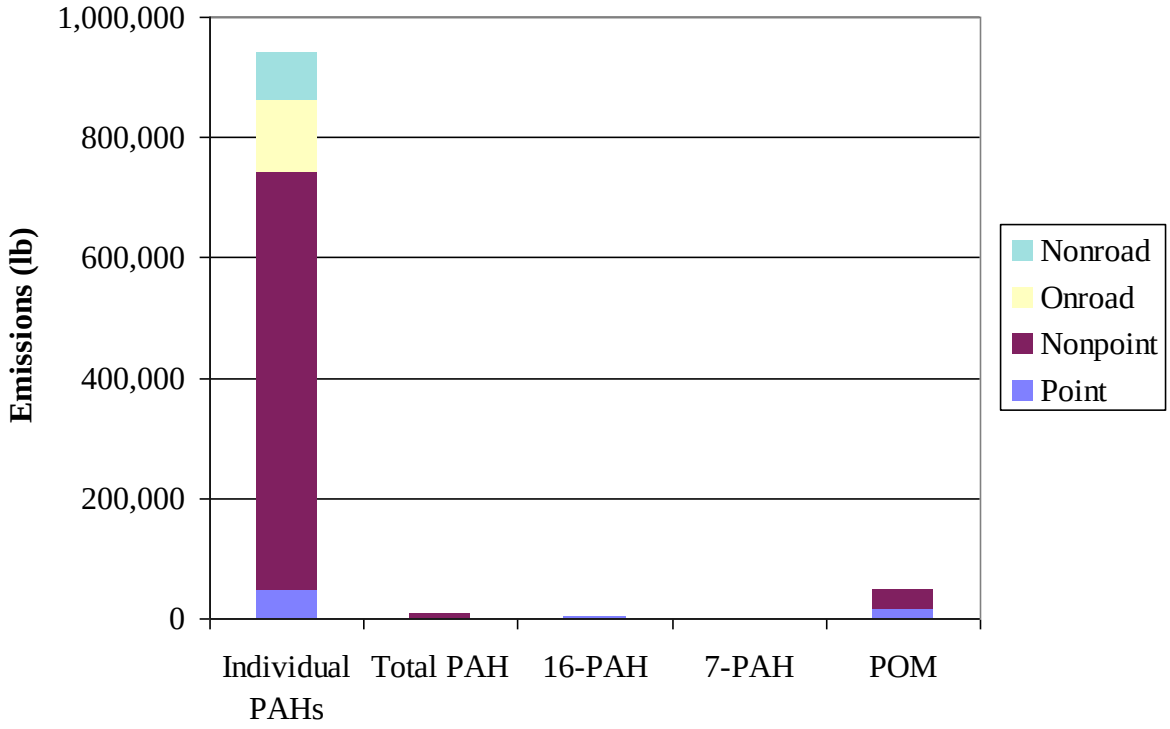
Figure 2. Emissions by principal source categories for dioxins.



PAH Emissions

In contrast to emissions for metal compounds and dioxins, about 75% of PAH emissions were from nonpoint sources. The statewide emission inventory was prepared individually for 16 PAHs of the most concern. However due to the emission factors in FIRE and other EPA literature, emissions were also estimated for PAH, 7-PAH, 16-PAH, and polycyclic organic matter (POM). Figure 2 shows the distribution of emissions among pollutants and groups.

Figure 3. Emission distribution for PAHs.



The refining process didn't change emissions of those groups. Instead, toxicity values were adjusted in the MNRisks input. EPA NATA 2002 guidance was generally followed in combination with guidance provided by the Minnesota Department of Health.[1]

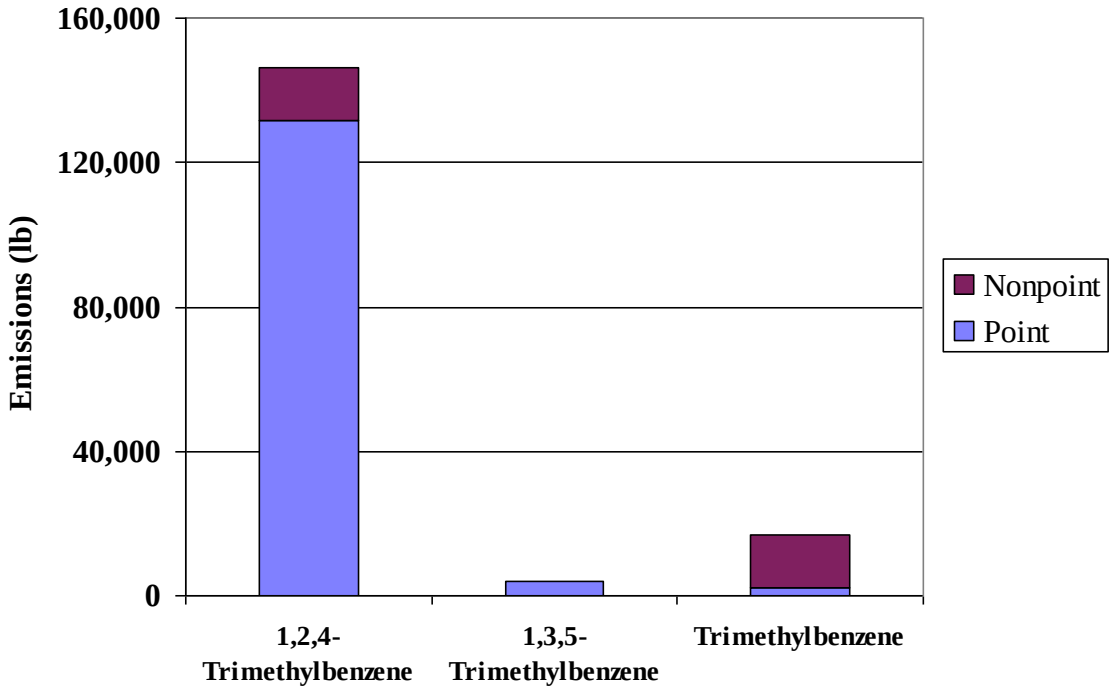
Trimethylbenzene Emissions

Trimethylbenzene emissions were from point and nonpoint sources only. The contribution from point sources was almost 5 times of that from nonpoint sources (Figure 1).

Emissions for trimethylbenzenes were estimated as 1,3,5-trimethylbenzenes, 1,2,4-trimethylbenzenes, and total. Majority emissions were estimated for 1,2,4-trimethylbenzenes, with a small amount for 1,3,5-trimethylbenzenes. Figure 3 shows emission distribution for each compound.

The emissions of 1,3,5-trimethylbenzenes and 1,2,4-trimethylbenzenes were combined as carried forward as total trimethylbenzenes to MNRiskS model input. When no total was reported, the total was taken as the sum of the isomers. When the sum of the isomers was greater than the total, the total was replaced with the sum of the isomers.

Figure 4. Emission distribution for trimethylbenzenes.



Xylene Emissions

Xylene emissions were mainly from mobile sources, more than 84% (Figure 1). Emissions for xylenes were estimated for m,p-xylene, m-xylene, p-xylene, o-xylene, and xylenes (mixed isomers). More than 99% of xylene emissions were estimated for xylenes (mixed isomers). Emissions for other xylenes were only from point and nonpoint sources.

Therefore, changes were not made to the emission inventory, but combined emissions of m,p-xylene, m-xylene, p-xylene, and o-xylene were carried forward as xylenes (mixed isomers) to the MNRiskS input. When emissions for xylenes (mixed isomers) were not estimated, the emission sum of the individual isomers was taken as emissions of xylenes (mixed isomers). When the emission sum of the individual isomers was less than emissions of xylenes (mixed isomers), emissions of xylenes (mixed isomers) were used and the emissions for individual isomers were deleted. When the emission sum of the individual isomers was greater than emissions of xylenes (mixed isomers), emissions of xylenes (mixed isomers) were replaced with the sum of the individual isomers.

Apportion Emissions to Census Tracts

Emissions for nonpoint sources and mobile sources are generally estimated at a county level. To meet the requirement of spatial resolution of MNRiskS, emissions of those sources either need to be at individual source level (with a definite geographic location) or apportioned to census tract level.

Get Data at Individual Facility Level for Selected Nonpoint Sources

The emission calculation methods and possible activity data for each category of nonpoint sources were reviewed carefully. There are three types of nonpoint sources with regard to the possibility of compilation of nonpoint source data at a facility-level emission inventory.

1. Categories with emission data at individual facility level in the 2005 statewide emission inventory, such as municipal solid waste landfills, public owned treatment works (POTWs), and dry cleaners.
2. Categories with emission data at the county level in the emission inventory, but the throughput data might be available from individual facilities. Human cremation and drum and barrel reclamation were determined to be this type and data collection procedures were followed.
3. Categories with emission data at the county level in the emission inventory, the throughput data were not available from individual facilities. All remaining categories were of this type and appropriate surrogates were used to allocate county emissions to census tracts.

Human Cremation

The number of cremations per county was available from the Mortuary Science Section of the Minnesota Department of Health.[13] The number of cremations per crematory was not readily available. To obtain the information, MPCA contacted the Mortuary Science Section of the Minnesota Department of Health. The number of cremations per crematory for 2006-2008 was obtained. Then, the average fraction of number of cremations per crematory for 2006-2008 was used to allocate the 2005 state total number of cremations to each crematory. Addresses for the majority of crematories were obtained except for several crematories with different names in data records. In the case of no address information, web search and phone calls were made to allocate the crematories. As a result, emissions were allocated to 55 crematories.

Drum and Barrel Reclamation

Emissions for drum and barrel reclamation were originally obtained from the 2002 NEI.[4] EPA estimated 1818,182 barrels were reclaimed from Hennepin County in 2002 and the data were used in the 2005 inventory. After a search, one facility was found with the operation. The facility was contacted. Only 480,000 barrels were reclaimed in 2008. This number was used in the emission inventory for MNRiskS.

Others

County level emissions from type 4 nonpoint sources and mobile sources were apportioned to census tracts using surrogates. For onroad mobile sources, both light duty and heavy duty vehicles were apportioned using the vehicle miles traveled in a census tract. The average annual daily traffic (AADT) count and the length of road segment within a given census tract were used to calculate the vehicle miles traveled (VMT) for a tract.[14] Using a geographic information system, each road segment fraction was assigned to a census tract. The traffic count data multiplied by the segment length within a census tract was then used to calculate VMT for each

segment fraction in each census tract. Separate values were produced for light duty vehicles and for heavy duty diesel vehicles.

County level non-road mobile source emissions were apportioned to census tracts using the surrogates and data sources shown in Table 3.

Table 3. Surrogates used to apportion county level nonroad mobile source emissions to census tracts.

Category	Surrogate	Data Source
Agricultural Equipment	Rural Land Area	Land Use
Commercial Equipment	Population	Census
Commercial Marine Vessel	Water Fraction	Land Cover
Construction and Mining Equipment	# Point Sources Per Tract	Point Source Inventory
Industrial Equipment	# Point Sources Per Tract	Point Source Inventory
Lawn and Garden Equipment	Population	Census
Logging Equipment	Forest Area	Land Cover
Pleasure Craft	Water Fraction	Land Cover
Railway Maintenance	Railway Miles	GIS Railway Coverage
Recreational Equipment	Population	Census
Locomotive Emissions	Railway Miles	GIS Railway Coverage

County level emissions for nonpoint sources were apportioned to census tracts using the surrogates and data sources shown in Table1.

Stack Parameters and Locational Coordinates

The 2005 MN emission inventory was compiled with emphasis on emission values. Emission inventory reporting did not require information on stack parameters and locational coordinates that are maintained in a permitting database. However, because the permitting process pays little attention to stack parameters and locational coordinates, it was anticipated that we would see incorrect or incomplete information in the emission inventory. Emission reporting must include requirements for stack parameters and locational coordinates to resolve the issue in the future.

Stack parameters and locational coordinates play an important role in the air dispersion modeling. To make sure the modeling results are representative, stack parameter data from the 2005 statewide emissions inventory were examined. If stack parameter data were provided, they were used. If no stack parameter data were provided, then average values by SCC code were used.[15] If neither of the preceding were available, then a stack height of 10 m, a stack diameter of 2 m, an exit velocity of 1 m/s, and a stack exit temperature of 293 K were used.

Point source locational data from the 2005 statewide emission inventory were compared with data from the draft 2005 NATA. The comparison indicated 89 facilities with a difference in coordinates between the MPCA emission inventory and NATA of more than 200 meters, 35 facilities with a difference of more than one kilometer, and 20 facilities with a difference of more

than 10 kilometers. For all cases where coordinates differed by more than 200 km, aerial photography was used to determine which sets of coordinates were more correct. Of the facilities with differences greater than 1 km, 71% of the incorrect coordinates were from NATA, and of facilities with differences greater than 10 km, 85% of the incorrect coordinates were from NATA. Incorrect MNRiskS coordinates identified in this manner were corrected.

CONCLUSION

Issues and concerns were encountered in the preparation of emission data for the MNRiskS modeling. Overestimated emissions were observed for many grouped compounds. Allocating county-level emissions for nonpoint sources and mobile sources to emissions at the census tracts requires better understanding of emission estimation methods and available activity data. Problems exist in stack parameters and locational coordinates in the MN emission inventory. Corrections must be made before modeling.

To obtain accurate emissions for grouped compounds, the recommendations for reporting emissions must be revised. Emission reporting must also include requirements for stack parameters and locational coordinates. It is always better to collect facility-level emissions for nonpoint sources whenever it is possible.

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KEY WORDS

Emission inventory, air toxics, multi-pathway risk assessment model, MNRiskS