Annual Pollution Report to the Legislature

A summary of Minnesota's air emissions and water discharges

Minnesota Pollution Control Agency

April 2012

Legislative Charge

Minn. Statutes § 116.011 Annual Pollution Report
A goal of the Pollution Control Agency is to reduce the amount of pollution that is emitted in the state. By April 1 of each year, the MPCA shall report the best estimate of the agency of the total volume of water and air pollution that was emitted in the state the previous calendar year for which data are available. The agency shall report its findings for both water and air pollution: (1) in gross amounts, including the percentage increase or decrease over the previous calendar year; and (2) in a manner that will demonstrate the magnitude of the various sources of water and air pollution.

HIST: 1995 c 247 art 1 s 36; 2001 c 187 s 3

Authors

Patricia Engelking
Kari Palmer

Contributors / acknowledgements

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Minnesota Pollution Control Agency
520 Lafayette Road North | Saint Paul, MN 55155-4194 | www.pca.state.mn.us | 651-296-6300
Toll free 800-657-3864 | TTY 651-282-5332

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Table of Contents

List of Tables

List of Figures

List of Figures continued

Foreword

The *Annual Pollution Report* statute requires the Minnesota Pollution Control Agency (MPCA) to estimate the total amounts of air and water pollution emitted in the state during the most recent calendar year for which data are available. The statute further directs the MPCA to estimate the percentage increase or decrease over the previous calendar year, and to estimate the relative contributions of the various sources of these emissions and discharges to the environment.

The Annual Pollution Report, prepared each year since 1996, has evolved to include new kinds of information, such as discharges of toxic air pollutants, greenhouse gas emissions, and emerging issues of concern as these kinds of data have become available. Observations of some advantages and limitations of this kind of report are presented below to add context for interested parties.

Advantages of the inventory approach

- The Annual Pollution Report is the only MPCA report that specifically asks for an accounting of emissions and discharges. Such inventories are inherently important, as understanding emission amounts and sources is fundamental in protecting the environment and human health.
- The report attempts to track trends year to year, which is valuable if data are reliable.
- The report covers both air and water pollutants in one document, instead of separate reports, reminding readers of the potential for cross-media impacts.
- The report shows relative contributions of various pollution sources to the total.

Challenges of the inventory report approach

- There is currently no completely reliable way to quantify the volumes of water pollutants released by nonpoint sources in the form of polluted runoff, such as city streets, construction sites and farm fields. This is a major gap in inventorying pollutants discharged. However, local watershed managers reporting to statewide data management systems like eLINK have enabled better estimates of pollutant loads from nonpoint sources. Reasonable estimates of benefits from preventing soil loss and reducing phosphorus from implementation of best management practices (BMPs) may now be made statewide and are discussed in this report. New monitoring approaches such as the MPCA’s Watershed Pollutant Load Monitoring Network, which is designed to monitor statewide water quality on a watershed scale, will also help aid understanding of the relative contribution of pollutants from various sources and water.
- Aggregating data into total volumes or mass lacks the important context of relative risk. Pollutants emitted in smaller amounts can have a greater impact than some emitted in tremendously larger amounts. Volume or mass figures are not able to indicate whether such emissions and discharges are acceptable or unacceptable from a risk perspective.
- The most current pollutant emissions and discharge data are usually at least two years behind real time, sometimes more, depending on the type of pollutants. Air emission estimates are frequently revised as industrial output models and factors used to estimate emissions are refined. Also, the number of facilities included varies from year to year. Therefore, year-to-year comparisons are not always reliable, as emissions inventory methodologies are evolving.

Outlook

Several important national, regional and state actions affecting pollutant emissions and discharges now and in the future were enacted recently and are worth mentioning:

- **Agency Focus on Watershed Approach:** The MPCA is employing a watershed approach to coordinate surface water quality management efforts throughout the agency. This means the state's 81 major watersheds provide a framework for analysis and decision making. This coordinated effort will help reduce discharges from both point and nonpoint source pollutants and better engage local partners. Activities coordinated as a system under this approach include:
  - monitoring, assessment and reporting
  - watershed protection and restoration strategies
  - permitting, compliance and enforcement (e.g. wastewater, stormwater, feedlots)
  - prevention and assistance activities, including financial and technical assistance
  - certification and licensing
  - training and educational activities
- **Progress on Total Maximum Daily Load (TMDL) Studies:** The federal Clean Water Act (CWA) requires states to adopt water-quality standards to protect waters from pollution. These standards define how much of a pollutant can be in the water and still allow it to meet designated uses, such as drinking water, fishing and swimming. The standards are set on a wide range of pollutants, including bacteria, nutrients, turbidity and mercury. Based on the federal CWA, lakes and streams that do not meet water quality standards are "impaired" and a Total Maximum Daily Load (TMDL) study is required. The MPCA's 2010 inventory showed 3,043 total river, lake and wetland impairments, which included 1,383 impaired by conventional pollutants and 1,660 by toxic pollutants including mercury, polychlorinated biphenyls (PCBs) and others. By following the TMDL process, states establish water quality-based controls for waters to reduce point and nonpoint sources of pollution to restore and maintain the quality of water resources. Once a TMDL study has been approved by the U.S. Environmental Protection Agency (EPA), an Implementation Plan is developed. The Implementation Plan identifies how pollutant reductions identified by the TMDL will be achieved. Some program highlights include:
  - As of February 2012, for conventional impairments, 235 approved TMDLs are in implementation and 710 are under development – 86 percent of total conventional TMDLs needed. For toxic impairments, 1,093 approved TMDLs are in implementation – 77 percent of total TMDLs needed for toxics (many of these are included in the statewide mercury TMDL).
  - Waters restored to attain water quality standards: 15 impairments (three lakes and 12 river segments). Other waters are showing improvement but have not yet achieved standards.
- **Statewide Nitrogen Study:** The MPCA is leading a study to characterize total nitrogen loading to Minnesota's surface waters. The study will help provide a scientific foundation of information that will be used to develop and evaluate nitrogen reduction strategies for two separate purposes. First, this work will assist in developing implementation strategies for Minnesota's nitrate toxicity-based standard (currently in draft). Additionally, by assessing where and why nitrate and

nitrogen loading is occurring in Minnesota streams, the study will assist in developing a better strategy to address Minnesota's total nitrogen contributions to downstream waters such as the Gulf of Mexico, Lake Winnipeg and Lake Superior. Nitrogen and phosphorus coming from the Mississippi River are contributing to algae blooms in the Gulf of Mexico, leading to hypoxia and large "dead zone" areas of oxygen deprivation.

- **Cross State Air Pollution Rule:** The Clean Air Act contains a requirement, known as the "good neighbor" provision, meant to prevent air emissions from one state from contributing to another state not meeting the National Ambient Air Quality Standards (NAAQS). In 2010, the EPA proposed the Transport Rule to address this interstate transport of air pollutants. It creates a market-based cap-and-trade program for SO_2 and NO_x. In July 2011, EPA finalized the Transport Rule, and renamed it the "Cross State Air Pollution Rule (CSAPR)."

  The CSAPR currently covers power plants in 27 Eastern States. Minnesota is included due to its impact on nonattainment of the $PM_{2.5}$ NAAQS in the Milwaukee area. Minnesota power plants will be required to reduce emissions of SO_2 and NO_x to levels specified in pollutant budgets set forth by EPA. Unlimited trading is allowed within Minnesota, along with limited trading with other states.

  Currently, CSAPR is stayed pending resolution of several legal challenges. The DC Circuit Court will hear the CSAPR challenges in April 2012.

- **New National Ambient Air Quality Standards (NAAQS):** The EPA has updated several of the NAAQS and plans to update others in the near future. For example, a more stringent one hour federal SO_2 standard became effective in August 2010. With this standard, EPA requires both air monitoring and modeling of sources that could cause or contribute to an exceedance of the SO_2 standard. By June 2013, the MPCA must submit a maintenance State Implementation Plan with a modeling demonstration that all sources that could cause or contribute to a violation of the standard will be sufficiently controlled to ensure attainment. Future SO_2 emissions reported in the APR may be lower as a result of refined emission estimates and decreases in facility emissions in order to meet the requirements of the new standard.

  EPA also plans to propose a new fine particle ($PM_{2.5}$) NAAQS in June 2012 with a final NAAQS expected in 2013. Minnesota meets the current $PM_{2.5}$ NAAQS, however, concentrations over the daily standard were measured in the Twin Cities in the 2008-2010 time-period (with concentrations below the standard in the 2009-2011 time period). In anticipation of potentially lower standards, the MPCA continues efforts to lower statewide emissions of $PM_{2.5}$ and $PM_{2.5}$ precursors, sulfur dioxide and nitrogen oxides, in order to improve Minnesota public health and keep $PM_{2.5}$ concentrations consistently below the NAAQS. The MPCA expects that this may be challenging and resource intensive due to the complexity of $PM_{2.5}$ formation and the resulting difficulty in achieving concentration reductions.

Greenhouse Gas Regulatory Update

- EPA Mandatory Reporting
  In 2009, EPA published a final rule to require reporting of greenhouse gas emissions. Most facilities which must now report belong to a sector listed in the rule and also have actual emissions of 25,000 tons per year (tpy) or more of carbon dioxide equivalents (CO_2e). Facilities report directly to EPA using electronic reporting. For more information, including emissions data by state, see http://www.epa.gov/climatechange/emissions/ghgrulemaking.html

- Greenhouse gas (GHG) permitting
  On May 13, 2010, EPA issued a final rule to establish permit thresholds for GHG emissions. The new permit threshold for GHGs is a potential to emit (PTE) of 100,000 tpy of CO_2e for both construction and operating permits. Effective dates are January 2, 2011, for certain new or modifying sources and July 1, 2011 for all facilities. The MPCA issued temporary rules on January 24, 2011, to comply with this new permit requirement as well as provide regulatory relief for small sources holding Registration Permits or Capped Permits. These temporary rules are effective for two years. The MPCA is in the process of making these temporary rules permanent.

  For more information on greenhouse gas permitting, see the following websites.
  EPA Tailoring rule documents: http://www.epa.gov/NSR/actions.html#may10

  EPA New Source Review – GHG permitting website:
  http://www.epa.gov/nsr/ghgpermitting.html
  MPCA rulemaking website: http://www.pca.state.mn.us/yhiz49d

Transportation Initiatives: The MPCA has little direct control over transportation sources; however, EPA emission and fuel economy standards for vehicles have resulted in reductions of major air pollutants. In fact, by 2020, emissions of carbon monoxide, hydrocarbons, nitrogen oxides and fine particles are expected to be 10-50 times less than if controls had not been in place. For more information on air pollutants from transportation see http://www.epa.gov/otaq/transport.htm .

The MPCA has sought further reductions through several programs designed to decrease diesel emissions and promote the use of electric vehicles over the past few years. These include the following:

- The MPCA has partnered with and provided state and federal grants to Clean Air Minnesota (CAM), a nonprofit organization that has focused on retrofitting school buses with emission reduction equipment over the past four years. MPCA's $2.4 million in funding from the Minnesota Legislature and $300,000 in federal funding helped retrofit 1,800 school buses with emission controls across Minnesota through our partnership with CAM's Project Green Fleet Program.

- MPCA received $1.55 million in federal American Recovery and Reinvestment Act grants in 2009 to reduce heavy-duty diesel emissions from nearly 250 vehicles in large and small private trucking fleets, a few construction companies, a river tour boat, a municipality fleet and one tribal community fleet. This work was completed in 2011.

- MPCA has also provided loans since 2008 using state small-business and federal grant funding for idle reduction devices on 111 long haul trucks.

- MPCA utilized the federal Congestion Mitigation and Air Quality (CMAQ) grant for emission control retrofits on 394 public, heavy-duty vehicles in the Twin Cities, including snowplows, dump trucks, garbage trucks and fire trucks.

- The MPCA is leading the Drive Electric Minnesota partnership which includes representatives from metro-area cities, counties, state agencies, businesses, non-profits, and Minnesota's largest utility. This partnership is working toward the installation of publicly available plug-in charging stations and early procurement of electric vehicles by local government fleets. With the help of a $500,000 CMAQ grant, awarded in March 2012, the Electric Vehicle Charging Station Infrastructure Development project will install 76 publicly available electric vehicle charging stations in the metro area. The federal grant, which will be implemented over the next two years, is matched with $125,000 in local funding bringing the total project cost to $625,000.

Introduction and Summary

The Minnesota Pollution Control Agency (MPCA) is required to submit to the Legislature an annual report of the volume of pollution emitted or discharged to the state's air and water resources. The basis of the MPCA's 2011 Annual Pollution Report is the 2008 MPCA Greenhouse Gas Inventory, the 2005 and 2010 Minnesota Criteria Pollutant Emission Inventories, the 2005 Air Toxics Emission Inventory and the 2010 Water Quality National Pollutant Discharge Elimination System (NPDES) Discharge Monitoring Reports.

Annual emission and discharge estimates are one important component of tracking progress on air and water pollution, and for tracking performance and relative contributions of pollution sources. The MPCA also regularly prepares reports on the physical, chemical and biological conditions measured in the environment, and on pollutants of special concern to human health and the environment. These reports and others are available on the Internet and are referenced throughout this document for readers who would like additional context and information.

The MPCA provides public access to ambient water quality monitoring data, surface water discharge monitoring data, and air emissions data. These data are available for viewing and download online at the Environmental Data Access on the following website:

http://www.pca.state.mn.us/eda

About Air Emission Inventories

The MPCA has been working to streamline its air emissions inventory process. In 2009, a combination of federal and state funding allowed the MPCA to begin development of a new air emissions inventory system called the Consolidated Emissions Data Repository (CEDR). The new system consolidates the air toxics, criteria pollutant, and greenhouse gas inventories into a single database. It also features web-based electronic reporting for facilities. The electronic reporting feature along with other system improvements will reduce the inventory completion time, improve data quality, and reduce the burden on staff at reporting facilities and the agency. By the summer of 2012, approximately 1700 facilities are expected to submit their 2011 emissions inventory electronically. For more information on web-based reporting, see http://www.pca.state.mn.us/0agx43

One consequence of investing MPCA staff time in developing the CEDR system has been a delay in completing the 2008 Air Toxics Emissions Inventory and the 2008 Criteria Pollutant Emissions Inventory for area and mobile sources until summer 2012. However, the expectation is that implementation of the CEDR system will significantly reduce inventory completion times in the future.

Air Emissions

In this report, the MPCA reports on emissions of major air pollutants including criteria air pollutants (pollutants with National Ambient Air Quality Standards), greenhouse gases and air toxics.

The MPCA reports data from the Minnesota Criteria Pollutant Emission Inventory. The major air pollutants summarized in this report include particulate matter, ammonia, sulfur dioxide (SO_2), nitrogen oxides (NO_x), volatile organic compounds (VOCs), carbon monoxide and lead. Emissions of criteria pollutants from large facilities are estimated every year with data from 2010 currently available. However, emissions from smaller sources are estimated every three years with 2005 estimates the most recent available.

Emissions for six greenhouse gases (CO_2, nitrous oxide, methane, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride) are reported in terms of CO_2 equivalents (CO_2e). The most recent emissions inventory completed for greenhouse gases in Minnesota is from 2008.

The Minnesota Air Toxics Emission Inventory estimates emissions of individual air toxics including compounds such as benzene, formaldehyde, acrolein, mercury and polycyclic organic matter. There is some overlap between the Minnesota Air Toxics Emission Inventory and the estimates for VOCs and particulate matter because many air toxics are components of these broader categories. The most recent inventory of air toxics emissions is from 2005.

Table 1 lists the total statewide emissions of the major air pollutants from 2006 to 2010. The percent change from 2009 to 2010 is given in the final column. It is possible to look at emission trends between these years; however, it is important not to place undue emphasis on a yearly change since emission estimates fluctuate as a result of changes and improvements in the inventory and other factors such as the economy and weather.

Table 1: Minnesota Air Pollution Emission Estimates, 2006-2010*
(thousand tons)

Pollutant	2006	2007	2008	2009	2010	2009-2010 % Change
Greenhouse gases**	160,000	161,800	159,400	--	--	-1.5%
Particulate matter (PM_{10})***	776	777	776	769	775	0.8%
Sulfur dioxide (SO_2)	148	138	129	101	92	-8.9%
Nitrogen oxides (NO_x)	409	408	391	353	358	1.4%
Volatile organic compounds (VOCs)	347	347	345	342	343	0.3%
Carbon monoxide (CO)	1,771	1,773	1,771	1,769	1,770	0.1%
Total Criteria Pollutants (not including CO_2)	3,451	3,443	3,413	3,333	3,338	0.2%

*2005 mobile and nonpoint emission estimates were used in the 2006-2010 emission estimates. The only changes are from point sources.

**Greenhouse gas emission estimates include net imported electricity. Data are not available for 2009 or 2010, so percent change is for 2007-2008.

***PM_{10} emissions represent only direct emissions; secondary formation is not included.

Most of the criteria pollutant emission estimates increased slightly between 2009 and 2010. Increased taconite mining drove most of this increase. Mining emissions vary annually depending on the demand for taconite pellets. There was a significant reduction in taconite production in 2009 at many facilities; however, production rebounded in 2010 with a corresponding increase in air emissions.

SO_2 emissions continued to decrease due to conversions of coal-powered electric plants to natural gas and the addition of pollution controls. Xcel Energy's Allen S. King coal-fired power plant in Oak Park Heights was renovated with state-of-the-art pollution controls while St. Paul's High Bridge power plant and Minneapolis' Riverside power plant were converted from coal to cleaner-burning natural gas. Minnesota Power also installed modern air pollution controls at its Boswell coal-fired power plant in Cohasset in 2009.

The Riverside plant completed its conversion in 2009 resulting in a decrease in emissions of more than 10,000 tons of SO_2 and nearly 10,000 tons of NO_x. The Boswell plant reduced its emissions by 8,000 tons of SO_2 and more than 4,000 tons of NO_x due to decreased burning of coal during renovation and air pollution control modernization. In addition, Xcel's Sherburne facility decreased its NO_x emissions by nearly 4,000 tons due to improved pollution control equipment. Additional reductions came from facilities such as Minnesota Power's Taconite Harbor power plant and Rochester Public Utilities Silver Lake burning less coal in 2009.

There may be differences in the total emission figures for a given year discussed in this report versus past MPCA emission reports because data may be updated in MPCA's emission inventory due to corrections or changes in methodology.

It should also be noted that despite the importance of the secondary formation of particulate matter, estimated air emissions data in this report are only based on direct releases from sources into the atmosphere. Secondary formation occurs when emissions of volatile gases combine and form fine particles downwind of the emission source.

Fine particulate matter ($PM_{2.5}$) and ammonia are not included in Table 1 since estimated values are only available for 2002 and 2005. However, $PM_{2.5}$ emissions are a subset of PM_{10} emissions, so $PM_{2.5}$ mass emissions are included within the PM_{10} estimate. Estimated $PM_{2.5}$ and ammonia emissions are provided in the body of the report.

Lead and mercury are pollutants which can be toxic at very low concentrations. In 2010, 18 tons of lead and 2,241 pounds of mercury were estimated to have been emitted in Minnesota.

Water Discharges

Owners or operators of any disposal system or point source are required by Minnesota Statutes, Chapter 115.03(7) to maintain records and make reports of any discharges to waters of the state. These self-monitoring reports submitted to MPCA are commonly referred to as Discharge Monitoring Reports (DMRs). Data in the DMRs are compiled in DELTA, a compliance tracking system maintained by MPCA data specialists. The 2012 Annual Pollution Report examines the most recent five-year period for which DMR data are available.

The MPCA's water quality program continues to evolve from a predominantly concentration-based, facility-by-facility regulatory approach to one that emphasizes managing total pollution discharges to Minnesota's watersheds. The current report represents a continuing effort to improve the agency's capacity to accurately perform loading analyses. Due to the multi-year life of permit requirements, however, many of our permits do not yet contain monitoring and reporting requirements that enable efficient, computerized calculations of total annual pollutant loadings. As the agency reissues permits and conducts ongoing review of data, it will continue to build capability in this area and the assessment of pollutant trends over multiple years will become more reliable.

This year's report looks at water discharge data from major municipal and industrial point sources for five commonly measured water pollutants covering the years 2006-2010 (Table 2). Major municipal and industrial dischargers are defined as facilities that discharge more than one million gallons per day to waters of the state. The 2010 figures, for example, represent the combined loading from 94 major municipal and industrial dischargers. These major facilities represent approximately 85 percent of the total volume of discharge to waters of the state from point sources. The remaining 15 percent comes from smaller municipal and industrial facilities. Although discharges from these facilities are small, they can have significant impacts on individual lakes and stream segments.

Data from 2010 are the most recent data incorporated into this report. Adjustments were made to include such data as late reports, and parameters added to permit requirements as a result of permit reissuance. The reader may therefore notice some differences in yearly pollutant loads reported in the current report compared with previous editions of the Annual Pollution Report.

In addition to the specific sources of variance highlighted above, a number of additional sources of variation, both up and down, can potentially impact year-by-year comparisons:

- Approximately 6,000 individually reported values have been incorporated into the yearly totals. These reported values are derived from an even larger set of around 94,000 environmental observations that has been summarized and interpreted by permittees before submission to MPCA, generally in ways that are optimized for concentration-based compliance determination.

- The loading calculations incorporate a number of data interpretation decisions that can legitimately be made in a variety of ways.

- Reporting requirements can vary with each permit issuance, resulting in variation in parameters, limit types, and reporting periods, making year-by-year comparisons difficult. Additionally, when a facility does not monitor a pollutant in a month that it discharges, the concentration for that month is presumed to be the average annual concentration.

- Wastewater treatment facilities regularly experience variations in influent strength, influent flow and facility performance that may not be fully reflected in the data used to generate this report.

This report discusses five common chemical parameters found in wastewater treatment plant effluent including total suspended solids (TSS), biochemical oxygen demand (BOD), total phosphorus (TP), ammonia (NH_3) and nitrate (NO_3). Table 2 shows the water pollution discharge estimate from major point sources by pollutant for 2006-2010. The percent change from 2009 to 2010 is shown in the final column of the table. In 2010, the total statewide loading from major dischargers was about five percent higher that the total loading in 2009. Discharges of ammonia and biochemical oxygen demand increased over the previous year with discharges of total suspended solids, phosphorus and nitrate remaining relatively the same.

Table 2: Minnesota Water Pollution Discharge Estimates from Major Point Sources, 2006-2010 (thousand kilograms)

Pollutant	2006	2007	2008	2009	2010	2009-2010 % Change
Total suspended solids	3,600	4,200	3,800	3,400	3,500	3%
Biochemical oxygen demand	2,100	2,500	2,700	2,200	2,400	9%
Total phosphorus	710	670	700	540	540	0%
Ammonia	500	550	650	770	970	26%
Nitrate	3,900	4,000	3,800	3,600	3,600	0%
Total	10,900	12,000	11,700	10,600	11,100	5%

Each pollutant is discussed in more detail beginning on page 47.

Chapter 1: Air Pollutant Emissions Overview

Thousands of chemicals are emitted into the air. Many of these are air pollutants that can directly or indirectly affect human health, reduce visibility, cause property damage and harm the environment. For these reasons, the MPCA attempts to reduce the amount of pollutants released into the air. In order to understand the sources of air pollution and to track the success of reduction strategies, the MPCA estimates the emissions of certain air pollutants released in Minnesota.

Criteria pollutants—The 1970 Clean Air Act identified six major air pollutants that were present in high concentrations throughout the United States called "criteria pollutants." These air pollutants are particulate matter ($PM_{2.5}$ and PM_{10}), sulfur dioxide (SO_2), nitrogen oxides (NO_x), ozone (O_3), carbon monoxide (CO) and lead (Pb). The Minnesota Criteria Pollutant Emission Inventory estimates emissions of five criteria pollutants (PM_{10}, SO_2, NO_x, CO and Pb). Ozone is not directly emitted, so a group of ozone precursors called volatile organic compounds (VOCs) is included instead. Emissions estimates for large facilities are available for 2010. Mobile and nonpoint source emissions are available for 2005.

$PM_{2.5}$ and ammonia (which contributes to $PM_{2.5}$ formation) emissions are estimated every three years with estimates available for 2002 and 2005. The Criteria Pollutant Emissions section also includes a summary of the MPCA's Air Quality Index (AQI) data for 2011.

Greenhouse gases—Increases in ambient levels of greenhouse gases can lead to global climate change. The MPCA tracks and reports emissions for six greenhouse gases (CO_2, nitrous oxide, methane, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride) in terms of CO_2 equivalents (CO_2e). CO_2e compares the warming potential of different gases to the impact of CO_2. Emission estimates for 2008 are included in this report. More information is available on climate change and greenhouse gases at the following link: http://www.pca.state.mn.us/udgx614

Air toxics—Many other chemicals are released in smaller amounts than most of the criteria pollutants, but are still toxic. The EPA refers to chemicals that can cause serious health and environmental hazards as hazardous air pollutants or air toxics. Air toxics include chemicals such as benzene, formaldehyde, acrolein, mercury and polycyclic organic matter. Minnesota data come from the 2005 Minnesota Air Toxics Emission Inventory.

This report is limited to a summary and discussion of emissions of various air pollutants in Minnesota. However, the MPCA has prepared other reports that discuss air pollution trends and emissions in more detail. Please reference the following reports for more information.

Air Quality in Minnesota: 2011 Report to the Legislature
http://www.pca.state.mn.us/yhizb6a

Annual Air Monitoring Network Plan for the State of Minnesota, 2012
http://www.pca.state.mn.us/mvri439

Criteria Air Pollutant Emissions

Minnesota's Emission Inventory Rule requires all facilities in Minnesota that have an air emissions permit to submit an annual emission inventory report to the MPCA. The report quantifies emissions of the following regulated pollutants:

- particulate matter less than 10 microns in diameter (PM_{10})
- sulfur dioxide (SO_2)
- nitrogen oxides (NO_x)
- volatile organic compounds (VOCs)
- carbon monoxide (CO)
- lead (Pb)

The emission inventory is used to track the estimated pollutant emissions of each facility and to determine the type and quantity of pollutants being emitted into the atmosphere. Ozone is a criteria pollutant that is not directly emitted, so a group of ozone precursors called VOCs is included instead. The data are then used to calculate an annual emission fee for each facility. Starting in 2002, MPCA also began estimating $PM_{2.5}$ and ammonia emissions every three years. Estimates are currently available for $PM_{2.5}$ and ammonia for 2002 and 2005.

The Minnesota Criteria Pollutant Emission Inventory estimates emissions from permitted facilities every year in order to fulfill Minnesota rules. In addition, federal rules require the MPCA to estimate emissions every three years from two other principal source categories: nonpoint sources and mobile sources. Overall, the Minnesota Criteria Pollution Emission Inventory includes emissions from three principal source categories.

1. **Point sources:** Typically large, stationary sources with relatively high emissions, such as electric power plants and refineries. A "major" source emits a threshold amount (or more) of at least one criteria pollutant, and must be inventoried and reported.

2. **Nonpoint sources**: Typically stationary sources, but generally smaller sources of emissions than point sources. Examples include dry cleaners, gasoline service stations and residential wood combustion. Nonpoint sources may also include a diffuse stationary source, such as wildfires or agricultural tilling. These sources do not individually produce sufficient emissions to qualify as point sources. For example, a single gas station typically will not qualify as a point source, but collectively the emissions from many gas stations may be significant.

3. **Mobile sources:** Mobile sources are broken up into two categories; on-road vehicles and non-road sources. On-road vehicles include vehicles operated on highways, streets and roads. Non-road sources are off-road vehicles and portable equipment powered by internal combustion engines. Lawn and garden equipment, construction equipment, aircraft and locomotives are examples of non-road sources.

The Minnesota Criteria Pollutant Emission Inventory is complete for point sources through 2010. Emission estimates are available for nonpoint and mobile sources for 2005. When 2010 summary data are given, they include nonpoint and mobile data from 2005 and point source data from 2010. This report presents trend data for point sources from 2006-2010.

With each new inventory, improvements are made in terms of pollutants covered, source categories included, and the accuracy of emission estimates. Therefore, changes in the way emissions are calculated may affect trends, even if there was no real increase or decrease in emissions.

The reader may note differences in the total emission figures for a given year discussed in this report, versus previous emission reports the MPCA has published, because data may be updated in past emission inventories due to corrections or changes in methodology.

In addition, despite the importance of secondary formation for some pollutants (e.g., $PM_{2.5}$), estimated air emission data in this report are based on direct releases from sources into the atmosphere.

Find more information on the Minnesota Criteria Pollutant Emission Inventory:
http://www.pca.state.mn.us/r0pg451

See the MPCA Environmental Data Access web site to download MPCA emission estimates for criteria pollutants and air toxics including county level emissions for 2005:
http://www.pca.state.mn.us/lupgd99

Find more information on criteria air pollutants in the following EPA website:
http://www.epa.gov/air/urbanair/index.html

See the EPA's National Emissions Inventory Browser to download EPA criteria pollutant emission estimates:
http://neibrowser.epa.gov/eis-public-web/home.html

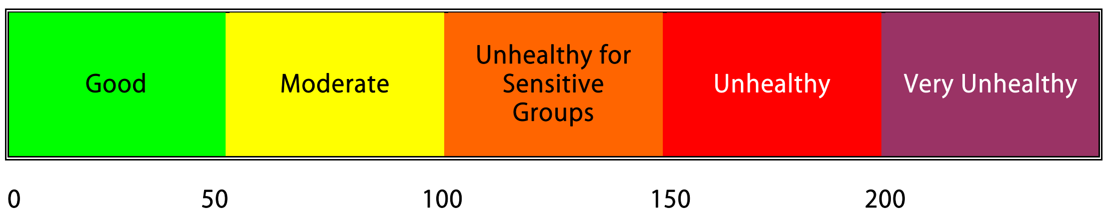
Air Quality Index (AQI)

The Air Quality Index (AQI) was developed by the EPA to provide a simple, uniform way to report daily air quality conditions.

In Minnesota, four criteria pollutants are used to calculate the AQI: ground-level ozone, sulfur dioxide, carbon monoxide and fine particles ($PM_{2.5}$). High AQI days in Minnesota are usually the result of elevated levels of ozone or $PM_{2.5}$. The AQI is currently calculated for the Brainerd area, Detroit Lakes, Duluth area, Ely, Grand Portage, Marshall, Rochester, St. Cloud, and the Twin Cities. Not all pollutants are monitored at each location.

The AQI translates each pollutant measurement to a common index, with a value of 100 reflecting when health effects might be expected in sensitive populations. The pollutant with the highest index value is used to determine the overall AQI. The table below shows the different AQI categories along with the corresponding index range. The MPCA issues an air quality alert when the AQI is unhealthy for sensitive groups or higher.

AQI Color Legend

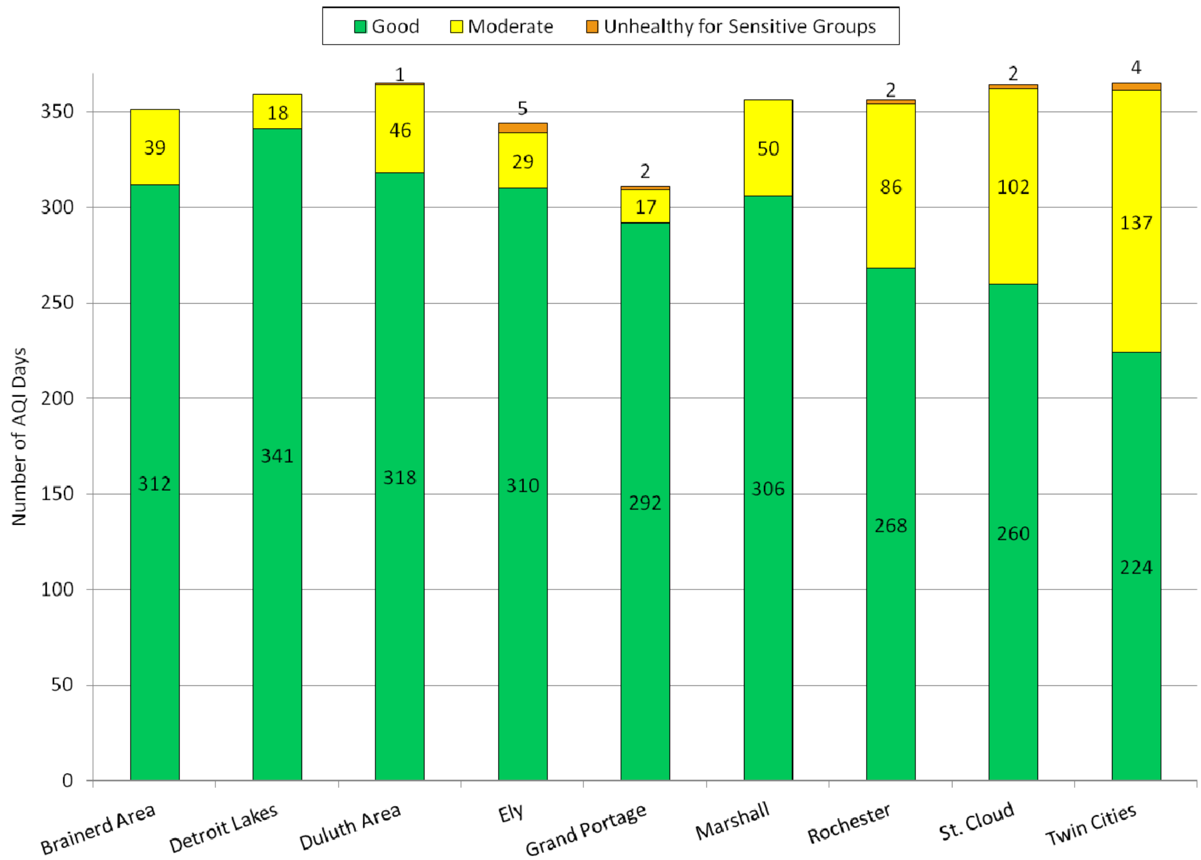


The chart on the next page displays the number of Good, Moderate, and Unhealthy for Sensitive Groups days for all monitored regions in 2011. The EPA may report slightly different AQI summary totals for Minnesota because the MPCA and EPA use different methods to calculate the AQI. The MPCA AQI summary totals will show a higher number of Moderate and Unhealthy for Sensitive Groups days than EPA summary totals due to the calculation method for the $PM_{2.5}$ AQI.

Yearly variations in weather patterns can affect air quality. While stagnant weather conditions in the early months of 2010 resulted in the highest number of measured Unhealthy for Sensitive Groups days since $PM_{2.5}$ monitoring began in 2002, weather conditions in 2011 were favorable for pollution dispersion, significantly reducing the number of Unhealthy for Sensitive Groups days across the state. However, the summer of 2011 experienced above average temperatures, including 14 days with temperatures above 90ºF, which contributed to the first ozone Unhealthy for Sensitive Groups day in the Twin Cities since 2007.

The majority of Unhealthy for Sensitive Groups days across Minnesota were the result of elevated concentrations of $PM_{2.5}$. As a result of wildfire smoke from the Pagami Creek Fire in the Boundary Waters Canoe Area Wilderness, Ely experienced the highest number of Unhealthy for Sensitive Groups days (5) in 2011. Other reporting regions in the state experienced the following number of Unhealthy for Sensitive Groups days: Twin Cities (4); St. Cloud, Rochester, and Grand Portage (2); Duluth area (1); Brainerd area, Detroit Lakes, and Marshall (0).

2011 Air Quality Index Days by Category and Reporting Region



References/web links

For more information on the AQI, see the following websites:

http://aqi.pca.state.mn.us/hourly/

http://www.epa.gov/airnow/

http://www.epa.gov/airnow/aqibroch/

Particulate Matter

Particulate matter is a broad class of chemically and physically diverse substances that exist as discrete particles (liquid droplets or solids) over a wide range of sizes. Some particles are seen as soot or smoke while others are so small they can only be detected with an electron microscope.

EPA currently has National Ambient Air Quality Standards (NAAQS) for particulate matter in two size classes, $PM_{2.5}$ and PM_{10}. $PM_{2.5}$, also known as fine particulate matter, includes particles with diameters less than or equal to 2.5 microns. PM_{10}, which is also known as inhalable particulate matter, includes particulate matter smaller than or equal to 10 microns. $PM_{2.5}$ and PM_{10} are associated with numerous adverse health effects, which are briefly described in the following sections. Health researchers have identified adverse health effects from a range of different sizes of particulate matter. Over time, federal particulate matter regulations have shifted to focus on smaller-sized particles.

Particulate matter also causes adverse impacts to the environment. Fine particles are the major cause of reduced visibility in parts of the United States. In addition, when particles containing nitrogen and sulfur deposit onto land or waters, they may affect nutrient balances and acidity. This can result in the depletion of nutrients in the soil, damage to sensitive forests and farm crops, and diversity changes in ecosystems. Particulate matter also causes soiling and erosion damage to materials and buildings. Finally, different types of particulate matter, for example black carbon (soot) and sulfate particles, play a role in climate change by altering cloud formation and precipitation and depending on the type of particle and location, contributing to global warming or cooling.

$PM_{2.5}$

Fine particles are an aerosol including solid particles and liquid droplets in the air that vary in size, composition and origin. Fine particles contain sulfate, nitrate, ammonium, elemental carbon, organic carbon-containing chemicals, minerals, trace elements and water.

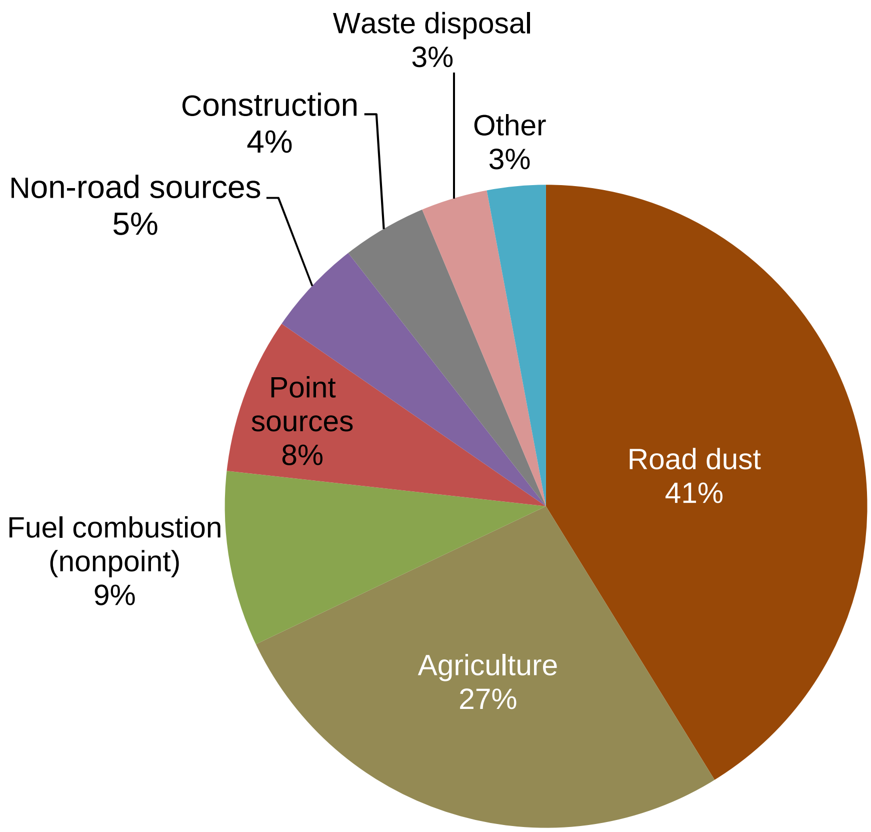
Studies have shown that ambient $PM_{2.5}$ concentrations are linked with increased hospital admissions and deaths from cardiovascular and respiratory problems. Elevated $PM_{2.5}$ concentrations are also associated with a number of adverse effects including heart attacks; atherosclerosis; acute and chronic bronchitis; asthma attacks; respiratory symptoms; and reduced lung function growth and increased respiratory illness in children.

Emissions data and sources

$PM_{2.5}$ concentrations in the air are the result of many manmade and natural sources of emissions. $PM_{2.5}$ can be directly emitted to the air in the form of small particles. Examples of these “directly” emitted $PM_{2.5}$ particles include the smallest particles created from mechanical, grinding or abrasion processes, blowing dust and the soot from combustion processes such as diesel engines and wood burning. MPCA estimates these types of emissions in the direct $PM_{2.5}$ emission inventory.

The MPCA estimate for statewide primary emissions of $PM_{2.5}$ in 2005 is 166,000 tons. This includes the $PM_{2.5}$ directly emitted from sources included in the MPCA emission inventory; however, it does not include secondarily formed or natural sources of $PM_{2.5}$, which can comprise at least half of the $PM_{2.5}$ found in the air.

Sources of Direct Fine Particulate ($PM_{2.5}$) Emissions in Minnesota, 2005*



*Does not include secondarily formed or natural sources

More than 40 percent of the estimated mass of primary, manmade $PM_{2.5}$ emissions comes from fugitive dust from unpaved and paved roads. A quarter of the emissions come from suspended soils released from agricultural tilling. Almost 10 percent come from industrial, commercial and residential fuel combustion. The remainder comes from a variety of large facilities such as electric utilities and the paper and mining industries; combustion of fuels in non-road sources; construction; and waste disposal.

Although this inventory suggests that most of the estimated $PM_{2.5}$ emissions are related to the soils found in the earth's crust, such as from agricultural tilling and road dust, in reality, only a small fraction of the $PM_{2.5}$ concentrations measured in typical air result from these "crustal" emission sources. Much of Minnesota's $PM_{2.5}$ air pollution results from secondary sources in Minnesota and other states that release "precursor" gases such as sulfur dioxide, nitrogen oxides, ammonia, or carbon-containing chemicals to the atmosphere. Depending on the weather conditions, these precursor gases will undergo chemical reactions in the air to form "secondary" $PM_{2.5}$. Emissions values for the major precursor gases, sulfur dioxide, nitrogen oxides and ammonia, are included later in this report.

At least half of the ambient fine particles measured in the Twin Cities and Rochester, and a proportionally larger fraction of the ambient $PM_{2.5}$ measured in rural areas, were found to result from $PM_{2.5}$ "precursor" gases. The following table describes the sources associated with the most common fine particle components, and whether they are the result of direct emissions or secondary formation.

Table 3: Major Sources of $PM_{2.5}$ Components

Component	Major Sources	Contributes to:
Sulfate (SO_4)	Coal combustion	Secondary formation
Nitrate (NO_3)	Coal combustion, mobile sources and gas heating	Secondary formation
Ammonia (NH_4)	Agriculture	Secondary formation
Elemental Carbon	Mobile sources and biomass burning	Primary emissions
Organic Carbon	Biogenic emissions (i.e. natural decay), mobile sources, and biomass burning	Primary emissions and secondary formation
Crustal material	Fugitive dust	Primary emissions
Metals	Combustion and fugitive dust	Primary emissions

Trends

Statewide $PM_{2.5}$ emissions are estimated every three years. $PM_{2.5}$ emissions were estimated for the first time in 2002 and 2005 estimates are now available. Total estimated $PM_{2.5}$ emissions were 169,000 tons in 2002 and 166,000 tons in 2005. Estimating $PM_{2.5}$ emissions is challenging and the methodology is expected to improve over time. Given the uncertainty in the emission estimates, and the ongoing improvements in the estimation methods, it is difficult to interpret whether there has been a decrease in actual emissions**.** Estimates for 2008 are expected to be available in the summer of 2012.

References/web links

For more information on $PM_{2.5}$, see the following websites:

http://www.epa.gov/oar/particlepollution/

http://www.epa.gov/airtrends/pm.html

PM_{10}

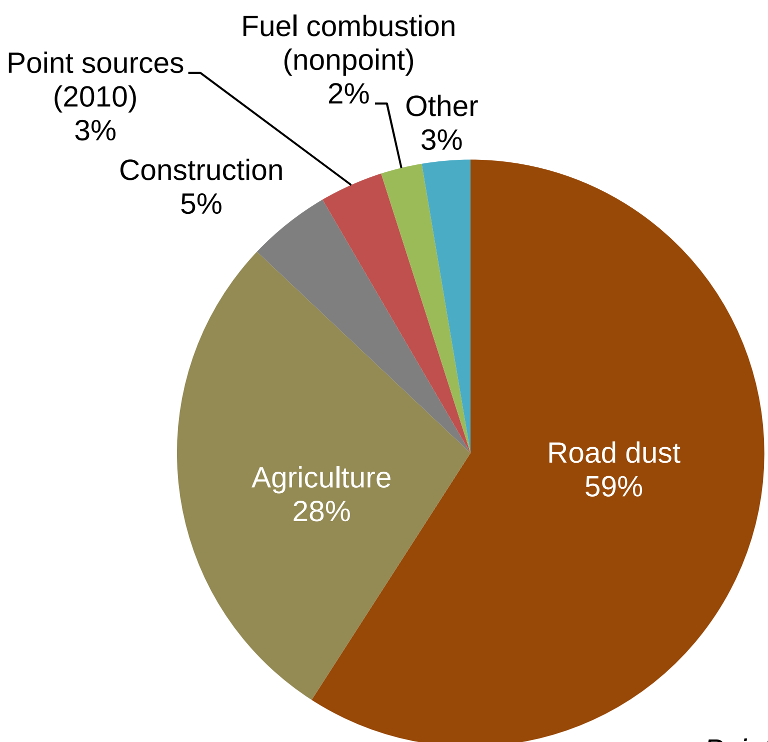
PM_{10} includes all particles with aerodynamic diameters less than 10 microns. $PM_{2.5}$ is a subset of PM_{10} emissions. Based on monitoring data, roughly half of the mass of Minnesota's ambient PM_{10} particles are of particles within the $PM_{2.5}$ size and so the direct and secondary formation and the health effects discussed for $PM_{2.5}$ have relevance for PM_{10}. However, ambient PM_{10} includes a much higher fraction of crustal materials. PM_{10} has been linked to cardiovascular and respiratory health effects, but the studies of PM_{10} indicate a weaker association with cardiovascular effects than for $PM_{2.5}$.

PM_{10} particles are generally emitted from sources such as vehicles traveling on unpaved roads; agricultural tilling; materials handling; crushing and grinding operations, and windblown dust. The larger of these particles can settle from the atmosphere within hours. Their spatial impact is typically more limited (compared to $PM_{2.5}$) because they tend to fall out of the air near where they were emitted.

Emissions data and sources

The MPCA estimate for statewide primary emissions of PM_{10} in 2010 is 775,000 tons. This includes the PM_{10} directly emitted from sources included in the MPCA emission inventory; however, it does not include secondarily formed PM_{10}.

Sources of Direct PM_{10} Emissions in Minnesota, 2005 and 2010



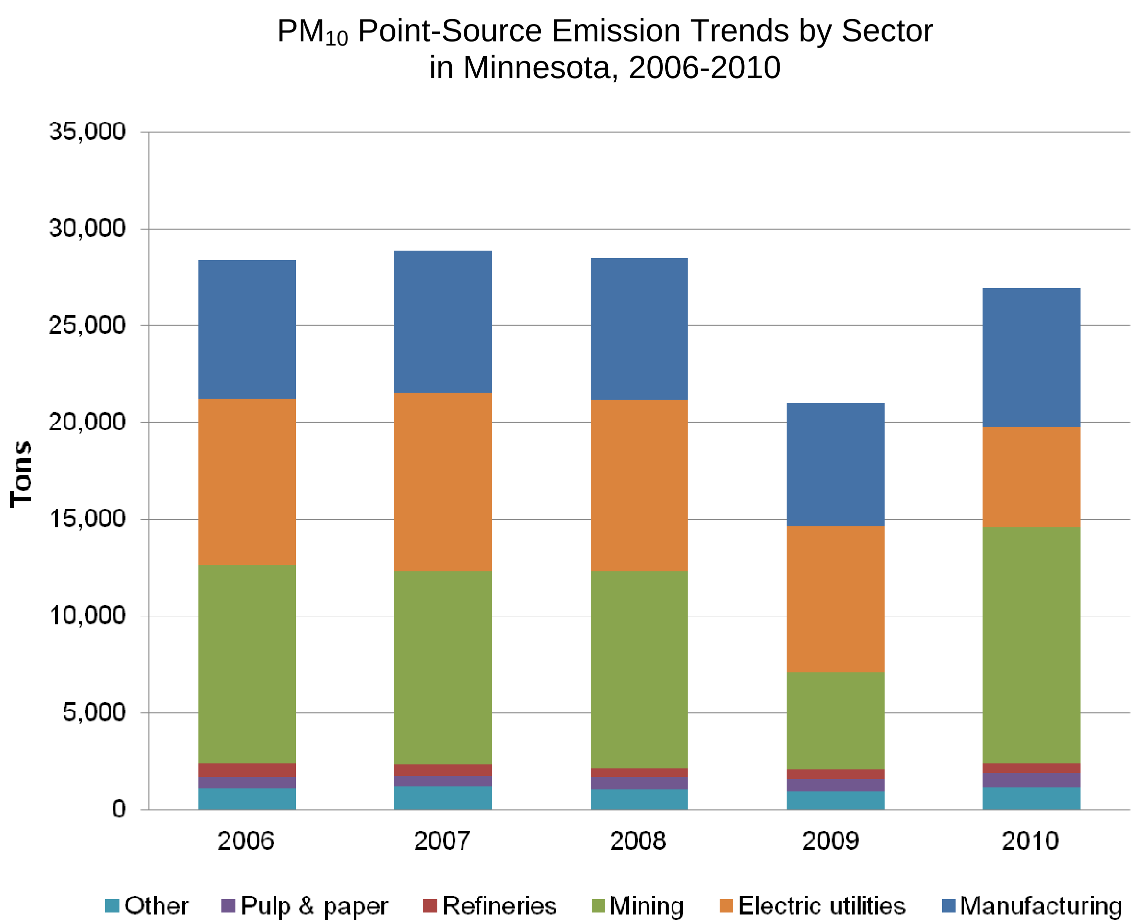
Point source data are from the 2010 Emissions Inventory. All other data are from the 2005 Emissions Inventory.

Almost 60 percent of the mass of direct primary PM_{10} emissions come from fugitive dust from unpaved and paved roads. Over a quarter of emissions come from agricultural tilling. Five percent is emitted from construction. The remainder comes from a variety of large facilities such as electric utilities and the paper and mining industries, and fuel combustion from smaller sources.

PM_{10} particles formed secondarily in the atmosphere from chemical reactions involving gaseous pollutants are not accounted for in these pie charts and graphs.

Trends

In 2010, point sources contributed three percent to the total state PM_{10} emissions. Between 2008 and 2009 there was a large reduction in PM_{10} emissions from the mining sector due to production decreases at taconite facilities in Northern Minnesota. In addition, there was a reduction in coal burned at electric utilities such as Minnesota Power's Boswell facility in Cohasset. While reductions in coal burning continued in 2010, taconite production increased to pre-2006 levels, resulting in PM_{10} emissions near the levels seen in 2006-2008.



References/web links

For more information on PM_{10}, see the following website:

http://www.epa.gov/oar/particlepollution

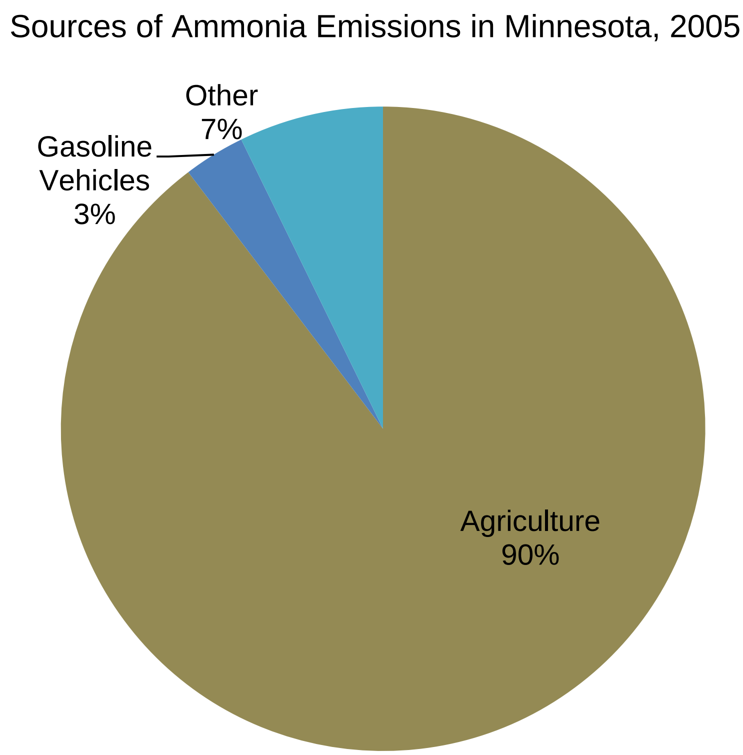
Ammonia

Ammonia is a colorless gas with a distinctive odor. The main source of ammonia gas in the air is livestock waste and fertilizer application. It can be smelled at a concentration near 50 ppm, but human health effects are not expected at that level. Exposure to high concentrations of ammonia may irritate the skin, eyes, throat and lungs and cause coughing and burns.

Federal rules direct the MPCA to track emissions of ammonia because it is a major component of fine particles ($PM_{2.5}$). Ammonia combines with sulfur dioxide and nitrogen oxides to form ammonium sulfate and ammonium nitrate particles. These particles make up half of fine particle mass in urban areas in Minnesota and at least three quarters of fine particle mass in rural areas.

Emissions data and sources

The MPCA estimate for statewide emissions of ammonia in 2005 is 180,000 tons. The majority of ammonia emissions were from agricultural production, mainly livestock waste and fertilizer application.



Trends

Statewide ammonia emissions are estimated every three years. Ammonia emissions were included in the emissions inventory for the first time in 2002 when total Minnesota ammonia emissions were estimated at 179,000 tons. In 2005, Minnesota ammonia emissions were estimated at 180,000 tons. Due to inherent uncertainties of the emissions estimating process, there was essentially no change in ammonia emissions between 2002 and 2005.

References/web links

For more information on how ammonia affects fine particle formation see the section on $PM_{2.5}$.

Sulfur Dioxide

Sulfur dioxide (SO_2) belongs to the family of sulfur oxide gases. Sulfur oxide gases are formed when fuel containing sulfur (mainly coal and oil) is burned and during gasoline production and metal smelting.

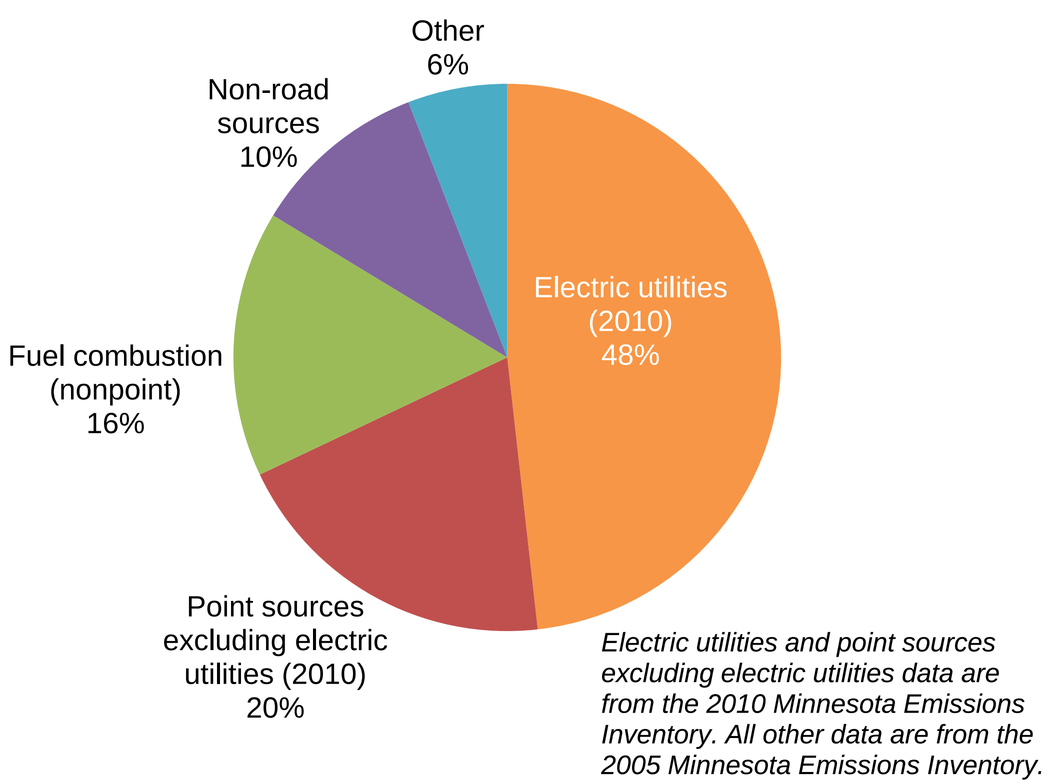
Current scientific evidence links short-term exposures to SO_2 with adverse respiratory effects including bronchoconstriction and increased asthma symptoms. Studies show a connection between exposure to SO_2 and increased visits to emergency departments and hospital admissions for respiratory illness. Children, asthmatics and the elderly may be particularly sensitive. SO_2 also reacts with other chemicals in the air to form tiny sulfate particles.

SO_2 also causes significant environmental damage. SO_2 reacts with other substances in the air to form acids, which fall to earth as rain, fog, snow, or dry particles. Acid rain damages forests and crops, changes the makeup of soil, and makes lakes and streams acidic and unsuitable for fish. In addition, SO_2 accelerates the decay of buildings and monuments and is a major cause of reduced visibility due to haze in Minnesota.

Emissions data and sources

The MPCA estimate for statewide emissions of SO_2 in 2010 is 92,000 tons. The figure below shows sources of 2005 and 2010 SO_2 emissions.

Sources of Sulfur Dioxide Emissions in Minnesota, 2005 and 2010

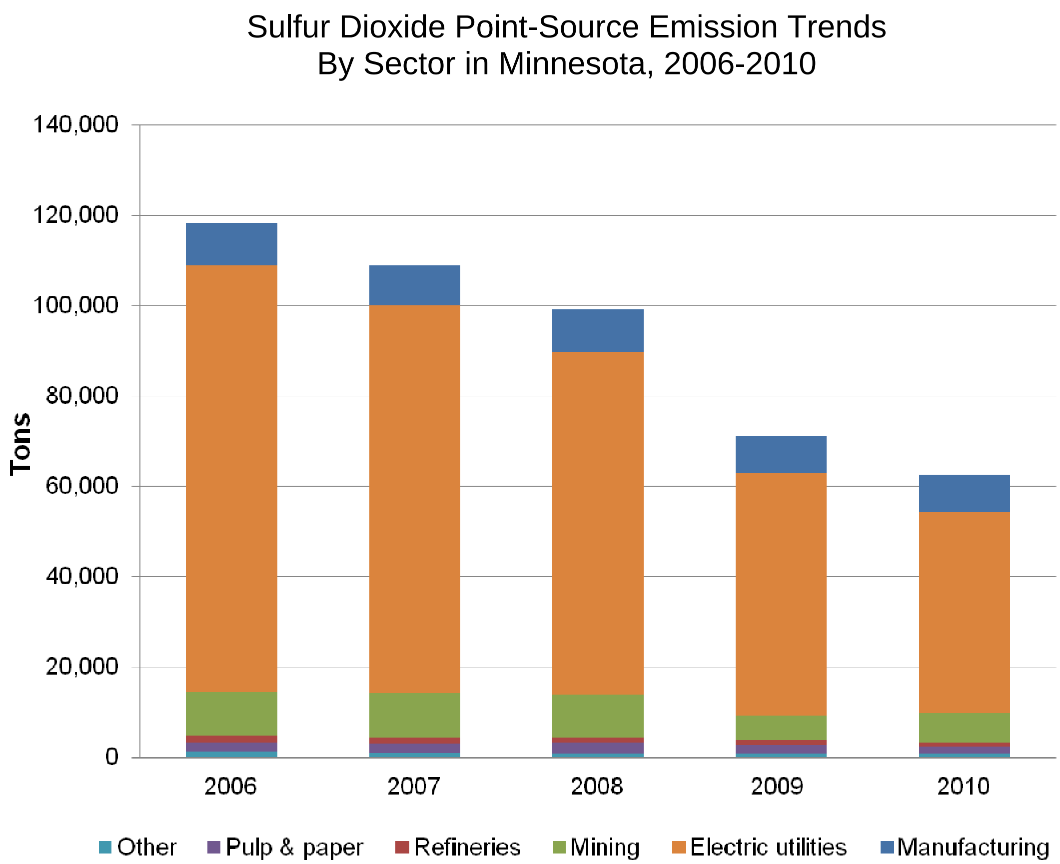


Nearly half (48 percent) of SO_2 emissions come from coal-burning electric utilities. Twenty percent come from industrial point sources while 16 percent are the result of smaller industrial burning of coal, distillate oil and prescribed burning. Non-road agricultural, railroad and construction equipment burning distillate oil make up the bulk of remaining SO_2 emissions.

Trends

Point sources contribute 68 percent to the total state SO_2 emissions with coal-burning electric utilities the greatest emitters. Emissions from point sources have been decreasing since 2005 due mainly to reductions in emissions from electric utilities. Xcel Energy's Allen S. King coal-fired power plant in Oak Park Heights was renovated with state-of-the-art pollution controls while St. Paul's High Bridge power plant and Minneapolis' Riverside power plant were converted from coal to cleaner-burning natural gas. Minnesota Power also installed modern air pollution controls at its Boswell coal-fired power plant in Cohasset in 2009.

As a result of these changes, the Allen S. King plant burned more coal in 2008 than it did in 2004, but decreased its emissions of SO_2 by over 26,000 tons. The High Bridge plant completed its conversion to natural gas in February 2008. Its emissions of SO_2 dropped from a high of nearly 4,000 tons in 2004, to just over one ton in 2008. In addition, the Riverside plant completed its conversion in 2009 resulting in a decrease in emissions of over 10,000 tons. The Boswell plant reduced its emissions by over 8,000 tons due to decreased burning of coal during renovation and air pollution control modernization. In 2010, the Xcel Energy Sherburne County Generating Plant decreased the tons of coal burned, further reducing statewide SO_2 emissions.



References/web links

For more information on sulfur dioxide, see the following websites:

http://www.epa.gov/air/sulfurdioxide/

http://www.epa.gov/air/airtrends/sulfur.html

Nitrogen Oxides

Nitrogen oxides (NO_x) is the generic term for a group of highly reactive gases, all of which contain nitrogen and oxygen. The two primary constituents are nitric oxide (NO) and nitrogen dioxide (NO_2). NO is a colorless, odorless gas that is readily oxidized in the atmosphere to NO_2. NO_2 exists as a brown gas that gives photochemical smog its reddish-brown color. NO_x is reported because NO and NO_2 continuously cycle between the two species. NO_x form when fuel is burned at high temperatures.

Current scientific evidence links short-term NO_2 exposures with adverse respiratory effects including increased asthma symptoms and an increase in other respiratory illnesses. Studies also show a connection between exposure to NO_2 and increased visits to emergency departments and hospital admissions for respiratory illnesses, particularly for children, the elderly, and asthmatics.

NO_x are a major precursor both to ozone and to fine particulate matter ($PM_{2.5}$). As discussed in the ozone and $PM_{2.5}$ sections of this report, exposure to these pollutants is associated with serious adverse health effects.

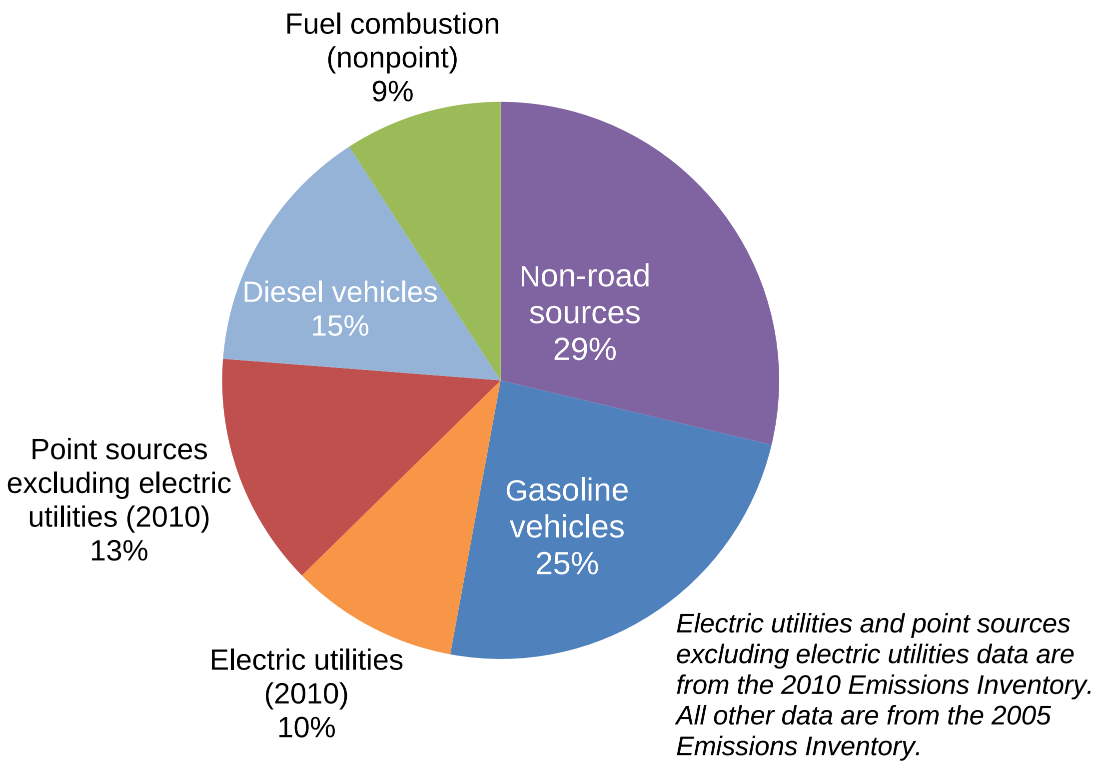
High NO_x concentrations also have environmental impacts. Deposition of nitrogen can lead to fertilization, eutrophication, and acidification of terrestrial, wetland and aquatic systems resulting in changes in species number and composition such as the reduction of fish and shellfish populations. Nitrate particles and nitrogen dioxide also increase visibility impairment in areas such as the Boundary Waters Canoe Area Wilderness and Voyageurs National Park and urban areas such as Minneapolis and St. Paul. In addition, nitrous oxide (N_2O), another component of NO_x, is a greenhouse gas that contributes to global climate change.

Emissions data and sources

The MPCA estimate for statewide emissions of NO_x in 2010 is 358,000 tons. The figure on the next page shows sources of 2005 and 2010 NO_x emissions.

More than a quarter of NO_x emissions come from non-road sources such as railroads and agricultural, construction and recreational equipment. Another 25 percent comes from on-road gasoline vehicles. Electric utilities contribute 10 percent of NO_x emissions. Combustion from other large point sources emits 13 percent while diesel vehicles emit an additional 15 percent. Fuel combustion from smaller sources contributes most of the remainder of NO_x emissions in Minnesota.

Sources of Nitrogen Oxide Emissions in Minnesota, 2005 and 2010



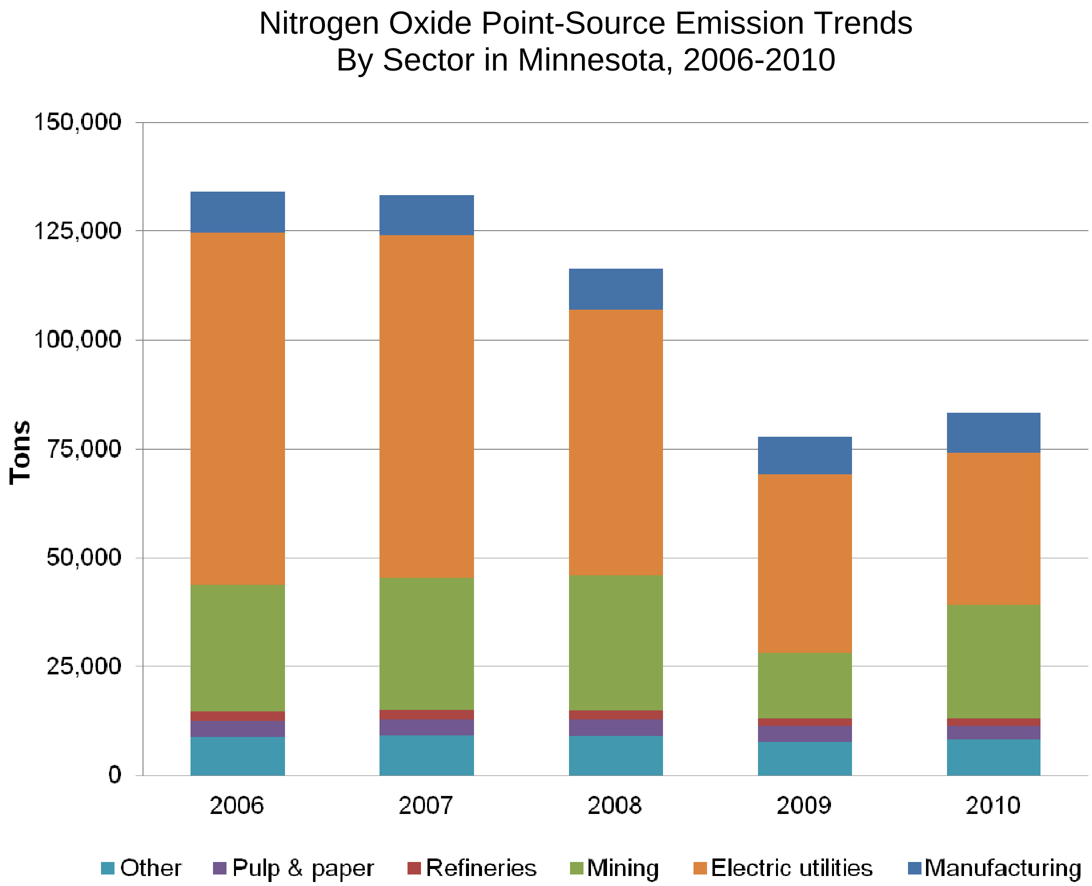
Trends

Point sources contribute 23 percent of the NO_x emissions in Minnesota. There was a pronounced decrease in NO_x emissions in 2008 and 2009 due to emission reductions in the electric utilities and mining sectors. While reductions in coal burning continued in 2010, taconite production increased, resulting in slightly higher statewide NO_x emissions from point sources.

Xcel Energy's Allen S. King coal-fired power plant in Oak Park Heights was renovated with state-of-the-art pollution controls while St. Paul's High Bridge power plant and Minneapolis' Riverside power plant were converted from coal to cleaner-burning natural gas. Minnesota Power also installed modern air pollution controls at its Boswell coal-fired power plant in Cohasset in 2009.

As a result of these changes, in 2008, the Allen S. King plant burned more coal than it did in 2004, but decreased its emissions of NO_x by more than 11,000 tons. The High Bridge plant completed its conversion to natural gas in February 2008. Its emissions of NO_x dropped from a high of more than 6,000 tons in 2004, to less than 30 tons in 2008. In addition, the Riverside plant completed its conversion in 2009 resulting in a decrease in emissions of nearly 10,000 tons. The Boswell plant reduced its emissions by over 4,000 tons due to decreased burning of coal during renovation and air pollution control modernization.

Mining emissions vary annually depending on the demand for taconite pellets. The kilns that bake the pellets burn a variety of fuels, including natural gas, which results in NO_x emissions. There was a significant reduction in taconite production in 2009 at many facilities; however, production rebounded in 2010 with a corresponding increase in NO_x emissions.



References/web links

For more information on nitrogen oxides, see the following websites:

http://www.epa.gov/air/nitrogenoxides/

http://www.epa.gov/airtrends/nitrogen.html

Ozone

Ozone is a colorless gas composed of three atoms of oxygen. Naturally occurring ozone in the upper atmosphere helps protect the earth's surface from ultraviolet radiation. However, ground-level ozone at elevated concentrations can trigger a variety of health problems.

Breathing air containing ozone can reduce lung function and inflame airways, which can increase respiratory symptoms and aggravate asthma or other lung diseases. Ozone exposure has been associated with increased susceptibility to respiratory infections, medication use, doctor visits, and emergency department visits and hospital admissions for individuals with lung disease. Ozone exposure also increases the risk of premature death from heart or lung disease. Children are at particular risk from ozone because their lungs are still developing and they are more likely to have increased exposure since they are often active outdoors.

Scientific evidence shows that repeated exposure to ground-level ozone has detrimental effects on plants and ecosystems including interfering with plants' ability to produce and store food, damaging the leaves of trees and other plants, and reducing forest growth and crop yields. Cumulative ozone exposure can lead to reduced tree growth; visibly injured leaves; and increased susceptibility to disease, damage from insects and harsh weather. These effects can have adverse impacts on ecosystems, including loss of species and changes to habitat quality, and water and nutrient cycles.

Emissions data and sources

Emissions of ozone are not reported because ozone is not normally emitted directly into the air. Instead, it is created when precursor gases such as nitrogen oxides (NO_x) and volatile organic compounds (VOCs) react in a hot stagnant atmosphere. Since heat and sunlight are needed for ozone to be produced, elevated levels of ozone in Minnesota are normally seen on very hot summer afternoons. Both urban and rural areas may have high levels of ozone since wind carries ozone and its precursors far from the original sources.

Ozone precursors come from a variety of sources. NO_x can form when fuels are burned at high temperatures. The major NO_x sources are combustion processes from highway vehicles and power plants. VOCs are emitted from a variety of sources, including industrial sources, motor vehicles and consumer products. NO_x and VOCs are also emitted by naturally occurring sources such as soil and vegetation. See the nitrogen oxides and volatile organic compounds sections of this report for more information regarding 2010 emissions of ozone precursors.

References/web links

For more information on ozone, see the following websites:

http://www.epa.gov/air/ozonepollution/index.html

http://www.epa.gov/airtrends/ozone.html

Volatile Organic Compounds

Volatile organic compounds (VOCs) are compounds containing the elements carbon and hydrogen that exist in the atmosphere primarily as gases because of their low vapor pressure. VOCs are defined in federal rules as chemicals that participate in forming ozone. Therefore, only gaseous hydrocarbons that are photochemically reactive and participate in the chemical and physical atmospheric reactions that form ozone and other photochemical oxidants are considered VOCs.

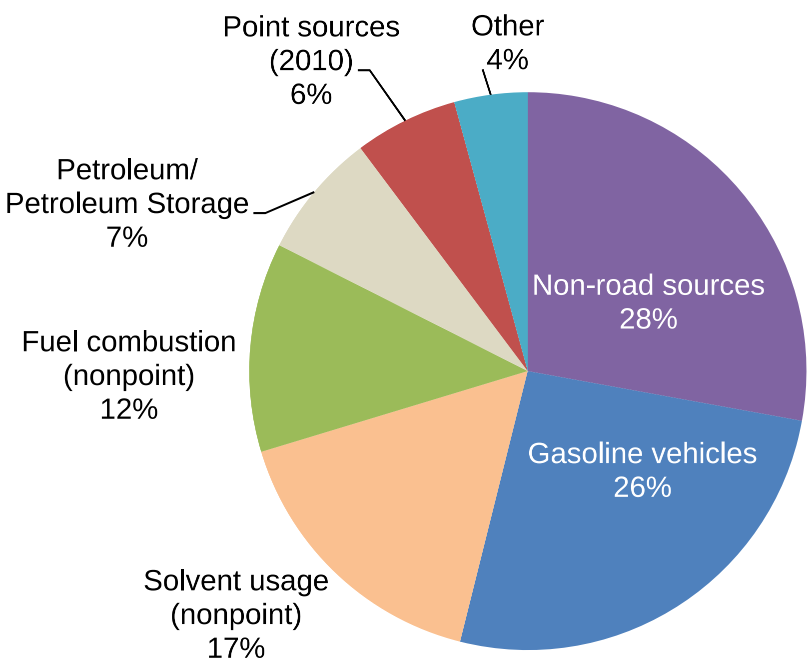
Many VOCs are also air toxics and can have harmful effects on human health and the environment. However, VOCs are regulated as a criteria pollutant because they are precursors to ozone. See the sections on ozone and air toxics for related human health and environmental effects.

Emissions data and sources

The MPCA estimate for statewide emissions of VOCs in 2010 is 343,000 tons.

VOCs are emitted from a variety of sources including industrial facilities, motor vehicles, consumer products, and natural sources such as soils and vegetation. The figure below shows only manmade Minnesota sources of VOCs in 2010.

Sources of Volatile Organic Compound Emissions in Minnesota, 2005 and 2010



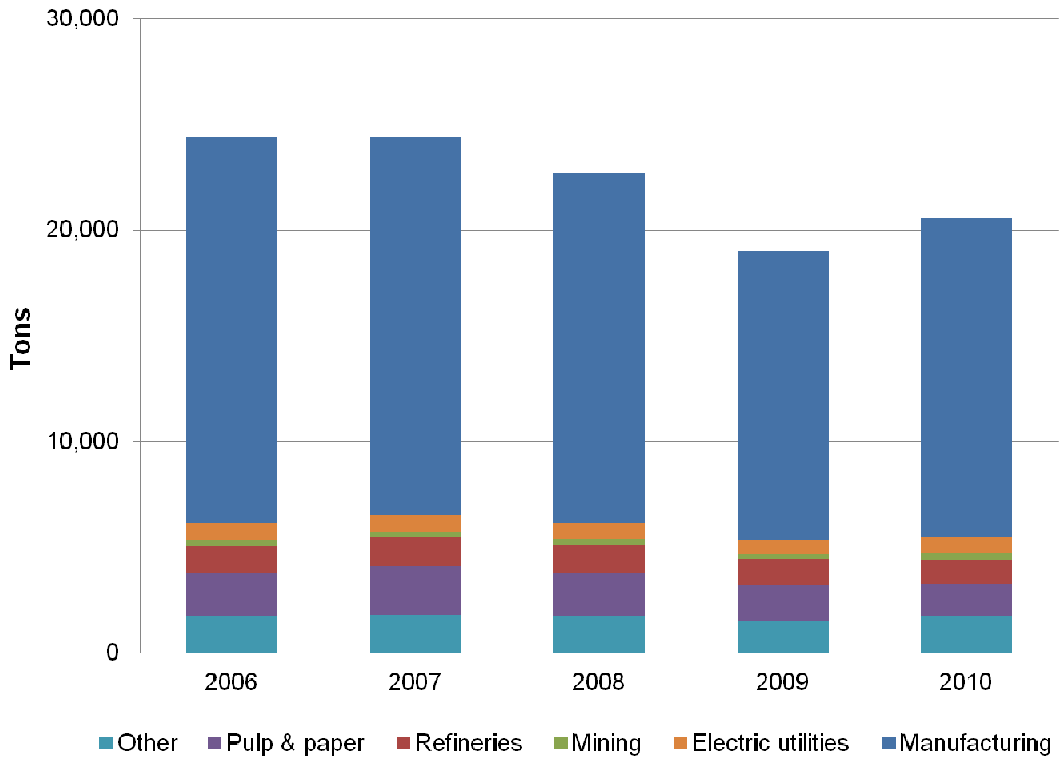
Point source data are from the 2010 Emissions Inventory. All other data are from the 2005 Emissions Inventory.

Almost 30 percent of VOC emissions are from non-road sources, in particular recreational vehicles such as snowmobiles, boats, ATVs and motorcycles burning gasoline. Some additional non-road sources of VOCs include agricultural, construction and lawn and garden equipment. On-road gasoline vehicles emit another quarter of VOC emissions. Solvent usage from smaller sources emits 17 percent. Twelve percent of VOC emissions are from residential burning of wood in fireplaces and woodstoves. The storage and transport of gasoline, solvent usage and other emissions from larger facilities make up the bulk of the remaining VOC emissions.

Trends

Point sources contribute six percent of the VOC emissions in the state. Emissions had been gradually decreasing since 2004 due mainly to decreases in the manufacturing sector, however, a rebounding economy resulted in higher VOC emissions from manufacturing in 2010.

Volatile Organic Compound Point-Source Emission Trends
By Sector in Minnesota, 2006-2010



References/web links

For more information on volatile organic compounds, see the sections on ozone and air toxics.

Carbon Monoxide

Carbon monoxide (CO) is a colorless and odorless toxic gas formed when carbon in fuels is not burned completely. A major source of CO is motor vehicle exhaust. Higher levels of CO generally occur in areas with heavy traffic congestion and during the colder months of the year.

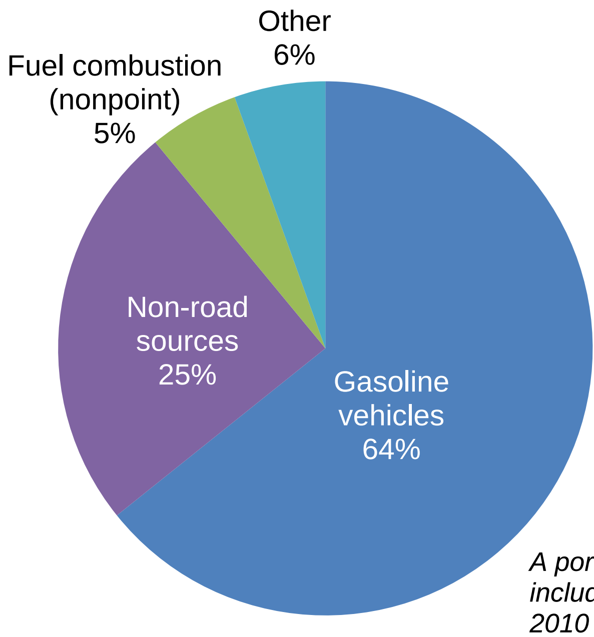
CO enters the bloodstream and reduces the delivery of oxygen to the body's organs and tissues. The health threat from CO is most serious for those who suffer from cardiovascular disease. At higher concentrations it also affects healthy individuals. Exposure to elevated CO levels is associated with impaired visual perception, work capacity, manual dexterity, learning ability and performance of complex tasks. Prolonged exposure to high levels can lead to death.

At concentrations commonly found in the ambient air, CO does not appear to have adverse effects on plants, wildlife or materials. However, CO is oxidized to form carbon dioxide (CO_2), a major greenhouse gas and contributor to global climate change. CO also contributes to the formation of ground-level ozone.

Emissions data and sources

The MPCA estimate for statewide emissions of CO in 2010 is 1,770,000 tons. The figure below shows sources of 2010 CO emissions.

Sources of Carbon Monoxide Emissions in Minnesota, 2005 and 2010



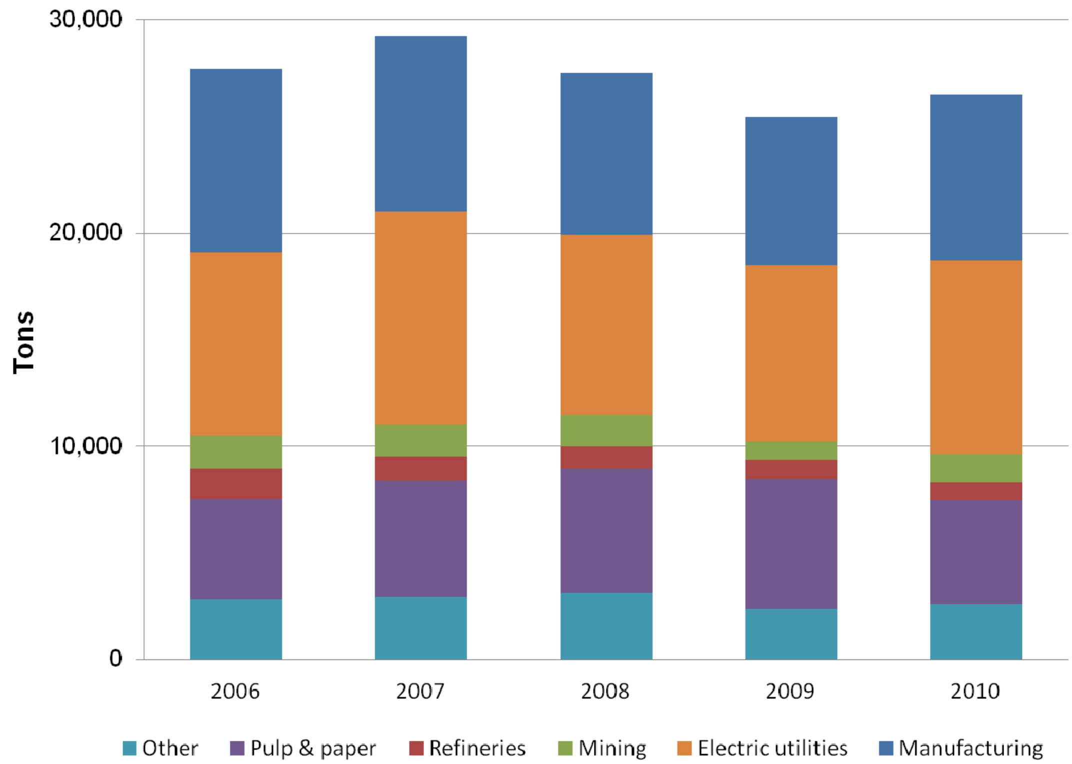
A portion of the other category includes point source data from the 2010 Emissions Inventory. All other data are from the 2005 Emissions Inventory.

The majority of CO emissions come from the combustion of gasoline in on-road vehicles. A quarter of emissions come from the combustion of fuels in non-road recreational vehicles such as snowmobiles, boats, golf carts, and ATVs as well as lawn and garden equipment. Fuel combustion, particularly residential wood combustion, contributes an additional five percent of CO emissions. A variety of sources, including emissions from fuel combustion and metals processing in large facilities, burning waste, and emissions from diesel vehicles comprise the remaining emissions of CO.

Trends

Point sources contributed fewer than two percent of the total Minnesota CO emissions in 2010. The CO values had been gradually increasing since 2005, but decreased in 2008 and 2009. In 2010, CO emissions from point sources were slightly higher due to increased emissions from electric utilities, mining and manufacturing.

Carbon Monoxide Point-Source Emission Trends
By Sector in Minnesota, 2006-2010



References/web links

For more information on carbon monoxide, see the following websites:

http://www.epa.gov/airquality/carbonmonoxide/

http://www.epa.gov/air/airtrends/carbon.html

http://www.health.state.mn.us/divs/eh/indoorair/co/index.html

Lead

Lead is a metal found naturally in the environment as well as in manufactured products. In the past, the major sources of lead emissions were motor vehicles and industrial sources. Since lead in gasoline was phased out, air emissions and ambient air concentrations have decreased dramatically. Currently, metals processing (lead and other metals smelters) and aircraft using leaded fuel are the primary sources of lead emissions.

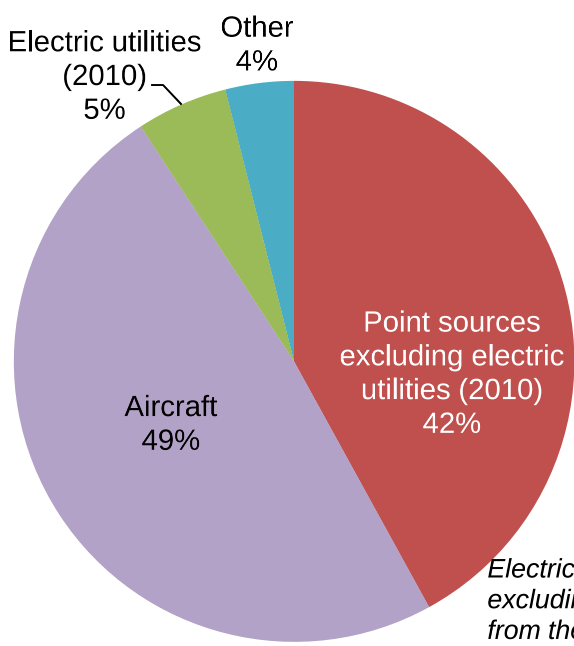
Scientific evidence about the health effects of lead has expanded significantly in the last 30 years. Exposures to low levels of lead early in life have been linked to effects on IQ, learning, memory and behavior. There is no known safe level of lead in the body.

Elevated lead levels are also detrimental to animals and to the environment. Ecosystems near sources of lead show many adverse effects including losses in biodiversity, changes in community composition, decreased growth and reproductive rates in plants and animals, and neurological effects in animals.

Emissions data and sources

The MPCA estimate for statewide emissions of lead in 2010 is 18 tons. The total mass of lead emitted is much less than the other criteria pollutants. However, it takes only a small amount of lead to cause serious and permanent health problems. Therefore, even relatively low lead emissions are a concern. The figure below shows sources of 2010 lead emissions.

Sources of Lead Emissions in Minnesota, 2005 and 2010



Electric utilities and point sources excluding electric utilities data are from the 2010 Emissions Inventory. All other data are from the 2005 Emissions Inventory.

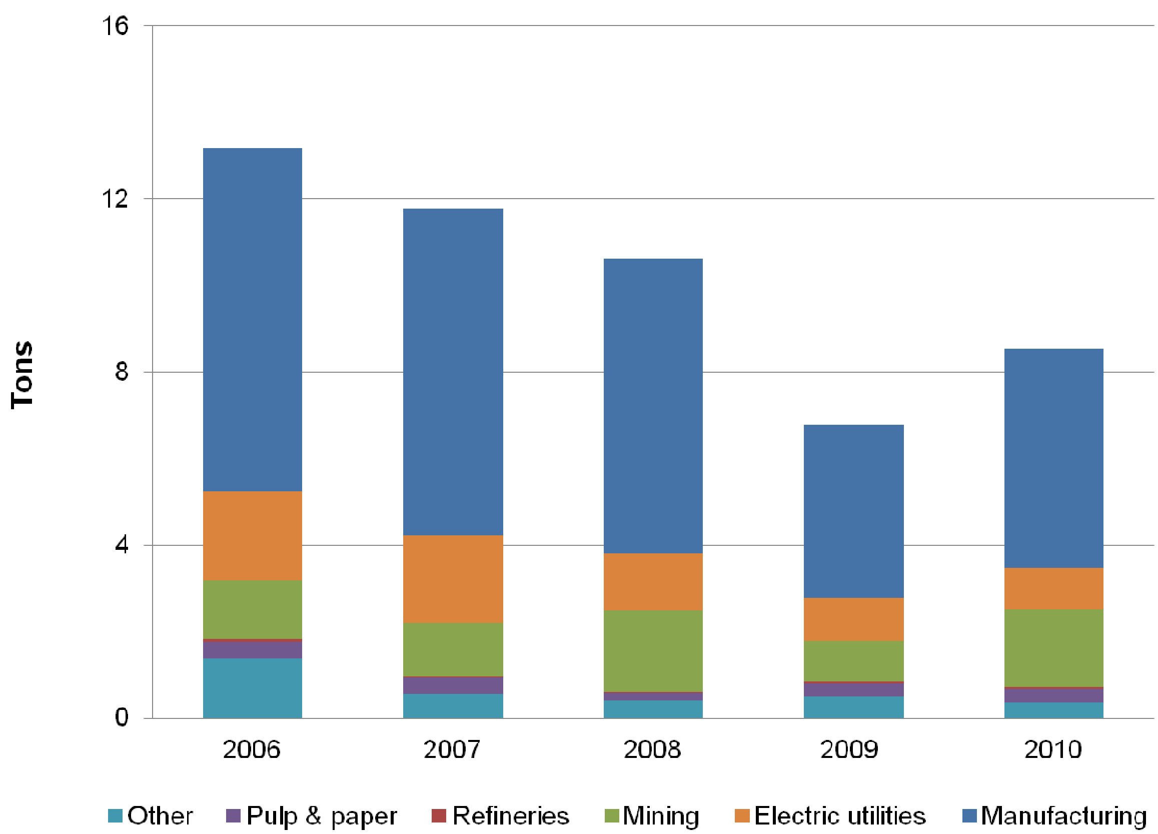
Point sources excluding electric utilities contribute 42 percent of Minnesota's lead emissions. These point sources include metal processing, and some combustion of waste and coal. General aviation aircraft emit

49 percent of lead emissions from burning leaded fuel. Coal-burning power plants add an additional five percent of lead to the environment while other small sources contribute the final four percent.

Trends

Point sources (including electric utilities) contribute 47 percent of the state's lead emissions. In Minnesota, the estimated lead emissions from point sources had been decreasing from most sectors. In 2009, taconite mining facilities and foundries reduced production, resulting in lead emission reductions. One foundry also completed a stack test, resulting in a lower emission factor for lead. Electric utilities emit lead when burning coal. Utilities burned less coal in 2009 due to conversions to natural gas and other factors. Increases in lead emissions from increased manufacturing and taconite mining resulted in increased lead emissions in 2010.

Lead Point-Source Emission Trends By Sector in Minnesota, 2006-2010



References/web links

For more information on lead, see the following websites:

http://www.epa.gov/air/lead/index.html

http://www.epa.gov/air/airtrends/lead.html

http://www.pca.state.mn.us/air/lead.html

http://www.health.state.mn.us/divs/eh/lead/index.html

Mercury

Mercury is a neurotoxin, a substance that damages the central nervous system of people and other animals. For most Minnesotans, eating fish contaminated with too much mercury poses the greatest risk of exposure. While fish provide a healthy source of protein, and consumption is generally encouraged, citizens are advised to restrict their consumption of larger predatory fish, which are more contaminated.

The vast majority of mercury in Minnesota's environment comes from air pollution. Minnesota's land and water become contaminated with mercury when it falls in rain and snow or as "dry deposition." Because mercury vapor can be transported long distances in the atmosphere, most of the mercury in Minnesota originates outside of the state and most of Minnesota's emissions are deposited in other states and countries.

MPCA scientists calculate that mercury pollution sources need to be reduced by about 93 percent from 1990 levels in order to safely eat larger predatory fish such as walleye and northern pike. Accordingly, under the federally mandated Total Maximum Daily Load (TMDL) provisions of the Clean Water Act, the MPCA established a goal of reducing air emissions of mercury to no more than 789 pounds per year by the year 2025. In 2009, with substantial stakeholder input, the MPCA developed a TMDL implementation plan to achieve these reductions.

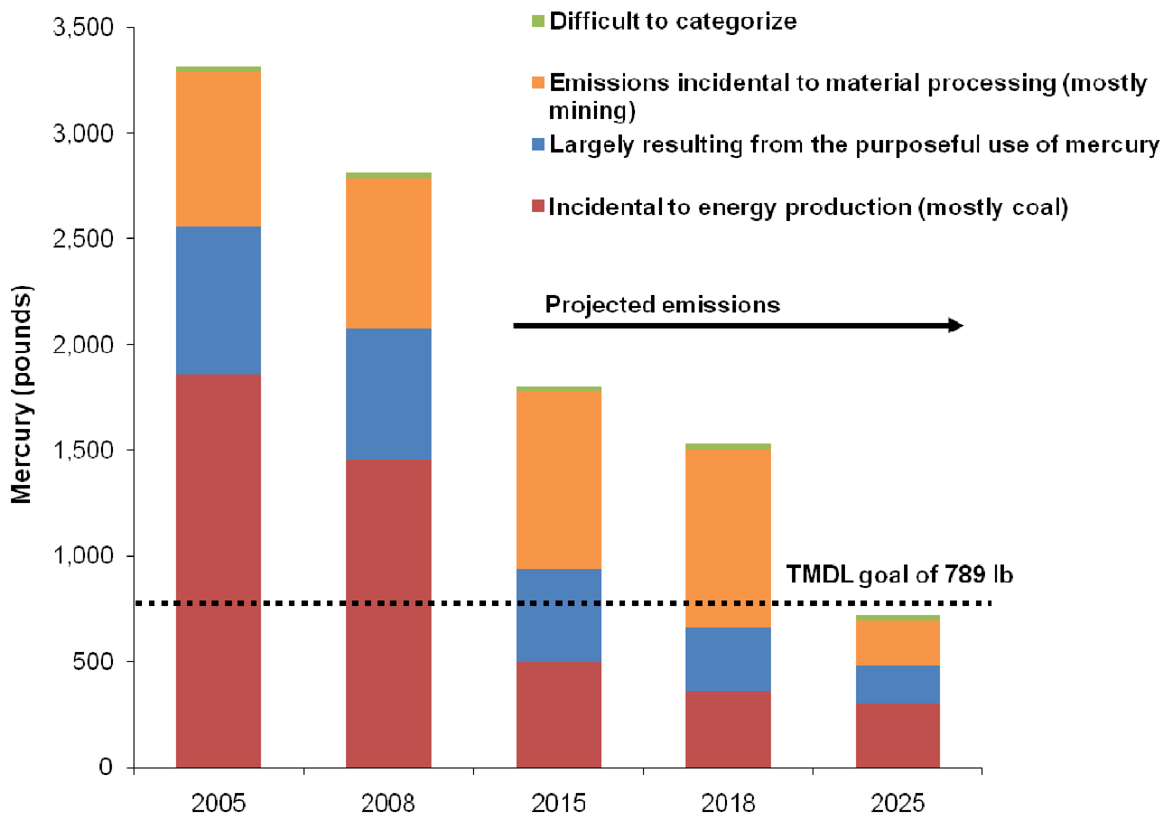
The largest emission sources in the state are the burning of coal and the processing of taconite iron ore. In addition, the use and disposal of a variety of mercury-added products contributes significantly to emissions. The MPCA estimates that in 2010, emissions of mercury from all sources in the state totaled 2,241 pounds, a level that is compatible with reaching the reduction goal by 2025. (See figure on next page.)

Reductions called for in the Minnesota Legislature's Mercury Emission Reduction Act of 2006 will contribute significantly to achieving the state's reduction goal. This law calls for reductions at the state's three largest coal-burning power plants by the end of 2014. The first phase of this reduction was completed in 2010 at Minnesota Power's Boswell Plant in Cohasset and Xcel Energy's Sherco Plant in Becker. Minnesota Power has completed an air pollution control retrofit of Boswell Unit 3, and is expecting to achieve 90 percent control of mercury from this coal-fired generating unit. Xcel Energy has installed mercury control equipment on Sherco Unit 3, and is expecting similar results. Data demonstrating mercury capture will be finalized in early 2011.

Minnesota's taconite-processing industry, soon to be the largest mercury emission source in the state due to decreases in the coal-fired energy sector, is working to identify and prove pollution control technologies suited to their unique industry. Promising initial research findings will be expanded with the aid of a federal grant awarded to the Minnesota Department of Natural Resources in 2010.

More information on strategies for meeting these targets can be found on the MPCA web site at http://www.pca.state.mn.us/air/mercury-reductionplan.html

Actual and Projected Mercury Emissions 2005-2025
(based on stakeholder recommended strategies)



Mercury concentrations in Minnesota fish

A recent analysis of a 25-year record of mercury in northern pike and walleye from Minnesota lakes has found a recent unexpected rise. After declining by 37 percent from 1982 to 1992, average mercury concentrations in these fish started to increase in the mid-1990s. During the last decade of the analysis, 1996-2006, the average mercury concentrations increased 15 percent. This is surprising because during this same period, emissions in Minnesota and the United States declined sharply. MPCA scientists believe that the most likely cause of this increase is either increased global mercury emissions by sources outside of the United States, or factors associated with global climate change, or both. This increase underscores the need to reduce global mercury emissions and address climate change.

References/web links

For more information on mercury, see the following websites:

http://www.pca.state.mn.us/air/mercury.html

http://www.epa.gov/mercury/

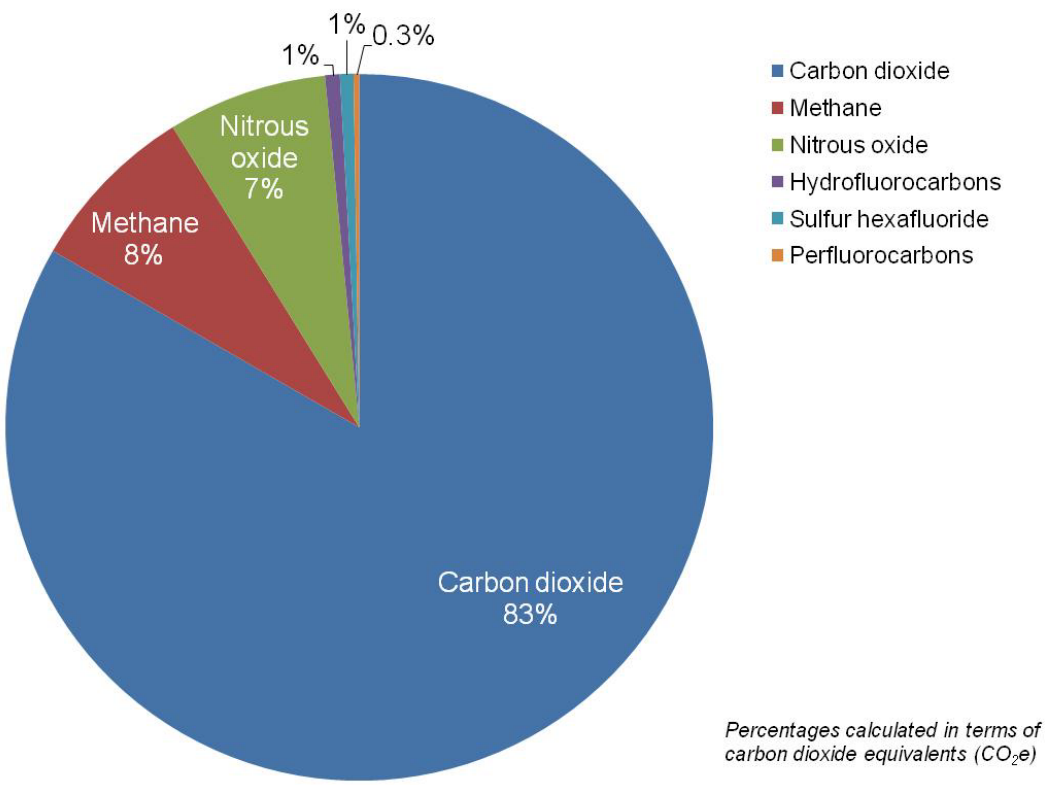
Greenhouse Gases

Climate change results from the buildup of a group of compounds, collectively called greenhouse gases. The most important greenhouse gas, carbon dioxide (CO_2), is mainly formed from the combustion of fossil fuels such as oil, natural gas and coal. Many greenhouse gases occur naturally, but fossil fuel burning and other human activities are adding gases to the natural mix at an accelerated rate.

Emissions data and sources

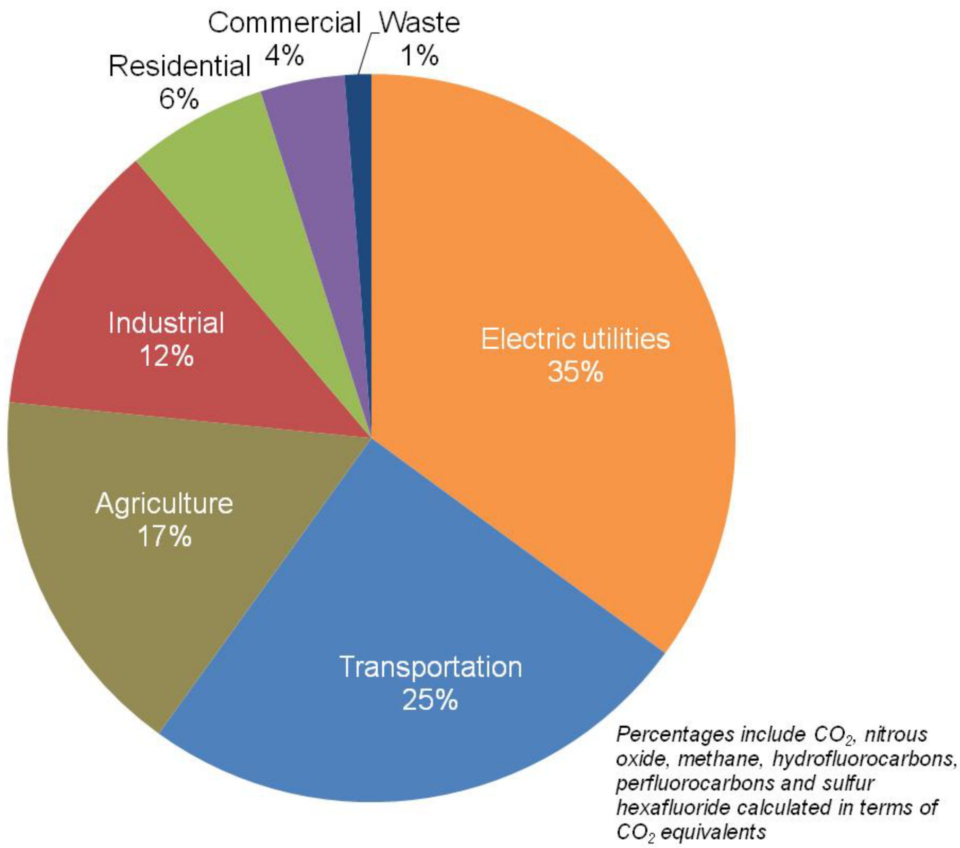
In the past, MPCA has reported only carbon dioxide (CO_2) emissions in this report. Here 2008 emissions for six greenhouse gases (CO_2, nitrous oxide (N_2O), methane (CH_4), hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride) are reported in terms of CO_2 equivalents (CO_2e). CO_2e compares the global warming potential of different gases to the impact of CO_2. In 2008, emissions of CO_2 accounted for about 83 percent of all greenhouse gas emissions from Minnesota.

Contribution of Six Greenhouse Gases to Minnesota Warming Potential, 2008



The most recent estimate for statewide emissions of greenhouse gases in 2008 is 159.5 million tons CO_2e. Roughly 85 percent of greenhouse gas emissions are associated with energy consumption or the production and transportation of fuels. The following pie chart shows greenhouse gas emissions by sector. The largest source of emissions is from electric power generation (35 percent). Included in the estimates from electric power generation are emissions associated with the net import of power from outside of Minnesota to meet domestic electric demand. Transportation contributes 25 percent, agriculture 17 percent and industrial sources 12 percent to estimated greenhouse gas emissions. The remaining emissions are from residential, commercial sources and waste disposal.

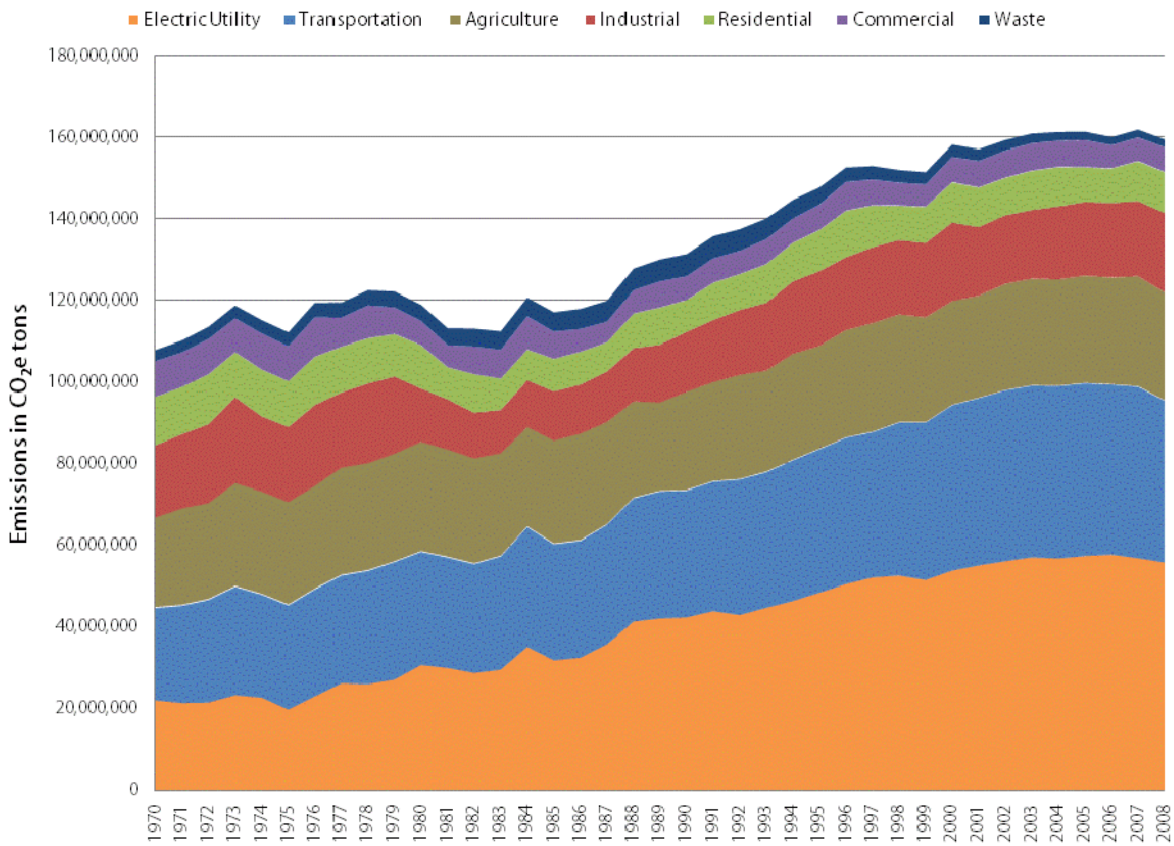
Sources of Greenhouse Gas Emissions in Minnesota, 2008
(Estimates include Net Imported Electricity in Minnesota)



Trends

Emission estimates of these six priority greenhouse gases are available from 1970-2008. They are reported as CO_2 equivalents. Between 1970 and 2008, the majority of the growth in estimated statewide greenhouse gas emissions occurred in two sectors, electric utilities and transportation. In 1970, emissions from these sectors comprised roughly 40 percent of all Minnesota greenhouse gas emissions; however, by 2008 they accounted for 60 percent of emissions.

Trends in Greenhouse Gas Emissions in Minnesota by Economic Sectors, 1970-2008
(Estimates include Net Imported Electricity in Minnesota)



References/web links

For more information on climate change and greenhouse gas emissions, see the following web sites:

http://www.pca.state.mn.us/tchy611

http://www.pca.state.mn.us/index.php/topics/climate-change/regulatory-initiatives-programs-and-policies/climate-change-publications-reports-and-fact-sheets.html

Air Toxics

The EPA defines air toxics as pollutants that cause or may cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental and ecological effects.

The Minnesota Air Toxics Emission Inventory estimates emissions of air toxics. Federal rules require air toxic emission inventories be completed every three years. The most recent completed inventory for Minnesota is for 2005. The 2008 Air Toxics Emission Inventory is expected to be completed in the summer of 2012. The inventory includes three principal source categories: point, nonpoint, and mobile sources.

Point Sources: Typically large, stationary sources with relatively high emissions, such as electric power plants and refineries.

Nonpoint Sources: Typically stationary sources, but generally smaller sources of emissions than point sources. Examples include dry cleaners, gasoline service stations and residential wood combustion. Nonpoint sources may also include a diffuse stationary source, such as wildfires or agricultural tilling. These sources do not individually produce sufficient emissions to qualify as point sources. For example, a single gasoline station typically will not qualify as a point source, but collectively the emissions from many gas stations may be significant.

Mobile Sources: Mobile sources are broken up into two categories; on-road vehicles and non-road sources. On-road vehicles include vehicles operated on highways, streets and roads. Non-road sources are off-road vehicles and portable equipment powered by internal combustion engines. Lawn and garden equipment, construction equipment, aircraft and locomotives are examples of non-road sources.

MPCA staff compiled the emissions estimates for point and the majority of nonpoint sources in the 2005 inventory. However, emissions for wildfires and prescribed burning were obtained from EPA. The results for aircraft (including ground support equipment), and locomotives were also estimated by the MPCA. The estimates for commercial marine vessels were estimated from the 2002 emissions, which were prepared by the Central States Regional Air Partnership (CENRAP) using state-specific data. For all non-road equipment and on-road vehicles, MPCA used estimates from EPA's national inventory.

Table 4 provides a summary of air toxics emissions from principal source categories taken from the 2005 Minnesota Air Toxics Emission Inventory. Values in the table reflect all updates since last year's report until February 2010. The table gives total statewide emissions of each chemical, along with the percent from point, nonpoint, on-road, and non-road mobile sources. The inventory includes 167 chemicals: 16 polycyclic aromatic hydrocarbon compounds (PAHs), 13 metal compounds and 138 non-metal compounds.

Table 4: 2005 Minnesota Air Toxics Emissions Inventory Statewide Summary

Pollutant Name	Total (short tons)	Point sources (%)	Nonpoint sources (%)	On-road mobile (%)	Non-road mobile (%)
PAHs					
Acenaphthene	8.7	56	31	4	9
Acenaphthylene	58.2	<1	93	3	3
Anthracene	6.1	7	79	7	7
Benz[a]Anthracene	6.6	<1	96	2	2
Benzo[a]Pyrene	1.9	4	88	3	4
Benzo[b]Fluoranthene	2.2	<1	93	3	3
Benzo[g,h,i,]Perylene	2.9	<1	85	4	10
Benzo[k]Fluoranthene	1.3	<1	89	6	5
Chrysene	4.7	<1	96	1	2
Dibenzo[a,h]Anthracene	0.1	10	88	<1	2
Fluoranthene	8.4	<1	83	5	11
Fluorene	9.6	5	72	8	16
Indeno[1,2,3-c,d]Pyrene	2.0	34	60	2	4
Naphthalene	323.1	5	69	16	9
Phenanthrene	27.7	2	83	4	10
Pyrene	10.4	1	83	6	10
PAHs (non-specified)	5.9	27	73	<1	<1
PAH Total	479.7	5	74	12	8
Metal Compounds					
Antimony	1.2	95	4		<1
Arsenic	7.9	92	2	2	4
Beryllium	0.3	79	12		9
Cadmium	1.1	79	19		2
Chromium	7.7	93	4	3	<1
Chromium VI	1.0	92	2	5	1
Cobalt	2.6	96	3		<1
Copper	8.0	98	2		<1
Lead	27.2	66	1		33
Manganese	46.1	99	<1	<1	<1
Mercury	1.8	81	19	<1	<1
Nickel	18.6	92	6	1	<1
Selenium	3.9	88	12		<1
Metal Total	127.4	89	3	<1	7
Non-Metal Compounds (Excluding PAHs)					
Acetaldehyde	1,854	9	13	46	32
Acetamide	0.0		100		
Acetone	914.0	57	40		3
Acetonitrile	2.5	100	<1		
Acetophenone	0.3	61	39		
Acrolein	246.8	23	34	23	20
Acrylamide	0.3	100			
Acrylic Acid	12.6	100	<1		
Acrylonitrile	4.8	38	62		
Aldehydes	42.5	100			
Allyl Chloride	0.006	89	11		
Aniline	0.00005	100			
Atrazine	96.8		100		
Benzaldehyde	70.3	2	80		19

Table 4: 2005 Minnesota Air Toxics Emissions Inventory Statewide Summary

Pollutant Name	**Total (short tons)**	**Point sources (%)**	**Nonpoint sources (%)**	**On-road mobile (%)**	**Non-road mobile (%)**
Benzene	6,146	2	24	51	23
Benzyl Chloride	2.0	91	9		
Biphenyl	1.6	69	31		
Dichloroethyl Ether (Bis[2-Chloroethyl]Ether)	<1	100			
Bromoform	0.4	98	2		
Methyl Bromide (Bromomethane)	532	1	99		
1,3-Butadiene	807	<1	12	41	46
Butyraldehyde	13.6	6			94
Carbon Disulfide	2.0	71	29		
Carbon Tetrachloride	8.3	99	<1		
Carbonyl Sulfide	6.7	95	5		
Catechol	0.5	100			
Trichlorofluoromethane (CFC-11, R-11)	1.6	43	57		
Trichlorotrifluoromethane (CFC-113, R-113)	95.9	<1	100		
Chlorine	44.5	24	76		
Chloroacetic Acid	0.2	100			
Chlorobenzene	170	<1	100		
Ethyl Chloride	3.2	72	28		
Chloroform	202	3	97		
2-Chloroacetophenone	0.1	98	2		
Cresol/Cresylic Acid (Mixed Isomers)	1.1	100	<1		
m-Cresol	0.0	100			
o-Cresol	2.6	98	2		
p-Cresol	0.6	77	23		
Crotonaldehyde	13.5	1			99
Cumene	21.3	43	57		
Cyanide Compounds	224	<1	2	21	78
2,4-D (2,4-Dichlorophenoxyacetic Acid)	21.7		100		
Dibenzofuran	1.0	16	84		
Ethylene Dibromide (Dibromoethane)	1.0	99	1		
Dibutyl Phthalate	3.6	94	6		
Ethylene Dichloride (1,2-Dichloroethane)	7.1	87	13		
Dichlorvos	0.1	100			
1,4-Dichlorobenzene	195	<1	99		
M-Dichlorobenzene	1.2	1	99		
O-Dichlorobenzene	0.6	28	72		
Dichlorobenzenes	0.1	29	71		
Ethylidene Dichloride (1,1-Dichloroethane)	1.6	45	55		
Cis-1,2-Dichloroethylene	0.2	100			
Cis-1,3-Dichloropropene	0.1	100			
1,3-Dichloropropene	376	<1	100		
Diethyl Sulfate	0.0	100			
Diethanolamine	1.4	34	66		
Dimethyl Phthalate	5.6	99	1		
Dimethyl Sulfate	0.5	98	2		
N,N-Dimethylformamide	21.1	100	<1		
Dimethylaniline(N,N-Dimethylaniline)	0.1	82	18		
4,6-Dinitro-o-Cresol (Including Salts)	0.0001	100			
2,4-Dinitrophenol	0.01	100			

Table 4: 2005 Minnesota Air Toxics Emissions Inventory Statewide Summary

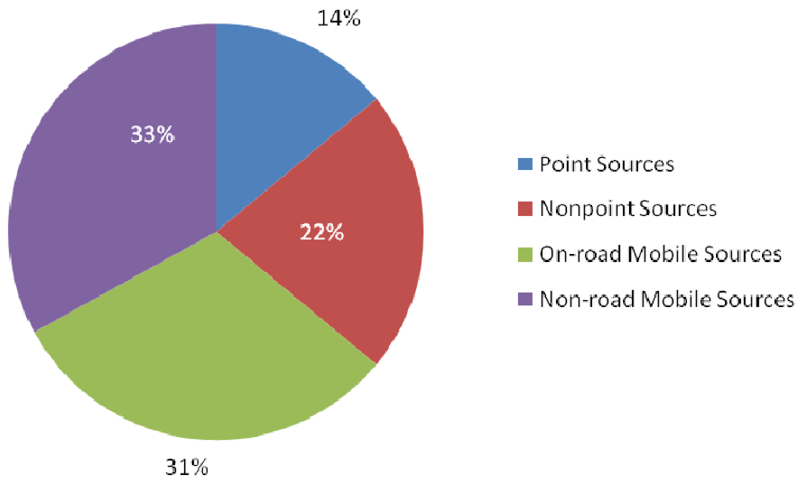
Pollutant Name	**Total (short tons)**	**Point sources (%)**	**Nonpoint sources (%)**	**On-road mobile (%)**	**Non-road mobile (%)**
2,4-Dinitrotoluene	0.1	98	2		
Bis(2-Ethylhexyl)Phthalate (Dehp)	2.7	91	9		
Di-N-Octylphthalate	0.1	100			
p-Dioxane	2.1	52	48		
Epichlorohydrin	0.01	98	2		
1,2-Epoxybutane	0.02	100			
Ethyl Acrylate	0.5	100	<1		
Ethyl Carbamate (Urethane) Chloride (Chloroeth	0.1	100			
Ethylbenzene	2,043	5	6	55	33
Ethylene Glycol	469	14	86		
Ethylene Oxide	15.8	2	98		
Formaldehyde	3,487	14	18	33	35
Glycol Ethers	530	33	67		
Hydrochloric Acid (Hydrogen Chloride Gas)	3,504	88	12		
Hexachlorocyclopentadiene	0.0	69	31		
Hexamethylene Diisocyanate	1.0	100			
Hexane	3,941	38	22	21	20
Hexachloroethane	0.0	100			
Hexachlorobutadiene	0.1	100	<1		
Hexachlorobenzene	0.0	1	99		
Hydrogen Fluoride (Hydrofluoric Acid)	581	94	6		
Hydroquinone	1.6	100			
Isophorone	17.8	85	15		
Maleic Anhydride	0.3	100			
Methyl Ethyl Ketone (2-Butanone)	695	37	63		
Methylhydrazine	1.8	98	2		
Methyl Iodide (Iodomethane)	0.0	100			
Methyl Isobutyl Ketone (Hexone)	177.2	59	41		
Methyl Isocyanate	0.0	100			
Methyl Methacrylate	45	98	2		
Methyl Tert-Butyl Ether	0.8	92	8	<1	
Methanol	2,449	24	76		
4,4'-Methylenediphenyl Diisocyanate (MDI)	4.0	75	25		
Methyl Chloride (Chloromethane)	65.2	9	91		
Methylene Chloride (Dichloromethane)	206.6	30	70		
Nitrobenzene	0.0	99	<1		
4-Nitrophenol	0.2	12	88		
2-Nitropropane	0.01		100		
N-Nitrosodimethylamine	0.004	100			
Parathion	0.1	100			
Polychlorinated Biphenyls (Aroclors)	0.6	<1	100		
Polychlorinated Dibenzodioxins, Total	0.02	98	2	<1	<1
Polychlorinated Dibenzo-P-Dioxins and Furans, Total	0.001	100			
Polychlorinated Dibenzofurans, Total	0.001	78	20	1	<1
Pentachlorophenol	0.3	96	4		
Tetrachloroethylene (Perchloroethylene)	245	38	62		
Phenol	131	67	33		<1
Phosphine	1.0	58	42		

Table 4: 2005 Minnesota Air Toxics Emissions Inventory Statewide Summary

Pollutant Name	**Total (short tons)**	**Point sources (%)**	**Nonpoint sources (%)**	**On-road mobile (%)**	**Non-road mobile (%)**
Phosphorus	2.0	95	4		<1
Phthalic Anhydride	0.1	100			
Polycyclic Organic Matter	25.3	34	66		<1
1,2-Propylenimine (2-Methylaziridine)	0.01	100			
Propionaldehyde	240	2	19	27	51
Propoxur	0.01	100			
Propylene Dichloride (1,2-Dichloropropane)	0.6	71	29		
Propylene Oxide	0.8	97	3		
Quinoline	0.001	100			
Quinone (p-Benzoquinone)	1.0	100			
Styrene	1,135	55	15	21	9
2,3,7,8-Tetrachlorodibenzo-p-Dioxin	0.000002	26	49	17	9
2,3,7,8-Tetrachlorodibenzofuran	0.00002	37	58	3	2
Dioxin and Furans (2,3,7,8-TCDD Equivalents)	0.000002	100	<1		
Methyl Chloroform (1,1,1-Trichloroethane)	989.4	<1	100		<1
1,1,2,2-Tetrachloroethane	3.0	69	31		
Toluene	20,072	3	11	38	47
2,4-Toluene Diisocyanate	1.0	86	14		
o-Toluidine	0.00009	32	68		
Trichloroethylene	145	97	3		
1,2,4-Trichlorobenzene	9.1	100	<1		
1,1,2-Trichloroethane	0.5	100	<1		
2,4,5-Trichlorophenol	0.0001	100			
2,4,6-Trichlorophenol	0.0003	100			
Triethylamine	4.6	26	74		
Trifluralin	6.0		100		
2,2,4-Trimethylpentane	7,699	<1	3	40	57
1,2,4-Trimethylbenzene	73.1	90	10		
1,3,5-Trimethylbenzene	2.0	100			
Trimethylbenzene	8.4	14	86		
Vinylidene Chloride (1,1-Dichloroethylene)	1.1	8	92		
Vinyl Acetate	24.9	97	3		
Vinyl Chloride	3.9	53	47		
m-Xylene	6.9	60	40		
p-Xylene	2.0	100			
Xylenes (Mixed Isomers)	10,554	5	10	41	44
Non-Metal Total	71,903	12	18	30	40
Grand Total	72,510	12	18	30	40

The following chart summarizes air toxics pollutant emissions in Minnesota from 2005. On-road and non-road mobile sources account for 64 percent of the emissions. Nonpoint sources contributed 22 percent of total emissions and point sources contributed 14 percent of emissions.

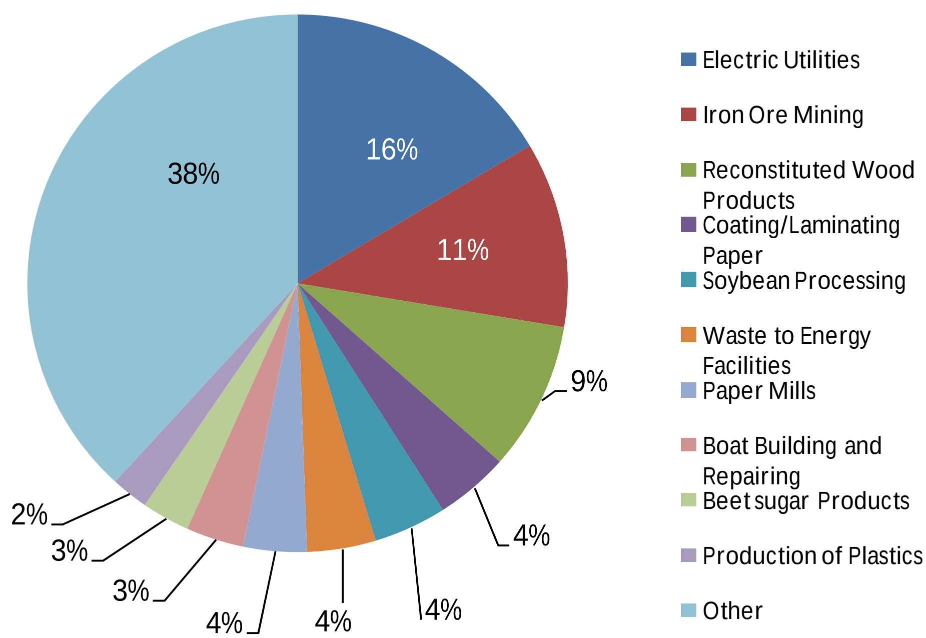
Contribution of Principal Source Categories to 2005 Air Toxics Emissions in Minnesota



Total air toxics emissions in 2005: 72,500 tons

A more detailed breakdown of emissions for each principal source category is shown in the following four pie charts. For point sources, no one source category dominates the air toxics emissions. The largest source category is electric utilities, which accounts for 16 percent of point source emissions.

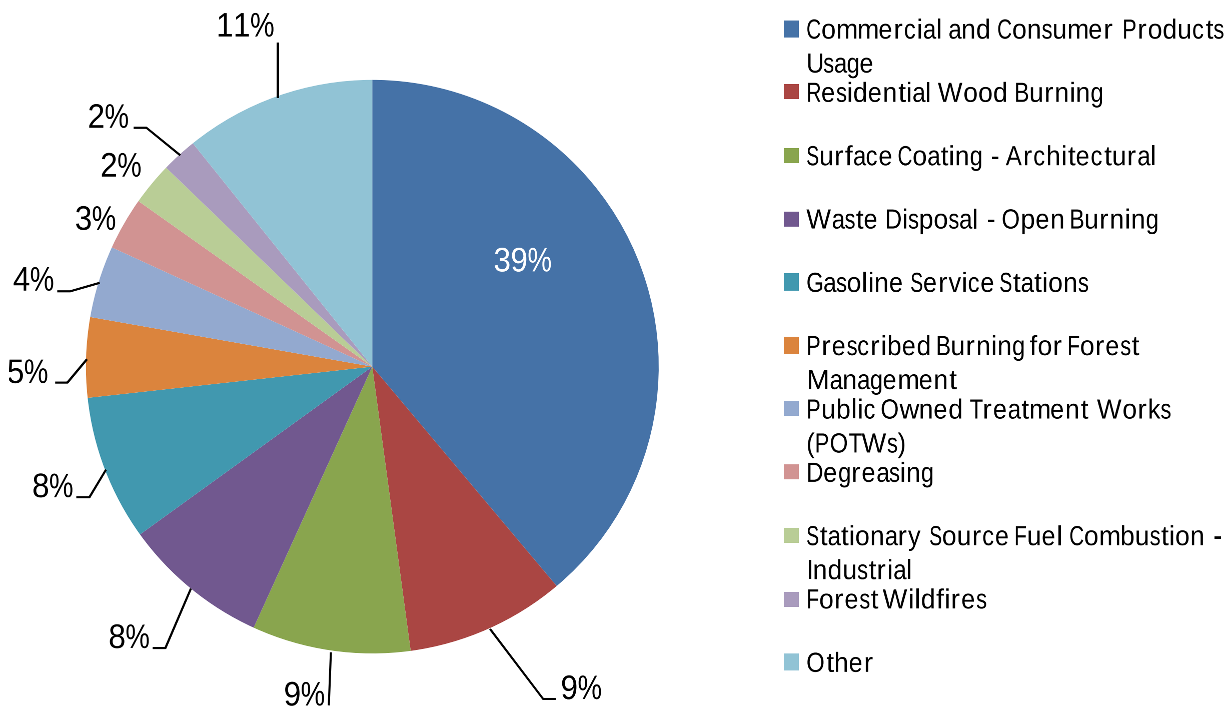
Contribution of Major Categories to 2005 Point Source Air Toxic Emissions in Minnesota



Total air toxics point source emissions in 2005: 11,700 tons

For nonpoint sources, the major contributors of emissions are industrial surface coating, commercial and consumer products usage and residential wood burning. Approximately 57 percent of the nonpoint source emissions are attributed to these three categories.

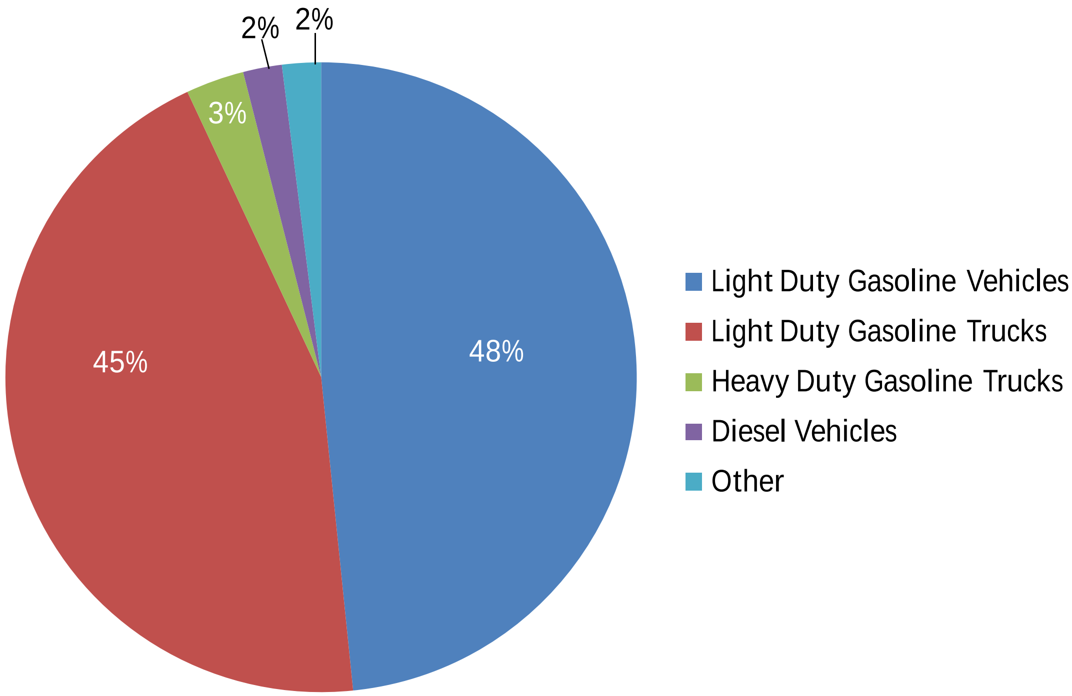
Contribution of Major Categories to 2005 Nonpoint Source Air Toxics Emissions in Minnesota



Total air toxics nonpoint source emissions in 2005: 16,100 tons

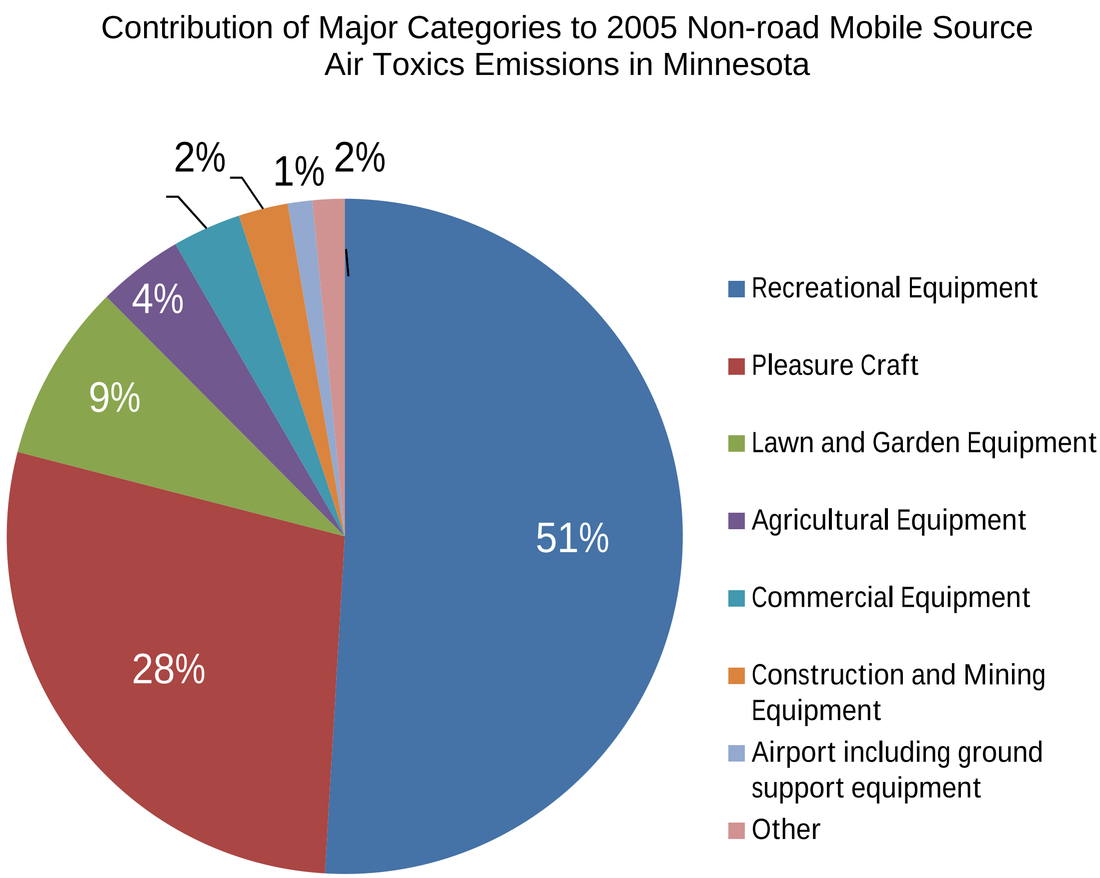
For on-road mobile sources, the largest emission contributor is light duty gasoline vehicles, which accounted for 48 percent of total mobile source emissions in 2005. The second largest contributor of on-road mobile source emissions is light duty gasoline trucks, which accounts for another 45 percent of mobile source air toxics emissions.

Contribution of Major Categories to 2005 On-road Mobile Source Air Toxics Emissions in Minnesota



Total air toxics on-road mobile source emissions in 2005: 22,700 tons

For non-road mobile sources, the largest emission contributor is recreational equipment (all-terrain vehicles, snowmobiles, etc.), which accounted for approximately half of all of the emissions. The second largest contributor is pleasure craft (boats, jet skis, etc,), which accounted for another 28 percent of the emissions.



Total non-road mobile source emissions in 2005: 24,200 tons

For more information on air toxics, the Minnesota Air Toxics Emission Inventory and the Great Lakes Air Emissions Inventory, see the following websites:

http://www.pca.state.mn.us/air/airtoxics.html

http://www.pca.state.mn.us/air/toxics/toxicsinventory.html

http://www.epa.gov/ttn/atw/index.html

http://www.glc.org/air/

Chapter 2: Water Pollutant Discharges Overview

Minnesota's rivers, streams and lakes provide great natural beauty, and supply the water necessary for recreation, industry, agriculture and aquatic life. The major goal of the MPCA's water quality program is to enable Minnesotans to protect and improve the state's rivers, lakes, wetlands and groundwater so that they support healthy aquatic communities and designated public uses such as fishing, swimming and drinking water. The key strategies for accomplishing this goal include regulating point source discharges, controlling nonpoint sources of pollution, and assessing water quality to provide data and information to make sound environmental management decisions.

Point sources consist mainly of municipal and industrial wastewater discharges. Point sources have the greatest potential to impact the environment during periods of low precipitation and stream flow. Nonpoint sources include runoff from agricultural fields, feedlots, urban areas, and on-site sewage treatment (septic) systems. Nonpoint sources are most significant during periods of high precipitation and stream flow.

Minnesota has been successful in controlling end-of-pipe discharges from wastewater treatment plants and industries to our state's waters. But at the same time, the challenges posed by nonpoint sources of pollution are increasing as land use changes and population expands. The federal Clean Water Act requires states to adopt water quality standards to protect the nation's waters. These standards define how much of a pollutant can be in a surface or groundwater supply while still allowing it to meet its designated uses, such as for drinking water, fishing, swimming, irrigation or industrial purposes.

For each pollutant that causes a water to fail to meet state water quality standards, the federal Clean Water Act requires the MPCA to conduct a Total Maximum Daily Load (TMDL) study. A TMDL study identifies both point and nonpoint sources of each pollutant that fails to meet water quality standards. While lakes, rivers and streams may have several TMDLs, each determining the limit for a different pollutant, the state is moving toward a watershed approach that addresses multiple pollutants and sites within a watershed to efficiently complete TMDLs. Many of Minnesota's water resources cannot currently meet their designated uses because of pollution from a combination of point and nonpoint sources.

At the state level, the Clean Water Legacy Act of 2006 provided one-time funding for accelerated testing of Minnesota's surface and ground water; provided resources to develop specific plans to clean up Minnesota's contaminated waters including those in TMDL studies, and to protect clean waters; and designated funding to existing state and local programs to improve water quality.

The Clean Water, Land and Legacy Amendment to the state constitution increased the state sales tax by three-eighths of a percent beginning July 1, 2009 through 2034. According to the law, 33 percent of the money raised is to be allocated to a Clean Water Fund. Money deposited into the fund may be spent only to protect, enhance and restore water quality in lakes, rivers and streams, and to protect groundwater from degradation. The Legislature appropriated $179.43 million of Clean Water Funds for water activities during fiscal years 2012-2013. These activities include a continuation of previous accelerated clean water efforts funded in the first biennium, plus some new water management efforts.

MPCA will receive approximately $47.77 million from the Clean Water Fund to be used for:

- Water quality monitoring and assessment, including a wild rice standards study: $16.5M,
- Water quality study development (Total Maximum Daily Loads) and tool development: $21.9M,

- Water quality protection and restoration efforts, including St. Louis River restoration: $5.1M, and
- Groundwater assessment and subsurface treatment systems: $4.27M.

Minnesota agencies released the 2012 Clean Water Fund Performance Report, in February 2012 to help Minnesotans clarify connections between Clean Water Funds invested, actions taken and outcomes achieved in FY2010-2011. Eighteen measures in the report provide a snapshot of how Clean Water Fund dollars are being spent and what progress has been made. The measures are organized into three sections: investment, surface water quality, and drinking water protection. Each measure has detailed status ranking and trend information.

For a link to the report and more information on the Clean Water Fund, please see the following web site: http://www.pca.state.mn.us/dm0r92d

Major Water Discharge Parameters and Trends

This section presents trends in total loading from the major municipal and industrial facilities as well as discharge information for the following pollutants that are released from major facilities into Minnesota waters: total suspended solids (TSS); biochemical oxygen demand (BOD); total phosphorus (TP); and ammonia (NH_3). Major facilities are defined as municipal and industrial facilities that discharge more than one million gallons per day to waters of the state. These major facilities represent approximately 85 percent of the total volume of discharge to waters of the state from point sources. The remaining 15 percent comes from smaller municipal and industrial facilities. Note that the number of facilities that are required to report discharge information varies by pollutant.

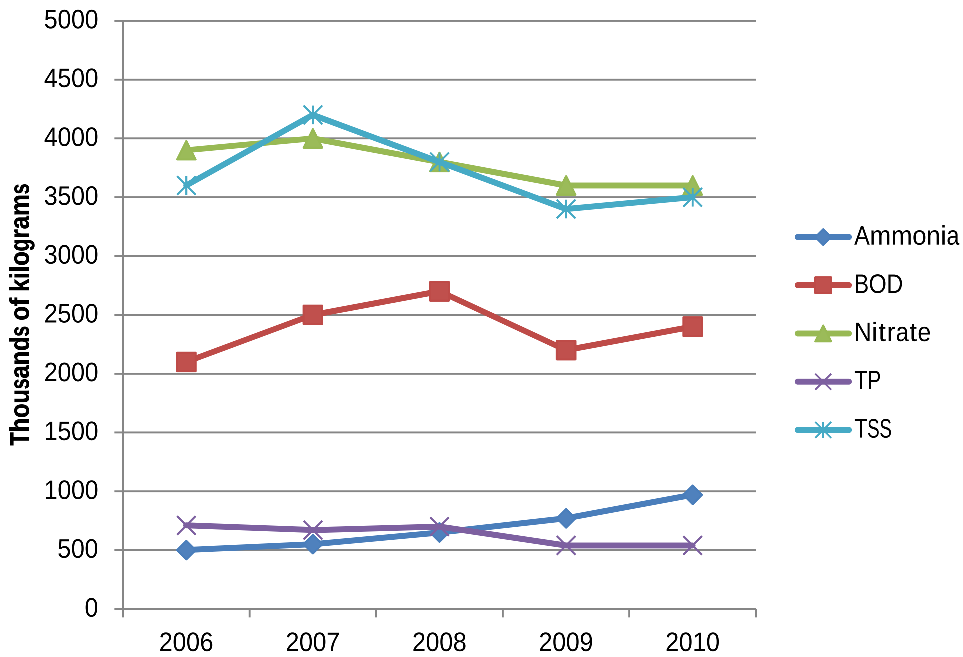
Since the MPCA is now trying to address water management using a holistic, watershed approach, the discharge summaries are presented by major watershed, rather than on a county-by-county basis, starting on page 46. By plotting individual discharge points rather than aggregating the data, it is hoped that the reader gets a clearer picture of how discharges from major treatment facilities impact watersheds statewide. A table of the data for each parameter from 2006-2010 (the five most recent years for which data are available) is found on page 4 of this report.

A graph of the pollution discharge loading trends for major facilities is shown on the next page. The total statewide annual pollutant load from major treatment facilities to Minnesota waters for 2010 showed an increase to 11,100 thousand kilograms from the 10,600 thousand kilograms reported in 2009.

The general trend in total loading of all pollutants examined has been slightly upward during the five most recent years of record, 2006-2010, with overall loading increasing by 2 percent over this period.

Improvements intended to increase biological nutrient removal at wastewater treatment plants across the state are beginning to have an effect in reducing phosphorus to Minnesota's surface waters with overall phosphorus loading decreasing 24 percent over the five-year period from 2006-2010. Nitrate levels have also decreased about 8 percent over the five-year period.

Minnesota Water Pollution Discharge Loading Trends from Major Point Sources, 2006-2010, in thousand kilograms



Point source contributions of nitrate and phosphorus to waters of the state are still small in many watersheds compared to nonpoint contributions of these pollutants from sources such as agriculture and urban runoff. Point sources tend to have the greatest impact on receiving waters during periods of low precipitation and stream flow, while nonpoint sources are most significant during periods of high precipitation and stream flow. However, it is difficult to measure directly the effects of nonpoint pollution on Minnesota’s lakes, rivers and groundwater.

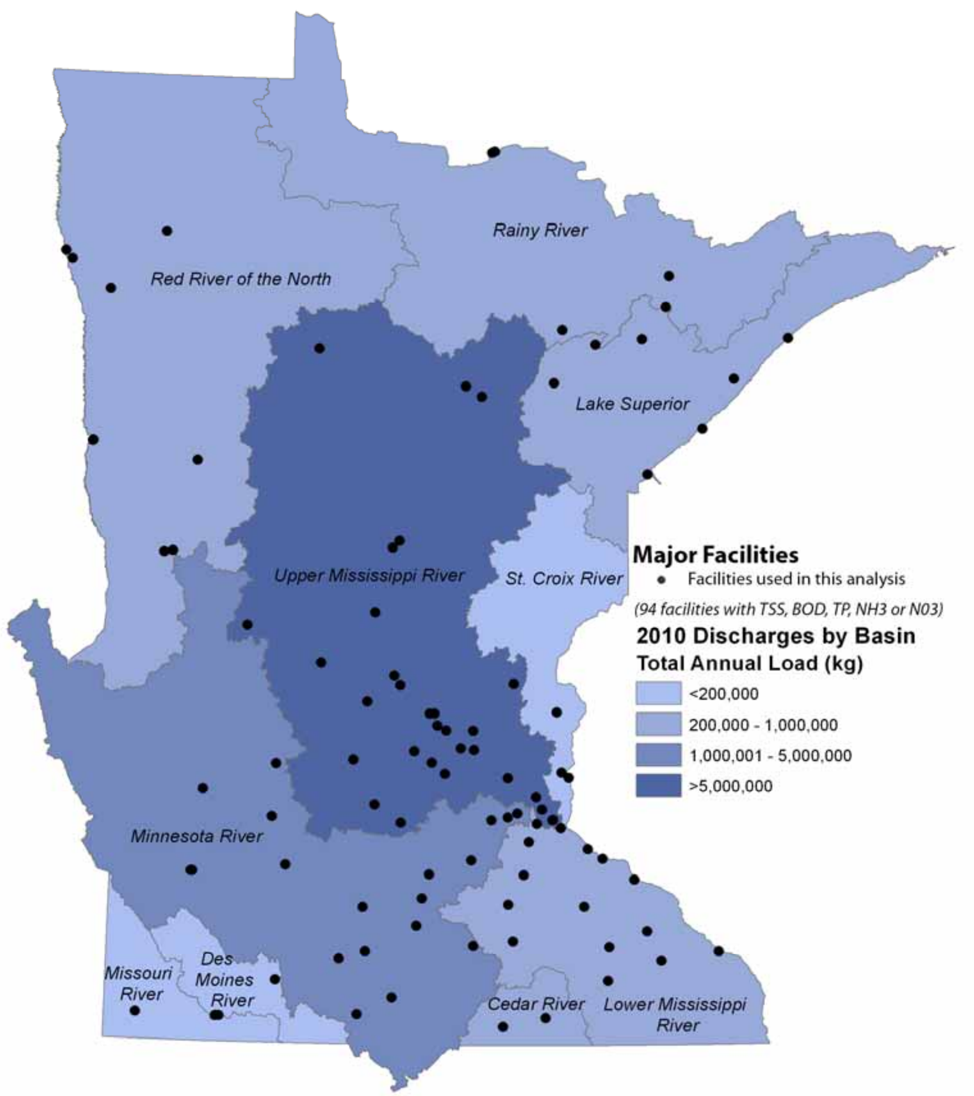
Ammonia and biochemical oxygen demand have increased over the five-year period from 2006-2010. See the discussion in the ammonia section for an explanation of the increase in ammonia levels.

Total Annual Pollutant Load by Drainage Basin

The total statewide annual pollutant load from major treatment facilities to Minnesota waters for 2010 showed an increase to 11,100,000 kilograms from the 10,600,000 kilograms reported in 2009.

The figure below shows the statewide distribution of pollutant loading by major river basin for 2010. The Upper Mississippi River Basin contributed about 6,665,000 kilograms (up from about 6,350,000 kilograms in 2009), while the Minnesota River Basin contributed 1,067,000 kilograms (up slightly from 1,050,000 kilograms in 2009). Together, these two river basins account for more than two-thirds of pollutants discharged from major wastewater treatment plants in the state. Following is a discussion of the statewide loadings of several individual pollutants that contribute to total loading and trends in discharge for those parameters noted in recent years.

Total Annual Pollutant Load by Basin from
Major Wastewater Treatment Facilities, 2010

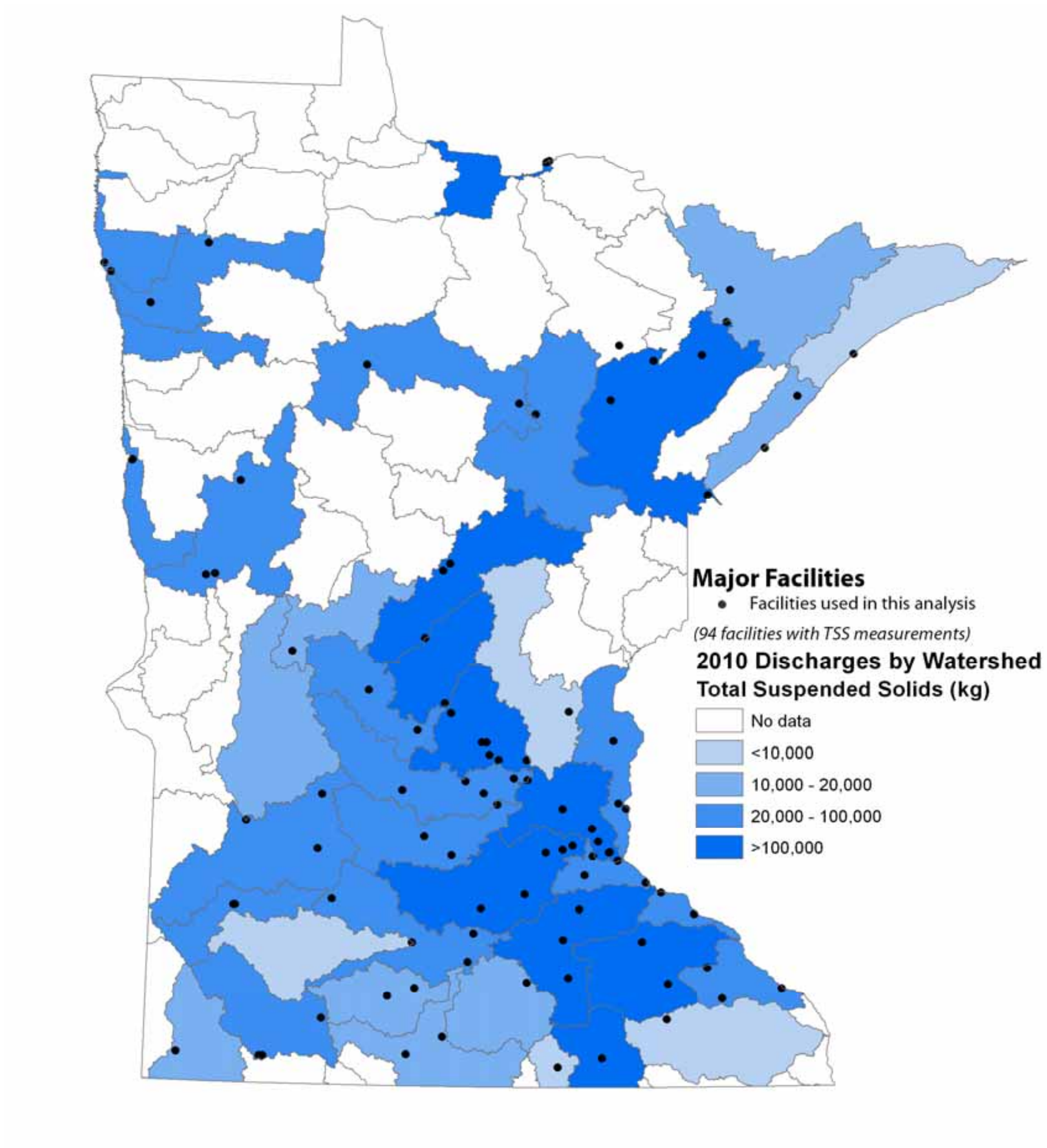


Total Suspended Solids

Total suspended solids (TSS) is a measure of the material suspended in water or wastewater. TSS causes interference with light penetration, buildup of sediment and potential degradation of aquatic habitat. Suspended solids also carry nutrients that cause algal blooms that are harmful to fish and other aquatic organisms.

Based on results of Discharge Monitoring Reports for 94 major treatment facilities, the estimated discharge of TSS to waters of the state for 2010 was approximately 3,500,000 kilograms, an increase of 3 percent from that reported in 2009. The map below shows the 2010 TSS discharges to surface waters by major point sources of water pollution by watershed.

Total Suspended Solids Discharges from Major Point Sources
by Major Watershed, 2010

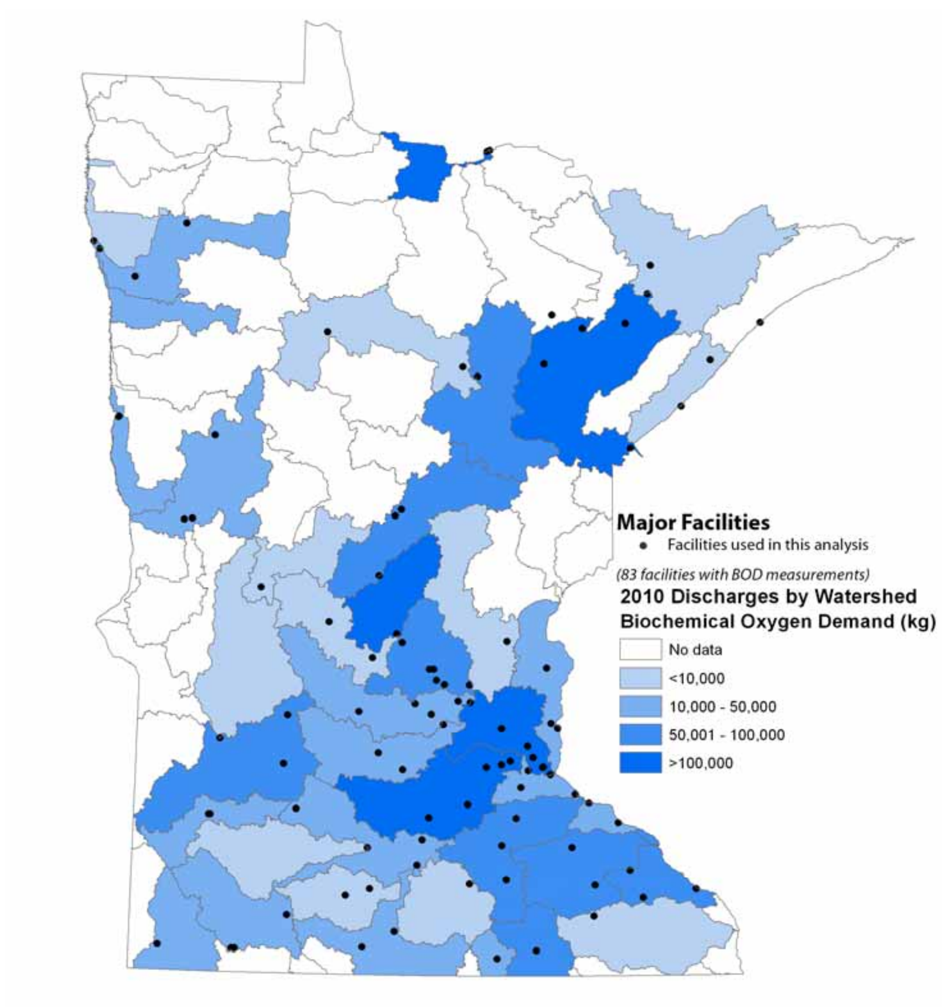


Biochemical Oxygen Demand (BOD)

When organic wastes are introduced into water, they require oxygen to break down. High concentrations of organic materials characterize untreated domestic wastes and many industrial wastes. The amount of oxygen required for decomposition of organic wastes by microorganisms is known as the biochemical oxygen demand (BOD), while carbonaceous biochemical oxygen demand (CBOD) is the amount of oxygen required for microorganisms to decompose waste carbonaceous materials. Both BOD and CBOD are indicators of the strength of waste effluent and effectiveness of treatment. For purposes of this report, BOD data were used wherever available; CBOD data were used only if BOD was not reported. A high demand for oxygen causes reduction in the concentration of oxygen in the receiving waters. Depletion of oxygen deteriorates water quality and impacts aquatic life, including fish and other organisms.

Based on results of Discharge Monitoring Reports for 83 major treatment facilities, the estimated discharge of BOD to waters of the state for 2010 was approximately 2,400,000 kilograms, an increase of 9 percent from 2009. The map below shows the 2010 BOD discharges to surface waters by major point sources of water pollution by watershed.

Biochemical Oxygen Demand Discharges from Major Point Sources
by Major Watershed, 2010

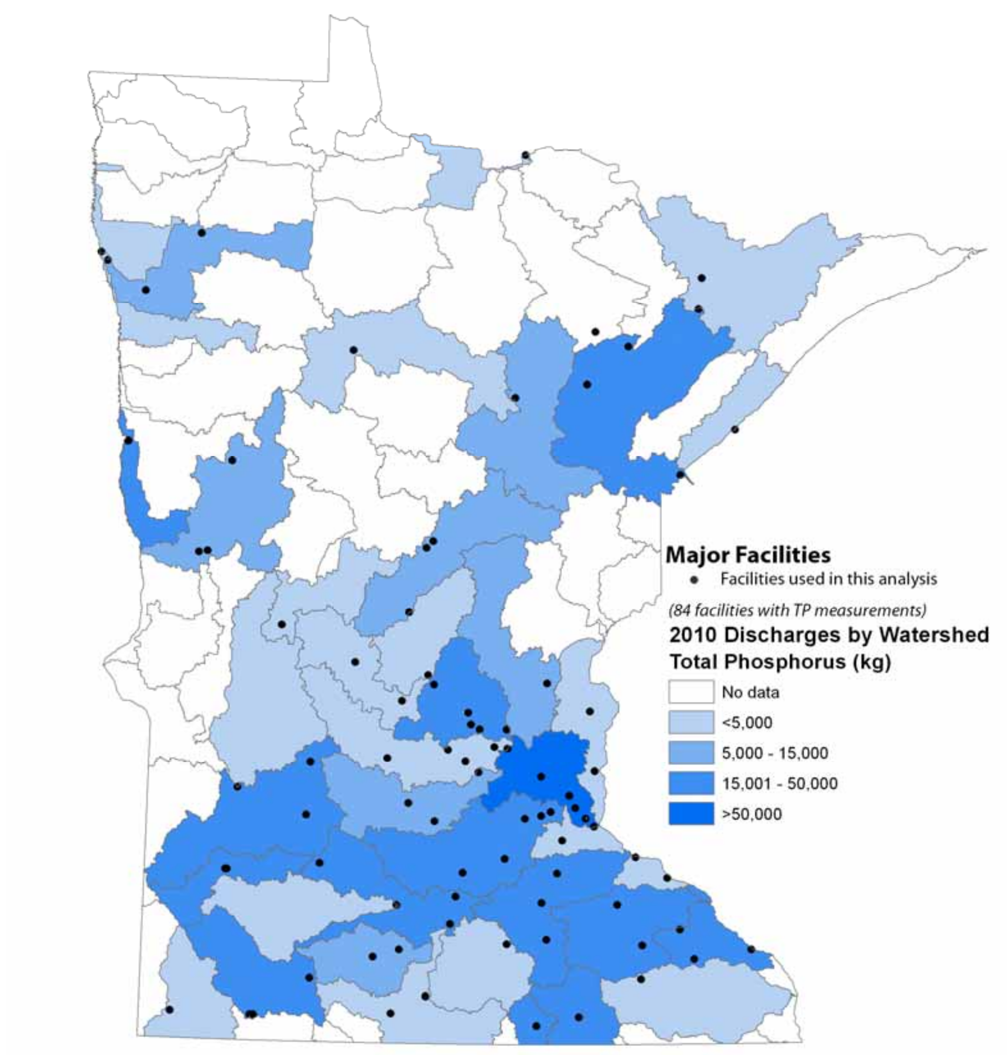


Total Phosphorus

Total phosphorus (TP) is the primary pollutant associated with increased algae growth in Minnesota's lakes and streams. Excess phosphorus from human activities causes algae blooms and reduced water transparency, making water unsuitable for swimming and other activities. Phosphorus is released from both point and nonpoint sources of pollution. Minnesota has had point source effluent limitations for phosphorus since the early 1970s.

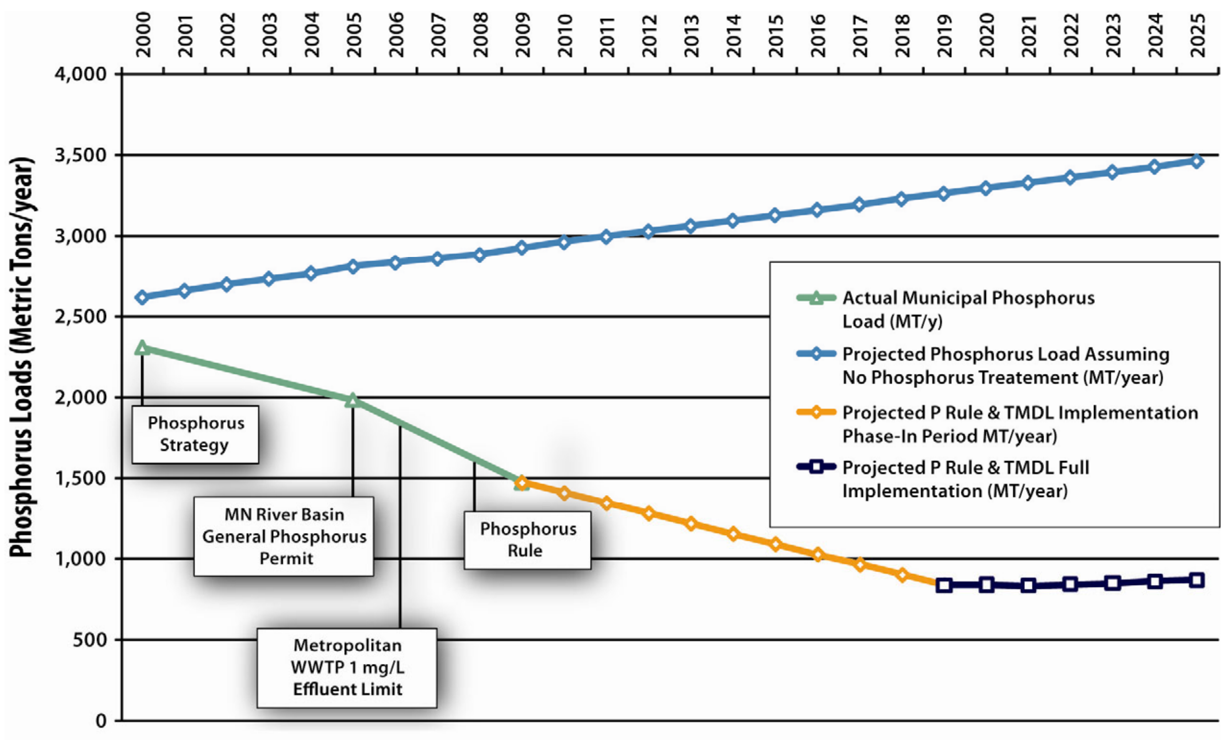
Based on the results of Discharge Monitoring Reports for 84 major treatment facilities, the estimated discharge of TP to waters of the state for 2010 was approximately 540,000 kilograms, remaining constant since 2009. Many treatment plants are now using advanced methods for phosphorus removal. It is encouraging when TP discharges decrease because, as a headwaters state, Minnesota seeks to do its share to reduce its contribution from phosphorus to national problems, like the hypoxic zone in the Gulf of Mexico. Since 2006, TP discharges have decreased 24 percent. The map below shows the 2010 TP discharges to surface waters by major point sources of water pollutants by watershed.

Total Phosphorus Discharges from Major Point Sources
by Major Watershed , 2010



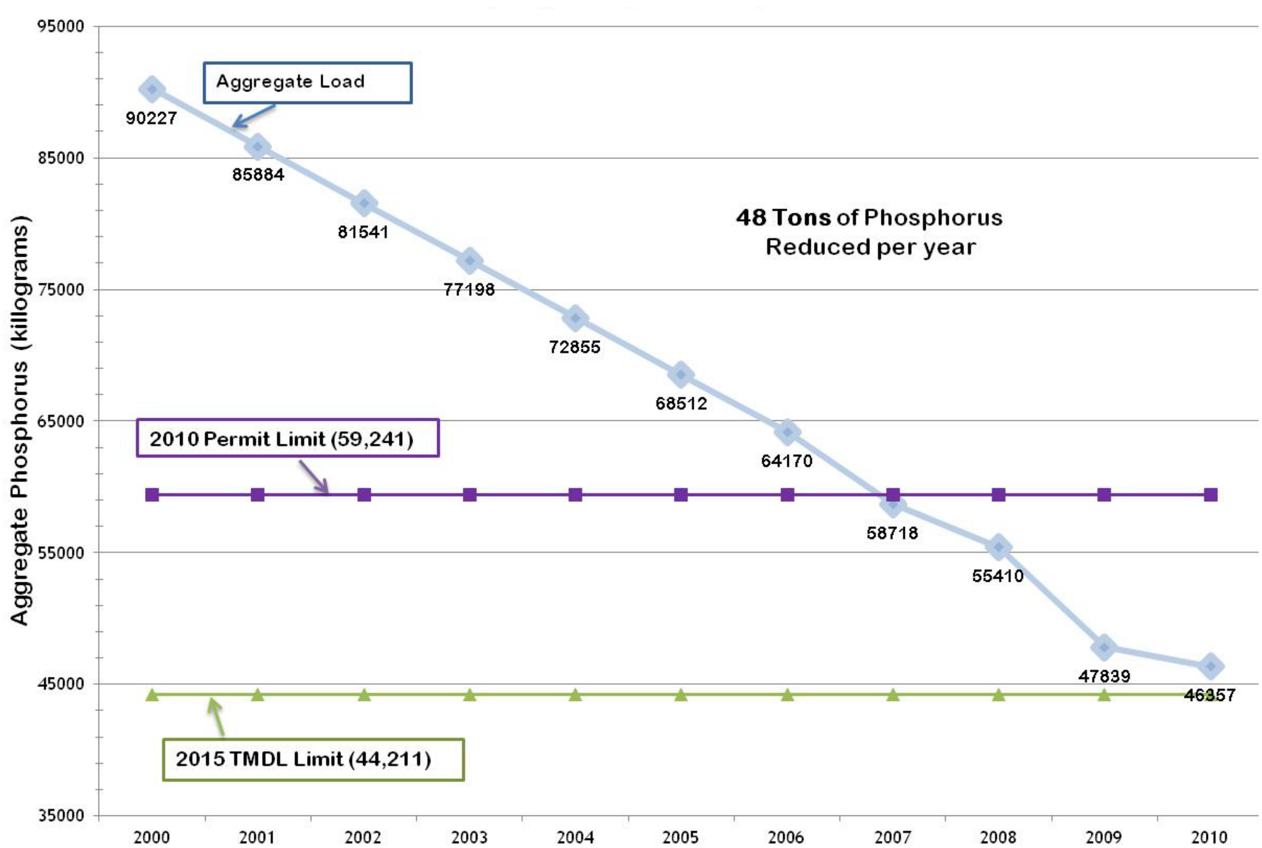
Controlling phosphorus is an important part of protecting Minnesota's water resources. Considerable reductions in phosphorus from wastewater treatment facilities have been achieved since the MPCA Citizens Board adopted a strategy for addressing phosphorus in National Discharge Elimination System (NPDES) permits several years ago. The graphic below represents estimated statewide municipal wastewater treatment facility phosphorus reductions since the year 2000 and estimates future reductions based on the implementation of current permitting policies. It also estimates the anticipated increases in phosphorus loading that would have resulted had these changes not occurred. Overall, these efforts have resulted in a steady decline of phosphorus pollution.

Municipal Wastewater Phosphorus Trends and Actual Phosphorus Load



Reductions in phosphorus loading to the Minnesota River have also occurred as a result of Minnesota River Basin General Phosphorus Permit, which was issued on December 1, 2005. The permit was developed as part of a TMDL to address a dissolved oxygen impairment in the Lower Minnesota River. The permit required the 40 largest continuously discharging wastewater treatment facilities in the basin to apply for coverage and receive a five-month mass phosphous limit. The chart on the next page shows the aggregate wastewater phosphourus reduction (from May-Demember) from 2000 to 2009.

Minnesota River: Aggregrate Wastewater Phosphorus Reduction (May-September)

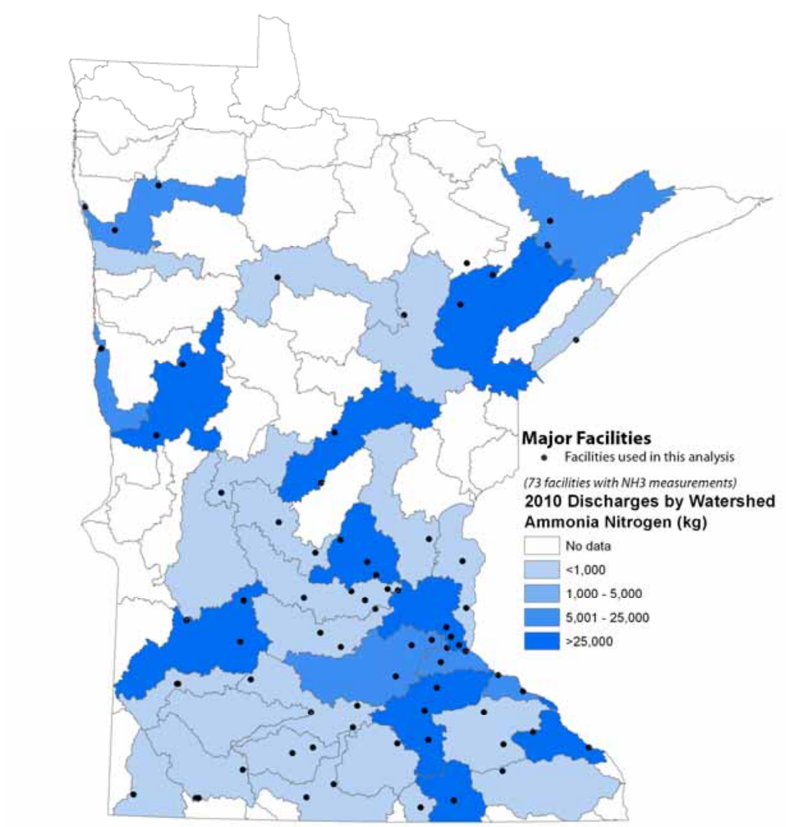


Nitrogen

Nitrogen, generally occurring as either nitrate or ammonia is present in a wide variety of effluents including sewage (wastewater treatment plants and on-site septic systems), food processing wastes, mining effluents, landfill leachate, and agricultural and urban runoff. Nitrate and/or ammonia concentrations in most of these sources are monitored under permit requirements. Nitrogen as ammonia can be toxic to aquatic life and nitrogen in the form of nitrate can be a significant problem in ground water supplies, and can also be toxic to aquatic life. Nonpoint sources of nitrogen from agricultural and urban runoff are an important source of loading to waters of the state, although very little of this contribution is captured through Discharge Monitoring Reports required by permit. To help better understand sources of nitrogen, MPCA is completing a statewide Nitrogen Study in 2012.

Based on the results of Discharge Monitoring Reports for 71 major treatment facilities, the estimated discharges for 2010 were 970,000 kilograms of ammonia, an increase of 26 percent from 2009. A review of the results from individual treatment facilities showed that the MCES Metropolitan Wastewater Treatment Facility had an ammonia increase of approximately 141,000 kilograms (approximately 0.5 mg/L) from 2009-2010. The ammonia discharges at the Metropolitan Wastewater Treatment Facility remain consistently below the water quality-based effluent limits assigned to the facility. Based on conversations with MCES staff, the increase in ammonia discharged from the Metropolitan Wastewater Treatment Facility is the result of the facility working to optimize phosphorus treatment (resulting in an approximate discharge reduction of 1500 kg/year total phosphorus from 2009 to 2010) and reduce energy consumption at the wastewater facility, resulting in changes in the ammonia removal efficiencies. Energy savings in 2009 and 2010 totaled more than 18.5 MW hours and a reduction of 12,000 pounds of CO_2 emissions, resulting in monetary savings of over $1,000,000 on an annualized basis.

Ammonia Discharges from Major Point Sources
by Major Watershed, 2010



Nonpoint Source Pollution

As previously discussed, Minnesota has made significant progress in cleaning up point sources of water pollution as measured by discharges of pollutants in municipal and industrial wastewater.
It is the nonpoint sources of pollution from rainfall or snowmelt moving over or through the ground carrying natural and human-made pollutants into lakes, rivers, wetlands and groundwater that now pose the greater challenge for prevention and cleanup. Both point and nonpoint sources of pollution must be controlled to reach the Clean Water Act and state goals of protecting human health and the environment. Despite significant improvements in recent years, too much phosphorus and nitrogen continue to reach many of our waters, carried in soil erosion and runoff from roads, yards, farms and septic systems.

Over the past few years, more regulatory controls for such sources as feedlots, septic systems and stormwater have been implemented, but other sources of nonpoint pollution can be diffuse and difficult to assess and manage. Much of the work to control unregulated nonpoint sources of pollution thus far has used financial incentives to encourage voluntary adoption of best management practices (BMPs). As described below, the Board of Water and Soil Resources (BWSR) reports the amount of nonpoint source pollutants (nitrogen, phosphorus and sediment) avoided by use of BMPs.

Many of the stresses from nonpoint sources of pollution that affect Minnesota's surface and groundwater resources are the result of choices that individuals make everyday such as lawn care practices, watercraft operation and waste disposal. The daily decisions that homeowners, developers, farmers and businesses make regarding land use are crucial to protecting water resources from the effects of nonpoint source pollution. Once a water resource declines in quality, recovery is costly and can take many years. Clearly, prevention is the key when it comes to nonpoint source pollution. What happens to Minnesota's water resources in the next 10 years will help determine the quality of those resources for the next 100 years.

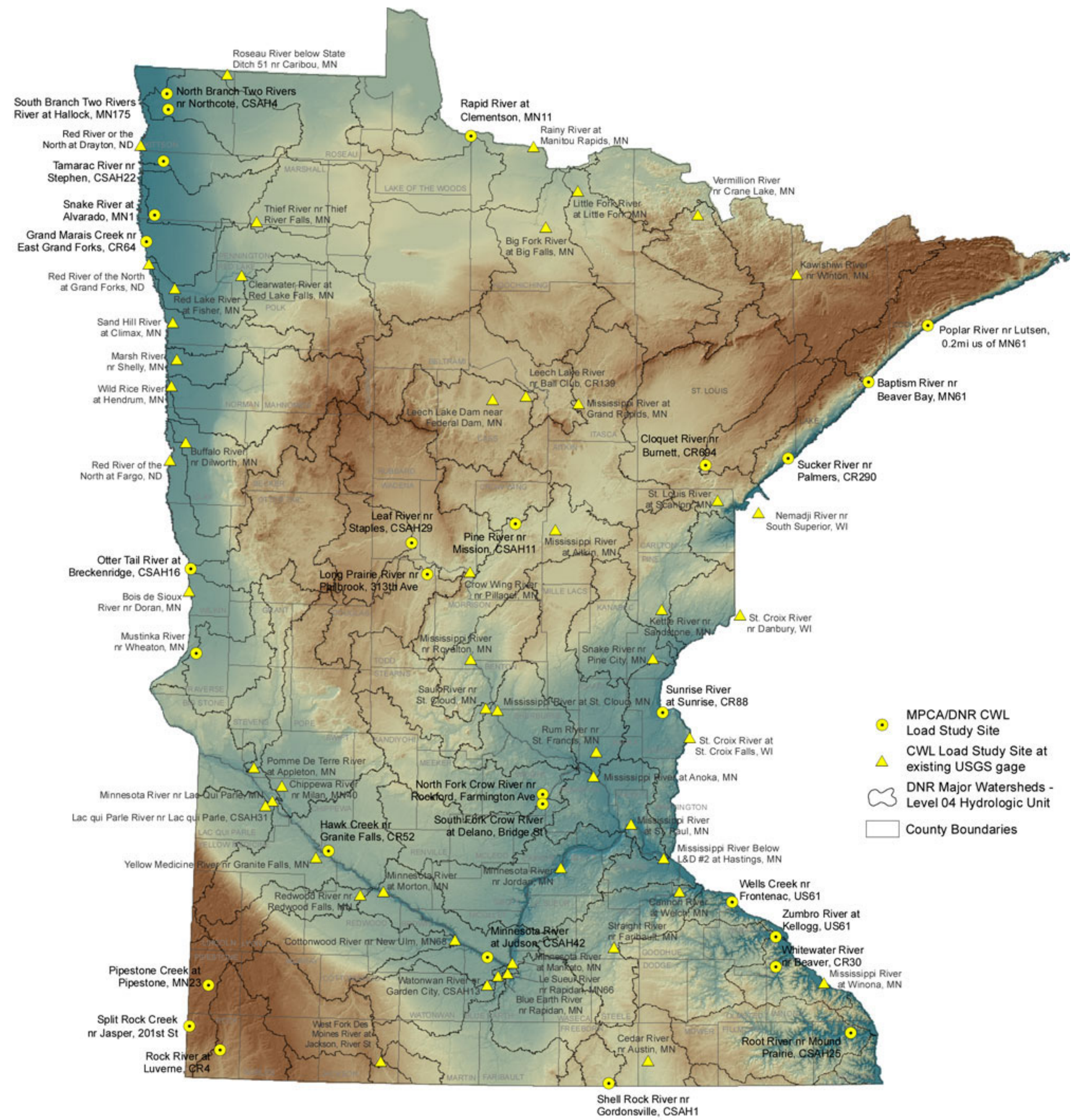
Minnesota Watershed Pollutant Load Monitoring Network

The passage of the Clean Water Land and Legacy Amendment and subsequent appropriations by the Legislature from the Clean Water Fund is enhancing monitoring of Minnesota waters, and our understanding of the relative contributions of pollutants from various sources and waters. One example of this is the MPCA's Watershed Pollutant Load Monitoring Network, which is designed to measure and compare regional differences and long-term trends in water quality among Minnesota's major rivers including the Red, Rainy, St Croix, Minnesota, and Mississippi and the outlets of major tributaries draining to these rivers. Since the program's inception in 2007, the network has adopted a multi-agency monitoring design. Site-specific stream flow data from United States Geological Survey (USGS) and Minnesota Department of Natural Resources (DNR) gaging stations is combined with water quality data collected by the Metropolitan Council Environmental Services (MCES), local monitoring organizations, and MPCA staff to compute annual pollutant loads at river monitoring sites across Minnesota.

Intensive water quality sampling is conducted year round at 79 sites. Thirty to 35 mid-stream grab samples are collected per site per year with sampling frequency greatest during periods of moderate to high flow. Water quality samples are analyzed for common nutrients and sediment and couple with site-related discharge data to compute annual pollutant loads. In addition to providing statewide comparative and trend information, data are also used to develop watershed protection and restoration plans and assist with modeling efforts.

Monitoring sites were incrementally installed during the first three years of the program with all sites fully operational by 2010. Pollutant loads for operational sites have been computed through 2009 and will be available along with statewide watershed maps of pollutant loads, yields and flow weighted mean concentrations by summer of 2012.

Watershed Pollutant Load Monitoring Network



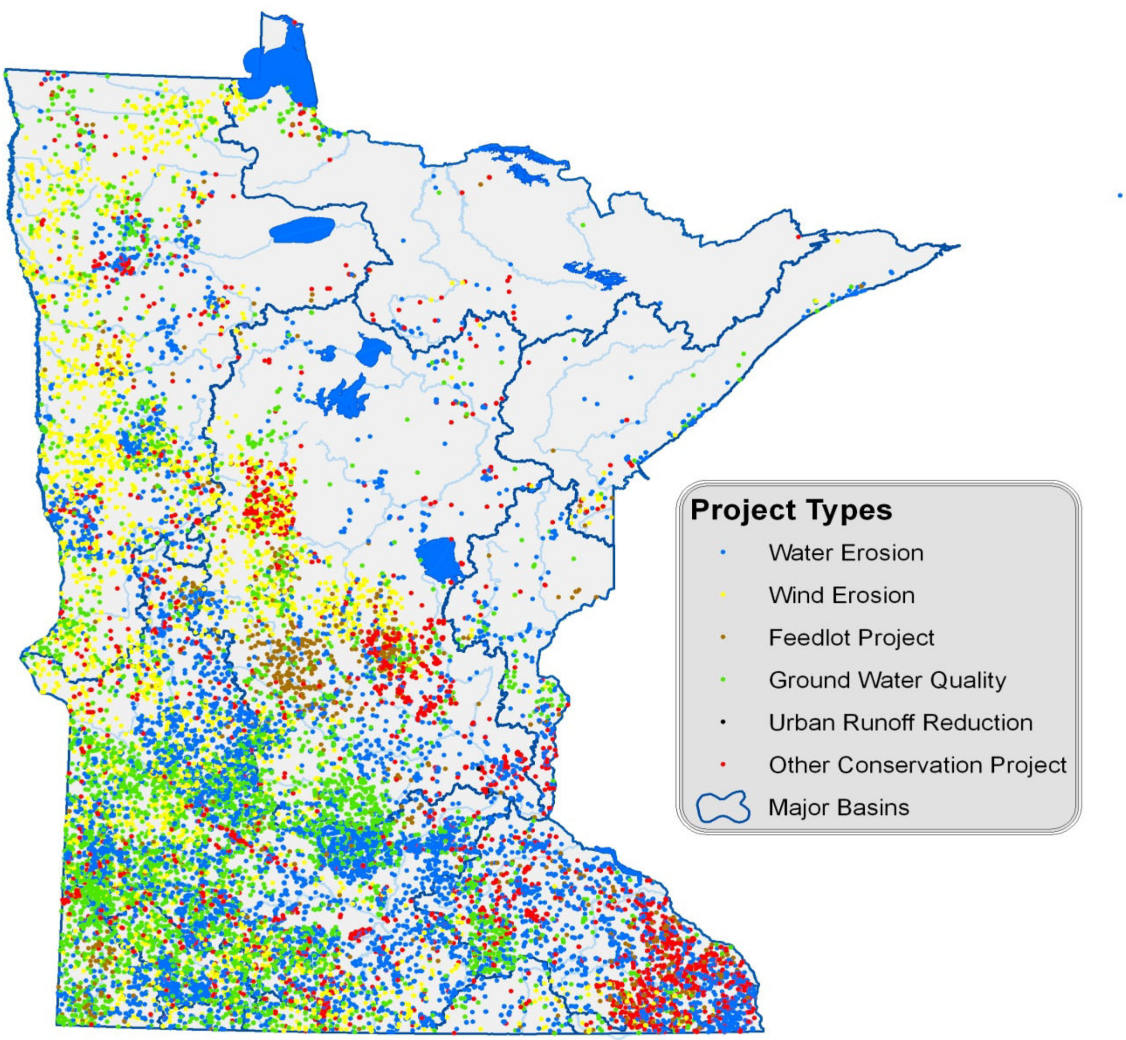
For more information about the MPCA's Watershed Pollutant Load Monitoring Network, see http://www.pca.state.mn.us/veize01

Soil Loss Reduction in Minnesota

Many conservation projects and best management practices prevent thousands of tons of soil, sediment and other pollutants from leaving fields and becoming airborne or flowing into rivers and lakes. Soil erosion means not only the loss of valuable topsoil, decreases in land productivity and higher fertilizer requirements, but also damage to surface water in the form of silt that chokes off rivers, lakes and wetlands, and possible groundwater contamination from over-application of fertilizer.

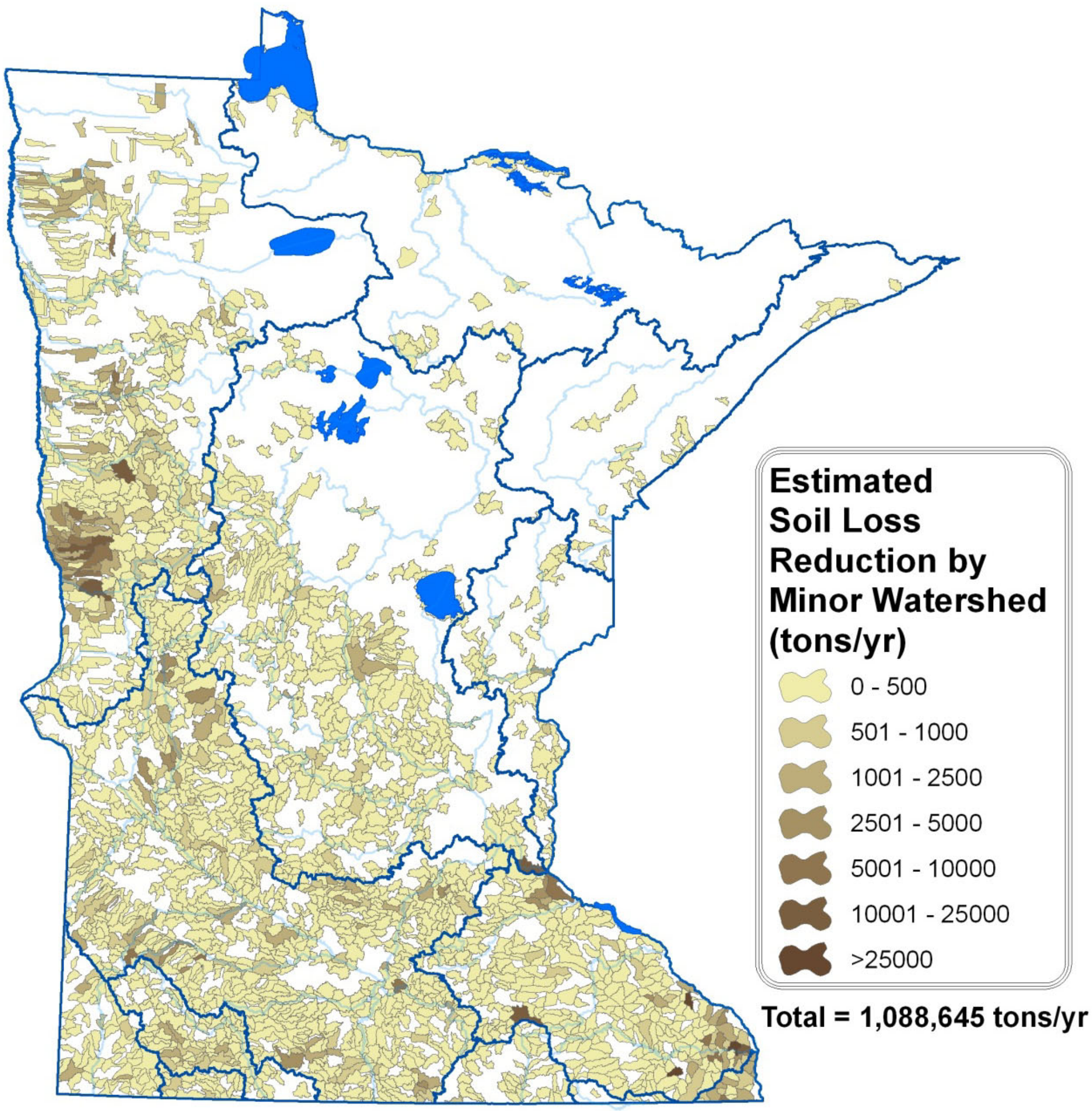
BWSR tracks soil loss and BMPs to reduce pollution from soil loss and sedimentation using the eLINK database (http://www.bwsr.state.mn.us/outreach/eLINK/). The figure below shows the locations of projects tracked by eLINK as reported by county soil conservation offices and local officials for the eight-year period 2003-2011. Sites are classified as preventive measures for wind erosion, water erosion, animal feedlot construction and operation, ground water quality, urban runoff reduction and other conservation measures.

Location of Conservation and Best Management Projects
Reported by e-LINK (2003-2011)



From 2003-2011, soil loss reduction statewide attributed to pollutant reduction measures was estimated to average about 1.09 million tons per year. Common pollution-reduction BMPs include gully stabilization; sheet and rill erosion control; stream and ditch stabilization; filter strips to trap sediment; and wind erosion control. Even at the minor watershed level, some areas of west-central Minnesota showed soil loss reductions of more than 25,000 tons/year. The map below shows soil loss reduction benefits from conservation and management practices by watershed during the period 2003-2011.

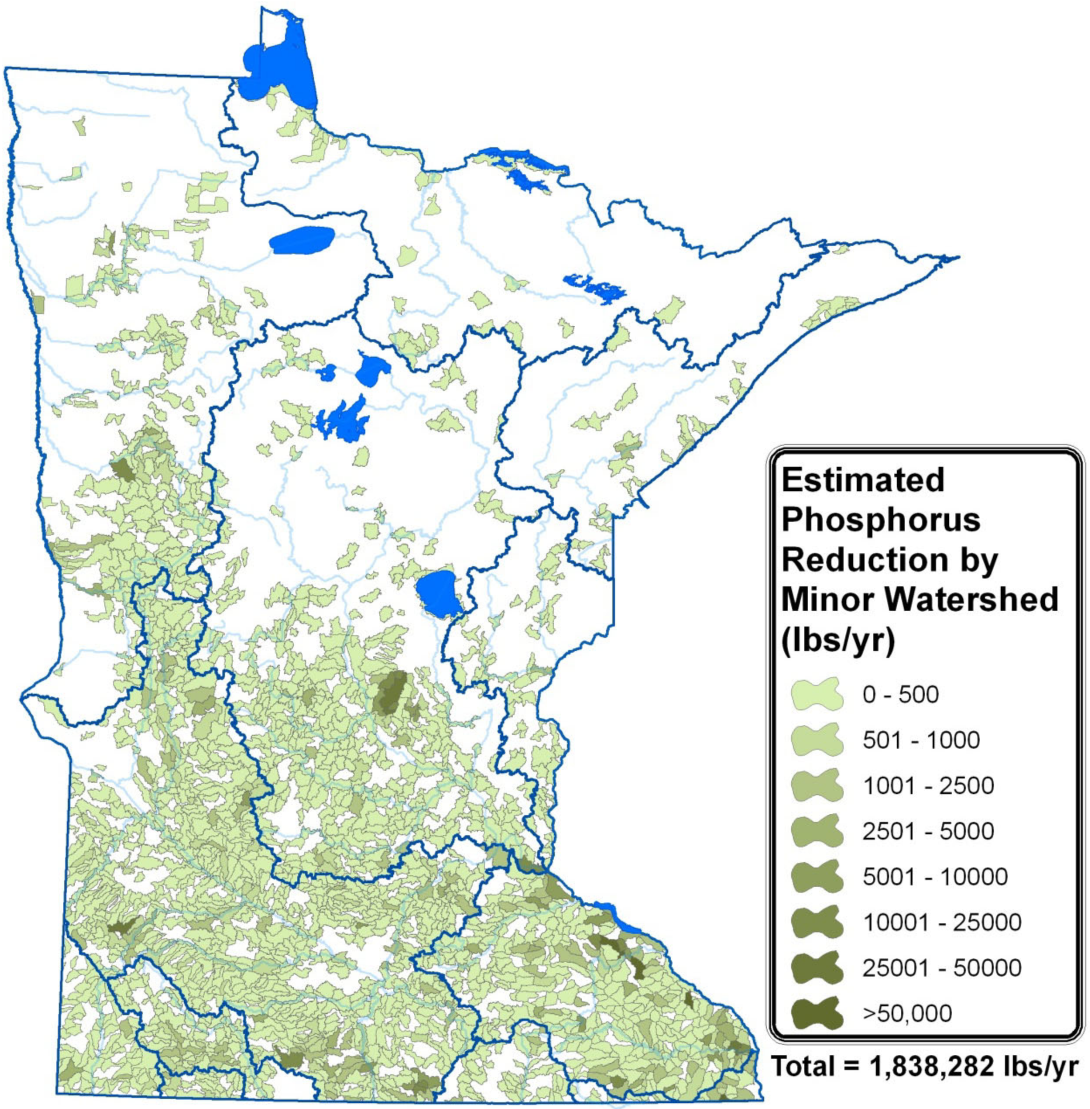
Soil Loss Reduction Benefits from Conservation and Management Practices
Reported Via eLINK (2003-2011)



Not only can sediment cause silting problems, but it can also carry chemicals attached to it into the water. One of these chemicals is phosphorus, a common element of fertilizer, which can create problems in surface water such as algae blooms. The proliferation of algae and other aquatic vegetation takes oxygen from the water, suffocating fish, discouraging wildlife and making lakes and waterways unsuitable for recreational use.

From 2003-2011, phosphorus reductions statewide were estimated at almost 1.84 million pounds/year. The map below shows phosphorus reduction benefits from conservation and management practices during the period 2003-2011.

Phosphorus Reduction Benefits from Conservation and Management Practices
Reported by eLINK (2003-2011)



Emerging Issues of Concern in Minnesota's Environment

In the arena of environmental protection, the term "emerging issue" refers to newly recognized environmental contaminants and other issues that are not fully understood, but which have the potential to cause adverse effects on human health or the environment. The MPCA uses the term to refer to newly recognized environmental concerns that are not currently incorporated into regular environmental protection activities in Minnesota or elsewhere.

Newly recognized environmental contaminants include pharmaceuticals, household and industrial-use products; endocrine active compounds (EACs); brominated flame retardants; and perfluorinated chemicals (PFCs). These chemicals can enter the environment through consumer products, solid waste disposal, agricultural and urban runoff, residential and industrial wastewater, and long-range atmospheric transport. Many newly recognized environmental contaminants have been identified because of advances in analytical chemistry that make it possible to analyze complex chemicals and detect these chemicals at extremely low concentrations, such as parts per trillion.

Studies conducted since 2000 demonstrate that some newly identified environmental contaminants have the ability to cause adverse effects on fish and wildlife, such as the feminization of male fish by chemicals that affect the endocrine system (i.e. EACs). This effect can occur at the tiny concentrations that have been documented in the environment. However, the risks posed to humans from exposure to these contaminants at similarly low concentrations are not well understood.

The MPCA began collaborating with researchers from the U.S. Geological Survey (USGS) in 2000 and with St. Cloud State University in 2004 to monitor the presence and effects of pharmaceuticals and household and industrial-use products in Minnesota's waters. In 2004, another class of emerging contaminants, the PFCs, was discovered at very low concentrations in drinking water supplies in parts of the eastern Twin Cities. This discovery sparked significant concern among residents and others that could not be readily addressed by public health officials, because so little knowledge about the effects of PFCs at low concentrations on human health then existed. The PFCs illustrate the difficult circumstances that can arise when human beings are exposed to newly recognized environmental contaminants about which we know very little.

The MPCA strives to stay abreast of emerging issues that are relevant to Minnesota, in order to help inform lawmakers, regulators, the public and industry, and determine when and how to address these issues through agency protection programs. The following paragraphs provide an overview of recent MPCA activities and other developments related to emerging issues of concern.

Environmental Monitoring and Research Studies

Pharmaceuticals, household and industrial-use products

The MPCA has been collaborating on an ongoing basis with researchers from the USGS to monitor the presence of pharmaceuticals, personal care products, and other wastewater-associated chemicals in Minnesota's groundwater, lakes, and flowing waters. In general, these studies show that industrial and household-use compounds and pharmaceuticals are present in streams, groundwater, wastewater, and landfill effluents. Steroidal hormones, prescription and non-prescription drugs, insect repellent, detergents and detergent degradates, and plasticizers are widespread at low concentrations in Minnesota's rivers, lakes, and streams. The chemicals are found downstream of potential sources such as wastewater treatment plants, and also, though less often, in more remote surface water where the source of these chemicals is not clear. The results of this work were published by the USGS in 2004 and are available in full at the USGS' website: http://water.usgs.gov/pubs/sir/2004/5138/.

Endocrine active chemicals (EACs)

Building on the results of the study referenced above and other surveys of pharmaceuticals, household, and industrial products in the aquatic environment, scientists from the USGS, St. Cloud State University (SCSU), the University of Minnesota, the University of St. Thomas, and the MPCA have conducted a series of investigations into the significance, sources, and occurrence of EACs in Minnesota's waste streams and waters. EACs can mimic the effects or hormones in animals and cause adverse behavioral and physiologic effects, including impairment of the reproductive system or disruption of growth and development of an organism. Many of the pharmaceuticals, personal care products, and other wastewater-associated chemicals monitored as part of the 2004 study are considered EACs.

Two studies of EACs in Minnesota waters that were recently completed focused on gaining further information about the presence of EACs in 1) Minnesota lakes and rivers (www.pca.state.mn.us/index.php/water/water-monitoring-and-reporting/water-quality-and-pollutants/endocrine-disrupting-compounds.html.), and 2) in the vicinity of wastewater treatment plants (http://www.pca.state.mn.us/index.php/view-document.html?gid=15610). The studies show that endocrine active chemicals - such as alkylphenols (breakdown products of detergents) or bisphenol A (a chemical used to make polycarbonate plastic) - are commonly found in surface water at low concentrations, even in lakes and rivers that do not receive effluent from wastewater treatment plants. In addition, fish from surface waters both with and without wastewater treatment plants showed evidence of exposure to estrogenic compounds (i.e. EACs). It is not generally known if these chemicals pose a risk to human health at the low concentrations being detected.

The MPCA, USGS and SCSU are currently collaborating on a study that examines in more detail the presence and effects of EACs on a single Minnesota lake from a variety of point and nonpoint sources. In addition, surface water from very remote Minnesota lakes was analyzed to understand the extent of contamination by personal care products, pharmaceuticals, and endocrine disrupting chemicals. Results of this study will be reported in Spring 2012.

Beginning in 2010, the MPCA began collecting groundwater samples from its Ambient Groundwater Monitoring Network for analysis of over 100 contaminants of emerging concern, which included EACs. The primary objective of the first year of sampling was to determine the magnitude of contamination in the groundwater; consequently, the sampling focused on areas with a high relative potential for groundwater contamination. The results from the 2010 survey are available here http://www.pca.state.mn.us/index.php/view-document.html?gid=17244 The MPCA is planning to continue monitoring Minnesota groundwater for EDCs and potentially other emerging contaminants for the foreseeable future.

The MPCA will continue monitoring for EACs and other emerging contaminants in Minnesota surface waters in conjunction with statewide and nationally based probabilistic surveys to build trend information over time. These include the 2010 large streams study funded by the U.S. Environmental Protection Agency (EPA) as part of the National Aquatic Resource Survey (NARS), for which the MPCA sampled 150 stream locations for about 25 pharmaceuticals and personal care product related compounds. Analysis of these samples (which were extracted and frozen) was performed by the Minnesota Department of Health laboratory in spring of 2011. Currently, the MPCA is planning to collect samples from 50 Minnesota lakes for analysis of pharmaceuticals and personal care product-related compounds as part of the 2012 NARS lake study.

Perfluorinated chemicals (PFCs)

Perfluorinated chemicals (PFCs) such as perfluorooctanesulfonic acid (PFOS), perfluorooctanic acid, (PFOA), perfluorobutyric acid (PFBA) and others, are manmade chemicals used to manufacture products that are heat and stain resistant and repel water. PFCs used in emulsifier and surfactant applications are found in fabric, carpet and paper coatings, floor polish, shampoos, fire-fighting foam and certain insecticides. PFCs are used to make fluoropolymers, which then are used in the production of many personal care products, textiles, non-stick surfaces and fire-fighting foam. PFCs are widespread and persistent in the environment and they have been found in animals and people all over the globe.

In Minnesota, 3M manufactured PFOS and PFOA from approximately 1950 until they were phased out in 2002. During that time, large volumes of PFCs were released into the Mississippi River in effluent from the 3M Cottage Grove wastewater treatment plant. In addition, four sites in Washington County were identified where 3M disposed of PFC wastes prior to the advent of modern solid and hazardous waste laws and regulations aimed at protecting groundwater. These are located in Oakdale, Woodbury and Cottage Grove, and at the former Washington County Landfill in Lake Elmo.

Initial work by the MPCA and MDH focused on identifying contaminated drinking water wells in these areas, and making sure residents had access both in the short and long term to safe drinking water. While these more immediate concerns were addressed by the MPCA, MDH and 3M, investigations and negotiations with 3M led to a formal Consent Order in 2007 between the MPCA and 3M regarding the release and discharge of PFCs from these sites. The consent decree set forth specific steps required of 3M to remediate its disposal sites and ongoing PFC releases. As of February 2012, all major excavation work is complete at the 3M disposal sites and the former Washington County Landfill. Additional work remains on containing, pumping and treating PFC-contaminated ground water, and monitoring their effectiveness over time.

MPCA investigations also detected PFOS at elevated concentrations in fish taken from Pool 2 of the Mississippi River and downstream, as well as in metro area lakes with no known connection to 3M's manufacturing or waste disposal. Mississippi River Pool 2, which received 3M Cottage Grove effluent during the years of PFOS and PFOA manufacturing, is listed as an impaired water, due to PFOS. This is based on fish tissue PFOS concentrations that prompted the MDH to issue a one-meal per month consumption advisory for certain species in that pool. Preliminary work in advance of a PFOS TMDL for Pool 2 also is underway, and TMDLs will be needed for the PFOS-impaired lakes.

The Consent Order also provided 3M funds for the MPCA to investigate the broader presence of PFCs in the ambient environment and a number of studies have been completed. In addition to fish tissue, PFCs have been found in some shallow groundwater wells, in the influent, effluent and sludge of wastewater treatment plants, in ambient air, in blood of bald eagles, in tree swallows, and in landfill leachate and gas. Several findings of elevated PFOS concentrations have been traced to chrome platers using PFOS-containing products in plating or for chrome mist suppression. The MPCA and the MDH continue to examine potential sources of exposure to PFCs.

An extensive description of all MPCA and MDH activities, and links to many PFC-related reports and studies is available on the following websites:

www.pca.state.mn.us/cleanup/pfc/index.html

www.health.state.mn.us/divs/eh/hazardous/topics/pfcshealth.html

A public health assessment of PFCs in the east metro area was published in February 2012 by the MDH, and is available at this link: MDH Public Health Assessment_01-05-2012.pdf

A copy of the 2007 consent order is available at:
http://www.pca.state.mn.us/index.php/view-document.html?gid=2860

Much remains to be learned about the origins, fate and mechanisms of PFC contamination in the environment. However, the results of investigations to date have begun to move PFCs beyond the realm of the emerging issue of concern and into the MPCA's prevention and regulatory work. Some examples include PFC effluent limits for wastewater treatment plants, monitoring at solid waste landfills, and development of TMDLs (total maximum daily loads) for impaired waters.

Related Activities and Developments

The MPCA is also engaged in other activities related to emerging issues. One example is pollution prevention. Since 2002, the MPCA has worked with several partner organizations to improve environmental compliance and pollution prevention in healthcare facilities in outstate Minnesota, with the goal of achieving proper disposal of discarded pharmaceuticals as well as other regulated wastes generated by these facilities. Related efforts were also undertaken by metro area counties, which have delegated authority to address hazardous waste. Previously, multimedia regulatory inspections of health care facilities had revealed widespread mismanagement of complex hazardous wastes such as pharmaceuticals, laboratory solvents and reagents, and mercury-containing wastes.

As a result of the MPCA's collaboration with several agencies and associations, health care facilities are now using more environmentally preferable waste management methods. Fiscal year 2008 resulted in outstate hospitals properly managing 677,000 pounds of pharmaceuticals and 618,000 pounds of laboratory wastes as hazardous waste. During the four-year period from calendar year 2005 to 2008, 37.8 million pounds of additional waste were properly managed by outstate hospitals compared to the previous four-year period (calendar year 2001 to 2004). Thirty-two hazardous waste compliance training events were presented throughout the state in fiscal year 2010 with over 1500 healthcare professionals in attendance. The MPCA Hazardous Waste Program's health care initiative ended in June 2010. More information on these efforts can be found at: http://www.pca.state.mn.us/nwqh859

Following the Legislature's passage of the Toxic Free Kids Act (TFKA) in 2009, the MPCA worked with MDH to develop recommendations for reducing and phasing-out priority chemicals in children's products and promoting consumer product design that uses green chemistry principles. Priority chemicals are chemicals the MDH was required to identify by February 1, 2011 using criteria specified in the TFKA. The MPCA and MDH recommendations were published in December 2010: http://www.pca.state.mn.us/index.php/view-document.html?gid=3942 and MDH published a list of nine priority chemicals on January 31, 2011: http://www.health.state.mn.us/divs/eh/hazardous/topics/toxfreekids/priority.html#chemicals

In addition, a stakeholder group including MPCA, MDH and other public and private sector leaders has been meeting since 2010 to identify issues and opportunities relevant to state chemicals policy and to develop consensus recommendations to improve Minnesota's approach to regulating and managing chemicals. The stakeholder group recommendations are due in April 2012. For more information, see: http://www.environmental-initiative.org/projects/minnesota-chemical-regulation-a-policy

Additionally, MPCA staff are working to promote Green Chemistry in the private sector by providing services such as grants and technical assistance in association with the Agency's toxic reduction and pollution prevention activities.

Another recent development relating to emerging issues in Minnesota is creation of the Drinking Water Contaminants of Emerging Concern (CEC) program at MDH. Launched with funds allocated during the 2009 legislative session, the MDH CEC program develops health-protective guidance values for chemicals that have been detected or have the potential to be detected in Minnesota drinking water. To date, MDH has developed health-based guidance for 10 contaminants. The MDH CEC program is an important resource for MPCA risk assessors and risk managers, who rely on MDH for health-based guidance. Note that the CEC program also has funds to contract research on the risks, toxicity or occurrence of contaminants. More information is available on the MDH CEC website: http://www.health.state.mn.us/divs/eh/risk/guidance/dwec/index.html.

The MPCA is continuing to partner with state and federal agencies, academic researchers, and stakeholders to identify and address emerging issues of concern to Minnesota.