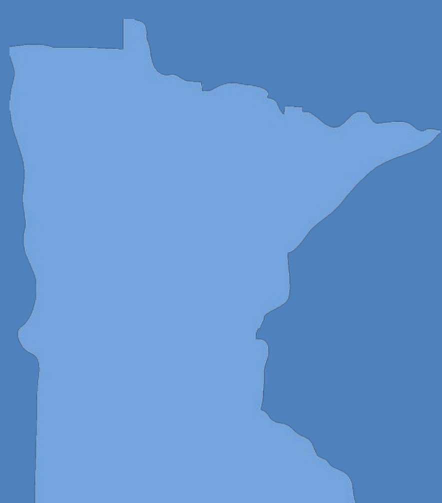
2014 Pollution Report to the Legislature

A summary of Minnesota's air emissions and water discharges



Minnesota Pollution Control Agency

April 2014

Legislative Charge

Minn. Statutes § 116.011 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 even-numbered year, the Pollution Control Agency shall report the best estimate of the agency of the total volume of water and air pollution that was emitted in the state in the previous two calendar years 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 previously reported two calendar years; and

(2) in a manner which will demonstrate the magnitude of the various sources of water and air pollution.

History:

1995 c 247 art 1 s 36; 2001 c 187 s 3; 2012 c 272 s 72

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Contributors / acknowledgements

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Foreword

The *2014 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 two calendar years for which data are available. The statute further directs the MPCA to estimate the percentage increase or decrease over the previous two calendar years, and to estimate the relative contributions of the various sources of these emissions and discharges to the environment.

The report, first produced in 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 data have become available. Advantages and limitations of this report are presented below to add context for interested parties.

Advantages of the inventory approach

- The 2014 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, highlighting 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.

Outlook

Several important national, regional and state actions affecting water pollutant discharges and air pollutant emissions now are listed below.

- **Agency Focus on Watershed Approach:** The MPCA employs a watershed approach to restoring and protecting Minnesota's rivers, lakes, and wetlands. During the 10-year cycle, the MPCA and its partner organizations work on each of the state's 81 major watersheds to evaluate water conditions, establish priorities and goals for improvement, and take actions designed to restore or protect water quality. When a watershed's 10-year cycle is completed, a new cycle begins. The primary feature of the watershed approach is that it focuses on the watershed's condition as the starting point for water quality assessment, planning, implementation, and measurement of results. This approach may be modified to meet local conditions, based on factors such as watershed size, landscape diversity, and geographic complexity (e.g., Twin Cities metro area).

    - **Progress on Watershed Assessment and Monitoring:** Intensive monitoring is complete on 49 of the state's 81 major watersheds (60 percent) through 2013. Assessments have been completed on 35 of the state's 81 major watersheds (43 percent) through 2012. Intensive watershed monitoring has been completed and will be the focus of the next assessment for the seven watersheds sampled in 2012 and 2013. Assessments follow two years of intensive water chemistry and biological community monitoring. Assessments are made for beneficial uses such as drinking water, recreation use, and healthy aquatic biota.
    - **Progress on Watershed Restoration and Protection Strategies (WRAPS):** Based on the watershed assessment, a watershed restoration and protection strategy (WRAPS) is completed. Each WRAPS
        - summarizes scientific studies of the watershed
        - identifies impairments and water bodies in need of protection
        - identifies biotic stressors and sources of pollution (both point and nonpoint)
        - includes development of a Total Maximum Daily Load (TMDLs) for impairments that determines the sources of pollution and the reductions needed to meet water quality standards
        - includes an implementation table which contains strategies and actions designed to achieve and maintain water quality standards and goals

      Fifty-three of the state's 81 major watersheds (65 percent) in Minnesota have WRAPS underway.

- **Statewide Nitrogen Study:** The MPCA, working in collaboration with the University of Minnesota and U.S. Geological Survey, completed a study to characterize total nitrogen loading to Minnesota's surface waters. The resulting report, entitled "Nitrogen in Minnesota Surface Waters – conditions, trends, sources and reductions," provides a scientific foundation of information for developing and evaluating nitrogen reduction strategies, including the state' s draft Nutrient Reduction Strategy. Following a press conference about the report on June 26, 2013, the report findings were presented at over 30 meetings, hearings, conferences, and seminars. The report executive summary can be found at http://www.pca.state.mn.us/index.php/view-document.html?gid=19623 and a two page summary at http://www.pca.state.mn.us/index.php/view-document.html?gid=19607

- **Draft Minnesota Nutrient Reduction Strategy:** In 2013 the MPCA completed a draft Minnesota Nutrient Reduction Strategy which identifies relative nutrient (phosphorous and nitrogen) source contributions to surface waters. The Strategy also establishes nutrient reduction goals for both point and non-point sources. The strategy includes year 2025 phosphorus reduction goals of 35 percent for the Mississippi River, 10 percent for the Red River and 3 percent for Lake Superior. Year 2025 nitrogen reduction goals are 20 percent for the Mississippi River and 13 percent for the Red River.

- **Focus on Small Diverse Air Pollution Sources:** Small, widespread sources of air emissions – like cars, trucks, wood burning and solvent use – are significant contributors to pollution in Minnesota. These types of sources do not have the same oversight as facilities with air quality permits such as factories or power plants. Working with many partners, the MPCA is focusing on the most efficient and effective ways to reduce pollution from small, widespread sources.

    - The MPCA and its partners will use recommendations from a project called Clean Air Dialogue and legislative funding to address pollution from small sources. The agency has contracted with Environmental Initiative to organize a group of business representatives, governmental organizations and nonprofit groups in Clean Air Minnesota (CAM). CAM members will work to identify strategies, implement projects and track and report emissions. One of the MPCA's projects is to reduce the use of solvents and other volatile organic compounds (VOCs) from small businesses, in partnership with the Minnesota Technical Assistance Program at the University of Minnesota.

    - As part of its focus on fine particles and ozone, the MPCA has enrolled in the voluntary PM Advance and Ozone Advance programs with EPA. These programs encourage emission reductions in areas that currently meet ozone and fine particle ($PM_{2.5}$) National Ambient Air Quality Standards (NAAQS) to help these areas continue to meet the standards.

    - The MPCA coordinates Drive Electric Minnesota, a partnership of businesses, non-profits, state agency and local government, and utilities working to promote use of electric vehicles and charging infrastructure development. The U.S. Department of Energy National Charging Station map reports 107 public and private charging stations in our state. The Zero Emission Charging Challenge is underway to pair renewable solar or wind generated electricity with public charging stations for further emissions reduction.

    - At the beginning of 2014, there are 1,891 electric vehicles on Minnesota roads. Use of these vehicles, which have zero emissions from the tailpipe, contributes to improving air quality. Annually, air pollution is reduced by 61,000 pounds of nitrous oxide, 2,500 pounds of particulate matter, 61,000 pounds of volatile organic compounds, and 10,000 tons of greenhouse gas emissions.

    - The MPCA continues its focus on reducing emissions from heavy duty diesel engines in fleets and construction equipment, with a new request for project proposals published in November, 2013. This ongoing program has utilized state and federal funding since 2006 to improve or replace 4,000 diesel engines in Minnesota, focusing on reducing $PM_{2.5}$. The cumulative result is a reduction of nearly 26 tons of ground level $PM_{2.5}$ annually, which equates to taking 465,690 cars off the road.

    - Emerging initiatives for further reductions in pollution from vehicles are being considered based on resources. These efforts may include truck idle reduction, low-cost emission repairs for low-income car owners, or a "Check Tire Pressure" campaign, among others.

- o Wood smoke has increased in Minnesota as more people have backyard fire pits or use wood for home heating. Emissions from wood burning include particles and toxic chemicals. Exposure to wood smoke affects public health. The MPCA continues to assess data about wood use and emissions in the state. The agency is revising its process regarding complaints about hydronic heaters (outdoor wood boilers) and evaluating a possible model ordinance to assist local units of government with potential problems. The MPCA is also establishing partnerships for education, outreach and other voluntary efforts to help reduce emissions from wood smoke.

§ **New federal regulations for boilers and wood stoves:** The US EPA finalized rules in early 2013 that regulate industrial, commercial and institutional boilers. These rules cover boilers using coal, oil or biomass. The rules require good work practices and/or controls that limit the emission of toxic metals, hydrogen chloride, and fine particles among other pollutants. Among the largest sources, approximately nine facilities in Minnesota with 19 boilers are affected by these rules.

The EPA placed amendments to the Standards of Performance for New Residential Wood Heaters on public notice in early 2014. The proposed changes update requirements for wood stoves and will now include the manufacture of new hydronic heaters (wood boilers), forced-air furnaces and residential masonry heaters which were previously unregulated. New units have to meet updated emission limits and test methods. Minnesota has approximately 17 manufacturers of wood stoves, furnaces, and hydronic heaters.

§ **Federal regulation of air pollution across state lines:** The EPA's Cross-State Air Pollution Rule (CSAPR), and its predecessor the Clean Air Interstate Rule, implement requirements in the federal Clean Air Act that address air pollution moving between states. Pollution from upwind states can cause standards to be exceeded in downwind states. These rules affect utilities and other large emission sources. The rules are the subject of multiple lawsuits. The U.S. Supreme Court heard arguments about CSAPR in December, 2013. Their decision is expected in early summer, 2014. Minnesota continues to work with facilities to reduce pollution until the final form of the federal regulation is promulgated.

§ **New state air quality rules:** The MPCA is amending its rules to reduce mercury emissions from sources within the state. The rules are expected to be final in mid-2014. The MPCA conducted this rulemaking because two-thirds of Minnesota's lakes and rivers are impaired due to mercury, mostly deposited from the air. Existing facilities will develop reduction plans and report emissions annually. The rules also incorporate federal standards and compliance language for electric generating units and incinerators.

The MPCA is considering possible amendments to a number of air quality rule chapters. This rulemaking is part of an ongoing effort to maintain and improve the MPCA's existing rules. The overall purpose of the rulemaking is to keep the air quality rules current, ensure consistency with applicable federal and state regulations, remove redundant language and clarify ambiguous rule language, and correct gaps or errors identified while administering the rules. In addition to housekeeping updates, the rules will address sulfur dioxide and nitrogen dioxide for consistency with federal standards.

Introduction and Summary

The Minnesota Pollution Control Agency (MPCA) is required to submit a report to the Legislature of the volume of pollution emitted or discharged to the state's air and water resources every two years. The basis of the MPCA's 2014 Pollution Report is the 2010 MPCA Greenhouse Gas Inventory, the 2008 and 2012 Minnesota Criteria Pollutant Emission Inventories, the 2008 Air Toxics Emission Inventory, the 2000-2013 Water Quality National Pollutant Discharge Elimination System (NPDES) Discharge Monitoring Reports and Board of Water and Soil Resources eLINK database.

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

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 (NH_3), sulfur dioxide (SO_2), nitrogen oxides (NO_x), volatile organic compounds (VOCs), carbon monoxide (CO) and lead (Pb). Emissions of criteria pollutants from large facilities are estimated every year with data from 2012 currently available. However, emissions from smaller sources are estimated every three years with 2008 estimates the most recent available.

There are a few changes to the 2008 statewide emissions inventory from past reported inventories. For one, EPA estimated fire emissions using a new methodology. Fire emissions are no longer part of the nonpoint category; rather they are separated into a distinct category. And for the first time starting in

About Air Emission Inventories

The MPCA completed the Consolidated Emissions Data Repository (CEDR) emission inventory system in 2009-2010. During the next few years there was a stepwise approach to transition facilities from reporting paper inventories to reporting emissions via the electronic reporting system. In 2010, large facilities (~450) reported their criteria air pollutants (CAPs) via CEDR; in 2011 both large and small facilities (~ 1650) reported both their CAPs and air toxics. Small facilities also reported greenhouse gas (GHG) emissions, as did all facilities in 2012. 2012 also was the first year facilities were able to report fine particle ($PM_{2.5}$) and ammonia emissions. If the facilities did not report them, the MPCA calculated the emissions and facilities were able to review them prior to finalization of the 2012 emissions inventory.

The electronic reporting feature along with other system improvements reduced the inventory completion time, improved data quality, and reduced the burden on staff at reporting facilities and the agency. Facilities are able to report all pollutant types to the MPCA using a consistent set of requirements for all pollutants. For more information on web-based reporting, see http://www.pca.state.mn.us/yhiz14e3

The 2011 Air Toxics Emissions Inventory and the 2011 Criteria Pollutant Emissions Inventory for fire, nonpoint and mobile sources will be completed by early 2015.

2008, emissions from biogenic sources are included in the statewide totals. Biogenic emissions are emitted from natural sources such as soils and vegetation.

Emissions for six greenhouse gases (carbon dioxide, nitrous oxide, methane, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride) are reported in terms of carbon dioxide equivalents (CO_2e). The most recent statewide emissions inventory completed for greenhouse gases in Minnesota is from 2010. Under new state and federal requirements, MPCA started tracking GHG emissions from point sources. Small point sources started GHG reporting in 2011, while in 2012 all facilities reported GHG emissions to the MPCA via CEDR electronic reporting. Point source breakdowns are not included in this report, but will be added in the future reports.

The Minnesota Air Toxics Emission Inventory estimates emissions of individual air toxics including compounds such as benzene, formaldehyde, acrolein, mercury and polycyclic organic matter. Some overlap exists between the Minnesota Air Toxics Emission Inventory and the estimates for VOCs and particulate matter in the Minnesota Criteria Pollutant Emissions Inventory because many air toxics are components of these broader categories. The most recent inventory of air toxics emissions is from 2008.

Table 1 provides estimated total statewide emissions of the major air pollutants from 2008 to 2012. The percent change from 2010 to 2011, and 2011 to 2012 is provided in the final two columns. 2008 emissions are from all sources including mobile, nonpoint, fire and point sources. Yearly emissions changes are due entirely to point sources. Mobile, nonpoint and fire emissions estimates were held constant. It is therefore important not to place undue emphasis on yearly changes. Emissions also 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, 2008-2012 (Thousand Tons)

Pollutant	2008	2009	2010	2011	2012	2010-2011 % Change	2011-2012 % Change
Greenhouse gases**	161,787	153,034	155,629				1.67
Particulate matter (PM_{10})***	774	766	772	770	769	-0.26	-0.22
Sulfur dioxide (SO_2)	110	82	74	68	54	-7.17	-20.71
Nitrogen oxides (NO_x)	421	383	388	384	379	-1.01	-1.51
Volatile organic compounds (VOCs)	1,207	1,204	1,205	1,204	1,204	-0.05	-0.04
Carbon monoxide (CO)	2,475	2,473	2,474	2,476	2,476	0.06	0.01
Particulate matter ($PM_{2.5}$)***	211				212		
Ammonia (NH_3)	203				202		
Total Criteria**** Pollutants (not including CO_2)	4,988	4,908	4,914	4,903	4,882	-0.21	-0.22

*2008 mobile, nonpoint and fire emission estimates were used in the 2008-2012 emission estimates. The only changes are from point sources.

**Greenhouse gas emission estimates include net imported electricity. Data are not available for 2011 or 2012, so percent change is for 2009-2010.

***PM_{10} and $PM_{2.5}$ emissions represent only direct emissions; secondary formation is not included.

**** Does not include $PM_{2.5}$ and NH_3 in the 2008 and 2012 totals.

Most of the criteria pollutant emission estimates from point sources decreased slightly between 2010 and 2011, and between 2011 and 2012. MPCA started calculating $PM_{2.5}$ and NH_3 emissions annually in 2012 for all permitted point sources. These pollutants are included in Table 1. Decreased coal usage by large electric utilities resulted in lower emission totals. Xcel Energy – Sherburne Generating Plant power boiler did not run for the duration of the 2012 calendar year and Verso Paper Corp – Sartell shut down permanently because of a fire that destroyed the plant. Emissions avoided from the two facilities totaled around 16,000 tons.

SO_2 emissions showed a dramatic decrease in part because of reduced coal usage from large facilities such as Minnesota Power's Taconite Harbor Energy Center and North Shore Mining – Silver Bay. Emissions avoided from a power boiler shutdown at Xcel Energy – Sherburne Generating Plant were the main driver, accounting for more than 20 percent of the reduction in emissions from 2011 to 2012.

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 in creating particulate matter and some other pollutants, 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 break down or combine and form fine particles and other pollutants downwind of the emission source, and reliable quantification is not possible at this time.

Lead, mercury and other air toxics are pollutants that can be toxic at very low concentrations. In 2012, 20 tons of lead and 2,834 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 law to obtain permits, 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). The 2014 Annual Pollution Report examines the 2000 to 2013 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 MPCA's capacity to accurately perform loading analyses. Due to the five-year permit cycle, however, for select pollutants, some permits have yet to be modified to incorporate the monitoring and reporting requirements necessary to enable efficient, computerized calculations of total annual pollutant loadings. As the MPCA 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 contains water discharge data from all municipal and industrial wastewater point sources for flow and five measures of water pollution covering the years 2000-2013. Summaries of pollutant loads discharged by 937 facilities including 577 domestic wastewater and 360 industrial facilities are included. Maps on page 55 and 56 show the distribution of municipal wastewater treatment facilities by size and the distribution of various types of industrial facilities found in Minnesota.

Pollutant loads are calculated by combining effluent flow data with reported pollutant concentrations or estimated pollutant concentrations where facility specific data are not available. Estimated concentrations used to calculate pollutant loads are based on categorical assumptions that account for waste stream and facility type characteristics. Concentration estimates are based on effluent data from similar waste streams and facilities types when available, and in some cases estimates are based on best professional judgment.

2014 effluent flow and pollutant loading estimates for NPDES permitted facilities exclude once through non-contact cooling water data from power generation facilities. Extremely large volumes of (primarily) river water are used by the power industry for cooling purposes. These once through non-contact cooling waters are discharged with the addition of heat, but neglible additions of other pollutants. Pollutant loads associated with these discharges were largely present in the waterbodies before the waters were withdrawn for cooling purposes so reporting them as wastewater pollutants would be misleading.

Pollutant loads calculated from measured wastewater flows and observed pollutant concentrations are considered to be highly reliable while less confidence is warranted for pollutant loads derived from estimated concentrations. The degree of confidence in each loading estimate can be expressed as the proportion of the load derived from observed values compared to the proportion derived from estimated values. The loading graphs in this report are color coded by 'Observed' and 'Estimated' to serve as a confidence measure for each pollutant load measure.

Previous Annual Pollution Reports were based on data reported by approximately 99 major wastewater dischargers. These are facilities permitted to discharge at least 1 million gallons per day and account for approximately 85 percent of the volume of wastewater discharged to waters of the state. This year's report includes data from all surface water dischargers, regardless of size. The inclusion of non-major facilities will present a more complete measure of pollutant loads since non-major facilities can collectively impact water quality.

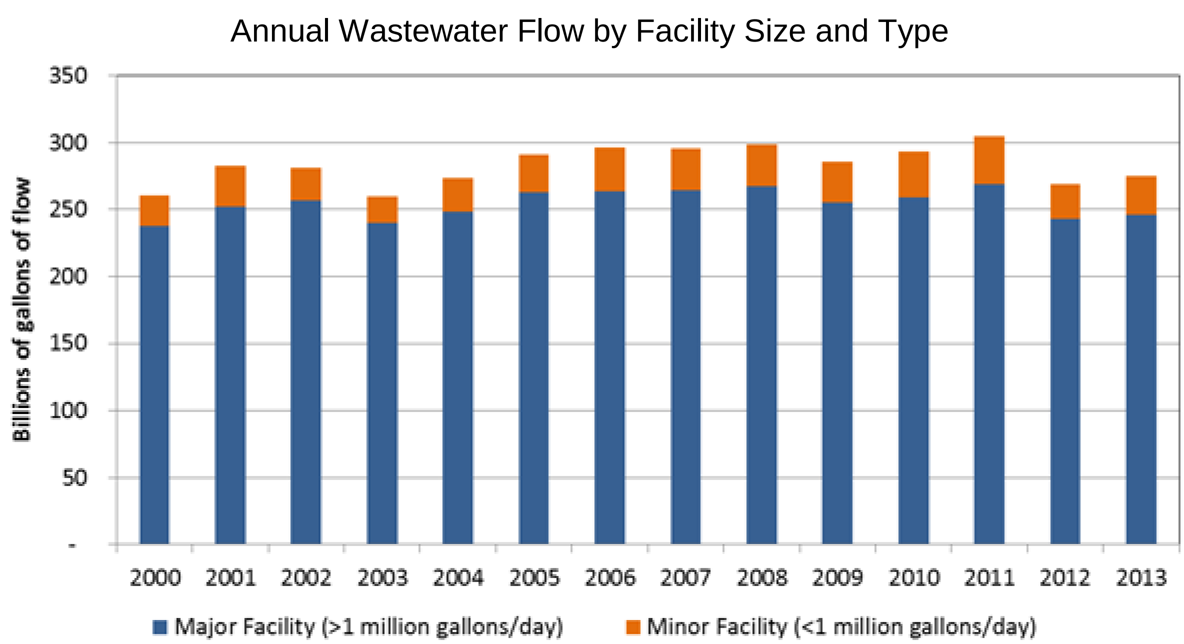
Five common chemical parameters found in wastewater treatment plant effluent will be highlighted in this report, including: total suspended solids (TSS), carbonaceous biochemical oxygen demand (CBOD), total phosphorus (TP), total nitrogen (TN) and mercury (Hg). Table 2 on page 7 summarizes effluent pollutant loading estimates from NPDES point sources for 2000-2013 by pollutant.

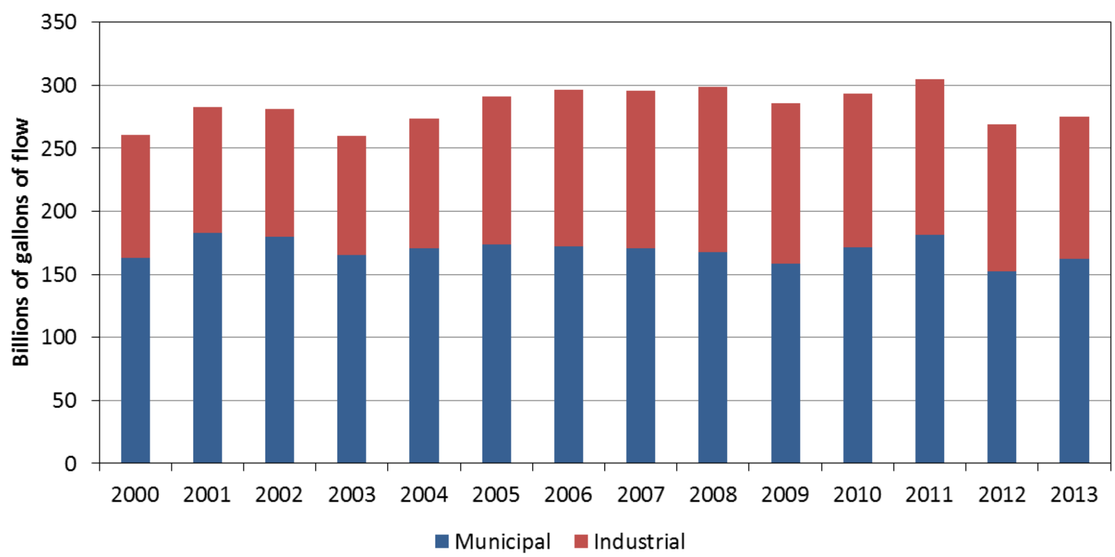
Effluent flow volumes are also included in this year's report. Although flow is not a regulated pollutant, it is a useful gauge of overall facility performance because of the direct relationship between pollutant loading and effluent flow volume. For example, if effluent flow and pollutant loading show proportional annual increases, it is an indication that overall effluent concentrations have remained stable and the loading increase is attributable to the increase in flow. Conversely, if the pollutant load showed consistent annual decreases despite an increase in effluent flow volume, the concentration has likely decreased and the effluent quality has improved.

Flow

Overall wastewater flow volumes have fluctuated from a low flow of 260 billion gallons per year in 2003 to a peak flow of 305 billion gallons per year in 2011. Since the year 2000 major facilities (municipal and industrial) have discharged approximately 90 percent of Minnesota's treated wastewater.

Municipal wastewater treatment facilities discharged 63 percent of wastewater flow from 2000 through 2004. Since 2005 the proportion of municipal wastewater flow has declined to 60 percent of the total. Wastewater flow reductions have occurred since 2011. 2012 was a particularly dry year which affected the volume of water being processed by municipal wastewater treatment facilities. The subsequent increase in municipal flows for 2013 was offset by an equivalent reduction in industrial flow volumes resulting in a steady overall wastewater flow volume rate for the 2012-2013 biennium.

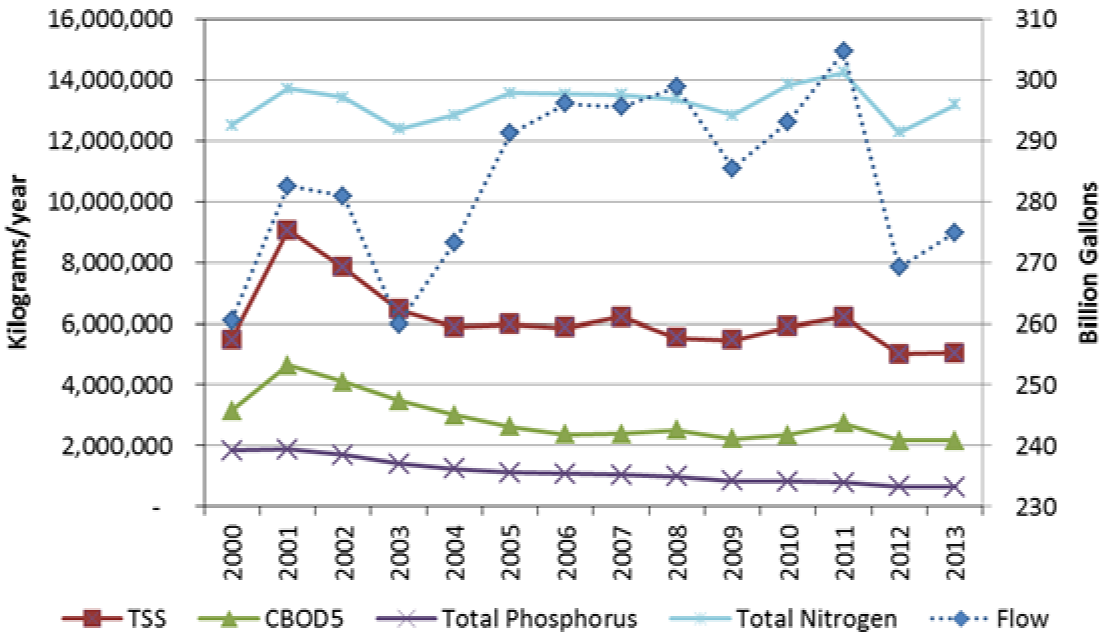




Pollutant Loading Trends

Flow and pollutant loading trends are shown in the following figures and Tables 2 through 4 below. The magnitude of statewide mercury loads is shown in the second figure below.

Pollutant Loading Trends from NPDES Wastewater Facilities, 2000-2013



Mercury Loading Trends From NPDES Wastewater Facilities 2000 – 2013

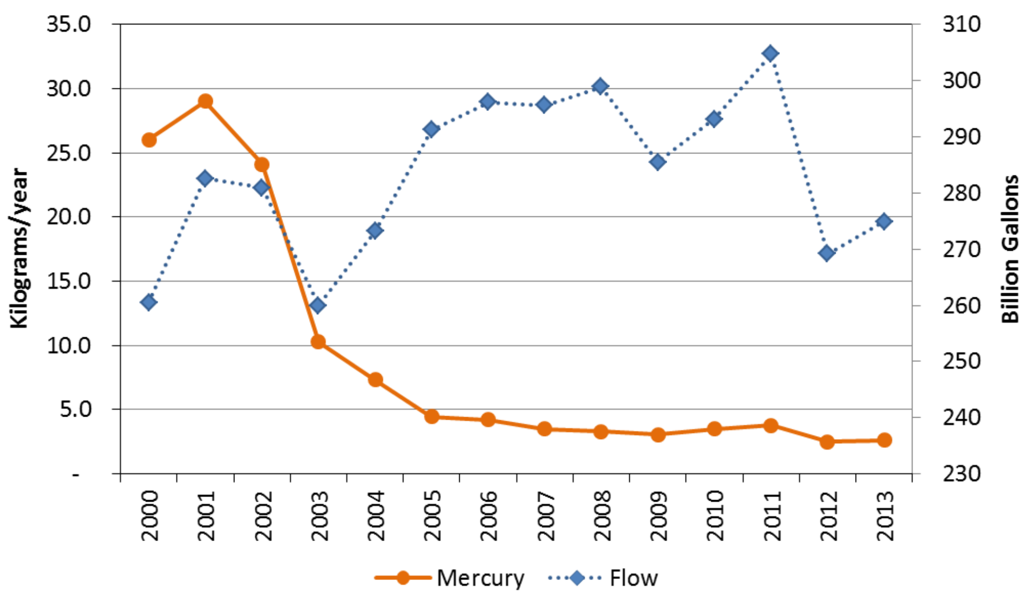


Table 2 shows pollutant effluent flow and loading trends from 2000 through 2013. Effluent flow is reported in billion gallons per year. Pollutant loads for TSS, $CBOD_5$, Total Phosphorus and Total Nitrogen are reported in thousand kilograms per year. Pollutant loads for Mercury are reported in kilograms per year.

Overall, effluent flows tend to fluctuate based on climate and market conditions. TSS loads increased in 2001 and 2002 but have otherwise remained fairly stable at approximately 6,000,000 kilograms per year. $CBOD_5$ loads have declined from 3,000,000 to 4,000,000 kilograms per year during the 2000 to 2004 period to an average load of 2,400,000 kilograms per year since 2005. Significant Total Phosphorus reductions have been achieved since 2000. Total nitrogen loads have remained stable at approximately 13,000,000 kilograms per year. Significant mercury load reductions have been achieved.

Table 2. Annual Flow and Pollutant Load Estimates from Minnesota Wastewater Treatment Facilities, (billion gallons, thousand kilograms and kilograms per year) 2000-2013

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Flow (billion gall/year)	260.5	282.6	280.9	259.9	273.2	291.2	296.1	295.6	298.8	285.5	293.1	304.7	269.1	274.9
TSS (thousand kg/year)	5,745	9,054	7,825	6,455	5,881	5,969	5,873	6,215	5,542	5,464	5,897	6,207	5,017	5,046
CBOD (thousand kg/year)[1]	3,146	4,639	4,095	3,470	3,010	2,631	2,369	2,389	2,512	2,224	2,345	2,724	2,159	2,172
TP (thousand kg/year)	1,838	1,872	1,695	1,401	1,233	1,103	1,067	1,039	987	843	812	781	653	633
TN (thousand kg/year)	12,509	13,712	13,419	12,388	12,854	13,567	13,533	13,513	13,367	12,845	13,841	14,250	12,277	13,193
Hg (Kg/year)[2]	26.0	29.0	24.1	10.3	7.3	4.5	4.2	3.5	3.3	3.1	3.5	3.8	2.5	2.6

[1]Industrial facilities are excluded from CBOD load calculations due to lack of data.

[2]Peat mining facilities are excluded from mercury calculations due to unreliability of flow and mercury data. Efforts are underway to improve the data about these facilities.

Table 3 shows the annual percent change in flow and pollutant loads. 2001 stands out as a year that saw significant increases in the loading of all pollutants, probably as a result of the significant flooding which occurred that year. Excluding 2001, the year to year percent change data show the following:

- An average 4% per year decline in annual TSS loads
- An average 6% decline in annual $CBOD_5$ loads
- An average 9% decline in annual Total Phosphorus loads
- No average change in annual Total Nitrogen loads
- An average 15% decline in annual Mercury loads

Table 3: Annual Percent Change in Flow and Pollutant Loads from Minnesota Wastewater Treatment Facilities, 2001-2013

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Flow (%)		8%	-1%	-7%	5%	7%	2%	0%	1%	-4%	3%	4%	-12%	2%
TSS (%)		65%	-14%	-17%	-9%	1%	-2%	6%	-11%	-1%	8%	5%	-19%	0%
CBOD (%)		47%	-12%	-15%	-13%	-13%	-10%	1%	5%	-11%	5%	16%	-21%	1%
TP (%)		2%	-9%	-17%	-12%	-11%	-3%	-3%	-5%	-15%	-4%	-4%	-16%	-3%
TN (%)		10%	-2%	-8%	4%	6%	0%	0%	-1%	-4%	8%	3%	-14%	7%
Hg (%)		11%	-17%	-57%	-29%	-39%	-5%	-17%	-5%	-7%	14%	8%	-34%	6%

Since 2001 was a year with significantly higher than normal loading, the MPCA is reporting longer-term trends in the report using a baseline defined as the average of the years 2000 and 2001. Table 4 shows the annual percent change in flow and pollutant loading from this baseline. From 2002 to 2013 percent change from this 2000-2001 baseline shows:

- An average 1 % increase in effluent flows
- An average 30% decrease in TSS loads
- An average 44% decrease in $CBOD_5$ loads
- An average 66% decrease in Total Phosphorus loads
- An average 1% decrease in Total Nitrogen loads
- An average 90% decrease in Mercury loads

Table 4: Annual Percent Change in Flow and Pollutant Loads from 2000-2001 Baseline (million gallons, thousand kilograms, and kilograms)

	Baseline 2000- 2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Flow (%)	271,570 (million gallons/year)	3%	-4%	1%	7%	9%	9%	10%	5%	8%	12%	-1%	1%
TSS (%)	7,277 (thousand kilograms/year)	8%	-11%	-19%	-18%	-19%	-14%	-23%	-25%	-19%	-14%	-31%	-30%
CBOD (%)	3,892 (thousand kilograms/year)	5%	-11%	-23%	-32%	-39%	-39%	-35%	-43%	-40%	-30%	-45%	-44%
TP (%)	1,855 (thousand kilograms/year)	-9%	-24%	-34%	-41%	-42%	-44%	-47%	-55%	-56%	-58%	-65%	-66%
TN (%)	13,111 (thousand kilogram/year)	2%	-6%	-2%	3%	3%	3%	2%	-2%	6%	9%	-6%	1%
Hg (%)	28 (kilograms/year)	-12%	-63%	-73%	-84%	-85%	-87%	-88%	-89%	-87%	-86%	-91%	-90%

A number of additional sources of variation, both up and down, can potentially impact annual comparisons:

- § The loading calculations incorporate data interpretation decisions that can legitimately be made in a variety of ways. This typically applies to the classification of waste-stream and facility types for the assignment of categorical concentrations. There are also select facilities that report highly inconsistent values for some parameters and are excluded until the questionable values can be verified.
- § 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.

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 2012. Fire, mobile and nonpoint source emissions are available for 2008.

$PM_{2.5}$ and ammonia (which contributes to $PM_{2.5}$ formation) used to be estimated every three years. Starting in 2012, $PM_{2.5}$ and ammonia emissions from large facilities are estimated annually, The emissions of $PM_{2.5}$ and ammonia from fires, mobile and nonpoint sources are calculated on a three-year basis, with the latest available for 2008. New additions to the 2008 statewide emission inventory include the addition of biogenic emissions into state totals, and fire emissions being separated into a separate source category. Biogenic emissions are emitted from natural sources such as soils and vegetation. The Criteria Pollutant Emissions section also includes a summary of the MPCA's Air Quality Index (AQI) data for 2013.

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 (carbon dioxide, nitrous oxide, methane, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride) in terms of carbon dioxide equivalents (CO_2e). CO_2e compares the warming potential of different gases to the impact of CO_2. Emission estimates for 2010 are included in this report. New federal and state rules require MPCA to estimate GHG emissions from point sources. Starting in 2011, small point sources started reporting GHG emissions. In 2012, all permitted point sources submitted GHG emissions to the MPCA using the CEDR electronic reporting system. Point source GHG emissions will be included in future reports. 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 air pollutants 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 comes from the 2008 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 report for more information.

Air Quality in Minnesota: 2013 Report to the Legislature
http://www.pca.state.mn.us/yhizb6a

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. Starting in 2012, MPCA also began estimating $PM_{2.5}$ and ammonia on an annual basis; prior to 2012 these emissions were estimated every three years.

The Minnesota Criteria Pollutant Emission Inventory estimates emissions from permitted facilities every year, as required in Minnesota's air quality rules. In addition, federal rules require the MPCA to estimate emissions every three years from three other principal source categories: fires, nonpoint sources and mobile sources. Overall, the Minnesota Criteria Pollution Emission Inventory includes emissions from four 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. 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. For the first time in the 2008 emission inventory, nonpoint sources include emissions from biogenic sources which include natural sources such as soils and vegetation.
3. **Mobile sources:** Mobile sources are broken up into two categories; onroad vehicles and nonroad sources. Onroad vehicles include vehicles operated on highways, streets and roads. Nonroad sources include off-road vehicles and portable equipment powered by internal combustion engines. Lawn and garden equipment, construction equipment, aircraft and locomotives are examples of nonroad sources.
4. **Fires:** Fire emissions are defined as emissions produced by inadvertent or intentional agriculture burning, prescribed burning or forest wild fires. EPA estimated 2008 emissions using the Satellite Mapping Automated Reanalysis Tool for Fire Incident Reconciliation version 2 (SFv2). SFv2 uses multiple fire information data sources for the development of fire emission inventory data.

The Minnesota Criteria Pollutant Emission Inventory is complete for point sources through 2012. Emission estimates are available for fire, nonpoint, and mobile sources for 2008. When 2012 summary data are given, they include fire, nonpoint and mobile data from 2008 and point source data from 2012. This report presents trend data for point sources from 2008-2012.

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 trend evaluations, 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/hqzqfb8

See the MPCA Environmental Data Access web site to download MPCA emission estimates for criteria pollutants and air toxics including county level emissions for 2008:
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

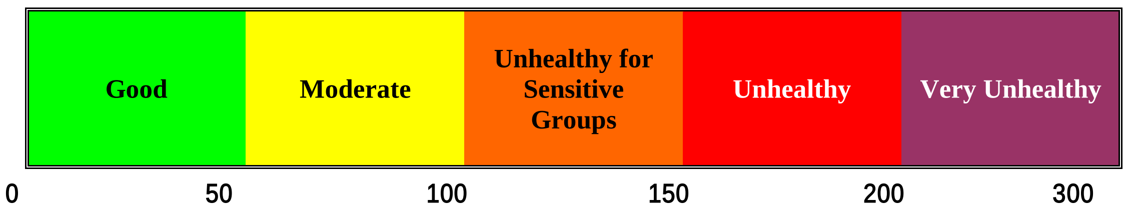
See the EPA's National Emissions Inventory Browser to download EPA criteria pollutant emission estimates:
http://www.epa.gov/ttnchie1/net/2008inventory.html

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. Minnesota's AQI results are based on hourly measurements of five pollutants: fine particles ($PM_{2.5}$), ground-level ozone, sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and carbon monoxide (CO). An AQI value is calculated for each pollutant, but the pollutant with the highest AQI value is reported as the overall AQI for that hour and reporting area. AQI values are updated hourly and posted on the MPCA's website at http://www.pca.state.mn.us/aqi.

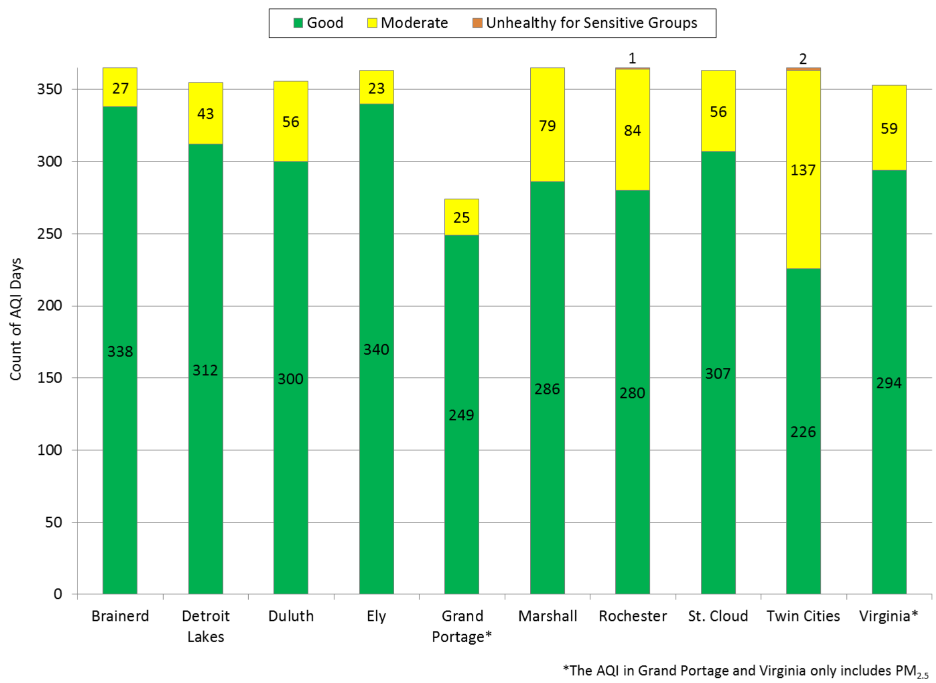
Air quality is ranked as good, moderate, unhealthy for sensitive groups (USG), unhealthy, or very unhealthy. If it is suspected through forecasting or monitoring that one of the five pollutants may be unhealthy for sensitive groups or higher, the MPCA issues an Air Pollution Health Alert to the media and to individuals who have signed up to receive e-mail alerts. Alerts allow the public to be proactive about protecting their health and reducing their own contributions to emissions and exposure to pollution.

AQI Color Legend



In 2013, the AQI was reported in 10 regions across the state including the Brainerd area, Detroit Lakes, the Duluth area, Ely, Grand Portage, Marshall, Rochester, St. Cloud, the Twin Cities metropolitan area, and Virginia. The chart below displays the number of good, moderate, and unhealthy for sensitive group days for each of these monitoring regions in 2013.

2013 Air Quality Index Days by Category and Reporting Region[1]

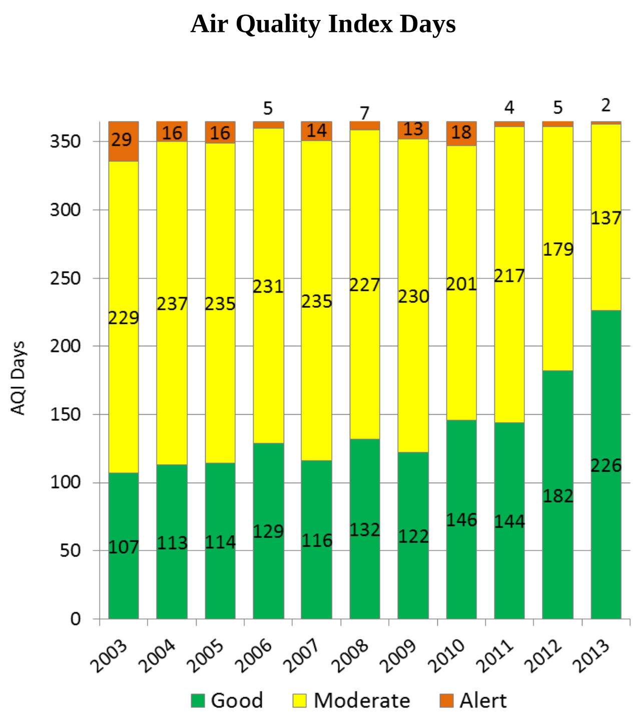


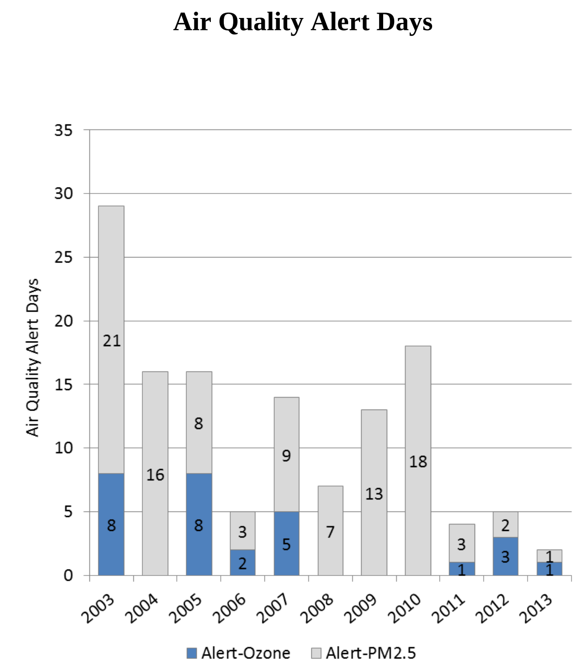
In 2013, across all areas of the state, the majority of days were rated good for air quality. Ely experienced the highest number of good air quality days (340) compared to the Twin Cities metropolitan which experienced the lowest number of good air quality days (226). The lower number of good AQI days in the Twin Cities compared to other areas of the state is an expected result, as the AQI is based on pollutants which are most abundant in urban areas. While the Twin Cities metropolitan area experiences the fewest number of good AQI days each year, the number of good AQI days in the Twin Cities has been increasing over time (see chart below). This suggests that overall air quality is improving in the Twin Cities metropolitan area.

In 2013, across Minnesota, the AQI reached a level considered unhealthy for sensitive groups on two days, which is the lowest number of air quality alert days in over a decade (see chart below). On February 26, 2013, fine particle concentrations reached unhealthy for sensitive group levels in the Twin Cities and in Rochester. The elevated fine particle concentrations measured on February 26 were the result of heavy fog and stagnant weather conditions that promoted the production and build-up of fine particle pollution across much of Minnesota and Iowa. On July 27, 2013, ozone concentrations reached unhealthy for sensitive group levels in the Twin Cities. The elevated ozone concentrations measured on July 27 were the result of increased ozone production due to high daytime temperatures (greater than 90° F), sunny-skies, low-wind speeds, and the presence of wildfire smoke transported to Minnesota from fires burning in central Canada and the western United States.

[1]The 2013 AQI results are preliminary and subject to change. Final 2013 results will be posted at www.pca.state.mn.us/9qwp864.

Air Quality Index Trends for the Twin Cities Metropolitan Area, 2003-2013





References/web links

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

MPCA AQI website**:** http://www.pca.state.mn.us/aqi

EPA AQI website: http://www.epa.gov/airnow/

EPA AQI publications: http://www.airnow.gov/index.cfm?action=pubs.index

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 growth rate and lung function and increased respiratory illness in children.

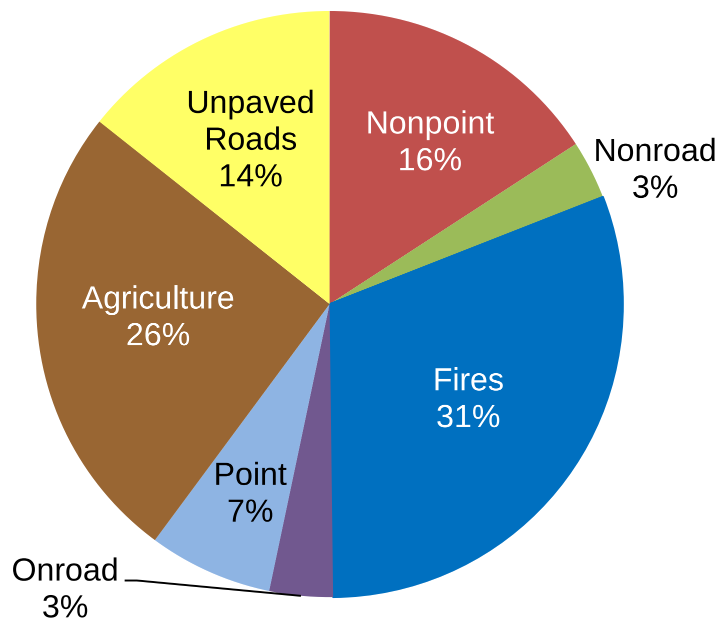
Emissions data and sources

$PM_{2.5}$ 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, fires 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 2012 is 211,749 tons. This includes the $PM_{2.5}$ directly emitted from sources included in the MPCA emission inventory. The estimates do not include secondarily formed $PM_{2.5}$, which can comprise of a large portion of the $PM_{2.5}$ found in the air.

Sources of Direct Fine Particulate (PM2.5) Emissions in Minnesota, 2008 and 2012

Point source data are from the 2012 Emission Inventory. All other data are from the 2008 Emission Inventory.



*Does not include secondarily formed $PM_{2.5}$

More than 30 percent of the estimated mass of primary $PM_{2.5}$ emissions comes from fire which includes agriculture burning, forest wild fires and prescribed burning. A quarter of the emissions come from suspended soils released from agricultural tilling. About 14 percent of emissions come from unpaved roads. Another 16 percent of the emissions are from nonpoint sources which include construction, residential, commercial, and industrial fuel combustion. The rest are attributed to large point sources such as electric utilities and combustion of fuels in nonroad and onroad sources.

The inventory suggests that most of the $PM_{2.5}$ emissions are from fire combustion which can have a negative impact on visibility, air quality and human health. These emissions can travel long distances and affect the air quality and human health far from their origin. In addition, a large portion of $PM_{2.5}$ 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" $PM_{2.5}$.

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 a result of secondary formation from "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 5: Major Sources of $PM_{2.5}$ Components

Component	Major Sources	Present in the air because…
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, then in 2005 and now 2008 estimates are available. Total estimated $PM_{2.5}$ emissions were 166,000 tons in 2005 and 211,749 tons in 2008. Starting in 2012 the MPCA started estimating $PM_{2.5}$ emissions on a yearly basis for all permitted point sources. These estimates are included in the totals.

Statewide $PM_{2.5}$ estimated emissions have increased significantly since 2005, due to methodology changes in certain categories such as fires. EPA estimated 2008 fire emissions using Satellite Mapping Automated Reanalysis Tool for Fire Incident Reconciliation version 2 (SFv2). SFv2 uses multiple fire information data sources for the development of fire emission inventory data. This methodology is a significant improvement over the 2005 emission estimates. For example, in 2005 a number of fires were left as unclassified because there were no observational data to assign the fires to any specific category. SFv2 resolved this problem.

In 2008, parts of Northern Minnesota specifically Beltrami and Marshall Counties had significant $PM_{2.5}$ emissions due to fires. Most of the emissions occurred in April, May and July.

Given the ongoing improvements in the estimation methods it is understandable that the emissions have changed significantly.

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}

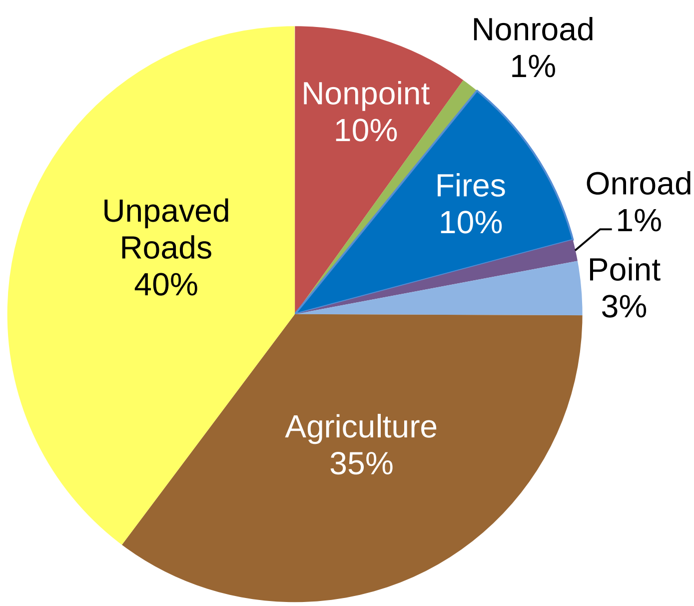
PM_{10} includes all particles with aerodynamic diameters less than 10 microns. $PM_{2.5}$ is a subset of PM_{10} emissions. Based on monitoring data, roughly half of the mass of Minnesota's ambient PM_{10} particles are of particles within the $PM_{2.5}$ size and so the direct and secondary formation 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. 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 2012 is 768,688 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, 2008 and 2012

Point source data are from the 2012 Emission Inventory. All other data are from the 2008 Emission Inventory.



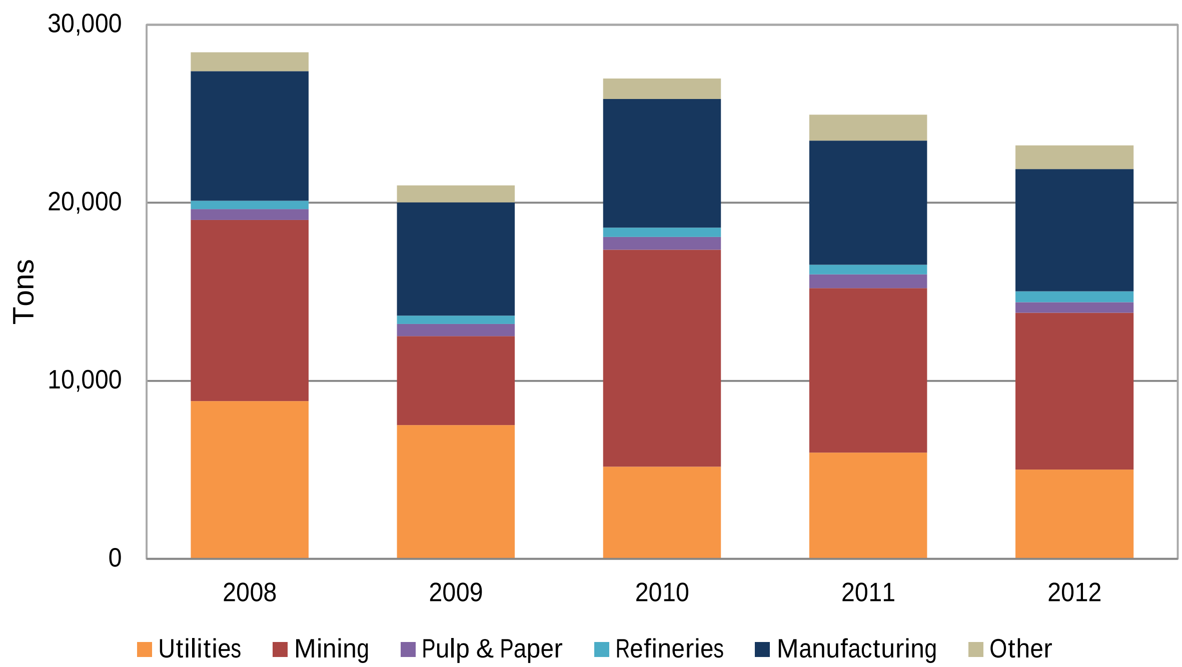
About 40 percent of the mass of direct primary PM_{10} emissions come from fugitive dust from unpaved roads. Another 35 percent of emissions come from agricultural practices. Ten percent is emitted from fires. The remainder comes from nonpoint sources which include construction, residential, commercial, and industrial fuel combustion, large point sources such as electric utilities, and combustion of fuels in nonroad and onroad 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 2012, 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 2008. PM_{10} emissions continue to decrease for 2011 and 2012 due to reduced coal use by some facilities such as Minnesota Power's Taconite Harbor Energy Center and North Shore Mining – Silver Bay. Verso Paper Corp – Sartell permanently shut down because of a fire which further reduced emissions. In addition there was an overall drop in all emissions due to power boiler shutdown at Xcel Energy – Sherburne Generating Plant for the entire 2012 calendar year.

PM10 Point-Source Emission Trends by Sector in Minnesota, 2008-2012



References/web links

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

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

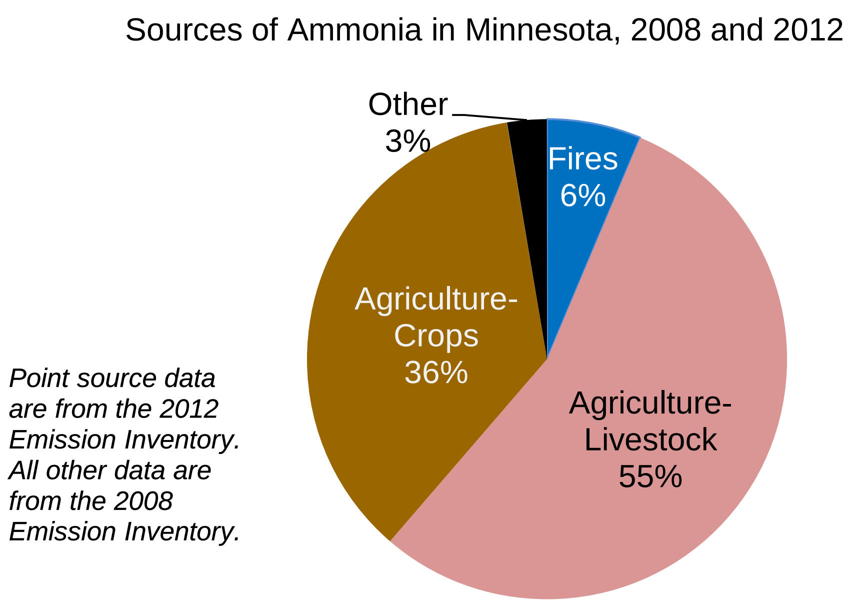
Ammonia

Ammonia is a colorless gas with a distinctive odor. The main source of ammonia gas in the air is livestock waste and fertilizer application. Exposure to ammonia in the air can be irritating to the eyes, throat and breathing passages. Exposure to higher concentrations of ammonia can cause burns.

Federal rules direct the MPCA to track emissions of ammonia because it is a major contributor to fine particle ($PM_{2.5}$) formation. 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 2012 is 202,007 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, then in 2005 and now the 2008 estimates are available. In 2005, Minnesota ammonia emissions were estimated at 180,000 tons, and in 2008 the estimate is 202,007 tons. Starting in 2012 the MPCA started estimating ammonia emissions annually for all permitted point sources. Those estimates are included in the totals.

Statewide ammonia emissions have increased significantly since 2005; this is because of methodology changes for certain source categories such as fire. In 2008 EPA estimated fire emissions using Satellite Mapping Automated Reanalysis Tool for Fire Incident Reconciliation version 2 (SFv2). SFv2 uses multiple fire information data sources for the development of fire emission inventory data. This methodology is a significant improvement over the 2005 emission estimates. Given the ongoing improvements in estimation methods, it is understandable that the emissions have changed significantly.

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 during gasoline production and metal smelting.

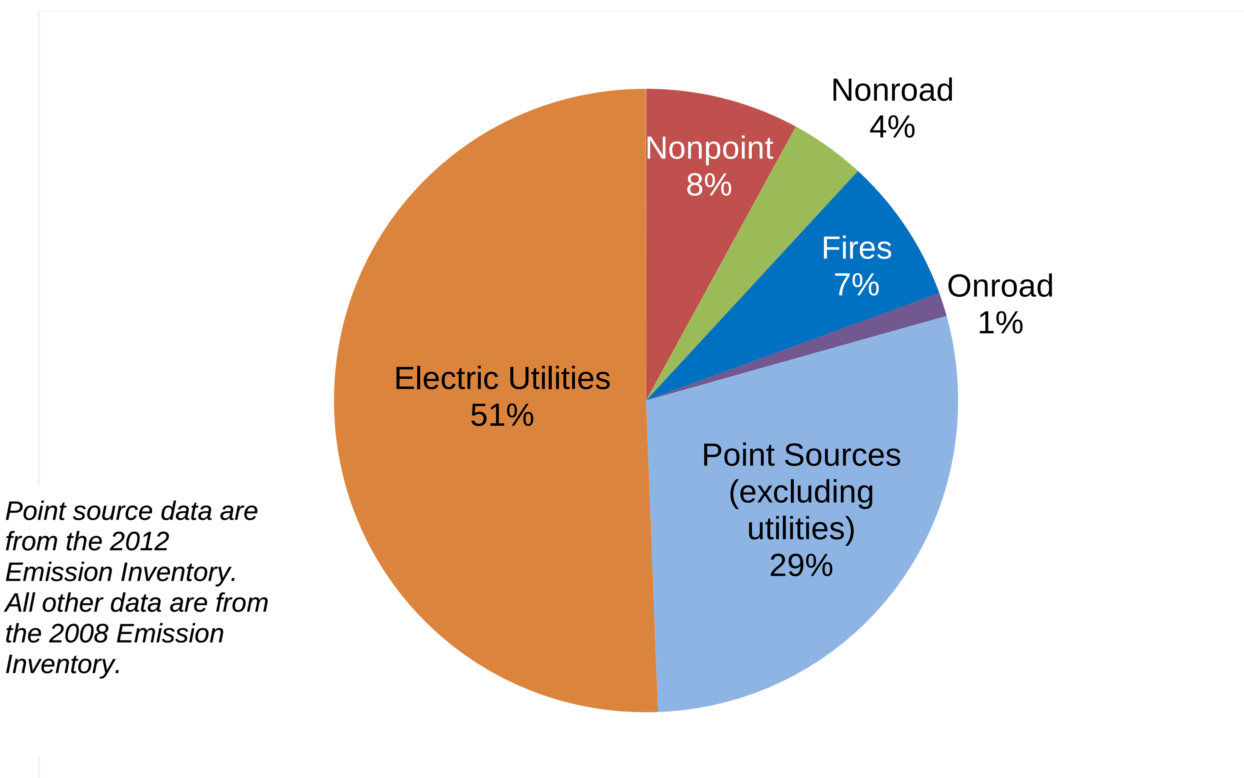
Current scientific evidence links short-term exposures to SO_2 with adverse respiratory effects including bronchoconstriction and increased asthma symptoms. Studies show a connection between exposure to SO_2 and increased visits to emergency departments and hospital admissions for respiratory illness. 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 2012 is 54,275 tons. The figure below shows sources of 2008 and 2012 SO_2 emissions.

Sources of Sulfur Dioxide Emissions in Minnesota, 2008 and 2012

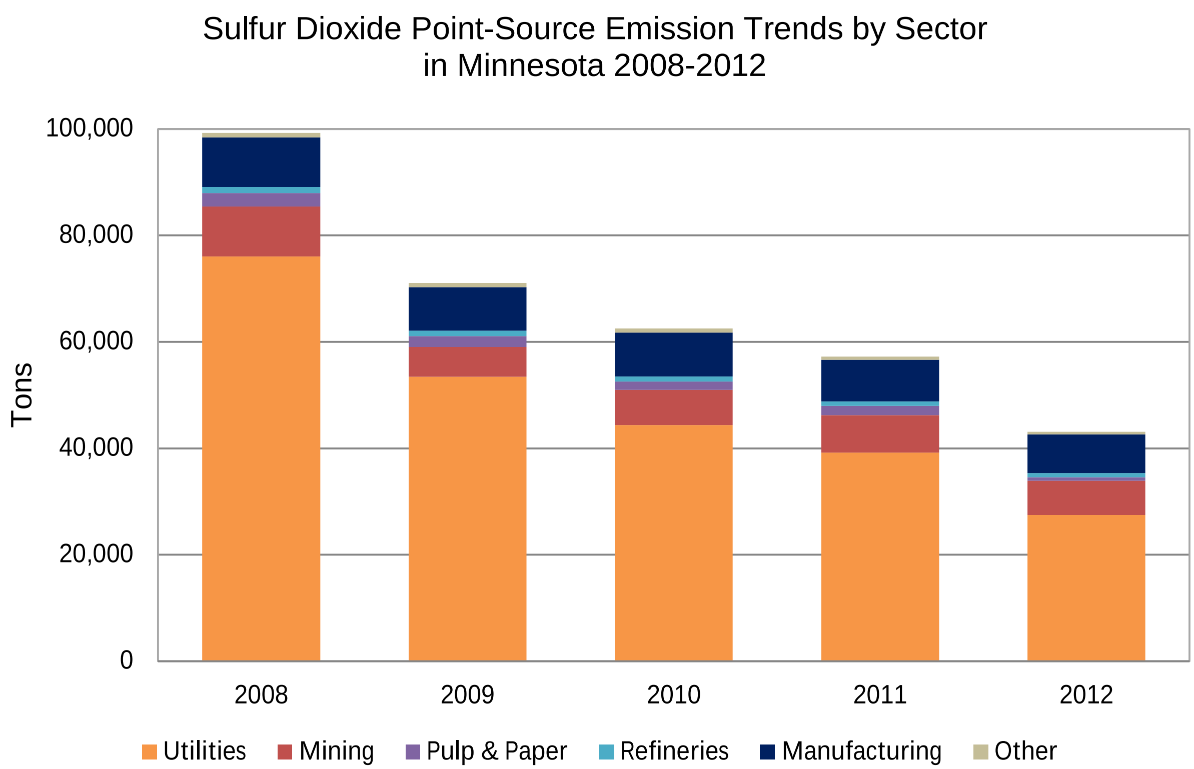


More than half (51 percent) of SO_2 emissions come from coal-burning electric utilities. About a third of emissions come from industrial point sources while eight percent are the result of nonpoint emissions which is mostly made up of smaller industrial burning of coal, distillate oil and prescribed burning. Nonroad, onroad and fire emissions account for the rest of SO_2 emissions.

Trends

Point sources contribute 80 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 more than 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 more than 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. SO_2 emissions continued to decrease in 2011 and 2012 due to reduction of coal use by electric utilities such as Minnesota Power's Taconite Harbor Energy Center. Verso Paper Corp – Sartell permanently shut down because of a fire which reduced emissions of all pollutants. In addition there is a drop in all emissions due to power boiler shutdown at Xcel Energy – Sherburne Generating Plant for the duration of the 2012 calendar year.



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.

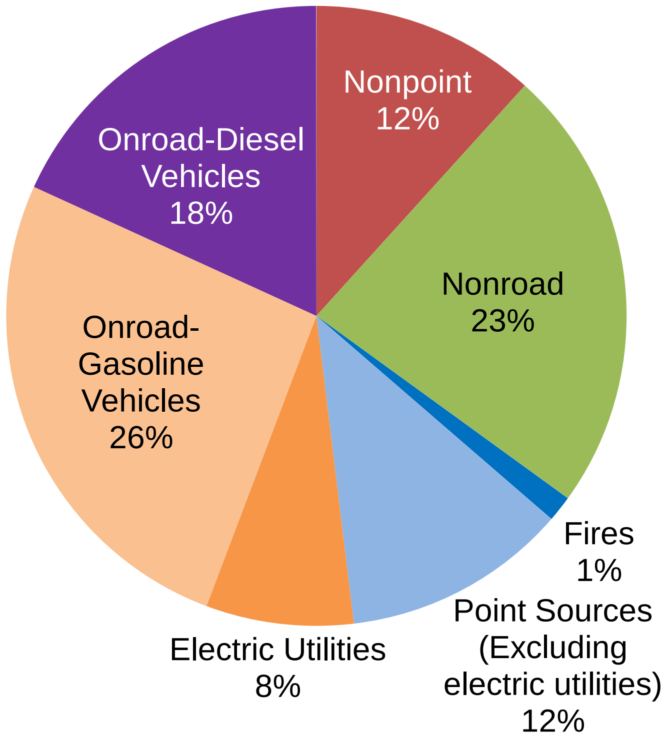
High NO_x concentrations also have environmental impacts. Deposition of nitrogen can lead to fertilization, eutrophication, and acidification of terrestrial, wetland and aquatic systems resulting in changes in species number and composition such as the reduction of fish and shellfish populations. Nitrate particles and nitrogen dioxide also increase visibility impairment in areas such as the Boundary Waters Canoe Area Wilderness and Voyagers 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 2012 is 378,550 tons. The figure below shows sources of 2008 and 2012 NO_x emissions.

About a quarter (23 percent) of NO_x emissions come from nonroad sources such as railroads and agricultural, construction and recreational equipment. Another 26 percent comes from onroad gasoline vehicles. Electric utilities contribute eight percent of NO_x emissions. Combustion from other large point sources emits 12 percent while diesel vehicles emit an additional 18 percent. NO_x emission from fire and fuel combustion from smaller nonpoint sources contributes accounts for the rest of the emissions in Minnesota.

Sources of Nitrogen Oxide Emissions in Minnesota, 2008 and 2012



Point source data are from the 2012 Emission Inventory. All other data are fron the 2008 Emission Inventory.

Trends

Point sources including electric utilities contribute 20 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.

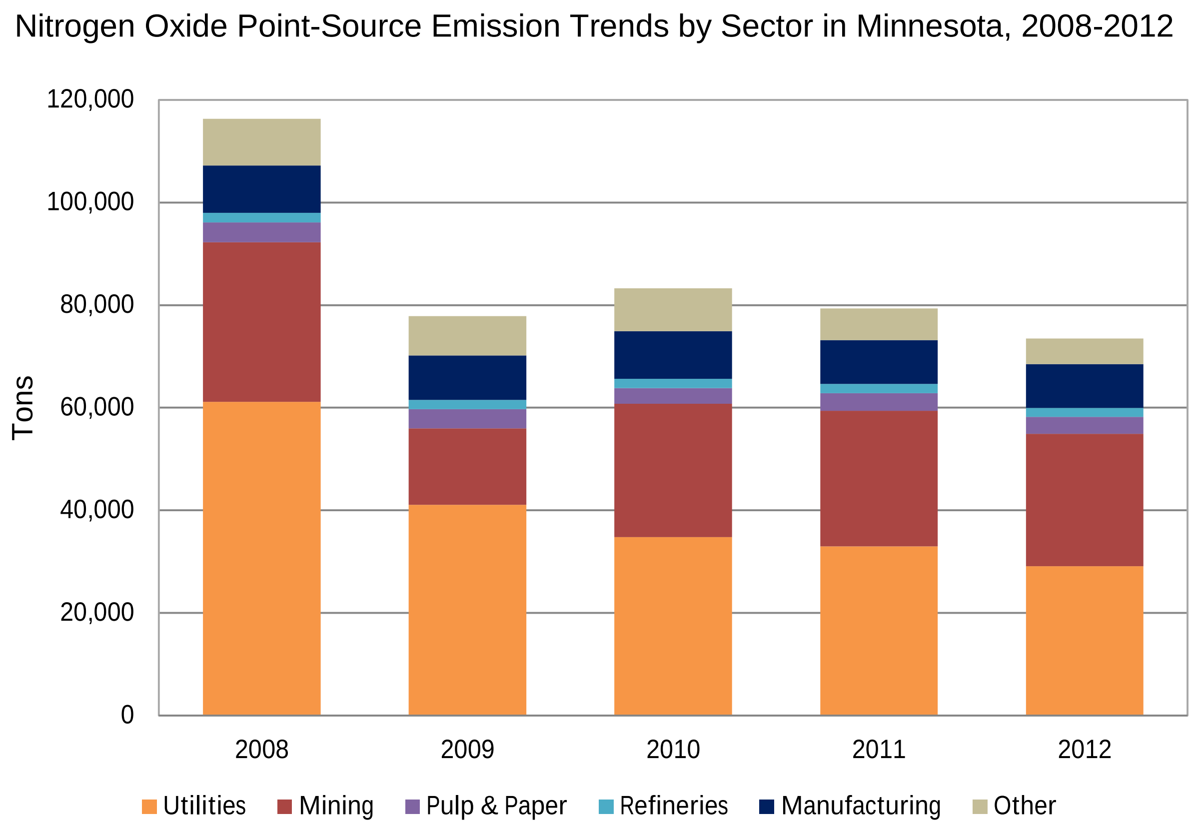
Xcel Energy's Allen S. King coal-fired power plant in Oak Park Heights was renovated with state-of-the-art pollution controls while St. Paul's High Bridge power plant and Minneapolis' Riverside power plant were converted from coal to cleaner-burning natural gas. Minnesota Power also installed modern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

Minnesota NO_x emissions decreased in 2011 and 2012 due to reduction of coal use by large facilities such as Minnesota Power's Taconite Harbor Energy Center and North Shore Mining – Silver Bay. Additionally, there is an overall drop in all emissions due to a power boiler shutdown at Xcel Energy – Sherburne

Generating Plant for the duration of the 2012 calendar year and a permanent shutdown of Verso Paper Corp – Sartell due to a fire.



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 2012 emissions of ozone precursors.

References/web links

For more information on ozone, see the following websites:

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

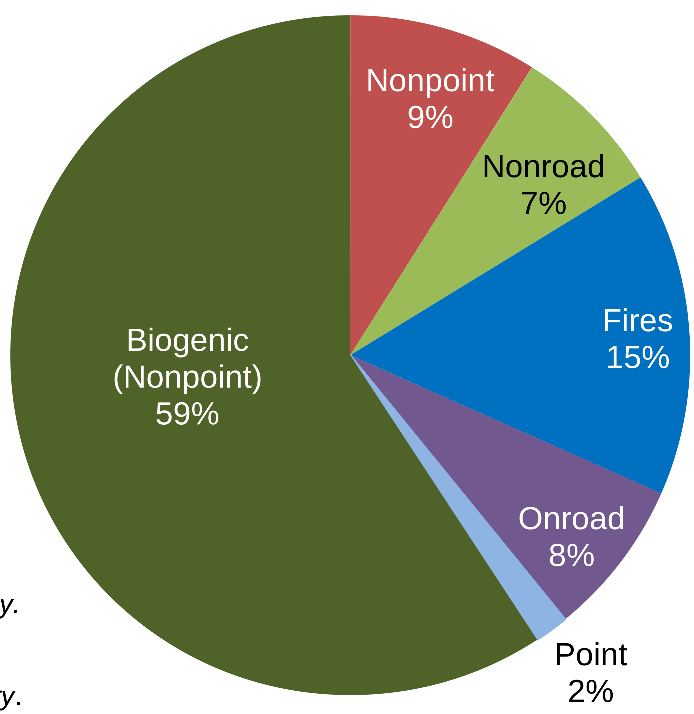
Many VOCs are also air toxics and can have harmful effects on human health and the environment. However, VOCs are regulated as a criteria pollutant because they are precursors to ozone. See the sections on ozone and air toxics for related human health and environmental effects.

Emissions data and sources

The MPCA estimate for statewide emissions of VOCs in 2012 is 1,203,977 tons.

VOCs are emitted from a variety of sources including industrial facilities, motor vehicles, consumer products, and biogenic sources. The figure below shows Minnesota sources of directly-emitted VOCs in 2012.

Sources of Volatile Organic Compound Emissions in Minnesota, 2008 and 2012



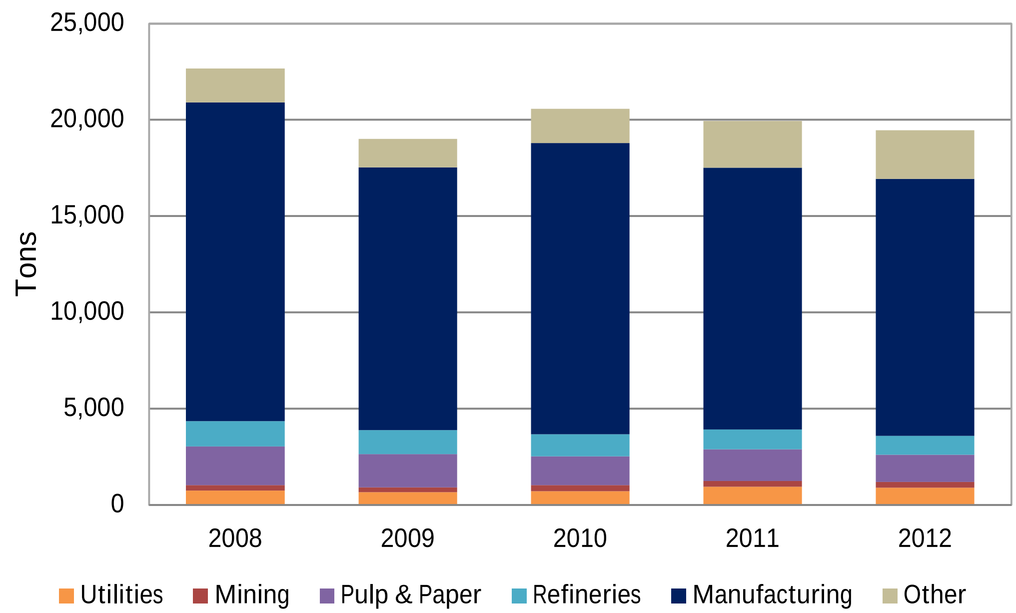
Point source data are from the 2012 Emission inventory. All other data are from the 2008 Emission Inventory.

Almost 60 percent of VOC emissions are from biogenic sources. Biogenic emissions are emitted from vegetation and soils. Prior to 2008 statewide emission inventory biogenic emissions were usually not included in the totals. An additional 15 percent is from fires including emissions from agricultural fires, prescribed burning and wild fires. Nonroad sources, in particular recreational vehicles such as snowmobiles, boats, ATVs and motorcycles burning gasoline contribute seven percent of the total emissions. Onroad gasoline vehicles emit eight percent of the Minnesota VOC total. The bulk of the remaining VOC emission is made up of large point sources which contribute about two percent, and fuel combustion from smaller nonpoint sources which account for nine percent of the total.

Trends

Point sources contribute two 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. In 2011 and 2012 VOC emissions from the manufacturing sector decreased, resulting in an overall drop in statewide VOC emissions.

Volatile Organic Compound Point-Source Emission Trends
By Sector in Minnesota, 2008-2012



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.

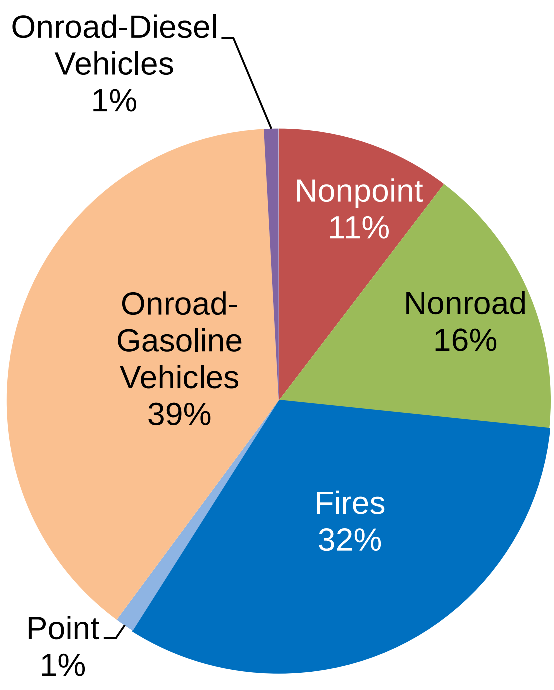
CO enters the bloodstream and reduces the delivery of oxygen to the body's organs and tissues. The health threat from CO is most serious for those who suffer from cardiovascular disease. At higher concentrations it also affects healthy individuals. Exposure to elevated CO levels is associated with impaired 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 2012 is 2,476,082 tons. The figure below shows sources of 2012 CO emissions.

Sources of Carbon Monoxide Emissions in Minnesota, 2008 and 2012

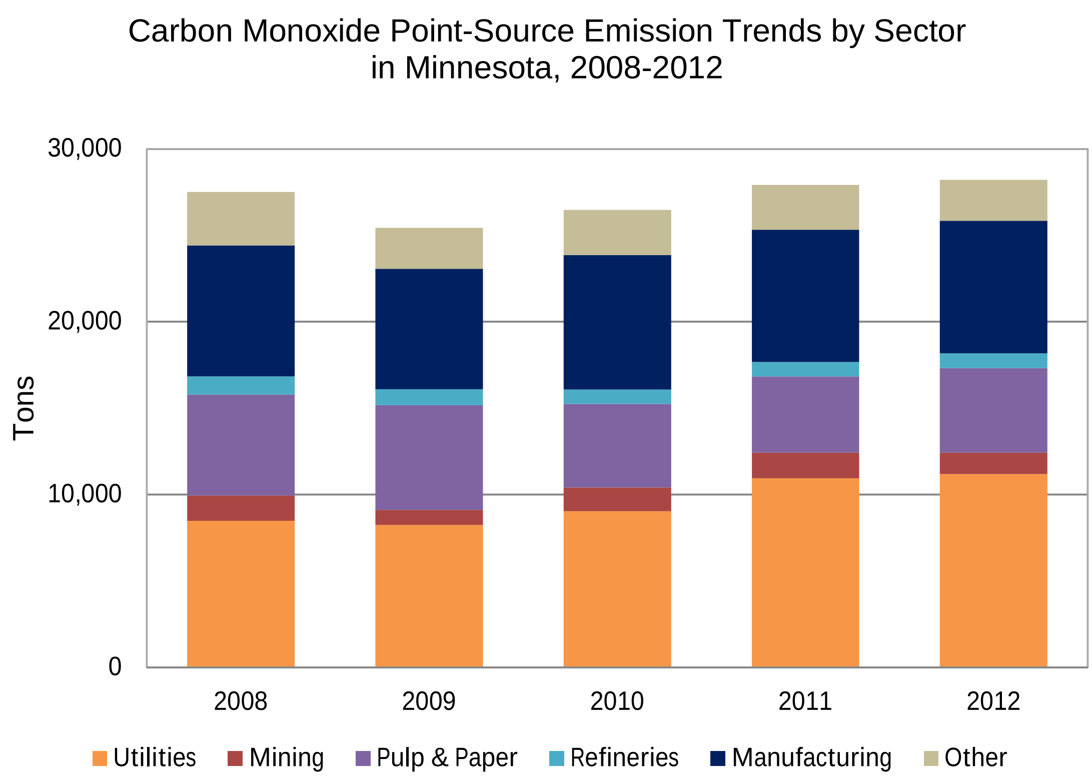


Point source data are from the 2012 Emission Inventory. All other data are from the 2008 Emission Inventory.

The majority (almost 40 percent) of CO emissions come from the combustion of gasoline in onroad vehicles. About a third of the emissions come from fires. In 2008 parts of Northern Minnesota specifically Beltrami and Marshall Counties had significant CO emissions from fire. Most of the emissions occurred in April, May and July. Sixteen percent of emissions come from the combustion of fuels in nonroad recreational vehicles such as snowmobiles, boats, golf carts, and ATVs as well as lawn and garden equipment. Fuel combustion particularly residential wood combustion and smaller industrial sources contributes another 11 percent of CO emissions. Emissions from large point sources and diesel vehicles comprise the remaining emissions from CO.

Trends

Point sources contributed about one percent of the total Minnesota CO emissions in 2012. 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. In 2011 and 2012 CO emissions continued to increase again due to higher emissions from electric utilities and mining.



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

Mercury

The MPCA continues its focus on mercury in the environment. A goal of the MPCA's strategic plan is that Minnesota reduces its contribution to regional, national and global air pollution.

Mercury is a naturally-occurring metal. Exposure to mercury can harm the nervous system, in particular. It can also harm the heart, kidneys, lungs, and immune system. For most Minnesotans, eating fish contaminated with too much mercury poses the greatest risk of exposure. While fish provide a healthy source of protein, citizens are advised to limit their consumption of older and larger predatory fish. Consult the Minnesota Department of Health Fish Consumption Advisory for lake-specific guidelines at http://www.health.state.mn.us/divs/eh/fish/eating/sitespecific.html

Most of the mercury in Minnesota's environment comes from air pollution. Minnesota's environment becomes contaminated with mercury when it falls on land or water from the air. Because mercury vapor can be transported long distances in the atmosphere, most of the mercury in Minnesota originates outside of the state. Similarly, most of Minnesota's emissions are deposited in other states and countries. Within Minnesota, mercury is emitted from burning coal, processing materials such as taconite ore, using it in products and the eventual disposal of those products.

Sector activities and reductions

A number of efforts are in place to reduce mercury emissions. When the state's power utilities embarked on state-ordered efforts to reduce mercury in the mid-1990s, emissions from Minnesota's coal-fired utilities were about 1,850 pounds per year. By 2013, mercury emissions were about 870 pounds and they are expected to be less than 200 pounds by 2016. The utilities are well ahead of the scheduled reductions laid out in the Minnesota Mercury Emissions Reduction Act of 2006.

The MPCA is working on a study to quantify mercury from crematoria. With partners in the funeral industry, the Minnesota Department of Health, The University of Minnesota School of Dentistry, and the University of Minnesota Mortuary Sciences Department, the MPCA is researching mercury emissions associated with dental amalgam to create a more confident estimate of mercury emissions from this sector. Following research on emissions, the group will work to identify possible reduction strategies, implement these strategies, evaluate progress, and explore further action, if needed.

MPCA staff conducted a training workshop for state and local compliance and enforcement staff in the spring of 2013. The workshop focused on mercury-containing products and components in the salvage, scrap, and demolition industries, including items found in vehicles, appliances, and HVAC equipment.

The taconite mining sector continues its research to identify possible mercury-reduction technologies, in cooperation with the Minnesota Department of Natural Resources. The facilities completed medium and longer term testing of activated carbon injection control for mercury in 2013. This information will inform the reduction plans that the facilities would submit in 2016 under the MPCA's proposed mercury air emission rulemaking.

Total Maximum Daily Load (TMDL) studies and related rulemaking

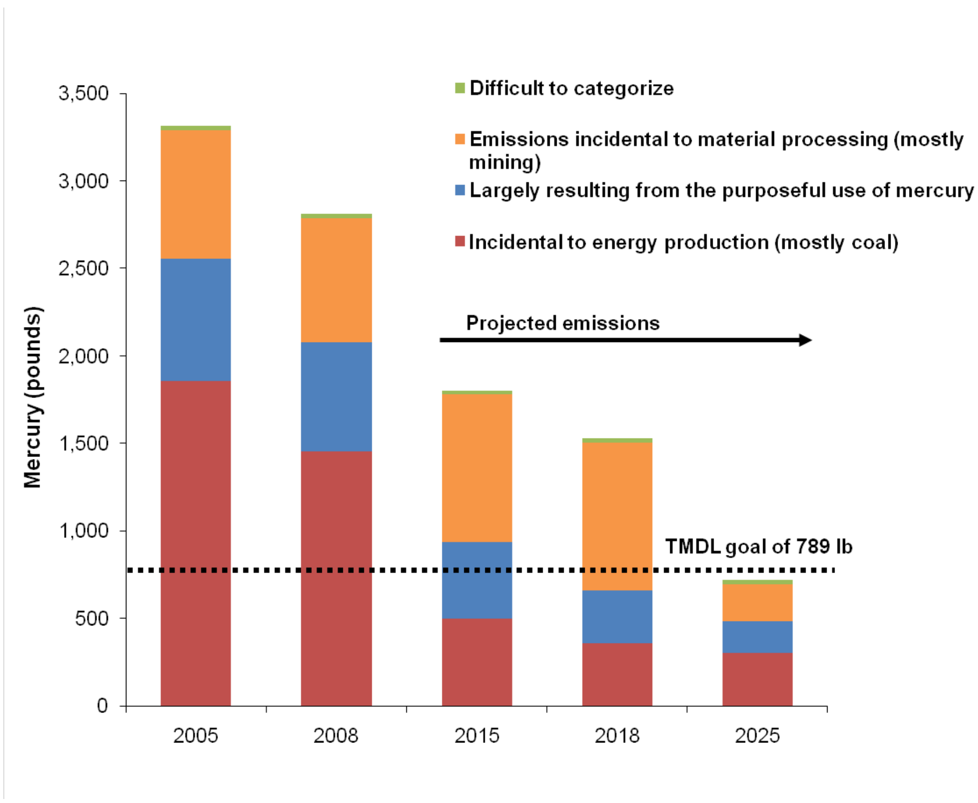
The MPCA developed a state-wide mercury Total Maximum Daily Load (TMDL) study and EPA approved it in 2007. The TMDL study assessed the mercury pollution in Minnesota's waters. With input from stakeholders, the MPCA established a clean-up or restoration plan. The TMDL Implementation Plan was finalized in 2009 and an update will be completed in 2014.

One recommendation of the TMDL Implementation Plan was for the MPCA to promulgate rules to address mercury air emission sources in Minnesota. In late 2013, the MPCA published draft rules to execute the recommendations of the statewide TMDL. The proposed rules implement the reduction activities called for in the Statewide Mercury TMDL Implementation Plan. The proposed rules:

- define an actual emission threshold of 3 lb/yr. above which facilities are subject to the rules;
- codify the mercury emission target of 789 lb/yr. by 2025;
- carry forward the TMDL implementation plan's strategy for facilities to prepare reduction plans;
- institute an annual emission inventory for larger emitters; and
- adopt federal regulations and compliance language for several sectors where EPA rules include mercury limits among the other pollutants regulated by these standards.

The statewide mercury TMDL established a target of 24 lb/yr. for discharges directly to water. Discharges remain below this level. The MPCA has a permitting strategy for addressing mercury in municipal and industrial wastewater permits to ensure that the goal continues to be met (http://www.pca.state.mn.us/index.php/view-document.html?gid=12813).

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

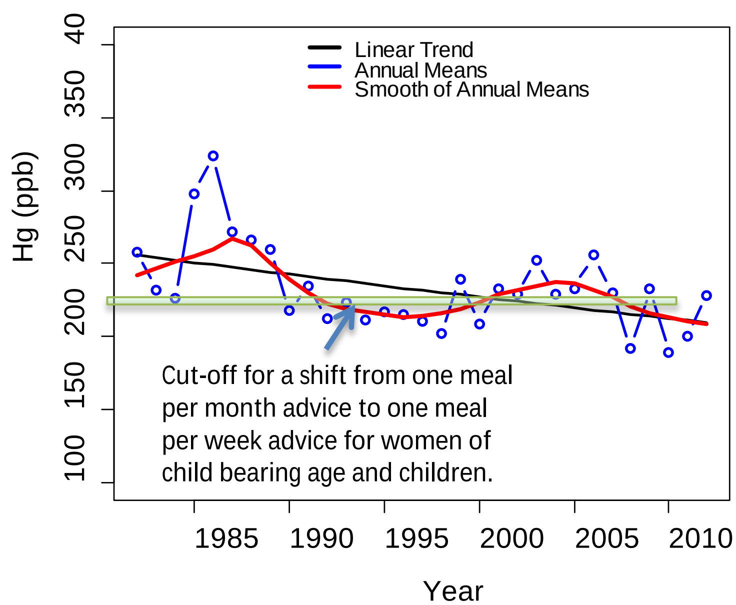


All of the lakes and rivers within Minnesota will benefit from the reduction in mercury emissions from accomplishing the goals of the statewide TMDL implementation plan. The 2007 Statewide Mercury Total Maximum Daily Load (TMDL) demonstrated that mercury deposition was essentially uniform throughout the state and that deposition represented 99 percent of the mercury source to lakes and rivers in the state. Despite the uniform deposition of mercury, monitoring data have shown that in about 10 percent of Minnesota surface waters, the levels of mercury found in fish are significantly higher than the levels found in fish from the rest of Minnesota's surface waters. These waters are more efficient at concentrating mercury into fish. Scientists understand some of the factors that cause this enhanced mercury accumulation, but not well enough to know the relative importance of each factor and what actions could reduce the enhanced mercury accumulation. Funding for the MPCA's proposed scientific research into the unusually high mercury concentrations in fish in some Minnesota waterbodies has been included in the Legislative-Citizen Commission on Minnesota Resources (LCMR) funding bill currently being considered by the 2014 Minnesota Legislature. MPCA continues to pursue additional funding from other sources for the remainder of the research. The agency estimates that $1.75 million is needed in addition to the LCCMR funding to fully research these questions. This will provide the information that is needed to complete and implement additional mercury TMDL(s) beyond the existing statewide TMDL.

Mercury concentration in Minnesota fish

An analysis of a 25-year record (1982-2006) of mercury in northern pike and walleye from Minnesota lakes found a downward trend until the mid-1990s and then an unexpected rise. After average mercury concentrations declined 37 percent from 1982 to 1992, they increased 15 percent between 1996 and 2006. The trend of mercury in fish was reanalyzed in 2013 with an additional six years of data from the fish contaminant monitoring program. The latest analysis shows another shift in the statewide trend. Over the 31 years (1982-2012), there was a downward trend in the average mercury concentrations. More explanation of the mercury trends in fish is available in the 2014 Clean Water Fund Performance Report http://www.legacy.leg.mn

Mercury Concentration Trends in Northern Pike and Walleye
from Minnesota Lakes (1982-2012)



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/

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.

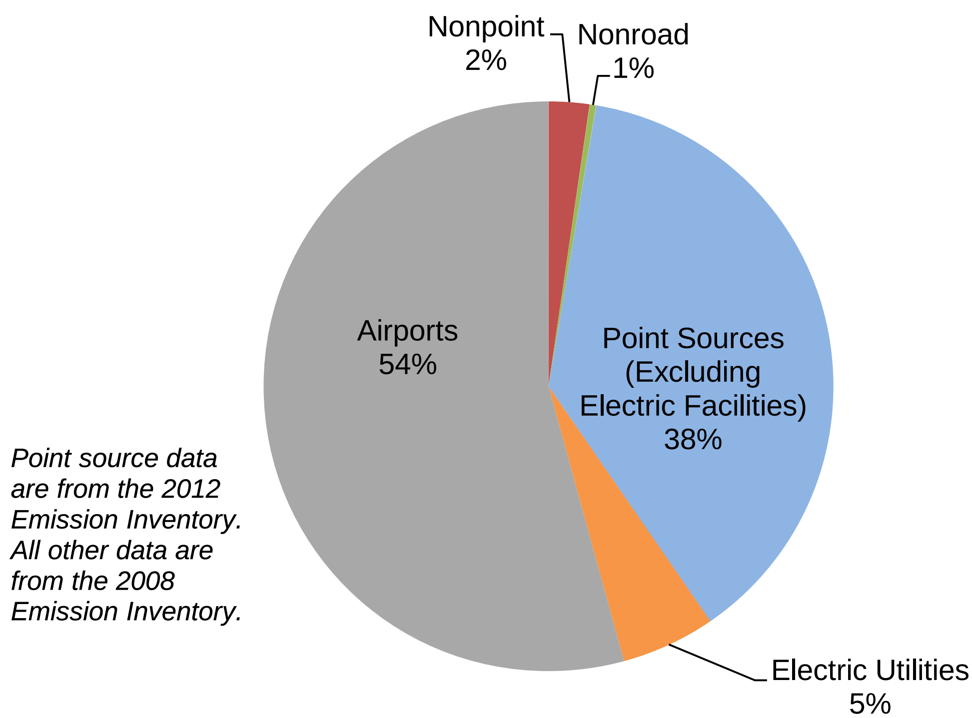
Scientific evidence about the health effects of lead has expanded significantly in the last 30 years. Exposures to low levels of lead early in life have been linked to effects on IQ, learning, memory and behavior. There is no known safe level of lead in the body. Chronic exposure or exposure to higher levels can result in multiple effects, including damage of the kidneys and nervous system in both children and adults.

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 2012 is 20 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 2012 lead emissions.

Sources of Lead Emissions in Minnesota, 2008 and 2012

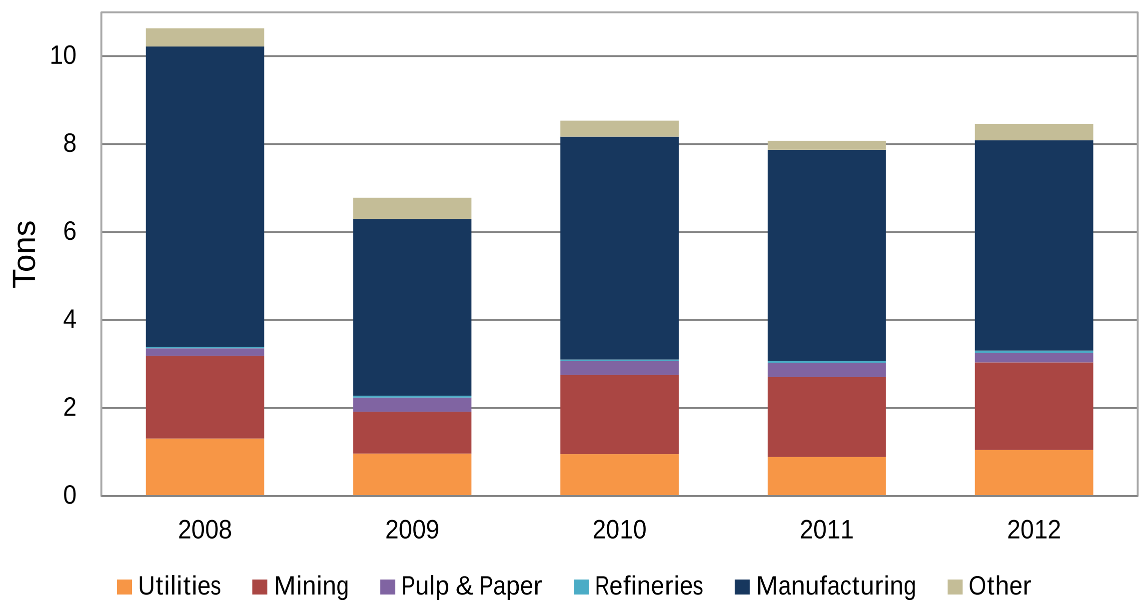


Point sources excluding electric utilities contribute 38 percent of Minnesota's lead emissions. These point sources include metal processing, and some combustion of waste and coal. General aviation aircraft emit 54 percent of lead emissions from burning leaded fuel. Coal-burning power plants add an additional five percent of lead to the environment while other small sources contribute the final three percent.

Trends

Point sources (including electric utilities) contribute 43 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. In 2011 there was a slight decrease in lead emissions due to decrease in manufacturing emissions, taconite mining, and electric utilities. In 2012 lead emissions rebounded to 2010 levels.

Lead Point-Source Emission Trends by Sector
in Minnesota, 2008-2012



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

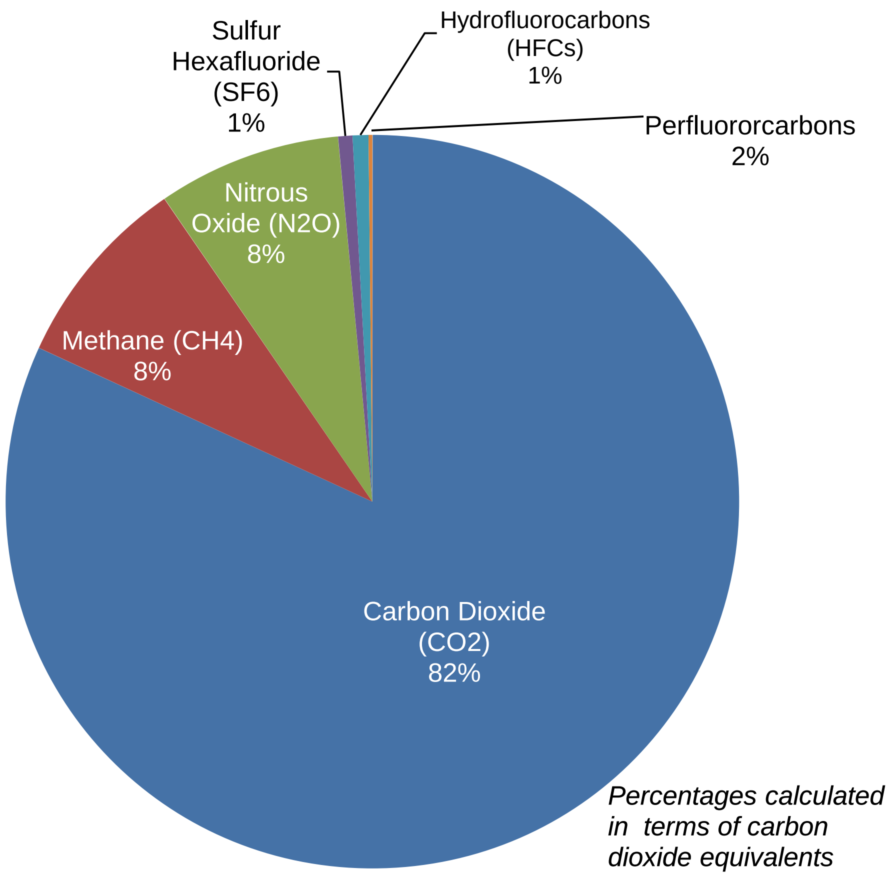
http://www.health.state.mn.us/divs/eh/lead/index.html

Greenhouse Gases

Climate change results from the buildup of a group of compounds, collectively called greenhouse gases (GHGs). Many greenhouse gases occur naturally, but fossil fuel burning and other human activities are adding gases to the natural mix at an accelerated rate. The most abundantly emitted greenhouse gas, carbon dioxide (CO_2), is mainly formed from the combustion of fossil fuels such as oil, natural gas and coal. In 2010, emissions of CO_2 accounted for about 82 percent of Minnesota greenhouse gas emissions.

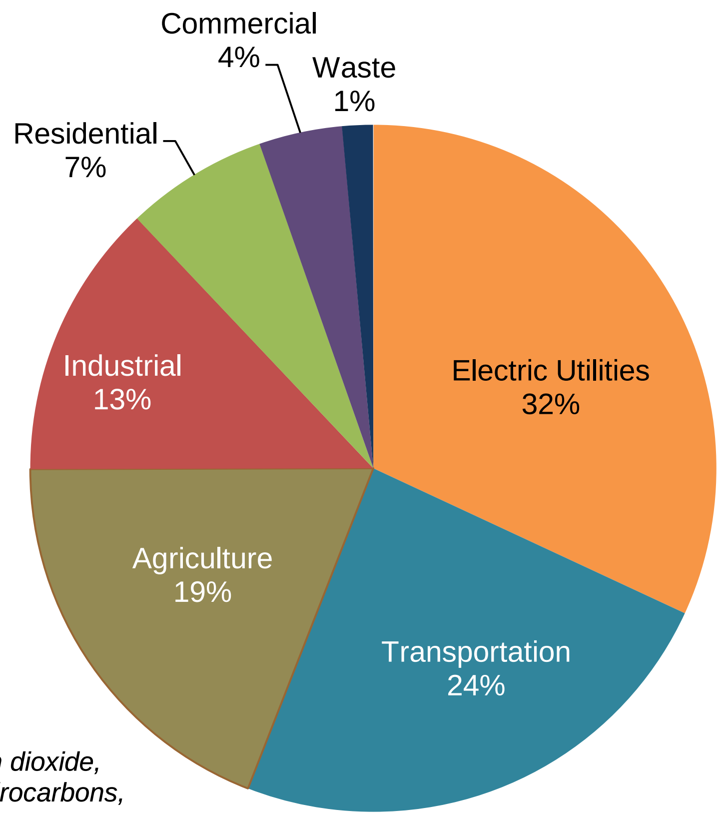
Emissions of greenhouse gases (carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), sulfur hexafluoride (SF_6), and gases collectively known as hydrofluorocarbons (HFCs) and perfluorocarbons are reported in terms of CO_2 equivalents (CO_2e). CO_2e compares the global warming potential of emissions of different gases to the impact of the emission of one ton of CO_2. The following figure shows the greenhouse gas emissions in Minnesota for 2010 as the percent of emissions from each type of greenhouse gas in CO_2-equivalent terms.

Greenhouse Gas Emissions (CO_2e) in Minnesota, 2010



In 2010, Minnesota's GHG emissions were estimated to be 155.6 million tons CO_2e. About 80 percent of Minnesota's GHG emissions are associated with energy consumption and the production and transportation of fuels. The following figure shows GHG emissions by economic sector. The largest source of emissions is from the generation of electricity (32 percent of total GHG emissions). Greenhouse gas emissions from electricity generation include emissions from electricity generated in other states to meet Minnesota's net electricity demand. Transportation contributed 24 percent, agricultural activities contributed 19 percent and industrial sources contributed 13 percent of Minnesota greenhouse gas emissions in 2010. The remaining emissions are from residential and commercial sources and waste disposal.

Sources of Greenhouse Gas Emissions in Minnesota, 2010
(Estimates include Net Imported Electricity in Minnesota)

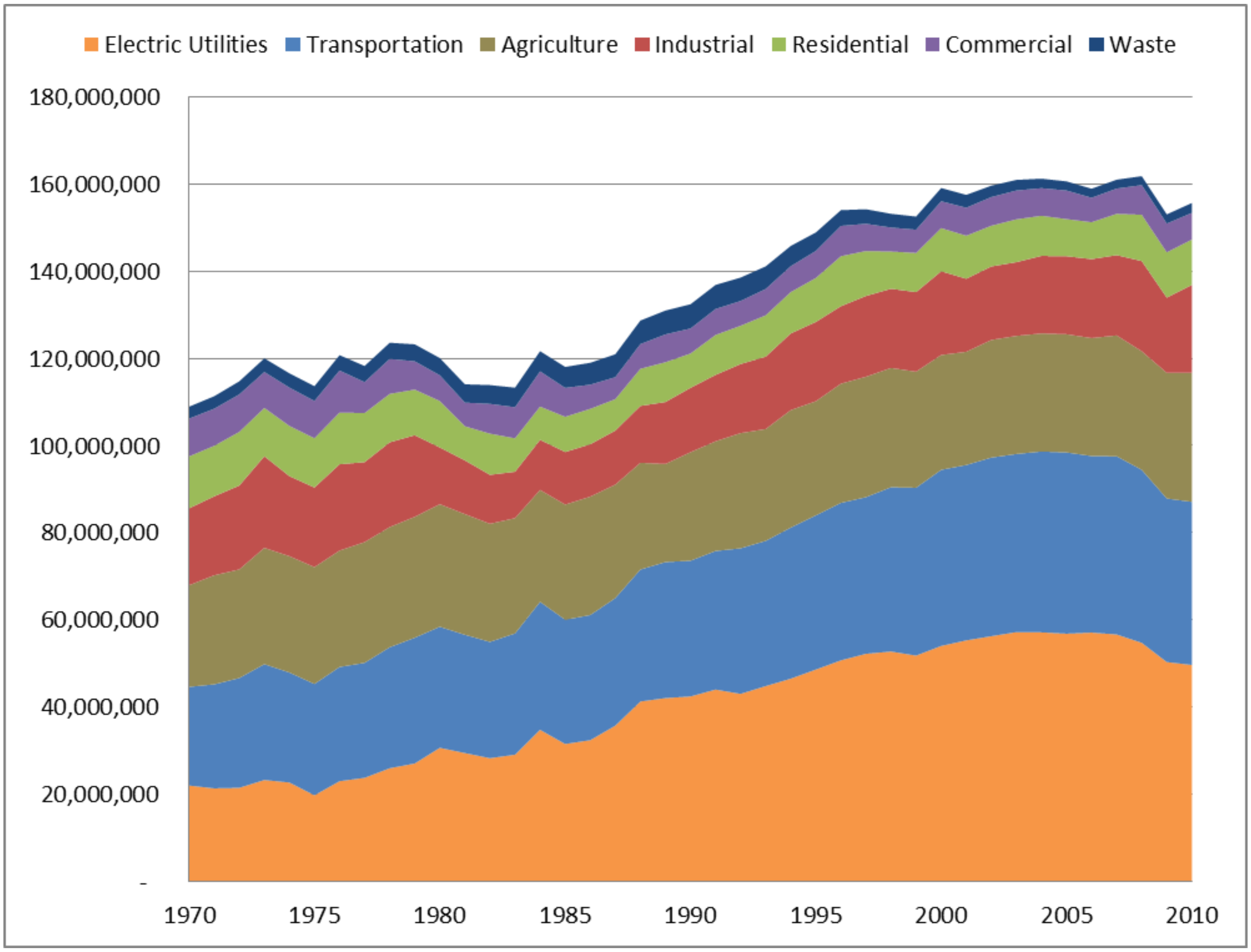


Percentages include carbon dioxide, nitrous oxide, methane, hydrocarbons, perfluorocarbons and sulfur hexafluoride calculated in terms of CO_2 equvalents.

Trends

Emission estimates of these greenhouse gases are available from 1970-2010. Between 1970 and 2010, the majority of the growth in estimated statewide greenhouse gas emissions occurred in two sectors, electric utilities and transportation. In 1970, emissions from transportation and electricity generation comprised 41 percent of all Minnesota greenhouse gas emissions and, by 2010 they accounted for 56 percent of emissions.

Trends in Greenhouse Gas Emissions in Minnesota by Economic Sectors, 1970-2010
(Estimates include Net Imported Electricity in Minnesota)



References/web links

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

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

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. The majority of pollutants with MPCA emission estimates are part of EPA's hazardous air pollutant group. Federal rules require hazardous air pollutant emission inventories be completed every three years. The most recent completed inventory for Minnesota is for 2008. The inventory includes four principal source categories: fires, point, nonpoint, and mobile sources.

Fires: Fire emissions are defined as emissions produced by inadvertent or intentional agriculture burning, prescribed burning or forest wildfires. EPA estimated 2008 emissions using the Satellite Mapping Automated Reanalysis Tool for Fire Incident Reconciliation version 2 (SFv2). SFv2 uses multiple fire information data sources for the development of fire emission inventory data. This methodology was a significant improvement over the 2005 emission estimates. For example, in 2005 a number of fires were left as unclassified because there were no observational data to assign the fires to any specific category. SFv2 resolved this problem.

Fires vary greatly from year to year so it is difficult to make yearly comparisons. In addition, because many fires were labeled as "unclassified" in past EPA emission inventories, it is especially difficult to compare 2008 emissions with previous years' data.

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-burning appliances. Nonpoint sources may also include a diffuse stationary source, such as open burning. 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. For the first time, the 2008 nonpoint source category includes emissions from biogenic sources. This includes emissions from natural sources such as soils and vegetation.

Mobile Sources: Mobile sources include two categories; onroad vehicles and nonroad sources. Onroad vehicles include vehicles operated on highways, streets and roads. Nonroad 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 nonroad sources.

MPCA staff compiled the emissions estimates for point and the majority of nonpoint sources in the 2008 inventory. Emissions for wildfires and prescribed burning were obtained from EPA. The results for aircraft (including ground support equipment), locomotives and commercial marine vessels were estimated by EPA. For the 2008 Air Toxics emission inventory EPA decided to include emissions from biogenic sources in the nonpoint category; this caused a significant increase in nonpoint source emissions. For all nonroad equipment and onroad vehicles, MPCA used estimates from EPA's national inventory.

Table 6 provides a summary of air toxics emissions from principal source categories taken from the 2008 Minnesota Air Toxics Emission Inventory. The table gives total statewide emissions of each chemical, its CAS Number, along with the percent from fires, point, nonpoint, onroad, and nonroad mobile sources. The inventory includes 217 chemicals: 16 polycyclic aromatic hydrocarbon compounds (PAHs), 13 metal compounds and 188 non-metal compounds. Even though emissions are estimated for many PAH compounds, 16 PAHs are placed into their own category because they are listed as priority pollutants.

Table 6: 2008 Minnesota Air Toxics Inventory Statewide Summary

Pollutant Name	CAS No	Total (Short Tons)	Fires (%)	Nonpoint (%)	Nonroad (%)	Onroad (%)	Point (%)
PAHs							
Acenaphthene	83-32-9	6.79		50.1	8.3	41.1	0.5
Acenapthylene	208-96-8	69.32		84.2	1.9	13.7	0.2
Anthracene	120-12-7	18.99	54.1	25.1	1.6	18.5	0.7
Benz(a)anthracene	56-55-3	22.46	56.7	38.6	0.4	4	0.2
Benzo(a)pyrene	50-32-8	5.64	54	34	1.2	9	1.7
Benzo(b)fluoranthene	205-99-2	2.95		81.6	1.8	16.3	0.4
Benzo(g,h,i)perylene	191-24-2	13.76	75.9	15.2	1.8	6.9	0.2
Benzo(k)fluoranthene	207-08-9	6.79	78.7	13.9	0.7	6.5	0.1
Chrysene	218-01-9	18.19	70.1	25.4	0.4	3.8	0.4
Dibenzo(a,h)anthracene	53-70-3	1.01		96.7	0.2	0.6	2.5
Fluoranthene	206-44-0	27.72	49.9	25.2	2.6	22	0.3
Fluorene	86-73-7	16.07		51	7.3	39.7	2.1
Indeno(1,2,3-c,d)pyrene	193-39-5	10.45	67.1	24.2	0.7	2.7	5.2
Naphthalene	91-20-3	387.64		37.8	4.5	53.7	4
Phenanthrene	85-01-8	57.95	17.7	49	3.8	27.8	1.6
Pyrene	129-00-0	36.02	53	21.7	2.3	22.5	0.5
PAH Total		**701.72**	**14.9**	**41.1**	**3.6**	**37.7**	**2.6**
Metal Compounds							
Antimony	7440-36-0	0.71		8.9			91.1
Arsenic	7440-38-2	7.42		2.5	3.5	1.9	92.1
Beryllium	7440-41-7	0.28		10.5	6		83.4
Cadmium	7440-43-9	0.77		25.5	2.4		72
Chromium	7440-47-3	5.04		5.8			94.2
Chromium (vi)	18540-29-9	0.5		4.2	2.9	47.9	45
Cobalt	7440-48-4	4.66		1.4	0.1		98.4
Copper	7440-50-8	8.53		5			95
Lead	7439-92-1	22.51		2	47.7		50.3
Manganese	7439-96-5	46.84		20	0.1	0.3	79.7
Mercury	7439-97-6	1.47		16.3	1.2	0.5	82
Nickel	7440-02-0	9.95		7.6	4.4	2.7	85.4
Selenium	7782-49-2	3.69		3.8	0.005		96.2
Metal Total		**112.39**		10.9	10.3	0.7	78.1
Non-Metal Compounds (Excluding PAHs)							
1,1,1-trichloroethane	71-55-6	918.35		99.7			0.3
1,1,2,2-tetrachloroethane	79-34-5	2.76		32.1			67.9
1,1,2-trichloroethane	79-00-5	0.06		0.1			99.9
1,1-dichloroethane	75-34-3	1.33		60.4			39.6

Table 6: 2008 Minnesota Air Toxics Inventory Statewide Summary

Pollutant Name	CAS No	Total (Short Tons)	Fires (%)	Nonpoint (%)	Nonroad (%)	Onroad (%)	Point (%)
1,2,3,4,5,5-hexachloro-1,3-cyclopentadiene	77-47-4	0.000068		31.1			68.9
1,2,4-trichlorobenzene	120-82-1	1.7		0.7			99.3
1,2,4-trimethylbenzene	95-63-6	86.58		7.8			92.2
1,2-dibromo-3-chloropropane	96-12-8	0.0023					100
1,2-dibromoethane	106-93-4	1.44		22			78
1,2-dichloroethane	107-06-2	2.67		39.6			60.4
1,2-dichloroethene	156-59-2	0.01					100
1,2-epoxybutane	106-88-7	0.07					100
1,2-propylenimine	75-55-8	0.0022					100
1,3,5-trimethylbenzene	108-67-8	3.49					100
1,3-butadiene	106-99-0	1709.61	48.7	9.5	20.3	21.4	0.2
1,3-dichloropropene	542-75-6	0.05					100
1,3-propane sultone	1120-71-4	0.00063					100
1,4-dichlorobenzene	106-46-7	113.57		99.3			0.7
1,4-dioxane	123-91-1	2.07		38.3			61.7
2,2,4-trimethylpentane	540-84-1	5969.27		2.9	67.5	29.4	0.1
2,4,5-trichlorophenol	95-95-4	0.0014					100
2,4,6-trichlorophenol	88-06-2	0.1		0.1			99.9
2,4-d, salts and esters	94-75-7	23.91		100			0
2,4-dinitrophenol	51-28-5	0.0075		13.8			86.2
2,4-dinitrotoluene	121-14-2	0.61		0.3			99.7
2-chloroacetophenone	532-27-4	0.07					100
2-chloronaphthalene	91-58-7	0.0001		13.7			86.3
2-methylnaphthalene	91-57-6	1.54		0.2	44.9		54.9
2-nitropropane	79-46-9	0.0057		89.5			10.5
3,3-dimethoxybenzidine	119-90-4	0.0009					100
3,3-dimethylbenzidine	119-93-7	0.00042					100
3-methylcholanthrene	56-49-5	0.0077		2.7			97.3
4,4-methylene bis(2-chloroaniline)	101-14-4	0.029					100
4,4-methylene dianiline	101-77-9	0.0011					100
4,4-methylenediphenyl diisocyanate	101-68-8	5		22.4			77.6
4,6-dinitro-o-cresol (including salts)	534-52-1	0.0001					100
4-aminobiphenyl	92-67-1	0.00045					100
4-nitrobiphenyl	92-93-3	0.00092					100
4-nitrophenol	100-02-7	0.21		98.4			1.6

Table 6: 2008 Minnesota Air Toxics Inventory Statewide Summary

Pollutant Name	CAS No	Total (Short Tons)	Fires (%)	Nonpoint (%)	Nonroad (%)	Onroad (%)	Point (%)
7h-dibenzo[c,g]carbazole	194-59-2	0.0041					100
Acetaldehyde	75-07-0	3389.68	24.8	19.4	15.7	35.5	4.7
Acetamide	60-35-5	0.01		3.1			96.9
Acetone	67-64-1	800.52		50.7			49.3
Acetonitrile	75-05-8	4.95		0.3			99.7
Acetophenone	98-86-2	0.32		37.5			62.5
Acrolein	107-02-8	1132.07	77	7.5	4.1	6.6	4.9
Acrylamide	79-06-1	1.62					100
Acrylic acid	79-10-7	7.51		0			100
Acrylonitrile	107-13-1	41.51		89.7			10.3
Allyl chloride	107-05-1	0.19		0.4			99.6
Aniline	62-53-3	0.00075					100
Atrazine	1912-24-9	88.06		100			0
Benzaldehyde	100-52-7	51.18		98			2
Benzene	71-43-2	7735.12	29.9	20.6	16.3	31.2	2.1
Benzidine	92-87-5	0.00032					100
Benzo(b+k)fluoranthene		0.032		49.9			50.1
Benzo(c)phenanthrene	195-19-7	8.02	100				
Benzo(e)pyrene	192-97-2	8.66	63.1	36.9			0.013
Benzo(g,h,i)fluoranthene	203-12-3	3.23		100			
Benzo[j]fluoranthene	205-82-3	0.059					100
Benzofluoranthenes	56832-73-6	10.57	100	0.006			0
Benzotrichloride	98-07-7	0.0011					100
Benzyl chloride	100-44-7	0.44		0.1			99.9
Biphenyl	92-52-4	14.2		92.2			7.8
Bis (2-chloroethyl) ether	111-44-4	0.0013					100
Bromoform	75-25-2	0.37					100
Bromomethane	74-83-9	8.9		0.971			99
Butylbenzylphthalate	85-68-7	0.32					100
Captan	133-06-2	0.0043					100
Carbon disulfide	75-15-0	1.17		44.3			55.7
Carbon tetrachloride	56-23-5	1.03		29.7			70.3
Carbonyl sulfide	463-58-1	2.62	41.9	9.3			48.9
Catechol	120-80-9	1.14					100
Cfc-113 (trichlorotrifluoroethane)	76-13-1	158.64		100			0
Chlorine	7782-50-5	32.7		13.8			86.2
Chloroacetic acid	79-11-8	0.16					100
Chlorobenzene	108-90-7	2.05		46.1			53.9

Table 6: 2008 Minnesota Air Toxics Inventory Statewide Summary

Pollutant Name	CAS No	Total (Short Tons)	Fires (%)	Nonpoint (%)	Nonroad (%)	Onroad (%)	Point (%)
Chloroethane	75-00-3	1.27		64.7			35.3
Chloroform	67-66-3	204.34		97.8			2.2
Chloroprene	126-99-8	0.00093		91.8			8.2
Chromium (iii)	16065-83-1	0.58			4.9	13.2	81.9
Cis-1,3-dichloropropene	10061-01-5	0.08					100
Cresol- mixed isomers	1319-77-3	176.63		99.4			0.6
Crotonaldehyde	123-73-9	0.21		27.3			72.7
Cumene	98-82-8	16.53		62	0.021		38
Cyanide	57-12-5	106.54		74.8			25.2
Dibenz[a,h]acridine	226-36-8	0.0053					100
Dibenz[a,j]acridine	224-42-0	0.0062					100
Dibenzo(a,h)pyrene	189-64-0	0.0048					100
Dibenzo(a,i)pyrene	189-55-9	0.0053					100
Dibenzo[a,e]pyrene	192-65-4	0.0061					100
Dibenzo[a,l]pyrene	191-30-0	0.0053					100
Dibenzofuran	132-64-9	0.67		74.6			25.4
Dibutyl phthalate	84-74-2	1.46		16.1			83.9
Dichlorobenzenes	25321-22-6	0.14		59			41
Dichlorvos	62-73-7	0.0084					100
Diethanolamine	111-42-2	1.46		46			54
Diethyl sulfate	64-67-5	0.0017					100
Dimethyl aminoazobenzene	60-11-7	0.00069					100
Dimethyl phthalate	131-11-3	3.77		2.1			97.9
Dimethyl sulfate	77-78-1	0.5		0.009			100
Dimethylaniline(n,n-dimethylaniline)	121-69-7	0.017		68.3			31.7
Dimethylbenz(a)anthracene	57-97-6	1.44		99.1			0.9
Dimethylformamide, n,n-	68-12-2	12.68		0.7			99.3
Dioctyl phthalate (dehp)	117-81-7	3.18		7.6			92.4
Dioxins/furans as 2,3,7,8-tcdd teqs - unspecified method		0.000043		36.2	1.9	2.9	59
Epichlorohydrin	106-89-8	0.0058		2.8			97.2
Ethyl acrylate	140-88-5	0.86		0.007			100
Ethylbenzene	100-41-4	2363.46		4.8	24.8	65.7	4.7
Ethylene glycol	107-21-1	503.32		93.6			6.4
Ethylene imine	151-56-4	0.0038					100
Ethylene oxide	75-21-8	15.92		97.9			2.1
Fine mineral fibers		0.000005					100
Formaldehyde	50-00-0	24920.49	21.2	67.5	4.4	5.3	1.6

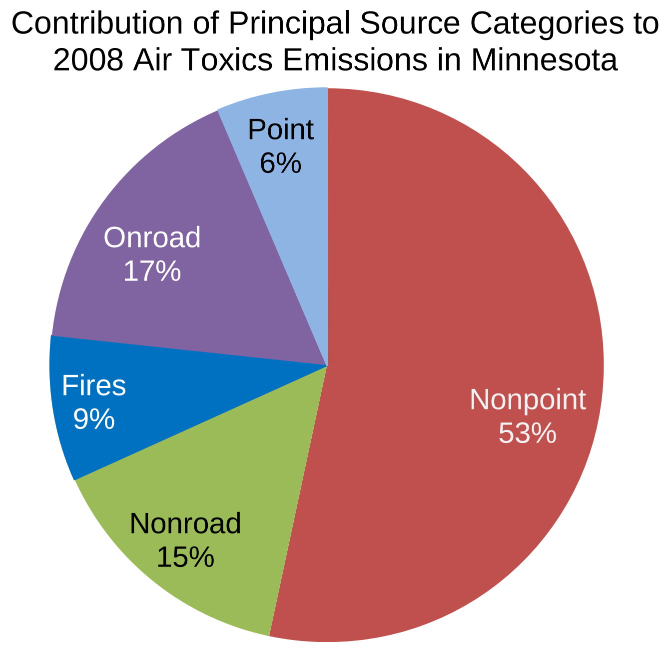
Table 6: 2008 Minnesota Air Toxics Inventory Statewide Summary

Pollutant Name	CAS No	Total (Short Tons)	Fires (%)	Nonpoint (%)	Nonroad (%)	Onroad (%)	Point (%)
Glycol ethers		624.76		66.8			33.2
Hexachloro-1,3-butadiene	87-68-3	0.11		0.0234			100
Hexachlorobenzene	118-74-1	0.0053		73.6	0.1		26.3
Hexachloroethane	67-72-1	0.0022					100
Hexamethylene-1,6-diisocyanate	822-06-0	0.73					100
Hydrazine	302-01-2	0.0000021					100
Hydrochloric acid	7647-01-0	2162.93		8			92
Hydrogen fluoride	7664-39-3	488		0.016			100
Hydroquinone	123-31-9	0.97					100
Isophorone	78-59-1	6.21		2.8			97.2
Maleic anhydride	108-31-6	0.27					100
M-cresol	108-39-4	0.0027					100
M-dichlorobenzene	541-73-1	1.57		69.7			30.3
Methanol	67-56-1	48317.59		99.2	0.004		0.8
Methyl chloride	74-87-3	302.88	87.1	11.3			1.7
Methyl ethyl ketone	78-93-3	826.37		71.7			28.3
Methyl hydrazine	60-34-4	1.65					100
Methyl iodide	74-88-4	0.01					100
Methyl isobutyl ketone	108-10-1	659.65		88.1			11.9
Methyl methacrylate	80-62-6	23.55		4.1			95.9
Methyl tert butyl ether	1634-04-4	1.16		5.1			94.9
Methylene chloride	75-09-2	211.97		70.6			29.4
M-xylene	108-38-3	10.78		51.4	18.6		29.9
N-hexane	110-54-3	4890.97	0.7	15	14.1	34	36.3
Nitrobenzene	98-95-3	0.0012		19.4			80.6
N-nitrosodimethylamine	62-75-9	0.0034					100
N-nitrosomorpholine	59-89-2	0.0023					100
O-anisidine	90-04-0	0.0013					100
O-cresol	95-48-7	4.14		1.6			98.4
O-dichlorobenzene	95-50-1	0.79		52.5			47.5
O-toluidine	95-53-4	0.001		6.5			93.5
O-xylene	95-47-6	135.55		96.9	0.8		2.3
Pah, total	130498-29-2	0.14		98.9	0.7		0.4
P-cresol	106-44-5	0.53		24.5			75.5
Pentachloronitrobenzene	82-68-8	0.004					100
Pentachlorophenol (pcp)	87-86-5	0.2		4.7			95.3
Perylene	198-55-0	2.47	71.2	28.8			0.018
Phenol	108-95-2	324.09		83.2	0.3		16.5

Table 6: 2008 Minnesota Air Toxics Inventory Statewide Summary

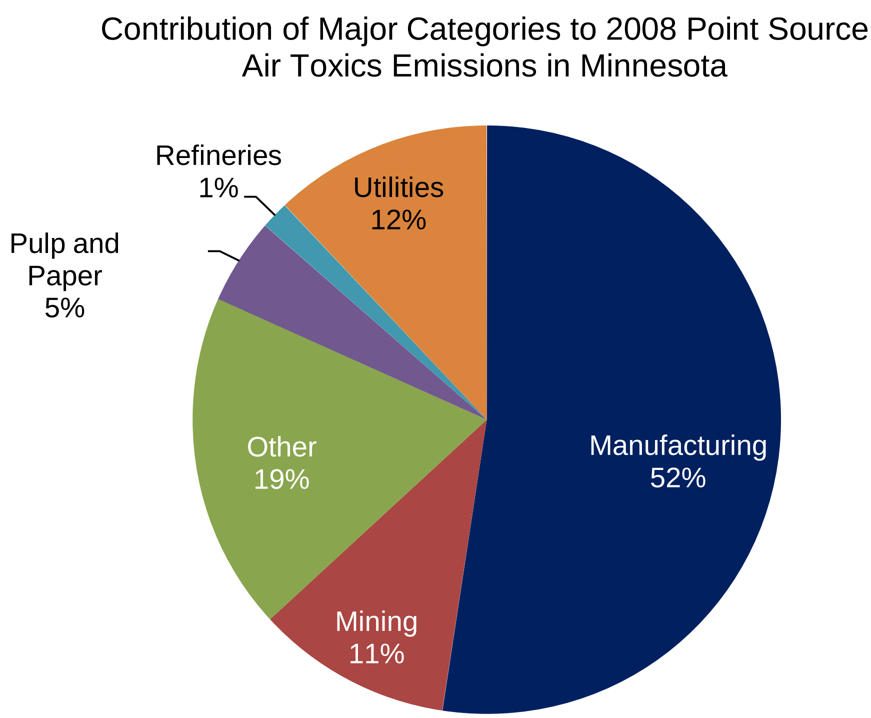
Pollutant Name	CAS No	Total (Short Tons)	Fires (%)	Nonpoint (%)	Nonroad (%)	Onroad (%)	Point (%)
Phosgene	75-44-5	0.00012					100
Phosphine	7803-51-2	0.09					100
Phosphorus (yellow or white)	7723-14-0	39.52		0.5	0.5		99
Phthalic anhydride	85-44-9	0.28					100
Polychlorinated biphenyls (pcbs)	1336-36-3	0.51		99.8	0.012		0.2
Polycyclic organic matter		0.019					100
P-phenylenediamine	106-50-3	0.00011					100
Propionaldehyde	123-38-6	232.58		18.3	45.5	34.3	2
Propylene dichloride	78-87-5	0.88		40.7			59.3
Propylene oxide	75-56-9	0.87		3			97
P-xylene	106-42-3	0.7					100
Quinone	106-51-4	0.8					100
Styrene	100-42-5	712.52		23.3	11.8	10	54.9
Tetrachloroethylene	127-18-4	141.93		87.2			12.8
Toluene	108-88-3	21915.65	5.3	11.8	40.2	36.8	5.9
Toluene-2,4-diisocyanate	584-84-9	0.35		46.1			53.9
Trans-1,3-dichloropropene	10061-02-6	0.00011					100
Trichloroethylene	79-01-6	120.68		12.2			87.8
Trichlorofluoromethane (cfc-11, r-11)	75-69-4	1.95		56.1			43.9
Triethylamine	121-44-8	3.53		70.1			29.9
Trifluralin	1582-09-8	3.88		99.9			0.1
Trimethylbenzene	25551-13-7	14.1		85.1			14.9
Vinyl acetate	108-05-4	12.48		7.7			92.3
Vinyl bromide	593-60-2	0					100
Vinyl chloride	75-01-4	6.77		76.9			23.1
Vinylidene chloride	75-35-4	1.39		69.8			30.2
Xylenes (mixed isomers)	1330-20-7	11486.9	4.3	7.5	34.7	49.3	4.1
Aldehydes		27.18					100
Benzo(a)fluo		5.34	100				
Butyraldehyd		0.62					100
Dioctylpht,n		0.16					100
Meth-anthrac		16.99	99.5	0.5			0.008
Methylchry,5		0.32					100
Methylnapht1		0.83			100		0.00024
Methylpyrene		18.6	100				
Non-metal Total		**144455.64**	**8.4**	**53.5**	**14.9**	**16.8**	**6.4**
Grand Total		**145269.76**	**8.5**	**53.4**	**14.9**	**16.9**	**6.4**

The following chart summarizes directly emitted air toxics pollutant emissions in Minnesota from 2008. It does not include secondarily formed pollutants. Nonpoint source contributed 53 percent of the total emissions, onroad and nonroad mobile sources account for 32 percent of the emissions. Point sources contributed six percent and fires accounted for nine percent of the total.



Total air toxics emissions in 2008: 145,270 tons

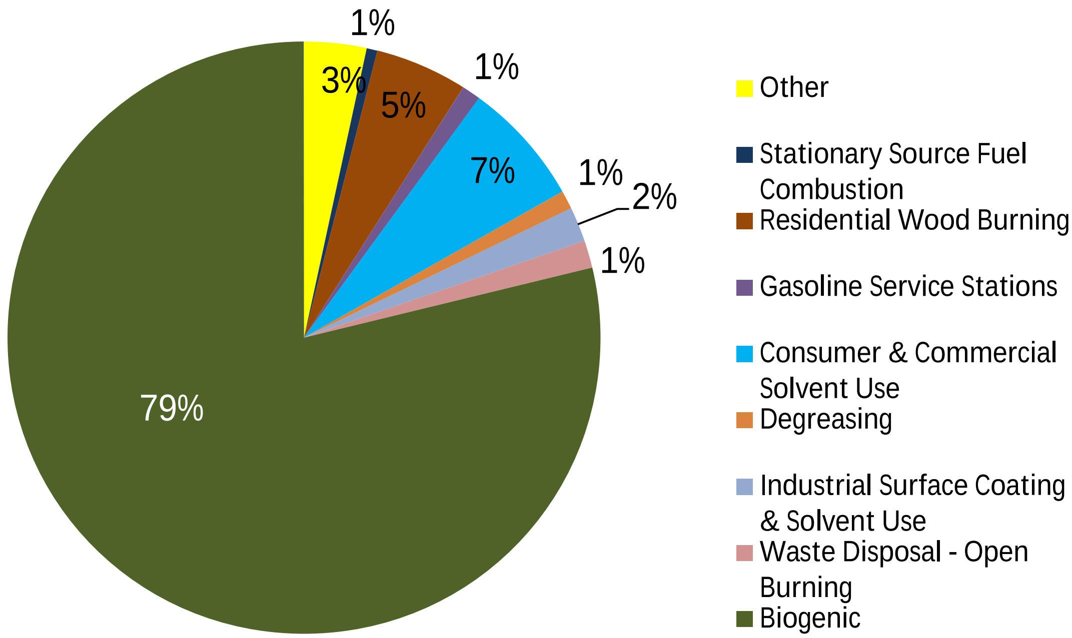
A more detailed breakdown of emissions for each principal source category is shown in the following five pie charts. For point sources, manufacturing dominates the air toxics emissions with 52 percent of the total. Electric utilities account for 12 percent of the point source emissions.



Total air toxics point source emissions in 2008: 9,346 tons

For nonpoint sources, 79 percent of emissions come from the biogenic category. Biogenic emissions are emitted from natural sources such as vegetation and soils. Prior to the 2008 Emission Inventory, biogenic emissions were usually not included in the totals. Other significant source categories were residential wood burning, and consumer and commercial solvent use.

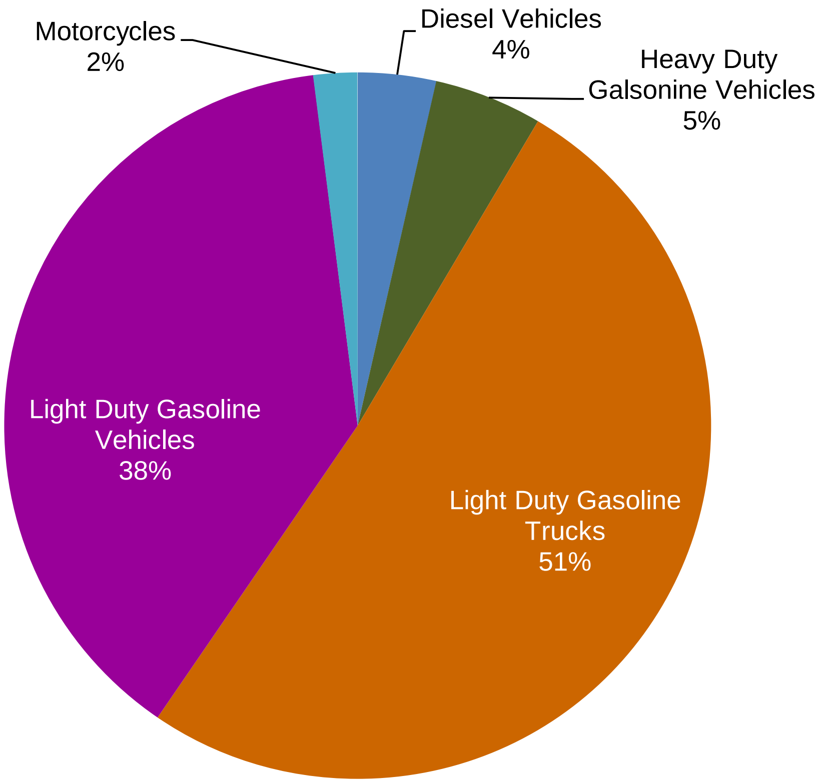
Contribution of Major Categories to 2008 Nonpoint Source Air Toxic Emissions in Minnesota



Total air toxic nonpoint source emissions in 2008: 77,521 tons

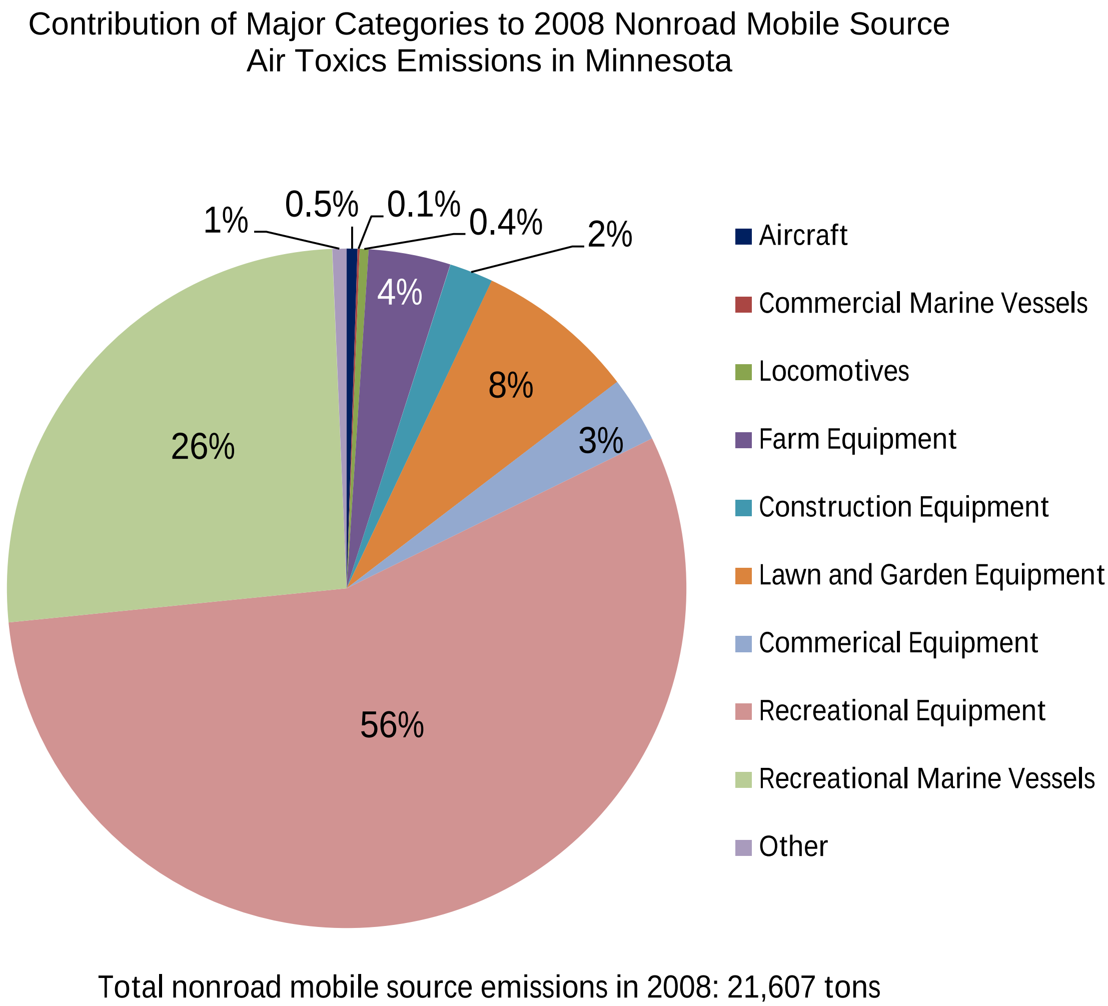
For onroad mobile sources, the largest emission contributor is light duty gasoline trucks, which accounts for about 51 percent of the total mobile source emissions in 2008. The second largest contributor of onroad mobile source emissions is light duty gasoline vehicles, which accounts for another 38 percent of mobile source air toxics emissions.

Contribution of Major Categories to 2008 Onroad Mobile Source Air Toxics Emissions in Minnesota



Total onroad mobile source emissions in 2008: 24,513 tons

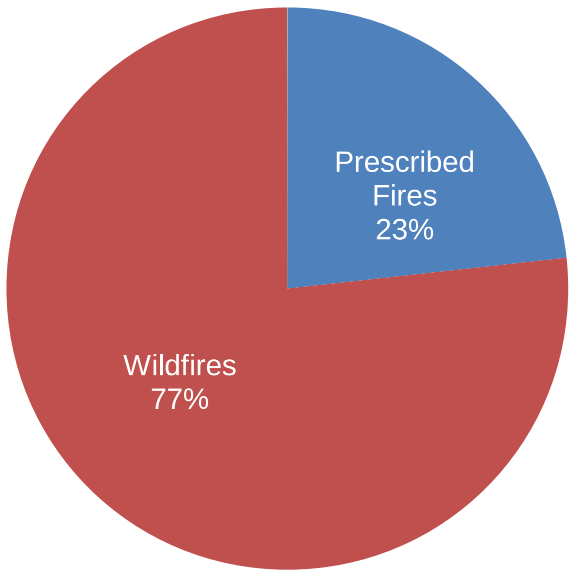
For nonroad mobile sources, the largest emission contributor is recreational equipment (all-terrain vehicles, snowmobiles, etc.), which accounted for 56 percent of all emissions. The second largest contributor is the recreational marine vessels which accounted for 26 percent of emissions.



Wildfires accounted for 77 percent of total emissions from fires while 23 percent of emissions can be attributed to prescribed burning. To estimate 2008 emission, EPA relied on the Satellite Mapping Automated Reanalysis Tool for Fire Incident Reconciliation version 2 (SFv2). This methodology significantly improved estimates relative to 2005 emissions making it difficult to compare the two data sets. In addition fires show great inter-annual variability which makes year to year comparisons hard to do.

In 2008, parts of Northern Minnesota specifically Beltrami and Marshall Counties had significant fire emissions. Most of the emissions occurred in April, May and July.

Contribution of Major Categories to 2008
Air Toxics Emissions from Fires in Minnesota



Total event category emissions in 2008: 12,283 tons

For more information on how 2008 Fire emissions were estimated please visit the following:

http://www.epa.gov/ttn/chief/net/2008neiv3/2008_neiv3_tsd_draft.pdf

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/tchyfb2

http://www.pca.state.mn.us/bkzqf88

http://www.epa.gov/ttnchie1/net/2008inventory.html

Chapter 2: Water Pollutant Discharges Overview

Minnesota's rivers, streams and lakes provide great natural beauty, and supply the water necessary for recreation, industry, households, 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 to our state's waters from wastewater treatment plants and industries. 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 and $194.9 million for fiscal years 2014-2015.

Minnesota agencies released the 2014 Clean Water Fund Performance Report, in February 2014 to help Minnesotans clarify connections between Clean Water Funds invested, actions taken and outcomes achieved in fiscal years 2010-2013. Twenty-four 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, drinking and groundwater measures. Each measure has detailed status ranking and trend information. A new category of measures, social measures, is also introduced in this report. Social measures track how the Clean Water Fund investment impacts the ability of people to support and engage in local projects.

For a link to the report and more information on the Clean Water Fund, please see the following web site: http://www.legacy.leg.mn/funds/clean-water-fund

Water Discharge Quality and Trends

This year's report contains water discharge data from all municipal and industrial wastewater point sources for flow and five measures of water pollution covering the years 2000-2013. Summaries of pollutant loads discharged by 937 facilities including 577 domestic wastewater and 360 industrial facilities are included. Maps on the next two pages show the distribution of municipal wastewater treatment facilities by size and the distribution of various types of industrial facilities found in Minnesota. A map of wastewater flow by major watershed for 2013 is also included.

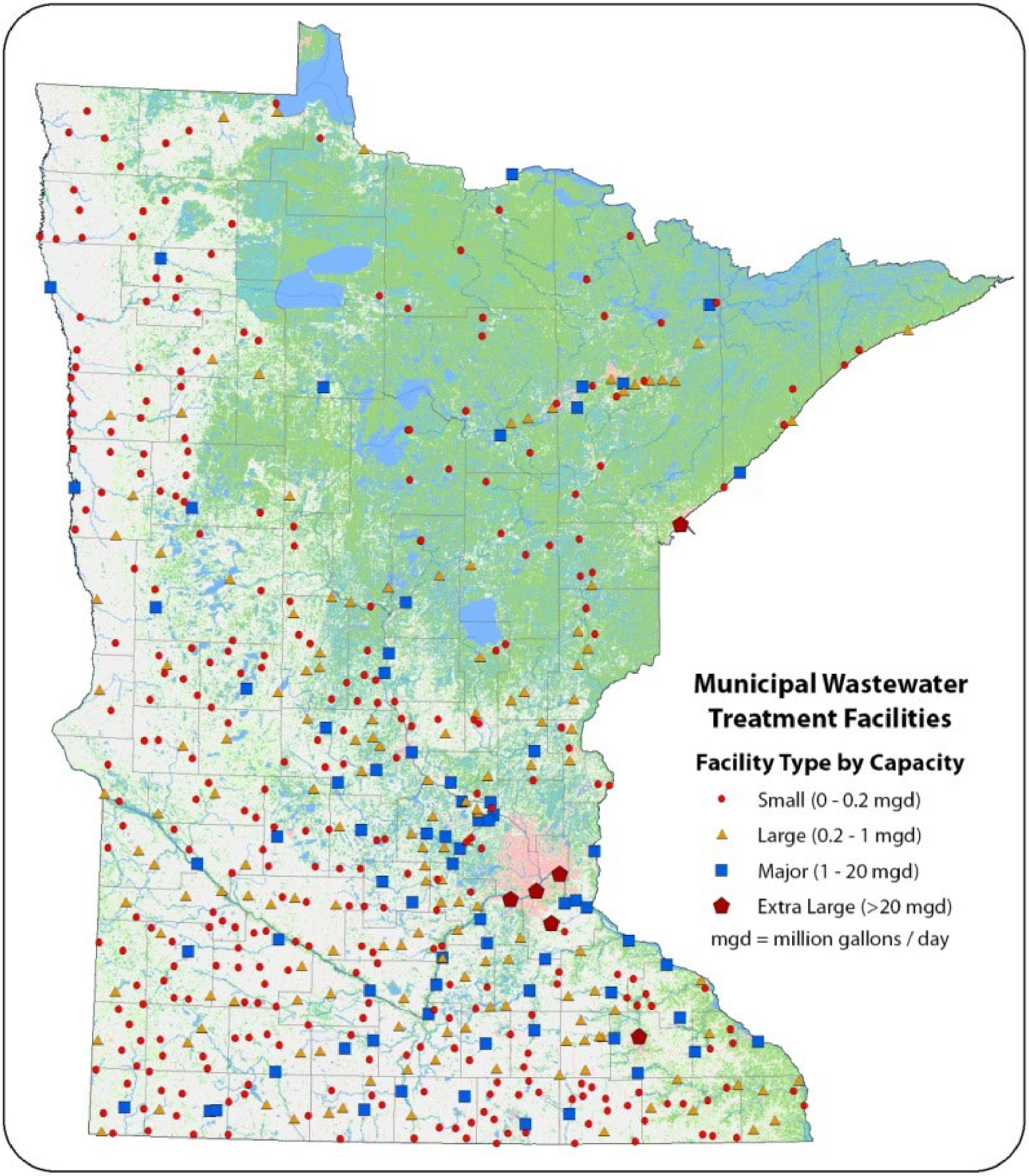
Pollutant loads are calculated by combining effluent flow data with reported pollutant concentrations or estimated pollutant concentrations where facility specific data are not available. Estimated concentrations used to calculate pollutant loads are based on categorical assumptions that account for waste stream and facility type characteristics. Concentration estimates are based on effluent data from similar waste streams and facilities types when available, and in some cases estimates are based on best professional judgment. 2014 effluent flow and pollutant loading estimates for NPDES permitted facilities exclude once through non-contact cooling water data from power generation facilities. Extremely large volumes of (primarily) river water are used by the power industry for cooling purposes. These once through non-contact cooling waters are discharged with the addition of heat, but minor additions of other pollutants. Pollutant loads associated with these discharges were largely present in the waterbodies before the waters were withdrawn for cooling purposes so reporting them as wastewater pollutants would be misleading.

Pollutant loads calculated from measured wastewater flows and observed pollutant concentrations are considered to be highly reliable while less confidence is warranted for pollutant loads derived from estimated concentrations. The degree of confidence in each loading estimate can be expressed as the proportion of the load derived from observed values compared to the proportion derived from estimated values. The loading graphs in this report are color coded by 'Observed' and 'Estimated' to serve as a confidence measure for each pollutant load measure.

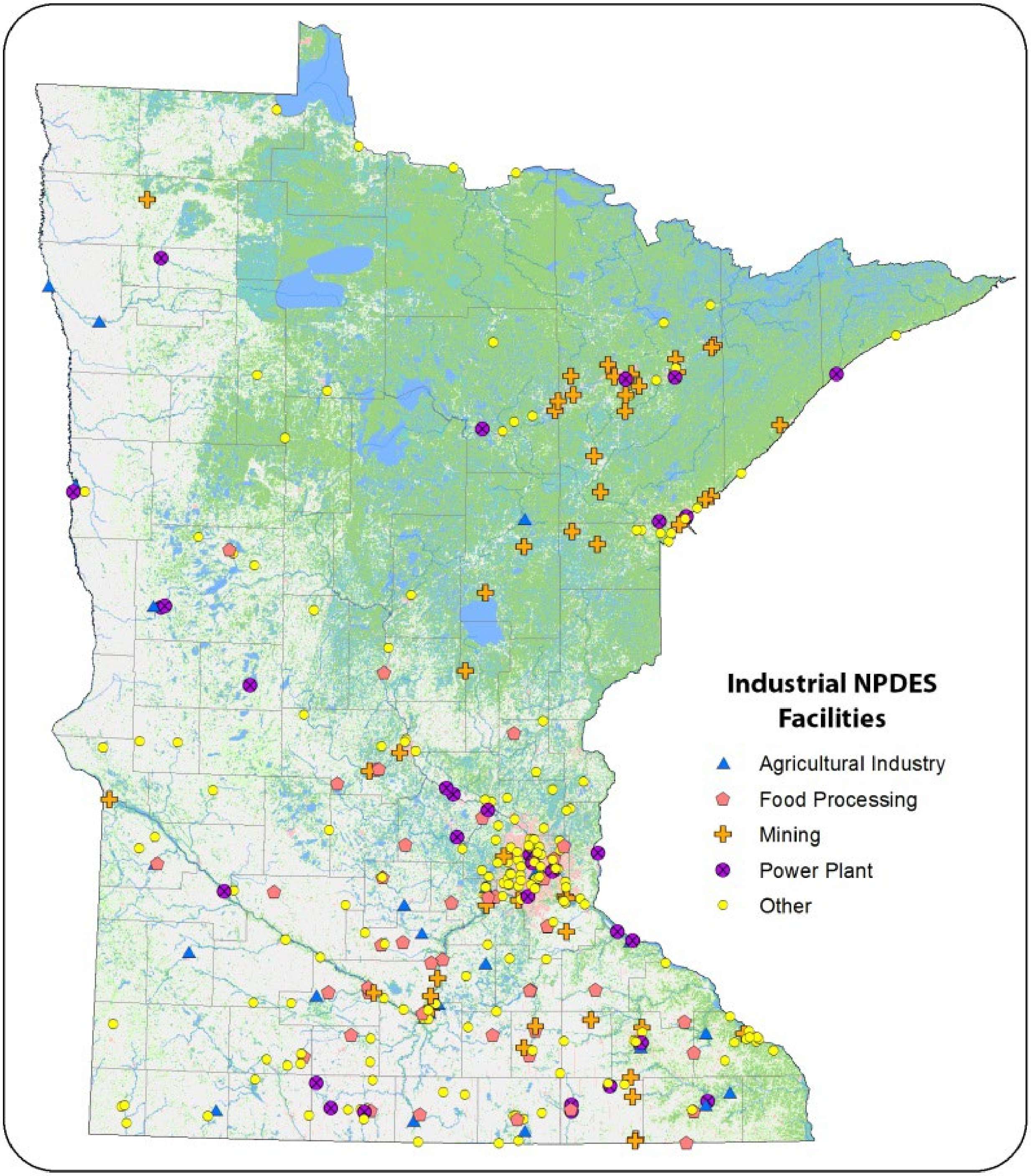
Previous Pollution Reports to the Legislature were based on data reported by approximately 99 major wastewater dischargers. These are facilities permitted to discharge at least 1 million gallons per day and account for approximately 85% of the volume of wastewater discharged to waters of the state. This year's report includes data from all surface water dischargers, regardless of size. The inclusion of non-major facilities will present a more complete measure of pollutant loads since non-major facilities can collectively impact water quality.

Five common chemical parameters found in wastewater treatment plant effluent will be highlighted in this report, including: total suspended solids (TSS), biochemical oxygen demand (BOD), total phosphorus (TP), total nitrogen (TN) and mercury (Hg). Effluent flow volumes are also included in this year's report and are discussed in the Introduction and Summary section on pages 3-10 of this report. Long-term trends for the five chemical parameters are measured as a percent change from a 2000-2001 baseline.

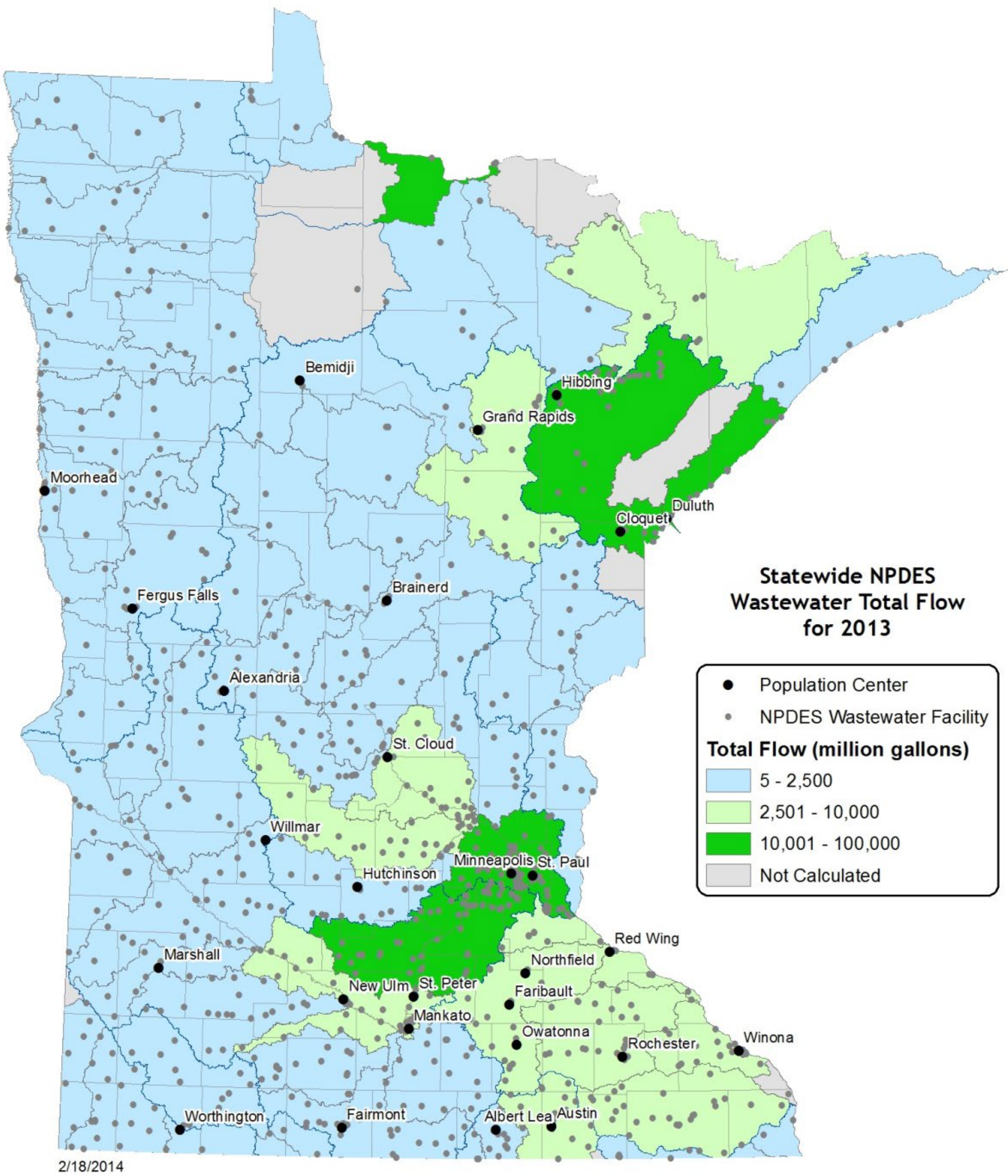
Distribution of Municipal Wastewater Facilities by Size



Distribution of Industrial Wastewater Dischargers by Type



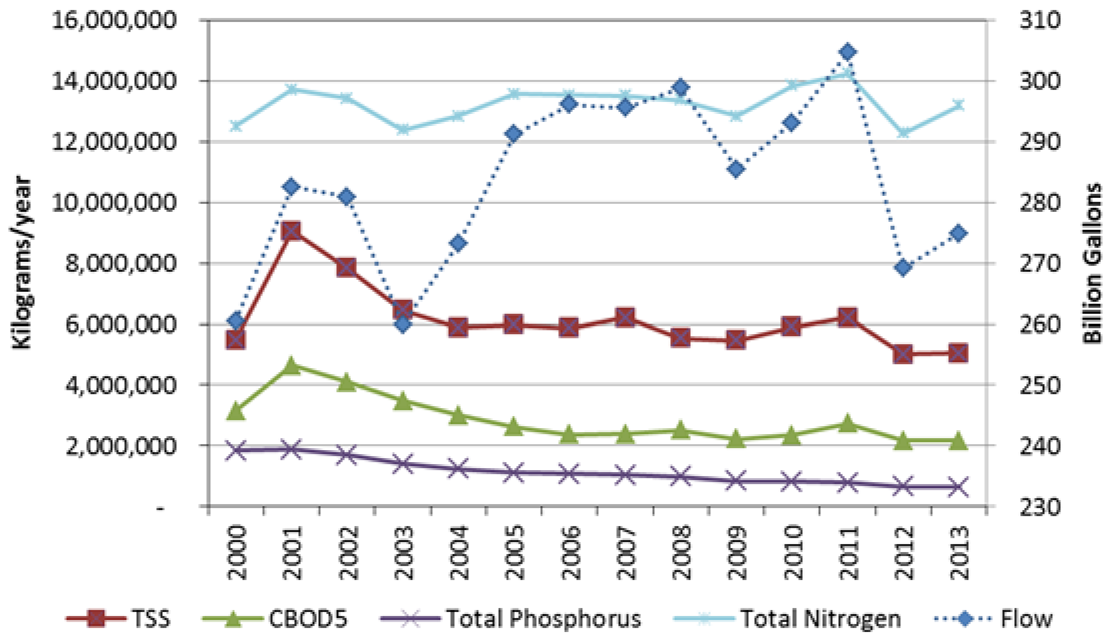
Wastewater Flow by Major Watershed for 2013



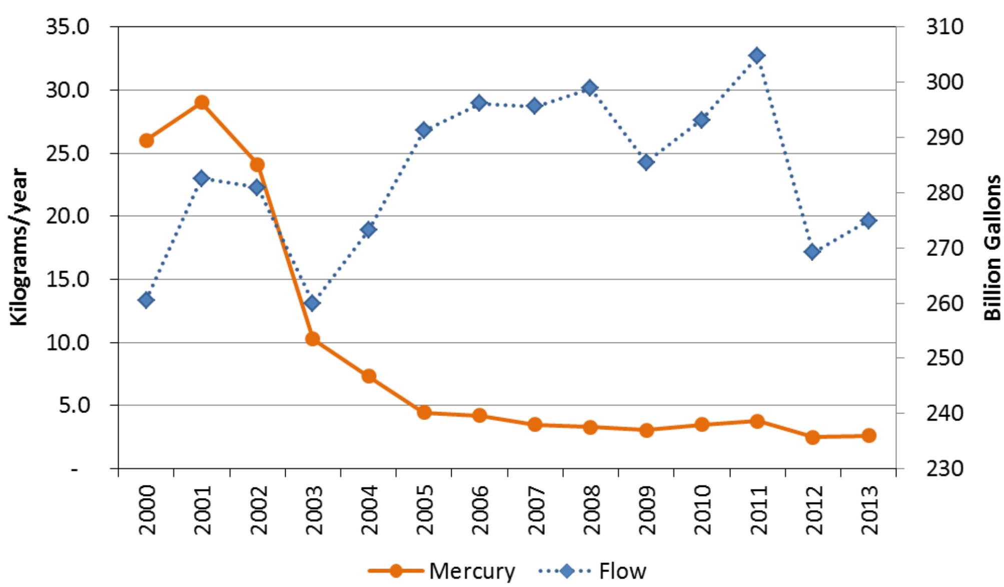
Pollutant Loading Trends

Pollutant loading and flow trends are shown in the following figure with pollutant loading shown as kilograms and flow in billion gallons.

Pollutant Loading Trends from NPDES Wastewater Facilities, 2000-2013



Mercury Loading Trends From NPDES Wastewater Facilities 2000 – 2013



Total Suspended Solids

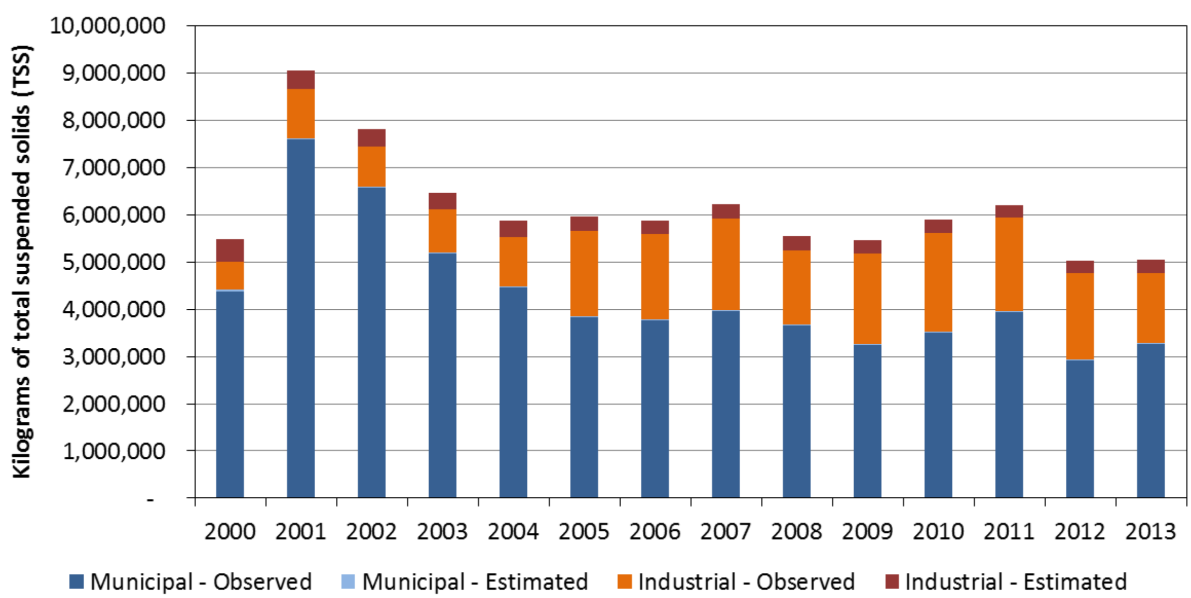
Total suspended solids (TSS) is a measure of the material suspended in water or wastewater. TSS causes interference with light penetration, buildup of sediment and potential degradation of aquatic habitat. Suspended solids also carry nutrients that cause algal blooms that are harmful to fish and other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

The TSS load for 2013 was 5,046,000 kilograms, a 10 percent decrease from the 2011-12 average. On average the data show an annual 30 percent reduction in TSS loads from a 7,265,000 kilogram per year baseline in 2000/2001.

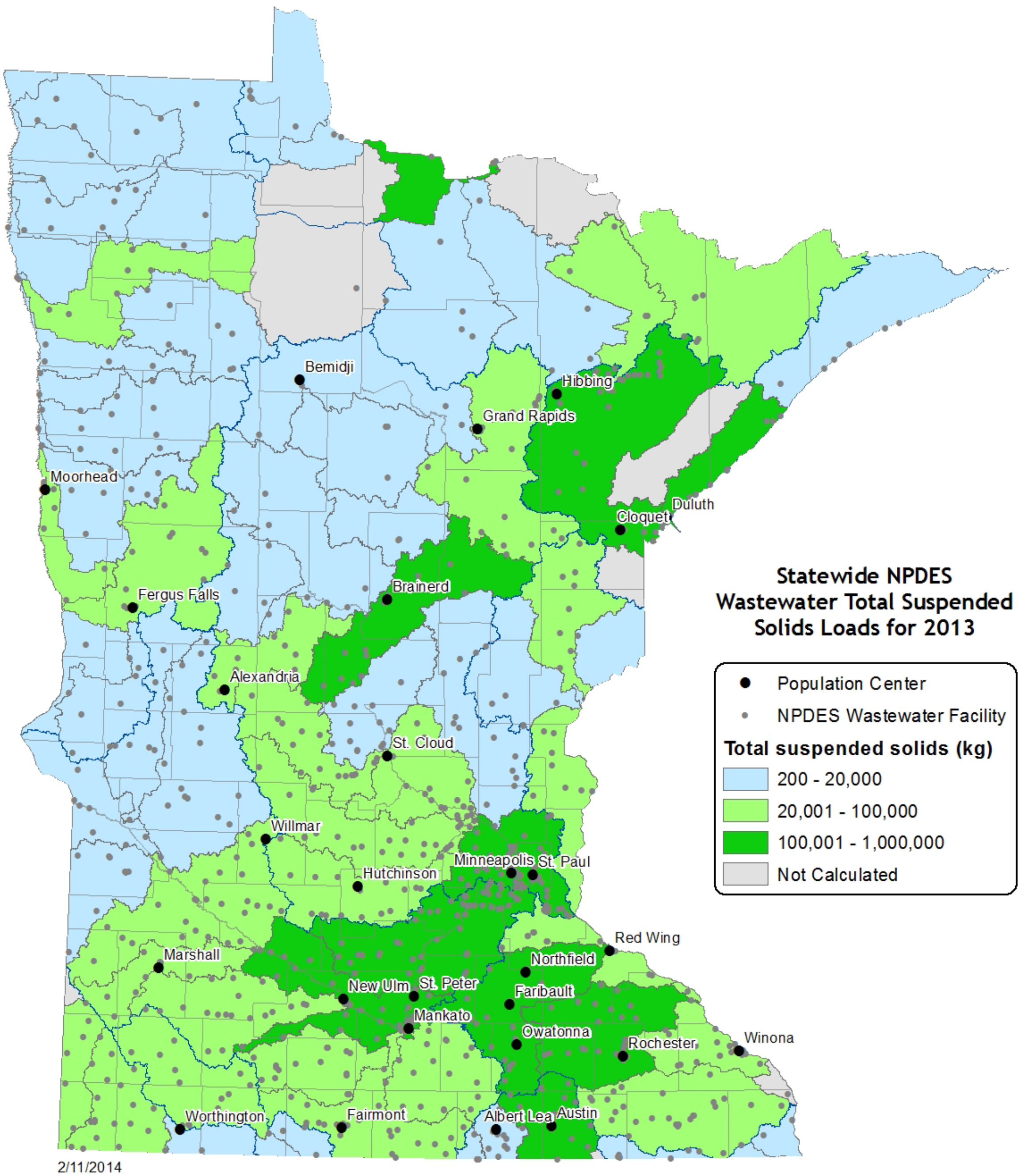
Wastewater TSS data are considered reliable, with 94 percent of values resulting from observed data points. On average, 82 percent of wastewater TSS loads are discharged by major facilities although the proportion of TSS loads discharged by major facilities has declined from an average of 86 percent from 2000 through 2003 to an average of 80 percent from 2004 through 2013. On average, municipal wastewater dischargers accounted for 82 percent of TSS loads from 2000 through 2003 while their proportion of TSS wastewater loading declined to an average of 65 percent from 2004 through 2013. Overall, wastewater TSS loads have declined from an average of 7,202,000 kilograms per year in the 2000 through 2003 period to an average of 5,711,000 kilograms per year from 2004 through 2013.

It should be noted that TSS is one of the most frequently monitored pollutants in wastewater. Most facilities must meet technology based effluent limits (TBELS) which, for most waterbodies, are at concentrations below proposed TSS water quality standards which are currently in development. As such, most facilities are discharging below a concentration level of concern and further reductions from most are not necessary at this time. For this reason, long term average TSS wastewater loading has remained relatively stable during the past decade. Nonetheless, advanced treatment to meet other effluent limits for pollutants like phosphorus or mercury could also result in TSS reductions since those pollutants tend to be components of or attached to suspended solids.

Annual Loading Values from Wastewater Treatment Facilities for Total Suspended Solids (TSS)



Total Suspended Solids Loads from Wastewater Treatment Facilities by Major Watershed, 2013



Carbonaceous Biochemical Oxygen Demand (CBOD)

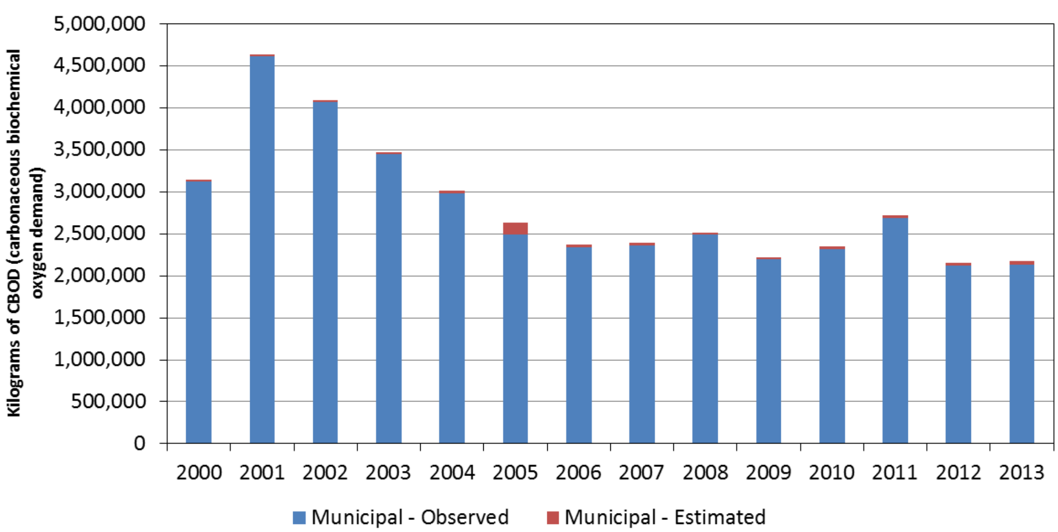
When organic wastes are introduced into water, they require oxygen to break down. High concentrations of organic materials characterize untreated domestic wastes and many industrial wastes. The amount of oxygen required for decomposition of organic wastes by microorganisms is known as the biochemical oxygen demand (BOD), while carbonaceous biochemical oxygen demand (CBOD) is the amount of oxygen required for microorganisms to decompose carbonaceous waste materials. Both BOD and CBOD are indicators of the strength of waste effluent and effectiveness of treatment. 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.

Historically municipal facilities were required to report total BOD. However, due to rule changes, described in greater detail in the 1984 Water Quality Standards Statement of Need and Reasonableness (SONAR), municipal wastewater limitations and reporting requirements were modified to CBOD. Industrial dischargers most frequently report BOD which reflects the industry-specific requirements within federal regulations. For purposes of this report, CBOD was used for load calculations because it provides a more complete data set for municipal loading calculations. Industrial facilities are not included in this calculation because there are too few observations to confidently estimate categorical concentrations. The complete BOD/CBOD load could be significantly higher than the currently reported values because industrial flow accounts for nearly half of the flow within the state.

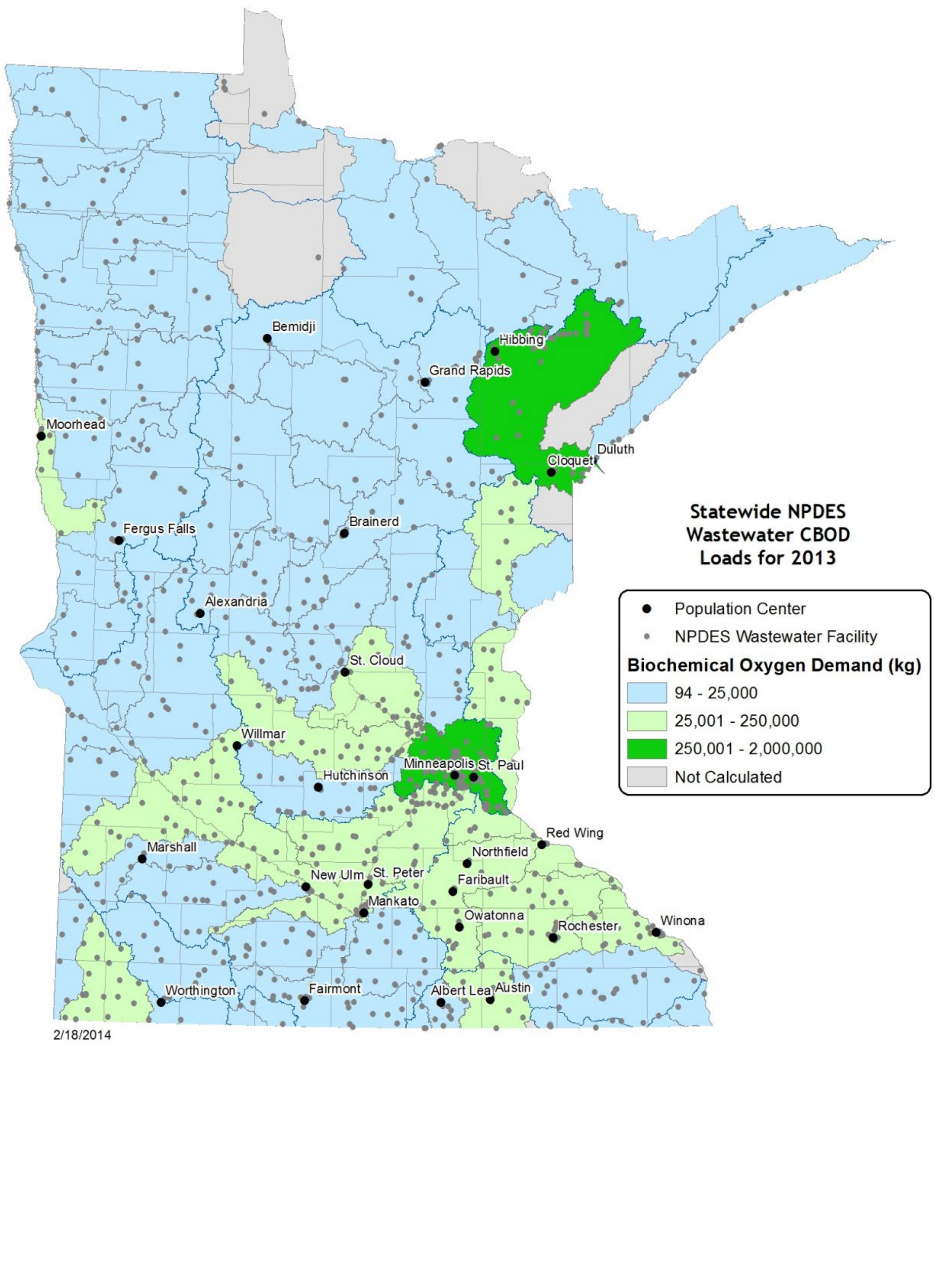
The total municipal CBOD load for 2013 was 2,172,000 kilograms, a 1 percent increase from the 2010-12 average. On average the data show an annual 44 percent reduction in CBOD loads from a 3,146,000 kilogram per year baseline in 2000/2001.

Municipal wastewater CBOD data are considered reliable, with 99 percent of values resulting from observed data points. On average, 85 percent of wastewater CBOD loads are discharged by major facilities although the proportion of CBOD loads discharged by major facilities has declined from an average of 89 percent from 2000 through 2003 to an average of 83 percent from 2004 through 2013. Overall, wastewater CBOD loads have declined from an average of 3,838,000 kilograms per year in the 2000 through 2003 period to an average of 2,453,000 kilograms per year from 2004 through 2013.

Annual Loading Values for Carbonaceous Biochemical Oxygen Demand (CBOD) from Wastewater Treatment Facilities, 2001-2013



Carbonaceous Biochemical Oxygen Demand Loads from Wastewater Treatment Facilities by Major Watershed, 2013



Total Phosphorus

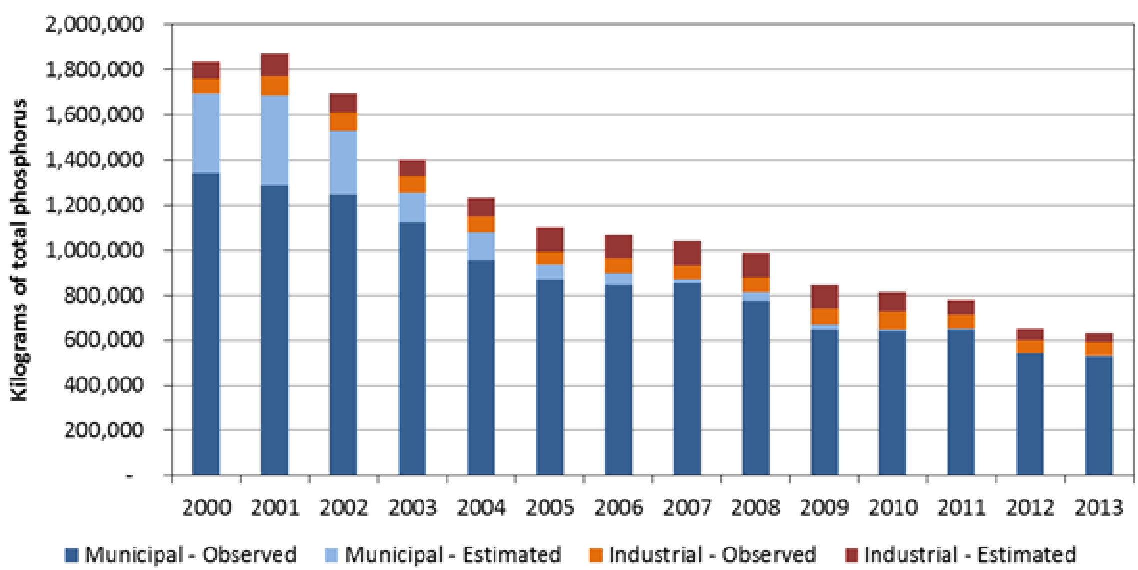
Total phosphorus (TP) is the primary pollutant associated with increased algae growth in Minnesota's lakes and streams. Excess phosphorus from human activities causes algae blooms and reduced water transparency, making water unsuitable for swimming and other activities. Phosphorus is released from both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

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 Pollutant Discharge Elimination System (NPDES) permits several years ago. Phosphorus loads were reduced by 50 percent from 2000-09 and have continued to decline since 2009. Current phosphorus loads are much lower than 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.

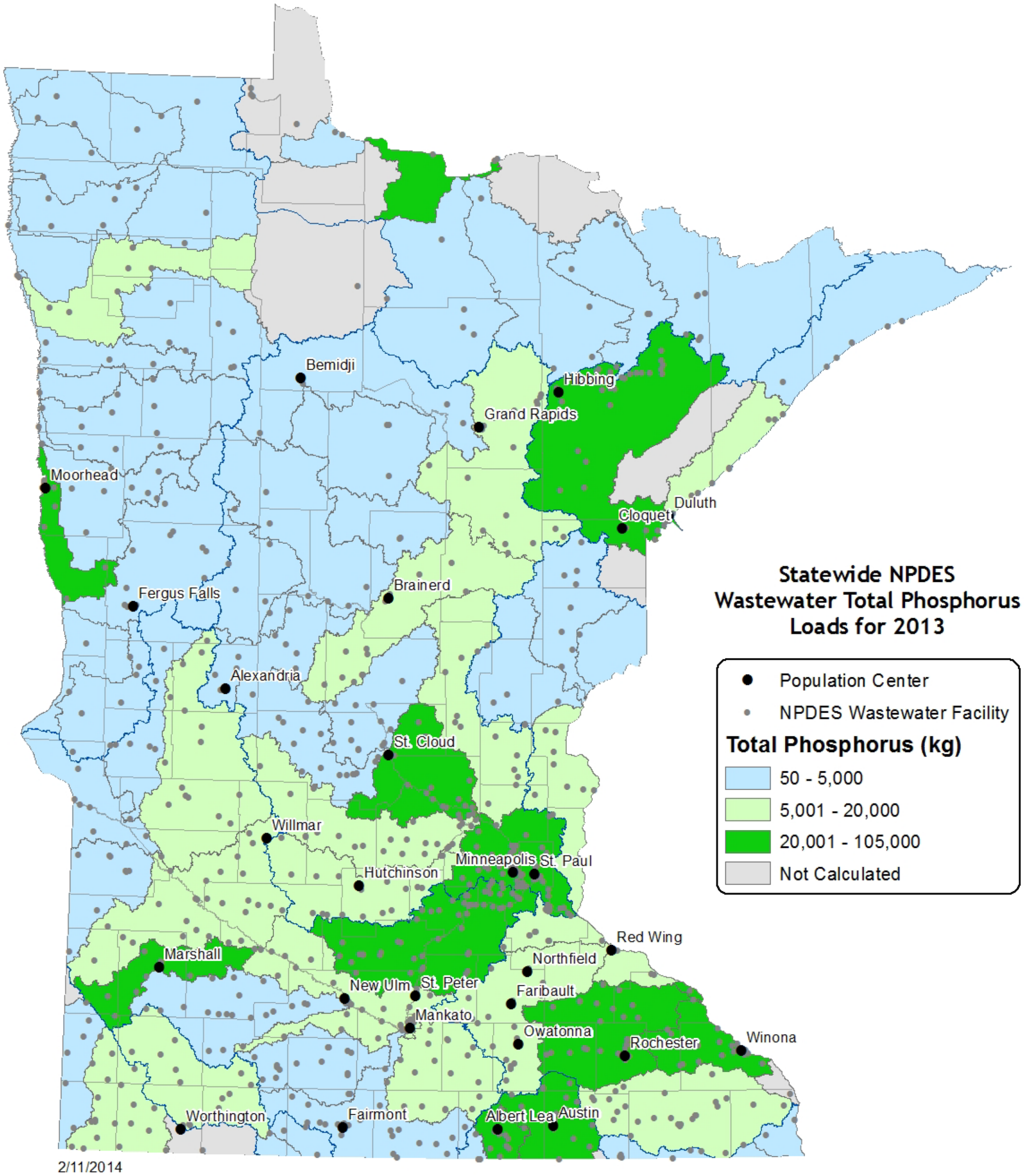
The 2013 total phosphorus load for the state was 633,000 kilograms, down 12 percent from the 2011-12 average of 717,000 kilograms. On average, the data show an annual 66 percent reduction in total phosphorus loads from a 1,855,000 kilogram per year baseline in 2000/2001.

Total phosphorus wastewater data are considered reliable, with 85 percent of values resulting from observed data points. On average, 84 percent of wastewater total phosphorus loads are discharged by major facilities although the proportion discharged by major facilities has declined from an average of 88 percent from 2000 through 2003 to an average of 83 percent from 2004 through 2013. Municipal wastewater dischargers accounted for 90 percent of total phosphorus loads from 2000 through 2003 with their proportion of the loading declining to an average of 84 percent from 2004 through 2013. Overall, wastewater total phosphorus loads have declined from an average of 1,702,000 kilograms per year in the 2000 through 2003 period to an average of 1,086,000 kilograms per year from 2004 through 2008 and further to an average load of 744,000 kilograms per year from 2009 through 2013.

Annual Loading Values for Total Phosphorus from Wastewater Treatment Facilities, 2001-2013



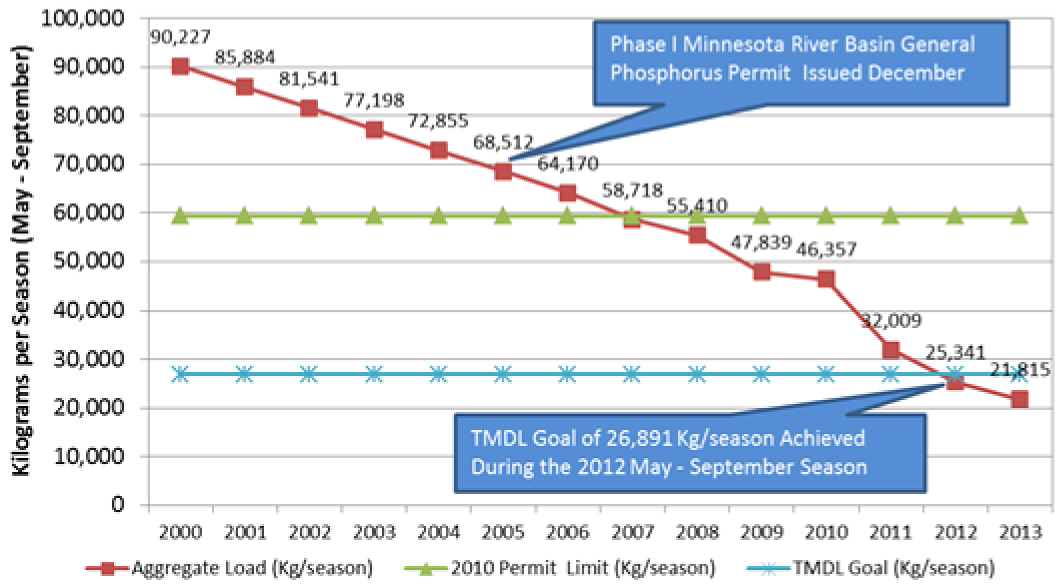
Total Phosphorus Loads from Wastewater Treatment Facilities by Major Watershed, 2013



Minnesota River Basin Phosphorus Reductions

Reductions in phosphorus loading to the Minnesota River have also occurred as a result of Minnesota River Basin General Phosphorus Permit (Permit), which was issued on December 1, 2005. The Permit was developed as part of the Lower Minnesota River Dissolved Oxygen TMDL that was completed to address a dissolved oxygen impairment in the Lower Minnesota River. The Permit required the 40 largest continuously discharging wastewater treatment facilities within the Minnesota River Basin to apply for coverage and receive a five-month (May-Dec) mass phosphorus limit. The Permit required incremental reductions over time. The TMDL's phosphorous reduction goal was met by 2012.

Minnesota River Basin General Phosphorus Permit Reductions Required and Achieved

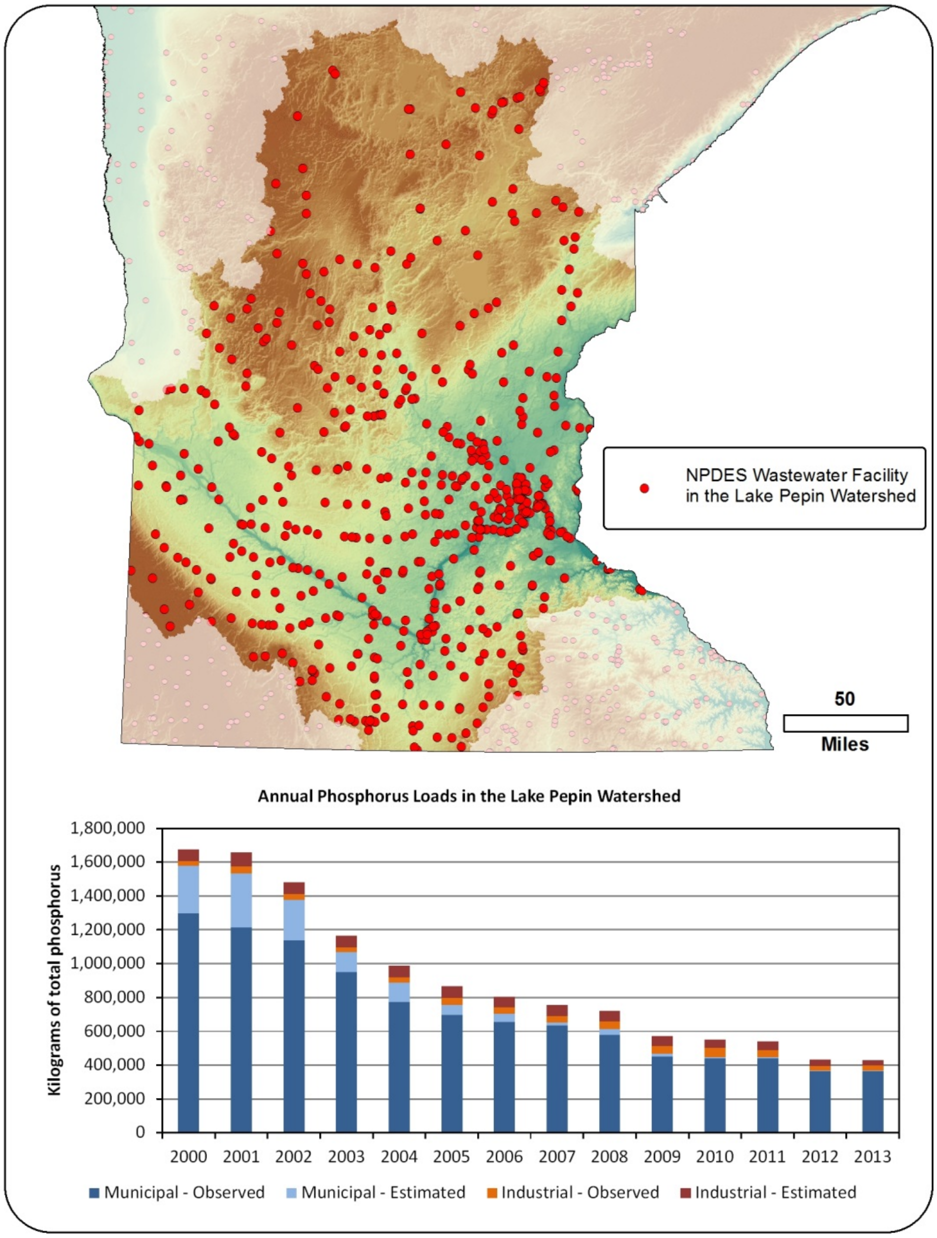


Lake Pepin Phosphorus Watershed Reductions

The Lake Pepin watershed covers a significant portion of the state and contains 82 percent of Minnesota residents. A draft site-specific phosphorus standard for Lake Pepin was developed in 2008 and the accompanying wasteload allocations are currently being incorporated into permits.

Phosphorus loads entering the lake have been greatly reduced since the adoption of the Phosphorus Rule in 2008. Increased facility monitoring has also increased the confidence in load values because most municipal loads are now from observed values. Although aggregate total phosphorus loads from Minnesota dischargers have reduced effluent loads below the 600 metric ton per year wastewater point source goal for Lake Pepin, the NPDES permit program is in the process of locking in permit limits to ensure that the load will remain consistent with watershed goals in the future.

Annual Phosphorus Loads from Wastewater Treatment Facilities within the Lake Pepin Watershed, 2000-2013



Total Nitrogen

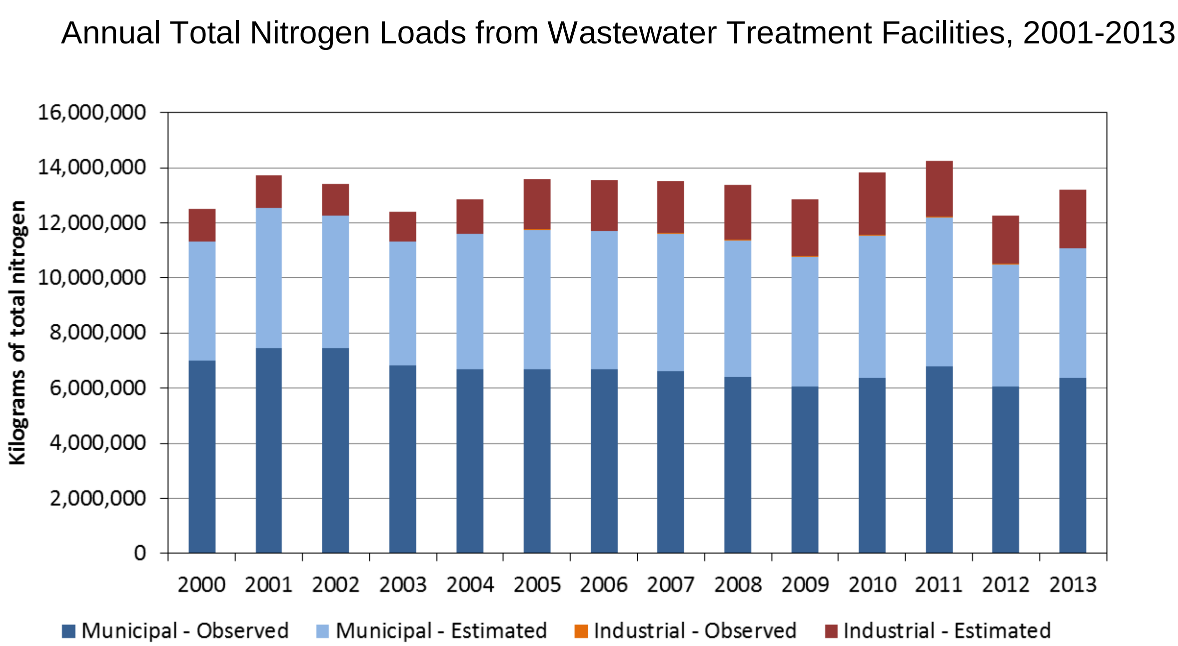
Nitrogen in wastewater generally occurs as either nitrate or ammonia. Nitrogen as ammonia can be toxic to aquatic life and nitrogen in the form of nitrate can be a significant problem in ground water supplies, and can also be toxic to aquatic life. Currently permits have required more frequent monitoring for ammonia than for nitrate and/or other nitrogen parameters. As a result it is difficult to accurately report the total nitrogen (a measure of all forms of nitrogen including nitrate, nitrite, ammonia, and organic nitrogen) loads from point source discharges.

The draft Minnesota Nutrient Reduction Strategy defines a total nitrogen load reduction goal of 20 percent from discharges to the Mississippi River and 13 percent from dischargers to the Red River by 2025. As a first step in reaching this goal additional monitoring for the necessary nitrogen parameters will be added to permits so that a more accurate calculation of the total nitrogen loading from point source discharges can be established. Once total nitrogen loadings can be accurately defined initial total nitrogen reductions efforts will be made through source reduction work.

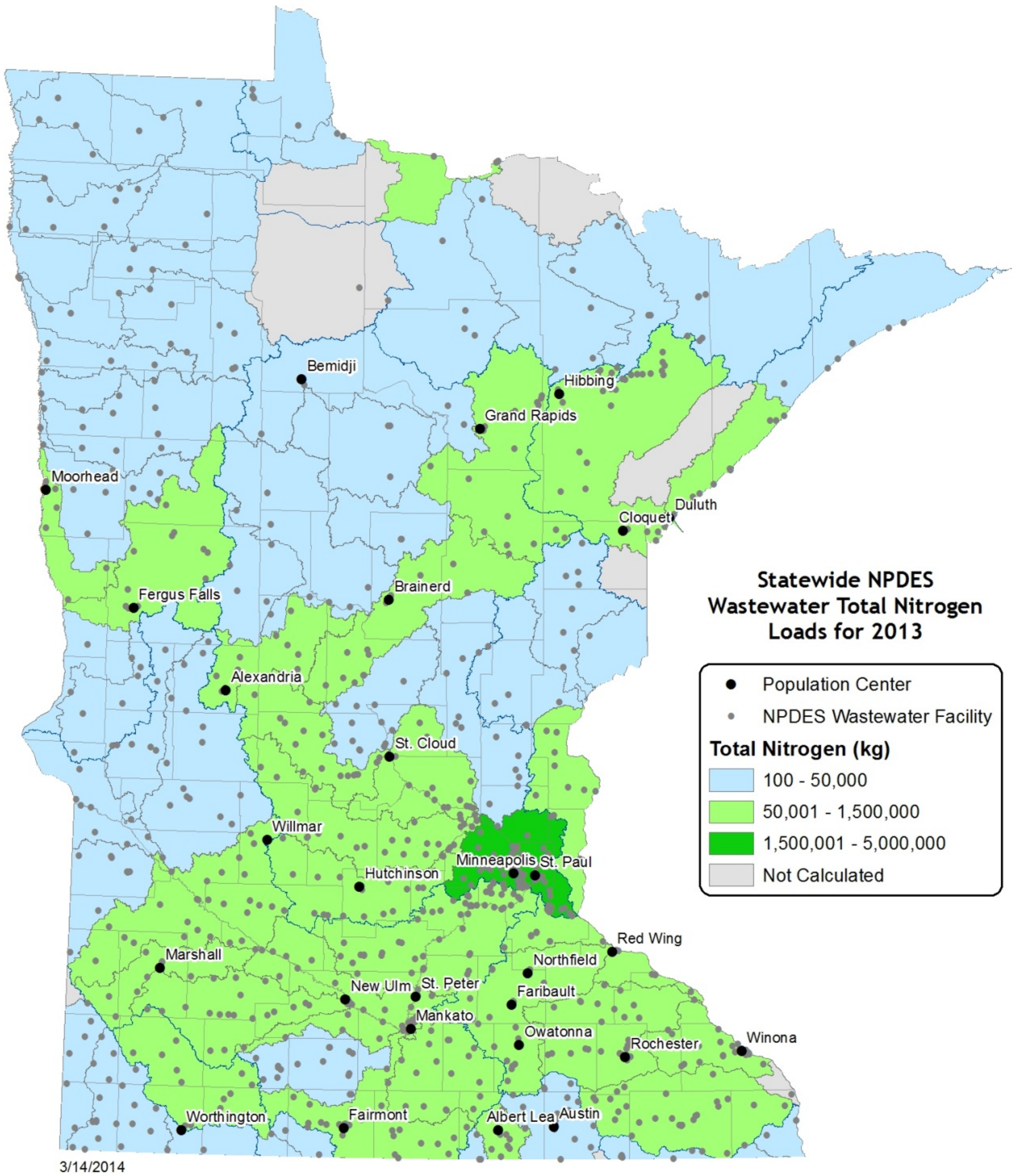
The 2013 wastewater load for total nitrogen was 13,193,000 kilograms, a 0.6 percent decrease from the 2011-12 average.

Total nitrogen wastewater data are not considered reliable, with only 51 percent of values resulting from observed data points. On average, 92 percent of wastewater total nitrogen loads are estimated to be discharged by major facilities. Municipal wastewater dischargers account for 87 percent of total nitrogen. Overall, wastewater total nitrogen loads are estimated to have remained fairly stable at an average annual loading of 13,324,000 kilograms per year.

Total nitrogen concentrations are not currently collected on a widespread basis and the majority of observed loads come from very large municipal facilities. Almost all existing total nitrogen wastewater data are from Metropolitan Council Environmental Service facilities. Increased monitoring by smaller facilities will reduce the amount of estimation in load calculations and provide a more accurate calculation of nitrogen loads in the future.



Total Nitrogen Load Estimates by Watershed for 2013



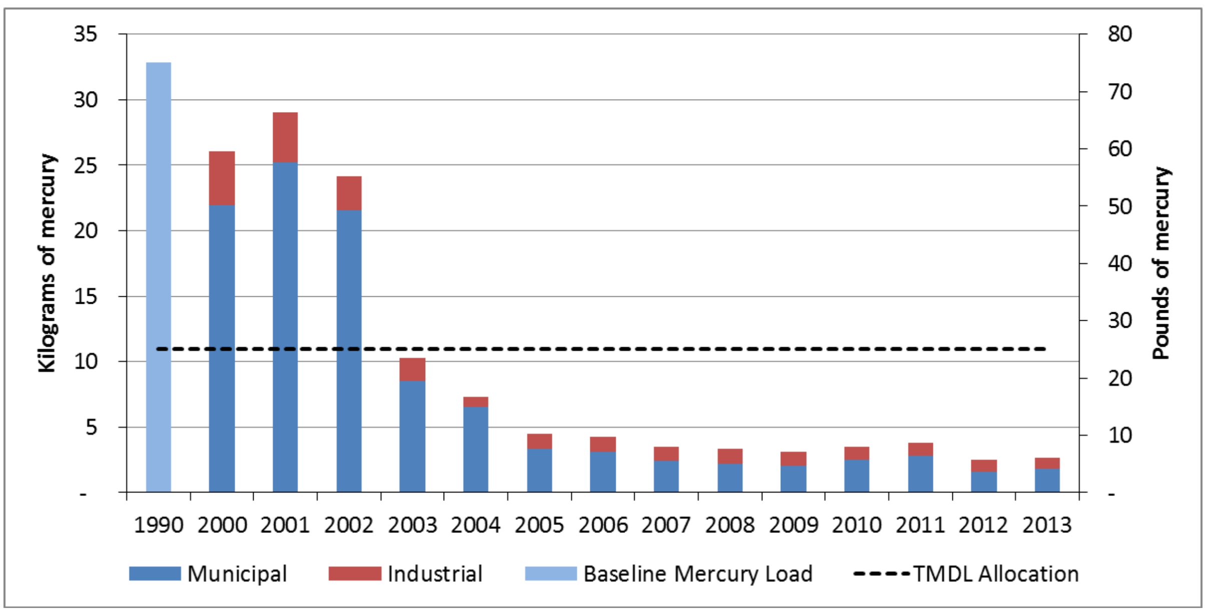
Total Mercury

The wastewater mercury load fell below the Statewide Mercury TMDL wasteload allocation in 2003 and has continued to decrease slightly since that time. The wastewater mercury load for 2013 was 2.6 kilograms, a 16 percent decrease from the 2011-12 average of 3.1 kilograms. Mercury reduction in wastewater is a result of successful source reduction programs and installation of treatment technologies for mercury removal, when appropriate. On average the data show an annual 90 percent reduction in mercury loads from a 28 kilogram per year baseline in 2000/2001.

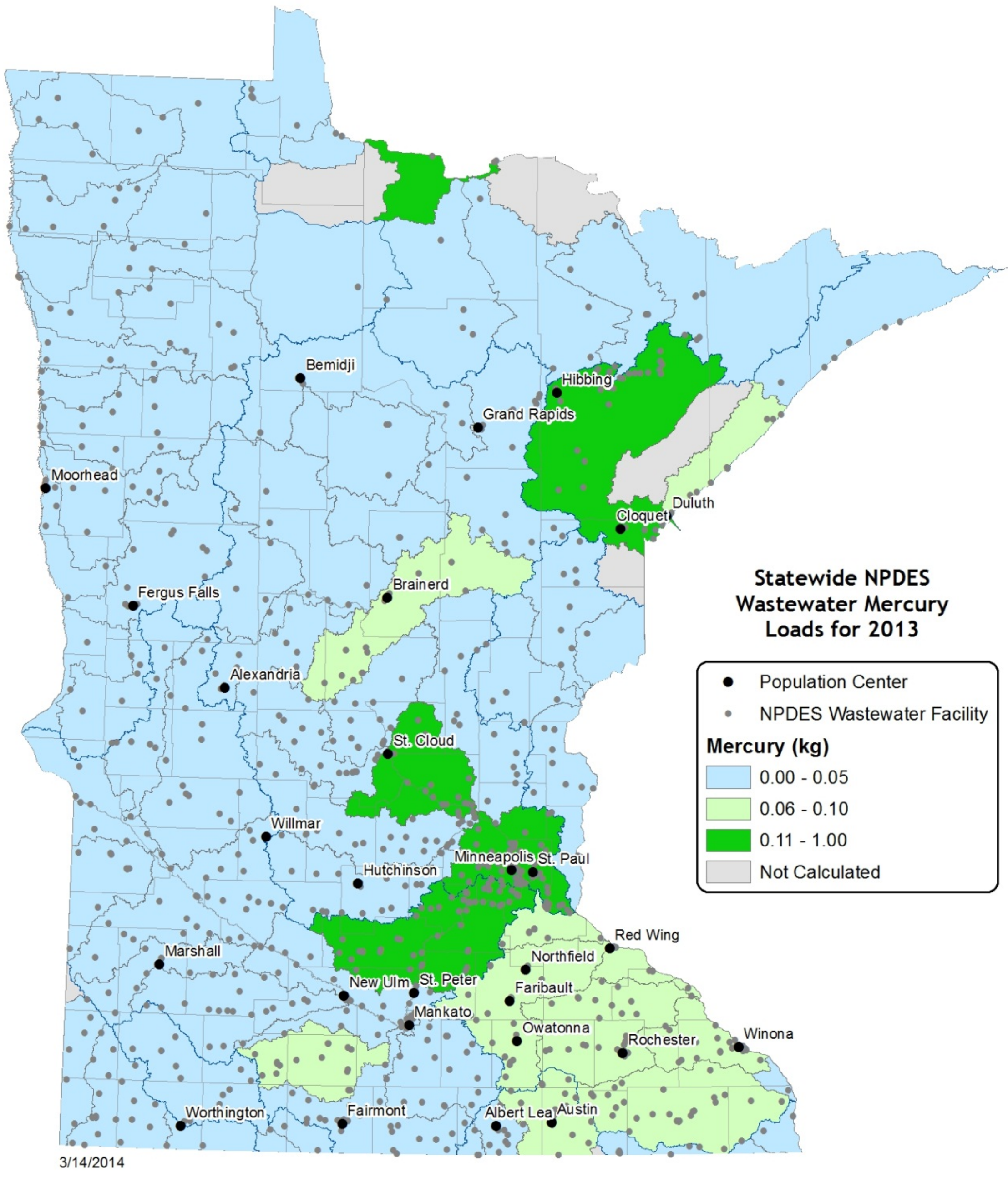
Total mercury wastewater data are considered moderately reliable with 82 percent of values resulting from observed data points. However, early mercury load estimates are considered unreliable due to the use of analytical methods with limited detection capabilities. Analytical laboratories started to provide more precise mercury detection methods in the early 2000s. Low level mercury data reported since 2005 is considered to be more reliable.

On average, major dischargers have accounted for 87 percent of total mercury loads in wastewater since 2005. Municipal wastewater dischargers are estimated to account for 73 percent since 2005. Overall, wastewater total mercury loads are estimated to have declined from an average of 4.4 kilograms per year in 2005 to 2.59 kilograms per year in 2013.

Annual Loads for Mercury from Wastewater Treatment Facilities, 2001- 2013



Wastewater Treatment Facility Total Mercury Load Estimates by Watershed for 2013



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 every day 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.

Focus on Sources of Nutrient Pollution

Multiple agencies and stakeholders in Minnesota are working together to address excessive levels of nutrients—primarily phosphorus and nitrogen—in Minnesota waters. Reductions in levels of nutrients are designed to protect both Minnesota and downstream waters, including both Lake Winnipeg and the Gulf of Mexico.

The MPCA, working in collaboration with the University of Minnesota and U.S. Geological Survey, completed a study in 2013 to characterize total nitrogen loading to Minnesota's surface waters. The Minnesota Legislature provided funding for the study, which used more than 50,000 water samples collected at 700 streams sites, 35 years worth of monitoring data, and findings from 300 published studies. The resulting report, titled *Nitrogen in Minnesota Surface Waters – conditions, trends, sources and reductions*, provides a scientific foundation of information for developing and evaluating nitrogen reduction strategies.

The MPCA study showed elevated nitrate levels, particularly in the southern third of Minnesota. Elevated nitrate levels can be harmful to fish and aquatic life. Because much of the nitrate moves into rivers and streams from groundwater, it may also pollute drinking water wells. Also, nitrate loads leaving Minnesota via the Mississippi River contribute to the oxygen-depleted "dead zone" in the Gulf of Mexico. The dead zone cannot support aquatic life, affecting commercial and recreational fishing and the overall health of the Gulf.

Study results showed that more than 70 percent of the nitrate is coming from cropland with the rest coming from sources such as wastewater treatment plants, septic and urban runoff, forests and the atmosphere. Nitrate concentrations have steadily increased in the Mississippi since the mid-1970s.

Phosphorus is the primary pollutant associated with algae growth in Minnesota's lakes and streams. Excess phosphorus from human activities increase algae blooms and reduce water transparency, making waters unsuitable for swimming and changing the types of fish and other aquatic life.

In 2003 concerns about the phosphorus content of automatic dishwashing detergents prompted the passage of legislation requiring a comprehensive study of all of the sources and amounts of phosphorus entering publicly owned treatment works and, ultimately, Minnesota surface waters. The assessment conducted for the MPCA by Barr Engineering, with assistance from the University of Minnesota and others, estimated how much phosphorus enters Minnesota's lakes, wetlands, rivers and streams, and where it comes from in each of the state's 10 major watersheds (basins). The 2004 report can be found at:
http://www.pca.state.mn.us/index.php/water/water-monitoring-and-reporting/water-qualityand-pollutants/phosphorus/detailed-assessments-of-phosphorus-sources-to-minnesota-watersheds.html
This detailed source assessment has been updated twice since 2004.

Using results from the statewide nitrogen study, the phosphorus study and water conditions in the state, 10 Minnesota agencies and local partners have developed a draft Nutrient Reduction Strategy to help guide state programs in achieving additional reductions in nutrients within Minnesota's waters. The Strategy establishes nutrient reduction goals for both point and nonpoint sources of pollution. The strategy describes the changes needed to meet milestones and final goals for both nitrogen and phosphorus going into the Mississippi River, Red River and Lake Superior. Year 2025 nitrogen reduction milestones are 20 percent for the Mississippi River and 13 percent for the Red River. Preliminary analysis of data show that Minnesota is positioned to reduce its fair share of the phosphorus heading toward the Gulf of Mexico by 2025, but it will take longer to reach in-state goals for Minnesota's lakes and rivers.

More information on the statewide study of nitrogen in surface waters can be found at the following link: http://www.pca.state.mn.us/d9r86k9. Please see www.pca.state.mn.us/nutrientreduction for additional information on phosphorus and Minnesota's draft Nutrient Reduction Strategy.

Minnesota Watershed Pollutant Load Monitoring Network

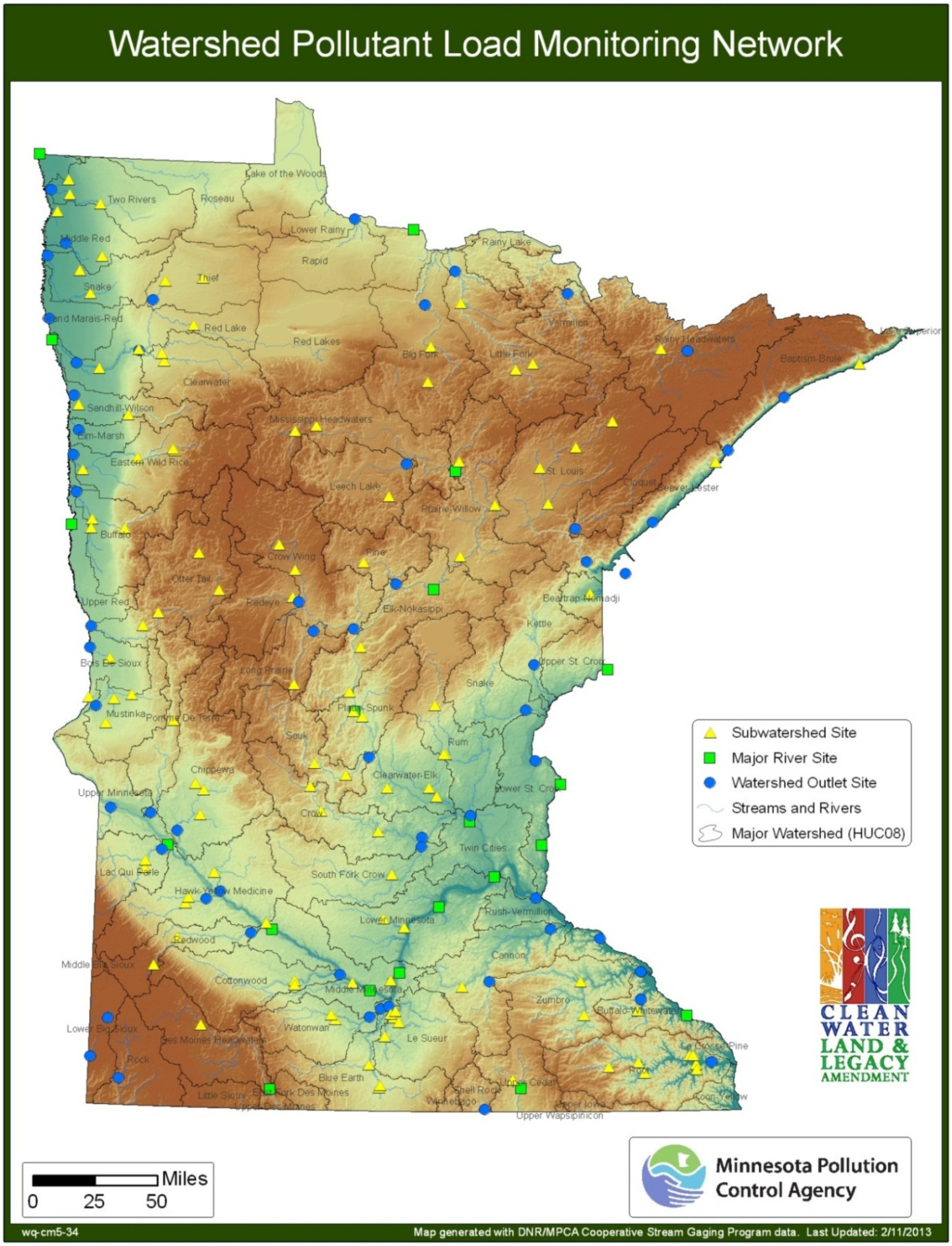
The passage of the Clean Water Land and Legacy Amendment and subsequent appropriations by the Legislature from the Clean Water Fund is enhancing monitoring of Minnesota waters, and our understanding of the relative contributions of pollutants from various sources and waters. One example of this is the MPCA's Watershed Pollutant Load Monitoring Network (WPLMN), which was designed to measure and compare pollutant load information from Minnesota's rivers and streams and track water quality trends. This long-term program utilizes state and federal agencies, universities, and local partners to collect water quality and flow data to calculate pollutant loads. Monitoring sites span three ranges of scale:

Basin – major river main stem sites along the Mississippi, Minnesota, Rainy, Red, and St Croix rivers

Major Watershed – tributaries draining to major rivers with an average drainage area of 1,350 square miles (8 digit HUC scales)

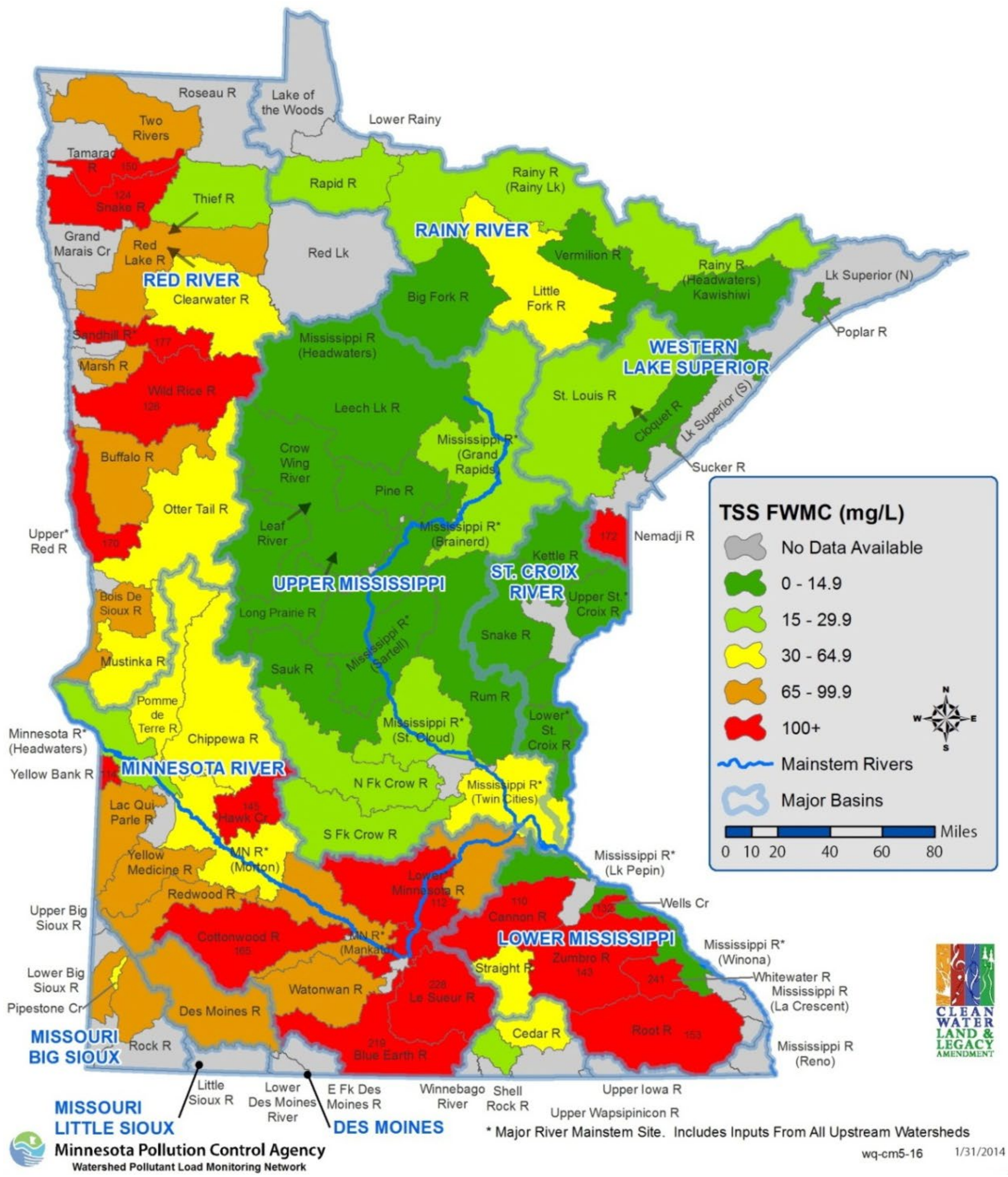
Subwatershed – major branches or nodes within major watersheds with average drainage areas of approximately 300-500 mi^2

Establishment of basin and major watershed sites within the network began in 2007 with all sites in operation by 2010**.** Determination and establishment of subwatershed sites began in 2011; all sites are scheduled to be in operation by 2015. There are currently 20 major river main stem sites, 59 major watershed sites, and 126 proposed subwatershed sites within the network (see figure on next page).



Site-specific stream flow data are computed at all sites by the Minnesota Department of Natural Resources or the United States Geological Survey. Water quality data are collected by the MPCA, local units of government, state colleges and universities, nonprofit organizations, or Metropolitan Council Environmental Services. Intensive water quality sampling occurs at all WPLMN sites. Approximately 35 water quality samples are collected annually at basin and major watershed sites and 25 samples collected seasonally at subwatershed sites. Water quality samples are analyzed for common nutrients and sediment and coupled with site-related discharge data to compute annual or seasonal pollutant loads. The figure below is an example of the type of information that is now available. In addition to providing statewide river water quality and trend information, data are also used to develop watershed protection and restorations plans, total maximum daily load reports, and assist with modeling efforts.

Watershed Pollutant Load Monitoring Network
Total Suspended Solids Flow Weighted Mean Concentration (FWMC)
By Monitoring Site Watershed Average: 2007-2011



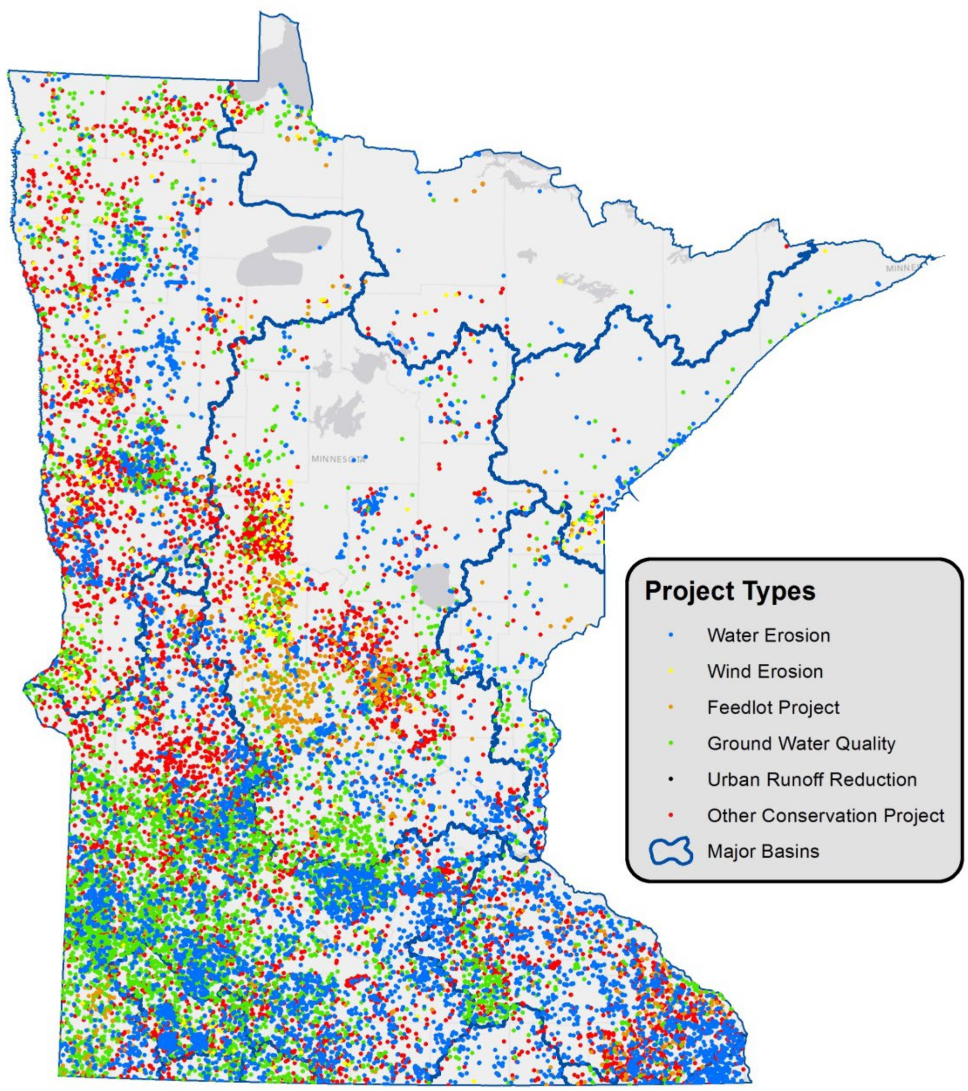
For more information about the MPCA's Watershed Pollutant Load Monitoring Network, see http://www.pca.state.mn.us/pyrieeb

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.

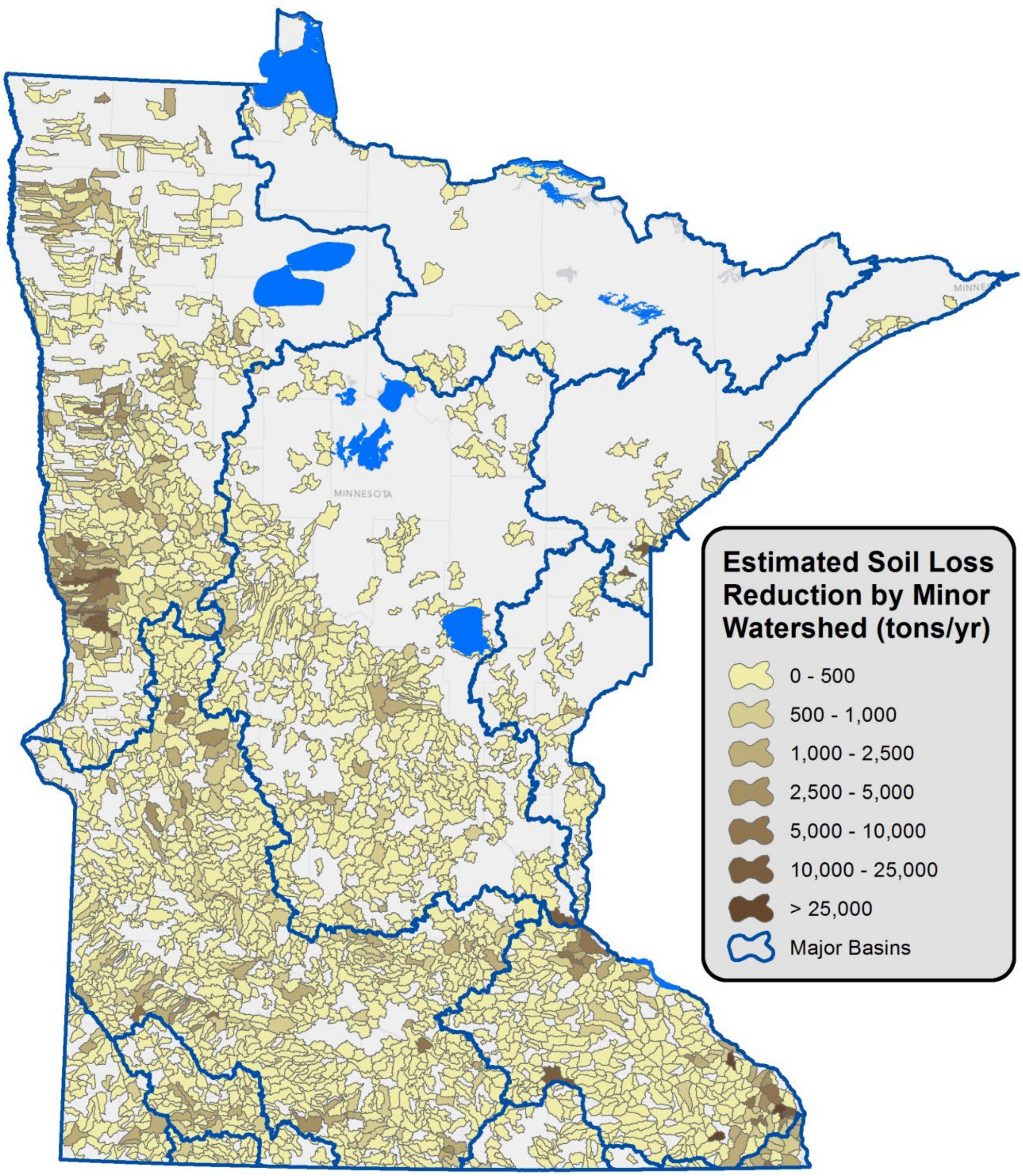
BWSR tracks soil loss and BMPs to reduce pollution from soil loss and sedimentation using the eLINK database (http://www.bwsr.state.mn.us/outreach/eLINK/). The figure below shows the locations of projects tracked by eLINK as reported by county soil conservation offices and local officials for the 10-year period 2003-2013. 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 (2003-2013)



From 2003-2013, soil loss reduction statewide attributed to pollutant reduction measures was estimated to be a total of 991,768 tons/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. The map below shows soil loss reduction benefits from conservation and management practices by watershed during the period 2003-2013.

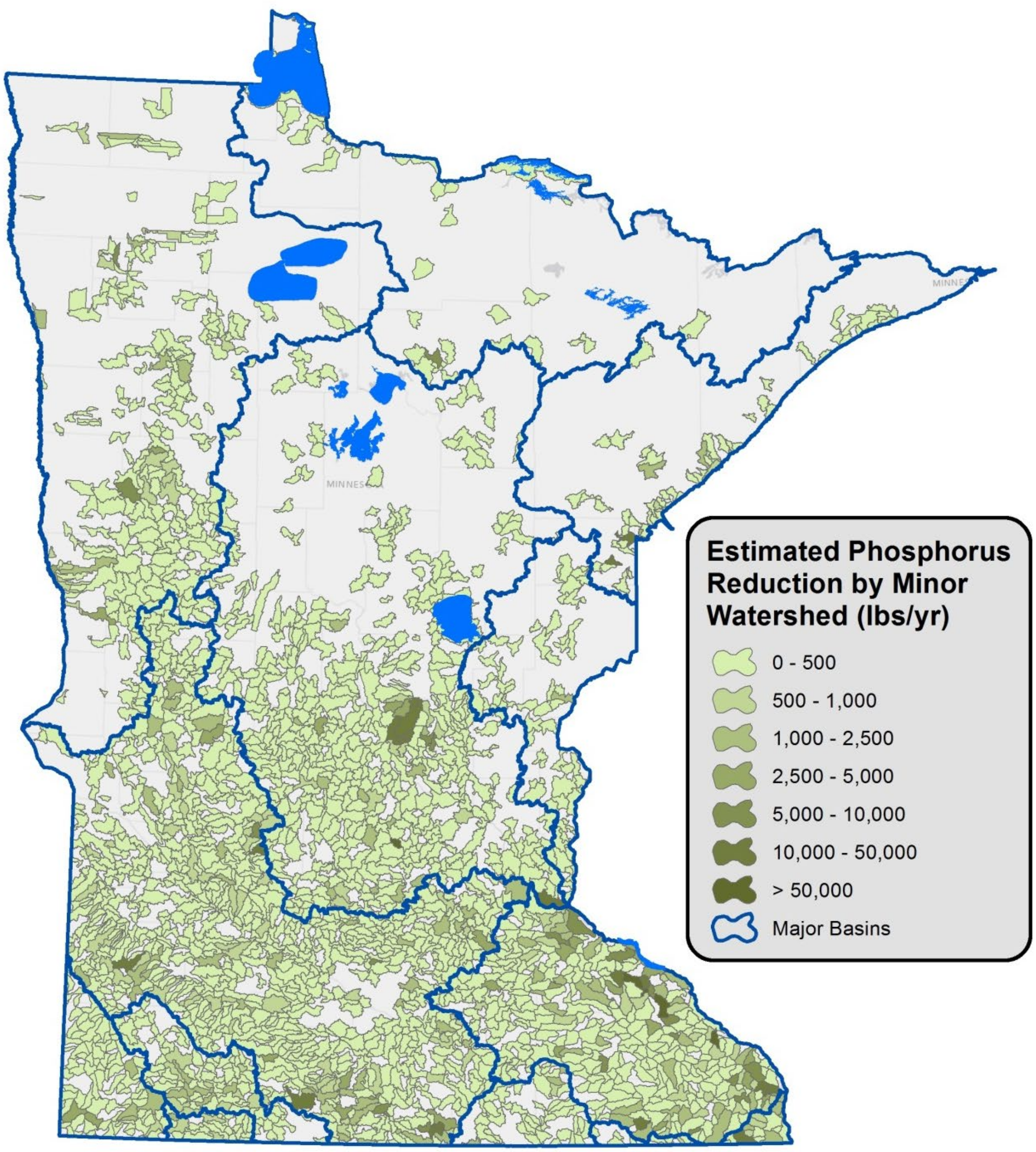
Soil Loss Reduction Benefits from Conservation and Management Practices Reported by eLINK (2003-2013)



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 2003-2013, phosphorus reductions statewide were estimated at 1,866,020 lbs/year. The map below shows phosphorus reduction benefits from conservation and management practices during the period 2003-2013.

Phosphorus Reduction Benefits from Conservation and Management Practices Reported by eLINK (2003-2013)



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.

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. Often called contaminants of emerging concern, or CECs, these chemicals are typically found downstream of sources such as wastewater treatment plants. However, they are also present in more remote surface water where sources of these chemicals are not clear. Two large monitoring campaigns in conjunction with EPA's National Aquatic Resource Survey—one of 150 river and stream locations and one that included a random selection of 50 lakes—revealed that these chemicals are widespread at low concentrations in Minnesota's ambient surface water. The results of many of these studies can be found in reports located at http://www.pca.state.mn.us/index.php/water/water-monitoring-and-reporting/water-quality-and-pollutants/endocrine-disrupting-compounds.html

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 U.S. Geological Survey (USGS), St. Cloud State University (SCSU), the University of Minnesota, the University of St. Thomas, and the MPCA conducted a series of investigations into the significance, sources, and occurrence of EACs in Minnesota's waste streams and waters. EACs mimic hormones causing adverse behavioral and physiologic effects, including impairment of the reproductive system or the disruption of growth and development of an organism. Many of the pharmaceuticals, personal care products, and other wastewater-associated chemicals included in MPCA's monitoring studies are considered EACs.

Three studies have focused on the presence and effect of EACs in Minnesota waters. The 2008 statewide study of selected streams and lakes showed that, in addition to wastewater treatment plant effluent, EACs are present in Minnesota lakes not influenced by wastewater treatment plants. (www.pca.state.mn.us/index.php/water/water-monitoring-and-reporting/water-quality-and-pollutants/endocrine-disrupting-compounds.html.). A subsequent, intensive study of 25 wastewater treatment plants greatly refined our understanding of the chemicals that are introduced into surface water via treated wastewater, and also revealed that surface water upstream of these facilities contained pharmaceuticals and personal care products (PPCPs) and EACs that were detected downstream of the plants and at similar concentrations (http://www.pca.state.mn.us/index.php/view-document.html?gid=15610). Analysis of fish from both of these studies showed evidence of exposure to estrogenic compounds (i.e. EACs), in many instances at lake or river locations unaffected by obvious sources of wastewater. Finally, an intensive study of one lake revealed that the effects of EACs on fish appear to vary among lake microhabitats that are influenced by various land uses.

Much remains to be learned about how these chemicals affect the hormone systems of aquatic life and humans at the low concentrations being detected. Animals and plants living in water can be more sensitive to exposure than humans. CEC concentrations found in these studies so far have not exceeded the human-health benchmarks for drinking water established by the Minnesota Department of Health (MDH) for about 20 CECs.

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. Locations that were sampled for the 2008 Statewide Study were again sampled in 2013, this time with an expanded list of PPCPs. In 2014, the MPCA will sample surface water at 50 randomly selected river locations in conjunction with the national survey.

Beginning in late 2009, the MPCA began collecting groundwater samples from its Ambient Groundwater Monitoring Network for analysis of over 100 CECs, 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 2009-2010 survey are available here: http://www.pca.state.mn.us/index.php/viewdocument.html?gid=17244 The MPCA is continuing to sample 40 wells annually for EACs and other CECs in partnership with the USGS, with a summary report of results from 2009-2012 expected in Spring 2014.

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 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, 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 was complete at the 3M disposal sites and the former Washington County Landfill. Additional long-term work remains to contain, pump and treat PFC-contaminated ground water, and monitoring remedy 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, most 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 impaired due to PFOS. Follow-up testing of fish and water has shown an overall decline in Pool 2 PFOS concentrations in fish, with elevated levels remaining in the lowest reach of the pool.

See 2012 report on fish, water, sediment, and invertebrate sampling at http://www.pca.state.mn.us/index.php/view-document.html?gid=19516

MPCA will continue to evaluate conditions in PFOS-affected waters to determine if further remedial, regulatory or prevention activity is needed to assure that these waters fully support their beneficial uses.

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 PFC exposure, and track advances in PFC toxicology and environmental fate.

Related Activities and Developments

Applied research

For the 2014-2015 biennium, the MPCA obtained funding from the Legislature to pursue additional projects focused on better understanding and addressing emerging issues relating to CECs in Minnesota's environment. Three projects utilizing this funding are currently underway:

- MPCA is monitoring groundwater in select areas with highly vulnerable aquifers to evaluate if CECs are being released into the environment via rapid infiltration basins, large drainfields, or via land-applied septage, and thereby contaminating groundwater resources. The goal of this project is to evaluate the best management practices of MPCA programs relative to how they may impact groundwater. The MPCA is collaborating with the USGS to conduct this project. This research will inform future prevention or mitigation efforts.

- MPCA is developing aquatic life screening values for specific CECs based on available information about their effects of on aquatic life. This effort will complement and benefit from the work underway in MDH's drinking water CEC program (focused on human exposure to CECs via drinking water) to evaluate the effects of CECs on aquatic life communities. The screening values will help assess whether the levels of CECs being detected in Minnesota waters are hazardous to aquatic life and also will be used to prioritize CECs for further monitoring and subsequent development of site-specific criteria or water quality standards. With this funding, the MPCA will develop a protocol and screening values for at least two CECs in FY 2014, and at least 8 more in 2015.

- MPCA recently issued a request for proposals for the development of wastewater treatment system designs and practices relating to CECs and other pollutants that are designed to explore minimization and treatment strategies through the use of pilot projects. Projects were requested that provide treatment strategies for implementing existing water quality standards in wastewater NPDES permits and reducing target contaminants in wastewater effluent including pollution prevention, source minimization, or pretreatment. Proposals must focus on achieving levels of reduction that are beyond those currently known to be achievable, and should target one or more of the following pollutants: chloride; phosphorus; nitrogen; sulfate; endocrine active compounds; parameters associated with pharmaceuticals or personal care products, and other unregulated CECs. Proposals were due to the MPCA in late February, 2014.

The work done by the MDH in developing human health-based guidance through its Drinking Water CEC program also provides important information that is used by MPCA in developing priorities. Using the results from its monitoring activities, the MPCA nominates five to ten chemicals of emerging concern to MDH's program each year for development of human health-based guidance. This collaboration is helping each agency focus its resources in a coordinated and efficient manner on chemicals that appear to pose the most risk to human health and the environment.

Outreach and assistance

The MPCA's Household Hazardous Waste Collection program helps county governments get the word out about proper disposal of un-needed or out-of-date pharmaceuticals. The MPCA website hosts the materials needed to launch a public campaign for pharmaceuticals collection that counties can reference when they get inquiries about this issue, or use to publish their own county specific materials. Pharmaceutical collection is based at law enforcement facilities in compliance with current DEA regulations. The communication materials ensure that a common message is delivered by local units of government, and eliminates the need for individual counties or governments to develop the materials for themselves. The Medication Disposal Toolkit is available here: http://www.pca.state.mn.us/sbiz10e6.

The MPCA is also partnering with the Western Lake Superior Sanitary District on an advertising project aimed at reducing the release of toxics, including pharmaceuticals, into the Lake Superior Basin, that is funded by a grant from the MDH drinking water CEC program.

MPCA's website also includes information for households to help locate the nearest collection site so they can properly handle their leftover pharmaceuticals, and links to reports describing the presence of pharmaceuticals in Minnesota waters.

Reducing toxic chemicals in products

Toxic chemicals present in a variety of consumer products often wind up in people or the environment as a result of product use or disposal in wastewater and solid waste systems. Preventing that exposure and release was the goal of the federal Toxic Substances Control Act (TSCA), passed in 1976, but the law is widely viewed as outdated and inadequate by all stakeholders.

TSCA applies primarily to "new chemicals" introduced after the law's enactment in 1976. There are some 62,000 chemicals in the TSCA inventory and an estimated 7,000 in active commercial use that were "grandfathered" from pre-market review and for which little to no information exists regarding their toxicity or whether they have adverse health or environmental effects. While TSCA does provide the United States Environmental Protection Agency (U.S. EPA) with some authority to regulate "existing chemicals," the legal standards U.S. EPA is required to meet in order to regulate such chemicals are so high that they have discouraged U.S. EPA from doing so.

Congressional proposals to reform TSCA were introduced in 2010 but failed to pass. A new bi-partisan proposal, the Chemical Safety Improvement Act, was introduced in May 2013; however, strong differences among stakeholders on key provisions in the revised proposal remain.

In the absence of a strong federal statute, Minnesota and other states have taken steps to enact chemicals policy to protect their citizens. Minnesota's Legislature passed the Toxic Free Kids Act language (TFKA) in the 2009-10 biennial budget (Minn. Stat. 116.9403), directing the MPCA and 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. The MPCA and MDH recommendations were published in a December 2010 report: "*Options to Reduce and Phase-out Priority Chemicals in Children's Products and Promote Green Chemistry*[2]" The law also called for establishment of Minnesota's lists of Priority Chemicals[3] and Chemicals of High Concern[4] however; there are currently no manufacturer

[2] http://www.pca.state.mn.us/index.php/view-document.html?gid=15319
[3] http://www.health.state.mn.us/divs/eh/hazardous/topics/toxfreekids/priority.html
[4] http://www.health.state.mn.us/divs/eh/hazardous/topics/toxfreekids/highconcern.html

requirements related to the chemicals that appear on these lists. The MPCA helps MDH maintain and update these lists, and is in regular dialogue with stakeholders and legislators interesting in advancing Minnesota's approaches.

Green Chemistry and Pollution Prevention

Preventing exposure to contaminants released in the product life cycle (manufacturing, usage, and recycling or disposal) often comes back to the question of up-front design. Minnesota's Pollution Prevention program has been promoting green chemistry and engineering since 2009. See this link for a fuller description of green chemistry): http://www.acs.org/content/acs/en/greenchemistry/what-is-green-chemistry/principles.html

Some examples include curriculum development grants awarded to several Minnesota post-secondary institutions and through exploration of products involving chemicals that have been named as Priority Chemicals or Chemicals of High Concern. The MPCA's 2012-2013 pollution prevention grant from U.S. EPA Region 5 funded three major projects on toxics in products:

- reducing the use of thermal receipt papers, many of which contain the Minnesota Priority Chemical Bisphenol A (BPA) or Bisphenol S (BPS), a common alternative now showing health effects similar to BPA.
- surveying use in Minnesota of formaldehyde and hexabromocyclododecane (HBCD) in building products, and
- surveying use of nonylphenol (NP) and nonylphenol ethoxylate (NPE) in industrial/institutional detergents.

(BPA, formaldehyde and HBCD are all listed as Priority Chemicals by MDH while NPE is listed as a Chemical of High Concern.)

More details on these and other pollution prevention efforts can be found in the MPCA's December 2013 Toxics and Pollution Prevention Evaluation Report. http://www.pca.state.mn.us/index.php/view-document.html?gid=20575

While reform of chemical regulation law remains elusive at the federal level, and Minnesota stakeholders also have some differing interests, more Minnesota businesses are seeing and acting on market opportunities to incorporate green chemistry principles in their operations and commerce. The MPCA will continue to partner with these businesses, and with state and federal agencies, lawmakers, academic researchers, NGOs and other stakeholders to identify and address emerging issues of concern to Minnesota.

Find more on MPCA's program at http://www.pca.state.mn.us/aj0r71a. In addition, a network of Minnesota stakeholders from these various sectors has been active since 2010, producing annual green chemistry conferences and other networking and awareness-building events: http://www.greenchemistrymn.org/node/2