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August 2016

GREAT LAKES REGIONAL POLLUTION PREVENTION ROUNDTABLE
GLRPPR

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This project was funded under U.S. EPA's Pollution Prevention Information Network grant program (agreement number NP-00E01338).

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Acronyms

CO2e – Carbon dioxide equivalent value
CBSM – Community-based social marketing
FTE – Full-time equivalent
GHG – Greenhouse Gas
GLRPPR – Great Lakes Regional Pollution Prevention Roundtable
GWP – Global warming potential
IL – Illinois
IN –Indiana
IPCC – Intergovernmental Panel on Climate Change
lbs – pounds
MDI - Methylene diphenyl di-isocyanate
MI - Michigan
MN – Minnesota
NA – Not applicable
NAICS – North American Industry Classification System
OH – Ohio
P2 - Pollution Prevention
POTW – Publicly-owned treatment works
TAPs – Technical Assistance Programs
TRI – Toxics Release Inventory
UIC – Underground Injection Control wells
U. S. EPA - United States Environmental Protection Agency
UV – Ultraviolet
VOCs – Volatile organic compounds
WI – Wisconsin

Introduction

Using publicly available environmental data to identify targets for pollution prevention technical assistance can be a powerful tool to help technical assistance programs (TAPs) decide where to focus their efforts. Several U.S. EPA Region 5 states are already using TRI data to target their P2 programs. Analysis of these data sets can also highlight areas where further identification of pollution prevention practices is needed.

In this report, the Great Lakes Regional Pollution Prevention Roundtable (GLRPPR) has used publicly available environmental data to establish a regional baseline for industrial chemical use and emissions; pollution prevention (P2) techniques; greenhouse gas (GHG) emissions; and economic impact data for selected industry sectors in U.S. EPA Region 5. GLRPPR staff searched, compiled, and analyzed selected data sets from USEPA's Toxics Release Inventory (TRI), the GHG emissions database on Envirofacts, and the Census Bureau's County Business Patterns database on American FactFinder.

TRI and County Business Patterns data for the years 2009-2013 were analyzed and compared for the six Great Lakes states in Region 5 (IL, IN, MI, MN, OH, and WI). GHG data were only available for 2010-2013. Three-digit NAICS codes encompassing the manufacturing sector, ranging from 311-337, were used in this analysis. NAICS code 339 (Miscellaneous Manufacturing) was excluded from this study because this code does not provide usable information for P2 TAPs, unless searched at the individual facility or subsector level. See Appendix A for a list of three-digit NAICS codes and corresponding industries studied for this report. TRI, GHG, and County Business Patterns entries that were blank for the categories of state, NAICS code, or year, or whose entries were incomplete in other ways, were also generally excluded from consideration in this study. The project team also explored the use of Tableau and Excel for data analysis and visualization capabilities.

The database searches performed for this study were designed to provide a general picture of the nature of industrial chemical emissions and P2 practices in the manufacturing sector in the Region 5 states. Therefore, the project team focused on analysis at the state level. However, the TRI data can be searched at more detailed levels depending on the situation or the specific information desired. These include county, city, zip code, address, and individual facility, as well as the recent addition of parent company. For this report, additional searches at the facility level were performed in some cases, which allowed for the gathering of specific statistics.

Within the subset of NAICS codes ranging from 311 through 337, over 82,000 TRI chemical emission entries were identified for the six states and five years studied for this project. These entries comprised reporting data from more than 5,200 facilities. Many facilities had multiple TRI Identification Numbers and/or multiple entries representing different chemicals and different years. Therefore, when discussing numbers of facilities within this report, the project team used the “facility name” data field as the identifier, rather than the TRI Identification Number (Note: the “facility address” field can also be used as a differentiator, with slightly different results).

Results of completed searches were downloaded into Excel databases. Data were subsequently refined and analyzed (See Appendix D for a detailed search methodology). The Excel databases used to develop a regional baseline contained the following information for all relevant years and states:

Amount of overall industrial emissions per NAICS code (TRI).

This information provides an overall view of which industry sectors have been the heaviest polluters. It can also allow for comparisons between states and provide a glimpse of emissions trends over time.

Amounts of *specific* chemicals emitted and to which environmental medium (air, land, water, underground injection wells, off-site releases) (TRI).

More specific emissions data provide a guide for P2 TAPs to identify the chemicals with which specific industry sectors are struggling and target where they could most use assistance.

Practices used by each industry sector to manage their production-related waste (TRI).

Methods of waste management have very different levels of environmental desirability. Knowing how industry sectors are managing their waste can assist P2 TAPs in placing their focus on industries that may be releasing waste rather than using the preferable options of source reduction, recycling, energy recovery, and treatment.

P2 techniques used by each industry sector to reduce their most prevalent emissions (TRI).

Data on successful P2 techniques provide ideas for TAPs, as well as for industries themselves, about how companies can improve their equipment and processes to improve their environmental performance.

Greenhouse gases emitted by each industry sector (Envirofacts).

By using detailed GHG information to identify the highest emitting industrial sectors, P2 TAPs can focus efforts on assisting these types of facilities or highlight areas where additional research is needed.

Census Bureau’s County Business Patterns database (American FactFinder).

By looking at the number of manufacturing facilities in an industry sector, as well as its contribution to the annual payroll of a state, a general picture emerges regarding the magnitude of the economic impact of this industry within the region. This information is useful because P2 TAPs can identify manufacturing sectors that are most crucial to the economic welfare of their state. Pilot studies and efforts to implement P2 activities within these industry sectors may enjoy more overall technical and financial support by state and local organizations that want to improve the economy.

All of the above environmental and economic data were reviewed and compiled into a report detailing the findings, as well as illustrating ways that these data can be further analyzed by using Excel or Tableau to visualize the data. These tools are useful in determining and comparing data trends and patterns between states, years, industry sectors, and chemicals. A future goal of this project is to aggregate the data from the searches described above into a larger comprehensive database (See Appendix D).

Data Gaps and Limitations

Most of the data analyzed for this report originates from U.S. EPA's TRI program, which is limited in scope. The TRI is a national database of toxic emissions self-reported by industrial sources. Only facilities that meet certain threshold limits of listed chemicals are required to report to the TRI program. The TRI website (U.S. EPA, 2015a) clarifies that if a facility meets the following three criteria, it is subject to TRI reporting:

- Is in a specific industry sector (U.S. EPA, 2015d)
- Employs 10 or more FTE (full-time equivalent) employees
- Manufactures or processes more than 25,000 pounds of a TRI-listed chemical (U.S. EPA, 2015d) or otherwise uses more than 10,000 pounds of a listed chemical in a given year.

In 2013, the TRI national analysis report stated that 21,598 facilities in the United States reported data (U.S. EPA, 2015c). Approximately 4,500 of these facilities were located in U.S. EPA Region 5 and classified with NAICS code 311-337 (manufacturing). In contrast, 59,466 facilities in U.S. EPA Region 5 were classified in the 2013 County Business Patterns data set as belonging to the manufacturing sector (NAICS 311-337). Clearly, the TRI data represents only a subset of industry and there are many manufacturers that are not required to report emissions through the TRI program because they do not meet one or more of the three criteria listed above.

U.S. EPA cautions that, "Users of TRI data should be aware that TRI captures a significant portion of toxic chemicals in wastes that are managed by industrial facilities, but it does not cover all toxic chemicals or all industry sectors of the U.S. economy" (U.S. EPA, 2015c). Although this is a limitation, emissions trends identified through TRI data can be used as an indicator of which industrial sectors and chemicals are most prevalent. By using TRI data in combination with County Business Patterns, P2 TAPs can get a more complete picture of the number of companies in particular manufacturing sectors within their states.

According to EPA, only 16% of TRI-reporting facilities actually listed a P2 Source Reduction code in their submitted data (Teitelbaum, 2015b). Beginning with reporting year 2012, EPA included a section for facilities not reporting P2 data to identify barriers that they faced to implementing P2 projects. As more facilities report their P2 activities, TRI pollution prevention data will become more useful for identifying potential projects and barriers to implementation within specific industrial sectors.

In the sections of this report on chemical emissions and P2 practices, discussion is centered on the specific chemicals in each industry sector with the highest overall emissions numbers. These data may be skewed in certain cases because of one or two extremely large release events in one state or in one year.

For this report, the project team generally used three-digit NAICS codes for analysis, which makes chemical emissions data specific only to a general industry sector, rather than a particular subsector. However, in the P2 section, they adjusted this methodology to discuss specific types of facilities in order to provide more detailed information that may be of use to P2 TAPs. Certain industry sectors have limited TRI P2 reporting data available from a very small number of facilities. Five industry sectors had less than 20 facilities reporting. Therefore, the assumptions made regarding trends in these industry sectors are based on limited data and may not be representative of the industry as a whole. In addition, the information that could be downloaded in a P2 search was limited in scope and required some cleaning to make it more useful for data analysis and visualization. For example, the project team assigned three-digit NAICS codes to each entry based on industry descriptions included in U.S. EPA data because NAICS codes were not included in the results of a TRI P2 search. Therefore, NAICS code assignments used in this study have an element of subjectivity. See Appendix D for details on search methodology and data cleaning and analysis techniques.

GHG information was only available through Envirofacts from 2010 through 2013. The GHG Reporting Program website (U.S. EPA, 2015b) states that the U.S. EPA requires annual reporting of GHG data from large direct emissions sources (25,000 metric tons of carbon dioxide equivalents (CO_2e) or more per year) and suppliers of fossil fuels and industrial gases. Only GHG emitters were looked at for this study. Supplier data was not included. Not all of the industry sectors studied in this report (NAICS codes 311-337) were required to report GHG information to U.S. EPA. Consequently, there will be data gaps for certain industry sectors. For this reason, some industry sectors outside of the defined study parameters were discussed in order to give a more accurate overall portrait of the major sources of GHG emissions. Again, the project team assigned three-digit NAICS codes to GHG entries based on industry descriptions included in U.S.

EPA data because a GHG search does not include this information. Therefore, NAICS code assignments in this section have an element of subjectivity.

The County Business Patterns data does not include specific facility-level name and address information. Therefore, analyses based on these data are somewhat limited in scope.

Overview of Emissions by Industrial Sector

Analysis of TRI data from 2009 through 2013 identified which states face the biggest challenges in industrial emissions in Region 5. To compare emissions numbers, the TRI search term "total on and off-site releases or disposal" was generally used for this report. This includes all releases/disposal to air, water, land, or underground injection wells on site, as well as all off-site transfers for release or disposal. The terms "emissions" and "releases" are used interchangeably within this report. See Appendix D for detailed search methodology for all sections of this report. The states with the highest total emissions in pounds from 2009-2013 inclusive were Indiana, Ohio, Illinois, Michigan, Wisconsin, and Minnesota, in that order. **Figure 1** illustrates these results, along with the general trend of regional emissions during these years.

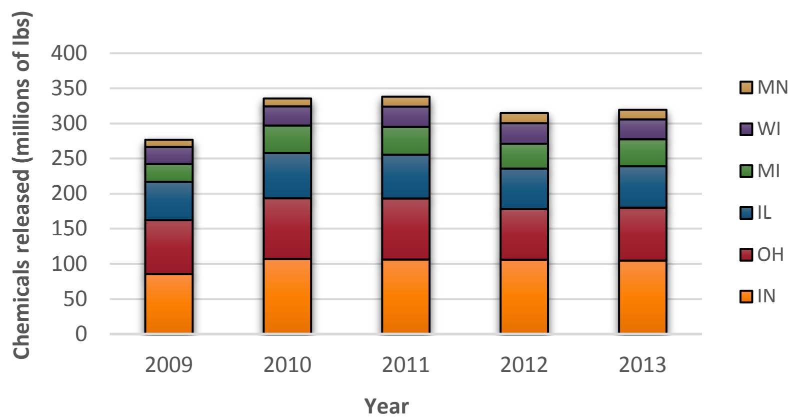


Figure 1: Industrial Emissions by State (2009-2013)

The number of facilities per state affects their relative emissions rates. **Table 1** lists the number of TRI chemical emission entries reported by the six Great Lakes States from 2009-2013 inclusive.

Table 1: State TRI Reporting Data		
State	**Number of TRI entries**	**Number of facilities**
Ohio	21,354	1,387
Illinois	16,106	1,083
Indiana	13,419	887
Michigan	12,447	789
Wisconsin	12,369	859
Minnesota	6,666	489

The three states with the lowest emissions rates (Minnesota, Wisconsin, and Michigan, as detailed in **Figure 1**) correlated with the actual TRI reporting statistics. The three states with the highest emissions (Indiana, Ohio, and Illinois) are in almost the same order as **Table 1**, with the exception of Indiana. Although Indiana companies reported to TRI fewer times from fewer facilities than those in

Ohio and Illinois, one can conclude that Indiana's reporting facilities were probably quite large and released greater amounts of chemicals, leading to its ranking as highest emitter.

The other trend shown in **Figure 1** is the total emissions from the manufacturing sector during the five years shown. Reported emissions were lowest in 2009. The years 2010 and 2011 showed an increase, with slight decreases following in 2012 and 2013. This reduction in emissions in 2012 and 2013 could be due a number of things, from changes in reporting statistics (i.e., the number of companies that met the reporting criteria) to actual improvement based on P2 practices implemented or technical assistance efforts.

The TRI database also allows users to explore emissions in specific industry sectors. For all chemicals, the top five emitting sectors in Region 5 (2009-2013) were, in order:

- NAICS code 331 – Primary metals
- NAICS code 325 – Chemicals
- NAICS code 311 – Food processing
- NAICS code 332 – Fabricated metals
- NAICS code 322 – Paper

When years were analyzed individually, the top five emitting sectors remained the same in all years.

Figure 2 illustrates the percentage of overall chemical emissions for various industry sectors in 2013 for Region 5 states. Only the sectors with emissions percentages above one percent are labeled. Refer to Appendix A for NAICS code definitions. Although the fabricated metals industry and the paper industry both claimed about five percent of total emissions, actual numbers placed the fabricated metals industry as the fourth highest emitter.

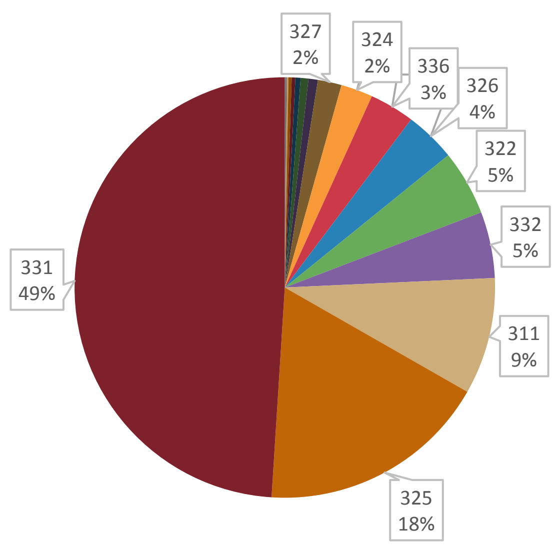


Figure 2: Percentage of Emissions by Industry Sector for all Region 5 States (2013)

In order to better understand the overall impact of specific industries, it is useful to compare emissions rankings to the total number of TRI reporting entries for each NAICS code. **Table 2** lists industry sectors in order of the numbers of TRI entries for each NAICS code. Three of the five industry sectors with the highest number of TRI entries matched three of the five industry sectors with the highest emissions numbers (chemicals, fabricated metals, and primary metals).

Although the transportation equipment and machinery manufacturing industries reported many TRI entries and took the other two top five spots in **Table 2**, one can conclude that the actual releases from these sectors were not as large as those from the food and paper industries, which have higher overall emissions numbers. **Table 2** also includes information on which state was the highest emitter for each industry sector studied for this project.

Table 2. Region 5 Industry Sector Statistics – 2009-2013					
NAICS Code	**Industry Sector**	**Number of TRI Entries**	**Number of Facilities**	**State with highest emissions**	**Years**
325	**Chemicals**	20,779	858	Ohio	All
332	**Fabricated metal products**	14,052	1,116	Ohio	All
331	**Primary metals**	11,530	592	Indiana	All
336	**Transportation equipment**	8,452	533	Michigan	All
333	**Machinery**	4,323	358	Ohio Illinois	2009-2011 2012-2013
311	**Food processing**	4,240	342	Illinois	All
324	**Petroleum and coal products**	3,779	102	Illinois	All
326	**Plastics and rubber products**	3,587	448	Illinois Indiana	2009-2012 2013
327	**Nonmetallic mineral products**	3,228	345	Ohio	All
322	**Paper**	2,444	127	Wisconsin	All
334	**Computer and electronic products**	1,846	251	Ohio Minnesota	2009-2012 2013
335	**Electrical equipment and appliances**	1,743	156	Ohio Illinois	2009, 2010, 2011, 2013 2012
337	**Furniture and related products**	745	65	Indiana	All
321	**Wood products**	725	69	Michigan	All
323	**Printing and related support activities**	517	58	Illinois Indiana	2009-2011 2012-2013
316	**Leather and allied products**	141	13	Minnesota	All
312	**Beverage and tobacco products**	105	10	Ohio	All
313	**Textile mills**	103	10	Ohio Wisconsin	2009, 2013 2010-2012
314	**Textile product mills**	15	2	Ohio	All
315	**Apparel**	7	2	Ohio No data	2009-2010 2011-2013

Another way to visualize the data is to look at emissions trends in a particular industry sector over all the years and in all states. For example, **Figure 3** shows emissions for the wood product manufacturing industry (NAICS code 321) from 2009-2013. In this sector, Michigan was the state with the highest emissions for all five years, with a total of over 1,830,000 pounds emitted (11 facilities reporting, 6 with emissions greater than zero). Therefore, Michigan TAPs would be important stakeholders if the wood products industry were a focus of regional emissions reduction efforts. In contrast, Illinois had only 28,241 pounds of chemical emissions in the wood industry (8 facilities reporting, 3 with emissions greater than 0).

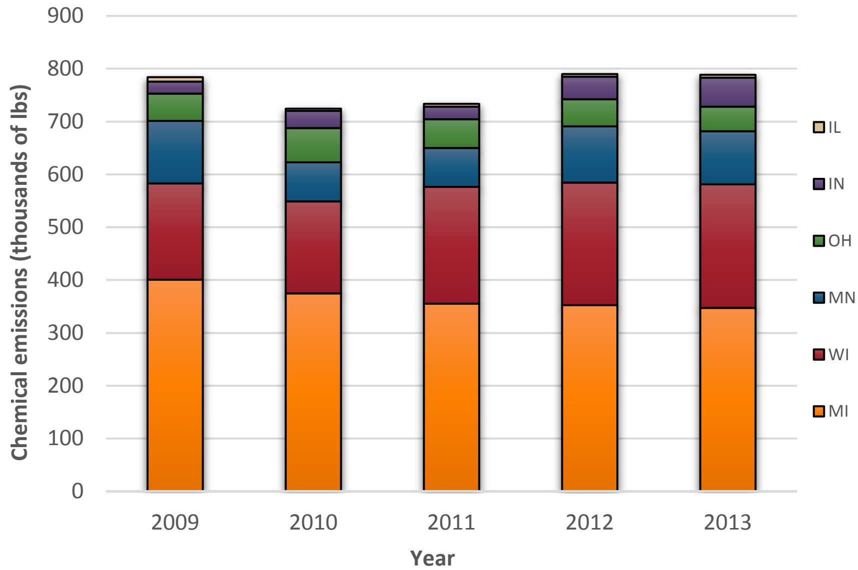


Figure 3: Wood Product Manufacturing Industry Emissions (2009-2013)

Although Michigan was the highest emitter in the wood products industry, this industry was not the top source of chemical emissions in the state. The two statistics do not necessarily correlate. Furthermore, the wood processing industry does not rank among the highest industrial emitters in the region.

The highest emitting industrial sectors for individual states are:

Illinois

- 2009 Food manufacturing and processing (NAICS 311)
- 2010 – 2013 Primary metals (NAICS 331)

Indiana

- 2009 – 2013 Primary metals (NAICS 331)

Michigan

- 2009 – 2013 Primary metals (NAICS 331)

Minnesota

- 2009 – 2013 Food manufacturing and processing (NAICS 311)

Ohio

- 2009 – 2013 Chemicals (NAICS 325)

Wisconsin

- 2009 – 2013 Paper manufacturing (NAICS 322)

Figure 4 shows the ten highest emitting industrial sectors (by state) in the region for 2013.

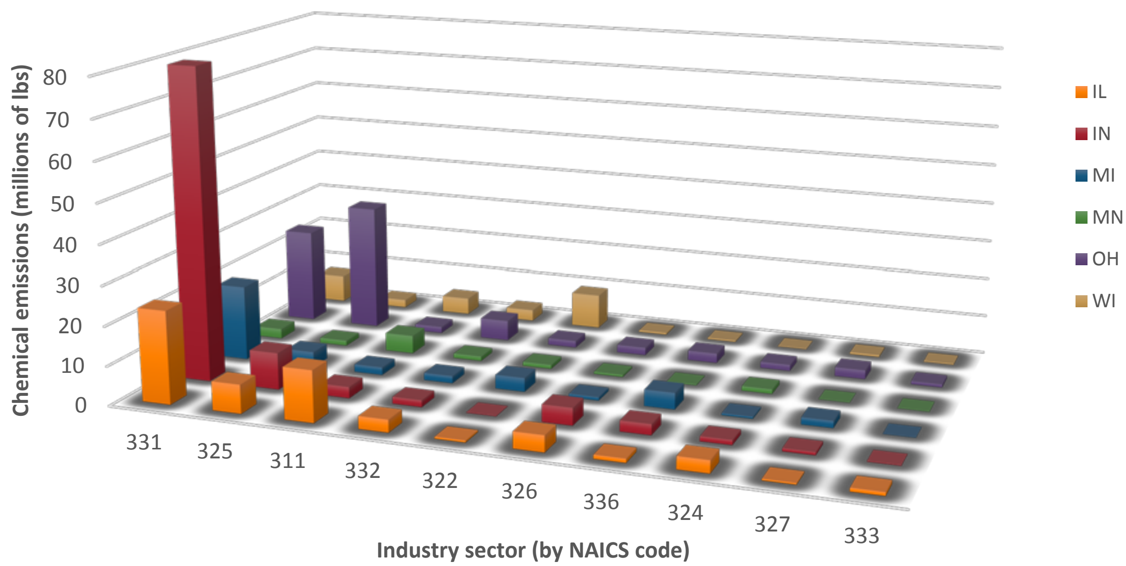


Figure 4: Chemical Emissions per State for the Top 10 Regional Industry Sectors (2013)

Overview of Emissions by Chemical

This section focuses on which specific chemicals were released in the highest amounts within each industrial sector and to which environmental medium (e.g., air, water, land, or off-site releases). P2 TAPs can use this information to ascertain which industrial sectors are primarily responsible for specific chemicals of concern and the destinations of these releases. Furthermore, they can identify which industry sectors might benefit from the use of P2 technologies and practices to reduce releases of specific chemicals.

These data can be filtered to create a variety of visualizations comparing a combination of industry sectors, states, years, and environmental media, depending on particular user interests. **Figures 5, 6, and 7** provide a series of examples. One method of analysis is to look at a specific chemical of interest to determine which industry sectors typically release this chemical. **Figure 5** shows the emission of nitrate compounds for selected industry sectors in Illinois in 2013.

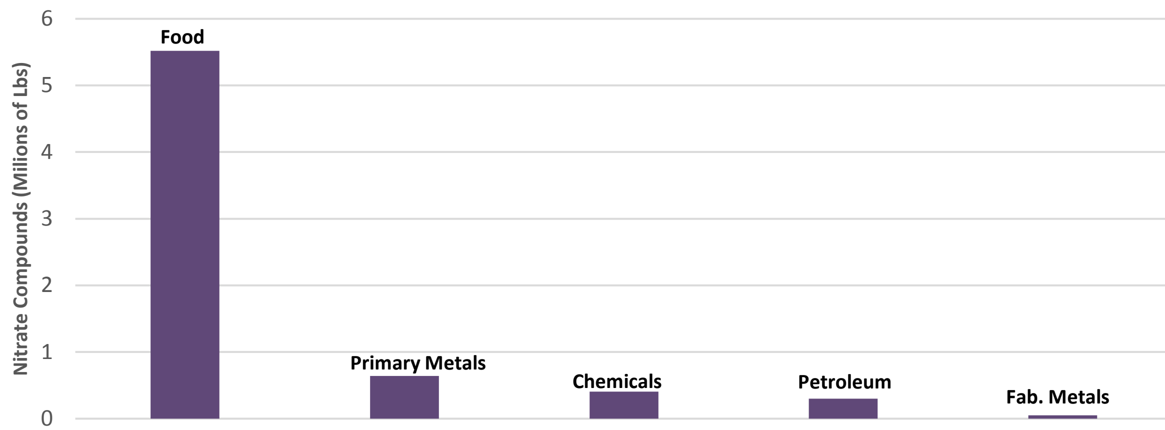


Figure 5: Top 5 Industry Sectors Emitting Nitrate Compounds in Illinois (2013)

Another way to look at the data is to investigate which chemicals are commonly released by facilities in that sector. **Figure 6** illustrates the chemicals emitted in significant amounts by the wood product manufacturing industry in Michigan (the highest emitter in this industry sector) in 2013.

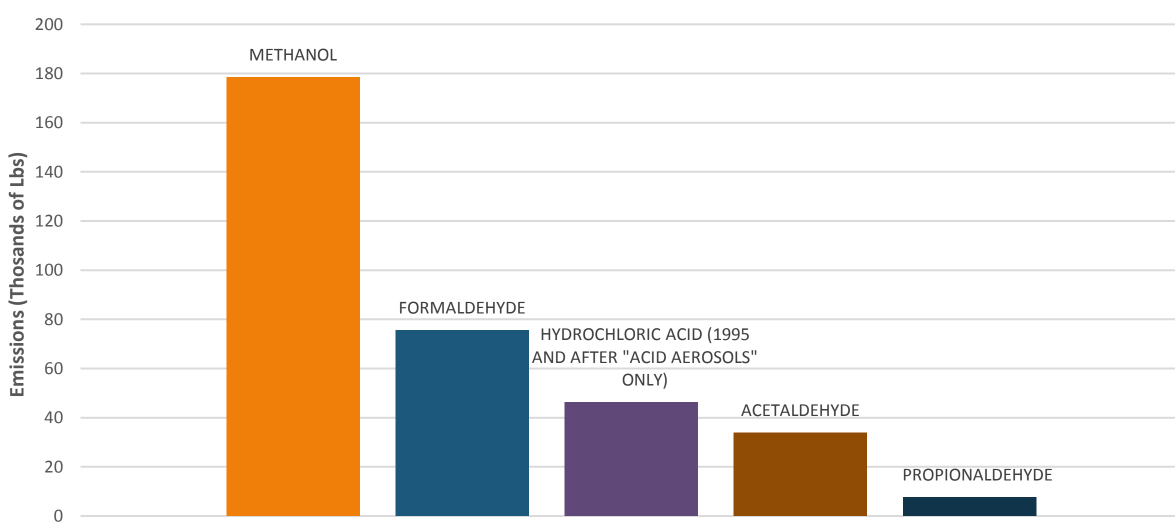


Figure 6: Chemical Emissions in the Michigan Wood Products Manufacturing Industry (2013)

It is also possible to view chemical releases by destination of the emissions. **Figure 7** shows the general emissions destinations of all chemicals emitted during 2013 for all combined manufacturing sectors. The highest overall emissions were off-site releases, with the second highest amount going to air. The off-site release category comprises a variety of sub-categories, which include transfers to publicly-owned treatment works, underground injection wells, landfills, or surface impoundments. Air releases consist of both "stack" releases (point sources) or "fugitive" releases (non-point sources).

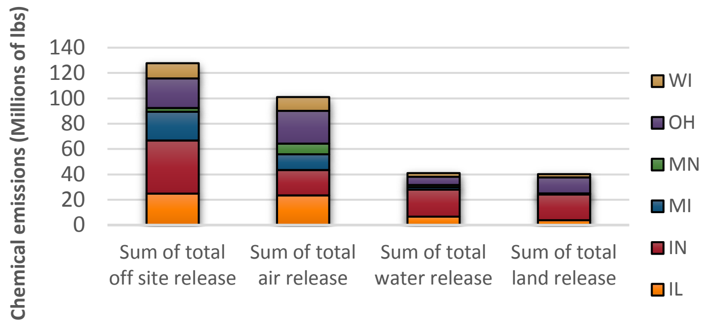


Figure 7: Emissions destinations in Region 5 States (2013)

Chemical Emissions by Industry Sector

The following section provides an in-depth look at the highest chemical emissions within each state for each industry sector. Differences between states and emission trends over time are highlighted. Each subsection also includes a sidebar with a brief summary of emissions in the industry sector from a comprehensive data perspective (Region 5, 2009-2013, all chemicals). Appendix B provides emission details for the top emitted chemicals for each state and year within the different industry sectors.

NAICS code 311 – Food Manufacturing and Processing

Illinois' most prevalent chemical emission in the food industry from 2009-2013 has been nitrate compounds to water. Overall emissions of nitrate compounds steadily decreased from 2009 (over eight million pounds) through 2012 (over four million pounds), but the number jumped back up to over five million pounds in 2013. The Wisconsin food industry's top emission was also nitrate compounds to water, land, and off-site releases at amounts roughly between three and a half to four and a half million pounds. Michigan was also in this group, with nitrate emissions to water hovering between one and two million pounds per year.

> The top chemicals emitted by the food industry were **nitrate compounds**, **N-hexane**, **ammonia**, and **hydrochloric acid**. **Illinois** was the largest emitter of nitrate compounds to water and **Minnesota** was the top emitter of N-hexane to air.

Minnesota's most prevalent chemical emission in the food industry from 2009-2013 was N-hexane to air, with emissions generally between one and a half and two and a half million pounds. Indiana was similar, with overall emissions of N-hexane to air remaining relatively stable from 2009-2013 at close to the two million pound mark. Ohio was also in this group, with N-hexane emissions hovering around one million pounds in all years.

NAICS code 312 – Beverage and Tobacco Product Manufacturing

The top chemicals emitted by the beverage and tobacco industry were **hydrochloric acid and nitrate compounds (only in Ohio)**, **ammonia, and "nicotine and salts" (only in Illinois)**. The largest emitter in this category was **Ohio** with its **hydrochloric acid releases**. Indiana and Minnesota had no emissions cited in this category.

Illinois' most prevalent chemical emissions in the beverage and tobacco industry from 2009-2013 were "nicotine and salts" to off-site releases. Overall emissions of "nicotine and salts" exhibited a large increase in 2011 and 2012 (about three times more than 2009 levels), then decreased again in 2013.

Ohio's most prevalent chemical emission in the beverage and tobacco industry from 2010-2013 was hydrochloric acid to air. Overall emissions of hydrochloric acid decreased during these years so that by 2013, they were less than a third of 2010 levels. In 2009, the largest chemical emission was nitrate compounds to water.

Wisconsin's most prevalent chemical emission in the beverage and tobacco industry from 2009-2013 was ammonia to air. Overall emissions of ammonia in 2013 were less than a third of 2010 levels. Michigan also reported releasing very small amounts of ammonia in all years except 2012. Indiana and Minnesota cited no emissions in this industry sector from 2009-2013.

NAICS code 313/314 – Textile Mills/Textile Product Mills (except apparel)

NAICS code 313

Illinois' most prevalent chemical emission in the textile mill industry from 2010-2013 was toluene to air. Overall emissions of toluene increased from 2010 to 2012, with a slight drop seen in the emission number for 2013. In 2009, the largest chemical emission was ammonia to air. Michigan's top emission from 2009-2013 was also toluene to air. Overall emissions of toluene generally increased during this time, with a slight drop seen in the emission number for 2012. Ohio was also in this group, with overall emissions of toluene generally decreasing from 2009-2013, except for a slight elevation in 2011.

Wisconsin's most prevalent chemical emission in the textile mill industry from 2009-2013 was N-methyl-2-pyrrolidone to air. Overall emissions of N-methyl-2-pyrrolidone increased substantially in 2010-2012 (between seven and nine times higher than 2009 levels), with a major drop in emissions reported again in 2013. Indiana and Minnesota cited no emissions in this industry sector from 2009-2013.

NAICS code 314

Minnesota's most prevalent chemical emission in the textile product mill industry from 2009-2013 was lead compounds to air, with overall emissions generally remaining relatively steady and at low amounts. Ohio's top emission in this industry sector was ammonia to air and off-site releases. Illinois, Indiana, Michigan, and Wisconsin had no data reported for NAICS code 314.

> The top chemicals emitted by the **textile mill industry** (313) were **toluene, N-methyl-2-pyrrolidone** (only in Wisconsin), **vinyl chloride** (only in Ohio), and **antimony compounds.** The largest emitter in this category was Wisconsin. Indiana and Minnesota had no data for this category.
>
> For the **textile product mill industry** (314), **ammonia and copper compounds** were the top emissions (only in Ohio), as well as **lead compounds** in Minnesota. The primary emitter in this category was Ohio. The only states reporting in the NAICS code 314 industry sector were Minnesota and Ohio.

NAICS code 315 – Apparel Manufacturing

Ohio's most prevalent emission in the apparel manufacturing industry was zinc compounds to off-site releases in 2009 and 2010. No emissions were reported in this category in Ohio from 2011-2013. Illinois, Indiana, Michigan, Minnesota, and Wisconsin had no data reported in any year for NAICS code 315.

NAICS code 316 – Leather and Allied Product Manufacturing

> The top chemicals emitted by the **leather and allied product industry** were **chromium compounds, certain glycol ethers, ammonia, and toluene.** The largest emitter in this category for 2009-2013 was **Minnesota**, although the single largest emission was in **Wisconsin** in 2011. **Illinois** was inconsistent in which chemicals were emitted in this category. **Indiana** and **Ohio** had no data reported for this category.

Minnesota's most prevalent chemical emission in the leather and allied product industry from 2009-2013 was chromium compounds to off-site releases. Overall emissions increased from 2009 to 2011, dropped in 2012, then increased again in 2013. Wisconsin's highest emission was chromium compounds as well, with overall emissions more than doubling from 2009 to 2011, then decreasing in 2012 and 2013. Illinois' top emissions in this industry sector were variable, comprising chromium compounds to off-site releases in 2010 and 2011; ammonia to air in 2009; and ammonia to air, land, and off-site releases in 2013. Ethylene glycol to air was Illinois' top emission in this sector in 2012. Michigan's top emission in the leather and allied product industry was chromium compounds to off-site releases in 2009, then toluene to air in 2010-2013.

Indiana and Ohio reported no emissions in this industry sector from 2009-2013.

NAICS code 321 – Wood Product Manufacturing

Illinois' most prevalent chemical emission in the wood product industry from 2009-2013 was creosote to air. Overall emissions were highest in 2009, then remained relatively stable from 2010-2013.

Indiana's top chemical emissions in this industry sector varied depending on the year. In 2009, emissions were primarily creosote; for 2010 and 2011, mostly toluene. In 2012-2013, methanol topped the list. All of these emissions were to air.

> The top chemicals emitted by the wood product industry were **methanol**, **formaldehyde**, **hydrochloric acid**, **acetaldehyde**, and **certain glycol ethers**. The largest emitter in this category was **Michigan**. In this industry sector, the chemicals most often released were quite diverse during the time period studied.

Minnesota's most prevalent chemical emission in the wood product industry from 2009-2013 was methanol to air, with emissions generally decreasing during that time. Wisconsin's highest emission from 2009-2013 was also methanol to air, with emissions generally increasing from 2009 to 2012, then decreasing slightly in 2013. Michigan was also in this group, citing methanol to air as its top emission from 2010-2013. In 2009, hydrochloric acid topped the list for Michigan.

Ohio's top emission in this industry sector from 2010-2013 was certain glycol ethers to air, with emissions amounts remaining relatively stable. In 2009, N-butyl alcohol topped the list.

NAICS code 322 - Paper Manufacturing

Illinois' most prevalent chemical emission in the paper industry from 2009-2013 was methanol to air, with emissions amounts generally increasing, except for a slight decrease seen in 2011. Minnesota's highest emission from 2009-2013 was also methanol to air, with emissions generally decreasing throughout that time. Wisconsin also was in this group, citing its top emission from 2009-2013 as methanol primarily to air, with emissions decreasing slightly in 2010 and 2011, then increasing again in 2012 and 2013.

> The top chemicals emitted by the paper industry were **methanol, hydrochloric acid, manganese compounds, toluene, and sulfuric acid.** The largest emitter in this category was **Wisconsin**, reporting methanol emissions somewhere between two and four million pounds during all years studied.

Indiana's most prevalent chemical emission in the paper industry from 2009-2013 was vinyl acetate to air, with emissions amounts generally increasing during those years.

Michigan's top emission in this industry sector from 2009-2011 and in 2013 was toluene to air. In 2012, methanol to air was the top emission.

Ohio's top emission in the paper industry from 2009-2011 was hydrochloric acid to air, with emissions generally decreasing throughout that time. In 2012 and 2013, the highest emission was toluene, primarily to air.

NAICS code 323 – Printing and Related Support Activities

The top chemicals emitted by the printing industry were **toluene**, **certain glycol ethers**, and **ethylene glycol. Illinois** was the state with the highest emissions in this sector.

Illinois' most prevalent chemical emission in the printing industry from 2009-2013 was toluene to air, with emissions highest in 2009 and 2010. Indiana's top emission from 2009-2013 was also toluene to air, with emissions highest in 2012. Wisconsin was in this group, citing its top emission from 2009-2013 as toluene to air, with its largest release being in 2013. Michigan cited its highest emission as toluene to air in 2012 and 2013 and nitric acid to air in 2009 through 2011.

Minnesota's most prevalent chemical emission in the printing industry from 2009-2013 was certain glycol ethers to air, with emissions generally increasing during those years, except for a slight drop in 2012. Ohio's highest emission from 2009-2013 was also certain glycol ethers to air, with emissions generally decreasing during this time.

NAICS code 324 – Petroleum and Coal Products Manufacturing

Illinois' most prevalent chemical emission in the petroleum industry was nitrate compounds to water in 2009 and 2010 and sulfuric acid to air from 2011-2013. Illinois' emissions were over one million pounds annually, easily making it the highest emitter in this industry sector. Minnesota's top emission was also nitrate compounds to water from 2009-2013. Emissions fluctuated between approximately 500,000 and 700,000 pounds throughout this time.

The top chemicals emitted by the petroleum industry were **sulfuric acid**, **nitrate compounds**, and **hydrochloric acid**, followed by **a number of VOCs**. The largest emitter in this category was **Illinois**.

Indiana's most prevalent chemical emissions in the petroleum industry were ammonia in 2009, lead compounds in 2010, and hydrochloric acid to air from 2011-2013. Ohio's top emissions were hydrochloric acid to air from 2009-2011 and sulfuric acid to air in 2012 and 2013. Michigan's top emissions in this industry sector varied from 2009-2013, although they were generally in the volatile organic compound (VOC) category, including benzene, propylene, and 1,2,4-trimethylbenzene. Wisconsin's highest emissions were also generally VOCs, including toluene and xylene.

NAICS code 325 – Chemical Manufacturing

Illinois' most prevalent emissions in the chemical industry were manganese compounds to off-site releases in 2009-2012 and ammonia to air in 2013. Emissions topped one million pounds in all of these years. Ohio's top emission in this industry sector varied from 2009-2013, although ammonia topped the list in three of these years; emissions in all years fluctuated between four and seven million pounds. Wisconsin's highest emission was also ammonia from 2009-2011 and certain glycol ethers in 2012 and 2013. Emissions of certain glycol ethers more than doubled from 2012 to 2013. Michigan cited ammonia as its top emission from 2009-2013, with emissions remaining relatively stable throughout that time.

> The top chemicals emitted by the chemical industry were **ammonia**, **manganese**, **carbonyl sulfide**, **nitrate compounds**, and **acetonitrile**. The largest emitter in this category was **Ohio**.

Indiana's most prevalent emission in the chemical industry varied from 2009-2013; however, nitrate compounds and sodium nitrite were often cited. Emissions generally increased during these years, with a decrease seen in 2013. Minnesota's highest emission was also nitrate compounds to water from 2009-2013. Emissions generally increased during that time, except for a decrease in 2012.

NAICS code 326 – Plastics and Rubber Products Manufacturing

Illinois' most prevalent chemical emission in the plastics and rubber industry was carbon disulfide to air from 2009-2013. Emissions remained relatively stable during that time, hovering between three and four million pounds.

Indiana's top emission in this industry sector was styrene to air from 2009-2013. Emissions steadily increased during those years, from one and a half million to over three million pounds. Michigan's highest emission was also styrene from 2009-2013. Emissions were generally stable during that time. Minnesota and Wisconsin were in this group, citing their top emission as styrene to air from 2009-2012 and toluene to air in 2013. Ohio's top emission was also styrene from 2010-2013. In 2009, 1-chloro-1,1-difluroethane was the primary chemical emitted in Ohio.

> The top chemicals emitted by the plastics and rubber industry **were styrene, carbon disulfide, zinc compounds, and toluene.** The largest emitter in this category was **Illinois**, where the top chemical emitted was carbon disulfide.

NAICS code 327 – Nonmetallic Mineral Product Manufacturing (i.e. Stone/Clay/Glass/Cement)

Illinois' most prevalent chemical emission in the nonmetallic mineral product industry was sulfuric acid to air in 2010, 2012, and 2013. In 2009 and 2011, ammonia to air topped the list.

Ohio's top emission was ammonia primarily to air in all years except 2011, in which the highest release was hydrochloric acid to air and land.

> The top chemicals emitted by the nonmetallic mineral product industry were **hydrochloric acid**, **ammonia**, **manganese**, and **formaldehyde**. The largest emitters in this category were **Michigan** and **Ohio**.

Wisconsin's highest emission in this industry sector was hydrochloric acid to air from 2009-2013. Emissions increased from 2009-2012, then decreased slightly in 2013. Indiana's top emission was also hydrochloric acid to air from 2010-2013, and carbonyl sulfide to air in 2009. Michigan's highest emission was hydrochloric acid to air in 2009-2011 and in 2013. In 2012, manganese to off-site releases topped the list.

Minnesota's most prevalent chemical emission in this industry sector was phenol to air from 2009-2013. Emissions remained relatively stable during those years, hovering between 20,000 to 31,000 pounds.

NAICS code 331 – Primary Metal Manufacturing

Illinois' most prevalent chemical emission in the primary metal industry was zinc compounds, primarily to off-site releases and land, from 2009-2013. Emissions increased from 2009 through 2011, then decreased in 2012 and 2013. Michigan's highest emission was also zinc compounds, primarily to off-site releases, from 2009-2013. Emissions increased during this time, other than a slight decrease in 2012. From 2009-2013, Ohio also cited its top emission as zinc compounds, primarily to off-site releases and land.

> The top chemicals emitted by the primary metals industry were **zinc compounds**, **nitrate compounds**, and **manganese compounds**. The largest emitter in this category was **Indiana**.

In 2009, 2012, and 2013, Indiana's top emission in this industry sector was zinc compounds, primarily to off-site releases and land. Nitrate compounds to water topped the list in 2010 and 2011. Minnesota's highest emission was zinc compounds to off-site releases from 2011-2013, and lead compounds to off-site releases in 2009 and 2010. Wisconsin's top emission was zinc compounds, primarily to off-site releases, from 2010-2013, and manganese to off-site releases in 2009.

NAICS code 332 – Fabricated Metal Product Manufacturing

Illinois' most prevalent chemical emission in the fabricated metals industry was zinc compounds to off-site releases from 2009-2013. Emissions decreased during this time, other than a slight increase in 2011. Indiana's highest emission was also zinc compounds from 2009-2013, primarily to off-site releases. Emissions increased from 2009 to 2010, than steadily decreased through 2013. Michigan and Ohio were also in this group, reporting their top emission from 2009-2013 as zinc compounds, primarily to off-site releases.

> The top chemicals emitted by the fabricated metals industry were **zinc compounds**, **certain glycol ethers**, **N-butyl alcohol**, and **aluminum oxide**. The largest emitter in this category was **Ohio**.

Minnesota's highest emissions in this industry sector were certain glycol ethers to air in 2009 and 2010 and N-butyl alcohol to air from 2011-2013. Wisconsin's top emission was aluminum oxide (fibrous forms) to off-site releases, from 2009-2013.

NAICS code 333 - Machinery Manufacturing

Ohio's most prevalent chemical emission in the machinery industry was manganese compounds to off-site releases from 2009-2013, with emissions hovering between 300,000 and 450,000 pounds. Illinois' top emission was aluminum oxide (fibrous forms) to off-site releases from 2011-2013, with steadily increasing emissions each year. In 2010, the highest emission was hydrochloric acid to air. In 2009, it was manganese to off-site releases.

Indiana's highest emission in this industry sector was formaldehyde to air from 2009-2012 and certain glycol ethers to air in 2013. Michigan's top emission was dichloromethane to air from 2009-2011 and 2013. Certain glycol ethers to air topped the list in 2012. Minnesota's highest emission was xylene (mixed isomers) to air in 2009 and 2013 and barium to off-site releases from 2010-2012. Wisconsin's top emission was ammonia to air in 2009-2011 and certain glycol ethers to air in 2012 and 2013.

> The top chemicals emitted by the machinery manufacturing industry were **manganese compounds, copper compounds, hydrochloric acid, aluminum oxide, and ammonia.** The largest emitter in this category was **Ohio**.

NAICS code 334 – Computer and Electronic Product Manufacturing

Illinois' most prevalent chemical emission in the computer/electronic products industry was copper compounds to off-site releases from 2009-2013, with the highest amount released in 2010. Michigan's highest emission was copper to off-site releases from 2010-2013, and ammonia to air in 2009.

Indiana's top emission in this industry sector was naphthalene to air in 2009, 2010, and 2013. Lead and lead compounds to off-site releases led emissions in 2012 and 2011, respectively. Minnesota's highest emission was toluene to air from 2010-2013 and manganese compounds to off-site releases in 2009. From 2009-2013, Ohio's top emission was zinc compounds, primarily to off-site releases with the highest amount released in 2010. Wisconsin's top emission was methanol to air from 2010-2013 and barium compounds to off-site releases in 2009.

The top chemicals emitted by the computer/electronic products industry were **zinc compounds**, **copper compounds**, **toluene**, and **methanol**. The largest emitter in this category was **Ohio**.

NAICS code 335 – Electrical Equipment, Appliance, and Component Manufacturing

Ohio's most prevalent chemical emission in the electrical equipment industry was certain glycol ethers to air from 2009-2013. Emissions generally decreased during this time period, except for an increase in 2012. Indiana's top emission was also certain glycol ethers to air in 2010 and 2013, antimony compounds in 2011 and 2012, and xylene (mixed isomers) in 2009.

The top chemicals emitted by the electrical equipment industry were **certain glycol ethers**, **barium compounds**, **lead compounds**, **zinc compounds**, and **manganese.** The largest emitter in this category was **Ohio** with its emissions of certain glycol ethers, although **Illinois** had some very high emissions of barium compounds in 2011 and 2012.

Illinois' highest emissions in this industry sector were zinc compounds in 2009 and 2010, barium compounds at much higher levels in 2011 and 2012, and lead compounds in 2013, all as off-site releases. Michigan cited its top emissions as N-butyl alcohol to air in all years except for 2012, when the largest release was of N-methyl-2-pyrrolidone. Minnesota's highest emission was styrene to air from 2010-2013, and xylene (mixed isomers) in 2009. Wisconsin's highest releases were manganese in 2010 and 2013, copper in 2012, and chlorodifluromethane in 2009 and 2011.

NAICS code 336 – Transportation Equipment Manufacturing

Illinois' most prevalent chemical emissions in the transportation equipment industry were N-butyl alcohol to air in 2011-2013 and styrene to air in 2009 and 2010. Minnesota's and Wisconsin's top emissions were styrene to air in 2009-2013. Indiana's highest emission was styrene to air in 2011 and 2013, N-butyl alcohol to air in 2012, and 1,2,4-trimethylbenzene to air in 2009 and 2010.

The top chemicals emitted by the transportation equipment industry were **N-butyl alcohol**, **xylene**, **1,2,4-trimethylbenzene**, and **styrene.** The largest emitter in this category was **Michigan**, with **Indiana** not far behind.

Michigan's highest emissions in this industry sector were xylene (mixed isomers) to air in 2011-2013, N-butyl alcohol to air in 2010, and 1,2,4-trimethylbenzene to air in 2009. Ohio's highest release was zinc compounds to off-site releases in 2009-2013. Emissions in Ohio increased from 2009-2012, then showed a slight decrease in 2013.

NAICS code 337 – Furniture and Related Product Manufacturing

Illinois' most prevalent chemical emission in the furniture industry was N-butyl alcohol to air from 2010-2013, and xylene (mixed isomers) to air in 2009. Indiana's top emission was also xylene (mixed isomers) to air in 2010, 2012, and 2013, and toluene to air in 2009 and 2011. Wisconsin's highest emission was xylene (mixed isomers) to air in 2011-2013, and toluene to air in 2009 and 2010.

> The top chemicals emitted by the furniture industry were **toluene, xylene, and N-butyl alcohol.** The largest emitter in this category was Indiana.

Minnesota's top emission in this industry sector was xylene (mixed isomers) to air from 2009-2013. Michigan reported its highest release as being toluene to air from 2009-2013. Ohio's highest emission was barium compounds to off-site releases from 2009-2013. Emissions numbers in these three states remained relatively stable over the time period studied.

Key Points

There are a variety of ways to look at emissions data to determine the industries that need the most assistance and the chemicals that may present the most significant P2 opportunities in these industry sectors. Below are some key points to highlight how this type of data analysis can be used by P2 TAPs.

- **Illinois** was the highest emitter in the **food processing** industry in all years studied, releasing its most prevalent pollutant (nitrate compounds) to water. Therefore, efforts to reduce that particular emission could be a programmatic goal for P2 TAPs in Illinois. Illinois was also the highest emitter in the **petroleum and coal products** industry in all years and in three other sectors for some of the years.
- **Minnesota** was the highest emitter in only one sector for all years (**leather and allied product manufacturing**), in which the primary chemical released was chromium compounds to off-site releases. Although this is an industry sector with very few TRI reporters, chemical emissions are moderately substantial. Therefore, Minnesota TAPs may want to investigate ways of reducing chromium emissions associated with common practices in the leather industry. This information may also benefit smaller facilities in this sector that do not meet TRI reporting thresholds, but could still implement P2 practices to reduce emissions. Minnesota was also the highest emitter in the **computer and electronic products** sector in 2013. Having more TRI reporters and also fairly

substantial emissions, this industry sector may also be a good technical assistance target.

- **Wisconsin** was the highest emitter in only one sector for all years (**paper manufacturing**), in which methanol was released to air. Therefore, reducing methanol emissions in this industry sector could be a goal for Wisconsin.
- **Michigan** was the highest emitter in the **transportation equipment industry** in all years studied, releasing its most prevalent pollutants (N-butyl alcohol, xylene, and 1,2,4-trimethylbenzene) to air. Michigan was also the highest emitter in the **wood products industry,** emitting methanol and hydrochloric acid to air. Finding and implementing P2 practices that successfully reduce air emissions related to these manufacturing concerns might be a priority for this state's TAPs.
- **Indiana** was the highest emitter in the **furniture manufacturing industry**, in which both xylene and toluene were released primarily to air. P2 practices that help to reduce VOC emissions in this industry sector may be useful, particularly in the area of solvent substitution. Indiana was also the highest emitter in the **primary metal industry**, which was the highest overall emitting industry sector studied.
- **Ohio** was the highest emitter in 10 of the 20 industry sectors in all or some of the years studied, including the second highest emitting industry sector overall, the **chemical industry**.

Waste Management Practices

Before discussing the specifics of waste management activities, it is important to understand how manufacturing facilities have routinely managed their production-related waste, which TRI defines as the quantities of toxic chemicals recycled, combusted for energy recovery, treated for destruction, and disposed of or otherwise released on-and off-site. These processes (recycling, energy recovery, treatment, and disposal) are discussed as waste management activities within this report. **Figure 8** illustrates the relative desirability of each waste management method (U.S. EPA, 2015e).

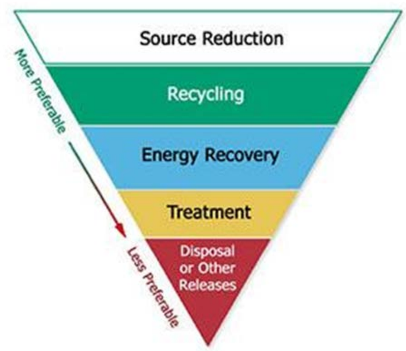


Figure 8: Waste reduction hierarchy. Image source: U.S. EPA

According to the Pollution Prevention Act of 1990, pollution should be prevented or reduced at the source whenever feasible and released to the environment only as a last resort. Unfortunately, ways to prevent waste generation in the first place can be easily overlooked and sometimes difficult to implement for a variety of reasons. Teaching workers and management to think with a prevention mindset can lead to behavior change within a facility. For some industry sectors, introducing the options of energy recovery or recycling (as opposed to treatment or disposal) may be the first step towards a more robust waste management strategy and eventual adoption of pollution prevention practices.

Table 3: Most Common Waste Management Methods

Industry (NAICS code)	Method
Food Processing (311)	On-site recycling
Beverage and Tobacco (312)	Disposal/release
Textile Mills (313)	On-site treatment
Textile Product Mills (314)	On-site treatment
Apparel (315)	Disposal/release
Leather (316)	On-site treatment
Wood (321)	On-site recycling
Paper (322)	On-site treatment
Printing (323)	On-site recycling
Petroleum (324)	On-site treatment
Chemicals (325)	On-site recycling
Plastics and Rubber (326)	Off-site treatment
Nonmetallic Mineral Products (327)	Off-site energy recovery
Primary Metals (331)	Off-site recycling
Fabricated Metals (332)	Off-site recycling
Machinery (333)	Off-site recycling
Computers and Electronic Products	Off-site recycling
Electrical Equipment (335)	Off-site recycling
Transportation Equipment (336)	Off-site recycling
Furniture (337)	Off-site recycling

Table 3 lists the most common waste management methods used by each manufacturing sector in the region, as reported in TRI from 2009-2013.

When examining only the 2013 data, it appears that certain industry sectors made changes in their waste management practices. In 2013, the only industry with the most of their waste being released was the furniture industry.

Figure 9 illustrates details regarding selected waste management trends in the furniture industry in Region 5 in 2013. TRI users can explore data for any industry sector, year, or individual state by adjusting search parameters to include only the information of interest to them; downloading search results into an Excel spreadsheet; and creating visualizations of the data. PivotCharts can be very useful in this context (see Appendix D for basic TRI search methodology). Industry sectors that have been releasing most of their waste (e.g. beverages and tobacco, apparel, and furniture) may need technical assistance to help them move in the direction of recycling, energy recovery, or waste treatment rather than disposal/release, which is the least attractive waste handling option.

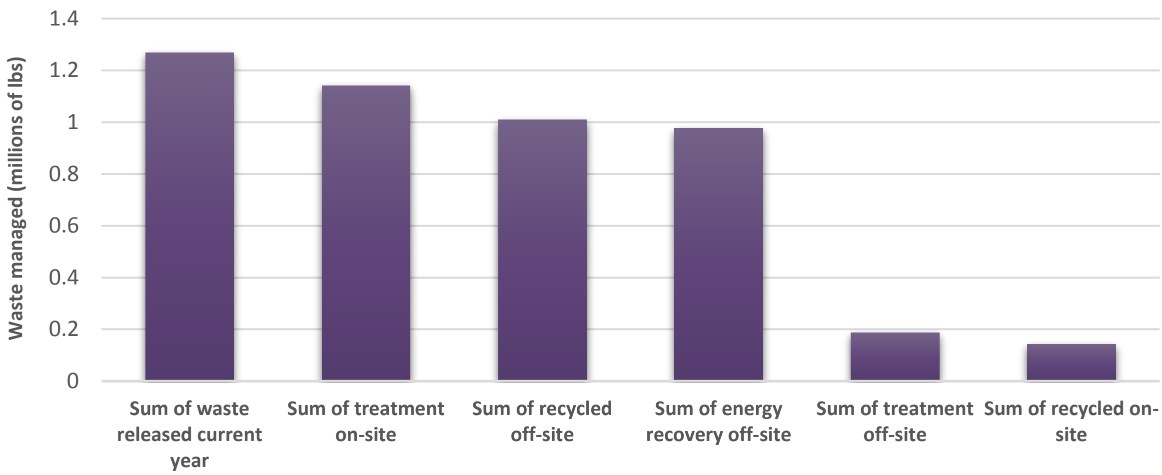


Figure 9: Waste Management Practices in the Furniture Industry (2013)

P2 Practices

The previous section of this report focused on the amounts and types of chemical emissions from different industry sectors. In this section, the focus shifts to the specific practices industries are using to reduce pollution at its source. U.S. EPA's waste management hierarchy identifies pollution prevention as the preferred option because waste that is never generated never has to be managed. Furthermore, companies that invest resources in making their processes more efficient and less damaging to the environment are role models for others in their industrial sectors. P2 TAPs share their stories with their peer companies. TAPs also offer on-site assistance, education, and training to companies that have not yet implemented pollution prevention practices. However, only 16% of all TRI facilities reported newly implemented source reduction activities in 2013. Although this information provides valuable data for the industrial community, it is clear that many companies still need assistance with implementing P2 projects (or with reporting them in TRI).

Dr. Tim Lindsey, formerly Caterpillar's Global Director of Sustainability, defines sustainability as a cluster of innovations and the subsequent diffusion of those innovations that are compatible with a company's corporate culture and provide the most advantages with the least complexity

(Lindsey, 2015). P2 data gathered through TRI reporting sometimes includes comments from the reporting facilities on what P2 practices or innovations they tried, how they measured success, and what barriers to implementation (e.g., prohibitive cost, concerns about product quality, or a need for additional technical information) they encountered. This information is useful to P2 TAPs when targeting industry sectors that could benefit from certain chemical and process-specific P2 practices that have a high probability of success.

According to TRI P2 data, the three most frequently reported source reduction categories in 2013 were good operating practices, process modifications, and spill and leak prevention (U.S. EPA, 2015c). Other general source reduction methods include raw material modifications; product modifications; inventory control; cleaning and degreasing; and surface preparation and finishing. More specific source reduction activities are commonly reported to U.S. EPA as a "W code", such as W52, the code for modifying equipment layout or piping. See Appendix C for a description of P2 activities and the source reduction category for each W code.

U.S. EPA also collects data on how a facility identifies an idea for a source reduction activity. EPA provides a number of suggestions, including participative team management; employee recommendations; internal P2 opportunity audits; state or federal government technical assistance programs, and trade association or vendor technical assistance programs. These identification methods are commonly reported to U.S. EPA as a "T code" (e.g., T07, the code for a state government technical assistance program). According to 2013 TRI P2 data, facilities most frequently identified source reduction opportunities through participative team management and internal P2 audits (U.S. EPA, 2015c).

The quality of P2 data reporting in TRI has varied widely, which makes it difficult to draw conclusions regarding the effectiveness of P2 practices. For example, some companies report generalized "environmental" program information with no associated source reduction code or specific description of activities, which does not provide enough data for statistically valid analysis. Many facilities report only a source reduction code, with no specific information as to the actual changes made in their processes or practices (these descriptions are optional on the TRI P2 reporting form). Some facilities report an incorrect source reduction code. In addition, some companies report what are commonly considered "end-of-pipe" technologies as a P2 practice. End-of-pipe practices are defined as control or treatment technologies that are added at the end of a production system (e.g., incinerators, filters or scrubbers, recycling or treatment of waste). These practices are not considered source reduction. However, they are discussed for some industry sectors below to illustrate their current waste management practices.

Although there quality issues with the first year or two of P2 reporting data, U.S. EPA records indicate that P2 reporting has improved greatly over the past few years. Reporters have better guidance from EPA and more companies are choosing to contribute the optional text descriptions that are so valuable for those who want more detailed information about a facility's project. Specifically, the number of TRI reporting forms including optional text descriptions increased from 2% in 2010 to 11% in 2013 (Teitelbaum, 2015a). Without detailed comments on P2 practices, it can be difficult for TAPs to act on the reported data if they wish to use them to suggest changes at another facility. In cases where detailed information is not available, the TAP must contact the reporting company to gather more detailed information before proceeding further (Liebl, 2015).

The data compiled and analyzed for this project could be used as a first step for a company that wants to know how similar facilities are reducing emissions of a specific chemical used for a specific purpose. In addition, U.S. EPA has created the TRI P2 Spotlight Series, which focuses on specific types of chemical waste. As of April 2016, four publications were available in the series (U.S EPA, 2014-2015). They focus on reducing glycol ether waste, dichloromethane waste, and trichloroethylene waste, and decabromodiphenyl oxide waste.

In the following section, P2 data for each industry sector are analyzed to see which practices facilities most commonly used for their most often emitted chemicals and whether reductions in emissions were seen as a result.

NAICS code 311 – Food Manufacturing and Processing

TRI data indicated that the most prevalent chemicals emitted in the food industry are N-hexane and ammonia to air and nitrate compounds to water. Although the order varied, almost all states in Region 5 listed these three chemicals in their top four emissions. The region's food manufacturers have reported a variety of P2 measures to reduce these emissions.

Specific industries most often reporting the release of nitrate compounds were the animal slaughtering and meat processing industry; the cheese and milk manufacturing industry; and the specialty canning industry. P2 practices most commonly employed to reduce emissions of nitrate compounds were process modifications (W58) or instituting modifications to cleaning and degreasing procedures (W71), such as reducing the overall use of cleaning chemicals and using alternative cleaners that do not contain nitric acid. Reductions in releases of nitrate compounds were often noted when these practices were used. Many facilities also cited improved maintenance scheduling, recordkeeping, or procedures (W13).

Companies often reporting the release of N-hexane were those in the soybean and other oilseed processing industry and the spice and extract manufacturing industry. P2 practices most commonly employed to reduce emissions of N-hexane were process modifications (W58), such as installing more efficient equipment (e.g., replacing condensers) and reducing vacuum pressure on extractors. The next most common practices were changing the production schedule to minimize equipment and feedstock changeovers (W14) and focusing more heavily on spill or leak prevention (W39). Facilities also reported modifications of equipment, layout, or piping (W52), such as valve replacement. Reductions in N-hexane releases were sometimes noted for all of these practices.

Companies in the wet corn milling industry, frozen specialty food manufacturing, and the rendering and meat processing industry most often reported ammonia releases. The P2 practice most commonly employed to reduce emissions of ammonia was improving maintenance scheduling, recordkeeping, or procedures (W13), specifically, starting a preventive maintenance program. The second most common P2 practice was modifying equipment, layout, or piping (W52), such as valve replacement. Also important were implementing an inspection or monitoring program for potential spill or leak sources (W36) and improving procedures for loading, unloading, and transfer operations (W32). Reductions in ammonia releases were sometimes noted for all of these practices.

Figure 10 shows the practices that companies in this sector used to reduce nitrate compounds, ammonia, and n-hexane.

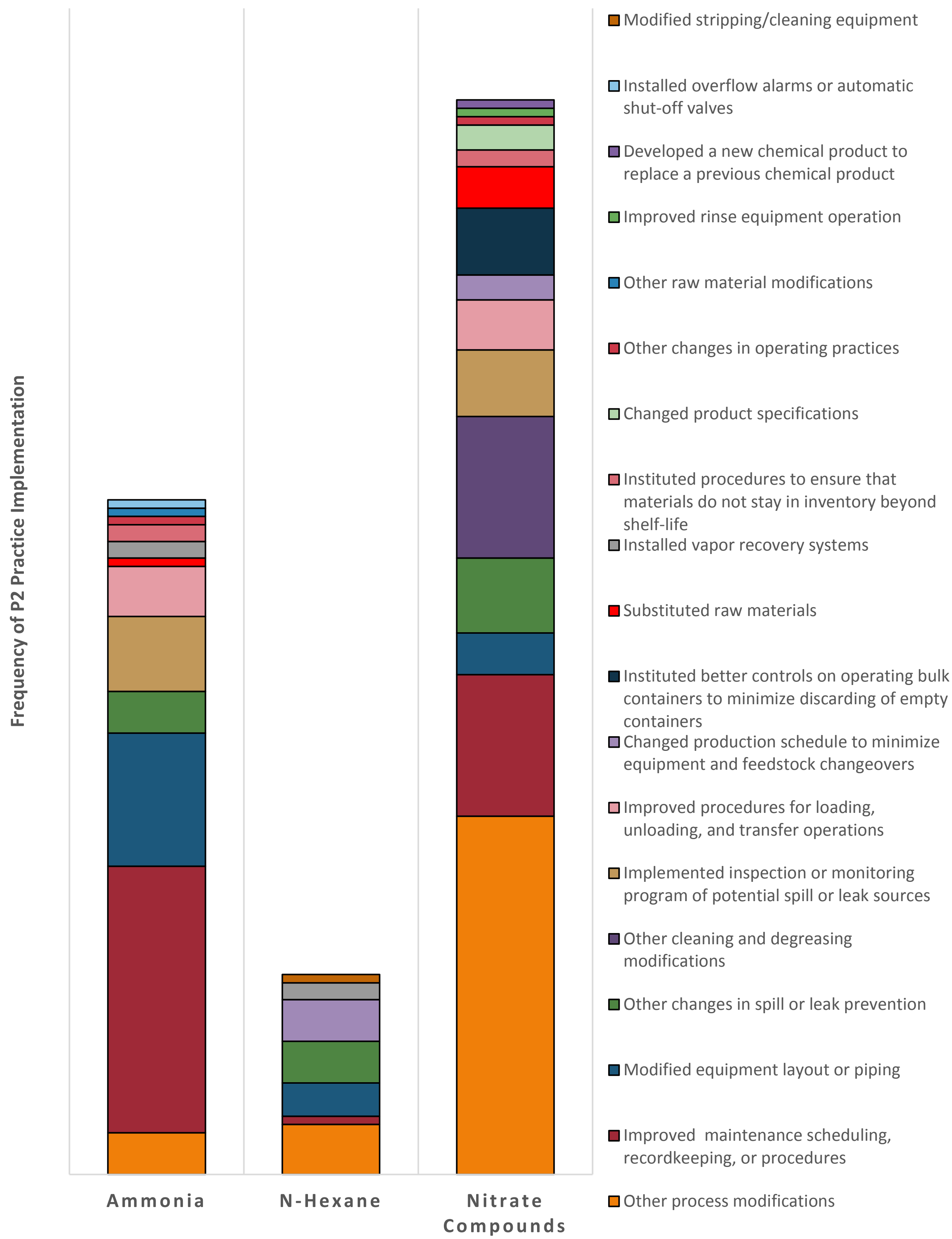


Figure 10: P2 Practices Used to Address Most Common Pollutants in the Food Industry

NAICS code 312 – Beverage and Tobacco Product Manufacturing

TRI data indicated that the highest total emissions in the beverage and tobacco product industry consisted primarily of hydrochloric acid, nitrate compounds, ammonia, and "nicotine and salts".

TRI and P2 reporting data is limited for this sector. Out of 10 facilities reporting to TRI, only two reported a source reduction code and neither included useful descriptive methods. Specific industries reporting were a brewery and a distillery. The only facility showing success in reduction of ammonia emissions (a distillery in Illinois in 2013) used changes in operating practices (W19) as a P2 technique. Illinois' top emission in this industry sector was actually "nicotine and salts" to off-site releases in all five years studied, but no P2 activities targeting these were noted. The beverage and tobacco product sector may present an opportunity for P2 technical assistance.

NAICS code 313/314 – Textile Mills/Textile Product Mills (except apparel)

NAICS code 313

TRI data indicated that the highest total emissions in the textile mill industry consisted primarily of toluene, N-methyl-2-pyrrolidone, and vinyl chloride.

Specific industries reporting P2 activities in this industrial sector were two fabric coating mills. One facility in Illinois reduced toluene emissions by substituting raw materials (W42). This included transitioning from a toluene-based polymer to an ethyl acetate-based polymer or alternative product and changing from a solvent-based to a water-based system. This Illinois facility was the only one reporting P2 activities for successful toluene reduction. This facility also mentioned in their comments that they collaborated with vendors to reduce costs and use of solvents in the manufacturing process and purchased a new regenerative thermal oxidizer to capture and incinerate VOC emissions.

One facility in Wisconsin reported unspecified changes in operating practices (W19) to reduce emissions of N-methyl-2-pyrrolidone. They also mentioned substitution of coating materials to use less N-methyl-2-pyrrolidone (W73). No P2 practices were mentioned in any state in association with reducing vinyl chloride emissions.

NAICS code 314

TRI data indicated that the highest total emissions in the textile product mill industry consisted primarily of ammonia, copper compounds, and lead compounds.

Only one facility in Minnesota, a rope, cordage, and twine mill, reported to the TRI at all. They did not cite any usable information on source reduction and showed an increase in emissions of lead compounds.

NAICS code 315 – Apparel Manufacturing

No TRI P2 data was available for the apparel industry.

NAICS code 316 – Leather and Allied Product Manufacturing

TRI data indicated that the highest total emissions in the leather and allied product industry consisted primarily of chromium compounds, certain glycol ethers, and ammonia.

The sector most often reporting chromium compound releases was the leather and hide tanning and finishing industry. One facility in Wisconsin reported using a variety of P2 practices to reduce chromium emissions. These included optimizing reaction conditions to facilitate better chrome fixation in the animal skins (W50); changing product specifications, thereby reducing the chrome content of their product by 12.5% (W81); developing a new chemical product to replace the old (W84); and other product modifications (W89). Another facility in Wisconsin implemented a chrome recovery system that recovered 80% of the available chrome from the spent tanning liquors. These two facilities both documented reductions in release of chromium compounds.

To attempt to reduce ammonia emissions, one of the facilities discussed above tried several things, none of which resulted in a decrease in emissions. These actions included instituting process modifications that removed excess lime in the stock so less ammonium salts were needed in the process (W58) and substituting a feedstock or reagent chemical with a different chemical (W43). No P2 practices were mentioned in association with reducing emissions of certain glycol ethers.

NAICS code 321 – Wood Product Manufacturing

TRI data indicated that the highest total emissions in the wood product industry consisted primarily of methanol, formaldehyde, and hydrochloric acid.

Specific industries most often reporting the release of methanol were the reconstituted wood product and miscellaneous wood product manufacturing industry. P2 practices most commonly used to reduce emissions of methanol were product modifications (W81 and W82) to adjust the target density or thickness of the wood. Also mentioned were process modifications (W58), such as eliminating tempering the hardboard in a bake oven. These activities resulted in mixed emissions reductions.

Specific industries most often reporting the release of formaldehyde were the reconstituted wood product and the hardwood veneer and plywood manufacturing industries. The P2 practice most commonly employed to reduce formaldehyde emissions was the substitution of raw materials (W42), including using a water-based product or glues with no formaldehyde content. One company reported switching from a formaldehyde resin (used to bind the strands of wood together in an engineered particleboard) to a methylene diphenyl di-isocyanate (MDI) resin. Substituting raw materials led to reductions in formaldehyde releases in most cases. Facilities also reported modifying the design or composition of the product (W82, W81, and W89), including increasing the target moisture content, density, and thickness of the wood product. Also mentioned was instituting recirculation within a process (W51). These practices had mixed reduction results.

A reconstituted wood product facility in Michigan utilized the substitution of raw materials (W42) to assist in the reduction of hydrochloric acid emissions. In their comments, they stated that hydrochloric acid was generated by the firing of coal in the boilers. They tried using an alternative fuel source, such as wood or natural gas, to supplement coal-firing boilers. Reductions in releases were noted in all three reporting years.

NAICS code 322 – Paper Manufacturing

TRI data indicated that the highest total emissions in the paper industry consisted primarily of methanol, hydrochloric acid, manganese compounds, and toluene.

Paper (except newsprint) and pulp mills and the paper bag and coated and laminated paper industries most often reported methanol emissions. The most common P2 practice to reduce methanol that facilities in these sectors reported was modifying equipment, layout, or piping (W52), such as upgrading a production line. The second most common P2 practice reported for methanol reduction was changing the production schedule to minimize equipment and feedstock changeovers (W14). These two practices led to release reductions in most cases. Facilities also mentioned re-use of methanol back into their processes or instituting recirculation (W51); installing vapor recovery systems (W35); and focusing on spill and leak prevention (W39). Reductions in releases were not cited with these techniques.

One paper mill in Michigan successfully reduced hydrochloric acid emissions by installing a gas-fired boiler to minimize the burning of coal, which produces hydrochloric acid. A pulp mill in Minnesota reported using unspecified process modifications (W58) to reduce emissions of manganese compounds.

The paper bag and the coated and laminated paper manufacturing industries most often reported toluene releases. Reporting facilities most often reported process modifications (W58), such as reducing the amount of solvent and/or reusing the solvent needed for shift-end cleanups, and replacing a solvent coating with a water-based system to reduce these emissions. The second most common P2 practice was modifying equipment, layout, or piping (W52), e.g., upgrading a production line, installing a new mixing technology system, or implementing actions to reduce the amount of coating scrap material. Some facilities also mentioned raw materials substitution (W42), such as utilizing low-toluene adhesives when they met performance standards, as well as modifying the design or composition of the product (W82). All of these practices resulted in reduced toluene emissions.

NAICS code 323 – Printing and Related Support Activities

TRI data indicated that the highest total emissions in the printing industry consisted primarily of toluene, certain glycol ethers, and ethylene glycol.

The commercial gravure and commercial lithographic printing industries most often reported toluene releases. Facilities in these sectors most commonly reported substitution of raw materials (W42), such as replacing toluene with methyl ethyl ketone or adhesives containing no solvent, and reducing the amount of toluene in inks and coatings. One company modified equipment by installing a centralized material blending system (W52). Some facilities also reported improving application techniques (W74) and testing outdated material to see if still usable, including implementing an Ink Work-Off program, which allows continued use rather than disposal of obsolete color formulations (W22). Most facilities reported that these P2 practices led to decreased toluene emissions.

Commercial screen, gravure, and lithographic printing facilities most often reported emissions of certain glycol ethers. To reduce these emissions, facilities reported using substitution of raw materials (W42) and coating materials (W73), such as using lower-VOC and ultraviolet (UV) coating materials; improved procedures (W13), such as decreasing use of coatings (using more ink instead); and improving the preventive maintenance program on machines. Some also mentioned changes in operating practices (W19) and other raw material modifications (W49), such as better internal controls on material conservation. Some facilities noted a reduction in releases of certain glycol ethers with all of these practices.

To reduce emissions of ethylene glycol, a commercial lithographic printing company in Wisconsin developed new chemical products that did not contain ethylene glycol to replace previous chemical products (W84) for developing and processing plates, but they did not cite a reduction in release of the chemical. One facility in Minnesota reported that they successfully reduced ethylene glycol emissions by using a different process catalyst for plate processing (W53).

NAICS code 324 – Petroleum and Coal Products Manufacturing

TRI data indicated that the highest total emissions in the petroleum industry consisted primarily of sulfuric acid, nitrate compounds, and hydrochloric acid.

A petroleum refinery in Minnesota reported using a P2 practice to reduce emissions of sulfuric acid and that was the modification of equipment, layout, or piping (W52). They were the only facility to report using P2 practices to reduce sulfuric acid emissions. No petroleum facility reported any P2 practices aimed at reducing emissions of nitrate compounds. Two petroleum facilities in Illinois reported that they reduced hydrochloric acid emissions using P2 practices. One used the substitution of a feedstock or reagent chemical with a different chemical (W43), specifically by reducing the use of chlorine as a raw material. The other reported less malfunctions in venting from their waste heat stacks.

Emissions data for the petroleum industry shows that the most frequently released chemicals are sulfuric acid, nitrate compounds, and hydrochloric acid. However, facilities in this sector are either not using or not reporting the P2 measures designed to reduce emissions of these chemicals. Understanding why the petroleum industry is either not employing or not reporting P2 activities for the most frequently emitted chemicals may be helpful in determining future directions for technical assistance in this sector.

NAICS code 325 – Chemical Manufacturing

TRI data indicated that the highest total emissions in the chemical industry consisted primarily of ammonia, manganese, and carbonyl sulfide.

Many facilities in the region reported ammonia emissions. These facilities most commonly reported using process modifications (W58) to reduce ammonia emissions. Some facilities reported substituting the use of anhydrous ammonia with another chemical. Ethyl alcohol manufacturing facilities reduced the need for ammonia by using different enzymes requiring a lower pH in the slurry process. A plastics material and resin manufacturer in Ohio replaced a 60-year old anhydrous ammonia refrigeration system with new equipment (W52) to try to reduce fugitive emissions. They reported that they reduced ammonia releases by over 77 percent. Other examples of modifying equipment, layout, or piping included upgrading connectors and valves; installing improved distribution piping; and replacing pumps that had faulty seals. A facility in Illinois reduced ammonia emissions through the creation of new low-emissions resin-coated sand products for foundry applications (W82). Other common P2 practices included improving maintenance scheduling, recordkeeping, or procedures (W13); instituting recirculation within a process (W51); and changes in operating practices (W19), such as ordering raw materials just in time for scheduled production.

Chemical manufacturers in the region also reported significant releases of nitrate compounds and acetonitrile. Facilities most often reported using improved maintenance scheduling, recordkeeping, or procedures (W13) and process modifications (W58) to reduce nitrate compounds. For acetonitrile, they most commonly used modification of equipment, layout, or piping (W52), such as installing dual mechanical sealed pumps and certified low-leak valves to reduce fugitive emissions or upgrading pump seals and connectors. Although facilities, particularly in Ohio, reported substantial releases of manganese and carbonyl sulfide, none reported associated P2 practices to reduce these emissions. This may present an opportunity for TAPs.

NAICS code 326 – Plastics and Rubber Products Manufacturing

TRI data indicated that the highest total emissions in the plastics and rubber industry consisted primarily of styrene, carbon disulfide, and zinc compounds.

Laminated plastics; plate, sheet, and shape manufacturing; and general plastics product manufacturing facilities most often reported styrene releases. To reduce these emissions, facilities reported substitution of raw materials (W42), such as changing the content of the gelcoats and resins being used to have a lower percentage of styrene; increasing the purity of raw materials (W41); and other general raw material modifications (W49). They also reported modifying equipment, layout, or piping (W52), such as modifying filter assemblies to prevent dripping of material and converting resin application guns from atomizing to non-atomizing, to effectively coat the product mold while reducing the amount of overspray. Some also reported improved maintenance scheduling, recordkeeping, or procedures (W13). A plastics manufacturer in Ohio changed from a spray-up system to a vacuum-injected resin transfer molding (W74 and W75). Another facility replaced spray-based solvent application with a powder-coating system.

Rubber products and plastics products manufacturers reported releases of zinc compounds. They commonly used process modifications (W58) to minimize scrap material; changes in operating practices (W19), including changes in production processing to avoid having boxes sit outside for long periods of time; improved maintenance scheduling, recordkeeping, or procedures (W13); and instituting procedures to ensure that materials do not stay in inventory beyond shelf-life (W21) to reduce emissions. No P2 practices were cited in association with reducing emissions of carbon disulfide.

NAICS code 327 – Nonmetallic Mineral Product Manufacturing (i.e., Stone/Clay/Glass/Cement)

TRI data indicated that the highest total emissions in the nonmetallic mineral products industry consisted primarily of hydrochloric acid, ammonia, and manganese.

The flat glass manufacturing and lime/other concrete product manufacturing industries reported hydrochloric acid releases. These facilities most often used raw material modifications (W49) (i.e., replacing coal with an alternative fuel) to reduce these emissions.

Mineral wool manufacturing and glass product manufacturing (made of purchased glass) facilities reported ammonia releases. An Indiana facility reported that they reduced these emissions by introducing an in-line product quality monitoring or other process analysis system (W15). This facility was the only one in the sector that reported using P2 practices to reduce ammonia successfully.

The concrete pipe and abrasive product manufacturing industries reported manganese releases, although no facilities in this sector reported P2 practices that led to reductions in these emissions.

NAICS code 331 – Primary Metal Manufacturing

TRI data indicated that the highest total emissions in the primary metals industry consisted primarily of zinc, nitrate, and manganese compounds.

Iron and steel mills and the copper rolling, drawing, and extruding industries most often reported releases of zinc compounds. These facilities most often reduced zinc emissions by using improved maintenance scheduling, recordkeeping, or procedures (W13), such as dedicating an employee to managing and auditing scrap metal. The second most common P2 practice among these facilities was improving procedures for loading, unloading, and transfer operations (W32).

Iron and steel mills and iron foundries most often reported manganese compound releases. Companies in these sectors reported P2 practices similar to those discussed above. One iron and steel mill in Illinois instituted recirculation within a process (W51). The water recirculation line was expected to significantly decrease the amount of trace levels of manganese compounds discharged to the Illinois River.

None of the facilities reported P2 practices associated with reduced emissions of nitrate compounds.

NAICS code 332 – Fabricated Metal Product Manufacturing

TRI data indicated that the highest total emissions in the fabricated metals industry consisted primarily of zinc compounds, certain glycol ethers, and N-butyl alcohol.

The electroplating, plating, polishing, anodizing, and coloring industry and the metal coating and engraving industries reported the release of zinc compounds. These facilities most often used improved procedures (W13), such as additional training of operators to reduce zinc drag-out to reduce these emissions. Several facilities also reported modifying equipment, layout, or piping (W52) (i.e., installing a reverse osmosis unit to recover metals and return them to the plating process). Some other P2 practices mentioned include: instituting recirculation within a process (W51) (i.e., re-routing zinc-rich demister collection water from on-site wastewater treatment back into the electrolyte tank for reuse, which reduced the amount of waste treatment sludge containing zinc); improving procedures for loading, unloading, and transfer operations (W32); and process modifications (W58) (i.e., using insoluble carbon anodes in place of zinc anodes).

The metal can and container manufacturing industries and the crown and closure manufacturing industry reported releases of certain glycol ethers. These facilities most often cited improved maintenance scheduling and procedures (W13) (i.e., reducing inside spray usage by instituting a more frequent equipment maintenance schedule) to reduce these emissions. Some facilities also mentioned substitution of coating materials (W73) to reduce the solvent content of the paints and coatings used in production; and the substitution of raw materials (W42). One facility in Minnesota reduced the overuse of varnish by improving application with a narrow gravure roll (W52 and W74).

To reduce N-butyl alcohol emissions, facilities focused on improved maintenance scheduling, recordkeeping, or procedures (W13). They also changed operating practices (W19) and production practices (W14).

NAICS code 333 – Machinery Manufacturing

TRI data indicated that the highest total emissions in the machinery industry consisted primarily of manganese and copper compounds.

The welding and soldering equipment and air and gas compressor manufacturing sectors reported releases of manganese compounds. P2 practices used to reduce these emissions included introducing an in-line product quality monitoring or other process analysis system (W15) and modifying the process (W58) to use a dust filter collection system.

The mechanical power transmission equipment and industrial/commercial fan and blower manufacturing sectors reported releases of copper compounds. Facilities in these sectors reported using the following P2 practices to reduce copper emissions: improved maintenance scheduling, recordkeeping, or procedures (W13); process modifications (W58); changing from small-volume containers to bulk containers to minimize discarding (W55); and raw material modifications (W49) (e.g., purchasing larger gear blanks with dimensions closer to the final part size resulting in less metal scrap).

NAICS code 334 – Computer and Electronic Product Manufacturing

TRI data indicated that the highest total emissions in the computer/electronic products industry consisted primarily of zinc and copper compounds and toluene.

The semiconductor and related device manufacturing industry most often reported zinc releases. An Ohio company reported that they reclaimed powder out of material that would have been sent to disposal (process modification (W58)). They also re-piped and added filters to the dispersion operation to allow reduced slurry loss to the wastewater treatment system (modifying equipment, layout, or piping (W52)).

The printed circuit assembly, bare printed circuit board, and totalizing fluid meter and counting device manufacturing industries reported copper emissions. These facilities reported raw material modifications (W49) to reduce these emissions. They also sometimes changed their operating practices (W19). One facility reported that they restricted access to the copper anode storage area via a locked cage and began keeping a running daily inventory of the anodes.

Some facilities also instituted recirculation within a process (W51). The manufacturing process involves sanding and rinsing copper panels with water spray that is often discharged into a POTW. One Wisconsin facility reported that they began recycling and reusing their rinsewater, which led to decreased discharge of water containing copper fines, with the added benefit of water conservation. This same facility reported modifying their equipment, layout, or piping (W52) to install a filter system to filter the copper fines out of the rinsewater and trap them in a particulate state. They tested several filter alternatives (including a centrifuge and diatomaceous earth-coated filters) that were unsuccessful because of the small size of the copper particles. They also piloted an ultrafiltration system. The facility only noted a reduction of copper emissions in one (of four) reporting years.

To attempt to reduce toluene emissions, one Minnesota company modified stripping/cleaning equipment (W59) by implementing disposal liners in their process, which allowed them to stop using toluene as a cleaner. However, this P2 activity did not lead to a reduction in overall toluene emissions during that reporting year.

NAICS code 335 – Electrical Equipment

TRI data indicated that the highest total emissions in the electrical equipment industry consisted primarily of certain glycol ethers and barium and lead compounds.

The major household appliance manufacturing sector reported emissions of certain glycol ethers. The only P2 practice reported in this sector involved process modifications (W58). The facility reporting this practice gave no further details.

A current-carrying wiring device manufacturing facility in Minnesota most often reported releases of barium compounds. This facility reported using improved maintenance scheduling, recordkeeping, or procedures (W13) and raw material modifications to reduce these emissions, but a reduction was only achieved in one out of five reporting years.

The storage battery; current-carrying wiring device; and electric lamp bulb and part manufacturing industries most often reported releases of lead compounds. To reduce these emissions, companies reported using: improved maintenance scheduling, recordkeeping, or procedures (W13); process modifications (W58); implementation of an inspection and monitoring program of potential spill or leak sources (W36); and the substitution or modification of raw materials (W42 and W49) (e.g., converting from a leaded glass product used in lamp manufacturing to a lead-free glass product (e.g., plastic pellets) or replacing the lead soldering of lamp base connections with welded connections).

NAICS code 336 – Transportation Equipment

TRI data indicated that the highest total emissions in the transportation equipment industry consisted primarily of N-butyl alcohol, xylene, and 1,2,4-trimethylbenzene.

The automobile; light truck and utility vehicle; and motor vehicle body and parts manufacturing industries most often reported N-butyl alcohol emissions. These facilities reduced these emissions by using improved application techniques (W74), which reduced the number of painted vehicles that needed to go back through booths for touch-ups. They also modified equipment, layout, or piping (W52). Several facilities changed their production schedule to minimize equipment or feedstock changeovers (W14). One specific strategy was to line up trucks of the same color when painting so that colors needed to be changed less often, which resulted in less purging of lines with chemicals containing N-butyl alcohol. One company reported purging or flushing lines with chemicals with a lower percentage of N-butyl alcohol (substituting a feedstock or reagent chemical with a different chemical (W43)).

These industry sectors also reduced xylene emissions. They most often reported substituting raw materials (W42) (e.g., changing surface coating and paint materials to contain less or no xylene). Facilities in these sectors also reported process modifications (W58). One company reported taking purge gasoline from the line side and reusing it for maintenance vehicles. Another outsourced their entire painting process to an outside contractor with a state-of-the-art emissions capture system. Another P2 practice reported was changing from solvent-based floor cleaners to aqueous cleaners (W61).

One company reported trying to improve spill and leak detection (W39) from both virgin and return lines by purchasing a new photoionization detector and installing hard-piped overflow alarms for all hazardous waste containers. However, no reduction in xylene releases were noted.

To reduce emissions of 1,2,4-trimethylbenzene, companies often reported process modifications (W58). Some facilities subcontracted production-part painting to outside vendors. Others reduced the number of pigment changes or substituted coating materials (W73) to use products that contain less solvent.

NAICS code 337 – Furniture

TRI data indicated that the highest total emissions in the furniture industry consisted primarily of toluene, xylene, and N-butyl alcohol.

The wood kitchen cabinet and countertop manufacturing industry most often reported toluene releases. Facilities in this sector most often reported substitution of raw materials (W42) (e.g., switching to products that contain less toluene) and improved maintenance scheduling, recordkeeping, or procedures (W13). Some facilities also reported equipment modifications (W52) (e.g., replacing spray painting equipment, which used solvent based paint, with a powder coating system). Some also reported improved application techniques (W74). Reductions in toluene releases were sometimes noted for all of these practices.

These same industrial sectors reduced xylene emissions through improved maintenance scheduling, recordkeeping, or procedures (W13); process modifications (W58); equipment modifications (W52): improved application techniques (W74); and spill or leak prevention (W39). One company replaced spray equipment with roll-coating and replaced xylene-based materials with UV-cured material (W75). Another company modified spray systems or equipment (W72) by installing a system that uses nitrogen instead of compressed air. In theory, this improves spray application and quality and reduces material usage. However, the facility did not note associated reductions in xylene emissions.

One facility reported reducing N-butyl alcohol releases by using a variety of P2 techniques including: spill and leak prevention (W36 and W39), good operating practices (W13 and W19), process modifications (W52 and W55), and product modifications (W82).

A more in-depth look at release reduction data

Analysis of the TRI P2 reporting data shows that some facilities are finding creative ways to reduce or adjust their chemical use at the source, which eventually leads to emissions reductions. From 2009-2013, there were 3,897 TRI P2 entries showing release reductions in Region 5 states for NAICS codes 311 through 337. This represented data from over 1,000 facilities. These facilities reported a reduction in 43,232,930 pounds of toxic emissions. **Table 4** gives an overview of the data from each industry sector that reported release reductions and TRI P2 data.

Some entries showing reductions did not list a specific W code, but were still included in this section. Reduction statistics were compiled from Database 4 (as described in Appendix D). Therefore, the numbers may be slightly different than those one would get from a search on the TRI site by individual NAICS code.

Table 4: P2 Release Reduction Data –2009-2013						
Industry sector (NAICS Code)	**TRI entries reporting release reductions**	**Facilities reporting release reductions**	**Lbs. of toxic emissions reduced**	**Subsectors with highest reductions**	**Most common P2 category**	**Most frequent W code**
Food Processing (311)	117	47	4,271,021	Cheese processing; Wet corn milling	Process modifications	W58
Beverage/Tobacco (312)	1	1	303	Distillery	Good operating practices	W19
Textile Mills (313)	9	3	78,831	Fabric coating mills	Raw material modifications	W42
Textile Product Mills (314)	0	0	NA	NA	NA	NA
Apparel (315)	0	0	NA	NA	NA	NA
Leather (316)	5	4	22,605	Leather and hide tanning and finishing; Rubber and plastics footwear	Product modifications	W19
Wood (321)	43	12	220,612	Reconstituted wood products	Product modifications	W81
Paper (322)	132	34	624.974	Paper mills (except newsprint)	Process modifications	W58
Printing (323)	67	18	99,601	Commercial gravure printing	Good operating practices	W13
Petroleum (324)	99	16	945,129	Petroleum refineries	Process modifications	W52
Chemicals (325)	1,204	250	16,444,688	Paint/coatings	Good operating practices	W13
Plastics/Rubber (326)	256	98	1,338,843	All other plastics product manufacturing	Good operating practices	W42
Nonmetallic Mineral Products (327)	80	34	1,185,508	Mineral wool manufacturing	Process modifications	W58
Primary Metals (331)	351	88	12,663,048	Iron and steel mills	Good operating practices	W13
Fabricated Metals (332)	476	158	2,103,045	Electroplating, anodizing, polishing, plating, and coloring	Good operating practices	W13
Machinery (333)	127	49	239,737	Commercial/industrial refrigeration equipment, heating/air conditioning equipment	Good operating practices	W42
Computers/ Electronic Products (334)	150	70	549,593	Printed circuit assembly manufacturing	Process modifications	W42
Electrical Equipment (335)	107	31	157,759	Other communication and energy wire manufacturing	Process modifications	W13
Transportation Equipment (336)	587	112	2,078,005	Automobile manufacturing	Process modifications	W58
Furniture (337)	86	13	209,626	Wood kitchen cabinet & countertop manufacturing	Good operating practices	W13

The industry sectors with the greatest reduction in toxic emissions by total pounds (as reported in TRI P2 entries) are:

- NAICS 325 – Chemicals
- NAICS 331 – Primary Metals
- NAICS 311 – Food Processing
- NAICS 332 – Fabricated Metals
- NAICS 336 – Transportation Equipment

A quantitative study published in *Environmental Science and Technology* described many of the empirical challenges associated with the study of P2 data (Ranson et al., 2015). For example, simply comparing releases from one year to the next for a facility-chemical combination does not account for other factors that may have influenced toxic releases. Production cycles, economic trends, and new environmental regulations can also have a measureable effect on emissions from one year to the next or over several years.

The data in **Table 4** provide a quick way to see which industries are most successful with P2 implementation, but they do not tell the full story. For that, it is important to look at the comments provided by the facilities that report TRI P2 data. For example, some facilities reported that reductions in releases were actually a result of decreased production due to a downturn in the economy. Conversely, one facility stated that although they had instituted a variety of P2 practices to reduce emissions, their emissions numbers increased because production had increased significantly that year, which resulted in using more of that particular chemical. Other facilities stated that it would take some time to really see the results of changes in processes and/or products or in getting new equipment to full functional capacity.

Another way to measure the impact of pollution prevention practices on regional emissions is to look at all of the TRI entries that report any P2 data to see whether these projects have contributed to an overall decrease in emissions while also taking the increases into account. This study looked at TRI data from facilities characterized by NAICS codes 311 through 337 from 2009-2013. Using these criteria, there were 9,359 TRI P2 data entries, with approximately 17,004,941 pounds of toxic emissions reductions reported. This includes facilities that reported increased emissions even after implementing P2 practices. Although this is quite a bit smaller than the number calculated for only those TRI P2 entries reporting reductions (over 43 million pounds as stated above), this still indicates a net reduction of 17 million pounds of toxic emissions from 2009-2013 that can be attributed to the use of source reduction practices.

Ranson et al. (2015) used more sophisticated statistical analysis methods to look at the entire United States in a different range of years. They also found that when facilities use source reduction techniques, toxic releases decrease overall. They also found that the average source reduction project resulted in a 9-16% decrease in chemical releases. Finally, they reported that different P2 practices have varying levels of effectiveness in reducing releases. The most effective methods were raw material modification and product modification. These methods also tend to be more difficult and costly. One future data analysis project that would be useful is to compare the emissions rates over several years of individual facilities that report P2 activities to determine the relative success rates of various P2 practices.

Barriers to P2

Although **Table 4** shows that almost all industry sectors have reported release reductions, the discussions for each industry sector in the P2 section of this report make it clear that facilities are not reporting P2 activities for the most chemicals most frequently emitted in the highest quantities. For example, the petroleum industry reported no P2 activities for nitrate compounds and very few for sulfuric and hydrochloric acids, which are the sector's three most prevalent chemical releases. This sector reports P2 activities for other chemicals, but if they had assistance with targeting their largest source of chemical emissions, it would go farther towards decreasing overall chemical releases in the sector. It would be useful to know whether there are real or perceived barriers to implementing P2 practices for these chemicals.

Understanding the barriers to using P2 practices can illuminate common roadblocks and make it easier to identify technical assistance solutions. By analyzing TRI P2 data, TAPs can see how other facilities in the same industry sector overcame a perceived or real barrier and apply this information to a facility that is not using P2 strategies.

The TRI program has only been collecting information on barriers to P2 implementation since 2012 (Teitelbaum, 2015b). Some of the most common barriers to using P2 practices were:

- Facility reports that they are "maxed out", or have already incorporated any P2 technologies that they have deemed feasible for their operations;
- Facility says they have to use a specific chemical and cannot change because of the nature of their product; and
- Facility is concerned about product quality and/or cost if they change anything.

U.S. EPA has assigned general "barrier labels" to the numerous reasons facilities cite for not using P2 practices. These include:

- Concern for product quality
- "Chemical use" , which indicates that a specific chemical is required for a certain process/product
- P2 activities already implemented
- Insufficient capital
- Customer demand
- Infeasible

- Require technical information on P2 techniques
- Source reduction efforts were unsuccessful
- Specific regulatory/permit burdens
- Unclear
- Other

Table 5 shows which barrier categories are most commonly reported in each manufacturing sector.

Table 5. Barrier Reporting – Region 5 – 2013			
Industry Sector	**Number of TRI entries reporting barrier info**	**Number of facilities reporting barrier info**	**Most commonly reported barrier type/number of entries**
311-Food Processing	60	35	Chemical use/21 entries
312-Beverage/Tobacco	0	0	N/A
313-Textile Mills	2	2	Chemical use/1 entry
314-Textile Product Mills	1	1	P2 activities already implemented/1 entry
315-Apparel	0	0	N/A
316-Leather	3	2	N/A; each entry in this industry sector reported a different barrier
321-Wood	9	5	Insufficient capital/4 entries
322-Paper	21	13	Chemical use/7 entries
323-Printing	6	6	P2 activities already implemented/2 entries
324-Petroleum	23	7	Require technical information on P2 techniques/11 entries
325-Chemicals	187	87	P2 activities already implemented /51 entries
326-Plastics and Rubber	38	25	Concern for product quality/13 entries
327-Nonmetallic Mineral Products	14	11	Concern for product quality/6 entries
331-Primary Metals	106	41	Chemical use/48 entries
332-Fabricated Metals	167	72	P2 activities already implemented/59 entries
333-Machinery	78	26	Chemical use/32 entries
334-Computers/ Electronic Products	25	19	Chemical use/11 entries
335-Electrical Equipment	9	7	P2 activities already implemented/3 entries
336-Transportation Equipment	65	32	Chemical use/24 entries
337-Furniture	1	1	P2 activities already implemented/1 entry

Sometimes, a facility will offer a more detailed explanation of their entry. For example, “chemical use” and “concern for product quality” were frequently reported as barriers to using P2 practices in the food manufacturing and processing industry. In particular, companies cited that they believed the use of nitric acid was necessary and had traditionally been used at their facility for sanitation of packaging and processing equipment. One way for TAPs to overcome this barrier is to assist companies with identifying alternative products or methods for safe and effective sanitation. This may also be an area for future alternatives research if no such products or methods currently exist.

P2 TAPs can also target companies reporting that they “require technical information on P2 techniques.” These facilities may be receptive to incorporating P2 practices once they learn about them. For example, **Table 5** indicates that the petroleum industry cited this category as their most frequent barrier type. This correlates with findings discussed in the P2 section of this report. This industry sector did not seem to be using or reporting P2 practices to reduce their most commonly released chemicals. Perhaps they are not using P2 because they need help identifying alternative technologies that would ultimately lead to reduced emissions. It could also be that they perceive any already identified technologies as too costly or difficult to implement. P2 TAPs might also find it useful to analyze data outside of Region 5 to see if facilities in other parts of the country also fit this profile. If there are facilities in this sector that are reporting success with particular P2 strategies, TAPs can use that information to educate facilities in Region 5.

Greenhouse Gas Emissions

Background

In August 2012, the Natural Resources Defense Council (NRDC) released a report entitled *Toxic Power: How Power Plants Contaminate Our Air and States*. This report used an analysis of TRI data from 2010 to rank states in terms of overall industrial pollution and develop a Toxic 20 list. Ohio ranked second on their list, primarily because of GHG emissions from its large electricity-generation industry which consists largely of coal-fired power plants. Indiana was ranked fourth, also because of its coal-fired power plants, which were responsible for a large portion of the state’s GHG emissions. Michigan, Illinois, and Wisconsin ranked 7^{th}, 16^{th}, and 18^{th}, respectively. Minnesota was the only Region 5 state that did not rank in the top 20 most polluted states in that report (Natural Resources Defense Council, 2012). From these statistics, it is clear that GHG emissions, especially from coal-fired power plants, are an issue that Great Lakes states need to address.

More recently, the American Council for an Energy-Efficient Economy (ACEEE) ranked the world's largest 16 economies on their energy efficiency policies and programs (Young et al., 2014). One of the sectors analyzed was industry. The United States was 13^{th} out of 16 in energy efficiency in the industrial sector and overall. According to this report, the United States is one of only two countries with no national GHG reduction plan.

GHG Emission Trends

In U.S. EPA's EnviroFacts database, GHG emissions data are reported in metric tons of carbon dioxide equivalent value (or CO_2e). CO_2e values were calculated using the 100-year Global Warming Potentials (GWPs) from the *Climate Change 2007: Synthesis Report* prepared by the Intergovernmental Panel on Climate Change (IPCC), more commonly known as the IPCC's Fourth Assessment Report [Greenhouse Gas Reporting Program help desk, personal communication (June 29, 2015) and IPCC, 2007]. GWP is an index that measures how long a particular GHG remains in the atmosphere and how strongly it absorbs energy. Gases with a higher GWP absorb more energy and contribute more to global warming. A variety of GHGs may be included as part of a CO_2e value, including carbon dioxide, nitrous oxide, methane, and fluorinated gases.

Most common releases reported to the GHG reporting program in 2013 (U.S. EPA, 2015b)

- Carbon dioxide = 91.4% of total metric tons of CO2e
- Methane = 7%
- Nitrous Oxide = 0.8%
- Fluorinated gases = 0.7%

GHG data for Region 5 from 2010 through 2013 indicated that the most prevalent emitter of GHG was Indiana, followed by Ohio, Illinois, Michigan, Wisconsin, and Minnesota in that order. Trends over time show decreases in CO_2e emissions in the year 2012, with most states exhibiting a slight increase in 2013, except for Michigan and Minnesota. **Figure 11** shows these trends in CO_2e emissions.

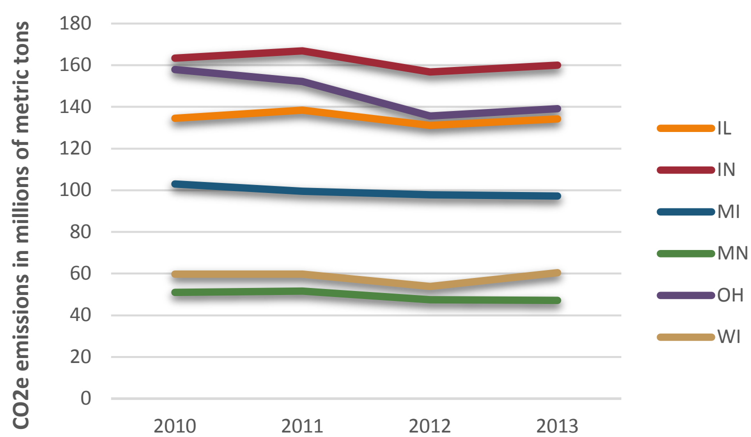


Figure 11: CO2e Emissions Trends (Region 5 States, 2010-2013)

GHG and Industry Sectors

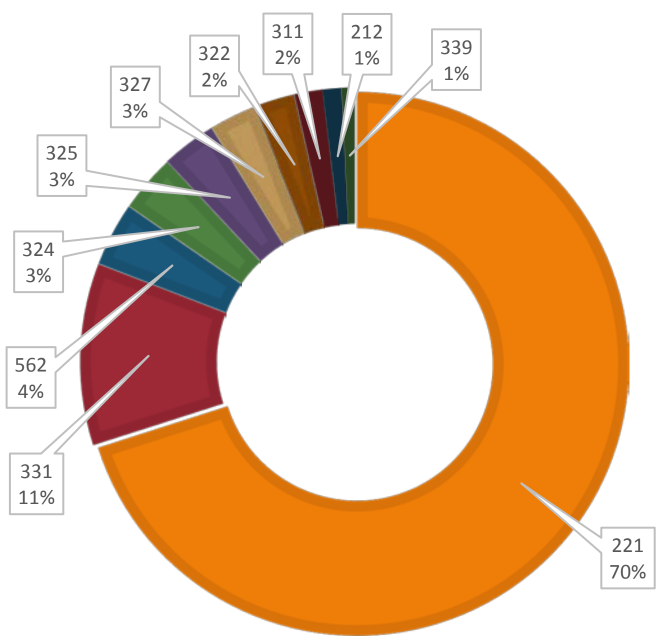
According to U.S. EPA, industry accounted for about 21% of total GHG emissions in the United States in 2013 (U.S.EPA, 2015b). In Region 5, the ten industry sectors listed in **Table 6** contributed the majority of CO_2e to air (in order by amount emitted).

Table 6: Top 10 CO_2e Emitters in Region 5 States -- 2013

Industry	NAICS code	Top State
Power plants, natural gas facilities, wastewater treatment plants	221	Indiana
Primary metal production	331	Indiana
Landfills	562	Michigan
Petroleum	324	Illinois
Chemical manufacturing	325	Illinois
Nonmetallic minerals	327	Ohio
Paper manufacturing	322	Wisconsin
Food processing	311	Illinois
Underground mining	212	Indiana
Misc. manufacturing	339	Ohio

Six of these sectors (shaded in red) are manufacturing industries included in this analysis. **Figure 12** shows the overall percentages of GHG emissions per industry sector in Region 5 states in 2013. This chart also provides more detail on the types of specific industries included in these sectors for this report. GHG emissions percentages from 2012 were the same as those shown in **Figure 12.** Some fluctuation in the percentages of emissions occurred in 2010 and 2011.

221 - Power plants, natural gas distribution companies, natural gas transmission and compression, wastewater treatment plants
331 - Production of aluminum, ferroalloy, lead, iron and steel, magnesium, and other metals
562 - Industrial and municipal landfills, solid waste combustion
324 - Petroleum refineries, other petroleum/natural gas



325 - Production of ammonia, ethanol, hydrogen, fluorinated GHG, nitric acid, titanium dioxide, petrochemicals, silicon carbide, and other chemicals
327 - Production of cement, glass, lime, and other minerals
322 - Pulp and paper mills, other paper producers
311 - Food processors
212 - Underground coal mines, zinc mining
339 - General manufacturing

Figure 12: Top 10 GHG Emitting Industrial Sectors (2013)

GHG data provides insight into which industrial sectors need assistance with air emissions. The authors of ACEEE's energy efficiency scorecard wrote, "Government should support the manufacturing and industrial sector to reduce the energy intensity of facilities by providing education, outreach, and training that will facilitate greater investment in energy efficiency and quicker adoption of systematic energy management practices.” (Young et al., 2014)

Energy efficiency improvements lead to reductions in GHG emissions. They also often lead to immediate cost savings, which make them an easier sell for technical assistance providers. They might ultimately also lead companies to investigate other changes to improve sustainability.

Economic Impact of Manufacturers

The U.S. Census Bureau’s County Business Patterns data includes information on the number of establishments and the sum of the annual payroll for each manufacturing sector analyzed during this project. Looking at these two economic indicators provides a general idea of the economic impact of different industry sectors within Region 5 and the variations between states.

When looking at the overall numbers of facilities, the top five manufacturing sectors in Region 5 from 2009-2013, in order, are:

1. NAICS code 332 - Fabricated metal products
2. NAICS code 333 - Machinery
3. NAICS code 323 - Printing and related support activities
4. NAICS code 311 - Food processing
5. NAICS code 326 - Plastics and rubber products.

There were no differences in these top five overall spots when data sets from each year for Region 5 were analyzed individually. However, there was some variation between individual states. Although every Region 5 state listed fabricated metal products and machinery manufacturers as first and second, respectively, in terms of numbers of facilities, the third through fifth spots showed a few differences.

Indiana and Michigan listed transportation equipment manufacturers as their third most prevalent industry; Illinois, Minnesota, and Ohio listed the printing industry in the third spot; Wisconsin ranked the food industry as third.

The printing industry was fourth in Indiana, Michigan, and Wisconsin; the food industry in Illinois and Minnesota; and the plastics and rubber products industry in Ohio.

Plastics and rubber facilities were ranked fifth for Illinois and Indiana; the food industry was fifth in Michigan and Ohio; Minnesota listed the furniture industry in the fifth spot; and the wood product industry was fifth in Wisconsin.

Figure 13 shows the top 10 industry sectors in terms of number of establishments by state for the combined years of 2009-2013.

The top five manufacturing sectors in Region 5 from 2009-2013 by sum of annual payroll dedicated to that industry, in order, are:

1. NAICS code 336 - Transportation equipment
2. NAICS code 332 - Fabricated metal products
3. NAICS code 333 - Machinery
4. NAICS code 311 - Food processing
5. NAICS code 325 – Chemical industry

Figure 14 shows the top 10 industry sectors in terms of amount of annual payroll per state, for 2009-2013 combined. As with the number of facilities, there were no differences in these top five overall spots when data sets from each year for Region 5 were analyzed individually. However, there was some variation between individual states.

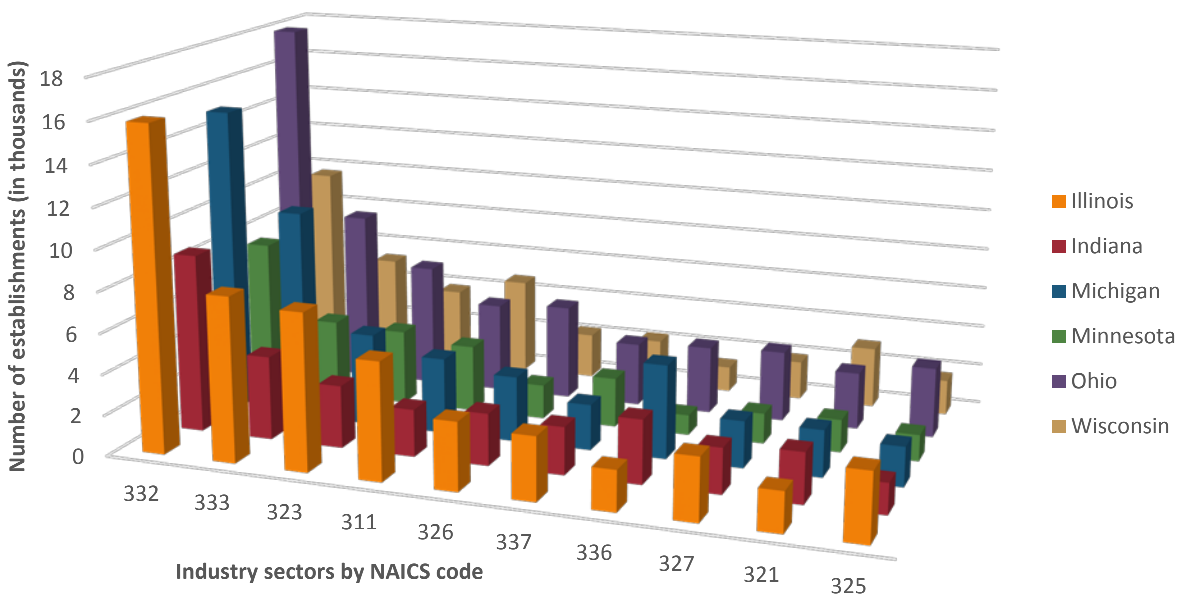


Figure 13: Manufacturing Establishments by Industry Sector (Top 10, 2009-2013)

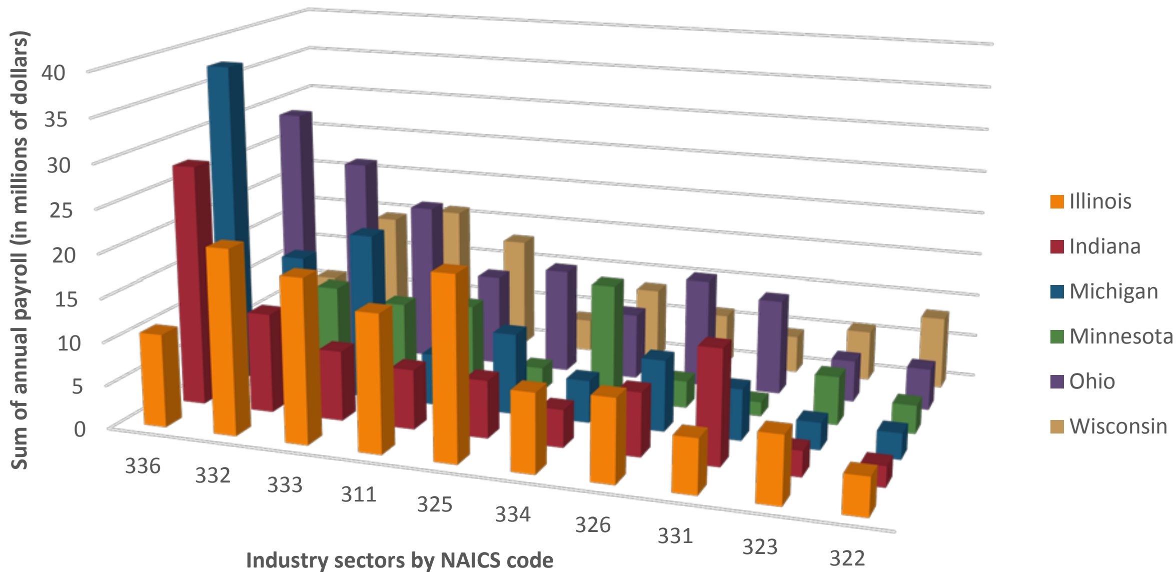


Figure 14: Annual Payroll by Industry Sector (Top 10, 2009-2013)

Fabricated metal products and machinery manufacturers were in the top five for every state, although the position in each state was slightly different. For Illinois, the fabricated metals industry was first. For Wisconsin, the machinery manufacturing industry took that spot. In Indiana, Michigan, and Ohio the transportation equipment industry had the highest total payroll, while Minnesota's highest was the computer and electronic product industry. The remaining five spots were generally occupied by the chemical, food, transportation, and plastics and rubber industries. Some other interesting trends included the following:

- Indiana was the only state where the primary metals industry appeared in the top five sectors by payroll.
- Wisconsin was the only state where the payroll for the paper manufacturing industry ranked in the top five.
- Computer and electronic product companies both ranked in the top five for Minnesota and Wisconsin in terms of payroll dollars.
- Minnesota was the only state with the printing industry occupying one of the top five payroll spots.

From these data, it is clear that each state has its own economic priorities. This shift in perspective may allow P2 TAPs to focus on the specific needs of their state to target the industries that have the highest economic and environmental impact.

Data Visualization Using Tableau

Tableau is a data visualization software package that allows users to easily blend together data from different sources and create maps, charts, and graphs to help them see trends that they might miss when looking at each data set separately. Tableau also allows users to create interactive dashboards and use them to highlight and filter data to show relationships.

Figure 15 shows how creating a compilation of TRI emissions data visualizations can immediately highlight key points. This allows states to identify areas of concern within their boundaries and provide TAPs with crucial information to guide the direction of future programs. The next phase of GLRPPR's data initiative involves creating web-based Tableau dashboards which will allow TAPs to filter environmental and economic data in different ways.

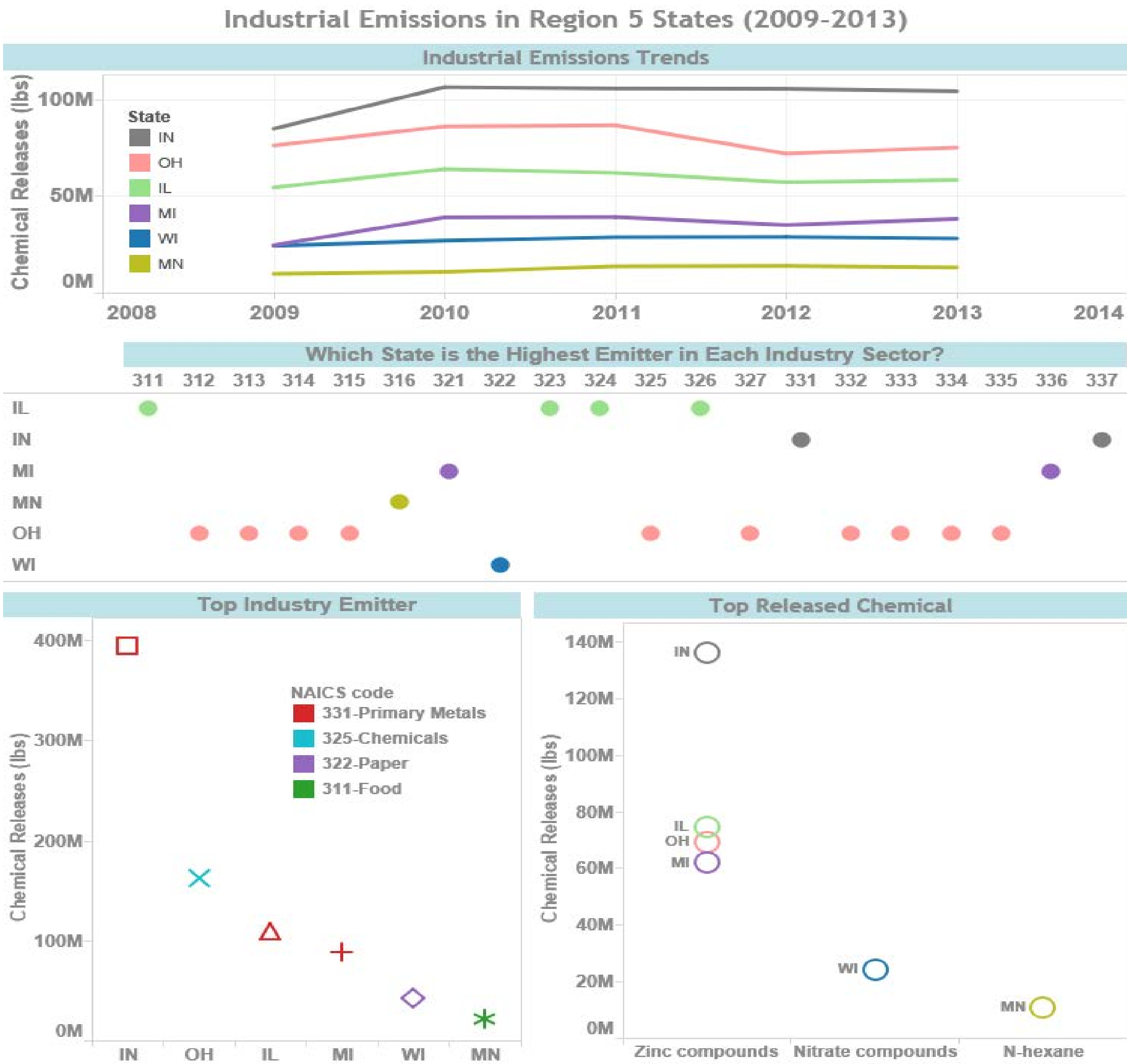


Figure 16 shows the number of times a P2 practice was reported as a tool for reduction of nitrate compound emissions by the food industry from 2009-2013. This chart also indicates which states in the region were most active in P2 for this particular chemical/industry combination and which source reduction techniques each state preferred. These types of data visualizations can easily be created in Tableau for any industry sector, chemical, state, or year. Users can also combine these variables to better understand trends across sectors, states, and time.

	Other process modifications	Other cleaning and degreasing modifications	Improved maintenance scheduling, recordkeeping, or procedures	Other changes in spill or leak prevention	Instituted better controls on operating bulk containers to minimize discarding of empty containers	Implemented inspection or monitoring program of potential spill or leak sources	Improved procedures for loading, unloading, and transfer operations	Modified equipment layout or piping	Substituted raw materials	Changed product specifications	Changed production schedule to minimize equipment and feedstock changeovers	Instituted procedures to ensure that materials do not stay in inventory beyond shelf-life	Developed a new chemical product to replace a previous chemical product	Improved rinse equipment operation	Other changes in operating practices
IN	2														
MN	14	13	10	1			6	4			3	2			
IL	3			8	8	8									
WI	16	4	1					1	2				1		1
OH			1							3					
MI	8		5						3					1	

Figure 16: P2 practices most frequently used in the food industry to reduce nitrate compound emissions.

By allowing users to combine data sets, Tableau makes it easier to identify industry sectors that are both important to the economy and high chemical emitters. **Figure 17** illustrates how data analysis can aid in decision-making on the state, local, agency, and programmatic levels. By looking at the dashboard, it is readily apparent that the food processing and fabricated metals industries both rank high in economic and environmental impact. The next highest are the plastics and rubber products manufacturing industry and the transportation equipment manufacturing industry.

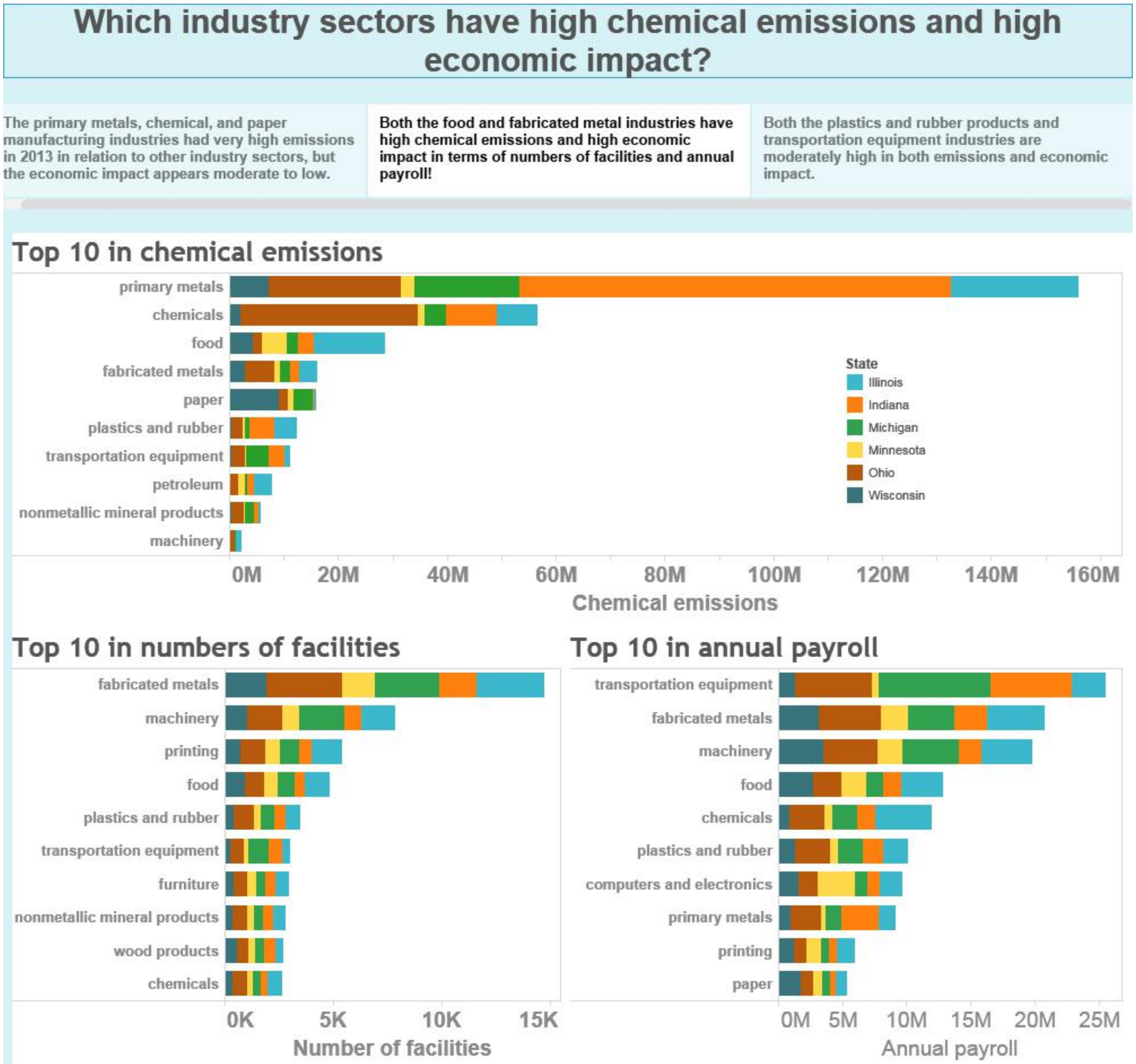


Figure 17: Tableau dashboard story showing the Region 5 manufacturing sectors with the highest economic and environmental impact

Conclusion

Because the Toxics Release Inventory focuses on large industrial emitters, it is an excellent starting point for studying trends in chemical emissions and the effectiveness of P2 practices in the manufacturing sector. Although smaller industries not subject to TRI reporting may not be represented in the data studied for this paper, P2 TAPs can utilize the information provided by leveraging the ideas that work for large manufacturers and implementing these P2 techniques at scale for smaller industries.

Larger facilities have more capital and personnel to invest in research and experimentation as they work to make their facilities more efficient and increasingly sustainable. Smaller companies might have fewer funds and limited (if any) personnel to dedicate to solving complex emissions problems. Scaling down to apply P2 solutions to small industries can present unique challenges and exciting opportunities. If a small local company is lacking funds to implement an identified P2 practice, P2 TAPs can help them find funding sources or brainstorm to identify alternate solutions. They can also provide individual training in more sustainable practices and the scientific expertise to facilitate change on a local level.

A recent paper published by David S. Liebl at the University of Wisconsin-Madison outlines an innovative strategy that P2 TAPs could use to successfully diffuse P2 information to non-TRI facilities. Begin by grouping facilities by NAICS codes and analyzing the chemical emissions and reductions achieved with P2 solutions over time, which allows TAPs to identify source reduction opportunities in the TRI data. Facilities that appear to be good prospects are then contacted to verify details of process- and chemical-specific successes. It is also important to understand the number of TRI and non-TRI facilities that would benefit from diffusion of the source reduction method in question, as well as the ability and priorities of the organization providing assistance. TAPs can then work directly with targeted facilities in the diffusion process as they implement a P2 practice and measure its rate of success in reducing emissions (Liebl, 2015).

Transformation to a more sustainable manufacturing environment in the Great Lakes states can also be achieved by the application of the principles of community-based social marketing (CBSM) and other behavior change strategies identified in the social science literature. See GLRPPR's Behavior Change and Sustainability sector resource (http://www.glrppr.org/contacts/gltopichub.cfm?sectorid=152) for recent publications on this topic. U.S. EPA's TRI P2 data collection efforts support this theory. They began collecting information on barriers to using P2 practices in 2012 and 2013, as illustrated in **Table 5** earlier in this report. They also have a rough method of evaluating the success of a P2 strategy by comparing the amount of a specific chemical released in the current year to the prior year, determining the percent change. From there, it is possible to identify which source reduction method (or W code) may have led to this release reduction from a purely statistical viewpoint (see **Table 4**). Analysis of facility comments regarding P2 practices and determination of their "diffusion potential" provides valuable process and chemical-specific information that can be used by P2 TAPs to develop pilot programs (Liebl, 2015).

The TRI P2 program and the regional P2Rx centers also highlight case studies from companies that have successfully implemented P2 strategies in their facilities. These can be used as an introduction to strategies that might work for a specific industry sector and/or a specific chemical. Companies can engage in a technique called social diffusion by reading about what worked for the respected leaders in their field and emulating those P2 practices to scale at their own facilities. Although this is admittedly an information-intensive method of supplying ideas, P2 TAPs and P2Rx Centers can serve as facilitators who translate technical information from one facility into the knowledge of how to implement that strategy in one or more similar facilities.

Data analysis tools like Tableau can assist in identifying which industry sectors to target for assistance by combining and visualizing both economic and chemical emissions data. The user can choose the issues that are most relevant in their state or agency and create visualizations that will help them understand their data. Training P2 TAPs in the use of interactive data analysis tools such as Tableau can lead to more informed decision-making and better communication with collaborative partners.

The next step of this project is to make these data sets available on the GLRPPR web site through Tableau or Excel dashboards, which will enable P2 TAPs in Region 5 to combine economic and environmental data in ways that are useful to them.

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Appendix A: List of NAICS codes and corresponding industry sectors

311	Food manufacturing
312	Beverage and tobacco product manufacturing
313	Textile mills
314	Textile product mills
315	Apparel manufacturing
316	Leather and allied product manufacturing
321	Wood product manufacturing
322	Paper manufacturing
323	Printing and related support activities
324	Petroleum and coal products manufacturing
325	Chemical manufacturing
326	Plastics and rubber products manufacturing
327	Nonmetallic mineral product manufacturing
331	Primary metal manufacturing
332	Fabricated metal product manufacturing
333	Machinery manufacturing
334	Computer and electronic product manufacturing
335	Electrical equipment, appliance, and component manufacturing
336	Transportation equipment manufacturing
337	Furniture and related product manufacturing

Appendix B: Top chemical emissions for Region 5 states in 2009-2013 listed by NAICS code

If the majority of the chemical emission is directed towards one environmental medium, only that one is listed. If emissions are relatively equally divided between two or more environmental media, all destinations are listed.

NAICS code	State	Year	Top emitted Chemical	Amount released (pounds)	Primary environmental medium destination
311	IL	2013	Nitrate compounds	5,521,506	Water
311	IL	2012	Nitrate compounds	4,620,175	Water
311	IL	2011	Nitrate compounds	5,380,499	Water
311	IL	2010	Nitrate compounds	6,470,274	Water
311	IL	2009	Nitrate compounds	8,754,348	Water
311	IN	2013	N-hexane	2,013,556	Air
311	IN	2012	N-hexane	1,991,132	Air
311	IN	2011	N-hexane	2,006,225	Air
311	IN	2010	N-hexane	2,151,069	Air
311	IN	2009	N-hexane	2,120,362	Air
311	MI	2013	Nitrate compounds	1,451,222	Water
311	MI	2012	Nitrate compounds	1,333,766	Water
311	MI	2011	Nitrate compounds	1,734,095	Water
311	MI	2010	Nitrate compounds	1,772,204	Water
311	MI	2009	Nitrate compounds	1,839,962	Water
311	MN	2013	N-hexane	2,400,843	Air
311	MN	2012	N-hexane	2,191,440	Air
311	MN	2011	N-hexane	1,900,817	Air
311	MN	2010	N-hexane	1,828,607	Air
311	MN	2009	N-hexane	1,709,315	Air
311	OH	2013	N-hexane	1,068,053	Air
311	OH	2012	N-hexane	1,167,619	Air
311	OH	2011	N-hexane	1,060,640	Air
311	OH	2010	N-hexane	1,017,616	Air
311	OH	2009	N-hexane	845,279	Air
311	WI	2013	Nitrate compounds	4,085,930	Water, land, off-site releases
311	WI	2012	Nitrate compounds	4,421,255	Water, land, off-site releases
311	WI	2011	Nitrate compounds	4,274,091	Water, land, off-site releases
311	WI	2010	Nitrate compounds	4,179,313	Water, land, off-site releases
311	WI	2009	Nitrate compounds	3,649,552	Water, land, off-site releases
312	IL	2013	“Nicotine and salts”	12,068	Off-site releases
312	IL	2012	“Nicotine and salts”	27,028	Off-site releases
312	IL	2011	“Nicotine and salts”	29,584	Off-site releases

312	IL	2010	“Nicotine and salts”	11,829	Off-site releases
312	IL	2009	“Nicotine and salts”	9,027	Off-site releases
312	IN	2013	No emissions cited	NA	NA
312	IN	2012	No emissions cited	NA	NA
312	IN	2011	No emissions cited	NA	NA
312	IN	2010	No emissions cited	NA	NA
312	IN	2009	No emissions cited	NA	NA
312	MI	2013	Ammonia	255	Air
312	MI	2012	No emissions cited	NA	NA
312	MI	2011	Ammonia	255	Air
312	MI	2010	Ammonia	255	Air
312	MI	2009	Ammonia	255	Air
312	MN	2013	No emissions cited	NA	NA
312	MN	2012	No emissions cited	NA	NA
312	MN	2011	No emissions cited	NA	NA
312	MN	2010	No emissions cited	NA	NA
312	MN	2009	No emissions cited	NA	NA
312	OH	2013	Hydrochloric acid	51,284	Air
312	OH	2012	Hydrochloric acid	90,505	Air
312	OH	2011	Hydrochloric acid	121,280	Air
312	OH	2010	Hydrochloric acid	137,000	Air
312	OH	2009	Nitrate compounds	179,967	Water
312	WI	2013	Ammonia	6,800	Air
312	WI	2012	Ammonia	12,276	Air
312	WI	2011	Ammonia	15,306	Air
312	WI	2010	Ammonia	21,107	Air
312	WI	2009	Ammonia	15,711	Air
313	IL	2013	Toluene	6,690	Air
313	IL	2012	Toluene	7,303	Air
313	IL	2011	Toluene	7,992	Air
313	IL	2010	Toluene	4,908	Air
313	IL	2009	Ammonia	6,746	Air
IL has no emissions data cited for NAICS code 314.					
313/314	IN	2013	No emissions cited	NA	NA
313/314	IN	2012	No emissions cited	NA	NA
313/314	IN	2011	No emissions cited	NA	NA
313/314	IN	2010	No emissions cited	NA	NA
313/314	IN	2009	No emissions cited	NA	NA
313	MI	2013	Toluene	30,750	Air
313	MI	2012	Toluene	24,825	Air
313	MI	2011	Toluene	28,825	Air
313	MI	2010	Toluene	24,079	Air
313	MI	2009	Toluene	14,614	Air
MI has no emissions data cited for NAICS code 314.					
MN has no emissions data cited for NAICS code 313.					
314	MN	2013	Lead compounds	0.056	Air
314	MN	2012	Lead compounds	0.055	Air
314	MN	2011	Lead compounds	0.041	Air
314	MN	2010	Lead compounds	0.045	Air
314	MN	2009	Lead compounds	0.058	Air
313	OH	2013	Toluene	29,142	Air
313	OH	2012	Toluene	33,028	Air
313	OH	2011	Toluene	40,447	Air

313	OH	2010	Toluene	39,027	Air
313	OH	2009	Toluene	43,074	Air
314	OH	2013	Ammonia	860	Air, off-site releases
314	OH	2012	Ammonia	1,260	Off-site releases, air
314	OH	2011	Ammonia	1,140	Off-site releases, air
314	OH	2010	Ammonia	600	Air, off-site releases
314	OH	2009	Ammonia	740	Air, off-site releases
313	WI	2013	N-methyl-2-pyrrolidone	14,684	Air
313	WI	2012	N-methyl-2-pyrrolidone	66,120	Air
313	WI	2011	N-methyl-2-pyrrolidone	89,659	Air
313	WI	2010	N-methyl-2-pyrrolidone	72,026	Air
313	WI	2009	N-methyl-2-pyrrolidone	9,559	Air
WI has no emissions data cited for NAICS code 314.					
315	IL	2013	No emissions cited	NA	NA
315	IL	2012	No emissions cited	NA	NA
315	IL	2011	No emissions cited	NA	NA
315	IL	2010	No emissions cited	NA	NA
315	IL	2009	No emissions cited	NA	NA
315	IN	2013	No emissions cited	NA	NA
315	IN	2012	No emissions cited	NA	NA
315	IN	2011	No emissions cited	NA	NA
315	IN	2010	No emissions cited	NA	NA
315	IN	2009	No emissions cited	NA	NA
315	MI	2013	No emissions cited	NA	NA
315	MI	2012	No emissions cited	NA	NA
315	MI	2011	No emissions cited	NA	NA
315	MI	2010	No emissions cited	NA	NA
315	MI	2009	No emissions cited	NA	NA
315	MN	2013	No emissions cited	NA	NA
315	MN	2012	No emissions cited	NA	NA
315	MN	2011	No emissions cited	NA	NA
315	MN	2010	No emissions cited	NA	NA
315	MN	2009	No emissions cited	NA	NA
315	OH	2013	No emissions cited	NA	NA
315	OH	2012	No emissions cited	NA	NA
315	OH	2011	No emissions cited	NA	NA
315	OH	2010	Zinc compounds	3,659	Off-site releases
315	OH	2009	Zinc compounds	4,061	Off-site releases
315	WI	2013	No emissions cited	NA	NA
315	WI	2012	No emissions cited	NA	NA
315	WI	2011	No emissions cited	NA	NA
315	WI	2010	No emissions cited	NA	NA
315	WI	2009	No emissions cited	NA	NA
316	IL	2013	Ammonia	755	Air, land, off-site releases
316	IL	2012	Ethylene glycol	10	Air
316	IL	2011	Chromium compounds	11,386	Off-site releases
316	IL	2010	Chromium compounds	11,386	Off-site releases
316	IL	2009	Ammonia	32,984	Air
316	IN	2013	No emissions cited	NA	NA
316	IN	2012	No emissions cited	NA	NA
316	IN	2011	No emissions cited	NA	NA
316	IN	2010	No emissions cited	NA	NA
316	IN	2009	No emissions cited	NA	NA

316	MI	2013	Toluene	11,208	Air
316	MI	2012	Toluene	17,553	Air
316	MI	2011	Toluene	14,307	Air
316	MI	2010	Toluene	17,151	Air
316	MI	2009	Chromium compounds	23,166	Off-site releases
316	MN	2013	Chromium compounds	85,092	Off-site releases
316	MN	2012	Chromium compounds	78,472	Off-site releases
316	MN	2011	Chromium compounds	102,167	Off-site releases
316	MN	2010	Chromium compounds	85,573	Off-site releases
316	MN	2009	Chromium compounds	59,490	Off-site releases
316	OH	2013	No emissions cited	NA	NA
316	OH	2012	No emissions cited	NA	NA
316	OH	2011	No emissions cited	NA	NA
316	OH	2010	No emissions cited	NA	NA
316	OH	2009	No emissions cited	NA	NA
316	WI	2013	Chromium compounds	35,837	Off-site releases
316	WI	2012	Chromium compounds	34,607	Off-site releases
316	WI	2011	Chromium compounds	129,671	Off-site releases
316	WI	2010	Chromium compounds	51,023	Off-site releases
316	WI	2009	Chromium compounds	51,230	Off-site releases
321	IL	2013	Creosote	5,211	Air
321	IL	2012	Creosote	4,807	Air
321	IL	2011	Creosote	5,109	Air
321	IL	2010	Creosote	4,112	Air
321	IL	2009	Creosote	8,314	Air
321	IN	2013	Methanol	27,184	Air
321	IN	2012	Methanol	19,949	Air
321	IN	2011	Toluene	13,054	Air
321	IN	2010	Toluene	13,939	Air
321	IN	2009	Creosote	12,260	Air
321	MI	2013	Methanol	178,398	Air
321	MI	2012	Methanol	180,625	Air
321	MI	2011	Methanol	174,444	Air
321	MI	2010	Methanol	163,365	Air
321	MI	2009	Hydrochloric acid	138,197	Air
321	MN	2013	Methanol	24,798	Air
321	MN	2012	Methanol	35,898	Air
321	MN	2011	Methanol	21,137	Air
321	MN	2010	Methanol	21,141	Air
321	MN	2009	Methanol	67,228	Air
321	OH	2013	Certain glycol ethers	26,050	Air
321	OH	2012	Certain glycol ethers	25,939	Air
321	OH	2011	Certain glycol ethers	26,859	Air
321	OH	2010	Certain glycol ethers	27,358	Air
321	OH	2009	N-butyl alcohol	21,916	Air
321	WI	2013	Methanol	62,915	Air
321	WI	2012	Methanol	63,666	Air
321	WI	2011	Methanol	55,116	Air
321	WI	2010	Methanol	47,423	Air
321	WI	2009	Methanol	31,000	Air
322	IL	2013	Methanol	373,698	Air
322	IL	2012	Methanol	353,768	Air
322	IL	2011	Methanol	326,182	Air

322	IL	2010	Methanol	332,973	Air
322	IL	2009	Methanol	298,678	Air
322	IN	2013	Vinyl acetate	71,649	Air
322	IN	2012	Vinyl acetate	63,627	Air
322	IN	2011	Vinyl acetate	62,057	Air
322	IN	2010	Vinyl acetate	58,170	Air
322	IN	2009	Vinyl acetate	54,400	Air
322	MI	2013	Toluene	794,799	Air
322	MI	2012	Methanol	684,880	Air
322	MI	2011	Toluene	853,431	Air
322	MI	2010	Toluene	894,443	Air
322	MI	2009	Toluene	891,902	Air
322	MN	2013	Methanol	233,497	Air
322	MN	2012	Methanol	297,140	Air
322	MN	2011	Methanol	318,624	Air
322	MN	2010	Methanol	319,472	Air
322	MN	2009	Methanol	332,792	Air
322	OH	2013	Toluene	343,278	Air, off-site releases
322	OH	2012	Toluene	353,641	Air, off-site releases
322	OH	2011	Hydrochloric acid	686,344	Air
322	OH	2010	Hydrochloric acid	818,501	Air
322	OH	2009	Hydrochloric acid	866,752	Air
322	WI	2013	Methanol	3,760,166	Air
322	WI	2012	Methanol	3,803,480	Air
322	WI	2011	Methanol	2,940,259	Air
322	WI	2010	Methanol	2,774,102	Air
322	WI	2009	Methanol	3,732,509	Air
323	IL	2013	Toluene	568,261	Air
323	IL	2012	Toluene	531,107	Air
323	IL	2011	Toluene	680,378	Air
323	IL	2010	Toluene	1,433,705	Air
323	IL	2009	Toluene	943,838	Air
323	IN	2013	Toluene	681,599	Air
323	IN	2012	Toluene	852,456	Air
323	IN	2011	Toluene	478,551	Air
323	IN	2010	Toluene	525,818	Air
323	IN	2009	Toluene	595,542	Air
323	MI	2013	Toluene	13,059	Air
323	MI	2012	Toluene	15,112	Air
323	MI	2011	Nitric acid	20,909	Air
323	MI	2010	Nitric acid	20,909	Air
323	MI	2009	Nitric acid	20,909	Air
323	MN	2013	Certain glycol ethers	36,850	Air
323	MN	2012	Certain glycol ethers	31,811	Air
323	MN	2011	Certain glycol ethers	33,313	Air
323	MN	2010	Certain glycol ethers	23,622	Air
323	MN	2009	Certain glycol ethers	18,065	Air
323	OH	2013	Certain glycol ethers	16,277	Air
323	OH	2012	Certain glycol ethers	19,760	Air
323	OH	2011	Certain glycol ethers	42,609	Air
323	OH	2010	Certain glycol ethers	41,379	Air
323	OH	2009	Certain glycol ethers	56,729	Air
323	WI	2013	Toluene	336,302	Air

323	WI	2012	Toluene	241,161	Air
323	WI	2011	Toluene	317,123	Air
323	WI	2010	Toluene	319,407	Air
323	WI	2009	Toluene	299,895	Air
324	IL	2013	Sulfuric acid	1,051,552	Air
324	IL	2012	Sulfuric acid	1,180,741	Air
324	IL	2011	Sulfuric acid	1,058,041	Air
324	IL	2010	Nitrate compounds	1,119,187	Water
324	IL	2009	Nitrate compounds	1,161,036	Water
324	IN	2013	Hydrochloric acid	377,557	Air
324	IN	2012	Hydrochloric acid	323,111	Air
324	IN	2011	Hydrochloric acid	424,856	Air
324	IN	2010	Lead compounds	129,491	Off-site releases
324	IN	2009	Ammonia	152,146	Air
324	MI	2013	Benzene	75,831	Air
324	MI	2012	4,4’-isopropylidenediphenol	404,355	Off-site releases
324	MI	2011	Benzene	98,584	Air
324	MI	2010	Propylene	94,858	Air
324	MI	2009	1,2,4-trimethylbenzene	45,364	Air
324	MN	2013	Nitrate compounds	569,670	Water
324	MN	2012	Nitrate compounds	733,324	Water
324	MN	2011	Nitrate compounds	624,680	Water
324	MN	2010	Nitrate compounds	523,597	Water
324	MN	2009	Nitrate compounds	603,167	Water
324	OH	2013	Sulfuric acid	308,408	Air
324	OH	2012	Sulfuric acid	319,353	Air
324	OH	2011	Hydrochloric acid	451,306	Air
324	OH	2010	Hydrochloric acid	417,613	Air
324	OH	2009	Hydrochloric acid	374,545	Air
324	WI	2013	Xylene (mixed isomers)	31,173	Air
324	WI	2012	Ammonia	16,124	Air
324	WI	2011	Xylene (mixed isomers)	20,604	Air
324	WI	2010	Toluene	5,835	Air
324	WI	2009	Toluene	5,921	Air
325	IL	2013	Ammonia	1,090,514	Air
325	IL	2012	Manganese compounds	1,369,887	Off-site releases
325	IL	2011	Manganese compounds	1,173,602	Off-site releases
325	IL	2010	Manganese compounds	1,293,558	Off-site releases
325	IL	2009	Manganese compounds	1,324,033	Off-site releases
325	IN	2013	Nitrate compounds	3,852,334	Off-site releases
325	IN	2012	Sodium nitrite	4,800,500	Off-site releases
325	IN	2011	Sodium nitrite	3,130,500	Off-site releases
325	IN	2010	Dichloromethane	815,986	Air
325	IN	2009	Nitrate compounds	396,936	Water
325	MI	2013	Ammonia	830,557	Air
325	MI	2012	Ammonia	816,962	Air
325	MI	2011	Ammonia	844,727	Air
325	MI	2010	Ammonia	787,974	Air
325	MI	2009	Ammonia	729,906	Air
325	MN	2013	Nitrate compounds	280,297	Water
325	MN	2012	Nitrate compounds	211,711	Water
325	MN	2011	Nitrate compounds	240,206	Water
325	MN	2010	Nitrate compounds	172,203	Water

325	MN	2009	Nitrate compounds	165,324	Water
325	OH	2013	Ammonia	6,818,223	Air, UIC wells, off-site releases
325	OH	2012	Ammonia	4,433,637	Air, UIC wells, off-site releases
325	OH	2011	Manganese	5,791,449	Land
325	OH	2010	Ammonia	4,919,888	Air, UIC wells, off-site releases
325	OH	2009	Carbonyl sulfide	5,631,257	Air
325	WI	2013	Certain glycol ethers	784,866	Off-site releases, air
325	WI	2012	Certain glycol ethers	387,525	Off-site releases, air
325	WI	2011	Ammonia	472,907	Air
325	WI	2010	Ammonia	476,197	Air
325	WI	2009	Ammonia	519,581	Air
326	IL	2013	Carbon disulfide	3,465,400	Air
326	IL	2012	Carbon disulfide	3,752,500	Air
326	IL	2011	Carbon disulfide	3,515,300	Air
326	IL	2010	Carbon disulfide	3,226,600	Air
326	IL	2009	Carbon disulfide	3,356,400	Air
326	IN	2013	Styrene	3,070,801	Air
326	IN	2012	Styrene	2,596,882	Air
326	IN	2011	Styrene	2,236,246	Air
326	IN	2010	Styrene	1,980,337	Air
326	IN	2009	Styrene	1,414,340	Air
326	MI	2013	Styrene	314,560	Air
326	MI	2012	Styrene	300,111	Air
326	MI	2011	Styrene	284,911	Air
326	MI	2010	Styrene	256,547	Air
326	MI	2009	Styrene	284,930	Air
326	MN	2013	Toluene	186,545	Air
326	MN	2012	Styrene	162,608	Air
326	MN	2011	Styrene	134,321	Air
326	MN	2010	Styrene	131,883	Air
326	MN	2009	Styrene	104,328	Air
326	OH	2013	Styrene	856,570	Air, off-site releases
326	OH	2012	Styrene	841,501	Air, off-site releases
326	OH	2011	Styrene	759,029	Air, off-site releases
326	OH	2010	Styrene	756,377	Air, off-site releases
326	OH	2009	1-chloro-1,1-difluoroethane	1,094,990	Air
326	WI	2013	Toluene	179,029	Air
326	WI	2012	Styrene	190,242	Air
326	WI	2011	Styrene	259,493	Air
326	WI	2010	Styrene	212,835	Air
326	WI	2009	Styrene	248,389	Air
327	IL	2013	Sulfuric acid	113,468	Air
327	IL	2012	Sulfuric acid	111,369	Air
327	IL	2011	Ammonia	181,585	Air
327	IL	2010	Sulfuric acid	116,383	Air
327	IL	2009	Ammonia	113,695	Air
327	IN	2013	Hydrochloric acid	221,530	Air
327	IN	2012	Hydrochloric acid	244,886	Air
327	IN	2011	Hydrochloric acid	247,420	Air
327	IN	2010	Hydrochloric acid	242,476	Air

327	IN	2009	Carbonyl sulfide	259,100	Air
327	MI	2013	Hydrochloric acid	873,548	Air
327	MI	2012	Manganese	509,987	Off-site releases
327	MI	2011	Hydrochloric acid	817,443	Air
327	MI	2010	Hydrochloric acid	859,332	Air
327	MI	2009	Hydrochloric acid	569,422	Air
327	MN	2013	Phenol	27,561	Air
327	MN	2012	Phenol	30,385	Air
327	MN	2011	Phenol	30,502	Air
327	MN	2010	Phenol	27,866	Air
327	MN	2009	Phenol	21,409	Air
327	OH	2013	Ammonia	799,637	Air
327	OH	2012	Ammonia	593,610	Air
327	OH	2011	Hydrochloric acid	612,437	Air, land
327	OH	2010	Ammonia	915,339	Air
327	OH	2009	Ammonia	567,391	Air
327	WI	2013	Hydrochloric acid	318,812	Air
327	WI	2012	Hydrochloric acid	349,864	Air
327	WI	2011	Hydrochloric acid	321,895	Air
327	WI	2010	Hydrochloric acid	302,669	Air
327	WI	2009	Hydrochloric acid	248,330	Air
331	IL	2013	Zinc compounds	12,474,149	Off-site releases, land
331	IL	2012	Zinc compounds	13,275,465	Off-site releases, land
331	IL	2011	Zinc compounds	15,521,752	Off-site releases, land
331	IL	2010	Zinc compounds	15,347,307	Off-site releases, land
331	IL	2009	Zinc compounds	7,846,704	Off-site releases, land
331	IN	2013	Zinc compounds	28,117,424	Off-site releases, land
331	IN	2012	Zinc compounds	24,774,301	Off-site releases, land
331	IN	2011	Nitrate compounds	26,713,573	Water
331	IN	2010	Nitrate compounds	32,843,093	Water
331	IN	2009	Zinc compounds	27,362,757	Off-site releases
331	MI	2013	Zinc compounds	12,841,876	Off-site releases
331	MI	2012	Zinc compounds	11,134,334	Off-site releases
331	MI	2011	Zinc compounds	12,839,079	Off-site releases
331	MI	2010	Zinc compounds	12,743,634	Off-site releases
331	MI	2009	Zinc compounds	7,141,718	Off-site releases
331	MN	2013	Zinc compounds	740,656	Off-site releases
331	MN	2012	Zinc compounds	1,260,190	Off-site releases
331	MN	2011	Zinc compounds	1,460,830	Off-site releases
331	MN	2010	Lead compounds	246,736	Off-site releases
331	MN	2009	Lead compounds	252,480	Off-site releases
331	OH	2013	Zinc compounds	9,432,147	Off-site releases, land
331	OH	2012	Zinc compounds	9,243,224	Off-site releases, land
331	OH	2011	Zinc compounds	11,563,937	Off-site releases, land
331	OH	2010	Zinc compounds	10,407,636	Off-site releases, land
331	OH	2009	Zinc compounds	8,587,260	Off-site releases, land
331	WI	2013	Zinc compounds	2,160,909	Off-site releases
331	WI	2012	Zinc compounds	2,176,751	Off-site releases
331	WI	2011	Zinc compounds	2,234,378	Off-site releases
331	WI	2010	Zinc compounds	1,783,705	Off-site releases
331	WI	2009	Manganese	1,214,893	Off-site releases
332	IL	2013	Zinc compounds	769,024	Off-site releases
332	IL	2012	Zinc compounds	1,019,990	Off-site releases

332	IL	2011	Zinc compounds	1,146,448	Off-site releases
332	IL	2010	Zinc compounds	1,132,253	Off-site releases
332	IL	2009	Zinc compounds	1,363,613	Off-site releases
332	IN	2013	Zinc compounds	506,989	Off-site releases
332	IN	2012	Zinc compounds	557,035	Off-site releases
332	IN	2011	Zinc compounds	650,882	Off-site releases
332	IN	2010	Zinc compounds	701,534	Off-site releases
332	IN	2009	Zinc compounds	550,693	Off-site releases
332	MI	2013	Zinc compounds	517,306	Off-site releases
332	MI	2012	Zinc compounds	494,727	Off-site releases
332	MI	2011	Zinc compounds	310,822	Off-site releases
332	MI	2010	Zinc compounds	477,810	Off-site releases
332	MI	2009	Zinc compounds	337,303	Off-site releases
332	MN	2013	N-butyl alcohol	408,863	Air
332	MN	2012	N-butyl alcohol	443,168	Air
332	MN	2011	N-butyl alcohol	494,792	Air
332	MN	2010	Certain glycol ethers	435,298	Air
332	MN	2009	Certain glycol ethers	425,157	Air
332	OH	2013	Zinc compounds	1,919,898	Off-site releases
332	OH	2012	Zinc compounds	2,063,291	Off-site releases
332	OH	2011	Zinc compounds	1,982,969	Off-site releases
332	OH	2010	Zinc compounds	2,017,818	Off-site releases
332	OH	2009	Zinc compounds	1,862,967	Off-site releases
332	WI	2013	Aluminum oxide	1,149,610	Off-site releases
332	WI	2012	Aluminum oxide	1,724,750	Off-site releases
332	WI	2011	Aluminum oxide	1,844,070	Off-site releases
332	WI	2010	Aluminum oxide	1,735,590	Off-site releases
332	WI	2009	Aluminum oxide	1,517,022	Off-site releases
333	IL	2013	Aluminum oxide	227,446	Off-site releases
333	IL	2012	Aluminum oxide	180,025	Off-site releases
333	IL	2011	Aluminum oxide	159,223	Off-site releases
333	IL	2010	Hydrochloric acid	120,000	Air
333	IL	2009	Manganese	134,088	Off-site releases
333	IN	2013	Certain glycol ethers	37,176	Air
333	IN	2012	Formaldehyde	68,970	Air
333	IN	2011	Formaldehyde	69,850	Air
333	IN	2010	Formaldehyde	65,900	Air
333	IN	2009	Formaldehyde	42,200	Air
333	MI	2013	Dichloromethane	14,387	Air
333	MI	2012	Certain glycol ethers	22,040	Air
333	MI	2011	Dichloromethane	11,989	Air
333	MI	2010	Dichloromethane	11,989	Air
333	MI	2009	Dichloromethane	19,008	Air
333	MN	2013	Xylene (mixed isomers)	26,609	Air
333	MN	2012	Barium	27,734	Off-site releases
333	MN	2011	Barium	25,814	Off-site releases
333	MN	2010	Barium	29,853	Off-site releases
333	MN	2009	Xylene (mixed isomers)	33,389	Air
333	OH	2013	Manganese compounds	356,967	Off-site releases
333	OH	2012	Manganese compounds	384,633	Off-site releases
333	OH	2011	Manganese compounds	432,027	Off-site releases
333	OH	2010	Manganese compounds	345,426	Off-site releases
333	OH	2009	Manganese compounds	307,986	Off-site releases

333	WI	2013	Certain glycol ethers	41,255	Air
333	WI	2012	Certain glycol ethers	45,277	Air
333	WI	2011	Ammonia	35,436	Air
333	WI	2010	Ammonia	33,457	Air
333	WI	2009	Ammonia	31,671	Air
334	IL	2013	Copper compounds	52,914	Off-site releases
334	IL	2012	Copper compounds	74,525	Off-site releases
334	IL	2011	Copper compounds	73,660	Off-site releases
334	IL	2010	Copper compounds	111,428	Off-site releases
334	IL	2009	Copper compounds	55,790	Off-site releases
334	IN	2013	Naphthalene	9,133	Air
334	IN	2012	Lead	2,116	Off-site releases
334	IN	2011	Lead compounds	2,337	Off-site releases
334	IN	2010	Naphthalene	9,732	Air
334	IN	2009	Naphthalene	8,830	Air
334	MI	2013	Copper	10,757	Off-site releases
334	MI	2012	Copper	5,656	Off-site releases
334	MI	2011	Copper	6,623	Off-site releases
334	MI	2010	Copper	6,797	Off-site releases
334	MI	2009	Ammonia	1,255	Air
334	MN	2013	Toluene	31,868	Air
334	MN	2012	Toluene	28,620	Air
334	MN	2011	Toluene	23,129	Air
334	MN	2010	Toluene	33,090	Air
334	MN	2009	Manganese compounds	33,322	Off-site releases
334	OH	2013	Zinc compounds	79,883	Off-site releases
334	OH	2012	Zinc compounds	278,142	Off-site releases
334	OH	2011	Zinc compounds	267,852	Off-site releases
334	OH	2010	Zinc compounds	493,901	Off-site releases
334	OH	2009	Zinc compounds	211,677	Off-site releases
334	WI	2013	Methanol	30,620	Air
334	WI	2012	Methanol	29,661	Air
334	WI	2011	Methanol	31,292	Air
334	WI	2010	Methanol	26,507	Air
334	WI	2009	Barium compounds	19,423	Off-site releases
335	IL	2013	Lead compounds	25,294	Off-site releases
335	IL	2012	Barium compounds	519,805	Off-site releases
335	IL	2011	Barium compounds	286,607	Off-site releases
335	IL	2010	Zinc compounds	25,108	Off-site releases
335	IL	2009	Zinc compounds	29,532	Off-site releases
335	IN	2013	Certain glycol ethers	21,308	Air
335	IN	2012	Antimony compounds	18,237	Off-site releases
335	IN	2011	Antimony compounds	15,685	Off-site releases
335	IN	2010	Certain glycol ethers	22,000	Air
335	IN	2009	Xylene (mixed isomers)	57,913	Air
335	MI	2013	N-butyl alcohol	18,191	Air
335	MI	2012	N-methyl-2-pyrrolidone	17,479	Off-site releases
335	MI	2011	N-butyl alcohol	17,651	Air
335	MI	2010	N-butyl alcohol	15,456	Air
335	MI	2009	N-butyl alcohol	14,321	Air
335	MN	2013	Styrene	16,130	Air
335	MN	2012	Styrene	19,131	Air
335	MN	2011	Styrene	21,890	Air

335	MN	2010	Styrene	18,270	Air
335	MN	2009	Xylene (mixed isomers)	12,168	Air
335	OH	2013	Certain glycol ethers	140,093	Air
335	OH	2012	Certain glycol ethers	200,702	Air
335	OH	2011	Certain glycol ethers	145,940	Air
335	OH	2010	Certain glycol ethers	208,374	Air
335	OH	2009	Certain glycol ethers	230,141	Air
335	WI	2013	Manganese	40,306	Off-site releases
335	WI	2012	Copper	48,031	Off-site releases
335	WI	2011	Chlorodifluoromethane	79,000	Air
335	WI	2010	Manganese	85,265	Off-site releases
335	WI	2009	Chlorodifluoromethane	63,000	Air
336	IL	2013	N-butyl alcohol	242,314	Air
336	IL	2012	N-butyl alcohol	248,847	Air
336	IL	2011	N-butyl alcohol	240,046	Air
336	IL	2010	Styrene	167,460	Air
336	IL	2009	Styrene	214,212	Air
336	IN	2013	Styrene	630,352	Air
336	IN	2012	N-butyl alcohol	599,426	Air
336	IN	2011	Styrene	638,432	Air
336	IN	2010	1,2,4-trimethylbenzene	687,134	Air
336	IN	2009	1,2,4-trimethylbenzene	449,011	Air
336	MI	2013	Xylene (mixed isomers)	807,161	Air
336	MI	2012	Xylene (mixed isomers)	899,385	Air
336	MI	2011	Xylene (mixed isomers)	650,010	Air
336	MI	2010	N-butyl alcohol	603,147	Air
336	MI	2009	1,2,4-trimethylbenzene	518,129	Air
336	MN	2013	Styrene	122,893	Air
336	MN	2012	Styrene	109,548	Air
336	MN	2011	Styrene	104,273	Air
336	MN	2010	Styrene	161,733	Air
336	MN	2009	Styrene	111,777	Air
336	OH	2013	Zinc compounds	505,044	Off-site releases
336	OH	2012	Zinc compounds	588,147	Off-site releases
336	OH	2011	Zinc compounds	339,162	Off-site releases
336	OH	2010	Zinc compounds	332,120	Off-site releases
336	OH	2009	Zinc compounds	291,826	Off-site releases
336	WI	2013	Styrene	131,188	Air
336	WI	2012	Styrene	125,427	Air
336	WI	2011	Styrene	117,975	Air
336	WI	2010	Styrene	119,263	Air
336	WI	2009	Styrene	71,021	Air
337	IL	2013	N-butyl alcohol	82,000	Air
337	IL	2012	N-butyl alcohol	59,100	Air
337	IL	2011	N-butyl alcohol	64,080	Air
337	IL	2010	N-butyl alcohol	44,559	Air
337	IL	2009	Xylene (mixed isomers)	38,700	Air
337	IN	2013	Xylene (mixed isomers)	287,851	Air
337	IN	2012	Xylene (mixed isomers)	249,250	Air
337	IN	2011	Toluene	214,667	Air
337	IN	2010	Xylene (mixed isomers)	202,120	Air
337	IN	2009	Toluene	221,461	Air
337	MI	2013	Toluene	21,830	Air

337	MI	2012	Toluene	24,604	Air
337	MI	2011	Toluene	25,683	Air
337	MI	2010	Toluene	24,459	Air
337	MI	2009	Toluene	21,526	Air
337	MN	2013	Xylene (mixed isomers)	82,269	Air
337	MN	2012	Xylene (mixed isomers)	73,973	Air
337	MN	2011	Xylene (mixed isomers)	85,986	Air
337	MN	2010	Xylene (mixed isomers)	76,330	Air
337	MN	2009	Xylene (mixed isomers)	66,758	Air
337	OH	2013	Barium compounds	28,142	Off-site releases
337	OH	2012	Barium compounds	32,839	Off-site releases
337	OH	2011	Barium compounds	23,630	Off-site releases
337	OH	2010	Barium compounds	27,582	Off-site releases
337	OH	2009	Barium compounds	32,820	Off-site releases
337	WI	2013	Xylene (mixed isomers)	33,259	Air
337	WI	2012	Xylene (mixed isomers)	25,453	Air
337	WI	2011	Xylene (mixed isomers)	40,266	Air
337	WI	2010	Toluene	41,950	Air
337	WI	2009	Toluene	28,622	Air

Appendix C: Source Reduction categories and corresponding P2 W codes

Good Operating Practices

W13 – Improved maintenance scheduling, recordkeeping, or procedures

W14 – Changed production schedule to minimize equipment and feedstock changeovers

W15 – Introduced an in-line product quality monitoring or other process analysis system

W19 – Other changes in operating practices

Inventory Control

W21 – Instituted procedures to ensure that materials do not stay in inventory beyond shelf-life

W22 – Began to test outdated material – continue to use if still effective

W23 – Eliminated shelf-life requirements for stable materials

W24 – Instituted better labeling procedures

W25 – Instituted clearinghouse to exchange materials that would otherwise be discarded

W29 – Other changes in inventory control

Spill and Leak Prevention

W31 – Improved storage or stacking procedures

W32 – Improved procedures for loading, unloading, and transfer operations

W33 – Installed overflow alarms or automatic shut-off valves

W35 – Installed vapor recovery systems

W36 – Implemented inspection or monitoring program of potential spill or leak sources

W39 – Other changes in spill and leak prevention

Raw Material Modifications

W41 – Increased purity of raw materials

W42 – Substituted raw materials

W43 – Substituted a feedstock or reagent chemical with a different chemical

W49 – Other raw material modifications

Process Modifications

W50 – Optimized reaction conditions or otherwise increased efficiency of synthesis

W51 – Instituted recirculation within a process

W52 – Modified equipment layout or piping

W53 – Used a different process catalyst

W54 – Instituted better controls on operating bulk containers to minimize discarding of empty containers

W55 – Changed from small volume containers to bulk containers to minimize discarding of empty containers

W56 – Reduced or eliminated use of an organic solvent

W57 – Used biotechnology in manufacturing process

W58 – Other process modifications

Cleaning and Degreasing

W59 – Modified stripping/cleaning equipment

W61 – Changed to aqueous cleaners (from solvents or other raw materials)

W63 – Modified containment procedures for cleaning units

W64 – Improved draining procedures

W65 – Redesigned parts racks to reduce drag out

W66 – Modified or installed rinse systems

W67 – Improved rinse equipment design

W68 – Improved rinse equipment operation

W71 – Other cleaning and degreasing modifications

Surface Preparation and Finishing

W72 – Modified spray systems or equipment

W73 – Substituted coating materials used

W74 – Improved application techniques

W75 – Changed from spray to other system

W78 – Other surface preparation and finishing modifications

Product Modifications

W81 – Changed product specifications

W82 – Modified design or composition of product

W83 – Modified packaging

W84 – Developed a new chemical product to replace a previous chemical product

W89 – Other product modification

Appendix D: Search methodology

The data for this study consists of six ~~major~~ Microsoft Excel databases that have been downloaded from a variety of U.S. EPA and American FactFinder searches and refined to contain only the information needed for data analysis and visualization. This section documents the steps taken to retrieve the data. There are numerous methodologies that can be used to query TRI and other data. Users are encouraged to experiment to locate the data sets they need.

One of the next steps for this project is to aggregate some of the data to create a combined database with a more comprehensive focus and more search options.

Database 1

This database includes only the essential information to establish an overall picture of industrial emissions in defined industry sectors (NAICS codes 311 through 337) in all Region 5 states from 2009-2013. It was used for portions of the section of the report entitled "Overview of Emissions by Industrial Sector".

Excel database: "general emissions data FINAL"

- Go to the U. S. EPA TRI website and under **TRI Data and Tools**, choose **Envirofacts** and **EZ Search**.
- When asked to choose a **Subject Area** to focus the search, choose **Releases – brief**. When asked to select Columns or Data Fields, choose the following:
    - Reporting year
    - State abbreviation
    - Total on and off-site release
    - Primary NAICS code
    - One is then asked to define Search Criteria. The following criteria were used for this study:
    - reporting years "between 2009 and 2013"
    - the six Region 5 states
    - the primary NAICS codes "between 31100 and 34000" so that the three-digit NAICS codes of interest would be represented (311 through 337). Note: I would currently use 33800 as my second range number to keep my search more focused.
- This search returns results that can be downloaded to CSV output, which can then be opened with Microsoft Excel. Perform the following steps:
    - Rename all of the columns to names that are easily understandable.

- We used an Excel formula to add a column with three-digit NAICS codes only (our base for this study).
    - Go to the column adjacent to the one with the six-digit NAICS code and to the cell in the row of the first entry.
    - Type “=left(x2,3)”, where x is the column containing six-digit NAICS codes
    - Press [Enter]. This provides you with one three-digit NAICS code
    - Double-click on the right bottom corner of this cell to flash-fill the entire column.
    - Copy the entire column by either right-clicking and selecting Copy from the context menu or selecting Copy from the menu on the Excel ribbon
    - Right click on the column to the right and select [Paste Special][Values] from the context menu.
    - Delete the original three-digit column to remove the formula from the database.
    - Name the new column.

Because there were many entries for each NAICS code in the same state in the same year (representing emissions for different chemicals), we wrote a SQL script to sum these to one entry per NAICS code per state and year. Although the “sum” feature in Excel PivotCharts and Tableau visualizations makes this optional, it does result in a more succinct database.

The database is now ready to search, sort, filter, or create visualizations based on year, state, three-digit NAICS code, and amount of total on and off-site releases.

Database 2

This database was created by using TRI EZ Search to choose additional Columns or Data Fields, which provides release information by specific chemical and the environmental medium (land, air, water, underground injection well, or off-site) into which the release occurred. It was also used for portions of the section of the report entitled “Overview of Emissions by Industrial Sector”.

Excel database: “chemical emissions FINAL”

The following Columns were chosen for this search:

- Reporting year
- Chemical name
- State abbreviation

- Air total release
- Land total release
- Total off-site release
- Total on and off-site release
- Total on-site release
- Underground injection total release
- Water total release
- Primary NAICS codes

Follow the steps for Database 1 to define search criteria, download data, and refine to create a more easily searchable database. Note: this database provides all of the information found in Database 1 described above, so there is no longer a need to have both.

The database allows users to search, sort, filter, or create visualizations based on chemical, year, state, three-digit NAICS code, amount of release to each environmental medium, and amount of total on and off-site releases. From this database, one can determine which chemicals are most commonly released in various industry sectors and whether these patterns have changed over the five year period of the study. The information can also be broken down by state to give P2 TAPs more information specific to their geography.

Database 3

This database provides a quick picture of waste management data using TRI EZ Search. It was used for the section of the report entitled “Waste Management Practices”.

Excel database: “waste management FINAL”

Choose “Production-Related Waste – Extended” as the Subject Area for the search.

The following Columns or Data Fields were chosen to obtain a snapshot into how states and/or industry sectors have managed their production-related waste:

- Reporting year
- State abbreviation
- Recycling onsite, current year quantity
- Recycling off-site, current year quantity
- Energy onsite, current year quantity
- Energy off-site, current year quantity
- Treated onsite, current year quantity
- Treated off-site, current year quantity
- Current year release quantity
- Total production-related waste

- Primary NAICS code

Follow the steps described for Database 1 to define Search Criteria, download data, and refine to create a more easily searchable database. Search, sort, filter and create visualizations to determine how states and/or industry sectors tend to manage waste.

Database 4

The P2 section of the TRI website utilized different search tools and presented some difficulties in obtaining the data that was needed for this study. Workarounds were invented to enable the data to fit our parameters more closely. This database was used for the section of the report entitled “P2 Practices”.

Excel database: “p2 with individual W codes and reductions FINAL”

Go to the TRI website and choose “P2 data”, then “Launch P2 search tool”.

The easiest way to retrieve all years, states, and industry descriptions in one step was to perform the following search:

- Select S**how P2 info for facilities**.
- Under **Industry Sector**, leave the default of **All Industry Sectors**.
- Under **Chemicals**, leave the default of **All Chemicals**.
- Under **Year**, choose **the five years of our study (2009-2013)**.
- Under State, choose **the six states in Region 5 (IL, IN, MI, MN, OH, WI)**.
- Click **Show P2 Activities**.

This search generates a database with the following columns, which can be downloaded to Excel:

- Facility name
- Address
- Chemical
- Industry
- Year
- Prior year release
- Current year release
- Percent change
- Pollution prevention information (activity codes and text).

As mentioned earlier, this database required some massaging to make it more usable for data analysis and visualization. One method is to do 20 separate searches by NAICS code on the P2 site and combine them all into one database to reduce the risk of improper operator NAICS code assignments. We decided to use the method below instead, even though there was a small risk of operator error when assigning 3-digit NAICS codes.

We used another Excel database called the 2012 NAICS index file, which provides industry descriptions with their corresponding six-digit NAICS codes. After adding these to the database, we still had a list of industry descriptions for which I had to go to the Internet and look up individual NAICS codes. If U. S. EPA had included NAICS codes in the P2 data search table instead of just using industry descriptions, this step could have been eliminated.

Use step b as described under Database 1 to obtain three-digit NAICS codes. There are NAICS codes other than those we are interested in (311 through 337) in this database. One can easily filter these out as needed.

The next major task was to separate out the source reduction codes (W codes) from the text in the P2 information column. Some entries have more than one W code, so this was a complicated process that was completed in several steps. After separating out the W codes into a column to the right of the P2 information, we created unique entries for each W code. Therefore, one original entry may have two or more rows with duplicate information except for the W code. This allowed for the creation of data visualizations in Tableau based on the number of times a particular source reduction activity (W code) was employed to reduce releases of a specific chemical by an industry sector (see Figure15).

Another way to analyze the data is to copy only the entries showing release reductions to another sheet. Then search, sort, or create visualizations to identify the most successful P2 practices in reducing emissions of specific chemicals in certain industry sectors. See Table 4 for an example of how these data can be compiled.

Note: this is the first database search in which information at the facility level was included, which made it easier to view the statistics in a simplistic fashion. The team later went back and performed brief emissions searches including this information in order to gather some basic statistics for this report. As GLRPPR continues the project, the team may consider including facility level information in all searches to make the data more useful to P2 TAPs. Because the primary goal of this study was to develop a regional database on industrial emissions, the team chose to place the focus on the state level for this paper.

Database 5

The greenhouse gas (GHG) data searches diverged away from the TRI website to the Envirofacts Greenhouse Gas Customized Search. This database was used for the section of the report entitled “Greenhouse Gas Emissions”.

Excel database: “GHG FINAL”

- Under Select Subject Area to be the Primary Focus of your Search, choose **Sector Summary Information**.
- Go to Step 2. Retrieve tables for selected subjects.
- Choose summary table of Sector Information for Emitters.
- Go to Step 3. Select the following columns:
  - Reporting year
  - CO2e emissions
  - Sector name
  - State abbreviation
  - Subsector description
- Go to Step 4. Enter your search criteria. I found that the simplest way to obtain all of the data covering my years, states, and industry descriptions in one step was to perform the following search:
  - Do not enter anything for state, NAICS code, year, or output options.
  - Search the database and download to a CSV file; open in Excel. GHG data is only available for 2010-2013, so your data will be inclusive of these years.
- Filter for the Region 5 states and made a copy to work with.

We again added the three-digit NAICS codes by hand using the industry description as a guide.

Search, sort, filter and create visualizations to determine the status of GHG emissions in states and/or industry sectors over time.

Database 6

We used the U.S. Census Bureau's County Business Patterns database for economic data on industry sectors in the Great Lakes states. The resulting database was used for the section of the report entitled "Economic Impact of Manufacturers".

Excel database: "county business patterns FINAL"

The census data is easily searchable using the American FactFinder website.

I found the fastest way to obtain the data I wanted was to use the "Advanced Search" option.

- Under Search options, choose Industry Codes and choose **All-L3-31-33: All available Subsector codes within Sector 31-33: Manufacturing**.
- Then choose Geographies and add the six Region 5 states.
- Then choose the table entitled **Geography Area Series: County Business Patterns**.

This will display a table for the most recent available year (2013 currently displayed) with the following columns:

- Geographic area name
- 2012 NAICS code
- Meaning of 2012 NAICS code
- Year
- Number of establishments
- Paid employees for pay period including March 12
- First-quarter payroll ($1,000)
- Annual payroll ($1,000).

This table can be downloaded into an Excel file. I completed separate searches for 2009-2013 and we combined these into one database containing all years.

Search, sort, filter and create visualizations to determine the economic impact of various industry sectors in different states and/or over time.

Combination Database (in draft format).

As mentioned in the Introduction, goals for the next project period include aggregating some or all of the databases used for this study into a larger comprehensive database, which ultimately can be made available on the GLRPPR website. This task is currently in progress. The following is a description of methodology to date (August 2015).

Excel database: "search combo 2009-2013 FINAL"

- Go to the U. S. EPA TRI website. Under **TRI Data and Tools**, choose **Envirofacts**, then **Customized Search**.
- When asked to choose a Subject Area to focus the search, choose S**ource Reduction Information**, **Form R Reporting Form Information**, **Submission NAICS codes**, and **Facility Information**.
- Select Tables and then Columns. Select the following:
    - v_tri_source_reduct_method
        - TRI ID
        - Source Reduction Activity
        - Code Expansion for Source Reduction Activity
    - v_tri_form_r_br_ez
        - TRI Facility ID
        - Facility Name
        - Reporting Year
        - Chemical Name
        - Street Address
        - City Name

    - State Abbreviation
    - Zip Code
    - Air Total Release
    - Land Total Release
    - Total Off-Site Release
    - Total On and Off-Site Release
    - Total Onsite Release
    - Underground Injection Total Release
    - Water Total Release
    - Primary NAICS Code
  - v_tri_form_r_waste_ext_ez
    - TRI Facility ID
    - Facility Name
    - Reporting Year
    - Chemical Name
    - Street Address
    - City Name
    - State Abbreviation
    - Zip Code
    - Recycling Onsite Current Year Quantity
    - Recycling Off-Site Current Year Quantity
    - Energy Onsite Current Year Quantity
    - Energy Off-site Current Year Quantity
    - Treated Onsite Current Year Quantity
    - Treated Off-Site Current Year Quantity
    - Current Year Release Quantity
    - Total Production-Related Waste
    - Primary NAICS Code
  - v_tri_submission_naics
    - TRI Facility ID
    - Primary NAICS Code
  - tri_facility.
    - TRI Facility ID
    - Facility Name
    - Street Address
    - City Name
    - State Abbreviation
    - Zip Code

One is then asked to define Search Criteria and Organize the Output. The following criteria were used for this study:

- Reporting year; a separate search was completed for each year of this study (2009-2013).
- the six Region 5 states were chosen under every section in which this choice was an option.
- the primary NAICS codes "between 31100 and 33800" were chosen under every section in which this choice was an option.

This search returns results that can be downloaded to CSV output, which can then be opened with Microsoft Excel. Perform the following steps:

Rename all of the columns to names that are easily understandable and delete any columns that are not needed (many are duplicates). Add a column with three-digit NAICS codes using the procedure described under Database 1. Complete the same process for each reporting year of interest.

The databases returned from these searches combines most of the information contained in Databases 1, 2, 3 and 4. Doing this search could have saved some of the arduous tasks performed in creating a usable P2 database (such as manually adding NAICS codes and separating out individual W codes from entries that listed more than one). However, some manipulation was still required in order to create a combination database providing all of the needed data.

First, we needed to combine the five separate searches for each reporting year of interest. At this point, it became clear that there were a few data columns from previous searches that would be useful to have. We added the column from Database 4 that includes the text of the P2 information. The above search gave us the Source Reduction code and the definition of the code only, and many companies provide information about their practices without assigning codes. We also added the columns from Database 4 entitled **Prior year release** and **% change**. These columns allow for the calculation of release reduction information to get a better idea of the success of selected P2 practices.

Databases 5 (GHG emissions) and 6 (County Business Patterns) were added as separate sheets in the Excel workbook. It was not possible to aggregate these data into the above combination database because no one-to-one correspondence in data was present. For example, the GHG database does not include chemicals and the County Business Patterns data does not filter down to facility-level.

One troubling fact about this database is that the number of entries is quite a bit less than the chemical emissions database and they should theoretically be the same. Limited analysis suggests that this search may not have included entries for facilities when their release amount was “0 pounds” for a particular chemical-year combination, whereas other searches listed these entries.