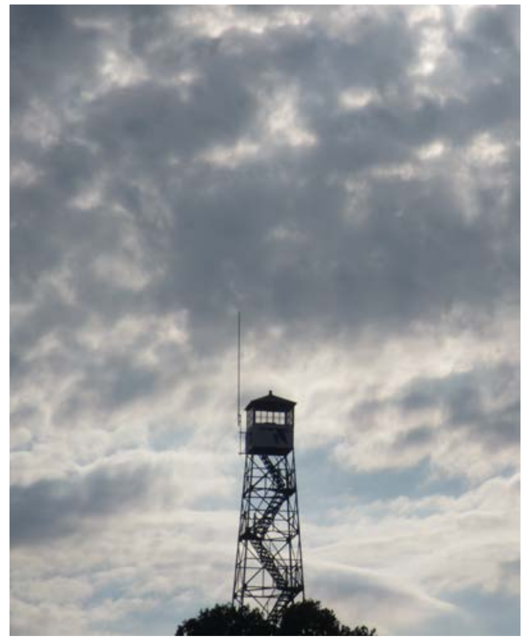
2013 Annual Air Quality Report

Michigan



DEQ Department of Environmental Quality

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ACKNOWLEDGMENTS

This publication was prepared utilizing information provided by the Air Quality Evaluation Section (AQES) and other staff of the Michigan Department of Environmental Quality (MDEQ), Air Quality Division (AQD). Copies can be obtained on-line at: http://www.michigan.gov/deqair, under “Spotlight,” “Air Publications,” “Reports,” then “Annual Air Quality Reports,” or call 517-284-6747 to request a hard copy.

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The AQD also wishes to acknowledge the significant contributions that were provided by William Endres of the **City of Grand Rapids, Air Pollution Control Division**, which operates and maintains air monitoring equipment in West Michigan.

Cover Photos: Upper Left, Upper Right, and Lower Right – Seney National Wildlife Refuge, Courtesy of Nicholas Marengo, Lower Left – Grand Ledge River Boat, Courtesy of Cindy Hodges

Printed: July 2014

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APPENDICES

2013 Air Quality Report

Introduction

The federal Clean Air Act (CAA) requires the U.S. Environmental Protection Agency (EPA) to establish National Ambient Air Quality Standards (NAAQS) for six criteria pollutants considered harmful to public health and the environment. Criteria pollutants are the pollutants for which the EPA must describe the characteristics and potential health and welfare effects.These standards define the maximum permissible concentration of criteria pollutants in the air (see **Table 1.1**).

The six criteria pollutants are monitored by the Michigan Department of Environmental Quality (DEQ), Air Quality Division (AQD). These criteria pollutants are:

- Carbon monoxide (CO),
- Lead (Pb),
- Nitrogen dioxide (NO_2),
- Ozone (O_3),
- Particulate matter smaller than 10 and 2.5 microns in diameter (PM_{10} and $PM_{2.5}$, respectively), and
- Sulfur dioxide (SO_2).

Chapters 2 through **7** provide information on each of the six criteria pollutants and include:

- Michigan's monitoring requirements for 2013,
- Attainment/nonattainment status,
- Monitoring site locations (tables show all the monitors active in 2013), and
- Air quality trends from 2008-2013 broken down by location.[1]

The 2013 data for each criteria pollutant is available in **Appendix A.**

The AQD also monitors air toxics. Air toxics are other hazardous air pollutants that can affect human health and the environment.[2] This data can be found in **Appendix B.**

The purpose of this report is to provide a snapshot of Michigan's 2013 air quality data, air quality trends, overview of the monitoring network (available in much greater detail in the 2014 Network Review)[3], air toxics monitoring program, and other AQD programs, such as MIair and Emissions Inventory[4].

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[1] The air quality trends are based on actual statewide monitored readings, which are also listed in the EPA's Air Quality Subsystem Quick Look Report Data at http://www.epa.gov/air/airtrends/

[2] A fact sheet and a Citizen's guide to participation is available on the DEQ's website at http://www.michigan.gov/documents/deq/deq-ess-caap-citizensguidetomiairpollutioncontrol_195548_7.pdf and at http://www.michigan.gov/documents/deq/deq-ead-guide-aqdguide_273529_7.pdf.

[3] Available on online at http://www.michigan.gov/deq/0,4561,7-135-3310_4195---,00.html

[4] Online information about criteria pollutants and air toxics, along with this and previous annual air quality reports, are available via the AQD's website at http://www.michigan.gov/deq/0,4561,7-135-3310_4195---,00.html

Chapter 1: Background Information

This chapter provides a summary of the development of the NAAQS and how compliance with these standards is determined. Also included is an overview of Michigan's air sampling network, long term air quality trends, a description of the metropolitan statistical areas (MSAs) and their uses, and the variety of monitoring techniques and requirements used to ensure quality data is obtained.

National Ambient Air Quality Standards (NAAQS)

Under Section 109 of the CAA, the EPA establishes a primary and secondary NAAQS for each pollutant for which air quality criteria have been issued. The primary standard is designed to protect the public health with an adequate margin of safety, including the health of the most susceptible individuals in a population, such as children, the elderly, and those with chronic respiratory ailments. Factors in selecting the margin of safety for the primary standard include the nature and severity of the health effects involved and the size of the sensitive population at risk. Secondary standards are chosen to protect public welfare (personal comfort and well-being) and the environment by limiting economic damage, impacts on visibility and climate, as well as the harmful effects on soil, water, crops, vegetation, wildlife, and buildings.

In addition, the NAAQS have various averaging times to address health impacts. Short averaging times reflect the potential for acute (immediate) effects, whereas long-term averaging times are designed to protect against chronic effects.

NAAQS have been established for CO, Pb, SO_2, NO_2, O_3, and PM. **Table 1.1** lists the primary and secondary NAAQS, averaging time, and concentration level for each criteria pollutant in effect in 2013. The concentrations are listed as parts per million (ppm), micrograms per cubic meter (µg/m^3), and/or milligrams per cubic meter (mg/m^3).

Table 1.1: NAAQS in Effect during 2013 for Criteria Pollutants

Pollutant	Primary (health-related)		Secondary (welfare-related)	
	Level	Averaging Time	Level	Averaging Time
Carbon Monoxide (CO)	9 ppm (10 mg/m^3)	8-hour average, not to be exceeded more than once per year	None*	
	35 ppm (40 mg/m^3)	1-hour average, not to be exceeded more than once per year		
Lead (Pb)	0.15 µg/m^3	Maximum rolling 3-month average	Same as Primary	
Nitrogen Dioxide (NO_2)	0.053 ppm (100 µg/m^3)	Annual mean	Same as Primary	
	0.100 ppm	98th percentile of 1-hr average, averaged over 3-years	None	
Particulate Matter (PM_{10})	150 µg/m^3	24-hour average, not to be exceeded more than once per year over 3 years	Same as Primary	
Particulate Matter ($PM_{2.5}$)	12.0 µg/m^3	Annual mean, averaged over 3 years	15.0 µg/m^3	Annual mean
	35 µg/m^3	98th percentile of 24-hour concentration, averaged over 3 years	Same as Primary	
Ozone (O_3)	0.075 ppm	Annual 4th highest 8-hour daily max averaged over 3 years	Same as Primary	
Sulfur Dioxide (SO_2)	0.075 ppm	99th percentile of 1-hour daily max averaged over 3 years	0.5 ppm	3 hours

*(In 1985, EPA revoked the secondary standard for CO (for public welfare) due to a lack of evidence of adverse effects on public welfare at or near ambient concentrations.)

To demonstrate compliance with the NAAQS, the EPA has defined specific criteria for each pollutant, which are summarized in **Table 1.2.**

Table 1.2: Criteria for the Determination of Compliance with the NAAQS

POLLUTANT	CRITERIA FOR COMPLIANCE
CO	Compliance with the CO standard is met when the second highest, non-overlapping 35 ppm 1-hour average standard and/or the 9 ppm 8-hour average standard is not exceeded more than once per year.
Pb	Compliance with the Pb standard is met when daily values collected for 3 consecutive months are averaged and do not exceed the 0.15 μg/m^3 standard.
NO_2	Compliance is met when the annual arithmetic mean concentration does not exceed the 0.053 ppm standard and the 98^{th} percentile* averaged over 3-years of the 1 hour concentration does not exceed 100 ppb.
O_3	The 8-hour O_3 primary and secondary standards are met when the 3-year average of the 4th highest daily maximum 8-hr average concentration is less than or equal to 0.075 ppm.
PM	**PM_{10}:** The 24-hour PM_{10} primary and secondary standards are met when 150 μg/m^3 is not exceeded more than once per year on average over 3 years.
	$PM_{2.5}$: The annual $PM_{2.5}$ primary and secondary standards are met when the annual arithmetic mean concentration is less than or equal to 12 μg/m^3 and 15 μg/m^3 , respectively. The 24-hour $PM_{2.5}$ primary and secondary standards are met when the 3-year average of the 98^{th} percentile ** 24-hour concentration is less than or equal to 35 μg/m^3.
SO_2	To determine compliance, the 99^{th} percentile*** 1-hour concentration averaged over a three year period does not exceed 0.075 ppm, and the 3-hour average concentration shall not exceed 0.5 ppm more than once per calendar year.

* *98th percentile daily maximum 1-hour value* is the value below which nominally 98 percent of all daily maximum 1-hour concentration values fall, using the ranking and selection method specified in section 5.2 of appendix S of CFR Part 50.

** *98th percentile* is the daily value out of a year of $PM_{2.5}$ monitoring data below which 98 percent of all daily values fall using the ranking and selection method specified in section 4.5(a) of appendix N of CFR Part 50.

*** *99th percentile daily maximum 1-hour value* is the value below which nominally 99 percent of all daily maximum 1-hour concentration values fall, using the ranking and selection method specified in section 5 of appendix T of CFR Part 50.

As part of the EPA's grant to the DEQ, the AQD provides an annual Network Review document[5] of all monitoring data collected from the previous year and recommendations on any network changes. These recommendations are based on each monitor's exceedance history, changes in population distribution, and modifications to federal monitoring requirements under the CAA. Under the amended air monitoring regulations that began in 2007, states are required to solicit public comment (in May of each year) on their future air monitoring network design prior to submitting the annual review to the EPA in July.

Michigan Air Sampling Network

The Michigan Air Sampling Network (MASN) is operated by the DEQ's AQD, along with other governmental agencies. For instance, the O_3 and $PM_{2.5}$ monitors in Manistee County and Chippewa County are tribal monitors handled by the Little River Band of Ottawa Indians and the Inter-tribal Council of Michigan, respectively. **Figure 1.1** shows the 2013 MASN monitoring sites. **Figures 1.2** and **1.3** are pictures of two monitoring stations in Bay City and Eliza Howell Park (Detroit), respectively. The Eliza Howell site is a near roadway monitoring station.
The MASN consists of federal reference method (FRM) monitors that enable continuous monitoring for the gaseous pollutants O_3, CO, NO_2, and SO_2, PM monitors that measure

[5] Most recent Network Reviews found online at: http://www.michigan.gov/documents/deq/deq-aqd-aqe-monitoring-network-review-2014_426389_7.pdf?20140513095631

particulate concentrations over a 24-hour period, and high volume samplers for Pb. In addition, continuous $PM_{2.5}$ and PM_{10} monitors provide real-time hourly data, and $PM_{2.5}$ chemical speciation monitors determine the chemical composition of $PM_{2.5}$. The MASN data is also used to provide timely reporting to the DEQ's air quality reporting web page (discussed in **Chapter 9**). The types of monitoring conducted in 2013 and the MASN locations are shown in **Table 1.3.**

The **NCore network** began January 1, 2011, as part of EPA's 2006 amended air monitoring requirements. NCore is a multi-pollutant network that integrates several advance measurement systems for particles, pollutant gases and meteorology. This information will support scientific studies ranging across technological, health, and atmospheric process disciplines. Michigan has two NCore sites, Allen Park and Grand Rapids-Monroe Street. Further information on the effects of these criteria pollutants are discussed in **Chapters 2** through **7**.

The **Near Road-NO_2 Monitoring network** will focus on vehicle emissions and how they disperse near roadways. In 2011 Michigan took over EPA's pre-existing near-roadway sites at Eliza Howell Park in Detroit. Data from these sites are discussed further in **Chapters 2** and **5.**

Figure 1.1: 2013 MASN Monitoring Sites

Figure 1.2: Bay City Monitoring Site

Figure 1.3: Eliza Howell Roadside Monitoring Site

Table 1.3 Types of Monitoring Conducted in 2013 and MASN Location

Area	AIRS ID	Site Name	Trace CO	NO_2	Trace NO_y	O_3	PM_{10}	$PM_{2.5}$	$PM_{2.5}$ TEOM	$PM_{2.5}$ Speciation	SO_2	Trace SO_2	VOC	Carbonyls	Trace Metals	Wind Speed & Direction, Temp.	Relative Humidity	Solar Radiation	Barometric Pressure
Detroit-Ann Arbor	260910007	Tecumseh				√		√	√	√						√			√
	260990009	New Haven				√		√								√	√	√	
	260991003	Warren				√													
	261250001	Oak Park				√		√								√			
	261470005	Port Huron				√		√	√	√	√					√			
	261470031	Port Huron-Rural St.													√@+Pb				
	261610008	Ypsilanti				√		√	√							√			√
	261630001	Allen Park	√		√	√	√	√	√	√		√			√@+Pb	√	√		√
	261630005	River Rouge					√							√	√@	√			
	261630015	Detroit-W. Fort St.					√	√		√	√		√	√	√@	√	√		√
	261630016	Detroit-Linwood						√											
	261630019	Detroit-E. Seven Mile		√		√		√								√	√		√
	261630025	Livonia						√								√	√		√
	261630027	Detroit-W. Jefferson													√@				
	261630033	Dearborn					√	√	√	√			√	√	√ + Pb	√	√		√
	261630036	Wyandotte						√											
	261630038	Detroit-Newberry						√	√							√			
	261630039	Detroit-W. Lafayette						√	√							√			
	261630093	Eliza Howell-Near Roadwa	√	√															
	261630094	Eliza Howell-Downwind	√	√															
Flint	260490021	Flint				√		√	√							√			√
	260492001	Otisville				√										√			
Grand Rapids	261390005	Jenison				√		√			√					√			
	260810007	Grand Rapids - Wealthy					√	√											
	260810020	Grand Rapids - Monroe	√		√	√	√	√	√	√		√			√@+Pb	√			√
	260810022	Evans				√										√			
Lansing/East Lansing	260650012	Lansing		√		√		√	√		√					√			√
	260370001	Rose Lake				√													
Monroe Co	261150005	Luna Pier						√		√									
	261150006	Sterling State Park						√		√	√					√			
Huron Co	260630007	Harbor Beach				√										√			
Bay Co	260170014	Bay City						√	√							√			
MissaukeeCo	261130001	Houghton Lake		√		√		√	√	√						√			√
Allegan Co	260050003	Holland				√		√								√	√	√	√
Benzie Co	260190003	Benzonia				√													
Berrien Co	260210014	Coloma				√		√								√			
Cass Co	260270003	Cassopolis				√										√			
Kalamazoo Co	260770008	Kalamazoo				√		√	√							√			
Manistee Co	261010922	Manistee $				√		√								√		√	√
Mason Co	261050007	Scottville				√										√			
Muskegon Co	261210039	Muskegon-Green				√										√			
	261210040	Muskegon-Apple Ave						√											
Schoolcraft Co	261530001	Seney Nat'l Wildlife				√			√							√	√	√	√
Chippewa Co	260330901	Sault Ste. Marie $				√		√	√							√			
Ionia Co	260670002	Belding-Reed St.													√@+Pb	√			
	260670003	Belding-Merrick St.													√@+Pb				
Tuscola Co	261570001	Vassar					√								√@+Pb				

√ = Data Collected
= Mn only
@ = Mn, As, Cd, Ni
$= Tribal monitor

Quality Assurance

The AQD's Air Monitoring Unit (AMU) ensures that all data collected and reported is of high quality and meets federal requirements. The AMU has a quality system in place that includes a Quality Assurance Project Plan (QAPP), standard operating procedures, standardized forms and documentation policies, and a robust audit and assessment program.

The monitoring network adheres to the requirements in Title 40 of the Code of Federal Regulations (CFR), Parts 50, 53, and 58. This ensures that the monitors are correctly sited, operated in accordance to the federal reference methods, and adhere to the quality assurance requirements.

Quality assurance checks are conducted by site operators at the frequencies required in the regulations and unit procedures. Independent audits are conducted by the AMU's Quality Assurance (QA) Team, which has a separate reporting line of supervision. The quality assurance checks and audits are reported to the EPA each quarter.

External audits are conducted annually by the EPA. The EPA conducts Performance Evaluation Program (PEP) audits for $PM_{2.5}$ samplers and the National Performance Audit Program (NPAP) checks for the gaseous monitors. The EPA also conducts program-wide Technical Systems Audits (TSAs) every three to five years to evaluate overall program operations, and assess adequacy of documentation and records retention. External audits are also conducted on the laboratory operations for certain analytical techniques using performance evaluation samples.

Long-term Trends

Congress passed the Clean Air Act (CAA) in 1970; however, Michigan has had a long-standing history of environmental awareness well before the Act was established. In 1887, Detroit was the first city in Michigan to adopt an air quality ordinance, which declared that the dense smoke from burning coal was a public nuisance.

The EPA is required to review the criteria pollutant standards every five years. Over time, based upon toxicological data, the standards (NAAQS) have been tightened to better protect public health. Areas that meet the NAAQS are considered to be in "attainment." Locations where air pollution levels persistently exceed the NAAQS may be designated as "nonattainment." That is why some areas in the state may be designated to nonattainment from attainment even though monitoring shows that air quality continues to improve.

Due to the vast availability of historical data, criteria pollutant data from Southeast Michigan are shown in **Figures 1.4** through **1.7.** These figures show how the ambient levels and the standards for these pollutants have changed over the last 35 plus years. Since this area is highly industrialized it is a good indicator of the Air Quality improvement for the rest of the state.

Figure 1.4 shows the ozone levels at the Detroit East Seven Mile Road site. This graph shows how the standard changed from a 1-hour average of 0.120 ppm to an 8-hour average of 0.08 ppm in 1997. The standard was further lowered to 0.075 ppm in 2008.

Figure 1.4: Historical Ozone at DEQ's Detroit East 7 Mile Site

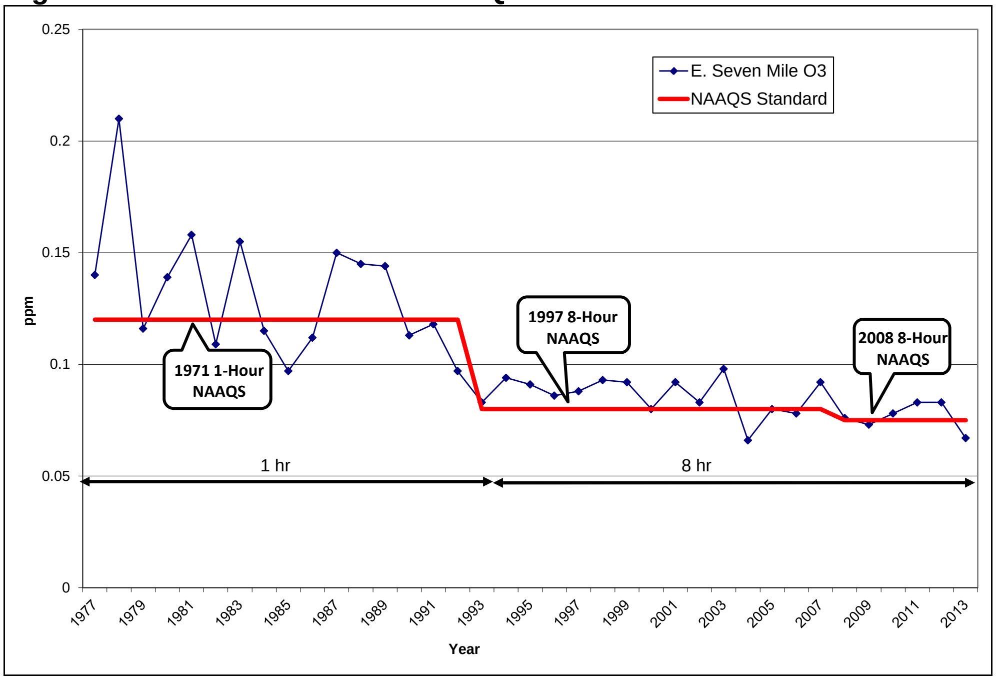


Figure 1.5 shows the SO_2 trend relative to the old annual standard for W. Fort Street (SWHS) in Detroit. In 2010, the EPA changed the standard from an annual average to 99th percentile of a 1-hour standard in which the SO_2 concentration cannot exceed 0.075 ppm averaged over 3 years. This resulted in nonattainment status for a portion of Wayne County (see **Chapter 4** for additional details and trends of the new standard). Even though the area is in nonattainment for 1-hour SO_2 standard, the levels of SO_2 have decreased significantly over the years.

Figure 1.5: Historical Annual SO_2 Averages at Detroit – W. Fort Street (SWHS)

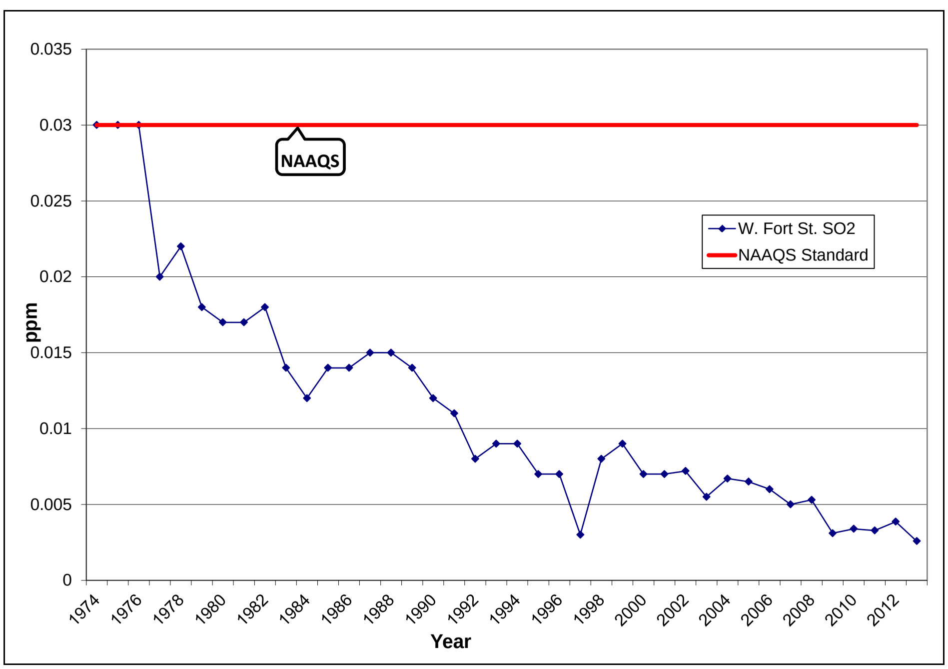


Figure 1.6 shows the CO trend to be well below the 1-hour standard of 35 ppm, which has not changed since 1971.

Figure 1.6: Historical 1-hour CO Averages at Allen Park

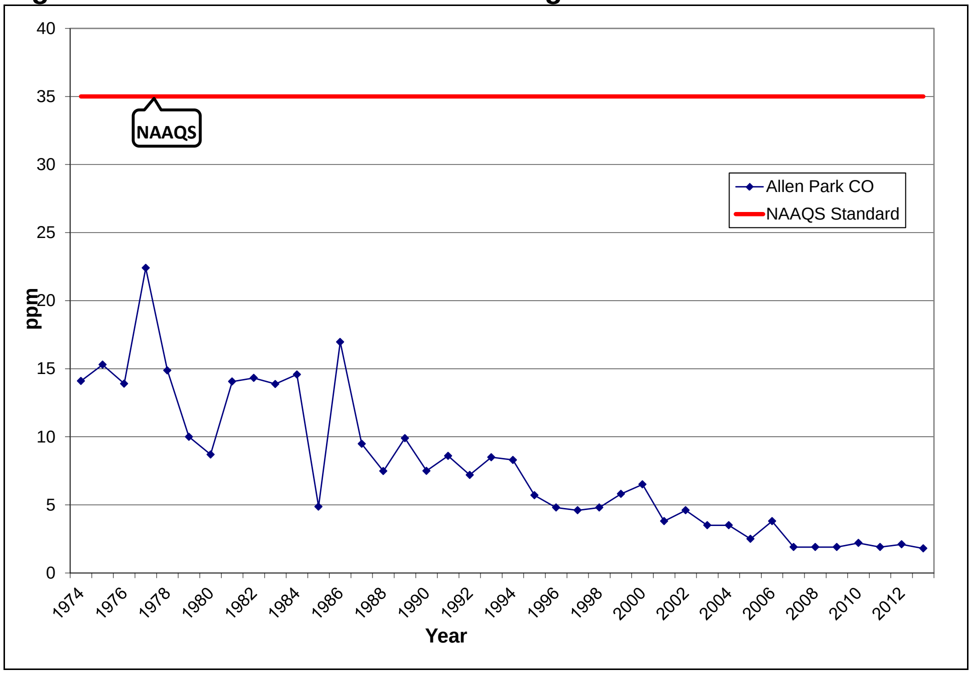
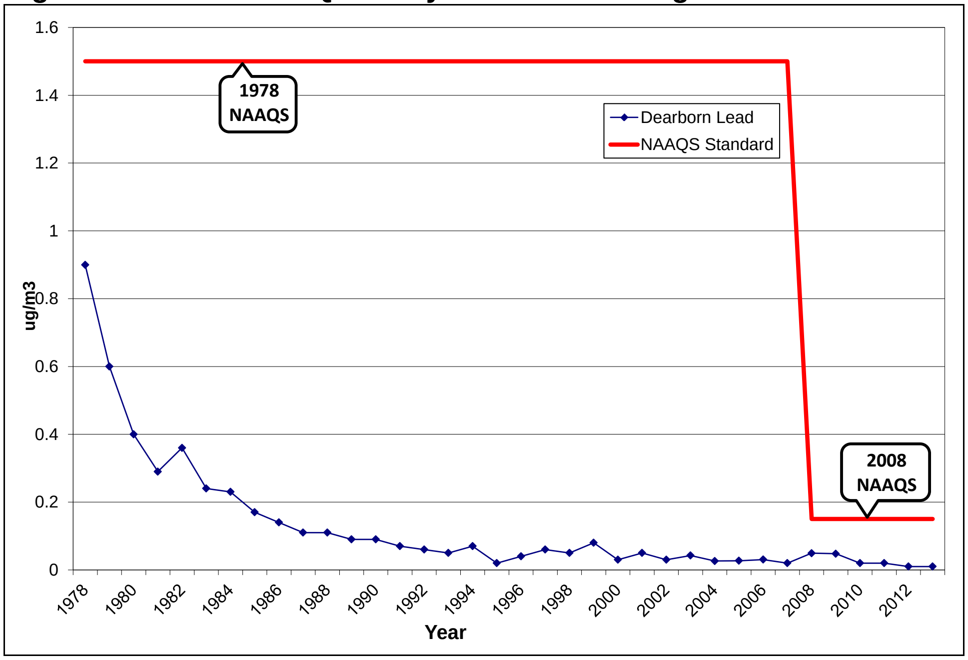


Figure 1.7 shows the trend for lead. It is of interest because lead is harmful to the neurological development of children. The largest decrease in lead in the air is due to the removal of lead in gasoline. By 1975, most newly manufactured vehicles no longer required leaded gasoline, and as a result, there was a dramatic decrease in ambient lead levels. In 1996, the EPA banned the sale of leaded fuel for use in on-road vehicles. The graph also shows the decrease in the lead standard that occurred in 2008.

Figure 1.7: Historical Quarterly / 3-month Averages for Lead at Dearborn



Chapter 2: Carbon Monoxide (CO)

Carbon monoxide is a colorless, odorless, tasteless, and poisonous gas, formed during incomplete burning of fuel. Levels peak during colder months primarily due to cold temperatures that affect combustion efficiency of engines. It has a standard of 9 ppm for the second highest 8-hour average and 35 ppm for the second highest 1-hour average. Its sources and effects are as follows:

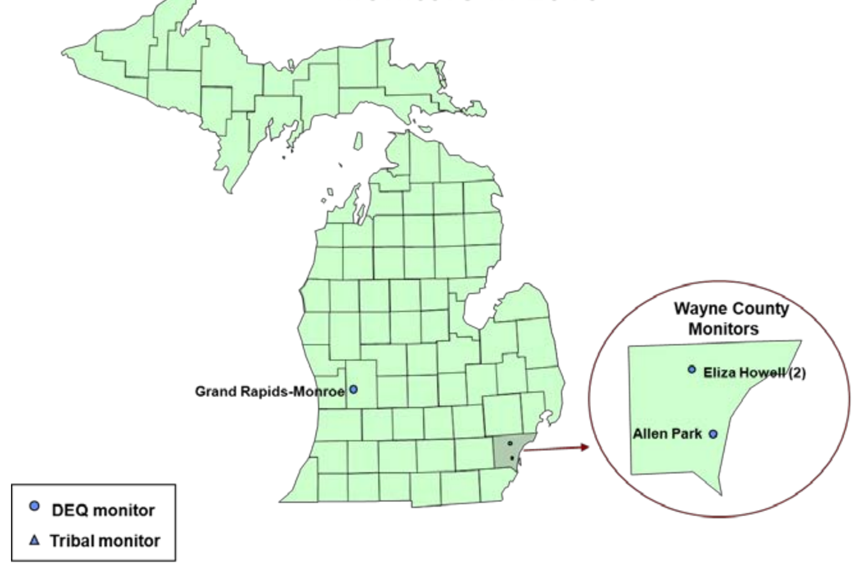
Sources: CO is given off whenever fuel or other carbon-based materials are burned. Outdoor exposure sources include automobile exhaust, industrial processes (metal processing and chemical production), and non-vehicle fuel combustion. Natural sources include volcano, forest fires and photochemical reactions in the atmosphere. Indoor exposure sources include wood stoves and fire places, gas ranges with continuous pilot flame ignition, unvented gas or kerosene heaters, and cigarette smoke.

Effects: CO enters the bloodstream through the lungs, where it displaces oxygen delivered to the organs and tissues. Elevated levels can cause visual impairment, interfere with mental acuity by reducing learning ability and manual dexterity, and can decrease work performance in the completion of complex tasks. In extreme cases, unconsciousness and death can occur. CO also alters atmospheric photochemistry contributing to the formation of ground-level O_3, which can trigger serious respiratory problems.

Population most at risk: Those who suffer from cardiovascular (heart and respiratory) disease, unborn babies, infants and the elderly are most at risk for exposure to elevated levels of CO. People with angina and peripheral vascular disease are especially at risk, as their circulatory systems are already compromised and less efficient at carrying oxygen; however, elevated CO levels can also affect healthy people.

Figure 2.1 shows the two locations in Detroit where CO is monitored. These are the Eliza Howell Park sites that are required under the Near-Roadway Network. The other two sites, Grand Rapids and Allen Park, are where trace CO (lower detection levels 1 ppm-50 ppb) is being monitored as part of the NCore Network.

Figure 2.1: Trace Carbon Monoxide (CO) Monitors in 2013



Figures 2.2 and **2.3** show CO emission sources and CO emissions by county (courtesy of the EPA's State and County Emission Summaries).

Figure 2.2: CO Emissions by Source Sector

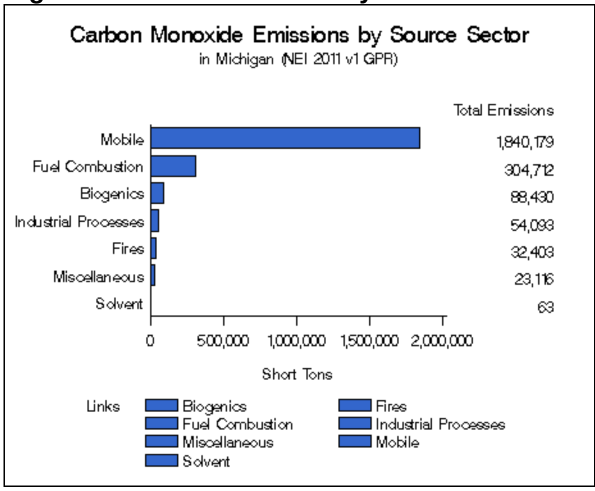
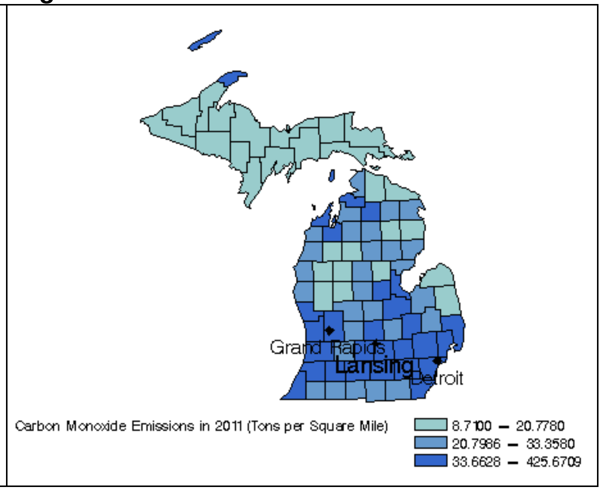
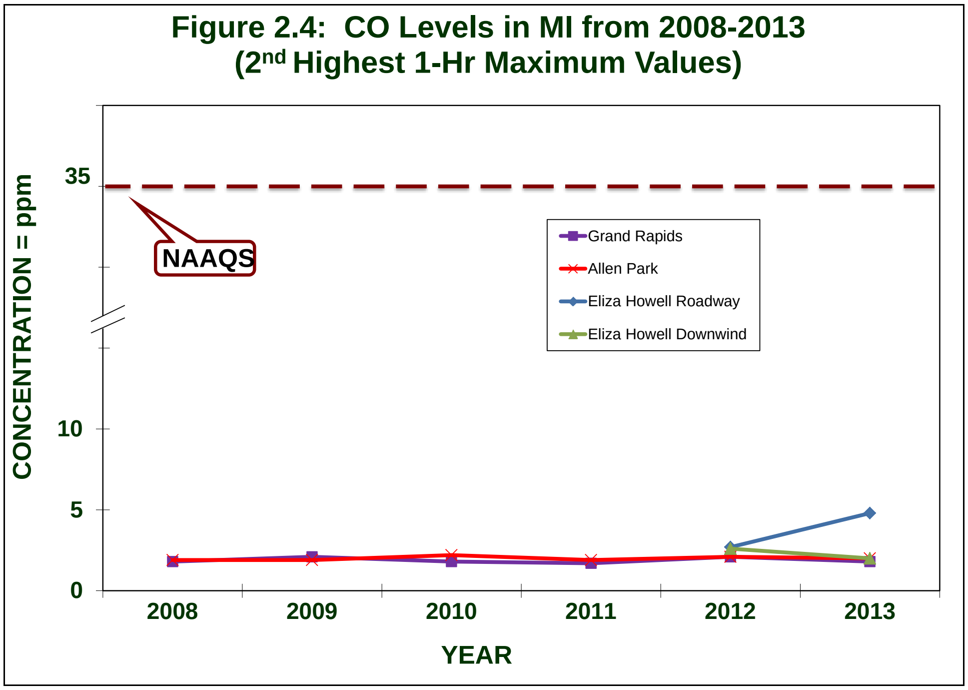


Figure 2.3: CO Emissions in 2011



Near-roadway Monitoring: On August 31, 2011, the EPA approved design changes to part of the CO ambient monitoring network. This network, now referred to as the near-roadway network, is focused on high traffic urban roads in Core-based Statistical Areas (CBSAs) with more than one million people. The DEQ took over two of the EPA's pre-existing, near-roadway sites at Eliza Howell Park, Detroit in June 2011.

Figure 2.4 provides the maximum second highest 1-hour CO level trends for Michigan from 2008-2013, which demonstrates that there have not been any exceedances of the 1-hour CO NAAQS.



Chapter 3: Lead (Pb)

Lead is a highly toxic metal found in coal, oil, and other fuels. It is also found in older paints, municipal solid waste and sewage sludge and may be released to the atmosphere during their combustion. On November 12, 2008, the EPA lowered the Pb NAAQS from a maximum quarterly average of 1.5 µg/m^3 to a 3-month rolling average of 0.15 µg/m^3. Its sources and effects are as follows:

Sources: With the phase-out of leaded gas in the 1970s, the major sources of lead emissions have been due to ore and metals processing and piston-engine aircraft operating on leaded aviation fuel. Other industrial sources include lead acid battery manufacturers, waste incinerators and utilities. The highest air concentrations of lead are usually found near lead smelters.

Effects: Exposure occurs through the inhalation or ingestion of Pb in food, water, soil, or dust particles. Pb primarily accumulates in the body's blood, bones, and soft tissues, and adversely affects the kidneys, liver, nervous system, and other organs.

Population most at risk: Fetuses and children are most at risk as low levels of lead may cause central nervous system damage. Excessive lead exposure during the early years of life is associated with lower IQ scores and neurological impairment (seizures, mental development, and behavioral disorders). Even at low doses, lead exposure is associated with changes in fundamental enzymatic, metabolic, and homeostatic mechanisms in the body, and Pb may be a factor in high blood pressure and subsequent heart disease.

Figure 3.1 shows the location of the Lead monitors in the MASN in 2013.

Figure 3.1: Lead (Pb) Monitors in 2013

Figures 3.2 and **3.3** show Pb emission sources and Pb emissions by county (courtesy of the EPA's State and County Emission Summaries).

Figure 3.2: Lead Emissions by Source Sector

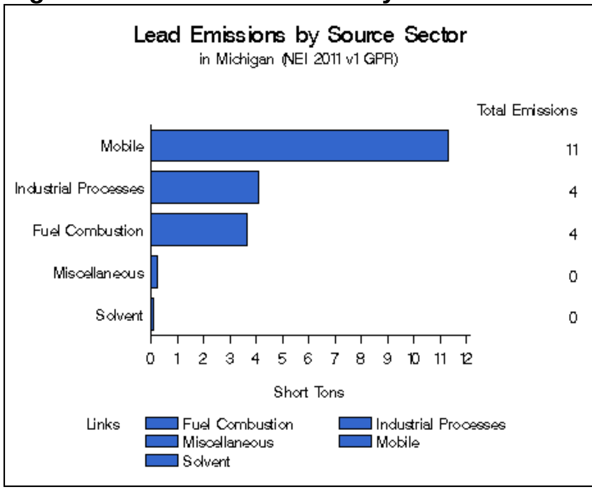
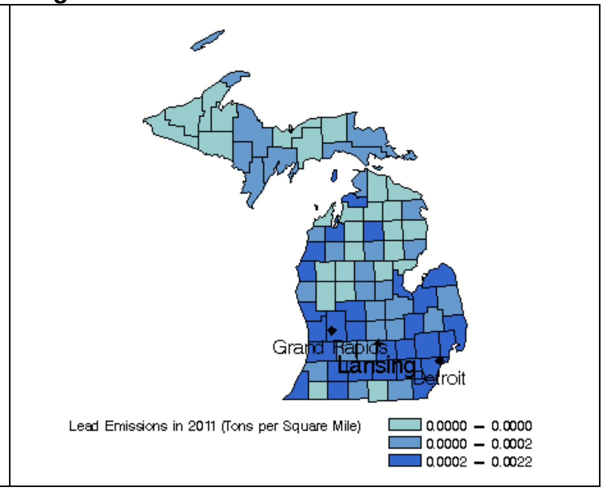


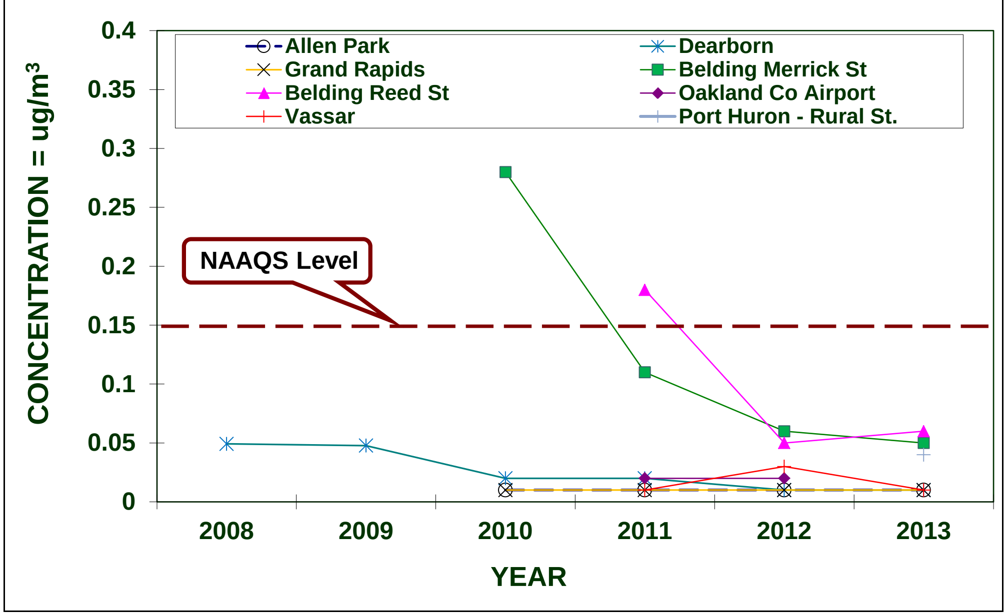
Figure 3.3: Lead Emissions in 2011



On November 12, 2008, the EPA modified the Pb NAAQS by reducing the level of the standard from a maximum quarterly average of 1.5 µg/m^3 to a 3-month rolling average of 0.15 µg/m^3. The monitoring network design was modified to consist of source-oriented monitors and population-oriented monitors.

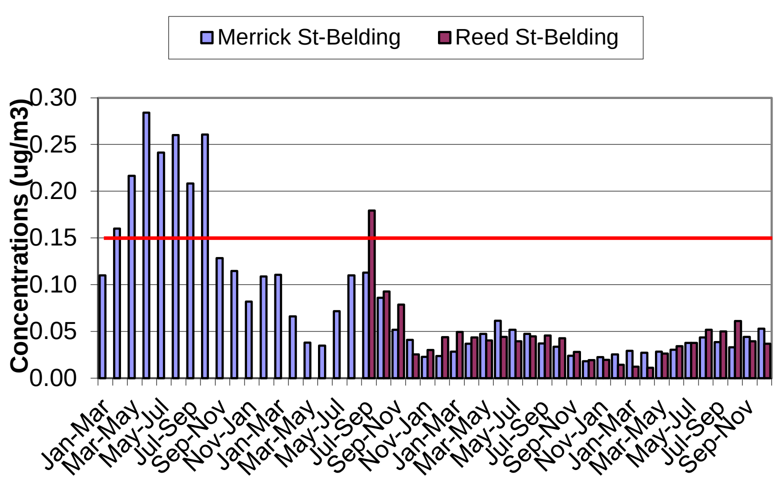
Figure 3.4 shows the maximum quarterly lead level values for the years 2008 to 2009. Then starting in 2010, it shows the maximum 3-month rolling average.

Figure 3.4: Lead Levels in Michigan from 2008-2013 (Maximum 3-Month Average Values)



As part of the new standard, the DEQ is required to monitor near stationary lead sources emitting more than 1/2 ton per year. Initially, six point-source lead monitoring sites were sampling: East Jordan (November 2011-November 2012), Oakland International Airport (July 2011-November 2012), Vassar (started October 2011), Rural St, Port Huron (started November 2012); Belding-Merrick St. (started January 2010) and Beling-Reed St.(started July 2011). The Merrick St. monitor located in Belding recorded a violation of the new health standard in 2010, as shown in **Figure 3.5.** Therefore the second site, Reed St., was added in July 2011 at Belding and this site recorded a violation of the new health standard in 2011. Values for both the sites have been below the NAAQS for the past two years.

Figure 3.5: 2010-2013 Belding Air Lead Levels



All other lead sites in Michigan are well below the standard. The Dearborn site is part of the National Air Toxics Trend Sites (NATTS) and monitors lead and trace metals, both as total suspended particulate (TSP) and PM_{10}. Lead measurements as $PM_{2.5}$ are also made throughout the $PM_{2.5}$ speciation network.

Chapter 4: Sulfur Dioxide (SO_2)

Sulfur dioxide is a gas formed by the burning of sulfur-containing material. Odorless at typical ambient concentrations, SO_2 can react with other atmospheric chemicals to form sulfuric acid. At higher concentrations it has a pungent irritating odor similar to a struck match. When sulfur-bearing fuel is burned, the sulfur is oxidized to form SO_2, which then reacts with other pollutants to form aerosols. These aerosols can form particles in the air causing increases in $PM_{2.5}$ levels. In liquid for, it is found in clouds, fog, rain, aerosol particles, and in surface films on these particles. In June 2010, the EPA changed the primary SO_2 standard to a 99th percentile of 1-hour concentrations not to exceed 0.075 ppm, averaged over a 3-year period. The secondary standard has not changed and is a 3-hour average of 0.5 ppm. Its sources and effects are as follows:

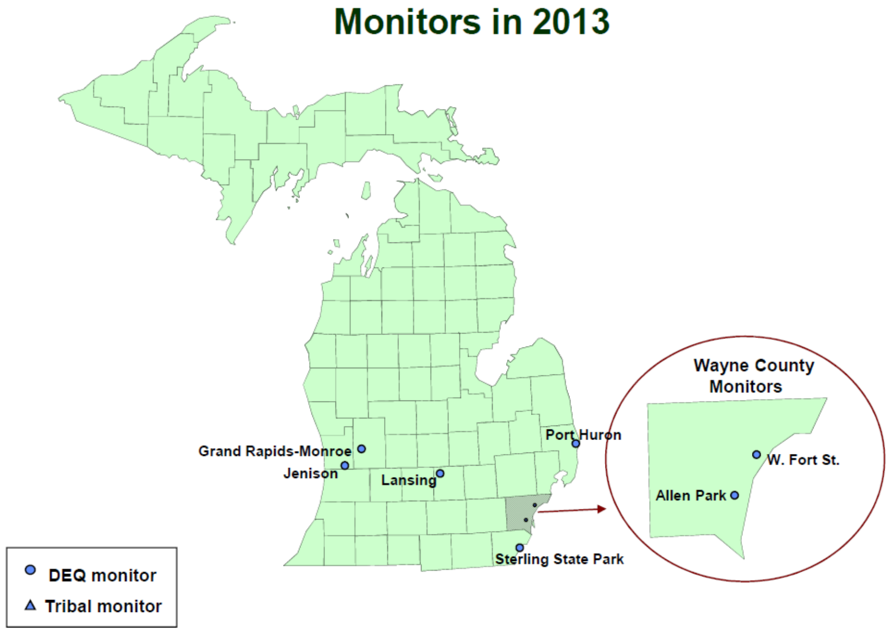
Sources: Coal-burning power plants are the largest source SO_2 emissions. Other sources include petroleum refineries, ore smelters, pulp and paper mills, steel mills and transportation sources. In addition, residential, commercial and industrial space heating are sources. SO_2 and particulate matter are often emitted together

Effects: Exposure to elevated levels can affect breathing, cause respiratory illnesses, aggravate existing cardiovascular and pulmonary diseases, and alter the body's immune system. SO_2 and NO_X together are the major precursors to acid rain and are associated with the acidification of soils, lakes, and streams; and accelerated corrosion of buildings and monuments.

Population most at risk: Asthmatics, children, and the elderly are especially sensitive to SO_2 exposure. Asthmatics receiving short-term exposures during moderate exertion may experience reduced lung function and symptoms, such as wheezing, chest tightness, or shortness of breath. Depending upon the concentration, SO_2 may also cause symptoms in people who do not have asthma.

Figure 4.1 shows the location of each SO_2 monitor. The two NCore Sites, Allen Park and Grand Rapids, have trace SO_2 monitors that detect lower concentrations of SO_2.

Figure 4.1: Sulfur Dioxide (SO_2) Monitors in 2013



Figures 4.2 and **4.3** show SO_2 emission sources and SO_2 emissions by county (courtesy of the EPA's State and County Emission Summaries).

Figure 4.2: SO_2 Emissions by Source Sector

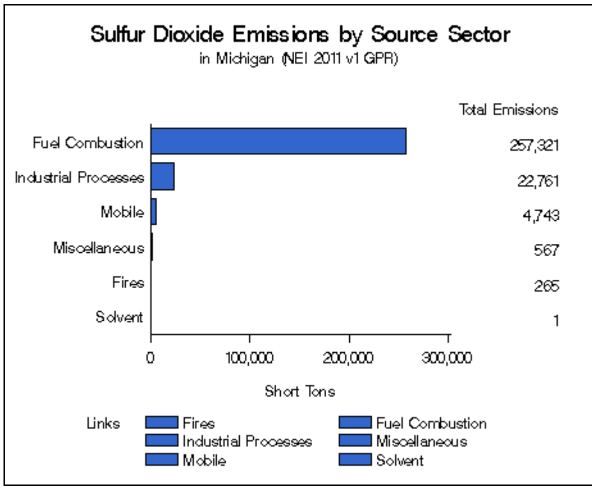
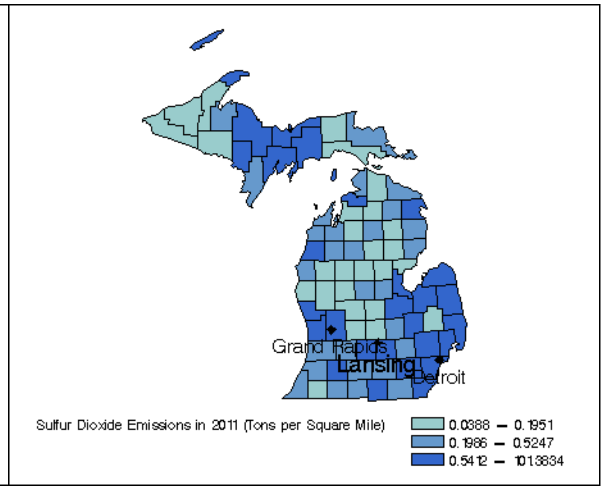


Figure 4.3: SO_2 Emissions in 2011



Michigan had been in attainment for SO_2 since 1982 with levels consistently well below the annual SO_2 NAAQS. However, the SO_2 monitor at W. Fort Street (SWHS) in Detroit currently does not meet the 2010 1-hour NAAQS (see Appendix A). The NCore sites, Grand Rapids and Allen Park, monitor for trace SO_2. For trend purposes, all SO_2 data is graphed together. Jenison and Port Huron were added to the SO_2 network in December 2011, and Sterling State Park in Monroe County was added to the SO_2 network in December 2012, shown in **Figure 4.4.**

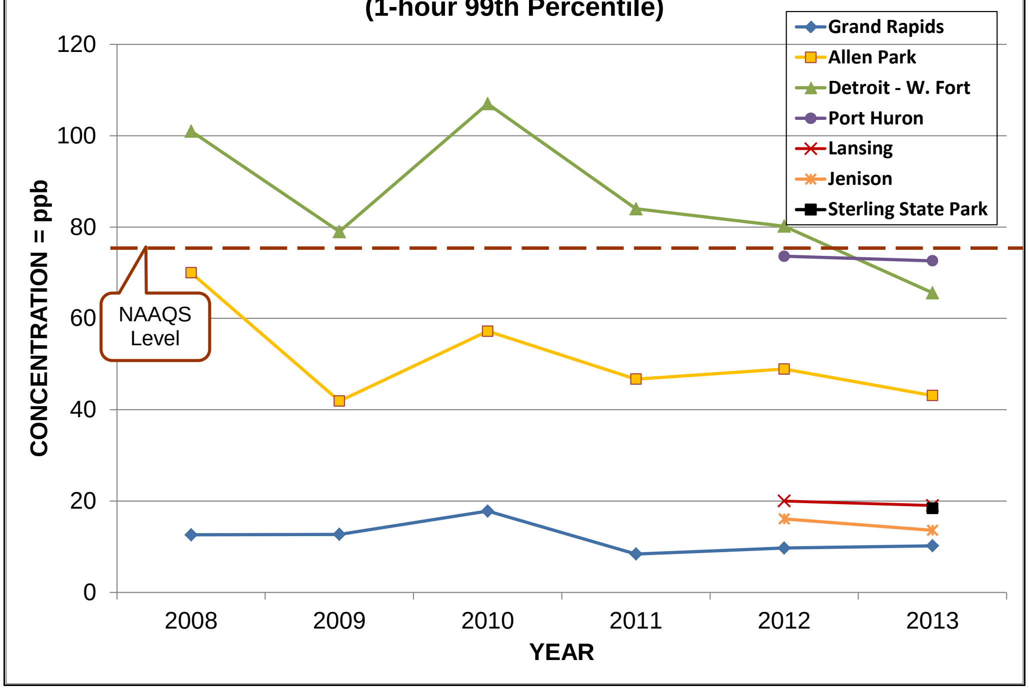


Figure 4.4: SO_2 Levels in Michigan from 2008-2013 (1-hour 99th Percentile)

Chapter 5: Nitrogen Dioxide (NO_2)

Nitrogen Dioxide is a reddish-brown, highly reactive gas formed through oxidation of nitric oxide (NO). Upon dilution, it becomes yellow or invisible. High concentrations produce a pungent odor and lower levels have an odor similar to bleach. NO_x is term used to describe the sum of NO, NO_2, and other nitrogen oxides. NO_x can lead to the formation of O_3 and NO_2, and can react with other substances in the atmosphere to form acidic products that are deposited in rain (acid rain), fog, snow, or as particulate matter. Since 1971, the primary and secondary standard for NO_2 was an annual mean of 0.053 ppm. On January 22, 2010, the EPA added a 1-hour NO_2 standard of 100 ppb, taking the form of the 98th percentile averaged over three years. The sources and effects of NO_2 are as follows:

Sources: NO_X compounds and their transformation products occur both naturally and as a result of human activities. Natural sources of NO_X are lightning, forest fires, bacterial processes in soil, and stratospheric intrusion. Stratospheric intrusion is when the stratospheric air descends towards the surface of the earth and mixes with the air at breathing level. Ammonia and other nitrogen compounds produced naturally are important in the cycling of nitrogen through the ecosystem. The major sources of man-made (anthropogenic) NO_x emissions come from high-temperature combustion processes (such as those occurring in automobiles and power plants. Home heaters and gas stoves produce substantial amounts of NO_2 in indoor settings.

Effects: Exposure to NO_2 occurs through the respiratory system, irritating the lungs. Short-term NO_2 exposures (i.e., less than three hours) can produce coughing and changes in airway responsiveness and pulmonary function. Evidence suggests that long-term exposures to NO_2 may lead to increased susceptibility to respiratory infection and may cause structural alterations in the lungs. Exercise increases the ventilation rate and hence exposure to NO_2. Nitrate particles and NO_2 can block the transmission of light, resulting in visibility impairment (i.e., smog or haze. Deposition of nitrogen can lead to fertilization, eutrophication, or acidification of terrestrial, wetland, and aquatic systems.

Population most at risk: Individuals with pre-existing respiratory illnesses and asthmatics are more sensitive to the effects of NO_2 than the general population. Short-term NO_2 exposure can increase respiratory illnesses in children.

Figure 5.1 shows the location of each NO_2 monitor.

Figure 5.1: Nitrogen Dioxide (NO_2) / Trace NO_y Monitors in 2013

The East 7 Mile monitor in Detroit is a downwind urban scale site that measures NO_2. The Detroit Eliza Howell sites measure NO_2 in a near road environment. The NCore sites, Grand Rapids and Allen Park, monitor trace NO_Y (however, only NO_2 monitors can be used for attainment/nonattain-ment purposes). In addition, in 2010, the AQD added NO_2 monitors at Lansing and Houghton Lake to provide background information for modeling applications.

Figures 5.2 and **5.3** show NO_2 emission sources and NO_2 emissions by county (courtesy of the EPA's State and County Emission Summaries).

Figure 5.2: NO_2 Emissions by Source Sector

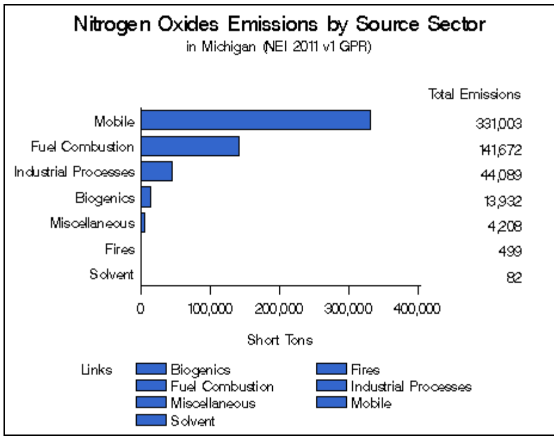
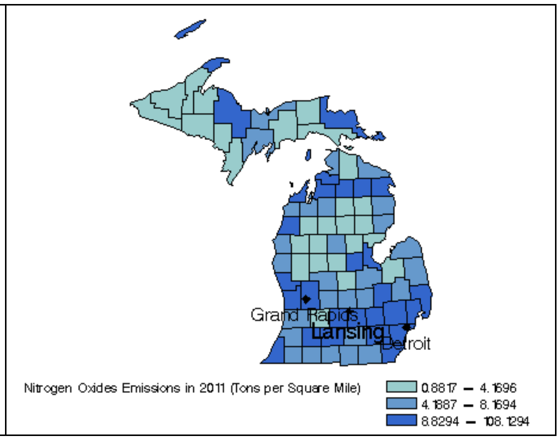
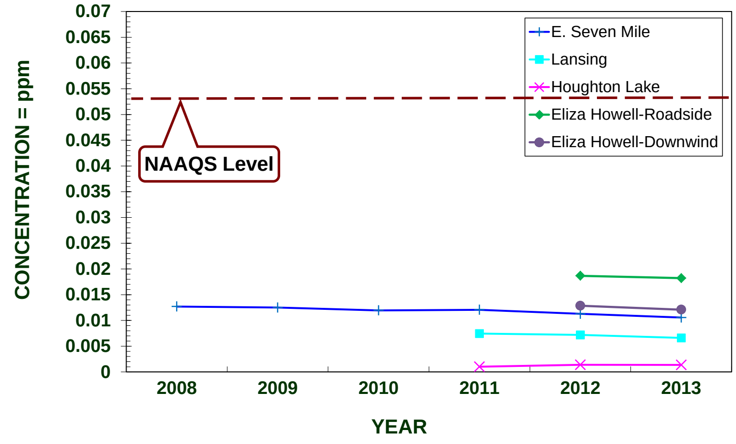


Figure 5.3: NO_2 Emissions in 2011



Michigan ambient NO_2 levels have always been well below the NAAQS. Since March 3, 1978, all areas in Michigan have been in attainment for the annual NO_2 NAAQS. As shown in **Figure 5.4**, all monitoring sites have had an annual NO_2 concentration at less than half of the 0.053 ppm NAAQS. As such, the DEQ requested a designation of unclassifiable/attainment for the entire state. Unclassifiable/attainment means that there are no air quality measurements that would justify classifying these attainment areas as either serious or moderate nonattainment areas.

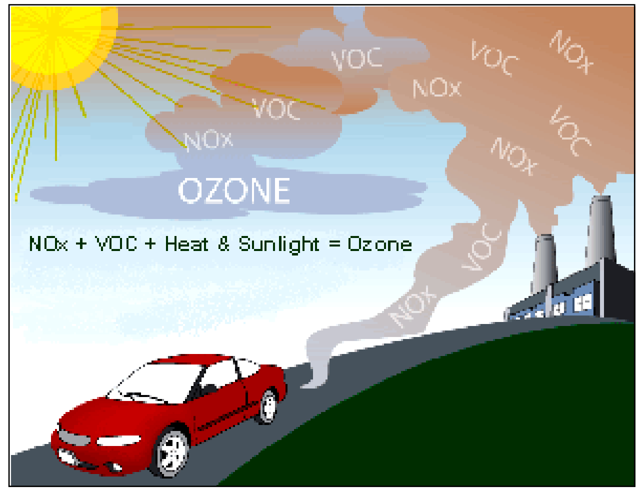
Figure 5.4: NO_2 Levels in MI from 2008-2013 (Annual Arithmetic Mean)



Even though there are no nonattainment areas for NO_2 in Michigan and monitoring for attainment purposes is not required, monitors continue to operate to support photochemical model validation work.

Chapter 6: Ozone (O_3)

Ground-level O_3 is created by reactions involving nitrogen oxides (NO_X) and volatile organic compounds (VOCs), or hydrocarbons, in the presence of sunlight as the illustration to the right depicts (image courtesy of the EPA). These reactions usually occur during the hot summer months as ultraviolet radiation from the sun initiates a sequence of photochemical reactions. O_3 is also a key ingredient of urban smog. In Earth's lower atmosphere (also known as the troposphere), ozone is an air pollutant. Ground level ozone can also be transported hundreds of miles under certain meteorological conditions. Ozone levels are often higher in rural areas than in cities due to transport to regions downwind from the actual emissions of NO_X and VOCs. Shoreline monitors along Lake Michigan often measure high ozone concentrations due to transport from upwind states. The ozone NAAQS was revised by the EPA and became effective on May 27, 2008. The new standard is a 3-year average of the 4th highest daily maximum 8-hour average concentration within an area that must not exceed 0.075 ppm. The sources and effects of ozone follow:

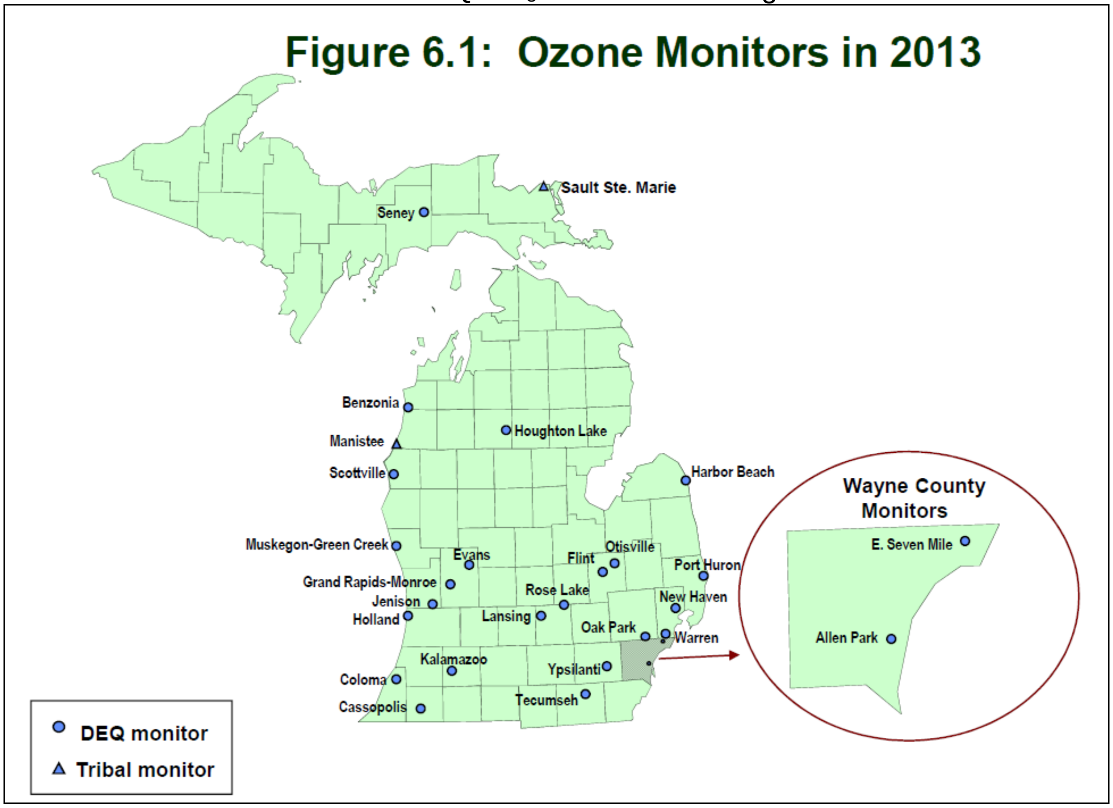


Sources: Major sources of NO_X and VOCs are engine exhaust, emissions from industrial facilities, combustion from power plants, gasoline vapors, chemical solvents, and biogenic emissions from natural sources. Ground-level O_3 can also be transported hundreds of miles under certain wind regimes. As a result, the long-range transport of air pollutants impacts the air quality of regions downwind from the actual area of formation.

Effects: Elevated O_3 exposure can irritate airways, reduce lung function, aggravate asthma and chronic lung diseases like emphysema and bronchitis, and inflame and damage the cells lining the lungs. Other effects include increased respiratory related hospital admissions with symptoms such as chest pain, shortness of breath, throat irritation, and cough. O_3 may also reduce the immune system's ability to fight off bacterial infections in the respiratory system, and long-term, repeated exposure may cause permanent lung damage. O_3 also impacts vegetation and the forest ecosystem, including agricultural crop and forest yield reductions, diminished resistance to pest and pathogens, and reduced survivability of tree seedlings.

Population most at risk: Individuals most susceptible to the effects of O_3 exposure include those with a pre-existing or chronic respiratory disease, children who are active outdoors, and adults who actively exercise or work outdoors.

Figure 6.1 shows the location of the DEQ's O_3 monitors in Michigan.



Figures 6.2 and **6.3** show VOC emission sources and VOC emissions by county (courtesy of the EPA's State and County Emission Summaries).

Figure 6.2: VOC Emissions by Source Sector

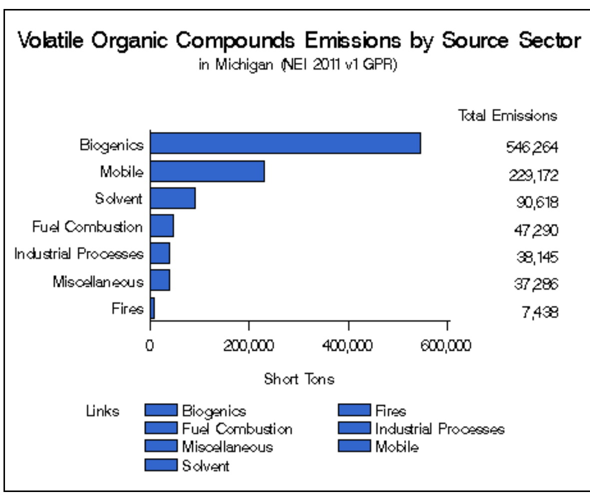
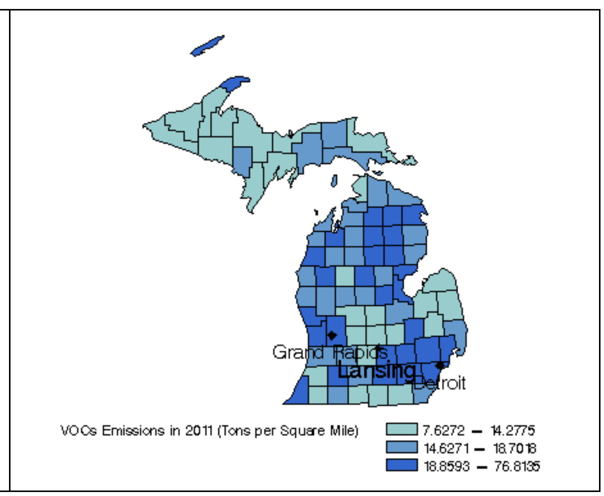


Figure 6.3: VOC Emissions in 2011



The primary 8-hour ozone NAAQS was revised by the EPA on March 12, 2008 to 0.075 ppm and became effective on May 27, 2008. To attain the 2008 standard, the 3-year average of the 4th highest daily maximum 8-hour average concentration within an area must not exceed 0.075 ppm. The secondary 8-hour ozone was also revised, making it identical to the primary standard.

According to the EPA's April 30, 2012 letter, no areas in Michigan violated the 2008 standards or contributed to a violation of the ozone standards. Thus as a result, all of Michigan was designated as unclassifiable/attainment. Although Michigan is designated unclassifiable/ attainment based on 2008-2010 ozone data, many monitors throughout the state are now violating the 0.075 ppm ozone standard (see **Table 6.1** and **Figure 6.4**)

The O_3 monitoring season in Michigan is from April 1 through September 30, the hottest portion of the year. During this time O_3 monitoring data is available for the public via the AQD's web site (discussed in **Chapter 9**). However year round O_3 monitoring is done at the following four sites: Allen Park, Grand Rapids, Houghton Lake and Lansing. This data helps in attainment designations and urban air quality and population exposure assessments.

Figure 6.1 shows all O_3 air quality monitors active in Michigan at the beginning of the 2013 ozone season. It is important to note that under the 2006 amended air monitoring regulations, Metropolitan Statistical Area (MSA) boundaries have been modified and population totals tied to measurements of ambient air quality have increased. Basically, the amended regulations state that any monitors with a design value greater than or equal to 85% of the O_3 NAAQS, have a higher probability of violating the standard. Therefore, more monitors could be required in these MSAs.[6]

Table 6.1: Three-year Average of the 4th Highest 8-hour Ozone Values from 2009-2011, 2010-2012, and 2011-2013 (concentrations in ppm). Numbers in Bold Indicate 3-year Averages Over the Ozone Standard.

Areas	County	Monitor Sites	2009-2011	2010-2012	2011-2013
Detroit-Ann Arbor MI	Lenawee	Tecumseh	0.069	**0.076**	0.075
	Macomb	New Haven	0.075	**0.078**	**0.077**
		Warren	**0.076**	**0.080**	**0.077**
	Oakland	Oak Park	0.075	**0.078**	**0.076**
	St. Clair	Port Huron	0.074	**0.077**	0.075
	Washtenaw	Ypsilanti*	0.069	**0.076**	0.075
	Wayne	Allen Park	0.069	0.074	0.072
		E 7 Mile	**0.078**	**0.081**	**0.077**
Flint MI	Genesee	Flint	0.069	**0.076**	0.074
		Otisville	0.069	0.074	0.074
Grand Rapids, MI	Ottawa	Jenison	0.073	**0.078**	**0.077**
	Kent	Grand Rapids	0.071	0.075	0.074
		Evans	0.071	0.074	0.074
Muskegon Co MI	Muskegon	Muskegon	**0.076**	**0.082**	**0.081**
Allegan Co MI	Allegan	Holland	**0.078**	**0.084**	**0.086**
Huron Co MI	Huron	Harbor Beach	0.068	0.074	0.072
Kalamazoo- Battle Creek MI	Kalamazoo	Kalamazoo	0.071	0.075	0.075
Lansing East Lansing MI	Ingham	Lansing	0.068	0.072	0.072
	Clinton	Rose Lake	0.066	0.071	0.071
Benton Harbor MI	Berrien	Coloma	0.075	**0.082**	**0.082**
Benzie Co MI	Benzie	Benzonia	0.070	0.075	0.074
Cass Co MI	Cass	Cassopolis	0.074	**0.078**	**0.078**
Chippewa Co MI	Chippewa	Sault Ste. Marie	data not available	0.064	0.067
Mason Co MI	Mason	Scottville	0.070	**0.076**	0.075
Missaukee Co MI	Missaukee	Houghton Lake	0.065	0.070	0.070
Manistee Co MI	Manistee	Manistee	0.069	0.074	0.074
Schoolcraft Co MI	Schoolcraft	Seney	0.068	0.075	0.072

[6] Additional information is available in Michigan's 2012 Ambient Air Monitoring Network Review Final Report at http://www.michigan.gov/documents/deq/aqd-amu-Final-2011-Air-Monitoring-Network-Review_326144_7.pdf

Tables 6.2 and **6.3** highlight the number of days when two or more O_3 monitors exceeded 0.075 ppm. It also specifies in which month they occurred and the temperature range.

Table 6.2

Daily High Temperature Range			2013 WEST MICHIGAN OZONE SEASON											
			April		May		June		July		August		September	
			Days	O_3 Days	Days	O_3 Days	Days	O_3 Days	Days	O_3 Days	Days	O_3 Days	Days	O_3 Days
	>=	95	0	0	0	0	0	0	4	0	0	0	0	0
90	<=	94	0	0	0	0	0	0	2	0	1	0	1	1
85	<=	89	0	0	4	1	5	0	7	0	5	1	2	0
80	<=	84	0	0	7	0	10	0	8	0	12	0	6	0
75	<=	79	1	0	9	0	7	0	5	0	10	0	6	0
70	<=	74	2	0	2	0	5	0	4	0	3	0	8	0
65	<=	69	3	0	2	0	2	0	1	0	0	0	4	0
60	<=	64	3	0	4	0	1	0	0	0	0	0	2	0
55	<=	59	3	0	2	0	0	0	0	0	0	0	1	0
50	<=	54	7	0	0	0	0	0	0	0	0	0	0	0
49	<=		11	0	1	0	0	0	0	0	0	0	0	0
Totals			**30**	**0**	**31**	**1**	**30**	**0**	**31**	**0**	**31**	**1**	**30**	**1**

Days: Number of days during month when the daily high temperature falls within the specified temperature range.
O_3 Days: Number of days, during specified temperature range, when two or more area monitors exceeded 75 ppb.

For West Michigan there were no O_3 days in April, one day in May, no days in June and in July, and only one day each in August and September when ozone exceeded 0.075 ppm at two or more ozone monitors. The respective temperatures for those days were between 85^0F and 94^0F.

Table 6.3

Daily High Temperature Range			2013 SOUTHEAST MICHIGAN OZONE SEASON											
			April		May		June		July		August		September	
			Days	O_3 Days	Days	O_3 Days	Days	O_3 Days	Days	O_3 Days	Days	O_3 Days	Days	O_3 Days
	>=	95	0	0	0	0	0	0	1	0	0	0	0	0
90	<=	94	0	0	0	0	0	0	4	0	0	0	2	0
85	<=	89	0	0	5	0	6	1	6	0	7	0	0	0
80	<=	84	1	0	8	0	8	0	10	0	12	0	4	0
75	<=	79	0	0	5	0	6	0	5	0	8	0	6	0
70	<=	74	3	0	6	0	8	0	4	0	3	0	9	0
65	<=	69	3	0	2	0	1	0	1	0	1	0	4	0
60	<=	64	4	0	2	0	1	0	0	0	0	0	5	0
55	<=	59	6	0	2	0	0	0	0	0	0	0	0	0
50	<=	54	3	0	1	0	0	0	0	0	0	0	0	0
49	<=		10	0	0	0	0	0	0	0	0	0	0	0
Totals			**30**	**0**	**31**	**0**	**30**	**1**	**31**	**0**	**31**	**0**	**30**	**0**

Days: Number of days during month when the daily high temperature falls within the specified temperature range.
O_3 Days: Number of days, during specified temperature range, when two or more area monitors exceeded 75 ppb.

For Southeast Michigan there were no O_3 days in April or May, only one day in June, and no days in July, August, or September when ozone exceeded 0.075 ppm at two or more ozone monitors. The temperature for that day was between 85^0F and 89^0F.

Table 6.4 gives a breakdown of the O_3 days and the specific monitors that went over the standard in the western, central/upper, and eastern Michigan.

Table 6.4: Eight-hour Exceedance Days (>0.075 ppm) and Locations

Date	Monitors with Exceedances of the Ozone Standard			Total
	Western Michigan	Central/Upper Michigan	Eastern Michigan	
05/20/2013	Benzonia, Manistee			2
06/17/2013	Coloma			1
06/20/2013	Cassopolis			1
06/21/2013			Harbor Beach, New Haven, Warren, Oak Park, Allen Park, E. Seven Mile	6
07/09/2013			New Haven	1
07/18/2013			New Haven	1
07/19/2013	Holland			1
08/20/2013		Seney		1
08/21/2013	Muskegon			1
08/25/2013	Holland, Muskegon			2
08/26/2013	Holland			1
08/27/2013	Holland			1
09/10/2013	Holland, Coloma, Muskegon			3
			TOTAL	22

June 21, 2013 had the most number of monitor readings that exceeded the level of the standard with six sites. New Haven exceeded the level of the standard most often in eastern Michigan. Sites with the most exceedances in the western region of Michigan were Holland and Muskegon, with five and three, respectively. The central/upper Michigan site with the most exceedances was Seney, with one.

Figure 6.4: O_3 Levels in Detroit-Warren-Flint CSA from 2008-2013, (4th Highest 8-Hour O_3 Values)

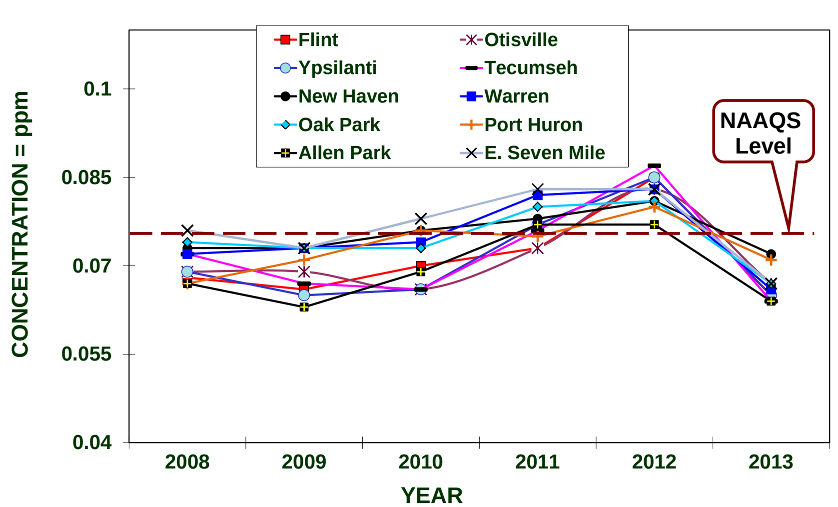
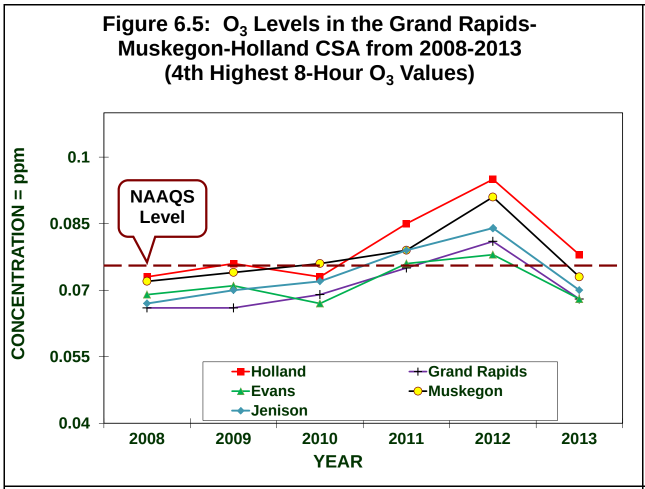
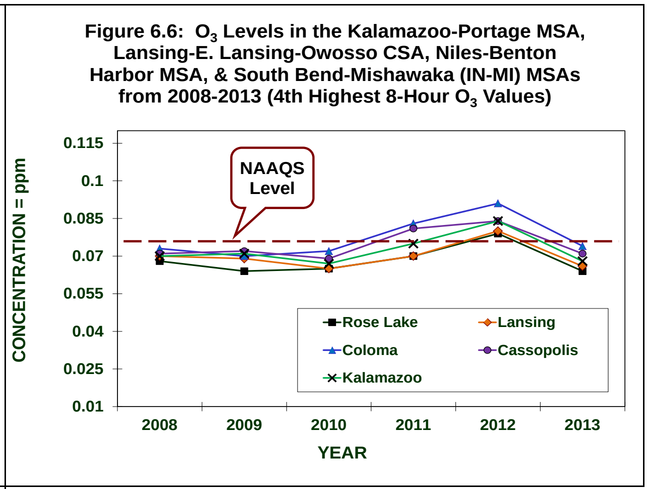


Figure 6.4 shows the 4th highest 8-hour O_3 values for southeast Michigan monitoring sites from 2008-2013. E. Seven Mile, New Haven, Oak Park and Warren violated the 3-year standard.





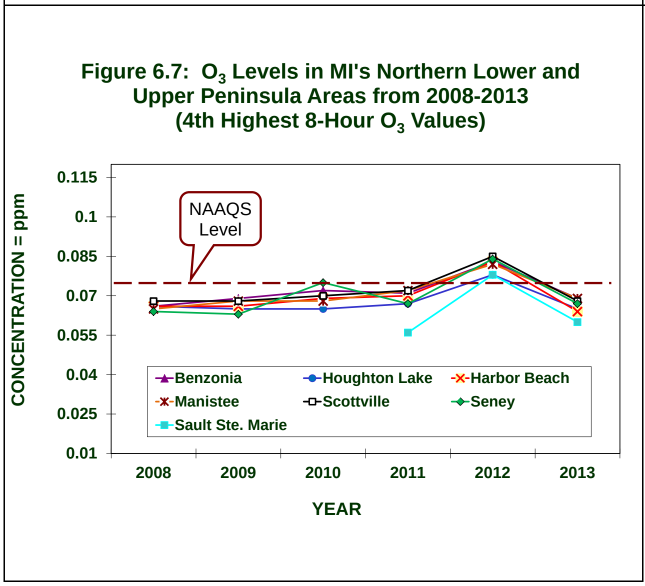


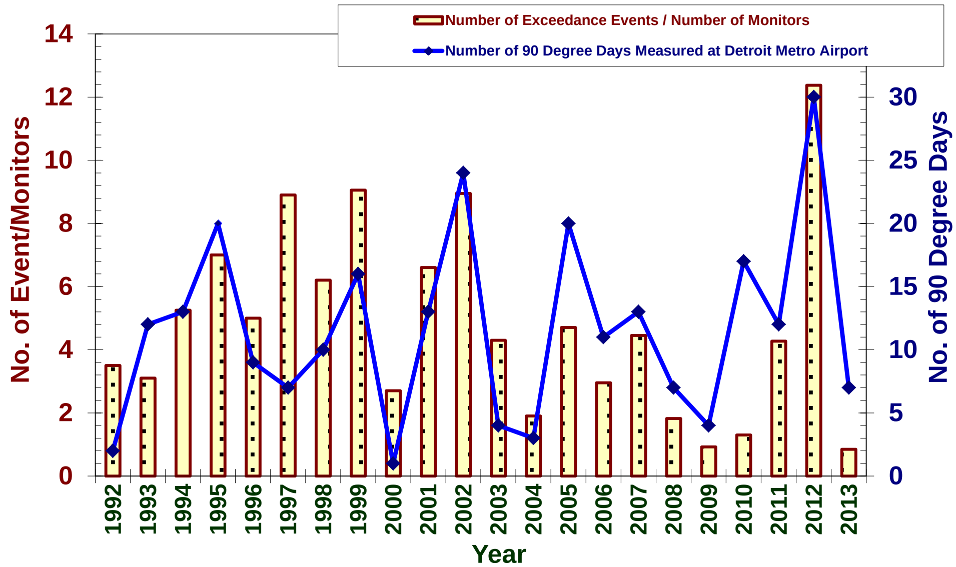
Figure 6.5 shows the 4th highest 8-hour O_3 values for Grand Rapids-Muskegon-Holland CSA. Three sites, Jenison, Muskegon and Holland, violated the 3-year standard

Figure 6.6 shows 4th highest 8-hour O_3 values for Mid-Michigan. Two sites, Coloma and Cassopolis, violated the 3-year standard.

Figure 6.7 shows 4th highest 8-hour O_3 values for Northern Lower and Upper Peninsula Michigan. No sites violated the 3-year standard.

Figure 6.8 shows 8-hour O_3 readings ≥ 0.075 ppm with the number of 90°F days (≥ 90°F) measured at the Detroit Metropolitan Airport. The total number of southeastern Michigan-area 8-hour readings above 0.075 ppm was divided by the number of monitors that were in operation each year to provide a relative indication of the frequency of elevated 8-hour O_3 values.

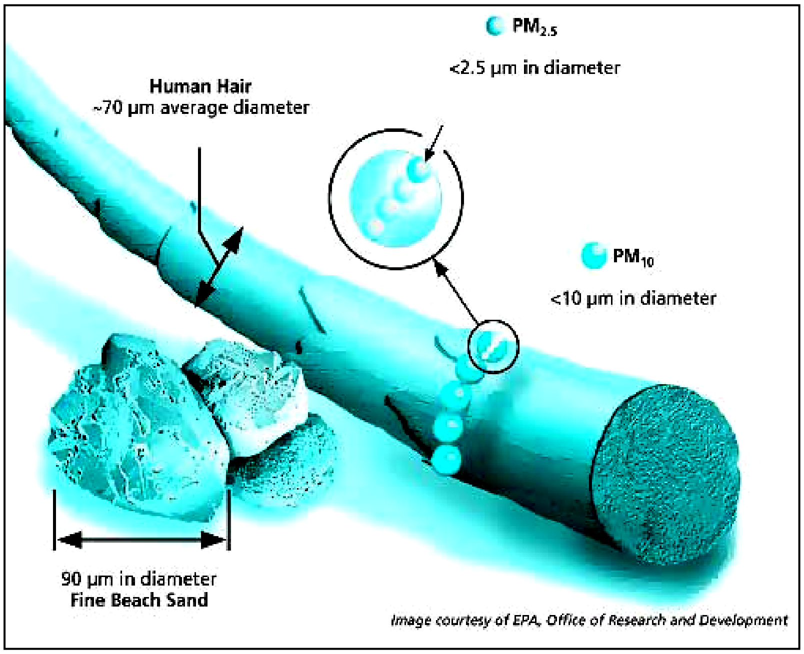
Figure 6.8: 8-Hour O_3 Level Events Exceeding the 0.075 ppm NAAQS from 1992-2013



This comparison shows the influence of temperature with respect to elevated O_3 levels. Over the past 20 years, a typical summer would have an average of 11 days with the maximum daily temperature exceeding 90°F. Over the time period from 1992 through 2013, the highest number of 90°F days occurred in 2012(30 days), while the lowest number occurred in 2000 (one day).

Chapter 7: Particulate Matter (PM_{10}, $PM_{2.5}$, $PM_{2.5}$ Chemical Speciation and TSP)

Particulate matter (PM) is a general term used for a mixture of solid particles and liquid droplets (aerosols) found in the air. These are further categorized according to size, larger particles with diameters of less than 50 micrometers (µm) are classified as total suspended particulates (TSP). PM_{10} consists of "coarse particles" less than 10 µm in diameter (about one-seventh the diameter of a human hair) and $PM_{2.5}$ are much smaller "fine particles" equal to or less than 2.5 µm in diameter. PM_{10} has a 24-hour average standard of 150 µg/m^3. $PM_{2.5}$ has an annual average standard of 12 µg/m^3, and a 98th percentile 24-hour average of 35 µg/m^3 over three years. The sources and effects of PM are as follows:



Sources: PM can be emitted directly (primary) or may form in the atmosphere (secondary). Most man-made particulate emissions are classified as TSP. PM_{10} consists of primary particles that can originate from power plants, various manufacturing processes, wood stoves and fireplaces, agriculture and forestry practices, fugitive dust sources (road dust and windblown soil), and forest fires. $PM_{2.5}$ can come directly from primary particle emissions or through secondary reactions that include VOCs, SO_2, and NO_X emissions originating from power plants, motor vehicles (especially diesel trucks and buses), industrial facilities, and other types of combustion sources.

Effects: Exposure to PM affects breathing and the cellular defenses of the lungs, aggravates existing respiratory and cardiovascular ailments, and has been linked with heart and lung disease. Particle size is the major factor that determines which particles will enter the lungs and how deeply the particles will penetrate. PM is the major cause of reduced visibility in many parts of the U.S. $PM_{2.5}$ is considered a primary visibility-reducing component of urban and regional haze. Airborne particles impact vegetation ecosystems and damage paints, building materials and surfaces. Deposition of acid aerosols and salts increases corrosion of metals and impacts plant tissue.

Population most at risk: $PM_{2.5}$ has been linked to the most serious health effects. People with heart or lung disease, the elderly, and children are at highest risk from exposure to PM.

PM_{10}

Since October 4, 1996, all areas in Michigan have been in attainment with the PM_{10} NAAQS. Due to the recent focus upon $PM_{2.5}$ and because of the relatively low concentrations of PM_{10} measured in recent years, Michigan's PM_{10} network has been reduced to a minimum level. **Table 1-3** identifies the locations of PM_{10} monitoring stations that were operating in Michigan during 2013. These monitors are located in the state's largest populated urban areas: four in the Detroit area, two in Grand Rapids and one added in September 2012 in the Saginaw Bay area in Vassar. To better characterize the nature of particulate matter in Michigan, many of the existing PM_{10} monitors are co-located with $PM_{2.5}$ monitors in population-oriented areas.

Figure 7.1 shows the location of each PM_{10} monitor.

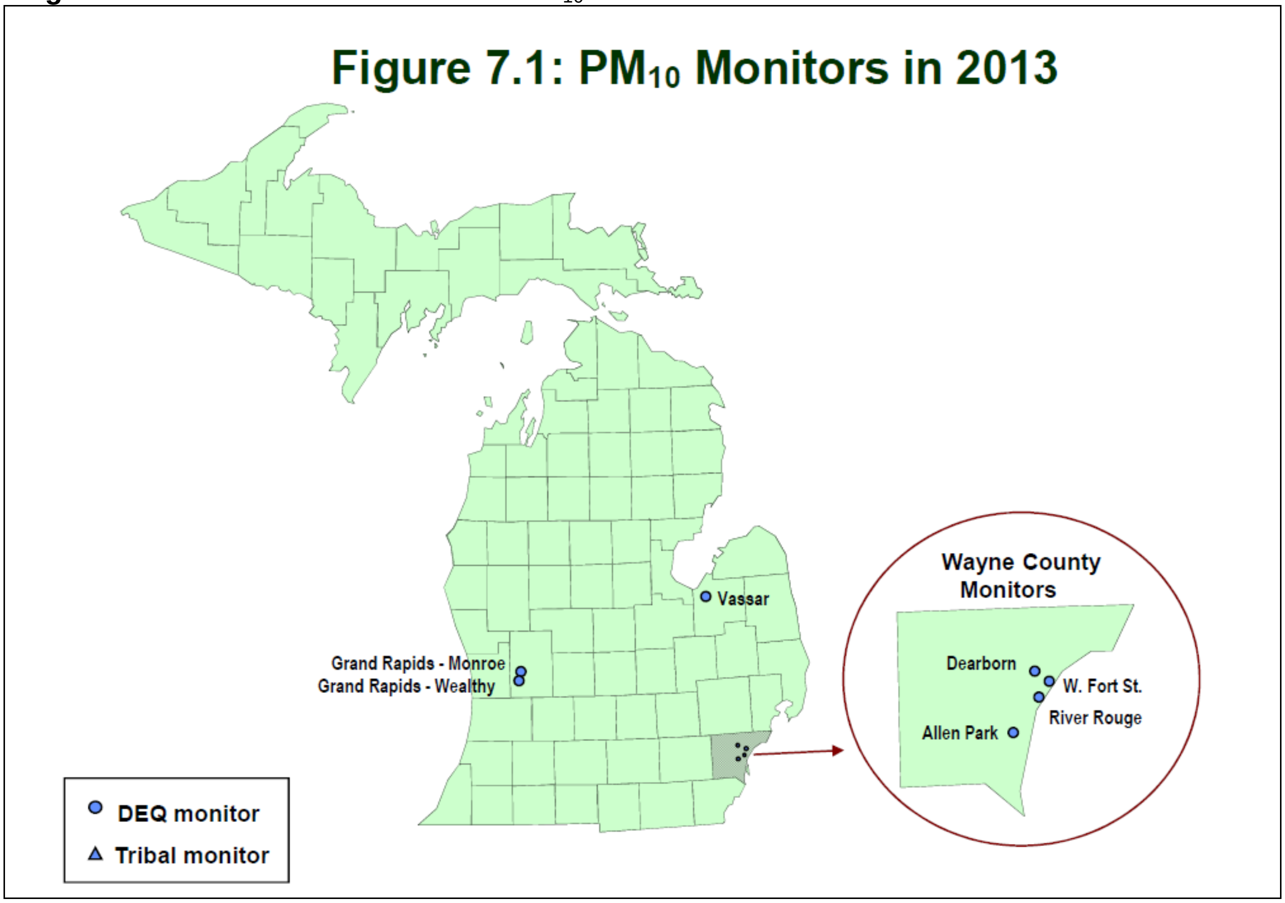
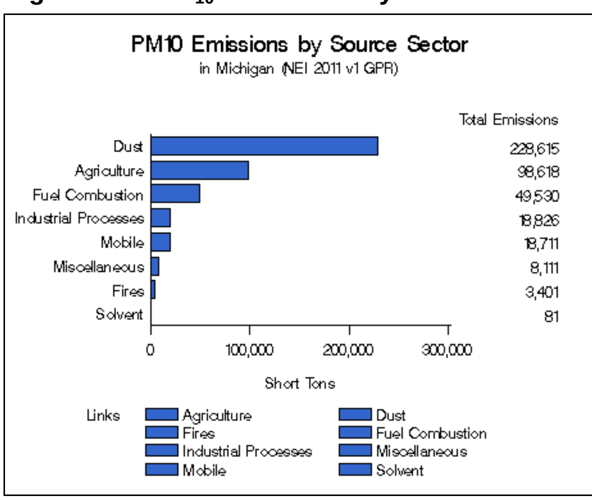


Figure 7.1: PM_{10} Monitors in 2013

Figures 7.2 and **7.3** show PM_{10} emission sources and PM_{10} emissions by county (courtesy of the EPA's State and County Emission Summaries).

Figure 7.2: PM_{10} Emissions by Source Sector **Figure 7.3: PM_{10} Emissions in 2011**



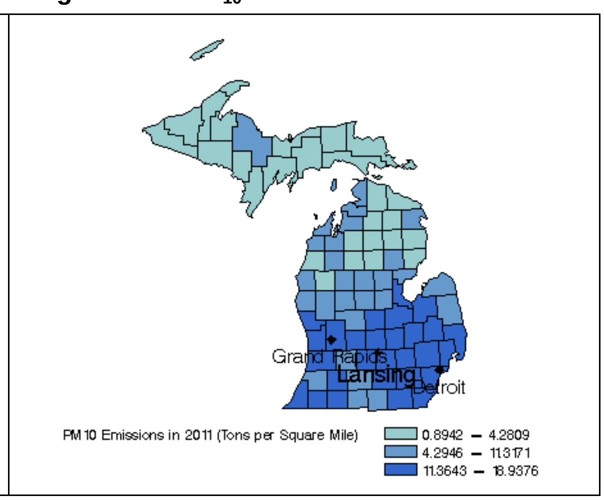
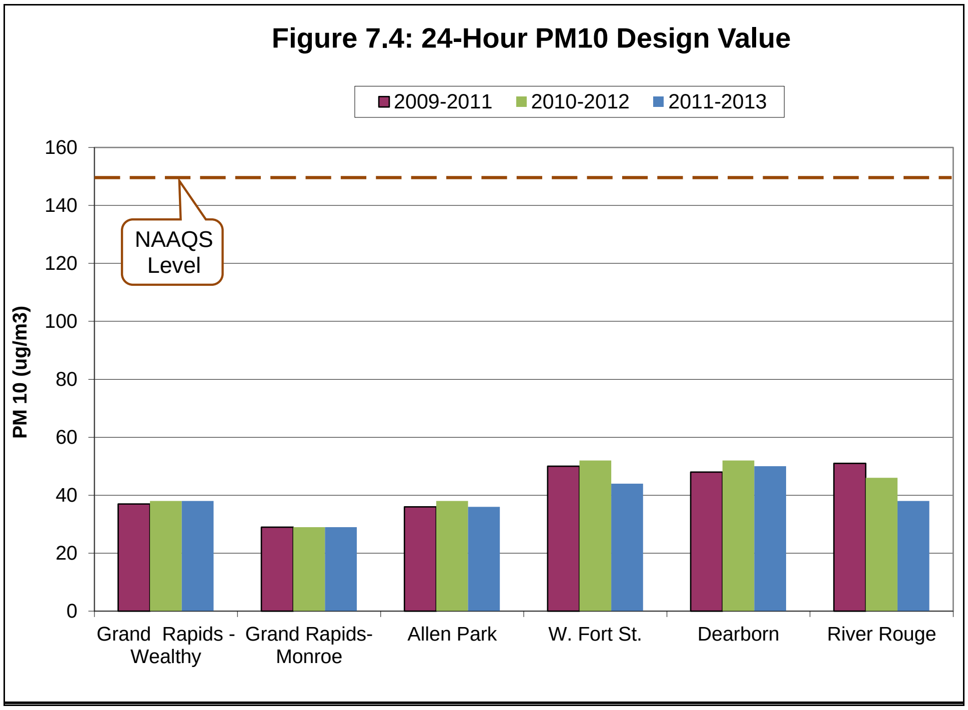


Figure 7.4 shows the PM_{10} levels in Michigan compared to the 24-hour average of 150 µg/m^3. This standard must not be exceeded on average more than once per year over a 3-year period. The design value is the 4th highest value over a 3-year period. The PM_{10} levels at all sites in Michigan are well below the national standard.



$PM_{2.5}$

All Michigan counties from 2008-2013 met the 1997 annual $PM_{2.5}$ standard of 15 µg/m^3 and the 2006 24-hour $PM_{2.5}$ standard of 35 µg/m^3. The EPA designated Michigan in attainment of these standards in August 2013. In December 2012, the EPA revised the annual primary standard to 12 µg/m^3 while the annual secondary standard remained at 15 µg/m^3. The primary and secondary 24-hour remained as 35 µg/m^3. The EPA has not made designations for the 2012 NAAQS revisions; however, $PM_{2.5}$ concentrations are below 12 µg/m^3 throughout Michigan.

Fine particulate matter ($PM_{2.5}$) is measured using three techniques: Federal Reference Method (FRM), Continuous Methods, and Chemical Speciation Methods. These methods are described in more detail below.

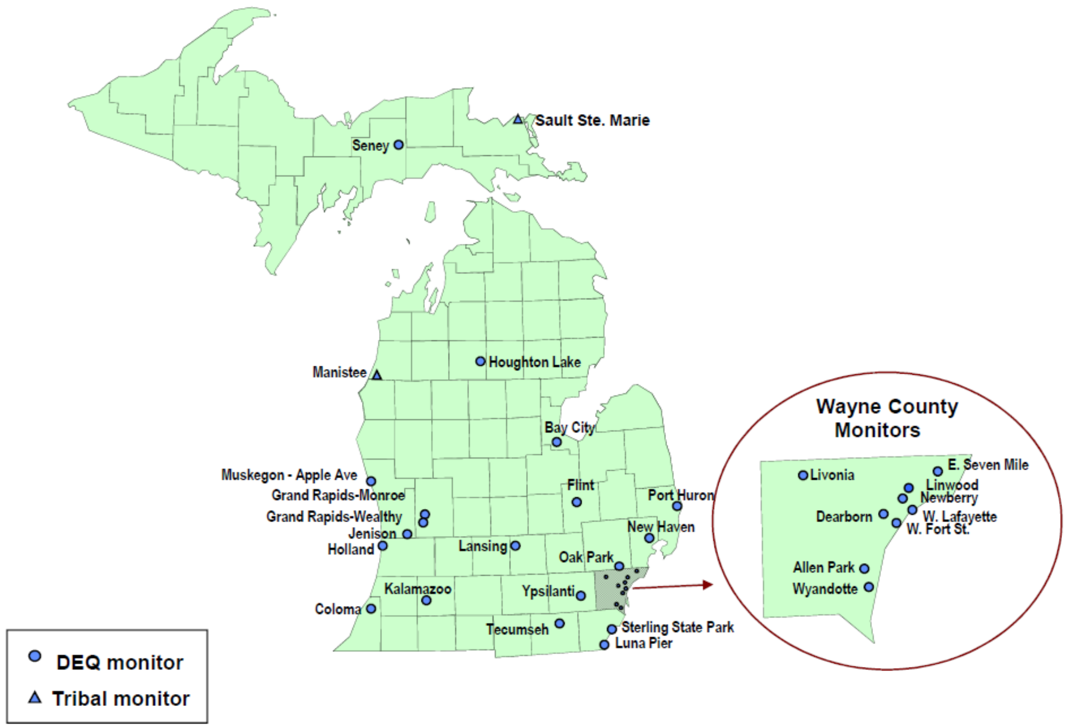
$PM_{2.5}$ FRM monitoring: The concentrations of $PM_{2.5}$ measured over a 24-hour time period are determined using the filter based gravimetric FRM. Only data generated by the FRM monitors are used for comparisons to the NAAQS in Michigan. The sites are located in urban, commercial, and residential areas where people are exposed to $PM_{2.5}$.

Continuous $PM_{2.5}$ monitoring: Continuous monitoring is beneficial as it provides real-time hourly data that supplements the $PM_{2.5}$ data collected by FRM monitors. This data forms the basis of the information reported on AirNow and MIair.

Chemical Speciation monitoring: Speciated monitoring provides a better understanding of the chemical composition of $PM_{2.5}$ material and better characterizes background levels.

Figure 7.5 shows the location of each $PM_{2.5}$ monitor.

Figure 7.5: $PM_{2.5}$ Monitors in 2013



$PM_{2.5}$ FRM Monitoring Network: $PM_{2.5}$ FRM monitors are deployed to characterize background or regional $PM_{2.5}$ transport collectively from upwind sources. Two of the monitoring sites in Detroit, W. Lafayette and Newberry, measure PM levels in an area that is heavily impacted by mobile source emissions. However in 2013, the Newberry site along with Muskegon–Apple Ave was shut down due to loss of site access. A third site, Luna Pier was moved to a new site in Monroe County, Sterling State Park.

Five $PM_{2.5}$ FRM monitoring sites are co-located with PM_{10} monitors to allow for $PM_{2.5}$ and PM_{10} comparisons[7]. Co-located PM_{10} and $PM_{2.5}$ sites include Grand Rapids (Monroe and Wealthy), Dearborn, Allen Park, and Detroit's W. Fort Street (SWHS) station.

Continuous $PM_{2.5}$ Network: Short-term measurements of $PM_{2.5}$ or PM_{10} are updated on an hourly basis using Tapered Element Oscillating Microbalance (TEOM) instruments. At least one continuous TEOM is required at the NCore $PM_{2.5}$ monitoring site in a metropolitan area with a population greater than one million. Both Detroit (Allen Park) and Grand Rapids (Monroe) meet this requirement[8]. Under the revised 2006 air monitoring regulations, 50 percent of the FRM monitoring sites are now required to have a continuous $PM_{2.5}$ monitor. For Michigan, there are 26 FRM monitoring sites, 14 of which also have TEOMS. One TEOM at Newberry was shut down due to loss of site access. The DEQ initially operated all TEOM units with an inlet temperature of 50ºC, but this high inlet temperature was volatilizing nitrate levels during the

[7] Requirements for $PM_{2.5}$ FRM sites are obtained from the Revised Requirements for Designation of Reference and Equivalent Methods for $PM_{2.5}$ and Ambient Air Quality Surveillance for PM [62 FR 38763]; Guidance for Using Continuous Monitors in $PM_{2.5}$ Monitoring Networks [EPA-454/R-98-012, May 1998]; and Appendix N to Part 50 -Interpretation of the National Ambient Air Quality Standards for PM [40 CFR Part 50, July 1, 1998].

[8] Under the Guidance for Using Continuous Monitors in $PM_{2.5}$ Monitoring Networks [EPA-454/R-98-012, May 1998].

winter months. Therefore, the DEQ began operating TEOMs with a 30°C inlet temperature October through March and a 50°C inlet temperature between April and September.

$PM_{2.5}$ Chemical Speciation Monitoring Network: Single event Met-One Speciation Air Sampling System (SASS) monitors are used throughout Michigan's speciation network and are placed in population-oriented stations in both urban and rural locations. $PM_{2.5}$ chemical speciation samples are collected over a 24-hour period and analyzed to determine various components of $PM_{2.5}$. There are eight SASS monitors operating in Michigan; see **Table 1.3.** The SASS at Luna Pier was moved to Sterling State Park.

The primary objectives of the chemical speciation monitoring sites are to provide data that will be used to determine the sources of poor air quality and to support the development of attainment strategies. Historical speciation data for Michigan indicates that $PM_{2.5}$ is made up of 30 percent nitrate compounds, 30 percent sulfate compounds, 30 percent organic carbon[9], and 10 percent unidentified or trace elements.

Continuous $PM_{2.5}$ Speciation Monitoring (EC/OC and Aethalometer) Network: To determine diurnal changes in $PM_{2.5}$ composition, the DEQ operated two aethalometers and two elemental carbon/organic carbon (EC/OC) monitors in 2013.

- Aethalometers measure carbon black, a combustion by-product typical of transportation sources, by concentrating particulate on a filter tape and measuring changes in optical transmissivity and absorption. In 2013, the DEQ's aethalometers were located at Allen Park and Dearborn.
- The EC/OC instruments measure elemental carbon, using pyroloysis coupled with a nondispersive infrared detector to separate the elemental and organic carbon fractions. Instruments are located at Dearborn and Tecumseh. A third EC/OC at Newberry was shut down.

$PM_{10-2.5}$

The 2006 amended air monitoring regulations specified that measurements of PM_{10}-$PM_{2.5}$ need to be added to the NCore sites[10]. The DEQ began PM_{10}-$PM_{2.5}$ monitoring in 2010 at Allen Park and Grand Rapids – Monroe Street.

Table 1.3 in chapter 1 shows all of Michigan's $PM_{2.5}$ FRM monitoring stations operating in 2013 and denotes which sites also have TEOM, SASS, Aethalometer or EC/OC monitors in operation.

[9] To better understand the chemical composition of the organic carbon fraction, a number of studies have been conducted in southeast Michigan to further investigate organic carbon. Information can be found in the Michigan 2012 Ambient Air Monitoring Network Review, available at http://www.michigan.gov/documents/deq/deq-aqd-aqe-2012-Air-Mon-Network-Review_357137_7.pdf

[10] Current information on both proposals can be found at http://www.epa.gov/air/particles/actions.html.

Figures 7.6 and **7.7** show $PM_{2.5}$ emission sources and $PM_{2.5}$ emissions by county (from the EPA's State and County Emission Summaries).

Figure 7.6: $PM_{2.5}$ Emissions by Source Sector

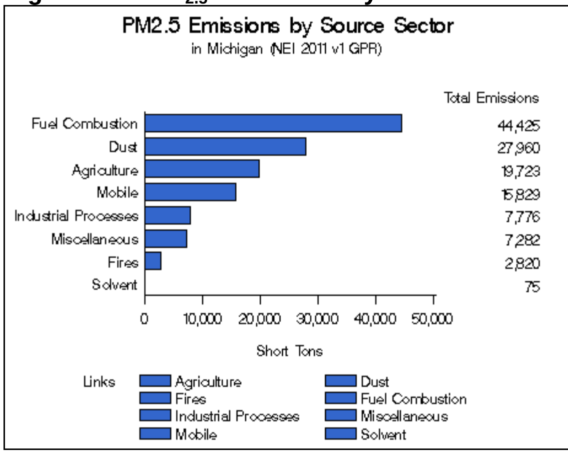


Figure 7.7: $PM_{2.5}$ Emissions in 2011

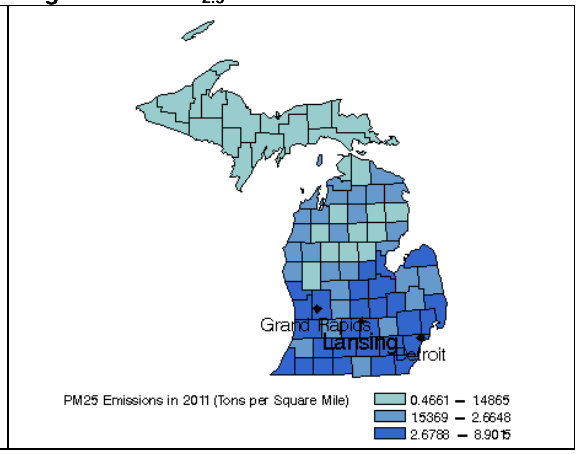


Table 7.1 provides the three year average of the annual mean $PM_{2.5}$ concentrations for 2011-2013. Michigan's levels are below the 12 μg/m^3 primary standard[11]. Stations labeled #2 provide a precision estimate of the overall measurement and operate on a one in six sampling schedule. All other monitors are sampled on a one-in-three-day schedule, except for Allen Park #1 and Detroit – W. Lafayette, which sample daily.

[11] For comparison to the standard, the average annual means is rounded to the nearest 0.1 μg/m^3.

Table 7.1: Three-Year Average of the Annual Mean PM2.5 Concentrations						
Areas	County	Monitoring Sites	2011	2012	2013	2011-2013 Mean
Detroit-Ann Arbor MI	Lenawee	Tecumseh	9.57	9.00	7.93	8.8
	Livingston					
	Macomb	New Haven	8.61	8.74	7.95	8.5
	Oakland	Oak Park	9.14	9.52	8.38	9.0
	St. Clair	Port Huron	9.14	9.37	8.44	9.0
	Washtenaw	Ypsilanti #1	9.74	9.20	8.64	9.2
		Ypsilanti #2	8.54	9.91	9.18	9.2
	Wayne	Allen Park #1	10.47	10.07	9.49	10.0
		Detroit- Linwood	10.08	10.00	8.86	9.6
		Detroit - E 7 Mile	9.43	9.90	8.71	9.3
		Detroit - W Fort	10.90	11.14	10.11	10.7
		Detroit - Newberry	10.59	10.00	10.15*	10.2*
		Detroit - W. Lafayette	10.49	10.14	9.34	10.0
		Wyandotte	8.93	9.31	8.00	8.7
		Dearborn #1	11.21	11.89	11.01	11.4
		Dearborn #2	11.23	12.30	10.80	11.4
		Livonia	9.47	9.62	8.67	9.3
Flint MI	Genesee	Flint	8.45	7.98	7.44	8.0
	Lapeer					
Grand Rapids, MI	Ottawa	Jenison	9.13	8.98	8.09	8.7
	Kent	Grand Rapids-Wealthy	9.46	9.64	8.99	9.4
		Grand Rapids #1	9.47	9.33	8.38	9.1
		Grand Rapids #2	9.25	9.36	8.80	9.1
Muskegon Co MI	Muskegon	Muskegon	8.40	8.81	9.95*	9.1*
Allegan Co MI	Allegan	Holland	8.44	8.51	7.82	8.3
Monroe Co MI	Monroe	Luna Pier	9.98	9.40	9.71*	9.7*
		Sterling State Park	--	--	8.91*	insufficient data
Kalamazoo- Battle Creek MI	Calhoun					
	Kalamazoo	Kalamazoo #1	9.01	9.52	8.27	8.9
		Kalamazoo #2	8.85	10.04	8.79	9.2
	Van Buren					
Lansing East Lansing MI	Ingham	Lansing	8.65	8.65	7.58	8.3
	Clinton					
	Eaton					
Benton Harbor MI	Berrien	Coloma	8.71	8.71	7.97	8.5
Bay Co MI	Bay	Bay City	7.67	7.73	7.47	7.6
Missaukee Co MI	Missaukee	Houghton Lake	6.16	5.92	5.49	5.9
Manistee Co MI	Manistee	Manistee	6.39	7.16	6.45	6.7
Chippewa Co MI	Chippewa	Sault Ste. Marie #1	6.37	6.30	6.04	6.2*
		Sault Ste. Marie #2	6.53	6.37	6.21	6.4

*indicates mean does not meet completeness criteria.

Table 7.2 is a detailed assessment of the 24-hour 98th percentile $PM_{2.5}$ concentrations for 2011-2013 showing Michigan's levels are below the 35 µg/m^3 standard (3-year average)[12].

Table 7.2: 98th Percentile PM2.5 Values Averaged over 3 Years						
Areas	County	Monitoring Sites	2011	2012	2013	2011-2013 Mean
Detroit-Ann Arbor MI	Lenawee	Tecumseh	23.9	26.6	16.8	22.4
	Livingston					
	Macomb	New Haven	24.1	22.2	18.3	21.5
	Oakland	Oak Park	23.4	25.2	18.9	22.5
	St. Clair	Port Huron	23.7	22.3	18.9	21.6
	Washtenaw	Ypsilanti #1	23.9	22.6	18.5	21.7
		Ypsilanti #2	18.8	21.8	18.9	19.8
	Wayne	Allen Park #1	25.3	23.2	22.8	23.8
		Detroit- Linwood	24.8	24.6	20.0	23.1
		Detroit - E 7 Mile	24.0	32.5	19.9	25.5
		Detroit - W. Fort St.	25.1	24.5	21.2	23.6
		Detroit - Newberry	24.9	24.3	10.2*	19.8*
		Detroit - W. Lafayette	25.3	24.0	22.0	23.8
		Wyandotte	21.4	20.9	17.7	20.0
		Dearborn #1	29.9	24.3	24.1	26.1
		Dearborn #2	26.1	25.5	20.8	24.1
		Livonia	22.8	22.7	19.6	21.7
Flint MI	Genesee	Flint	20.7	21.2	16.6	19.5
	Lapeer					
Grand Rapids, MI	Ottawa	Jenison	23.5	27.2	18.2	23.0
	Kent	Grand Rapids-Wealthy	22.6	28.9	19.0	23.5
		Grand Rapids #1	22.8	26.0	18.3	22.4
		Grand Rapids #2	21.8	21.7	18.7	20.7
Muskegon Co MI	Muskegon	Muskegon	22.2	23.9	18.0*	21.4*
Allegan Co MI	Allegan	Holland	25.6	23.4	17.7	22.2
Monroe Co MI	Monroe	Luna Pier	23.5	23.7	9.7*	19.0*
		Sterling State Park	--	--	19.5*	insufficient data
Kalamazoo- Battle Creek MI	Calhoun					
	Kalamazoo	Kalamazoo #1	20.3	26.5	17.7	21.5
		Kalamazoo #2	17.4	24.5	17.9	19.9
	Van Buren					
Lansing East Lansing MI	Ingham	Lansing	20.6	24.3	17.4	20.8
	Clinton					
	Eaton					
Benton Harbor MI	Berrien	Coloma	20.5	21.6	17.4	19.8
Bay Co MI	Bay	Bay City	20.9	22	16	19.6
Missaukee Co MI	Missaukee	Houghton Lake	17.8	15.4	17.1	16.8
Manistee Co MI	Manistee	Manistee	17.5	16.8	18.2	17.5
Chippewa Co MI	Chippewa	Sault Ste. Marie #1	18.3	16.6	14.4	16.4
		Sault Ste. Marie #2	17.0	15.7	15.5	16.1

*indicates mean does not meet completeness criteria.

[12] The 98th percentile value was obtained from the EPA AQS. For the purpose of comparing calculated values, the 3-year 24-hour average is rounded to the nearest 1 µg/m^3.

Figures 7.8 through **7.11** illustrate the current annual mean $PM_{2.5}$ trend for each monitoring site in Michigan for the years monitoring was conducted. For clarity, the monitoring sites within the Detroit-Warren-Flint CSA have been broken down into two graphs. **Figure 7.8** shows those sites in Wayne County, and **Figure 7.9** shows the remaining counties within the CSA.

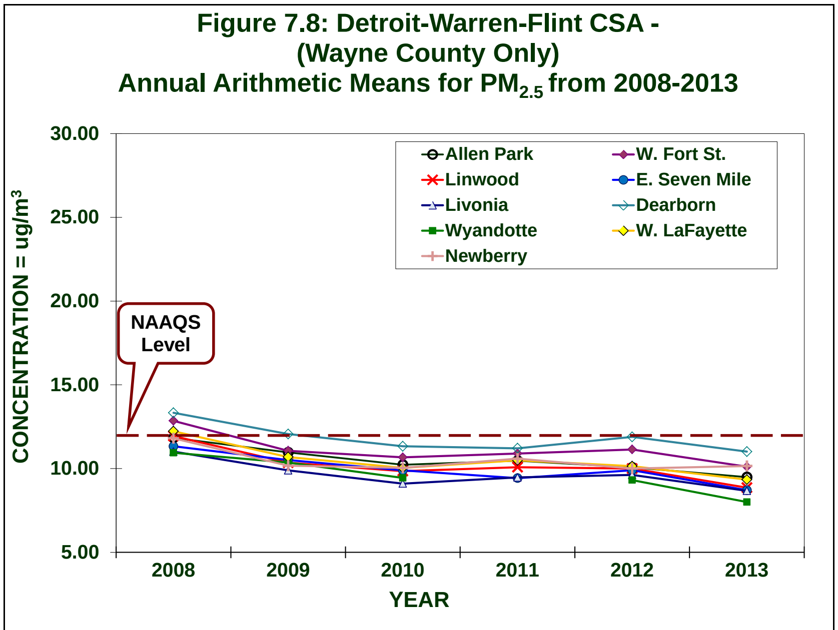


Figure 7.8 shows that 2013 levels in Wayne County remained below the standard. Historically, Dearborn has had the highest readings in the state.

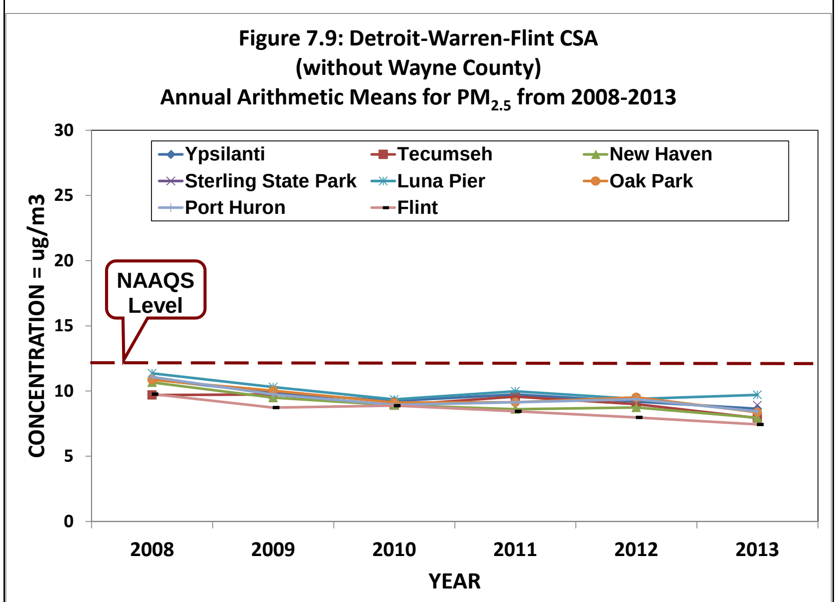


Figure 7.9 contains the remainder of those sites in the Detroit-Warren-Flint CSA that are outside of Wayne County. These sites also show readings in 2013 to be below the $PM_{2.5}$ NAAQS.

Figure 7.10: West MI - Grand Rapids-Muskegon-Holland CSA, Kalamazoo & Benton Harbor MSAs Annual Arithmetic Means for $PM_{2.5}$ from 2008-2013

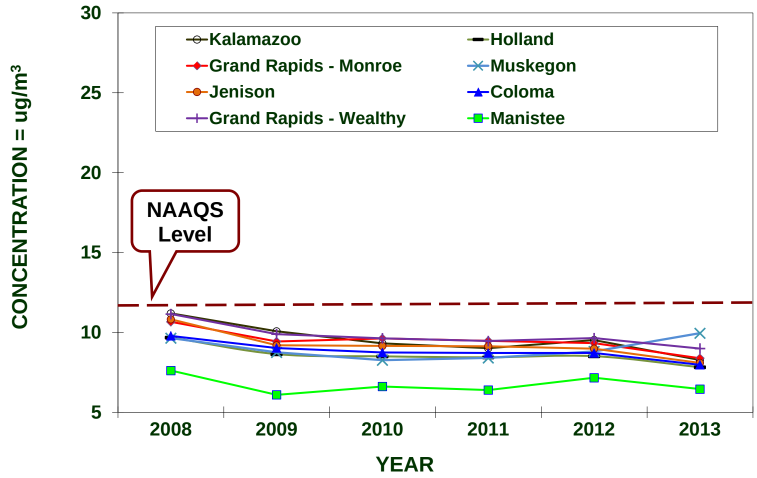


Figure 7.10 combines the $PM_{2.5}$ monitoring sites located in West Michigan-Grand Rapids-Muskegon-Holland CSA, Kalamazoo and Benton Harbor MSAs. All sites are below the annual $PM_{2.5}$ NAAQS.

Figure 7.11: Lansing-E. Lansing CSA, Saginaw-Bay City CSA, Cadillac MiSA & Upper Penninsula Annual Arithmetic Means for PM2.5 from 2008-2013

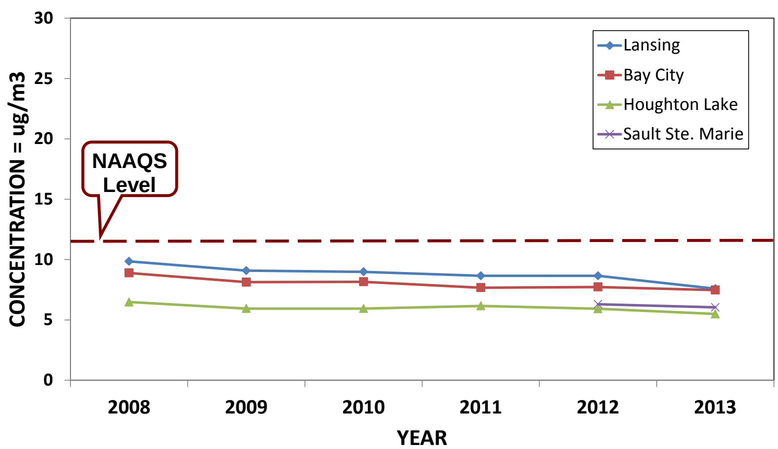


Figure 7.11 displays the remaining monitoring sites in the Northern Lower and Upper Peninsula. All of these sites are below the annual $PM_{2.5}$ NAAQS standard.

Chapter 8: Toxic Air Pollutants

In addition to the six criteria pollutants discussed in the previous chapters, the AQD monitors for a wide variety of substances classified as toxic air pollutants, and/or Hazardous Air Pollutants (HAPs). Under the Clean Air Act (CAA), the EPA specifically addresses a group of 187 HAPs. Under Michigan's air regulations, Toxic Air Contaminants (TACs) are defined as all non-criteria pollutants that may be *"…harmful to public health or the environment when present in the outdoor atmosphere in sufficient quantities and duration."* The definition of TACs lists 41 substances that are not TACs, indicating that all others are TACs.

Sources: Air toxics come from a variety of mobile, stationary, and indoor man-made sources as well as outdoor natural sources. Mobile sources include motor vehicles, stationary sources include industrial factories and power plants, indoor sources include household cleaners, and natural sources include forest fires and eruptions from volcanoes.

Effects: Once air toxics enter the body, there is a wide range of potential health effects. They include the aggravation of asthma; irritation to the eyes, nose, and throat; carcinogenicity; developmental toxicity (birth defects); nervous system effects and various other effects on internal organs. Some effects appear after a shorter period of exposure, while others may appear after long-term exposure or after a long period of time has passed since the exposure ended. Most toxic effects are not unique to one substance, and some effects may be of concern only after the substance has deposited to the ground or to a water body (e.g., mercury, dioxin), followed by exposure through an oral pathway such as the eating of fish or produce. This further complicates the assessment of air toxics concerns due to the broad range of susceptibility that various people may have.

Population most at risk: People with asthma, children, and the elderly**.**

Air Toxics can be categorized as:

- *Metals:* Examples include aluminum, arsenic, beryllium, barium, cadmium, chromium, cobalt, copper, iron, mercury, manganese, molybdenum, nickel, lead, vanadium, and zinc.
- *Organic Substances*: Further divided into sub-categories that include -
  - VOCs, include benzene (found in gasoline), perchlorethylene (emitted from some dry cleaning facilities), and methylene chloride (a solvent and paint stripper used by industry);
  - carbonyl compounds (formaldehyde, acetone, and acetyladehyde);
  - semi-volatile compounds (SVOCs);
  - polycyclic aromatic hydrocarbons (PAHs)/polynuclear aromatic hydrocarbons (PNAs);
  - pesticides and;
  - polychlorinated biphenyls (PCBs).
- *Other substances*: Asbestos, dioxin, and radionuclides such as radon.

Because air toxics are such a large and diverse group of substances, regulatory agencies sometimes further refine these classifications to address specific concerns.

For example:

- Some initiatives have targeted those substances that are ***persistent, bioaccumulative* and *toxic*** (PBT), such as mercury, which accumulates in body tissues.
- The EPA has developed an Integrated *Urban Air Toxics Strategy* with a focus on 33 substances (the Urban HAPs List).[13]

The evaluation of air toxics levels is difficult due to several factors.

- There are no health-protective NAAQS. Instead, air quality assessments utilize various short- and long-term screening levels and health benchmark levels estimated to be safe considering the critical effects of concern for specific substances.
- There is incomplete toxicity information for many substances. For some air toxics, the analytical detection limits are too high to consistently measure the amount present, and in some cases, the risk assessment-based "safe" levels are below the detection limits.
- Data gaps are present regarding the potential for interactive toxic effects for co-exposure to multiple substances present in emissions and in ambient air. Air toxics also pose a challenge due to monitoring and analytical methods that are either unavailable for some compounds or cost-prohibitive for others (e.g., dioxins).

These factors make it difficult to accurately assess the potential health concerns of all air toxics. Nevertheless, it is feasible and important to characterize the potential health hazards and risks associated with many air toxics.

Table 8.1 shows the monitoring stations and what air toxic was monitored at each station in 2013. This table can also be found in **Appendix B** with the Air Toxics Monitoring Summary. In 2013, speciated $PM_{2.5}$ monitor at Luna Pier was moved to Sterling State Park.

Table 8.1: 2013 Toxics Sampling Sites

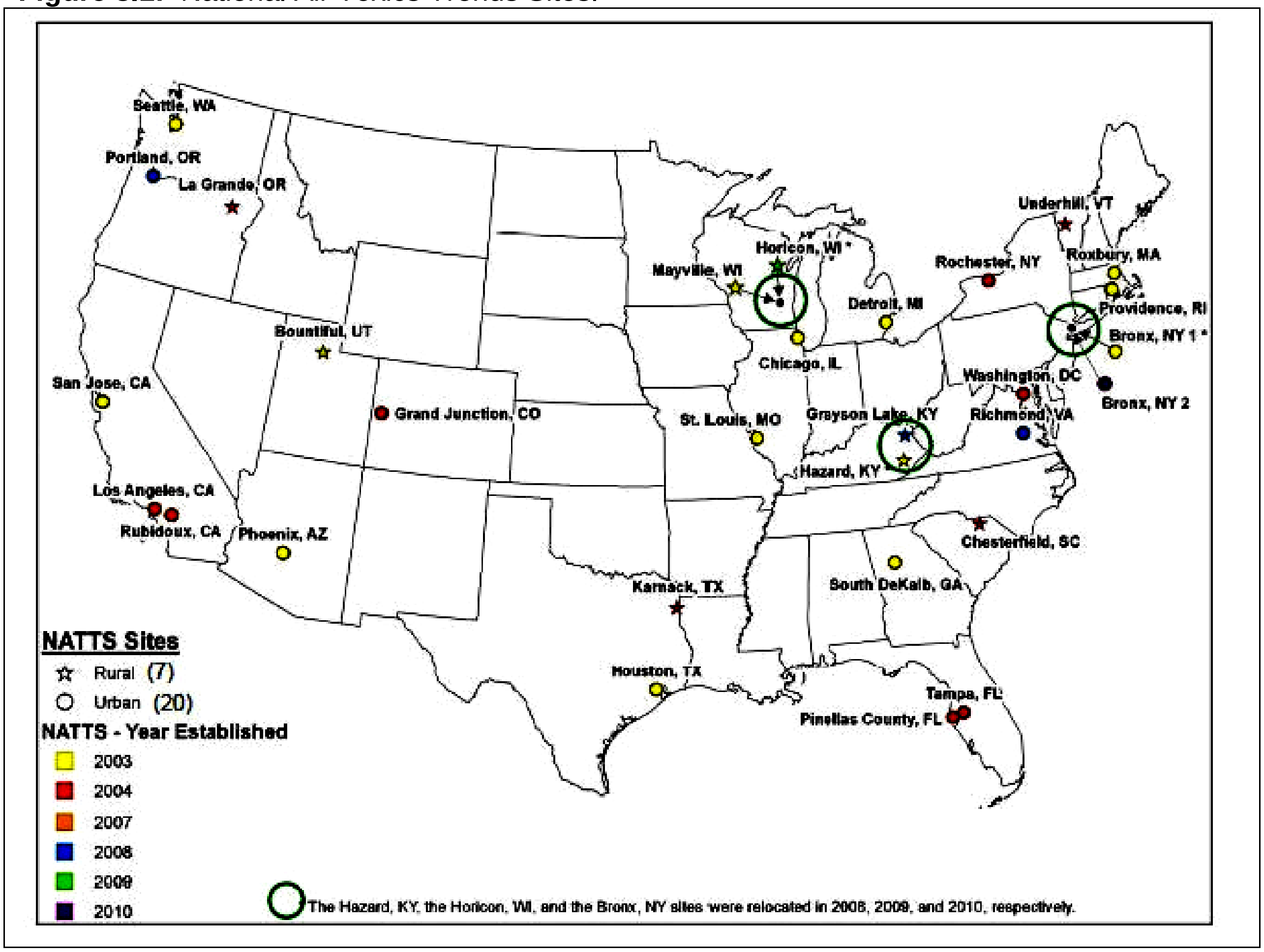
SITE NAME	VOC	Carbonyl	PAHs	Metals TSP	Metals PM_{10}	Hex Chrome	Speciated $PM_{2.5}$
Allen Park				x	x		x
Dearborn	x	x	x	x	x	x	x
Detroit-W. Fort St.	x	x		x	Mn		x
Detroit-W. Jefferson				x			
Grand Rapids-Monroe				x			x
Belding-Merrick St.				x			
Belding-Reed St.				x			
Vassar				x	x		
Houghton Lake							x
Luna Pier (moved to Sterling)							x
Sterling State Park							x
Port Huron-Nat'l Guard Arm.							x
Port Huron-Rural St.				x			
River Rouge		x		x	Mn		
Tecumseh							x

[13] EPA's Air Toxics Website – Urban Strategy is located at http://www.epa.gov/ttn/atw/urban/urbanpg.html.

National Monitoring Efforts and Data Analysis

The EPA administers national programs that identify air toxics levels, detect trends, and prioritize air toxics research. The DEQ participates in these programs. In addition, the AQD operates a site in Dearborn that is part of EPA's National Air Toxics Trend Stations (NATTS). The purpose of the NATTS network is to detect trends in high-risk air toxics such as benzene, formaldehyde, chromium, and 1,3-butadiene and to measure the progress of air toxics regulatory programs at the national level. Currently, the NATTS network contains 27 stations, 20 urban and seven rural (see **Figure 8.1**). The EPA requires that the NATTS sites measure VOCs, carbonyls, PAHs, hexavalent chromium, and trace metals on a once every six day sampling schedule. The Dearborn NATTS site measures trace metals as TSP, PM_{10}, and $PM_{2.5}$.

Figure 8.1: National Air Toxics Trends Sites.



Chapter 9: **MIair** – Air Quality Information in Real-Time

MIair is the internet tool that provides real-time air quality information via the DEQ's webpage. The www.deqmiair.org hotlink opens to the current Air Quality Index (AQI) map and displays air quality forecasts for "today" and "tomorrow." **MIair** also hosts EnviroFlash, the automated air quality notification system.

Air Quality Index

The Air Quality Index (AQI) is a simple tool developed to communicate current air quality information to the public. The current day's color-coded AQI values, ranging from Good to Hazardous (**Table 9.1**), are displayed in a forecast table and as dots on a Michigan map.

As can be seen from the annual summaries in **Appendix C**, air quality in Michigan is generally in the Good or Moderate range. An area will occasionally fall into the Unhealthy for Sensitive Groups range, but rarely reaches Unhealthy levels.

MIair includes an 'Actions to Protect Health' link: http://www.deqmiair.org/assets/AQIActionsToProtectHealth_2011.pdf which helps as an activity recommendations guide during the good to hazardous AQI levels.

Air Quality Forecasts

Air Quality Division meteorologists provide air pollution forecasts to alert the public when air pollution levels may become elevated. *Action!* Days are declared when levels are expected to reach or exceed the Unhealthy for Sensitive Groups AQI health indicator. On *Action!* Days, businesses, industry, government and the public are encouraged to reduce air pollution levels by limiting vehicle use, refueling only after 6 PM, carpooling, walking, biking or taking public transit, deferring the use of gasoline-powered lawn and recreation equipment, limiting the use of volatile chemicals and curtailing all burning. More information on voluntary air pollution control measures can be found under the *Action!* Days tab on **MIair**.

Air Quality Notification

EnviroFlash is a free service that provides automated air quality (AQI) and ultraviolet (UV) forecasts to subscribers. Those enrolled receive e-mail or mobile phone text messages when the health level they select is predicted to occur. AIRNow iPhone and Android applications deliver ozone and fine particle air quality forecasts plus detailed real-time information that can be used to better protect health when planning daily activities. To receive notices and learn more about this program, select the 'Air Quality Notification' tab in **MIair** when logged onto www.michigan.gov/air. Michigan's EnviroFlash network has the potential to reach up to 98% of the state's population.

AIRNow

The DEQ supplies Michigan air monitoring data to AIRNow, the EPA's nation-wide air quality mapping system. Information about AIRNow is available at www.epa.gov/airnow or you can select the AIRNow hot link at the bottom of each **MIair** webpage.

Table 9.1: AQI Colors and Health Statements

AQI Color, Category & Value	**PARTICULATE MATTER** (µg/m3) 24-hour	**OZONE** (ppm) 8-hour / 1-hr	**CARBON MONOXIDE** (ppm) 8-hour	**SULFUR DIOXIDE** (ppm) 24-hour	**NITROGEN DIOXIDE** (ppm) 1-hour
GREEN: Good 1- 50	None	None	None	None	None
YELLOW: Moderate 51- 100	Unusually sensitive people should consider reducing prolonged or heavy exertion.	Unusually sensitive people should consider reducing prolonged or heavy exertion.	None	None	None
ORANGE: Unhealthy For Sensitive Groups 101- 150	People with heart or lung disease, Children, and Older adults should reduce prolonged or heavy exertion.	People with heart or lung disease, Children & older adults, and People who are active outdoors should reduce prolonged or heavy exertion.	People with heart disease, such as angina, should limit heavy exertion and avoid sources of CO, such as heavy traffic.	People with asthma should consider limiting outdoor exertion.	None
RED: Unhealthy 151- 200	People with heart or lung disease, Children, and Older adults should avoid prolonged or heavy exertion. Everyone should reduce prolonged or heavy exertion.	People with heart or lung disease, Children & older adults, and People who are active outdoors should avoid prolonged or heavy exertion. Everyone should reduce prolonged or heavy exertion.	People with heart disease, such as angina, should reduce moderate exertion and avoid sources of CO, such as heavy traffic.	Children, Asthmatics, and People with heart or lung disease should reduce outdoor exertion.	None
PURPLE: Very Unhealthy 201- 300	People with heart or lung disease, Children, and Older adults should avoid all physical exertion outdoors. Everyone else should limit outdoor exertion.	People with heart or lung disease, Children & older adults, and People who are active outdoors should avoid all physical exertion outdoors. Everyone else should limit outdoor exertion.	People with heart disease, such as angina, should avoid exertion and sources of CO, such as heavy traffic.	Children, Asthmatics, and People with heart or lung disease should avoid outdoor exertion; Everyone should reduce outdoor exertion.	Children and People with respiratory disease, such as asthma, should reduce outdoor exertion.
MAROON: Hazardous 301- 500	People with heart or lung disease, Children, and Older adults should remain indoors. Everyone should avoid prolonged or heavy exertion.	People with heart or lung disease, Children, and Older adults should remain indoors. Everyone should avoid all outdoor exertion.	People with heart disease, such as angina, should avoid exertion and sources of CO, such as heavy traffic. Everyone else should limit heavy exertion.	Children, Asthmatics, and People with heart or lung disease should remain indoors. Everyone should avoid outdoor exertion.	Children and People with respiratory disease, such as asthma, should avoid outdoor exertion.

Chapter 10: Meteorological Information

The following **Figures 10.1** through **10.3** (average daily temperatures) and **Figures 10.4** through **10.6** (total monthly precipitation amounts) show total amounts as compared to their climatic norms for sites in the Northern, Southern Lower and Upper Peninsula. These figures were constructed by averaging data from several National Weather Service stations and therefore are not meant to be representative of any one single location in Michigan. Instead, they are intended to depict the regional trends that occurred during the year 2013.

Figure 10.1: Southern Lower Peninsula Observed Average Daily Temperatures vs. Normal Average Daily Temperatures

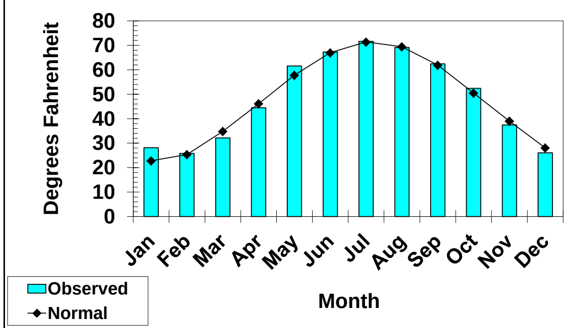


Figure 10.2: Northern Lower Peninsula Observed Average Daily Temperatures vs. Normal Average Daily Temperatures

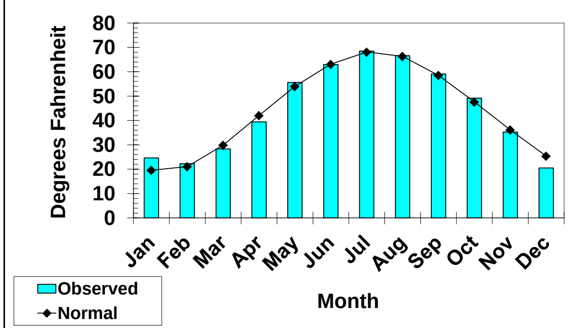


Figure 10.3: Upper Peninsula Observed Average Daily Temperatures vs. Normal Average Daily Temperatures

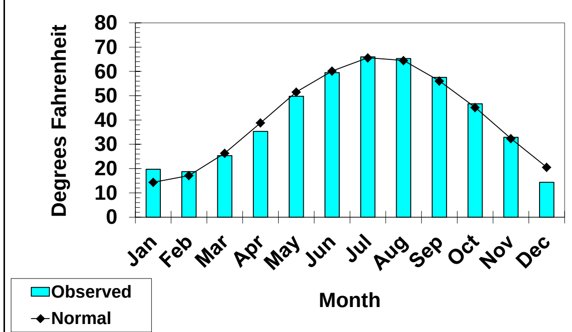


Figure 10.4: Southern Lower Peninsula Observed Monthly Precipitation vs. Normal Monthly Precipitation

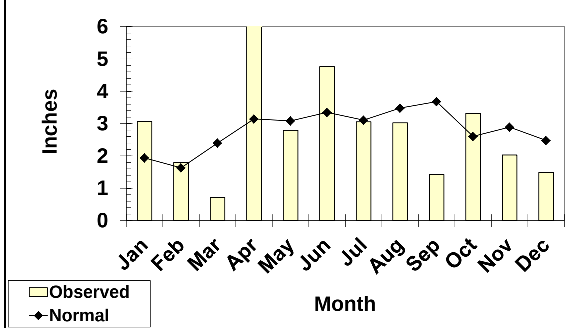


Figure 10.5: Northern Lower Peninsula Observed Monthly Precipitation vs. Normal Monthly Precipitation

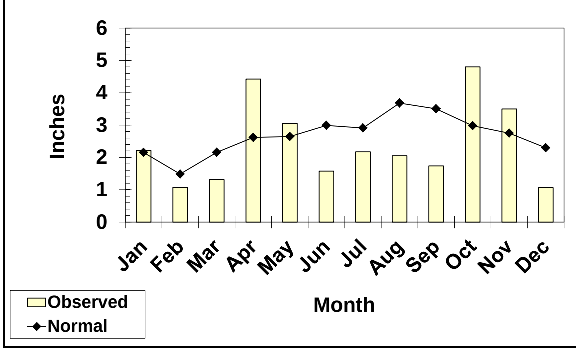
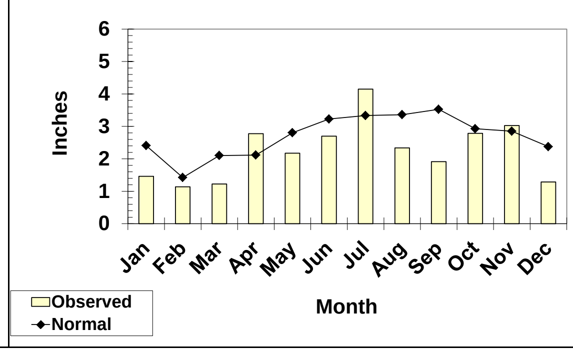


Figure 10.6: Upper Peninsula Observed Monthly Precipitation vs. Normal Monthly Precipitation



The weather plays a significant role in air quality, and can either help increase or decrease the amount of pollution in the air. High temperatures, sun and longer days (i.e. more daylight hours) is conducive to ozone formation, whereas rain tends wash pollutants out of the air. *Action!* Days are declared when levels are expected to reach or exceed the Unhealthy for Sensitive Groups AQI health indicator; specifically, when meteorological conditions are conducive for the formation of elevated ground-level O_3 or $PM_{2.5}$ concentrations.

Table 10.1 Shows that there were only 3 *Action!* Days declared during the summer of 2013.

Table 10.1: *Action!* Days declared during the summer of 2013

Location	Year	Number	Dates
Ann Arbor	2013	3	6/21, 8/20, 8/21
Detroit	2013	3	6/21, 8/20, 8/21
Grand Rapids	2013	2	8/20, 8/21
Ludington	2013	1	8/20

Appendix A: Criteria Pollutant Summary for 2013

Appendix A utilizes EPA's 2013 AQS Quick Look Report Data to present a summary of ambient air quality data collected for the criteria pollutants at monitoring locations throughout Michigan. Concentrations of non-gaseous pollutants are generally given in $\mu g/m^3$ and in ppm for gaseous pollutants. The following define some of the terms listed in the **Appendix A** reports.

Site I.D.: The AQS site ID is the EPA's code number for these sites.

POC: The Parameter Occurrence Code or POC is used to assist in distinguishing different uses of monitors, i.e. under Pb, NO_2, and SO_2, POC #1-5 are used to help differentiate between individual monitors. For PM, the POC numbers are used more for the type of monitoring, such as:

- 1 - federal reference method (FRM);
- 2 - co-located FRM;
- 3 - TEOM hourly PM_{10} and $PM_{2.5}$ measurements; and
- 5 - $PM_{2.5}$ speciation monitors (shown at right is a Met One SASS - spiral aerosol speciation sampler).

 # OBS: For Pb, TSP, $PM_{2.5}$, and PM_{10}, the # OBS (number of observations) refers to the number of valid 24-hour values gathered.

For continuous monitors (CO, NO_2, O_3, $PM_{2.5}$ TEOM, and SO_2,), # OBS refers to the total valid hourly averages obtained from the analyzer.

Values: The value is listed for each criteria pollutant per its NAAQS (primary and secondary). The number of exceedances per site for the primary and secondary standards utilize running averages for continuous monitors (except for O_3) and does not include averages considered invalid due to limited sampling times. For example, a particulate-mean based only on six months could not be considered as violating the annual standard. As noted, each site is allowed one short-term standard exceedance before a violation is determined.

>: The "greater than" symbol (>) heads the column reporting values or observations above the corresponding primary or secondary standards.

CRITERIA POLLUTANT SUMMARY FOR 2013

CO Measured in ppm

Site ID	POC	City	County	Year	# OBS	1-hr Highest Value	1-hr 2nd Highest Value	1-hr OBS > 35	8-hr Highest Value	8-hr 2nd Highest Value	8-hr OBS > 9
260810020	1	Grand Rapids	Kent	2013	7535	2.0	1.8	0	1.3	1.0	0
261630001	1	Allen Park	Wayne	2013	8322	2.2	2.0	0	1.3	1.1	0
261630093	1	Eliza Howell - Roadway	Wayne	2013	8311	6.3	4.8	0	1.8	1.6	0
261630094	1	Eliza Howell - Downwind	Wayne	2013	8449	2.0	2.0	0	1.7	1.4	0

Pb (24-Hour) Measured in $\mu g/m^3$

Site ID	POC	City	County	Year	# OBS	Highest rolling 3-month Arith Mean	Highest Value (24 hr)	2nd Highest Value (24hr)
260670002	1	Belding - Reed St.	Ionia	2013	60	0.06	0.190	0.160
260670003	1	Belding - Merrick St.	Ionia	2013	60	0.05	0.162	0.157
260810020	1	Grand Rapids	Kent	2013	54	0.01	0.012	0.10
261470031	1	Port Huron Rural St.	St. Clair	2013	59	0.04	0.172	0.145
261570001	1	Vassar	Tuscola	2013	61	0.01	0.074	0.069
261630001	1	Allen Park	Wayne	2013	61	0.01	0.011	0.009
261630033	1	Dearborn	Wayne	2013	55	0.01	0.047	0.029

NO_2 Measured in ppb

Site ID	POC	City	County	Year	# OBS	1-Hr Highest Value	1-Hr 2nd Highest Value	Annual Arith Mean
260650012	1	Lansing	Ingham	2013	7891	47.0	46.0	6.61
261130001	1	Houghton Lake	Missaukee	2013	7862	13.0	9.0	1.36
261630019	2	Detroit - E. Seven Mile	Wayne	2013	8516	48.0	48.0	10.56
261630093	1	Eliza Howell - Roadway	Wayne	2013	8546	71.0	53.0	18.22
261630094	1	Eliza Howell - Downwind	Wayne	2013	8687	48.0	48.0	12.09

NO_Y Measured in ppb

Site ID	POC	City	County	Year	# OBS	1-Hr Highest Value	1-Hr 2nd Highest Value	Annual Arith Mean
260810020	1	Grand Rapids	Kent	2013	8598	206.6	206.3	13.33
261630001	1	Allen Park	Wayne	2013	8459	313.1	308.7	20.77

O_3 (1-Hour) Measured in ppm

Site ID	POC	City	County	Year	Num Meas	Num Req	Highest Value	2nd Highest Value	3rd Highest Value	4th Highest Value	Day Max >/= 0.125 Measured	Values >/= 0.125 Estimated	Missed Days < 0.125 Standard
260050003	1	Holland	Allegan	2013	179	183	0.107	0.100	0.098	0.094	0	0	1
260190003	1	Benzonia	Benzie	2013	183	183	0.080	0.079	0.077	0.077	0	0	0
260210014	1	Coloma	Berrien	2013	179	183	0.094	0.092	0.090	0.089	0	0	0
260270003	2	Cassopolis	Cass	2013	183	183	0.086	0.084	0.083	0.083	0	0	0
260330901	1	Sault Ste. Marie	Chippewa	2013	173	183	0.067	0.066	0.065	0.064	0	0	2
260370001	2	Rose Lake	Clinton	2013	183	183	0.075	0.073	0.073	0.070	0	0	0
260490021	1	Flint	Genesee	2013	180	183	0.076	0.071	0.071	0.070	0	0	0
260492001	1	Otisville	Genesee	2013	182	183	0.076	0.075	0.072	0.072	0	0	1
260630007	1	Harbor Beach	Huron	2013	180	183	0.092	0.090	0.070	0.068	0	0	1
260650012	2	Lansing	Ingham	2013	182	183	0.075	0.075	0.074	0.072	0	0	1
260770008	1	Kalamazoo	Kalamazoo	2013	183	183	0.086	0.079	0.077	0.076	0	0	0
260810020	1	Grand Rapids	Kent	2013	181	183	0.090	0.089	0.081	0.080	0	0	0
260810022	1	Evans	Kent	2013	183	183	0.077	0.077	0.075	0.074	0	0	0
260910007	1	Tecumseh	Lenawee	2013	183	183	0.078	0.075	0.072	0.071	0	0	0
260990009	1	New Haven	Macomb	2013	182	183	0.098	0.097	0.087	0.083	0	0	0
260991003	1	Warren	Macomb	2013	180	183	0.084	0.082	0.074	0.072	0	0	0
261010933	1	Manistee	Manistee	2013	176	183	0.081	0.081	0.080	0.078	0	0	3
261050007	1	Scottville	Mason	2013	181	183	0.086	0.083	0.079	0.078	0	0	0
261130001	1	Houghton Lake	Missaukee	2013	183	183	0.074	0.072	0.072	0.070	0	0	0
261210039	1	Muskegon	Muskegon	2013	181	183	0.091	0.089	0.089	0.088	0	0	2
261250001	2	Oak Park	Oakland	2013	182	183	0.087	0.081	0.079	0.077	0	0	1
261390005	1	Jenison	Ottawa	2013	182	183	0.089	0.088	0.088	0.087	0	0	1
261470005	1	Port Huron	St .Clair	2013	182	183	0.088	0.085	0.084	0.083	0	0	1
261530001	1	Seney	Schoolcraft	2013	182	183	0.085	0.080	0.076	0.076	0	0	1
261610008	1	Ypsilanti	Washtenaw	2013	183	183	0.078	0.076	0.074	0.071	0	0	0
261630001	2	Allen Park	Wayne	2013	181	183	0.086	0.077	0.076	0.073	0	0	2
261630019	2	Detroit - E. Seven Mile	Wayne	2013	176	183	0.089	0.084	0.077	0.076	0	0	4

O_3 (8-Hour) Measured in ppm

Site ID	POC	City	County	Year	% OBS	Valid Days Measured	Highest Value	2nd Highest Value	3rd Highest Value	4th Highest Value	Day Max > 0.075
260050003	1	Holland	Allegan	2013	97	178	0.087	0.080	0.079	0.078	5
260190003	1	Benzonia	Benzie	2013	100	183	0.076	0.070	0.070	0.069	1
260210014	1	Coloma	Berrien	2013	97	178	0.078	0.077	0.075	0.074	2
260270003	2	Cassopolis	Cass	2013	100	183	0.077	0.075	0.074	0.071	1
260330901	1	Sault Ste. Marie	Chippewa	2013	89	163	0.065	0.062	0.061	0.060	0
260370001	2	Rose Lake	Clinton	2013	100	183	0.073	0.069	0.065	0.064	0
260490021	1	Flint	Genesee	2013	98	179	0.072	0.068	0.065	0.065	0
260492001	1	Otisville	Genesee	2013	99	181	0.071	0.069	0.069	0.067	0
260630007	1	Harbor Beach	Huron	2013	98	180	0.080	0.066	0.064	0.064	1
260650012	2	Lansing	Ingham	2013	99	181	0.071	0.068	0.067	0.066	0

O_3 (8-Hour) Measured in ppm (continued)

Site ID	POC	City	County	Year	% OBS	Valid Days Measured	Highest Value	2nd Highest Value	3rd Highest Value	4th Highest Value	Day Max > 0.075
260770008	1	Kalamazoo	Kalamazoo	2013	99	182	0.072	0.068	0.068	0.068	0
260810020	1	Grand Rapids	Kent	2013	99	181	0.075	0.072	0.070	0.068	0
260810022	1	Evans	Kent	2013	100	183	0.071	0.068	0.068	0.068	0
260910007	1	Tecumseh	Lenawee	2013	100	183	0.072	0.068	0.067	0.064	0
260990009	1	New Haven	Macomb	2013	99	182	0.079	0.078	0.077	0.072	3
260991003	1	Warren	Macomb	2013	97	178	0.077	0.073	0.067	0.066	1
261010922	1	Manistee	Manistee	2013	96	175	0.077	0.070	0.070	0.069	1
261050007	1	Scottville	Mason	2013	99	181	0.074	0.073	0.068	0.068	0
261130001	1	Houghton Lake	Missaukee	2013	99	182	0.071	0.070	0.067	0.065	0
261210039	1	Muskegon	Muskegon	2013	99	181	0.078	0.077	0.076	0.073	3
261250001	2	Oak Park	Oakland	2013	99	182	0.076	0.072	0.069	0.067	1
261390005	1	Jenison	Ottawa	2013	99	182	0.075	0.073	0.070	0.070	0
261470005	1	Port Huron	St .Clair	2013	99	182	0.075	0.073	0.072	0.071	0
261530001	1	Seney	Schoolcraft	2013	99	181	0.078	0.073	0.071	0.067	1
261610008	1	Ypsilanti	Washtenaw	2013	100	183	0.071	0.068	0.067	0.065	0
261630001	2	Allen Park	Wayne	2013	98	180	0.078	0.068	0.064	0.064	1
261630019	2	Detroit - E. Seven Mile	Wayne	2013	96	176	0.079	0.075	0.070	0.067	1

$PM_{2.5}$ (24-Hour) Measured in $\mu g/m^3$ at Local Conditions

Site ID	POC	Monitor	City	County	Year	# OBS	Highest Value	2nd Highest Value	3rd Highest Value	4th Highest Value	98%	Wtd. Arith. Mean
260050003	1	FRM	Holland	Allegan	2013	119	20.0	18.6	17.7	17.6	17.7	7.82
260170014	1	FRM	Bay City	Bay	2013	113	19.8	18.4	16.0	15.7	16.0	7.47
260210014	1	FRM	Coloma	Berrien	2013	120	19.6	18.3	17.4	17.0	17.4	7.97
260330901	1	FRM	Sault Ste. Marie	Chippewa	2013	96	18.2	14.4	14.1	14.1	14.4	6.04*
260330901	2	FRM	Sault Ste. Marie	Chippewa	2013	54	17.6	15.5	13.7	13.0	15.5	6.21
260490021	1	FRM	Flint	Genesee	2013	113	18.7	18.0	16.6	16.1	16.6	7.44
260650012	1	FRM	Lansing	Ingham	2013	112	18.3	18.2	17.4	17.2	17.4	7.58
260770008	1	FRM	Kalamazoo	Kalamazoo	2013	108	18.4	17.9	17.7	17.1	17.7	8.27
260770008	2	FRM	Kalamazoo	Kalamazoo	2013	56	18.0	17.9	17.7	17.0	17.9	8.79
260810007	1	FRM	Grand Rapids - Wealthy	Kent	2013	121	20.8	19.3	19.0	18.3	19.0	8.99
260810020	1	FRM	Grand Rapids - Monroe	Kent	2013	118	19.2	18.4	18.3	17.6	18.3	8.38
260810020	2	FRM	Grand Rapids - Monroe	Kent	2013	56	18.9	18.7	18.3	18.3	18.7	8.80
260910007	1	FRM	Tecumseh	Lenawee	2013	118	19.0	17.9	16.8	16.4	16.8	7.93
260990009	1	FRM	New Haven	Macomb	2013	122	19.7	18.5	18.3	17.7	18.3	7.95

*Indicates the mean does not satisfy summary criteria

$PM_{2.5}$ (24-Hour) Measured in $\mu g/m^3$ at Local Conditions (continued)

Site ID	POC	Monitor	City	County	Year	# OBS	Highest Value	2nd Highest Value	3rd Highest Value	4th Highest Value	98%	Wtd. Arith. Mean
261010922	1	FRM	Manistee	Manistee	2013	108	45.0	18.5	18.2	17.6	18.2	6.45
261130001	1	FRM	Houghton Lake	Missaukee	2013	121	18.2	17.6	17.1	14.6	17.1	5.49
261150005	1	FRM	Luna Pier	Monroe	2013	63	19.1	17.8	16.0	15.0	17.8	9.71*
261150006	1	FRM	Sterling State Park	Monroe	2013	49	19.5	18.3	17.9	17.7	19.5	8.91*
261210040	1	FRM	Muskegon	Muskegon	2013	66	20.1	18.0	17.2	16.9	18.0	9.95*
261250001	1	FRM	Oak Park	Oakland	2013	119	19.7	19.5	18.9	18.7	18.9	8.38
261390005	1	FRM	Jenison	Ottawa	2013	120	19.0	18.6	18.2	17.4	18.2	8.09
261470005	1	FRM	Port Huron	St. Clair	2013	122	26.5	19.1	18.9	18.7	18.9	8.44
261610008	1	FRM	Ypsilanti	Washtenaw	2013	115	20.1	20.0	18.5	17.9	18.5	8.64
261610008	2	FRM	Ypsilanti	Washtenaw	2013	59	19.4	18.9	18.1	16.1	18.9	9.18
261630001	1	FRM	Allen Park	Wayne	2013	348	33.8	24.5	24.3	23.8	22.8	9.49
261630015	1	FRM	Detroit - W. Fort	Wayne	2013	121	23.5	23.0	21.2	20.8	21.2	10.11
261630016	1	FRM	Detroit - Linwood	Wayne	2013	113	20.5	20.5	20.0	19.7	20.0	8.86
261630019	1	FRM	Detroit - E. Seven Mile	Wayne	2013	116	20.4	19.9	19.9	19.5	19.9	8.71
261630025	1	FRM	Livonia	Wayne	2013	113	21.5	19.7	19.6	18.2	19.6	8.67
261630033	1	FRM	Dearborn	Wayne	2013	118	28.0	24.9	24.1	22.8	24.1	11.01
261630033	2	FRM	Dearborn	Wayne	2013	61	21.1	20.8	20.0	19.7	20.8	10.80
261630036	1	FRM	Wyandotte	Wayne	2013	111	18.5	18.4	17.7	17.7	17.7	8.00
261630038	1	FRM	Detroit - Newberry.	Wayne	2013	11	16.6	15.3	15.3	13.5	16.6	10.15*
261630039	1	FRM	Detroit - W. Lafayette	Wayne	2013	316	33.7	27.3	26.7	26.3	22.0	9.34

*Indicates the mean does not satisfy summary criteria

$PM_{2.5}$ TEOM (1-Hour) Measured in $\mu g/m^3$

Site ID	POC	Monitor	City	County	Year	# OBS	Highest Value	2nd Highest Value	3rd Highest Value	4th Highest Value	Wtd. Arith. Mean
260170014	3	TEOM	Bay City	Bay	2013	8018	249.0	127.0	86.0	62.0	8.30
260330901	3	BAM	Sault Ste. Marie	Chippewa	2013	5364	66.2	65.7	56.7	56.5	6.42*
260490021	3	TEOM	Flint	Genesee	2013	8342	174.0	115.0	112.0	101.0	8.56
260650012	5	TEOM	Lansing	Ingham	2013	8513	107.0	98.0	80.0	76.0	8.65
260770008	3	TEOM	Kalamazoo	Kalamazoo	2013	8550	81.0	71.0	60.0	58.0	9.06
260810020	3	TEOM	Grand Rapids	Kent	2013	8650	340.0	338.0	228.0	151.0	9.08
260910007	3	TEOM	Tecumseh	Lenawee	2013	8207	46.0	36.0	33.0	33.0	8.89
261130001	3	TEOM	Houghton Lake	Missaukee	2013	8459	47.0	44.0	43.0	40.0	6.84
261470005	3	TEOM	Port Huron	St. Clair	2013	8702	55.0	49.0	43.0	42.0	8.96
261530001	3	TEOM	Seney	Schoolcraft	2013	8584	36.0	32.0	30.0	29.0	5.86
261610008	3	TEOM	Ypsilanti	Washtenaw	2013	8544	86.0	74.0	55.0	53.0	9.32
261630001	3	TEOM	Allen Park	Wayne	2013	8587	107.0	69.0	68.0	62.0	9.96
261630033	3	TEOM	Dearborn	Wayne	2013	8653	131.0	116.0	84.0	82.0	11.39
261630038	3	TEOM	Detroit – Newberry	Wayne	2013	815	43.0	29.0	29.0	28.0	10.04*
261630039	3	TEOM	Detroit – W. Lafayette	Wayne	2013	8630	58.0	57.0	57.0	54.0	10.11
261630039	3	BAM	Detroit – W. Lafayette	Wayne	2013	7831	58.7	56.5	56.2	49.3	10.93

*Indicates the mean does not satisfy summary criteria

PM_{10} (24-Hour) Measured in µg/m^3

Site ID	POC	Monitor	City	County	Year	# OBS	# Req.	Valid Days	% OBS	Highest Value	2nd Highest Value	3rd Highest Value	4th Highest Value	Wtd Arith Mean
260810007	1	GRAV	Grand Rapids - Wealthy	Kent	2013	58	61	58	95	35	29	29	26	13.7
260810020	1	GRAV	Grand Rapids - Monroe	Kent	2013	52	61	52	85	28	26	26	23	12.6*
261570001	1	GRAV	Vassar	Tuscola	2013	61	61	61	100	56	47	31	27	13.9
261630001	1	GRAV	Allen Park	Wayne	2013	61	61	61	100	28	27	24	24	14.1
261630005	1	GRAV	River Rouge	Wayne	2013	59	61	59	97	35	35	33	33	17.1
261630015	1	GRAV	Detroit - W. Fort	Wayne	2013	61	61	61	100	44	43	42	36	19.6
261630033	1	GRAV	Dearborn	Wayne	2013	60	61	59	97	45	41	41	38	22.7
261630033	9	GRAV	Dearborn	Wayne	2013	31	31	30	97	40	38	34	33	21.2

*Indicates the mean does not satisfy summary criteria

PM_{10} TEOM (1-Hour) Measured in µg/m^3

Site ID	POC	Monitor	City	County	Year	# OBS	Highest Value	2nd Highest Value	3rd Highest Value	4th Highest Value	Wtd. Arith. Mean
261630033	3	TEOM	Dearborn	Wayne	2013	8624	262	201	176	169	22.4

SO_2 Measured in ppb

Site ID	POC	City	County	Year	# OBS	1-hr Highest Value	1-hr 2nd Highest Value	99th %ile 1-hr	24-hr Highest Value	24-hr 2nd Highest Value	OBS >0.5	Arith Mean
260650012	1	Lansing	Ingham	2013	8243	30.1	20.9	19.0	7.0	5.4	0	1.18
260810020	2	Grand Rapids	Kent	2013	8181	68.8	11.8	10.2	4.3	2.9	0	0.72
261150006	1	Sterling State Park	Monroe	2013	8344	25.5	25.1	18.4	6.6	5.0	0	1.10
261390005	1	Jenison	Ottawa	2013	8588	25.3	17.0	13.6	3.0	2.8	0	0.45
261470005	1	Port Huron	St. Clair	2013	8428	77.8	77.8	72.2	20.4	16.6	0	2.60
261630001	1	Allen Park	Wayne	2013	8092	65.6	60.7	43.1	12.9	8.9	0	1.25
261630015	1	Detroit - W. Fort	Wayne	2013	8346	74.1	73.1	65.6	26.6	23.5	0	2.58

Appendix B: 2013 Air Toxics Monitoring Summary for Metals, VOCs, Carbonyl Compounds, PAHs, Hexavalent Chromium & Speciated $PM_{2.5}$

Appendix B provides summary statistics of ambient air concentrations of various substances monitored in Michigan during 2013. At each monitoring site, air samples were taken over a 24-hour period (midnight to midnight). These air samples represent the average air concentration during that 24-hour period. The frequency of air samples collected is typically done once every 6 or 12 days. Sometimes the sampled air concentration is lower than the laboratory's analytical method detection level (MDL). When the concentration is lower than the MDL, two options are used to estimate the air concentration. The calculation of the minimum average ("Average (ND=0)") uses 0.0 $\mu g/m^3$ for a value less than the MDL. In the calculation of the maximum average ("Average (ND=MDL/2)") the MDL divided by 2 (i.e., ½ the MDL) is substituted for air concentrations less than the MDL.

Table B shows the monitoring stations and what types of air toxics were monitored at each station in 2013. The following terms and acronyms are used in **Appendix B-1** and **B-2** data tables:

- Num Obs: Number of Observations (number of daily air samples taken during the year)
- Obs>MDL: Number of daily samples above the MDL
- Average (ND=0): average air concentration in 2013, assuming daily samples below MDL were equal to 0.0 $\mu g/m^3$.
- Average (ND=MDL/2): average air concentration in 2013, assuming daily samples below MDL were equal to one half MDL.
- MDL: Analytical MDL in units of $\mu g/m^3$
- Max1: Highest daily air concentration during 2013
- Max2: Second highest daily air concentration during 2013
- Max3: Third highest daily air concentration during 2013
- $\mu g/m^3$: Micrograms per cubic meter (1,000,000 µg = 1 g)

Table B: Monitoring Stations and Types of Air Samples Collected							
	Appendix B-1						Appendix B-2
Site Name	**VOC**	**Carbonyl**	**PAHs**	**Metals TSP**	**Metals PM_{10}**	**Hex Chrome**	**Speciated PM2.5**
Allen Park				x	x		x
Dearborn	x	x	x	x	x	x	x
Detroit-W. Fort St.	x	x		x	Mn		x
Detroit-W. Jefferson				x			
Grand Rapids - Monroe				x			x
Belding-Merrick St.				x			
Belding-Reed St.				x			
Vassar				x	x		
Houghton Lake							x
Luna Pier							x
Sterling State Park							x
Port Huron - Nat'l Guard Arm.							x
Port Huron-Rural St.				x			
River Rouge		x		x	Mn		
Tecumseh							x

VOC = volatile organic compound; PAHs = polycyclic aromatic hydrocarbon; TSP = total suspended particulate; PM_{10} = particulate matter with aerodynamic diameter less than 10 µm; Hex Chrome = hexavalent chromium (Cr+6); Mn = manganese;

APPENDIX B-1

Allen Park (261630001) Concentrations in micrograms per cubic meter (µg/m³)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Arsenic (Tsp)	61	61	0.00143	0.00143	0.00003	0.00889	0.00302	0.00301
Arsenic Pm10	61	61	0.00114	0.00114	0.00004	0.00582	0.0026	0.00251
Cadmium (Tsp)	61	61	0.000159	0.000159	0.00002	0.00056	0.00037	0.0003
Cadmium Pm10	61	61	0.000398	0.000398	0.00003	0.00263	0.0019	0.00178
Lead (Tsp) Lc Frm/Fem	61	61	0.00428	0.00428		0.0116	0.00979	0.00822
Lead Pm10 Lc	61	61	0.00328	0.00328		0.00884	0.00711	0.00709
Manganese (Tsp)	61	61	0.0215	0.0215	0.000241	0.0672	0.0478	0.0435
Manganese Pm10	61	61	0.00731	0.00731	0.000295	0.0214	0.0176	0.0145
Nickel (Tsp)	61	61	0.00122	0.00122	0.000129	0.00211	0.00209	0.00205
Nickel Pm10	61	61	0.000723	0.000723	0.000159	0.00158	0.00141	0.00119

Dearborn (261630033) Concentrations in micrograms per cubic meter (µg/m³)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
1,1,2,2-Tetrachloroethane	62	2	0.00144	0.0895	0.182	0.0481	0.0412	0
1,1,2-Trichloroethane	62		0	0.0528	0.106	0	0	0
1,1-Dichloroethane	62	0	0	0.031	0.0619	0	0	0
1,1-Dichloroethylene	62	1	0.00121	0.0231	0.0445	0.0753	0	0
1,2,4-Trichlorobenzene	62	1	0.000718	0.0902	0.182	0.0445	0	0
1,2,4-Trimethylbenzene	62	62	0.635	0.635	0.0903	5.31	3.25	2.52
1,2-Dichlorobenzene	62	3	0.00145	0.0687	0.141	0.0361	0.0301	0.024
1,2-Dichloropropane	62	0	0	0.0401	0.0802	0	0	0
1,3,5-Trimethylbenzene	62	59	0.212	0.214	0.0952	1.84	0.806	0.752
1,3-Butadiene	62	57	0.075	0.076	0.0248	0.321	0.239	0.208
1,3-Dichlorobenzene	62	0	0	0.0797	0.159	0	0	0
1,4-Dichlorobenzene	62	8	0.00601	0.067	0.141	0.0661	0.0601	0.0481
2,5-Dimethylbenzaldehyde	68	0	0	0.00548	0.011	0	0	0
Acenaphthene	67	67	0.00954	0.00954	4.63E-05	0.0411	0.0375	0.0375
Acenaphthylene	67	49	0.000503	0.00051	4.76E-05	0.00163	0.00151	0.00148
Acetaldehyde	68	68	1.75	1.75	0.0119	2.83	2.69	2.56
Acetone	68	68	3.45	3.45	0.0337	7.27	6.53	6.34
Acetonitrile	62	62	0.91	0.91	0.0531	2.08	1.81	1.8
Acetylene	62	61	0.862	0.862	0.0184	2.83	2.74	2.6
Acrylonitrile	62	1	0.00147	0.0287	0.0554	0.0912	0	0
Anthracene	67	63	0.000671	0.000672	3.37E-05	0.00418	0.00216	0.00209
Arsenic (Tsp)	88	88	0.00152	0.00152	0.00003	0.00342	0.00339	0.00334
Arsenic Pm10	91	91	0.00129	0.00129	0.00004	0.00344	0.00318	0.00303
Barium (Tsp)	88	88	0.0185	0.0185	0.00127	0.0642	0.0624	0.0383

Dearborn (261630033) Concentrations in micrograms per cubic meter (µg/m^3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Barium (Tsp)	88	88	0.0185	0.0185	0.00127	0.0642	0.0624	0.0383
Barium Pm10	91	91	0.0102	0.0102	0.00159	0.0247	0.0237	0.0215
Benzaldehyde	68	68	0.158	0.158	0.0131	0.295	0.291	0.269
Benzene	62	62	0.638	0.638	0.0619	1.32	1.25	1.15
Benzo[A]Anthracene (Tsp)	67	67	0.000138	0.000138	9.37E-05	0.000552	0.000468	0.000436
Benzo[A]Pyrene (Tsp)	67	67	0.00013	0.00013	6.26E-05	0.00056	0.000446	0.00044
Benzo[B]Fluoranthene (Tsp)	67	67	0.000382	0.000382	4.92E-05	0.00272	0.000937	0.000922
Benzo[G,H,I]Perylene (Tsp)	67	67	0.000177	0.000177	4.43E-05	0.000972	0.000526	0.000473
Benzo[K]Fluoranthene (Tsp)	67	66	0.000105	0.000105	6.21E-05	0.000815	0.0003	0.00027
Beryllium (Tsp)	88	88	0.000071	0.000071	0.00001	0.00026	0.00019	0.00017
Beryllium Pm10	91	72	0.000021	2.21E-05	0.000011	0.00008	0.00006	0.00006
Bromochloromethane	62	0	0	0.0432	0.0864	0	0	0
Bromodichloromethane	62	0	0	0.0649	0.129	0	0	0
Bromoform	62	2	0.0025	0.11	0.222	0.0827	0.0724	0
Bromomethane	62	32	0.0239	0.0344	0.0436	0.066	0.066	0.066
Butyraldehyde	68	68	0.43	0.43	0.00889	2.82	2.37	1.07
Cadmium (Tsp)	88	88	0.000337	0.000337	2.01E-05	0.00116	0.00116	0.00079
Cadmium Pm10	91	89	0.00028	0.00028	0.00003	0.00115	0.00111	0.00078
Carbon Disulfide	62	62	0.147	0.147	0.035	0.545	0.417	0.408
Carbon Tetrachloride	62	62	0.67	0.67	0.103	0.975	0.893	0.868
Chlorobenzene	62	0	0	0.0422	0.0845	0	0	0
Chloroethane	62	5	0.0043	0.0179	0.0296	0.0633	0.0581	0.0501
Chloroform	62	62	0.638	0.638	0.0748	1.42	1.22	1.19
Chloromethane	62	62	1.3	1.3	0.0274	3.1	1.67	1.65
Chloroprene	62	0	0	0.0222	0.0444	0	0	0
Chromium (Tsp)	88	88	0.00533	0.00533	0.000215	0.0191	0.0137	0.0108
Chromium Pm10	91	91	0.00311	0.00311	0.000268	0.0055	0.00499	0.00499
Chromium Vi (Tsp)	33	24	3.31E-05	3.37E-05	3.92E-06	0.000129	0.000101	8.73E-05
Chrysene (Tsp)	67	67	0.000366	0.000366	2.86E-05	0.00202	0.000815	0.000784
Cis-1,2-Dichloroethene	62	0	0	0.0323	0.0646	0	0	0
Cis-1,3-Dichloropropene	62	0	0	0.0325	0.0648	0	0	0
Cobalt (Tsp)	88	88	0.000201	0.000201	0.00001	0.00041	0.0004	0.00038
Cobalt Pm10	91	85	0.000108	0.000108	0.000011	0.00035	0.00027	0.00025
Copper (Tsp)	88	88	0.119	0.119	0.00067	0.487	0.269	0.256
Copper Pm10	91	91	0.0482	0.0482	0.000836	0.459	0.122	0.115
Dibenzo[A,H]Anthracene (Tsp)	67	30	1.83E-05	0.000031	0.000045	0.00012	9.65E-05	7.98E-05
Dibromochloromethane	62	5	0.00453	0.0757	0.156	0.0852	0.0596	0.0511
Dichlorodifluoromethane	62	62	2.62	2.62	0.0506	3.83	3.54	3.31
Dichloromethane	62	62	5.23	5.23	0.0527	67.4	11.3	9.38
Ethyl Acrylate	62	0	0	0.0313	0.0626	0	0	0
Ethylbenzene	62	62	0.383	0.383	0.0753	2.31	1.88	0.99
Ethylene Dibromide	62	0	0	0.0628	0.126	0	0	0
Ethylene Dichloride	62	57	0.0768	0.0798	0.066	0.121	0.121	0.121
Fluoranthene (Tsp)	67	67	0.00449	0.00449	5.46E-05	0.0184	0.018	0.0149
Fluorene (Tsp)	67	66	0.00829	0.00829	6.42E-05	0.0337	0.0304	0.0303
Formaldehyde	68	68	3.03	3.03	0.0138	7.21	5.82	5.8
Freon 114	62	62	0.116	0.116	0.0784	0.154	0.154	0.14
Hexachlorobutadiene	62	3	0.00378	0.149	0.305	0.096	0.0746	0.064
Hexanaldehyde	68	68	0.169	0.169	0.00819	0.315	0.315	0.311
Indeno[1,2,3-Cd]Pyrene (Tsp)	67	67	0.00017	0.00017	4.06E-05	0.00109	0.000476	0.000425

Dearborn (261630033) Concentrations in micrograms per cubic meter (µg/m³)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Iron (Tsp)	88	88	1.2	1.2	0.00311	3.48	3.43	3.14
Iron Pm10	91	91	0.507	0.507	0.00388	1.29	1.27	1.26
Isovaleraldehyde	68	0	0	0.00352	0.00705	0	0	0
Lead (Tsp) Lc Frm/Fem	87	87	0.0103	0.0103		0.0471	0.0293	0.0285
Lead Pm10 Lc	91	91	0.00889	0.00889		0.0513	0.05	0.0286
M/P Xylene	62	62	1.06	1.06	0.125	7.25	5.99	2.76
Manganese (Tsp)	88	88	0.0944	0.0944	0.000237	0.345	0.287	0.239
Manganese Pm10	91	91	0.0311	0.0311	0.000296	0.1	0.0934	0.0841
Methyl Chloroform	62	27	0.0173	0.0409	0.0835	0.0655	0.06	0.06
Methyl Ethyl Ketone	68	68	0.412	0.412	0.0059	1.21	0.752	0.693
Methyl Isobutyl Ketone	62	57	0.244	0.247	0.0752	1.39	0.738	0.684
Methyl Methacrylate	62	0	0	0.0272	0.0544	0	0	0
Methyl Tert-Butyl Ether	62	5	0.0172	0.0374	0.0441	0.386	0.328	0.263
Molybdenum (Tsp)	88	88	0.000756	0.000756	3.94E-05	0.00205	0.00189	0.00153
Molybdenum Pm10	91	91	0.000609	0.000609	0.00005	0.00181	0.00175	0.00112
Naphthalene (Tsp)	67	67	0.102	0.102	0.000255	0.314	0.25	0.212
Nickel (Tsp)	88	88	0.00187	0.00187	0.000128	0.00378	0.00372	0.00356
Nickel Pm10	91	91	0.00114	0.00114	0.000159	0.00311	0.00288	0.00276
N-Octane	62	62	0.131	0.131	0.0573	0.477	0.374	0.238
O-Xylene	62	62	0.342	0.342	0.0709	1.89	1.46	1.02
Phenanthrene (Tsp)	67	67	0.0163	0.0163	4.92E-05	0.063	0.0589	0.0577
Propionaldehyde	68	68	0.382	0.382	0.00954	1	0.77	0.701
Propylene	62	62	0.658	0.658	0.0632	1.54	1.4	1.26
Pyrene (Tsp)	67	67	0.00226	0.00226	5.78E-05	0.00831	0.00805	0.00631
Styrene	62	62	3.88	3.88	0.083	140	5.71	4.47
Tert-Butyl Ethyl Ether	62	0	0	0.0298	0.0596	0	0	0
Tetrachloroethylene	62	62	0.389	0.389	0.0968	7.87	1.3	0.699
Tolualdehydes	66	65	0.133	0.133	0.0198	0.319	0.305	0.29
Toluene	62	62	1.06	1.06	0.0577	4.22	3.1	2.34
Trans-1,2-Dichloroethylene	62	0	0	0.0242	0.0485	0	0	0
Trans-1,3-Dichloropropene	62	0	0	0.0371	0.0741	0	0	0
Trichloroethylene	62	7	0.0107	0.0496	0.0876	0.279	0.0752	0.0752
Trichlorofluoromethane	62	62	1.52	1.52	0.0689	2.07	1.96	1.89
Valeraldehyde	67	67	0.11	0.11	0.0107	0.187	0.183	0.173
Vanadium (Tsp)	88	88	0.00333	0.00333	3.94E-05	0.012	0.00899	0.00871
Vanadium Pm10	91	91	0.00151	0.00151	0.00005	0.00616	0.00594	0.0054
Vinyl Chloride	62	14	0.00594	0.0171	0.0287	0.0383	0.0332	0.0307
Zinc (Tsp)	88	88	0.0988	0.0988	0.000797	0.308	0.258	0.238
Zinc Pm10	91	91	0.0666	0.0666	0.000995	0.187	0.186	0.183

Detroit, Fort Street (N. Delray-SWHS) (261630015) Concentrations in micrograms per cubic meter (µg/m^3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
1,1,2,2-Tetrachloroethane	31	3	0.0348	0.237	0.436	0.4	0.34	0.34
1,1,2-Trichloroethane	31	2	0.0219	0.255	0.488	0.34	0.34	0
1,1-Dichloroethane	31	2	0.0223	0.175	0.328	0.35	0.34	0
1,1-Dichloroethylene	31	2	0.0265	0.202	0.377	0.41	0.41	0
1,2,4-Trichlorobenzene	31	4	0.358	1.05	1.6	5.9	2	1.6
1,2,4-Trimethylbenzene	31	11	0.217	0.353	0.395	0.98	0.86	0.81
1,2-Dichlorobenzene	31	4	0.0803	0.3	0.495	1.1	0.53	0.43
1,2-Dichloropropane	31	2	0.0206	0.194	0.367	0.32	0.32	0
1,3,5-Trimethylbenzene	31	2	0.02	0.203	0.385	0.31	0.31	0
1,3-Butadiene	31	2	0.00968	0.123	0.237	0.15	0.15	0
1,3-Dichlorobenzene	31	4	0.0703	0.262	0.426	1.1	0.42	0.33
1,4-Dichlorobenzene	31	4	0.0997	0.321	0.5	1.5	0.69	0.45
2,2,4-Trimethylpentane	31	6	0.0826	0.223	0.347	0.56	0.56	0.45
Acetaldehyde	31	31	1.8	1.8		3.05	2.85	2.62
Acetone	31	31	2.28	2.28		4.78	3.79	3.72
Acetonitrile	31	4	0.0423	0.224	0.386	0.57	0.38	0.18
Acrylonitrile	31	2	0.029	0.205	0.381	0.45	0.45	0
Arsenic (Tsp)	61	61	0.00146	0.00146	0.00003	0.0045	0.00368	0.00339
Benzaldehyde	31	30	0.132	0.136		0.646	0.281	0.279
Benzene	31	31	0.628	0.628	0.235	1.4	1.3	1
Benzyl Chloride	7		0	0.396	0.791	0	0	0
Bromodichloromethane	31	2	0.0235	0.276	0.529	0.37	0.36	0
Bromoform	31	2	0.0219	0.335	0.649	0.34	0.34	0
Bromomethane	31	2	0.0445	0.402	0.758	0.69	0.69	0
Cadmium (Tsp)	61	61	0.000274	0.000274	0.00002	0.00168	0.00084	0.00059
Carbon Tetrachloride	31	12	0.178	0.333	0.471	0.55	0.51	0.5
Chlorobenzene	31	2	0.0174	0.195	0.373	0.27	0.27	0
Chloroethane	31	2	0.0129	0.167	0.321	0.2	0.2	0
Chloroform	31	20	0.329	0.407	0.348	1.1	0.73	0.71
Chloromethane	31	31	1.04	1.04	0.228	1.6	1.5	1.5
Chloroprene	31	2	0.02	0.157	0.295	0.31	0.31	0
Cis-1,2-Dichloroethene	31	2	0.0226	0.171	0.319	0.35	0.35	0
Cis-1,3-Dichloropropene	31	2	0.0213	0.209	0.397	0.33	0.33	0
Dibromochloromethane	31	2	0.0355	0.398	0.76	0.55	0.55	0
Dichlorodifluoromethane	31	31	2.14	2.14	0.299	2.9	2.7	2.7
Dichloromethane	31	29	0.517	0.529	0.32	1.1	0.84	0.78
Ethylbenzene	31	3	0.091	0.376	0.633	1.6	0.61	0.61
Ethylene Dibromide	31	2	0.0323	0.345	0.656	0.5	0.5	0
Ethylene Dichloride	31	2	0.0194	0.172	0.325	0.3	0.3	0
Formaldehyde	31	31	2.91	2.91		6.4	6.36	5.19
Freon 113	31	2	0.0406	0.334	0.628	0.63	0.63	0
Freon 114	31	2	0.0284	0.378	0.727	0.44	0.44	0

Detroit, Fort Street (N. Delray-SWHS) (261630015) Concentrations in micrograms per cubic meter (µg/m³)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Hexachlorobutadiene	31	3	0.229	0.85	1.37	4.5	1.3	1.3
Hexanaldehyde	31	26	0.103	0.123		0.292	0.251	0.232
M/P Xylene	31	9	0.505	0.831	0.918	4.7	2.2	1.6
Manganese (Tsp)	61	61	0.0532	0.0532	0.000237	0.211	0.166	0.141
Manganese Pm10	61	61	0.0185	0.0185	0.000298	0.0614	0.0504	0.0487
Methyl Chloroform	31	2	0.0345	0.286	0.537	0.54	0.53	0
Methyl Ethyl Ketone	31	27	1.93	2	0.802	9.4	7.7	3.9
Methyl Isobutyl Ketone	31	6	1.14	1.53	0.967	23	5.4	3
Methyl Tert-Butyl Ether	31	2	0.0245	0.182	0.339	0.38	0.38	0
N-Hexane	31	26	0.615	0.635	0.269	1.8	1.5	1.3
Nickel (Tsp)	61	61	0.00218	0.00218	0.000127	0.00535	0.00533	0.00504
O-Xylene	31	9	0.166	0.311	0.393	1.5	0.77	0.61
Propionaldehyde	31	31	0.325	0.325		0.689	0.583	0.549
Styrene	31	3	0.0313	0.183	0.33	0.41	0.28	0.28
Tetrachloroethylene	31	3	0.0994	0.395	0.663	2	0.54	0.54
Tolualdehydes	31	7	0.0129	0.0571		0.0784	0.0657	0.0613
Toluene	31	28	1.81	1.83	0.335	25	3	2.9
Trans-1,2-Dichloroethylene	31	2	0.0239	0.189	0.353	0.37	0.37	0
Trans-1,3-Dichloropropene	31	2	0.0155	0.173	0.331	0.24	0.24	0
Trichloroethylene	31	2	0.0277	0.239	0.449	0.43	0.43	0
Trichlorofluoromethane	31	31	1.17	1.17	0.546	1.7	1.5	1.4
Valeraldehyde	31	31	0.236	0.236		0.483	0.412	0.41
Vinyl Chloride	31	2	0.0148	0.166	0.316	0.23	0.23	0

Detroit, W. Jefferson, South Delray (261630027) Concentrations in micrograms per cubic meter (µg/m³)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Arsenic (Tsp)	60	60	0.00193	0.00193	0.0000302	0.00667	0.00493	0.0036
Cadmium (Tsp)	60	60	0.000456	0.000456	0.0000205	0.00183	0.00147	0.00147
Manganese (Tsp)	60	60	0.143	0.143	0.000245	0.806	0.591	0.545
Nickel (Tsp)	60	60	0.00248	0.00248	0.000132	0.00741	0.00619	0.00579

River Rouge (261630005) Concentrations in micrograms per cubic meter (µg/m³)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Acetaldehyde	31	31	2.12	2.12		9.04	2.99	2.91
Acetone	31	31	2.32	2.32		4.83	4.15	4.11
Arsenic (Tsp)	61	61	0.00147	0.00147	0.00003	0.00763	0.00442	0.00324
Benzaldehyde	31	31	0.174	0.174		0.959	0.453	0.415
Cadmium (Tsp)	61	61	0.000364	0.000364	0.00002	0.00284	0.00126	0.00111
Formaldehyde	31	31	5.62	5.62		56.2	7.57	7.2
Hexanaldehyde	31	26	0.171	0.204		1.32	0.322	0.311
Manganese (Tsp)	61	61	0.0485	0.0485	0.000237	0.192	0.14	0.124
Manganese Pm10	59	59	0.0149	0.0149	0.000299	0.0503	0.0503	0.0394
Nickel (Tsp)	61	61	0.00141	0.00141	0.000128	0.00294	0.00245	0.00243
Propionaldehyde	31	31	0.316	0.316		0.795	0.693	0.633
Tolualdehydes	31	6	0.0136	0.0703		0.092	0.0781	0.0771
Valeraldehyde	31	31	0.249	0.249		1.3	0.463	0.421

Vassar (261570001) Concentrations in micrograms per cubic meter (µg/m³)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Arsenic (Tsp)	61	61	0.00101	0.00101	0.0000302	0.00422	0.00268	0.00254
Arsenic Pm10	61	61	0.000816	0.000816	0.0000398	0.00414	0.00223	0.00209
Cadmium (Tsp)	61	61	0.00061	0.00061	0.0000202	0.0116	0.00455	0.00445
Cadmium Pm10	61	59	0.000446	0.000446	0.0000298	0.00478	0.00453	0.00434
Lead (Tsp) Lc Frm/Fem	61	61	0.00736	0.00736		0.0747	0.069	0.0443
Manganese (Tsp)	61	61	0.0345	0.0345	0.00024	0.369	0.298	0.235
Manganese Pm10	61	61	0.0126	0.0126	0.000241	0.215	0.208	0.0602
Nickel (Tsp)	61	61	0.00113	0.00113	0.000128	0.00298	0.00261	0.00232
Nickel Pm10	61	61	0.0108	0.0108	0.000215	0.354	0.0569	0.0519

Grand Rapids - Monroe St. (260810020) Concentrations in micrograms per cubic meter (µg/m³)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Arsenic (Tsp)	54	54	0.00116	0.00116	0.0000309	0.00535	0.00411	0.00317
Cadmium (Tsp)	54	54	0.000132	0.000132	0.0000217	0.00082	0.00026	0.00024
Lead (Tsp) Lc Frm/Fem	54	54	0.00419	0.00419		0.0123	0.0109	0.0107
Manganese (Tsp)	54	54	0.0111	0.0111	0.000241	0.0423	0.0285	0.0258
Nickel (Tsp)	54	54	0.00137	0.00137	0.00013	0.00263	0.00258	0.00228

Belding - Merrick St. (260670003) Concentrations in micrograms per cubic meter (µg/m^3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Arsenic (Tsp)	60	60	0.00095	0.00095	0.00003	0.00356	0.00313	0.00263
Cadmium (Tsp)	60	60	0.000409	0.000409	0.00002	0.00631	0.00252	0.00165
Lead (Tsp) Lc Frm/Fem	60	60	0.0379	0.0379		0.163	0.158	0.13
Manganese (Tsp)	60	60	0.00743	0.00743	0.000237	0.0222	0.0213	0.0182
Nickel (Tsp)	60	60	0.00105	0.00105	0.000127	0.00187	0.00176	0.00162

Belding - Reed St. (260670002) Concentrations in micrograms per cubic meter (µg/m^3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Arsenic (Tsp)	60	60	0.000849	0.000849	0.00003	0.00356	0.00352	0.00224
Cadmium (Tsp)	60	60	0.000276	0.000276	0.00002	0.0018	0.00112	0.00083
Lead (Tsp) Lc Frm/Fem	60	60	0.0334	0.0334		0.19	0.161	0.123
Manganese (Tsp)	60	60	0.00625	0.00625	0.000238	0.0238	0.0194	0.0169
Nickel (Tsp)	60	60	0.000909	0.000909	0.000127	0.00182	0.00155	0.00151

Port Huron - Rural St. (261470031) Concentrations in micrograms per cubic meter (µg/m^3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Arsenic (Tsp)	60	60	0.00153	0.00153	0.00003	0.014	0.0101	0.00919
Cadmium (Tsp)	60	60	0.000799	0.000799	0.00002	0.0104	0.00997	0.00299
Manganese (Tsp)	60	60	0.00869	0.00869	0.000238	0.0256	0.025	0.0247
Nickel (Tsp)	60	60	0.0014	0.0014	0.000128	0.00468	0.00416	0.00385
Lead (Tsp) Lc Frm/Fem	59	59	0.0224	0.0224		0.173	0.145	0.125

APPENDIX B-2

Allen Park (261630001), Speciated PM2.5 (µg/m3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Aluminum Pm2.5 Lc	120	84	0.0201	0.0226	0.0171	0.191	0.187	0.182
Ammonium Ion Pm2.5 Lc	120	119	0.817	0.817	0.0155	2.98	2.86	2.81
Antimony Pm2.5 Lc	120	33	0.00405	0.0182	0.0374	0.0712	0.0362	0.0292
Arsenic Pm2.5 Lc	120	64	0.000754	0.00116	0.00172	0.0063	0.00594	0.00397
Barium Pm2.5 Lc	120	27	0.00122	0.00546	0.0143	0.0135	0.0131	0.0126
Bromine Pm2.5 Lc	120	116	0.00358	0.0036	0.00165	0.0119	0.0113	0.011
Cadmium Pm2.5 Lc	120	28	0.00156	0.00784	0.0163	0.0292	0.0128	0.0117
Calcium Pm2.5 Lc	120	116	0.0287	0.0288	0.00588	0.158	0.0995	0.0907
Cerium Pm2.5 Lc	120	11	0.000131	0.00559	0.0149	0.00362	0.00292	0.00233
Cesium Pm2.5 Lc	120	30	0.000879	0.0072	0.0202	0.012	0.00746	0.00678
Chlorine Pm2.5 Lc	120	103	0.00852	0.009	0.00686	0.0676	0.0572	0.0426
Chromium Pm2.5 Lc	120	96	0.00391	0.00414	0.00223	0.0541	0.0315	0.025
Cobalt Pm2.5 Lc	120	73	0.000379	0.000648	0.00135	0.00311	0.00203	0.00186
Copper Pm2.5 Lc	120	113	0.00637	0.00645	0.00182	0.0297	0.0244	0.0222
Ec Csn_Rev Unadjusted Pm2.5 Lc Tot	114	114	0.352	0.352		1.46	0.958	0.92
Indium Pm2.5 Lc	120	35	0.00254	0.0095	0.0198	0.0268	0.0268	0.0198
Iron Pm2.5 Lc	120	120	0.0856	0.0856	0.00188	0.378	0.299	0.261
Lead Pm2.5 Lc	120	76	0.00166	0.0024	0.00396	0.00675	0.00642	0.00595
Magnesium Pm2.5 Lc	120	44	0.00426	0.00835	0.0134	0.0485	0.0475	0.046
Manganese Pm2.5 Lc	120	104	0.00195	0.00207	0.00189	0.00715	0.00645	0.0061
Nickel Pm2.5 Lc	120	83	0.00084	0.00104	0.00136	0.00731	0.00724	0.00634
Oc Csn_Rev Unadjusted Pm2.5 Lc Tot	114	114	2.03	2.03		6.17	4.59	4.17
Phosphorus Pm2.5 Lc	120	5	0.000226	0.00549	0.0109	0.0112	0.0094	0.00282
Potassium Ion Pm2.5 Lc	120	96	0.0419	0.0437	0.0153	0.384	0.256	0.163
Potassium Pm2.5 Lc	120	119	0.0507	0.0507	0.00638	0.366	0.249	0.214
Rubidium Pm2.5 Lc	120	34	0.000184	0.000897	0.00194	0.00163	0.00152	0.00151
Selenium Pm2.5 Lc	120	60	0.000597	0.00111	0.00213	0.00432	0.00339	0.00319
Silicon Pm2.5 Lc	120	118	0.0415	0.0416	0.0124	0.19	0.132	0.131
Silver Pm2.5 Lc	120	18	0.000824	0.00787	0.0163	0.0198	0.0117	0.00932
Sodium Ion Pm2.5 Lc	120	120	0.0622	0.0622	0.0149	0.322	0.303	0.184
Sodium Pm2.5 Lc	120	95	0.0316	0.036	0.0393	0.293	0.157	0.155
Strontium Pm2.5 Lc	120	45	0.000629	0.0014	0.00242	0.0129	0.00795	0.00746
Sulfate Pm2.5 Lc	120	120	1.81	1.81	0.00797	6.43	6.1	4.71
Sulfur Pm2.5 Lc	120	120	0.697	0.697	0.00771	2.6	2.31	1.94
Tin Pm2.5 Lc	120	23	0.00226	0.0129	0.0257	0.0268	0.0263	0.0234
Titanium Pm2.5 Lc	120	70	0.00122	0.00217	0.00462	0.00899	0.0078	0.00758
Total Nitrate Pm2.5 Lc	120	119	1.46	1.46	0.0141	8.15	6.65	5.86
Vanadium Pm2.5 Lc	120	54	0.000529	0.00141	0.00312	0.00315	0.00292	0.00236
Zinc Pm2.5 Lc	120	117	0.012	0.0121	0.00256	0.071	0.0672	0.0445
Zirconium Pm2.5 Lc	120	25	0.00096	0.00351	0.00677	0.0199	0.0129	0.01

Dearborn (261630033), Speciated PM2.5 (µg/m3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Aluminum Pm2.5 Lc	59	46	0.0239	0.026	0.0179	0.213	0.12	0.0708
Antimony Pm2.5 Lc	59	19	0.00567	0.0191	0.0388	0.0559	0.042	0.0419
Arsenic Pm2.5 Lc	59	33	0.000765	0.00111	0.0016	0.0042	0.00292	0.00292
Barium Pm2.5 Lc	59	16	0.000954	0.00464	0.0107	0.00899	0.00642	0.00594
Bromine Pm2.5 Lc	59	58	0.00497	0.00498	0.00157	0.0213	0.0113	0.0106
Cadmium Pm2.5 Lc	59	11	0.00158	0.00844	0.0164	0.0187	0.0175	0.0152
Calcium Pm2.5 Lc	59	58	0.0661	0.0661	0.00615	0.239	0.186	0.16
Cerium Pm2.5 Lc	59	2	1.58E-05	0.0038	0.00914	0.0007	0.00023	0
Cesium Pm2.5 Lc	59	17	0.000797	0.00634	0.0162	0.00958	0.00561	0.00559
Chlorine Pm2.5 Lc	59	54	0.0291	0.0295	0.00669	0.182	0.126	0.12
Chromium Pm2.5 Lc	59	48	0.00607	0.00629	0.00227	0.0992	0.0837	0.0387
Cobalt Pm2.5 Lc	59	46	0.000888	0.00103	0.00131	0.00339	0.00322	0.00263
Copper Pm2.5 Lc	59	59	0.0132	0.0132	0.00184	0.0516	0.037	0.0337
Indium Pm2.5 Lc	59	10	0.00132	0.00985	0.02	0.0233	0.0117	0.00933
Iron Pm2.5 Lc	59	59	0.259	0.259	0.00178	1.04	0.899	0.798
Lead Pm2.5 Lc	59	47	0.00569	0.00603	0.00361	0.0477	0.0273	0.0238
Magnesium Pm2.5 Lc	59	36	0.0137	0.0161	0.013	0.222	0.0567	0.0394
Manganese Pm2.5 Lc	59	56	0.00817	0.00823	0.00181	0.0651	0.0245	0.0224
Nickel Pm2.5 Lc	59	34	0.00053	0.000811	0.00132	0.00387	0.00239	0.0021
Phosphorus Pm2.5 Lc	59	1	2.98E-05	0.00577	0.0117	0.00176	0	0
Selenium Pm2.5 Lc	59	36	0.00103	0.00145	0.00206	0.00474	0.00435	0.00419
Tin Pm2.5 Lc	59	10	0.00214	0.0129	0.0258	0.0409	0.0269	0.0176
Titanium Pm2.5 Lc	59	32	0.00166	0.0027	0.00475	0.0113	0.00758	0.00735

Detroit, Fort Street (N. Delray-SWHS) (261630015), Speciated PM2.5 (µg/m3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Aluminum Pm2.5 Lc	59	45	0.0375	0.04	0.019	0.154	0.153	0.0981
Ammonium Ion Pm2.5 Lc	59	59	1	1	0.0183	3.17	3.08	3.05
Antimony Pm2.5 Lc	59	15	0.00429	0.0185	0.0367	0.035	0.0314	0.0303
Arsenic Pm2.5 Lc	59	40	0.000808	0.00113	0.00176	0.00362	0.00338	0.00304
Barium Pm2.5 Lc	59	19	0.00201	0.0062	0.013	0.0182	0.0171	0.0133
Bromine Pm2.5 Lc	59	58	0.00531	0.00532	0.0016	0.0311	0.017	0.0166
Cadmium Pm2.5 Lc	59	16	0.00178	0.00767	0.0156	0.0197	0.0163	0.0128
Calcium Pm2.5 Lc	59	59	0.167	0.167	0.00597	1.14	0.81	0.66
Cerium Pm2.5 Lc	59	4	0.0000651	0.00424	0.0129	0.00256	0.00093	0.00024
Cesium Pm2.5 Lc	59	17	0.00105	0.00639	0.0175	0.0103	0.0098	0.0077
Chlorine Pm2.5 Lc	59	57	0.0443	0.0444	0.00687	0.952	0.202	0.16
Chromium Pm2.5 Lc	59	46	0.00252	0.00275	0.00219	0.0339	0.014	0.00683
Cobalt Pm2.5 Lc	59	46	0.000856	0.00102	0.00136	0.00326	0.00325	0.00298
Copper Pm2.5 Lc	59	53	0.00835	0.00847	0.00196	0.0255	0.0251	0.0247
Ec Csn_Rev Unadjusted Pm2.5 Lc Tot	59	59	0.433	0.433		0.863	0.821	0.801
Indium Pm2.5 Lc	59	17	0.00205	0.00905	0.0199	0.0176	0.0164	0.0151
Iron Pm2.5 Lc	59	59	0.23	0.23	0.00191	0.953	0.676	0.569
Lead Pm2.5 Lc	59	47	0.0037	0.00404	0.00381	0.0195	0.0145	0.0106
Magnesium Pm2.5 Lc	59	40	0.0187	0.021	0.0139	0.113	0.102	0.0821
Manganese Pm2.5 Lc	59	58	0.00617	0.00619	0.00183	0.0245	0.0183	0.0177
Nickel Pm2.5 Lc	59	31	0.000442	0.000798	0.00141	0.00408	0.00246	0.0023
Oc Csn_Rev Unadjusted Pm2.5 Lc Tot	59	59	2.25	2.25		4.47	4.44	4.04
Phosphorus Pm2.5 Lc	59	6	0.000772	0.00557	0.0105	0.0301	0.00713	0.00491
Potassium Ion Pm2.5 Lc	59	50	0.0544	0.0561	0.0175	0.306	0.245	0.17
Potassium Pm2.5 Lc	59	59	0.0742	0.0742	0.00701	0.315	0.284	0.26
Rubidium Pm2.5 Lc	59	21	0.000309	0.000928	0.00189	0.00279	0.00178	0.00155
Selenium Pm2.5 Lc	59	38	0.000904	0.0013	0.00227	0.00384	0.00366	0.00315
Silicon Pm2.5 Lc	59	59	0.124	0.124	0.0135	0.549	0.385	0.363
Silver Pm2.5 Lc	59	9	0.00095	0.00799	0.0166	0.0199	0.014	0.00467
Sodium Ion Pm2.5 Lc	59	59	0.0902	0.0902	0.0162	0.425	0.326	0.249
Sodium Pm2.5 Lc	59	53	0.0629	0.0651	0.0411	0.506	0.476	0.217
Strontium Pm2.5 Lc	59	29	0.000958	0.00156	0.00238	0.00814	0.00571	0.00443
Sulfate Pm2.5 Lc	59	59	2.34	2.34	0.00758	8.25	7.03	5.99
Sulfur Pm2.5 Lc	59	59	0.856	0.856	0.00774	2.92	2.51	2.08
Tin Pm2.5 Lc	59	14	0.00229	0.0122	0.0256	0.0302	0.0245	0.0128
Titanium Pm2.5 Lc	59	33	0.00185	0.00291	0.00464	0.0122	0.00935	0.0069
Total Nitrate Pm2.5 Lc	59	59	1.73	1.73	0.0149	8.53	6.48	5.99
Vanadium Pm2.5 Lc	59	32	0.000965	0.00168	0.00311	0.00524	0.00454	0.00409
Zinc Pm2.5 Lc	59	59	0.039	0.039	0.00255	0.864	0.0723	0.0661
Zirconium Pm2.5 Lc	59	10	0.000851	0.00376	0.00747	0.0105	0.00934	0.00839

Port Huron, Nat'l Guard Arm. (261470005), Speciated PM2.5 (µg/m3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Aluminum Pm2.5 Lc	61	41	0.0238	0.0266	0.0175	0.312	0.136	0.0794
Ammonium Ion Pm2.5 Lc	61	60	0.814	0.814	0.0147	4.81	2.64	2.14
Antimony Pm2.5 Lc	61	19	0.00547	0.0184	0.037	0.0573	0.0292	0.0282
Arsenic Pm2.5 Lc	61	33	0.000573	0.001	0.00162	0.00315	0.00279	0.00269
Barium Pm2.5 Lc	61	8	0.000448	0.0052	0.0132	0.00817	0.00501	0.00455
Bromine Pm2.5 Lc	61	60	0.00526	0.00527	0.00156	0.0344	0.024	0.0161
Cadmium Pm2.5 Lc	61	13	0.00114	0.00755	0.0158	0.014	0.00934	0.00817
Calcium Pm2.5 Lc	61	59	0.0412	0.0413	0.0062	0.161	0.138	0.124
Cerium Pm2.5 Lc	61	5	0.000162	0.00446	0.013	0.00547	0.00175	0.00105
Cesium Pm2.5 Lc	61	12	0.000738	0.00696	0.0175	0.0111	0.0077	0.00536
Chlorine Pm2.5 Lc	61	57	0.00989	0.0101	0.00704	0.0915	0.0376	0.0274
Chromium Pm2.5 Lc	61	45	0.00488	0.00519	0.00225	0.0553	0.0461	0.0444
Cobalt Pm2.5 Lc	61	36	0.000289	0.000575	0.00135	0.0014	0.00125	0.00111
Copper Pm2.5 Lc	61	42	0.000939	0.00128	0.00187	0.00334	0.00317	0.00315
Ec Csn_Rev Unadjusted Pm2.5 Lc Tot	61	61	0.207	0.207		0.571	0.477	0.448
Indium Pm2.5 Lc	61	14	0.00111	0.00846	0.0191	0.0128	0.0093	0.007
Iron Pm2.5 Lc	61	61	0.0457	0.0457	0.00187	0.234	0.133	0.107
Lead Pm2.5 Lc	61	35	0.00156	0.00237	0.00367	0.00899	0.00839	0.00641
Magnesium Pm2.5 Lc	61	25	0.00374	0.0077	0.0136	0.0316	0.025	0.0229
Manganese Pm2.5 Lc	61	43	0.00114	0.00142	0.00186	0.00834	0.0035	0.00346
Nickel Pm2.5 Lc	61	38	0.000897	0.00116	0.00137	0.00957	0.00593	0.0053
Oc Csn_Rev Unadjusted Pm2.5 Lc Tot	61	61	2.21	2.21		6.02	5.99	4.23
Phosphorus Pm2.5 Lc	61	9	0.00228	0.00705	0.0114	0.0457	0.044	0.0199
Potassium Ion Pm2.5 Lc	61	48	0.031	0.0326	0.0148	0.135	0.0857	0.0772
Potassium Pm2.5 Lc	61	61	0.048	0.048	0.00693	0.145	0.144	0.091
Rubidium Pm2.5 Lc	61	14	0.000122	0.000855	0.00191	0.00111	0.0011	0.00082
Selenium Pm2.5 Lc	61	32	0.000662	0.00115	0.00209	0.00315	0.00306	0.00282
Silicon Pm2.5 Lc	61	59	0.0583	0.0585	0.0127	0.344	0.165	0.153
Silver Pm2.5 Lc	61	12	0.00095	0.00698	0.0156	0.0116	0.00818	0.00817
Sodium Ion Pm2.5 Lc	61	59	0.056	0.0562	0.0138	0.206	0.194	0.131
Sodium Pm2.5 Lc	61	49	0.0247	0.0289	0.0395	0.138	0.109	0.0843
Strontium Pm2.5 Lc	61	16	0.000491	0.00136	0.00236	0.014	0.00303	0.00198
Sulfate Pm2.5 Lc	61	60	1.96	1.96	0.00908	11	5.92	4.81
Sulfur Pm2.5 Lc	61	61	0.754	0.754	0.00805	4.04	2.21	1.85
Tin Pm2.5 Lc	61	11	0.00156	0.0115	0.0247	0.0163	0.014	0.014
Titanium Pm2.5 Lc	61	29	0.00147	0.0027	0.00474	0.012	0.00781	0.00617
Total Nitrate Pm2.5 Lc	61	60	1.25	1.25	0.0138	6.27	6.2	4.51
Vanadium Pm2.5 Lc	61	40	0.00144	0.00201	0.00321	0.0092	0.00912	0.00886
Zinc Pm2.5 Lc	61	60	0.0108	0.0108	0.00246	0.039	0.0315	0.0314
Zirconium Pm2.5 Lc	61	10	0.000553	0.00297	0.0064	0.00699	0.00643	0.00642

Luna Pier (261150005), Speciated $PM_{2.5}$ ($\mu g/m^3$)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Aluminum Pm2.5 Lc	33	21	0.0147	0.0175	0.0167	0.107	0.061	0.0477
Ammonium Ion Pm2.5 Lc	33	33	0.931	0.931	0.0158	1.92	1.9	1.8
Antimony Pm2.5 Lc	33	7	0.00329	0.0186	0.0377	0.0292	0.0222	0.0198
Arsenic Pm2.5 Lc	33	18	0.000705	0.00109	0.00161	0.00279	0.00233	0.00233
Barium Pm2.5 Lc	33	3	0.000254	0.00551	0.0114	0.00431	0.00373	0.00035
Bromine Pm2.5 Lc	33	33	0.00432	0.00432	0.00159	0.0113	0.00852	0.0079
Cadmium Pm2.5 Lc	33	10	0.00159	0.00761	0.0163	0.0105	0.0093	0.00816
Calcium Pm2.5 Lc	33	33	0.026	0.026	0.00582	0.0599	0.0597	0.0497
Cerium Pm2.5 Lc	33	3	0.0000673	0.00351	0.00994	0.00117	0.00058	0.00047
Cesium Pm2.5 Lc	33	6	0.000618	0.00907	0.022	0.00666	0.00443	0.00385
Chlorine Pm2.5 Lc	33	30	0.00679	0.00714	0.0064	0.0341	0.0236	0.0167
Chromium Pm2.5 Lc	33	31	0.00256	0.00263	0.00221	0.0111	0.00826	0.00713
Cobalt Pm2.5 Lc	33	17	0.00027	0.000572	0.00127	0.00117	0.00099	0.00084
Copper Pm2.5 Lc	33	23	0.00107	0.00138	0.00175	0.00491	0.00432	0.00329
Ec Csn_Rev Unadjusted Pm2.5 Lc Tot	33	33	0.229	0.229		0.59	0.459	0.391
Indium Pm2.5 Lc	33	4	0.00123	0.00969	0.0197	0.021	0.0116	0.00466
Iron Pm2.5 Lc	33	33	0.0589	0.0589	0.00173	0.24	0.139	0.099
Lead Pm2.5 Lc	33	20	0.0013	0.00211	0.00395	0.00674	0.00666	0.00513
Magnesium Pm2.5 Lc	33	10	0.00279	0.00731	0.0131	0.0249	0.0126	0.0113
Manganese Pm2.5 Lc	33	26	0.0011	0.00129	0.0018	0.00396	0.0032	0.00297
Nickel Pm2.5 Lc	33	21	0.000591	0.000821	0.00131	0.00351	0.00262	0.00258
Oc Csn_Rev Unadjusted Pm2.5 Lc Tot	33	33	1.85	1.85		3.4	3.31	2.84
Phosphorus Pm2.5 Lc	33	2	0.000114	0.00522	0.0108	0.00363	0.00012	0
Potassium Ion Pm2.5 Lc	33	25	0.0378	0.0398	0.0151	0.109	0.0925	0.075
Potassium Pm2.5 Lc	33	33	0.0464	0.0464	0.00634	0.131	0.0811	0.0777
Rubidium Pm2.5 Lc	33	12	0.000139	0.000726	0.00181	0.00126	0.00078	0.00051
Selenium Pm2.5 Lc	33	21	0.00147	0.00185	0.00212	0.00968	0.00816	0.00442
Silicon Pm2.5 Lc	33	33	0.052	0.052	0.0127	0.187	0.168	0.107
Silver Pm2.5 Lc	33	7	0.00102	0.0071	0.0149	0.00815	0.007	0.00698
Sodium Ion Pm2.5 Lc	33	33	0.0703	0.0703	0.0171	0.184	0.168	0.126
Sodium Pm2.5 Lc	33	28	0.037	0.04	0.0412	0.175	0.0987	0.078
Strontium Pm2.5 Lc	33	9	0.000325	0.00113	0.00227	0.00291	0.00257	0.00174
Sulfur Pm2.5 Lc	33	33	0.743	0.743	0.00788	1.66	1.51	1.48
Tin Pm2.5 Lc	33	8	0.00258	0.0126	0.0268	0.0232	0.021	0.0163
Titanium Pm2.5 Lc	33	15	0.00119	0.00242	0.00462	0.00839	0.00631	0.00524
Total Nitrate Pm2.5 Lc	33	33	1.82	1.82	0.0129	6.08	5.81	5.18
Vanadium Pm2.5 Lc	33	18	0.000385	0.00111	0.00314	0.00233	0.00167	0.0014
Zinc Pm2.5 Lc	33	33	0.00831	0.00831	0.00282	0.021	0.0174	0.0169
Zirconium Pm2.5 Lc	33	4	0.000124	0.00264	0.00554	0.00174	0.00117	0.0007

Sterling State Park (261150006), Speciated PM2.5 (µg/m3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Antimony Pm2.5 Lc	25	7	0.00501	0.0191	0.0383	0.0314	0.0279	0.0244
Arsenic Pm2.5 Lc	25	19	0.00105	0.0013	0.00181	0.00547	0.00303	0.00278
Aluminum Pm2.5 Lc	25	15	0.0134	0.0169	0.0185	0.0485	0.0481	0.0448
Barium Pm2.5 Lc	25	4	0.000703	0.00473	0.0135	0.00721	0.00431	0.00314
Bromine Pm2.5 Lc	25	24	0.00291	0.00295	0.0017	0.0086	0.0057	0.00476
Cadmium Pm2.5 Lc	25	4	0.000744	0.0077	0.0168	0.00814	0.00466	0.00465
Calcium Pm2.5 Lc	25	24	0.0326	0.0326	0.00575	0.107	0.102	0.0806
Chromium Pm2.5 Lc	25	13	0.0121	0.0127	0.00224	0.0988	0.0738	0.0457
Cobalt Pm2.5 Lc	25	19	0.000454	0.00061	0.00137	0.00205	0.00191	0.00119
Copper Pm2.5 Lc	25	21	0.00228	0.00244	0.00187	0.0202	0.00489	0.00431
Chlorine Pm2.5 Lc	25	17	0.00608	0.00717	0.00666	0.0173	0.0168	0.0163
Cerium Pm2.5 Lc	25	2	0.000107	0.00668	0.0137	0.00256	0.00012	0
Cesium Pm2.5 Lc	25	4	0.000344	0.00582	0.0173	0.0043	0.00302	0.00105
Iron Pm2.5 Lc	25	25	0.0844	0.0844	0.00188	0.44	0.291	0.153
Lead Pm2.5 Lc	25	13	0.00143	0.0023	0.00392	0.00838	0.00616	0.00558
Indium Pm2.5 Lc	25	3	0.000839	0.0105	0.0213	0.0105	0.00698	0.00349
Manganese Pm2.5 Lc	25	18	0.00272	0.00296	0.00188	0.0104	0.0097	0.00776
Nickel Pm2.5 Lc	25	17	0.00112	0.00133	0.00136	0.00791	0.00593	0.0027
Magnesium Pm2.5 Lc	25	13	0.0066	0.00939	0.013	0.0321	0.0252	0.0238
Phosphorus Pm2.5 Lc	25	2	0.000307	0.00537	0.0106	0.00407	0.0036	0
Selenium Pm2.5 Lc	25	16	0.000923	0.00129	0.00218	0.00697	0.00238	0.00216
Tin Pm2.5 Lc	25	4	0.000711	0.0123	0.0266	0.00814	0.00523	0.00325
Titanium Pm2.5 Lc	25	14	0.0016	0.00258	0.00459	0.00895	0.00606	0.00442
Vanadium Pm2.5 Lc	25	11	0.000434	0.00134	0.00312	0.00203	0.00186	0.00174
Silicon Pm2.5 Lc	25	25	0.0459	0.0459	0.0125	0.102	0.0972	0.0928
Silver Pm2.5 Lc	25	5	0.00106	0.00893	0.019	0.0093	0.00582	0.00558
Zinc Pm2.5 Lc	25	25	0.022	0.022	0.00243	0.104	0.102	0.064
Strontium Pm2.5 Lc	25	5	0.000316	0.00134	0.00256	0.00418	0.00151	0.00081
Sulfur Pm2.5 Lc	25	25	0.774	0.774	0.00758	2.38	2.17	1.74
Rubidium Pm2.5 Lc	25	5	0.000082	0.000896	0.00202	0.00138	0.00038	0.00012
Potassium Pm2.5 Lc	25	25	0.0436	0.0436	0.00628	0.0964	0.0919	0.066
Sodium Pm2.5 Lc	25	19	0.0412	0.0454	0.0376	0.299	0.121	0.102
Zirconium Pm2.5 Lc	25	5	0.000888	0.00422	0.00904	0.00907	0.00779	0.00349
Ammonium Ion Pm2.5 Lc	25	25	0.879	0.879	0.0158	2.67	2.56	2.04
Sodium Ion Pm2.5 Lc	25	25	0.0571	0.0571	0.012	0.124	0.11	0.104
Potassium Ion Pm2.5 Lc	25	22	0.0346	0.0359	0.0157	0.134	0.0854	0.0499
Total Nitrate Pm2.5 Lc	25	25	1.51	1.51	0.0153	7.09	6.97	2.74
Oc Csn_Rev Unadjusted Pm2.5 Lc Tot	25	25	1.94	1.94		3.44	3.42	3.22
Ec Csn_Rev Unadjusted Pm2.5 Lc Tot	25	25	0.23	0.23		0.359	0.358	0.353
Sulfate Pm2.5 Lc	25	25	2.17	2.17	0.00847	6.29	6.1	4.34

Houghton Lake (261130001), Speciated $PM_{2.5}$ ($\mu g/m^3$)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Aluminum Pm2.5 Lc	60	23	0.00921	0.0143	0.0172	0.0864	0.0833	0.0451
Ammonium Ion Pm2.5 Lc	60	55	0.395	0.396	0.015	2.64	1.56	1.34
Antimony Pm2.5 Lc	60	16	0.0041	0.0181	0.0382	0.028	0.0257	0.0233
Arsenic Pm2.5 Lc	60	28	0.000385	0.000816	0.00156	0.00303	0.0021	0.00198
Barium Pm2.5 Lc	60	2	0.0000757	0.0049	0.0116	0.00291	0.00163	0
Bromine Pm2.5 Lc	60	57	0.00225	0.0023	0.00155	0.00922	0.00793	0.00689
Cadmium Pm2.5 Lc	60	13	0.00132	0.00798	0.0163	0.0128	0.0105	0.0105
Calcium Pm2.5 Lc	60	32	0.0104	0.0118	0.00624	0.0724	0.0628	0.0612
Cerium Pm2.5 Lc	60	6	0.0000915	0.00374	0.0106	0.0021	0.00093	0.00082
Cesium Pm2.5 Lc	60	17	0.000969	0.00656	0.0169	0.00794	0.00747	0.00561
Chlorine Pm2.5 Lc	60	43	0.00308	0.00405	0.00687	0.0176	0.0145	0.0136
Chromium Pm2.5 Lc	60	42	0.00612	0.00647	0.00229	0.119	0.0624	0.0621
Cobalt Pm2.5 Lc	60	30	0.000226	0.000548	0.00132	0.00127	0.00104	0.00086
Copper Pm2.5 Lc	60	22	0.000359	0.000952	0.00181	0.00272	0.00231	0.00208
Ec Csn_Rev Unadjusted Pm2.5 Lc Tot	61	60	0.073	0.0742		0.206	0.199	0.192
Indium Pm2.5 Lc	60	12	0.0022	0.00978	0.0194	0.0233	0.0152	0.0152
Iron Pm2.5 Lc	60	59	0.0171	0.0171	0.0018	0.0525	0.0502	0.0448
Lead Pm2.5 Lc	60	24	0.000616	0.00177	0.00359	0.00898	0.00501	0.00396
Magnesium Pm2.5 Lc	60	12	0.0022	0.00746	0.0131	0.0479	0.0215	0.0161
Manganese Pm2.5 Lc	60	33	0.000379	0.000784	0.00184	0.00227	0.00194	0.00185
Nickel Pm2.5 Lc	60	22	0.000159	0.000585	0.00133	0.00117	0.00098	0.00089
Oc Csn_Rev Unadjusted Pm2.5 Lc Tot	61	61	1.26	1.26		3.28	2.93	2.8
Phosphorus Pm2.5 Lc	60		0	0.00597	0.0119	0	0	0
Potassium Ion Pm2.5 Lc	60	41	0.0271	0.0302	0.015	0.141	0.089	0.085
Potassium Pm2.5 Lc	60	60	0.0336	0.0336	0.00678	0.292	0.127	0.0614
Rubidium Pm2.5 Lc	60	12	0.000126	0.000901	0.00191	0.00217	0.00112	0.0009
Selenium Pm2.5 Lc	60	19	0.000173	0.000848	0.00201	0.00225	0.0018	0.00098
Silicon Pm2.5 Lc	60	56	0.0261	0.0265	0.0123	0.126	0.126	0.114
Silver Pm2.5 Lc	60	8	0.0007	0.00747	0.016	0.00816	0.007	0.007
Sodium Ion Pm2.5 Lc	60	60	0.0409	0.0409	0.0138	0.14	0.112	0.111
Sodium Pm2.5 Lc	60	32	0.0139	0.023	0.0384	0.17	0.0835	0.055
Strontium Pm2.5 Lc	60	14	0.000419	0.00134	0.00237	0.0107	0.00467	0.00303
Sulfate Pm2.5 Lc	60	60	1.3	1.3	0.00821	5.81	4.99	3.39
Sulfur Pm2.5 Lc	60	60	0.511	0.511	0.00823	2.07	1.56	1.38
Tin Pm2.5 Lc	60	16	0.00305	0.0124	0.0251	0.0292	0.0256	0.0245
Titanium Pm2.5 Lc	60	23	0.00062	0.00207	0.00478	0.00478	0.00327	0.00303
Total Nitrate Pm2.5 Lc	60	60	0.619	0.619	0.0137	6.31	4.24	3.74
Vanadium Pm2.5 Lc	60	19	0.000216	0.00136	0.00328	0.00266	0.00139	0.0011
Zinc Pm2.5 Lc	60	54	0.00316	0.00329	0.00245	0.0107	0.0104	0.0102
Zirconium Pm2.5 Lc	60	10	0.000691	0.00296	0.00645	0.0104	0.007	0.007

Tecumseh (260910007), Speciated PM2.5 (µg/m3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Aluminum Pm2.5 Lc	58	26	0.0139	0.0187	0.0177	0.115	0.114	0.0658
Ammonium Ion Pm2.5 Lc	58	56	0.791	0.791	0.0141	2.84	2.25	2.16
Antimony Pm2.5 Lc	58	18	0.00517	0.0185	0.039	0.0658	0.0466	0.0245
Arsenic Pm2.5 Lc	58	29	0.000542	0.00093	0.00154	0.00349	0.00282	0.00239
Barium Pm2.5 Lc	58	2	0.0000583	0.00485	0.00993	0.00198	0.0014	0
Bromine Pm2.5 Lc	58	56	0.00318	0.00321	0.00154	0.00873	0.00816	0.00692
Cadmium Pm2.5 Lc	58	20	0.00263	0.00831	0.0165	0.0222	0.0222	0.0163
Calcium Pm2.5 Lc	58	49	0.0138	0.0143	0.00623	0.0556	0.0532	0.0529
Cerium Pm2.5 Lc	58	3	0.0000502	0.00379	0.00788	0.00186	0.0007	0.00035
Cesium Pm2.5 Lc	58	8	0.000384	0.00678	0.0158	0.00698	0.00431	0.00327
Chlorine Pm2.5 Lc	58	46	0.00472	0.00538	0.00665	0.0249	0.0138	0.0127
Chromium Pm2.5 Lc	58	45	0.00406	0.00432	0.00229	0.059	0.0363	0.0223
Cobalt Pm2.5 Lc	58	33	0.000268	0.000545	0.00129	0.00178	0.00087	0.00087
Copper Pm2.5 Lc	58	36	0.000835	0.00122	0.00181	0.0067	0.00327	0.00316
Ec Csn_Rev Unadjusted Pm2.5 Lc Tot	58	58	0.143	0.143		0.361	0.311	0.276
Indium Pm2.5 Lc	58	10	0.000724	0.00909	0.0198	0.00816	0.007	0.00699
Iron Pm2.5 Lc	58	58	0.0391	0.0391	0.00174	0.101	0.0896	0.0855
Lead Pm2.5 Lc	58	35	0.00127	0.00197	0.00352	0.00665	0.0064	0.00548
Magnesium Pm2.5 Lc	58	13	0.00171	0.0066	0.0129	0.0158	0.0131	0.012
Manganese Pm2.5 Lc	58	45	0.00228	0.00247	0.00179	0.0304	0.024	0.0101
Nickel Pm2.5 Lc	58	27	0.000412	0.000758	0.00131	0.00516	0.00355	0.00263
Oc Csn_Rev Unadjusted Pm2.5 Lc Tot	58	58	1.7	1.7		3.83	3.46	3.3
Phosphorus Pm2.5 Lc	58	2	0.000192	0.00597	0.0119	0.00959	0.00152	0
Potassium Ion Pm2.5 Lc	58	51	0.0367	0.0376	0.0141	0.143	0.0992	0.0906
Potassium Pm2.5 Lc	58	58	0.0454	0.0454	0.00682	0.11	0.101	0.0932
Rubidium Pm2.5 Lc	58	11	0.000104	0.000893	0.0019	0.00113	0.00105	0.00075
Selenium Pm2.5 Lc	58	24	0.000447	0.00102	0.00201	0.0034	0.00267	0.00249
Silicon Pm2.5 Lc	58	58	0.0417	0.0417	0.0125	0.232	0.116	0.108
Silver Pm2.5 Lc	58	10	0.00119	0.00808	0.0164	0.0163	0.00932	0.00814
Sodium Ion Pm2.5 Lc	58	57	0.0507	0.0508	0.0149	0.208	0.136	0.126
Sodium Pm2.5 Lc	58	37	0.0205	0.0281	0.0382	0.09	0.0757	0.0694
Strontium Pm2.5 Lc	58	11	0.000239	0.00121	0.00236	0.00361	0.00256	0.00163
Sulfate Pm2.5 Lc	58	58	1.68	1.68	0.00846	5.52	4.42	4.37
Sulfur Pm2.5 Lc	58	58	0.661	0.661	0.00831	1.9	1.85	1.61
Tin Pm2.5 Lc	58	14	0.00386	0.0133	0.0257	0.0454	0.0385	0.0245
Titanium Pm2.5 Lc	58	26	0.000748	0.00204	0.00479	0.00454	0.00408	0.00373
Total Nitrate Pm2.5 Lc	58	58	1.56	1.56	0.0131	7.54	6.27	5.34
Vanadium Pm2.5 Lc	58	18	0.000257	0.00142	0.00331	0.00186	0.00163	0.00158
Zinc Pm2.5 Lc	58	58	0.00914	0.00914	0.00247	0.0465	0.0381	0.021
Zirconium Pm2.5 Lc	58	9	0.000596	0.00341	0.00684	0.0105	0.00827	0.00351

Grand Rapids - Monroe St. (260810020), Speciated PM2.5 (µg/m3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Aluminum Pm2.5 Lc	95	51	0.0105	0.0146	0.017	0.0786	0.0706	0.0592
Ammonium Ion Pm2.5 Lc	97	96	0.896	0.896	0.017	3.64	3.09	2.9
Antimony Pm2.5 Lc	95	35	0.00548	0.0174	0.0364	0.0431	0.0431	0.0302
Arsenic Pm2.5 Lc	95	60	0.000763	0.00107	0.00161	0.0049	0.00431	0.00409
Barium Pm2.5 Lc	95	14	0.000953	0.00547	0.0136	0.0438	0.00885	0.00582
Bromine Pm2.5 Lc	95	94	0.00328	0.00328	0.00156	0.0111	0.0104	0.00914
Cadmium Pm2.5 Lc	95	26	0.00148	0.00737	0.0157	0.0233	0.014	0.0128
Calcium Pm2.5 Lc	95	88	0.0222	0.0224	0.00611	0.0993	0.0975	0.0972
Cerium Pm2.5 Lc	95	8	0.0000784	0.00495	0.0136	0.00209	0.00152	0.0014
Cesium Pm2.5 Lc	95	22	0.00083	0.00722	0.0195	0.0118	0.00817	0.00618
Chlorine Pm2.5 Lc	95	84	0.011	0.0114	0.00699	0.263	0.0922	0.0566
Chromium Pm2.5 Lc	95	68	0.00389	0.00421	0.00223	0.0705	0.0473	0.0462
Cobalt Pm2.5 Lc	95	62	0.000327	0.000561	0.00133	0.00168	0.00151	0.00141
Copper Pm2.5 Lc	95	77	0.00333	0.00356	0.00184	0.0241	0.0211	0.0166
Ec Csn_Rev Unadjusted Pm2.5 Lc Tot	101	101	0.319	0.319		0.808	0.675	0.643
Indium Pm2.5 Lc	95	24	0.00204	0.00906	0.0188	0.0221	0.0221	0.0187
Iron Pm2.5 Lc	95	95	0.0554	0.0554	0.00186	0.208	0.157	0.157
Lead Pm2.5 Lc	95	49	0.00135	0.0023	0.00377	0.0154	0.00652	0.00571
Magnesium Pm2.5 Lc	95	29	0.00358	0.00833	0.0137	0.0675	0.0556	0.0214
Manganese Pm2.5 Lc	95	73	0.00191	0.00212	0.00185	0.00966	0.0079	0.00771
Nickel Pm2.5 Lc	95	53	0.000559	0.000855	0.00137	0.0129	0.00638	0.00446
Oc Csn_Rev Unadjusted Pm2.5 Lc Tot	101	101	2.17	2.17		5.14	5.11	4.8
Phosphorus Pm2.5 Lc	95	5	0.000202	0.00558	0.0112	0.00713	0.00597	0.00328
Potassium Ion Pm2.5 Lc	97	83	0.0588	0.0598	0.0166	1.1	0.827	0.187
Potassium Pm2.5 Lc	95	95	0.0651	0.0651	0.00681	1.01	0.909	0.116
Rubidium Pm2.5 Lc	95	22	0.00017	0.000909	0.00187	0.00207	0.00193	0.00166
Selenium Pm2.5 Lc	95	49	0.00041	0.000897	0.0021	0.00315	0.00265	0.00162
Silicon Pm2.5 Lc	95	92	0.0406	0.0408	0.0126	0.202	0.17	0.157
Silver Pm2.5 Lc	95	13	0.000494	0.00697	0.0148	0.0128	0.00702	0.007
Sodium Ion Pm2.5 Lc	97	96	0.0682	0.0683	0.0148	0.763	0.269	0.247
Sodium Pm2.5 Lc	95	76	0.0194	0.0239	0.0404	0.141	0.0817	0.0775
Strontium Pm2.5 Lc	95	22	0.000398	0.00131	0.00232	0.0149	0.00524	0.00291
Sulfate Pm2.5 Lc	97	97	1.74	1.74	0.00808	7.43	5.86	4.99
Sulfur Pm2.5 Lc	95	95	0.601	0.601	0.00798	2.16	1.77	1.65
Tin Pm2.5 Lc	95	21	0.0029	0.0126	0.0248	0.0303	0.0292	0.028
Titanium Pm2.5 Lc	95	51	0.00153	0.00261	0.0047	0.00806	0.00699	0.00652
Total Nitrate Pm2.5 Lc	97	97	1.64	1.64	0.0144	8.45	8.02	7.87
Vanadium Pm2.5 Lc	95	30	0.000242	0.00133	0.00317	0.00268	0.00216	0.00181
Zinc Pm2.5 Lc	95	94	0.0102	0.0102	0.00257	0.0355	0.031	0.0234
Zirconium Pm2.5 Lc	95	15	0.000366	0.00247	0.00566	0.00572	0.00513	0.00513

Appendix C: 2013 AQI Pie Charts

Appendix C contains pie charts that were created to show the AQI values for each of Michigan's 2013 monitoring sites and includes the total number of days measurements were taken, along with the pollutant distribution of the AQI values for those measurements. It is important to note that not all pollutants are measured at each site. In fact, some sites only obtain AQI measurements for that portion of the year corresponding to the ozone season; therefore, the number of days for each site may not be equivalent to 365. **Figures C.1** through **C.4** are grouped by CSA. **Figures C.5** and **C.6** show the remaining sites (not part of a CSA) located in Michigan's Upper and Lower Peninsulas.

Figure C.1: AQI Summaries for Detroit-Warren-Flint CSA

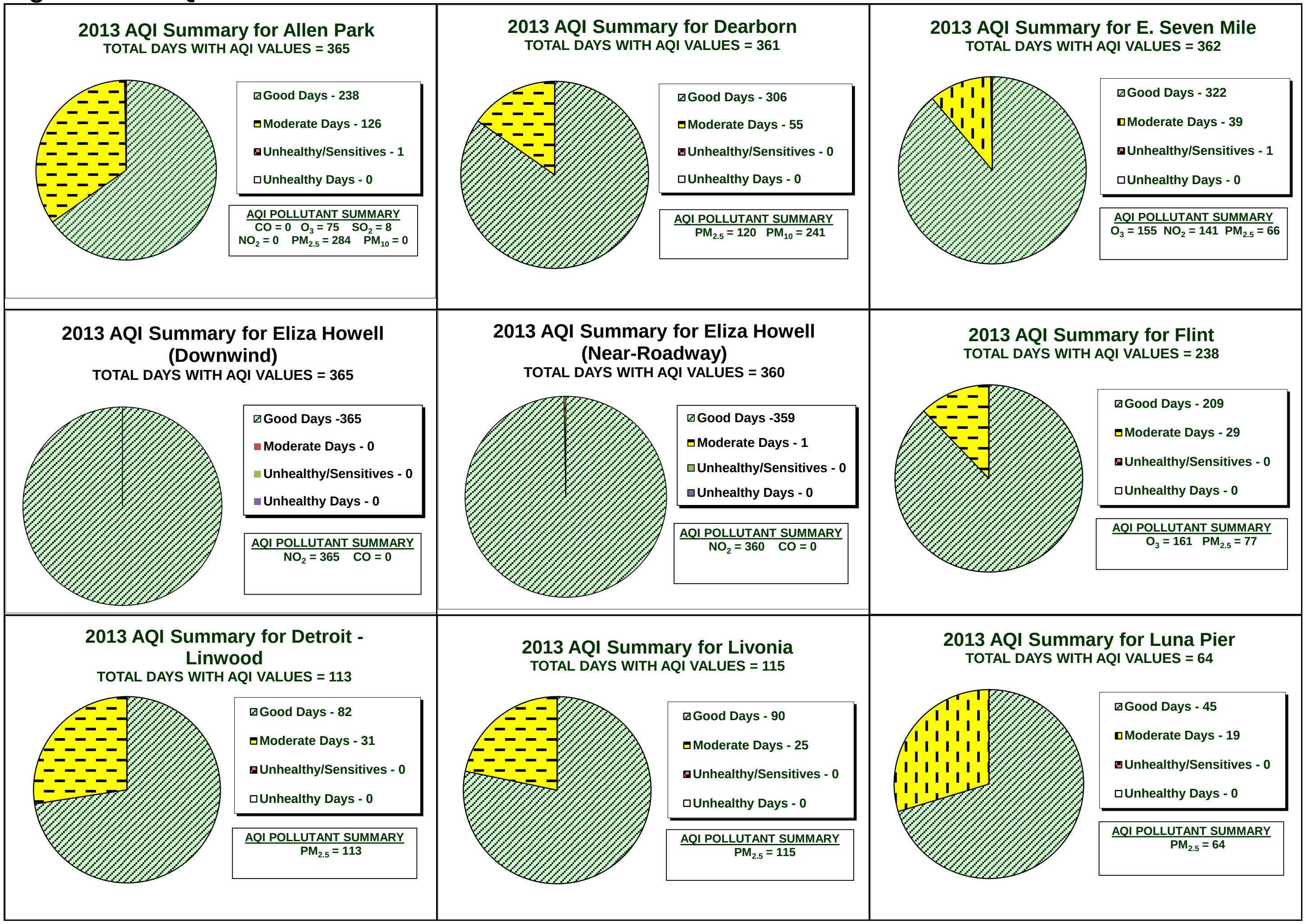


Figure C1, continued: AQI Summaries for Detroit-Warren-Flint-CSA

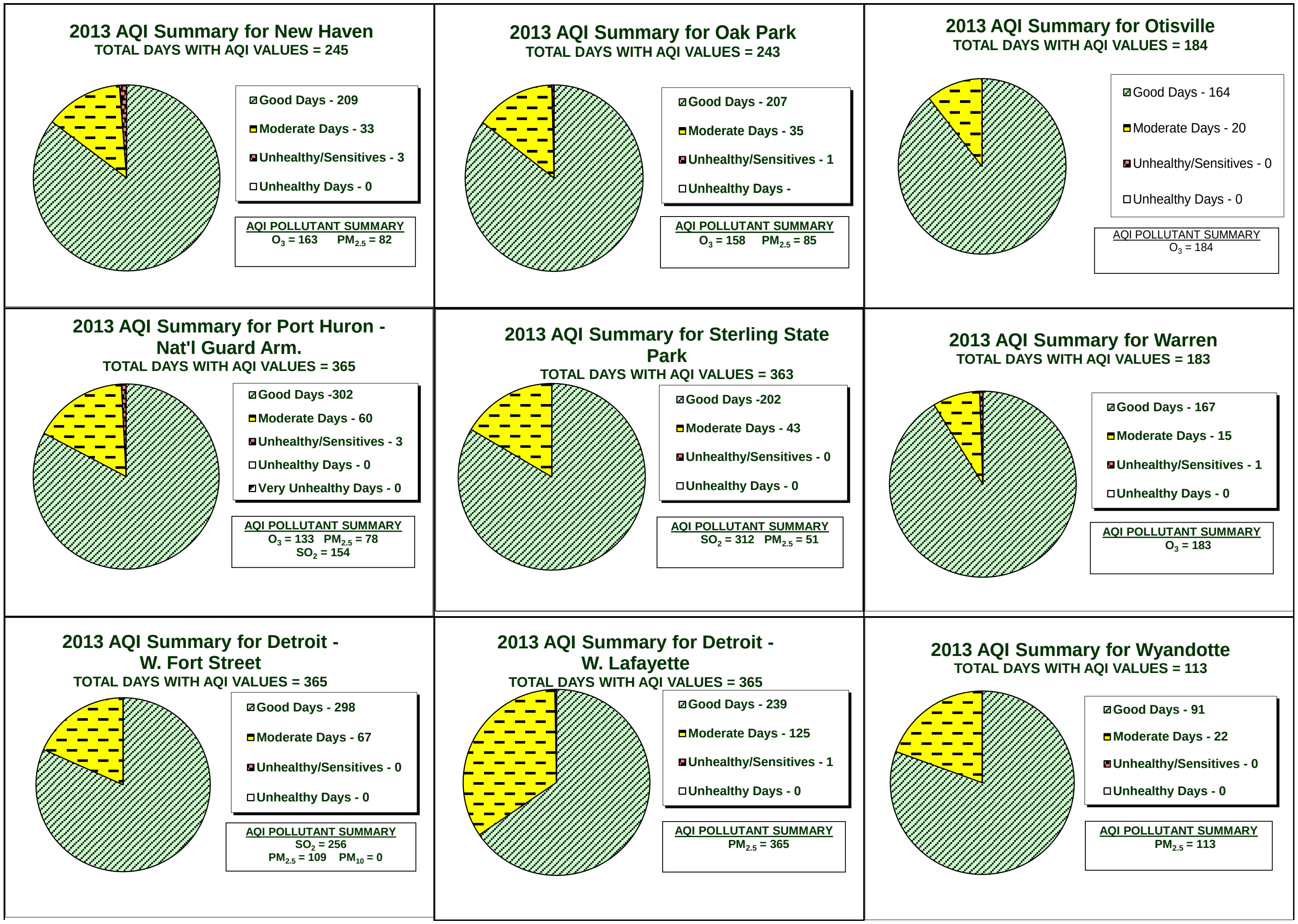


Figure C1, continued: AQI Summaries for Detroit-Warren-Flint-CSA

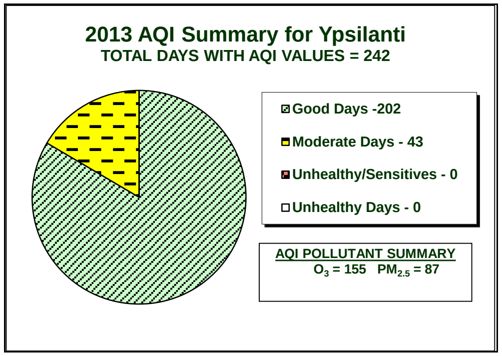
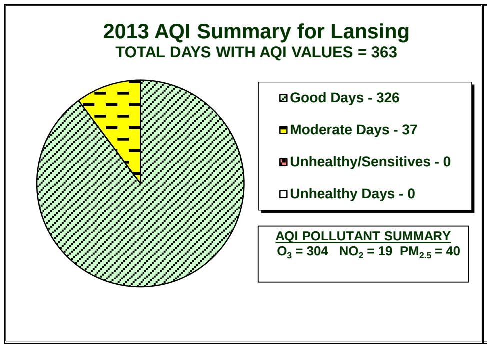


Figure C2: AQI Summaries for Lansing-East Lansing-Owosso CSA



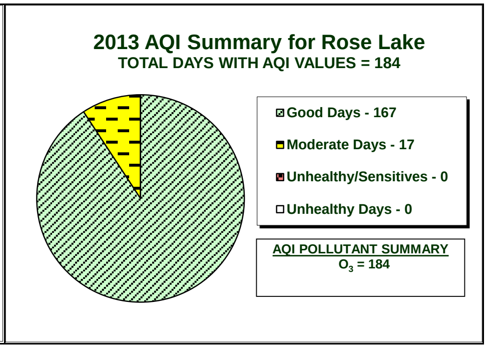


Figure C3: AQI Summary for Saginaw-Bay City-Saginaw Twp North CSA

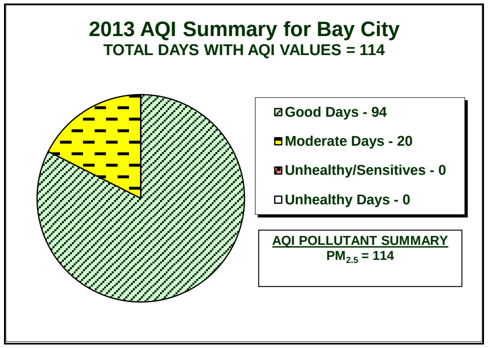
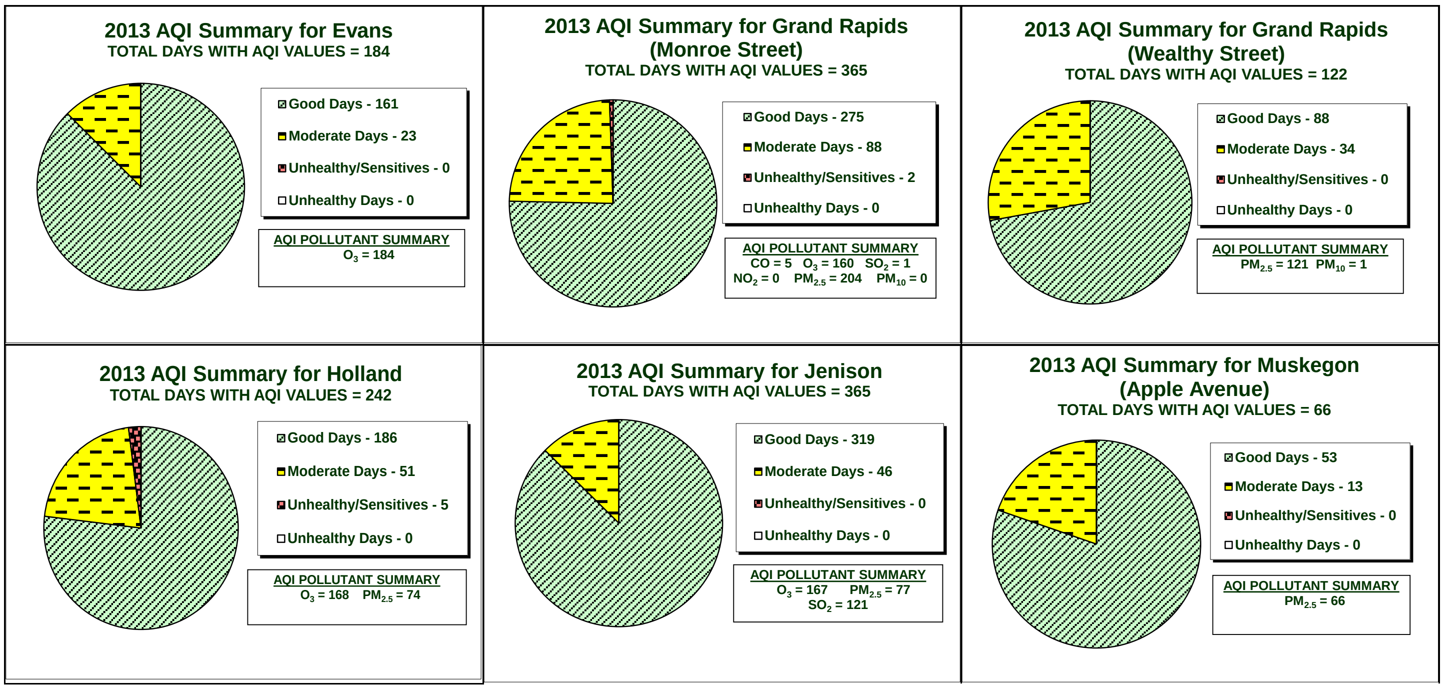


Figure C4: AQI Summaries for Grand Rapids-Muskegon-Holland CSA



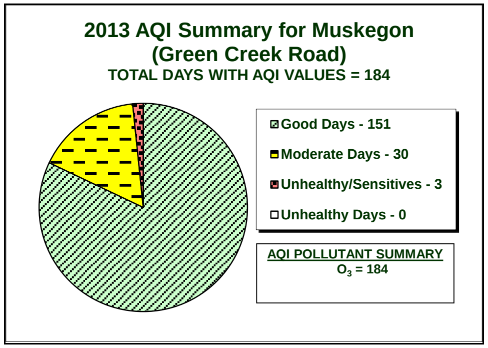


Figure C5: AQI Summary for Upper Peninsula

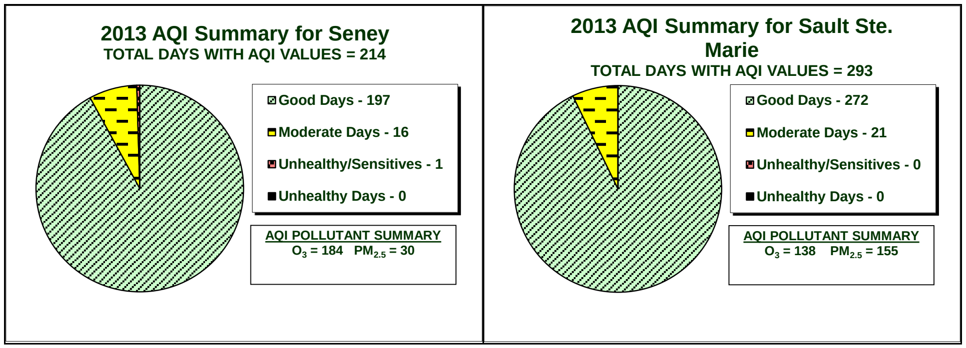
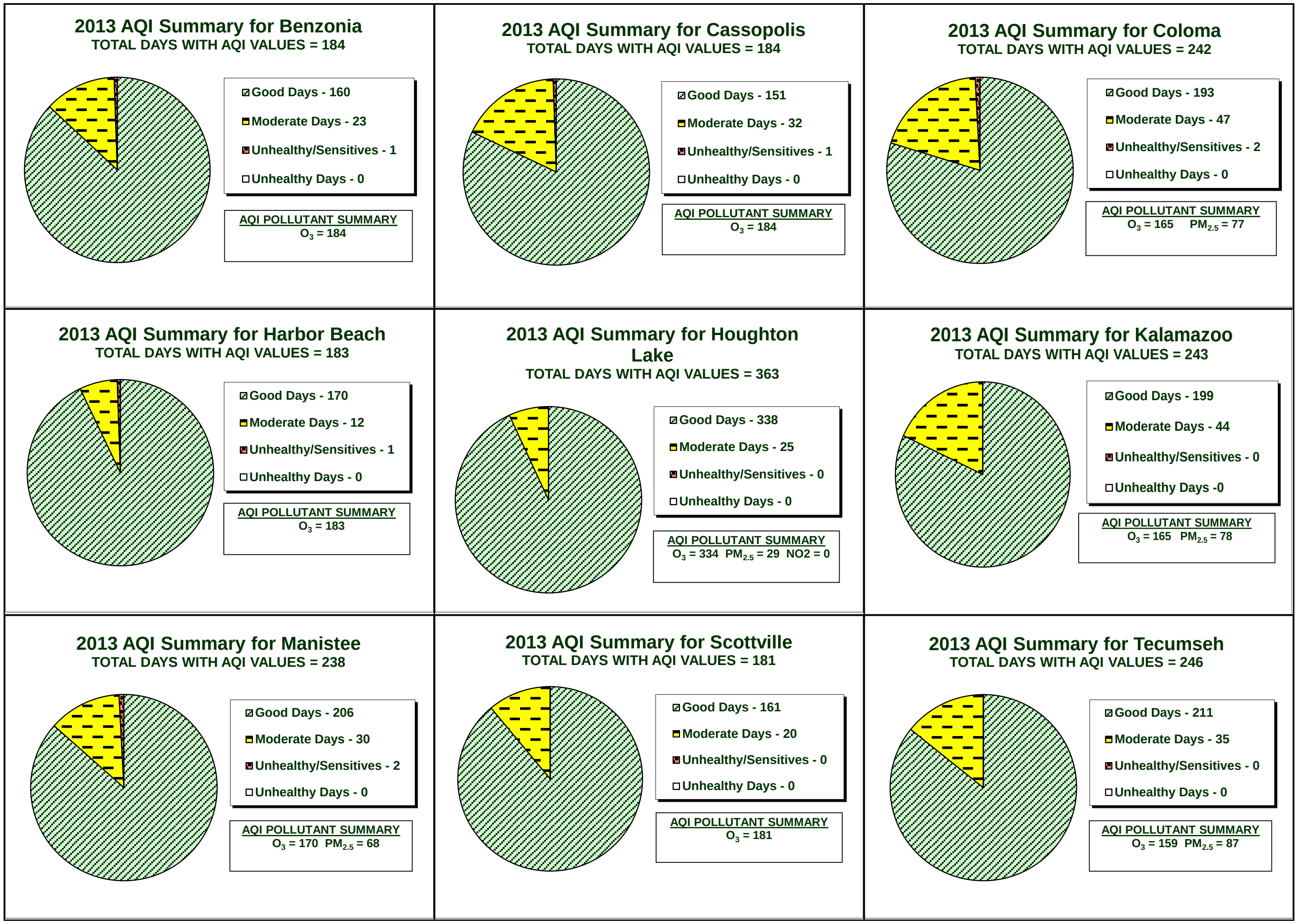


Figure C6: AQI Summaries for Michigan's Other Lower Peninsula Areas



Appendix D: Acronyms and Their Definitions:

>	Greater than
<	Less than
≥	Greater than or equal to
≤	Less than or equal to
%	Percent
$\mu g/m^3$	Micrograms per cubic meter
µm	micrometer
AIRS ID	Aerometric Information Retrieval System Identification Number
AMU	Air Monitoring Unit
AQD	Air Quality Division
AQES	Air Quality Evaluation Section
AQI	Air Quality Index
AQS	Air Quality System (EPA air monitoring data archive)
As	Arsenic
BAM	Beta Attenuation Monitor (hourly $PM_{2.5}$ measurement monitor)
CAA	Clean Air Act
CBSA	Core-Based Statistical Area
Cd	Cadmium
CFR	Code of Federal Regulations
CO	Carbon monoxide
CSA	Consolidated Statistical Area
EC/OC	Elemental carbon/Organic carbon
EPA	U.S. Environmental Protection Agency
FDMS	Filter Dynamic Measurement System
FEM	Federal Equivalent Method
FIA	Family Independence Agency
FR	Federal Register
FRM	Federal Reference Method
HAP	Hazardous Air Pollutant
hr	Hour
Lc	Local Conditions
MASN	Michigan Air Sampling Network
MDEQ	Michigan Department of Environmental Quality
MDL	Method Detection Limit
mg/m^3	Milligrams per meter cubed
MI	Michigan
MiSA	Micropolitan Statistical Area
Mn	Manganese
MSA	Metropolitan Statistical Area
NAAQS	National Ambient Air Quality Standard
NAMS	National Air Monitoring Station
NATTS	National Air Toxics Trend Sites
NCore	National Core Monitoring Sites
ND	Non-detect
NEI	National Emission Inventory
Ni	Nickel

Appendix D: Acronyms and Their Definitions, Continued

NO	Nitric oxide
NO_2	Nitrogen dioxide
NO_X	Oxides of Nitrogen
NO_Y	Oxides of nitrogen + nitric acid + organic and inorganic nitrates
NPAP	National Performance Audit Program
O_3	Ozone
Obs	Observations
PAHs	Polynuclear Aromatic Hydrocarbon
Pb	Lead
PBT	Persistent, Bioaccumulative Toxics
PCP	Polychorinated biphenyls
PEP	Performance Evaluation Program
PM	Particulate matter
$PM_{2.5}$	Particulate matter with an aerodynamic diameter less than or equal to 2.5 microns
PM_{10}	Particulate matter with a diameter of 10 microns or less
$PM_{10-2.5}$	Coarse PM equal to the concentration difference between PM_{10} and $PM_{2.5}$
PNA	Polynuclear aromatic hydrocarbons
POC	Parameter Occurrence Code
ppb	parts per billion
ppm	parts per million = mg/kg, mg/L, µg/g (1 ppm = 1,000 ppb)
QA	Quality assurance
QAPP	Quality Assurance Project Plan
SASS	Spiral Aerosol Speciation Sampler ($PM_{2.5}$ Speciation Sampler)
SO_2	Sulfur dioxide
STN	Speciation Trend Network ($PM_{2.5}$)
SVOC	Semi-Volatile Compound
SWHS	Southwestern High School
TACs	Toxic Air Contaminants
TEOM	Tapered element oscillating microbalance (hourly $PM_{2.5}$ measurement monitor)
tpy	ton per year
TRI	Toxic Release Inventory
TSP	Total Suspended Particulate
U.S.	United States
UV	Ultra-violet
VOC	Volatile organic compounds
Vs	Versus

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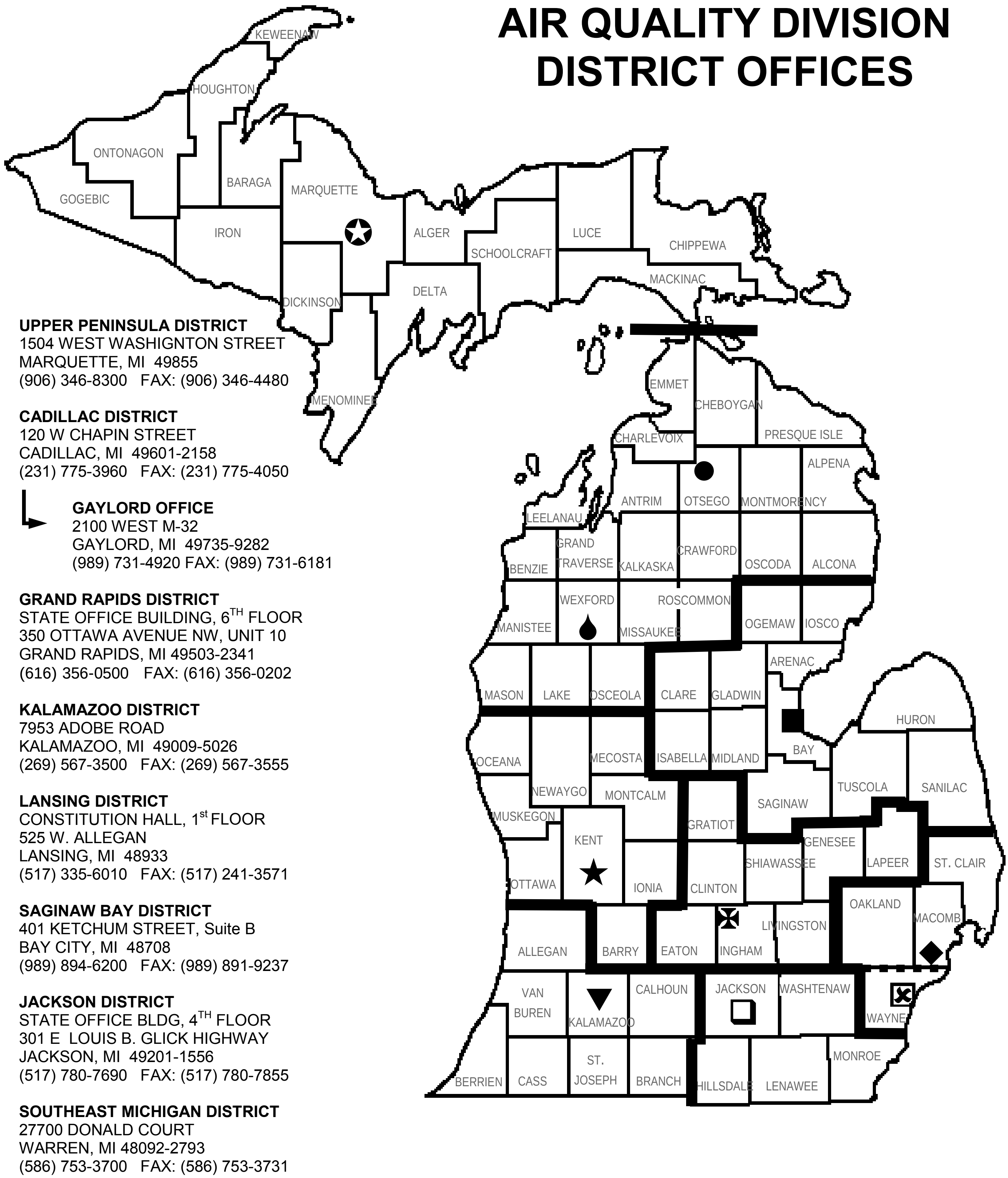

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