2012 Annual Air Quality Report

Michigan

Department of Environmental Quality

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Michigan Department of Environmental Quality

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Courtesy of Bryan Lomerson.

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TABLE OF CONTENTS

Page No.

TABLES

TABLE OF CONTENTS
Continued

Page No.

FIGURES

TABLE OF CONTENTS
Continued

Page No.

FIGURES, Continued

APPENDICES

2012 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 the public and the environment. 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 2012,
- Attainment/nonattainment status,
- Monitoring site locations (tables show all the monitors active in 2012), and
- Air quality trends from 2007-2012 broken down by location.[1]

The actual 2012 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 2012 air quality data, air quality trends, overview of the monitoring network (available in much greater detail in the 2013 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, 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.

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, visibility and climatic factors, 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 2012. The concentrations are listed as parts per million (ppm), micrograms per cubic meter ($\mu g/m^3$), and/or milligrams per cubic meter (mg/m^3).

Table 1.1: NAAQS in Effect during 2012 for Criteria Pollutants

Pollutant	Primary (health-related)		Secondary (welfare-related)	
	Level	**Averaging Time**	**Level**	**Averaging Time**
Carbon Monoxide (CO)	9 ppm ($10\ mg/m^3$)	2^{nd} highest 8-hour	None	
	35 ppm ($40\ mg/m^3$)	2^{nd} highest 1-hour		
Lead (Pb)	$0.15\ \mu g/m^3$	Maximum rolling 3-month average	Same as Primary	
Nitrogen Dioxide (NO_2)	0.053 ppm ($100\ \mu g/m^3$)	Annual arithmetic mean	Same as Primary	
	0.100 ppm	98^{th} percentile 1-hr averaged over 3-years		
Particulate Matter (PM_{10})	$150\ \mu g/m^3$	24-hour	Same as Primary	
Particulate Matter ($PM_{2.5}$)	$12.0\ \mu g/m^3$	Annual arithmetic mean	$15.0\ \mu g/m^3$	Annual mean
	$35\ \mu g/m^3$	98^{th} percentile 24-hour averaged over 3 years	Same as Primary	
Ozone (O_3)	0.075 ppm	4^{th} highest 8-hour daily max. averaged over 3 years	Same as Primary	
Sulfur Dioxide (SO_2)	0.075 ppm	99^{th} percentile of 1-hour averaged over 3 years	0.5 ppm	3 hours

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 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 98th 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 $PM_{2.5}$ annual and secondary standards are met when the annual arithmetic mean concentration is less than or equal to 12 µg/m^3. 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 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.

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

<u>Michigan Air Sampling Network</u>

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 handled by the Little River Band of Ottawa Indians and the Inter-tribal Council of Michigan, respectively. **Figure 1.1** shows the 2012 MASN monitoring sites. **Figures 1.2** and **1.3** are pictures of two monitoring stations in Port Huron and Sterling State Park, Monroe, respectively. The Sterling State Park site started operation in January of 2013.

Figure 1.1: 2011 MASN Monitoring Sites

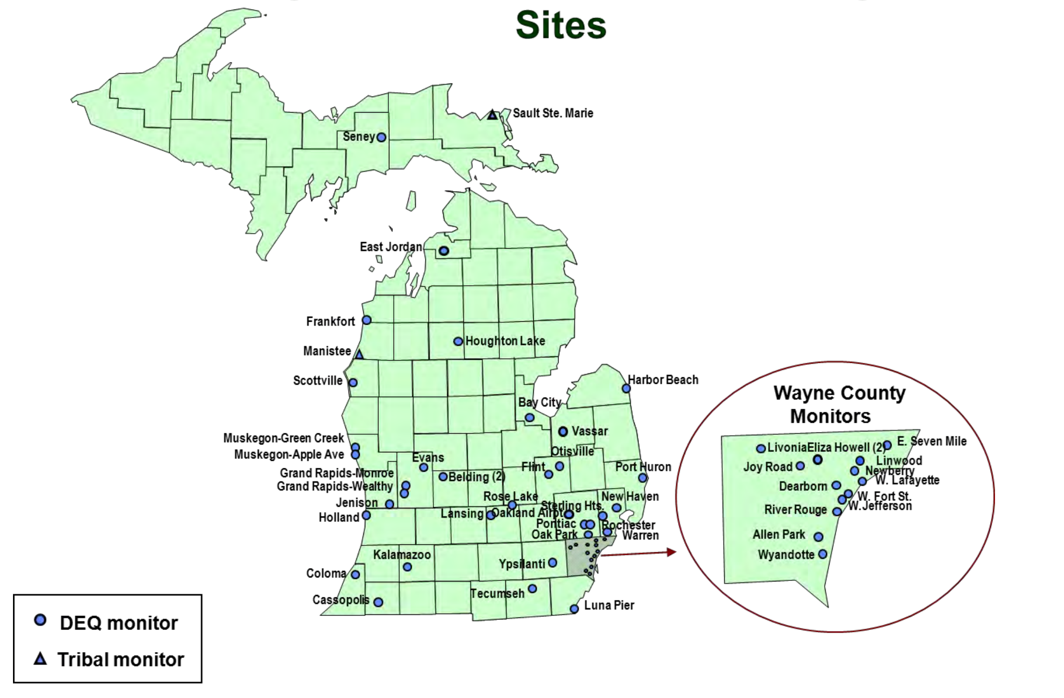


Figure 1.2: Port Huron monitoring site

Figure 1.3: Sterling State Park, Monroe monitoring site

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 particulate concentrations over a 24-hour period, and high volume samplers for Pb. In addition, continuous $PM_{2.5}$ and PM_{10} monitors are used to provide real-time hourly data, and $PM_{2.5}$ chemical speciation monitors determine the chemical composition of $PM_{2.5}$ and help characterize background levels. 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 2012 and the MASN locations are shown in **Table 1.3.**

Table 1.3 Types of Monitoring Conducted in 2012 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				√		√								√			
	261250012	Oakland Co Int'l Airport													Pb				
	261470005	Port Huron				√		√	√	√	√					√			
	261470031	Port Huron- Rural St.													√@				
	261610008	Ypsilanti				√		√	√							√			√
	261630001	Allen Park	√		√	√	√	√	√	√		√			√@	√	√		√
	261630005	River Rouge					√							√	√@	√			
	261630015	Detroit- W Fort S					√	√		√	√		√	√	√@	√	√		√
	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 #1	√	√															
	261630094	Eliza Howell #2	√	√															
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						√		√									
Huron Co	260630007	Harbor Beach				√										√			
Bay Co	260170014	Bay City						√	√							√			
MissaukeeCo	261130001	Houghton Lake		√		√		√	√	√						√			√
Allegan Co	260050003	Holland				√		√								√	√	√	√
Benzie Co	260190003	Frankfort				√													
Berrien Co	260210014	Coloma				√		√								√			
Cass Co	260270003	Cassopolis				√										√			
Kalamazoo Co	260770008	Kalamazoo				√		√	√							√			
Manistee Co	261010922	Manistee $				√		√								√		√	√
Mason Co	261050007	Scottville				√										√			
Muskegon Co	261210038	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				
Charlevoix Co	260290011	East Jordan													√@+Pb				
Tuscola Co	261570001	Vassar					√								√@+Pb				

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

In 2006, the EPA amended its air monitoring requirements to include more co-located monitors. The amended air monitoring requirements also added National Core (NCore) sites that are multi-pollutant in nature, and are enhancing the understanding of how the various forms of air pollution are related and how it is transported. Michigan has two NCore sites, Allen Park and Grand Rapids – Monroe Street. Information on the effects of the 2006 amended monitoring requirements is discussed by criteria pollutant in **Chapters 2** through **7**.

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, 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 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 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 national ambient air quality standard are considered to be in "attainment." Locations where air pollution levels persistently exceed ambient air quality standards 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.

Figures 1.4 through **1.7** show how the levels and the standards for these pollutants have changed over the last 35 plus years.

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

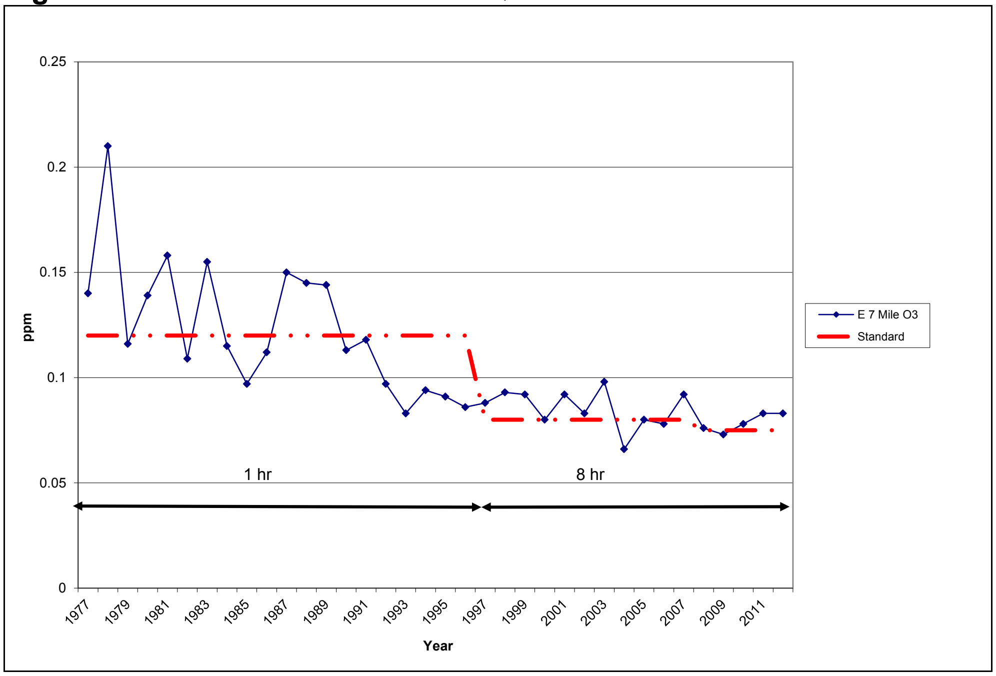


Figure 1.5 shows the SO_2 trend relative to the old annual standard for W. Fort Street in Detroit. In 2010, the EPA changed the standard from an annual average to 99th percentile of a 1-hour standard in which the SO_2 concentration cannot exceed 0.075 ppm averaged over 3 years. This resulted in nonattainment 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)

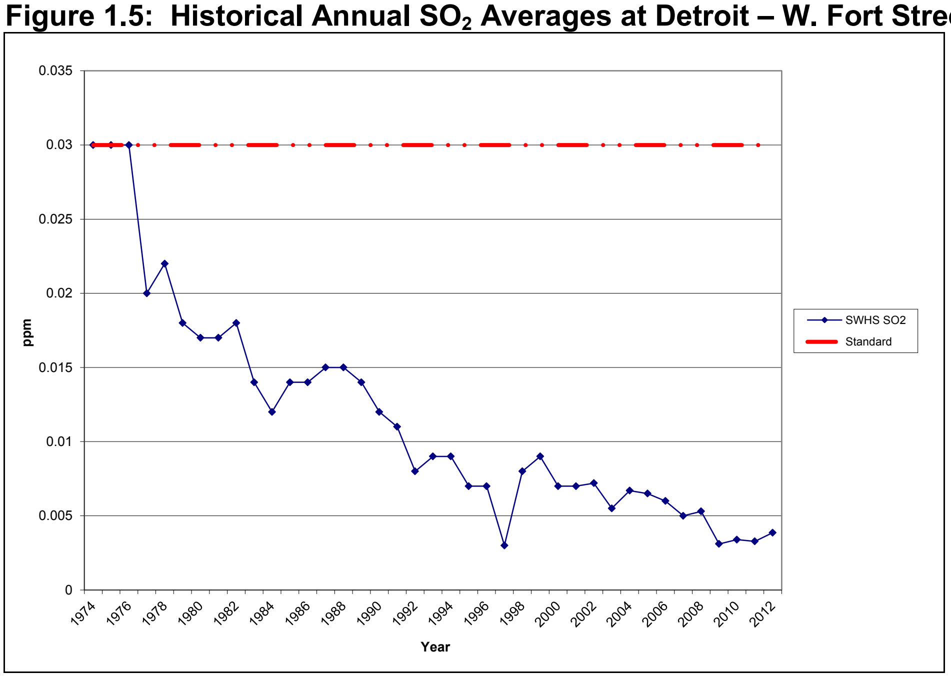
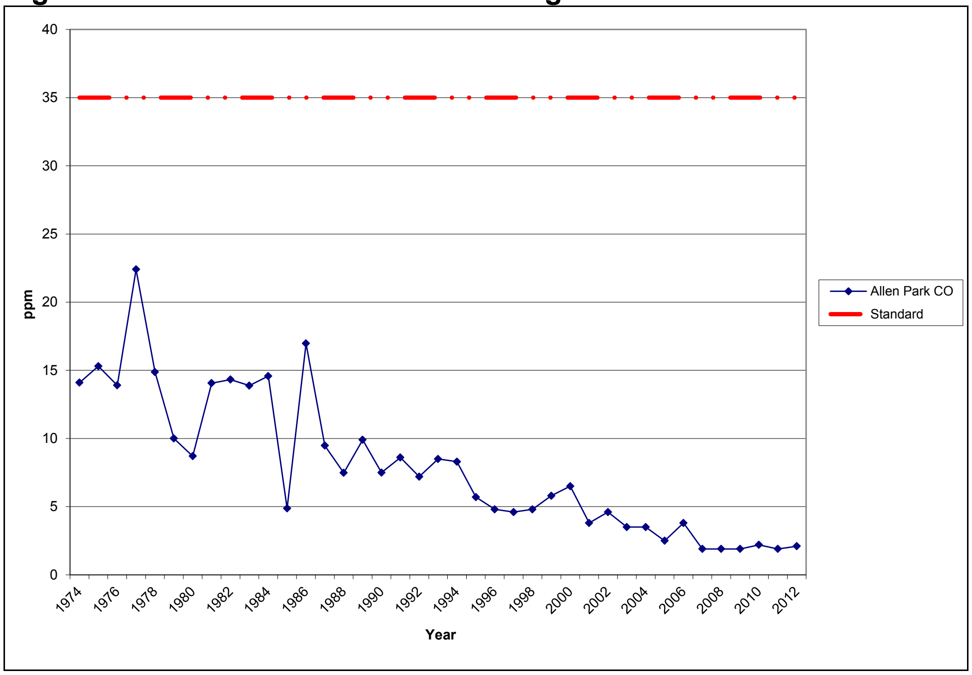
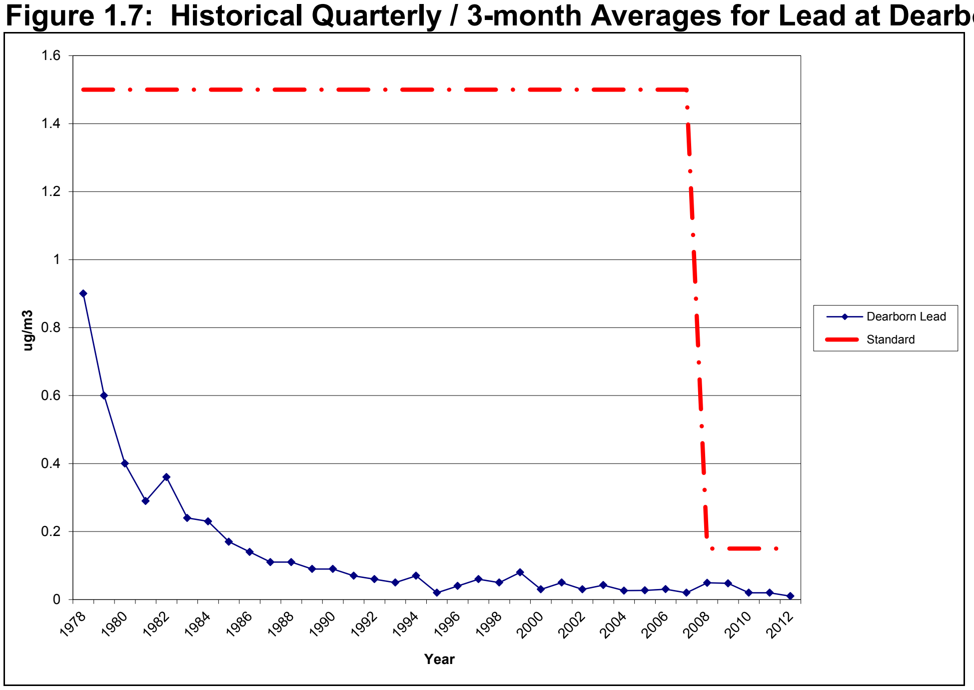


Figure 1.6: Historical 1-hour CO Averages at Allen Park



The historical trend for lead is shown in **Figure 1.7**. It is of interest because lead is harmful to the neurological development of children. This 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 in 1996, the EPA banned the sale of leaded fuel for use in on-road vehicles. As a result, there was a dramatic decrease in ambient lead levels. 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 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: Outdoor exposure sources are automobile exhaust, industrial processes (metal processing and chemical production), non-vehicle fuel combustion, and natural sources, such as forest fires. Indoor exposure sources are wood stoves, 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. CO also alters atmospheric photochemistry that contributes 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 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 Grand Rapids and Allen Park where trace CO is being monitored as part of the NCore Network and in Detroit at Eliza Howell Park, which is the near-roadway site operated by the DEQ.

Figure 2.1: Trace Carbon Monoxide (CO) Monitors in 2012

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

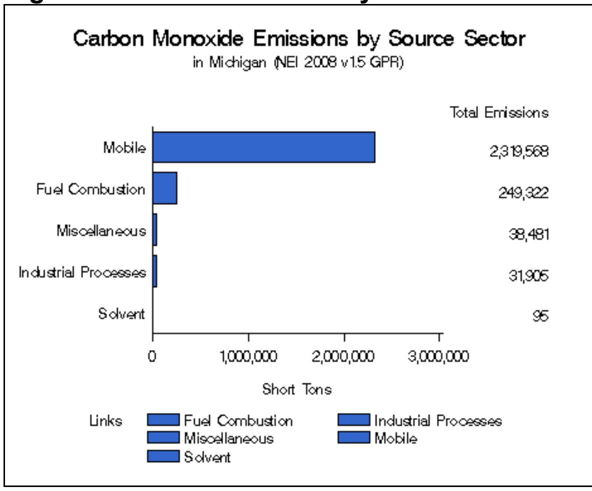
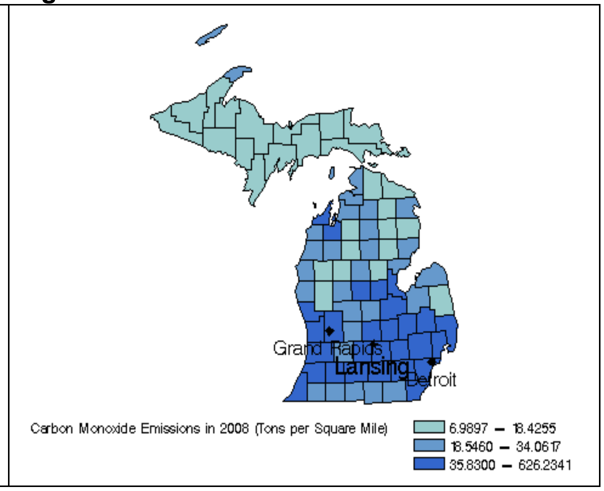


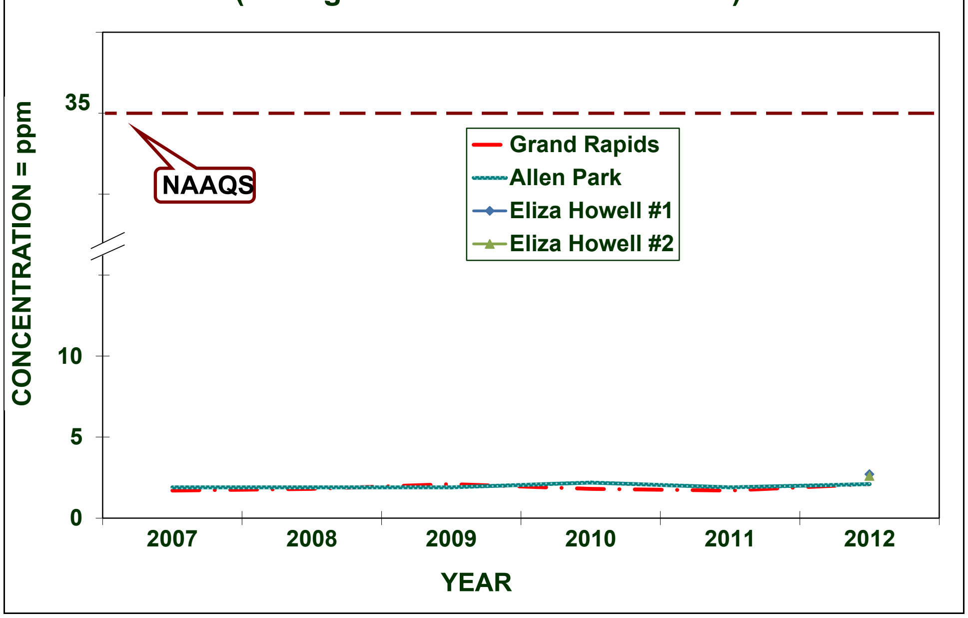
Figure 2.3: CO Emissions in 2008



Near-roadway Monitoring: On August 31, 2011, the EPA approved design changes to the CO ambient monitoring network. It is referred to as near-roadway monitoring and is focused on highly trafficked urban roads in Core-based Statistical Areas (CBSAs) with more than one million people. Final implementation is expected by January 2014; however, the DEQ took over two of the EPA's pre-existing, near-roadway sites in Detroit at Eliza Howell Park in June 2011.

Figure 2.4 provides the maximum second highest 1-hour CO level trends for Michigan from 2007-2012, which demonstrates that there have not been any exceedances of the 1-hour CO NAAQS.

Figure 2.4: CO Levels in MI from 2007-2012
(2nd Highest 1-Hr Maximum Values)



Chapter 3: Lead (Pb)

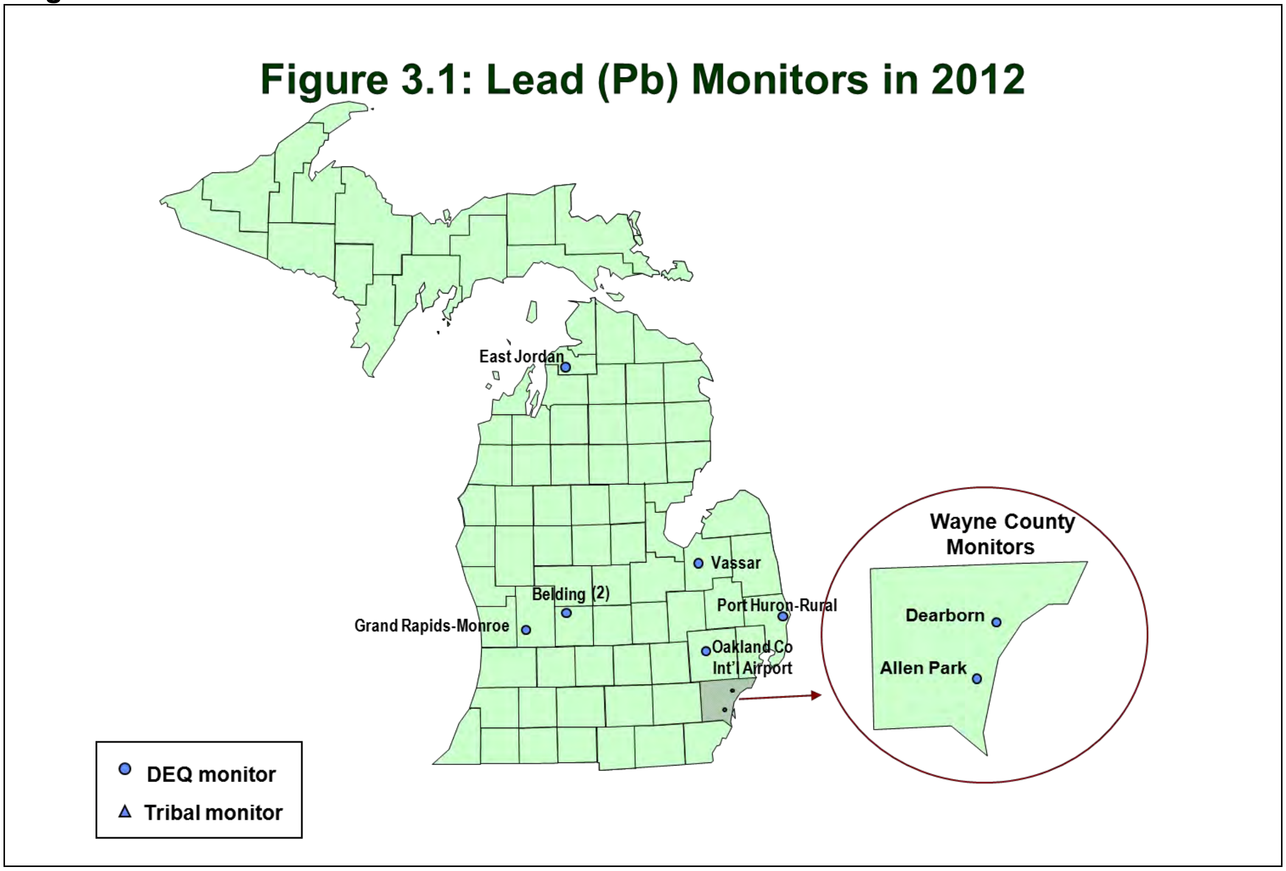
Lead is a highly toxic metal found in coal, oil, and other fuels. It is also found in older paints, municipal solid waste and sewage sludge and may be released to the atmosphere during their combustion. On November 12, 2008, the EPA modified the Pb NAAQS to a 3-month rolling average of 0.15 µg/m^3. Its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

Sources: With the phase-out of leaded gas in the 1970s, the major sources of Pb emissions are industrial and combustion sources. The highest air concentrations of Pb are found near smelters and battery manufacturers (Pb acid batteries, Pb oxide/pigments). Other industrial sources include Pb glass, Portland cement, and solder production.

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.

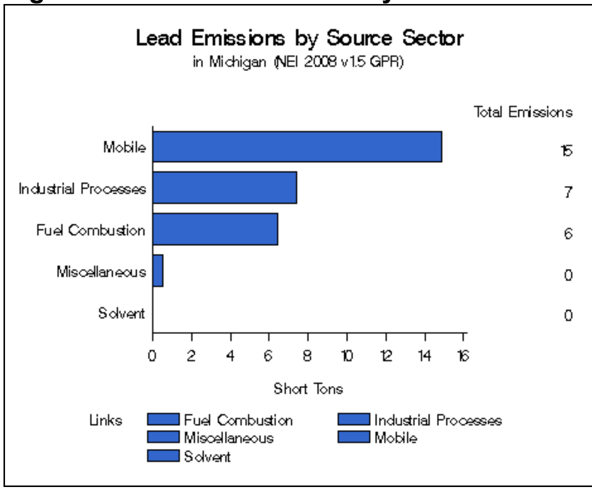
Population most at risk: Fetuses and children are most at risk as low levels of Pb may cause central nervous system damage. Excessive Pb exposure during the early years of life is associated with lower IQ scores and neurological impairment (seizures, mental retardation, and behavioral disorders). Even at low doses, Pb 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.

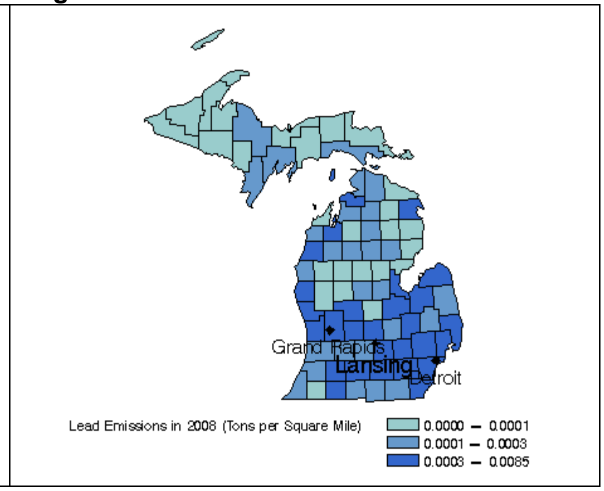
Figure 3.1 shows the location of the Pb monitors in the MASN in 2012.



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 2008**

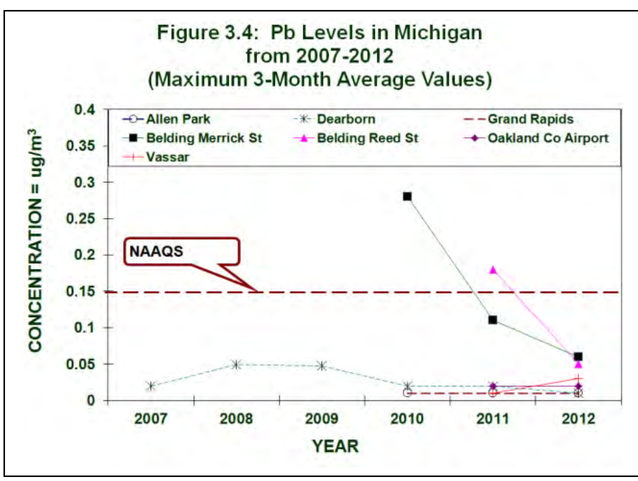


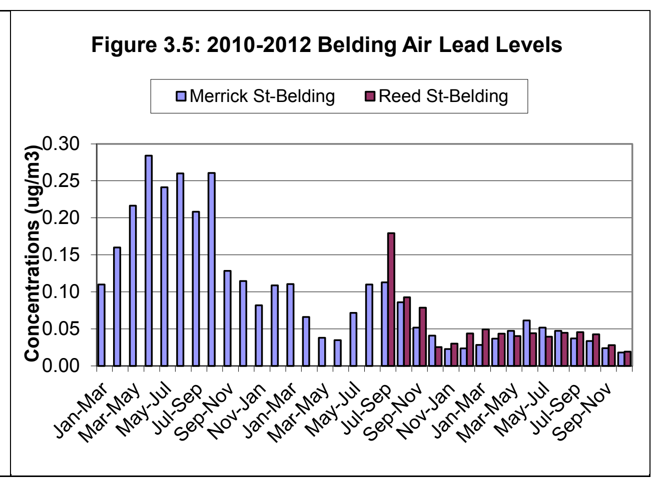


On November 12, 2008, the EPA modified the Pb NAAQS by reducing the level of the standard from a maximum quarterly average of 1.5 µg/m^3 to a 3-month rolling average of 0.15 µg/m^3. The monitoring network design was modified to consist of source-oriented monitors and population-oriented monitors. For details of the new Pb network that has been in progress since 2010, see Michigan's 2013 Annual Ambient Air Monitoring Network Review.

Figure 3.4 shows the maximum quarterly Pb level values for the years 2005 to 2009. Then starting in 2010, it shows the maximum 3-month rolling average.

As part of the new standard, the DEQ was required to monitor near stationary lead sources emitting more than 1 ton per year. One of these sources is located in Belding. Monitoring in Belding began in January 2010. As a result of this effort, the DEQ recorded a violation of the new health standard in 2010 and 2011, as shown in **Figure 3.5.** Four other point-source lead monitoring sites were sampling in East Jordan (November 2011 – November 2012), Vassar started October 2011), Oakland International Airport (July 2011 - August 2012) and Rural St, Port Huron (November 2012). The MDEQ was required to collect only 12 months of data at East Jordan and the Oakland International Airport sites. Values for the first three sites have been well below the NAAQS.





All other Pb sites in Michigan are well below the standard. The Dearborn site is part of the National Air Toxics Trend Sites (NATTS) program and monitors Pb and other trace metals, both as total suspended particulate (TSP) and PM_{10}. Pb measurements as $PM_{2.5}$ are 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. When sulfur-bearing fuel is burned, the sulfur is oxidized to form SO_2, which then reacts with other pollutants to form aerosols. In liquid form, it is found in clouds, fog, rain, aerosol particles, and in surface films on these particles. It is a major precursor to $PM_{2.5}$. 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:

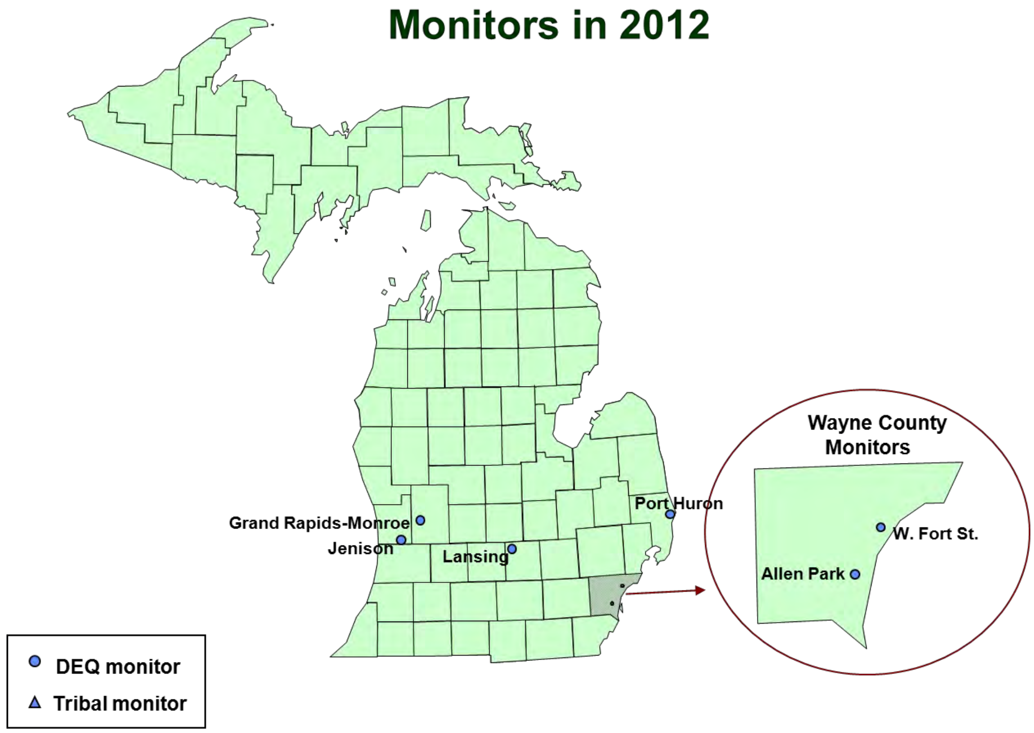
Sources: Coal-burning power plants are the largest source of SO_2 emissions. It is also emitted from smelters, petroleum refineries, pulp and paper mills, transportation sources, and steel mills. Other sources include residential, commercial and industrial space heating. SO_2 and PM are often emitted together.

Effects: Exposure to elevated levels aggravates existing cardiovascular and pulmonary disease. SO_2 and PM together may cause respiratory illness, alteration of the body's defense and clearance mechanisms, and aggravation of existing cardiovascular disease. SO_2 and NO_X together are the major precursors to acid rain; 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.

Figure 4.1: Sulfur Dioxide (SO_2) Monitors in 2012



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

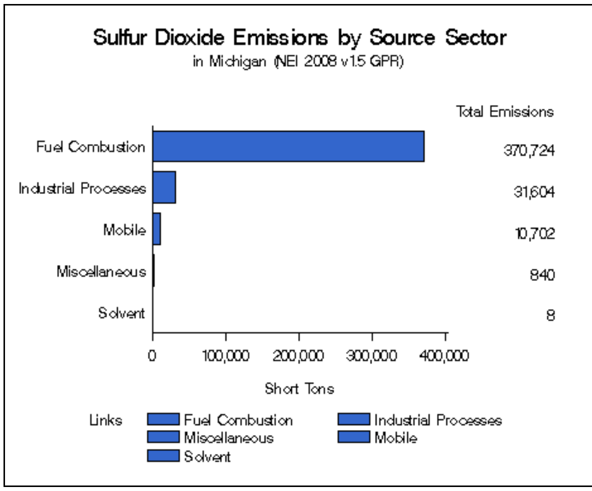
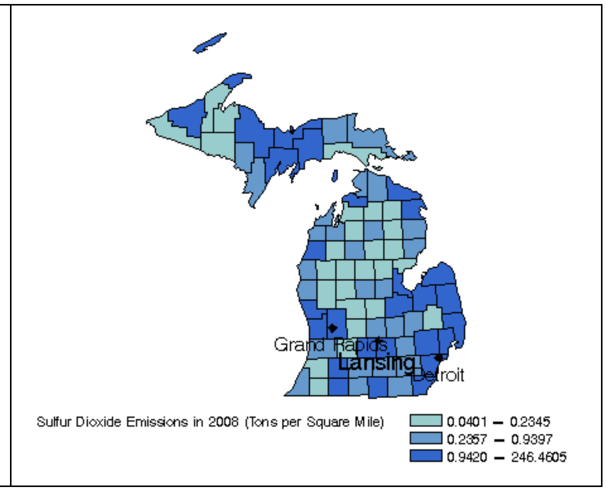


Figure 4.3: SO_2 Emissions in 2008



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 (Southwestern High School [SWHS]) in Detroit currently does not meet the new 1-hour NAAQS (see appendix A). For the NCore network, trace SO_2 is monitored at the Grand Rapids and Allen Park NCore sites. For trend purposes, W. Fort Street is graphed together with Allen Park and Grand Rapids SO_2 data. Jenison and Port Huron were also added to the SO_2 network in December 2011 as shown in **Figure 4.4.**

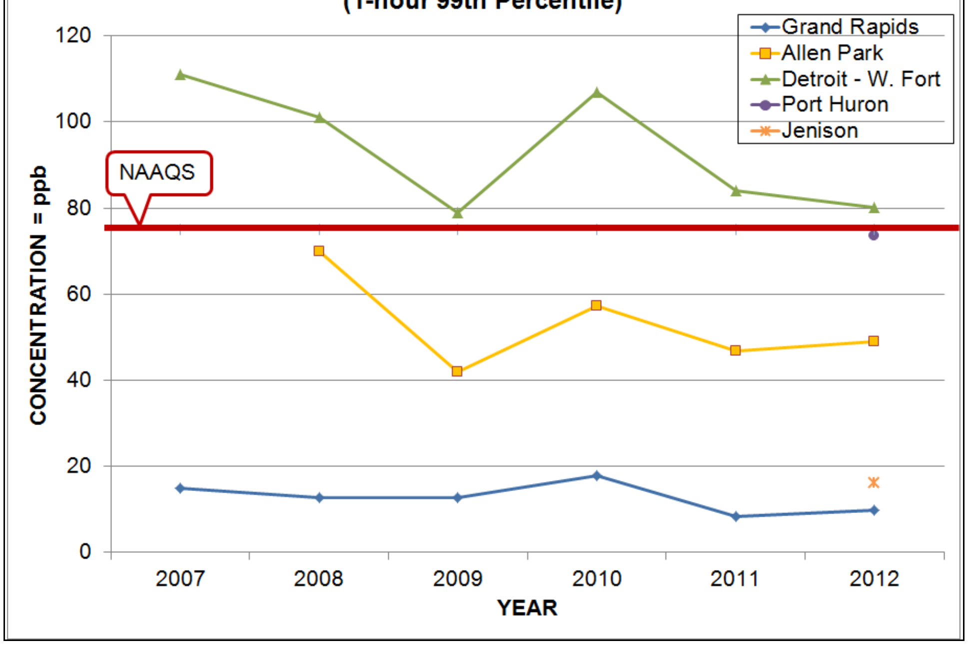


Figure 4.4: SO_2 Levels in Michigan from 2007-2012 (1-hour 99th Percentile)

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 the 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 PM. 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 98^{th} 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, biological and abiological processes in soil, and stratospheric intrusion. 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, thus causing visibility impairment. 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 2012

The East 7 Mile monitor in Detroit is a downwind urban scale site that measures NO_2. The Grand Rapids and Allen Park sites monitor trace NO_Y, which began in early January 2008 as part of the NCore program (however, only NO_2 monitors can be used for attainment/nonattainment purposes). In addition, in 2010, the AQD added NO_2 monitors at Lansing and Houghton Lake to provide background information for modeling applications.

Due to the January 22, 2010, near-roadway monitoring regulations, the EPA deployed two NO_2 sites at Eliza Howell in September 2010. The monitoring of these two sites was taken over by the DEQ in October 2011. Please see the 2013 Annual Network Review document for more details. **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

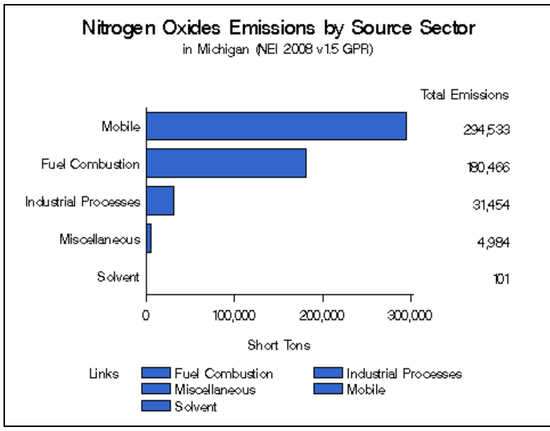
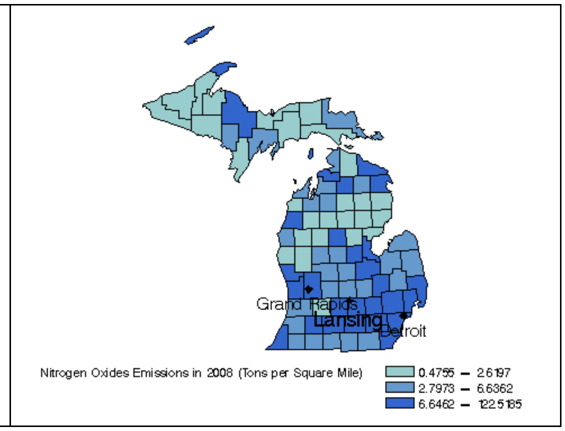
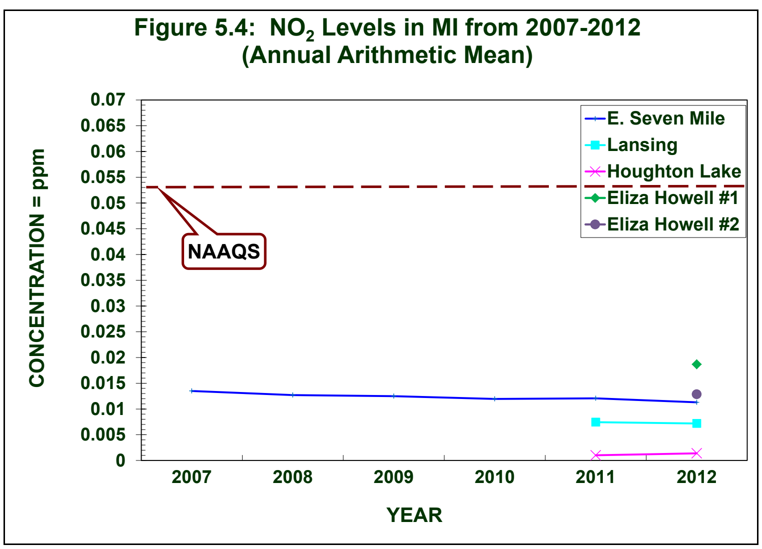


Figure 5.3: NO_2 Emissions in 2008



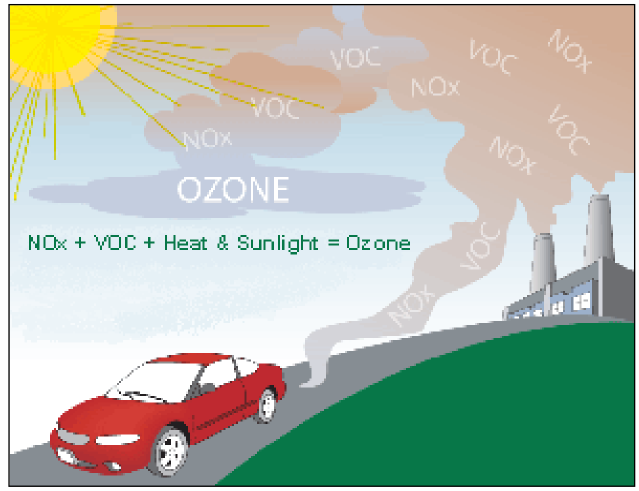
Michigan ambient NO_2 levels have always been well below the NAAQS. Since March 3, 1978, all areas in Michigan have been in attainment for the annual NO_2 NAAQS. As shown in **Figure 5.4**, all monitoring sites have had an annual NO_2 concentration at less than half of the 0.053 ppm NAAQS. As such, the 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 attainment areas.



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 photo-chemical 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:

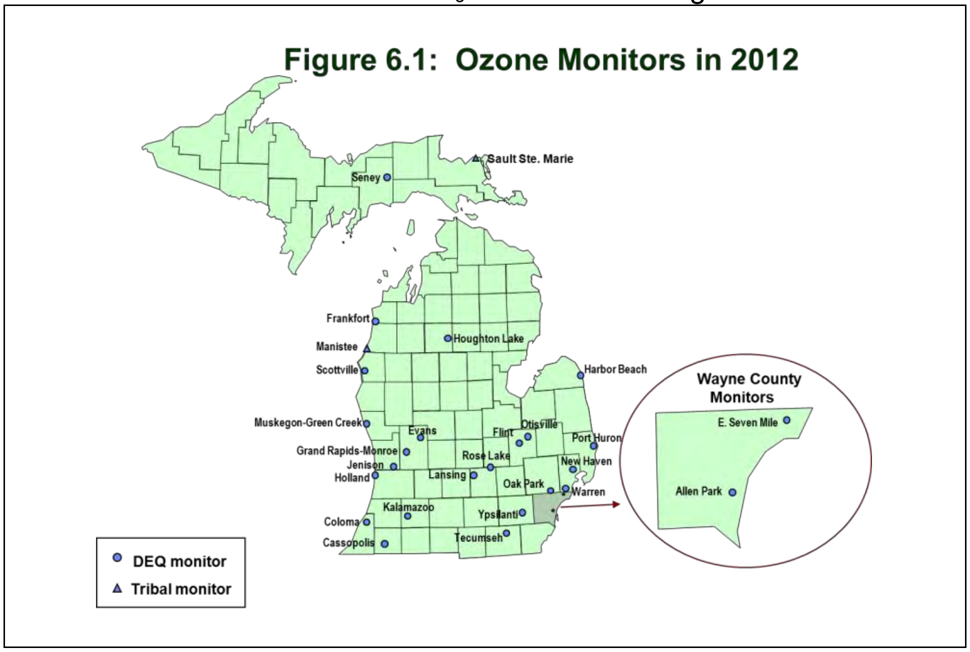


Sources: Major sources of NO_X and VOCs are engine exhaust, emissions from industrial facilities, combustion from power plants, gasoline vapors, chemical solvents, and biogenic emissions from natural sources. Ground-level O_3 can also be transported hundreds of miles under certain wind regimes. As a 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 a person's 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

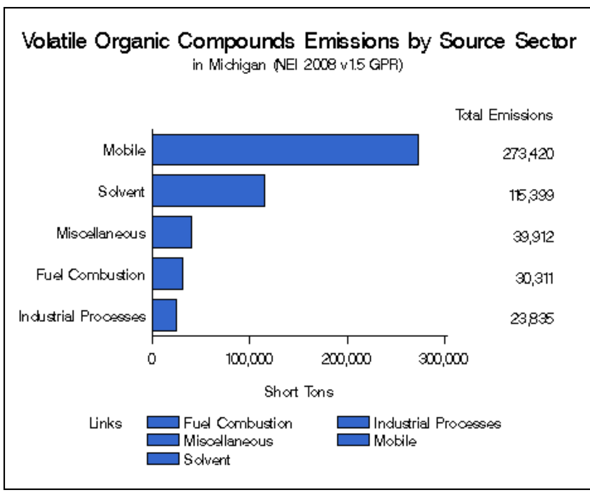
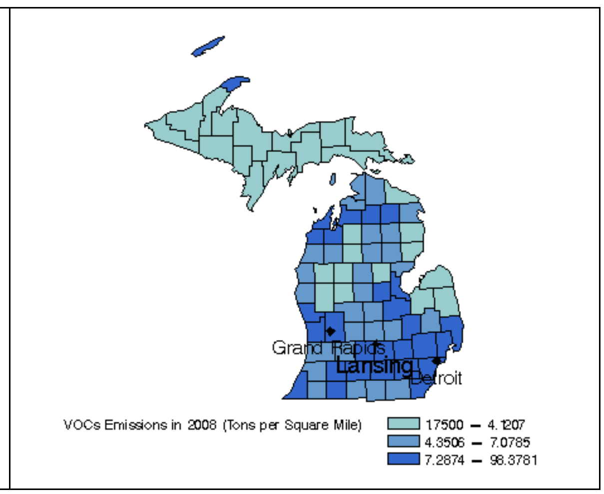


Figure 6.3: VOC Emissions in 2008



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, during which time

O_3 monitoring data is available for the public via the AQD's web site (discussed in **Chapter 9**). This data helps in attainment designation applications, to assess urban air quality, and population exposure.

Table 1.3 in **Chapter 1** shows all 27 O_3 air quality monitors active in Michigan at the beginning of 2012. It is important to note that under the 2006 amended air monitoring regulations, 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, using the most recent three years of data 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.[5]

Table 6.1: Three-year Average of the 4th Highest 8-hour Ozone Values from 2008-2010, 2009-2011, and 2010-2012 (concentrations in ppm).

Areas	County	Monitor Sites	2008-2010	2009-2011	2010-2012
Detroit-Ann Arbor MI	Lenawee	Tecumseh	0.068	0.069	0.076
	Macomb	New Haven	0.074	0.075	0.078
		Warren	0.073	0.076	0.080
	Oakland	Oak Park	0.073	0.075	0.078
	St. Clair	Port Huron	0.071	0.074	0.077
	Washtenaw	Ypsilanti	0.066	0.069	0.076
	Wayne	Allen Park	0.066	0.069	0.074
		E 7 Mile	0.075	0.078	0.081
Flint MI	Genesee	Flint	0.068	0.069	0.076
		Otisville	0.068	0.069	0.074
Grand Rapids, MI	Ottawa	Jenison	0.069	0.073	0.078
	Kent	Grand Rapids	0.067	0.071	0.075
		Evans	0.069	0.071	0.074
Muskegon Co MI	Muskegon	Muskegon	0.074	0.076	0.082
Allegan Co MI	Allegan	Holland	0.074	0.078	0.084
Huron Co MI	Huron	Harbor Beach	0.067	0.068	0.074
Kalamazoo- Battle Creek MI	Kalamazoo	Kalamazoo	0.069	0.071	0.075
Lansing East Lansing MI	Ingham	Lansing	0.068	0.068	0.072
	Clinton	Rose Lake	0.065	0.066	0.071
Benton Harbor MI	Berrien	Coloma	0.071	0.075	0.082
Benzie Co MI	Benzie	Frankfort	0.069	0.070	0.075
Cass Co MI	Cass	Cassopolis	0.070	0.074	0.078
Chippewa Co MI	Chippewa	Sault Ste. Marie	data not available		0.064
Mason Co MI	Mason	Scottville	0.068	0.070	0.076
Missaukee Co MI	Missaukee	Houghton Lake	0.065	0.065	0.070
Manistee Co MI	Manistee	Manistee	0.067	0.069	0.074
Schoolcraft Co MI	Schoolcraft	Seney	0.067	0.068	0.075

[5] Additional information is available in Michigan's 2011 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 monitors exceeded 0.075 ppm. It also specifies in which month they occurred and the temperature range.

Table 6.2

Daily High Temperature Range	2012 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	1	1	8	6	0	0	0	0
90 <= 94	0	0	2	1	7	4	10	4	4	3	0	0
85 <= 89	0	0	4	2	5	1	9	1	9	4	2	0
80 <= 84	0	0	6	1	8	1	3	0	7	0	6	0
75 <= 79	0	0	4	0	5	0	1	0	7	0	7	0
70 <= 74	1	0	4	0	3	0	0	0	2	0	6	0
65 <= 69	5	0	6	0	0	0	0	0	1	0	5	0
60 <= 64	7	0	4	0	0	0	0	0	1	0	3	0
55 <= 59	11	0	1	0	0	0	0	0	0	0	1	0
50 <= 54	4	0	0	0	1	0	0	0	0	0	0	0
49 <=	2	0	0	0	0	0	0	0	0	0	0	0
Totals	**30**	**0**	**31**	**4**	**30**	**7**	**31**	**11**	**31**	**7**	**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.

Table 6.3

Daily High Temperature Range	2012 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	1	1	4	1	6	3	1	1	0	0
90 <= 94	0	0	1	0	5	2	7	1	5	4	0	0
85 <= 89	0	0	3	1	6	1	14	0	7	2	3	0
80 <= 84	0	0	6	1	7	0	3	0	9	0	7	0
75 <= 79	2	0	7	0	4	0	1	0	6	0	2	0
70 <= 74	2	0	6	0	2	0	0	0	3	0	9	0
65 <= 69	0	0	5	0	1	0	0	0	0	0	7	0
60 <= 64	11	0	2	0	1	0	0	0	0	0	1	0
55 <= 59	9	0	0	0	0	0	0	0	0	0	1	0
50 <= 54	3	0	0	0	0	0	0	0	0	0	0	0
49 <=	3	0	0	0	0	0	0	0	0	0	0	0
Totals	**30**	**0**	**31**	**3**	**30**	**4**	**31**	**4**	**31**	**7**	**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.

There were no days in April, four days in May, seven days in June, eleven days in July, seven days in August, and no days in September when ozone exceeded 0.075 ppm at two or more monitors in west Michigan. The respective temperatures for those days were between 70^0F to ≥ 94^0F. There were no days in April, three days in May, four days in June, four days in July, seven days in August, and no days in September when ozone exceeded 0.075 ppm at two or more monitors in southeast Michigan. The respective temperatures for those days were between 80^0F to ≥ 94^0F. **Table 6.4** gives a breakdown of those days and the specific monitors that went over the standard in the western, central/upper, and eastern portions of the state.

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

Date	Monitors			Total
	Western Michigan	Central/Upper Michigan	Eastern Michigan	
05/15/2012	Holland, Coloma, Evans, Jenison		Tecumseh	5
05/18/2012		Seney	Harbor Beach	2
05/19/2012	Holland, Benzonia, Coloma, Cassopolis, Kalamazoo, Grand Rapids, Evans, Muskegon, Jenison Scottville, Manistee	Bath Twp, Lansing, Houghton Lake, Seney	Flint, Otisville, Harbor Beach, Tecumseh, New Haven, Oak Park, Port Huron, Ypsilanti, Allen Park, E-7 Mile	25
05/20/2012	Holland, Benzonia, Muskegon, Scottville, Manistee	Flint, Manistee, Otisville, Seney	Flint, Otisville, Tecumseh, New Haven, Oak Park, Ypsilanti, E-7 Mile	16
05/23/2012			Harbor Beach	1
05/24/2012	Coloma, Muskegon, Scottville	Seney		5
05/28/2012	Muskegon		New Haven, Port Huron, E-7 Mile	4
06/08/2012	Holland, Benzonia, Coloma, Cassopolis, Muskegon, Scottville			6
06/09/2012	Holland, Benzonia, Coloma, Cassopolis, Kalamazoo, Grand Rapids, Evans, Muskegon, Jenison, Scottville, Manistee	Bath Twp, Lansing, Seney	Flint, Otisville, Harbor Beach, Tecumseh, New Haven, Warren, Oak Park, Ypsilanti, E-7 Mile	23
06/10/2012	Evans, Muskegon	Houghton Lake	Flint, Otisville, Tecumseh, New Haven, Warren, Oak Park, Port Huron, Ypsilanti, Allen Park, E-7 Mile	13
06/15/2012	Holland, Benzonia, Coloma, Cassopolis, Kalamazoo, Grand Rapids, Evans, Muskegon, Jenison, Scottville, Manistee	Bath Twp, Lansing, Seney	Flint, Otisville, Harbor Beach, Tecumseh, Oak Park, Ypsilanti	20
06/16/2012	Benzonia, Kalamazoo	Seney		3
06/24/2012	Coloma			1
06/27/2012	Holland, Benzonia, Scottville, Manistee	Seney	Harbor Beach	6
06/28/2012	Holland, Coloma, Cassopolis, Kalamazoo, Grand Rapids, Evans, Muskegon, Jenison	Bath Twp, Lansing	Flint, Otisville, Tecumseh, New Haven, Warren, Oak Park, Port Huron, Ypsilanti, Allen Park, E-7 Mile	20
06/30/2012	Coloma			1
07/01/2012	Holland			1
07/02/2012	Coloma, Cassopolis, Kalamazoo, Grand Rapids	Bath Twp.	Tecumseh, New Haven, Warren, Oak Park, Ypsilanti, E-7 Mile	11
07/03/2012	Holland, Coloma, Cassopolis, Kalamazoo, Grand Rapids, Muskegon, Jenison		Tecumseh	8
07/04/2012	Holland			1
07/05/2012	Holland, Benzonia, Muskegon			3
07/06/2012	Holland, Coloma, Cassopolis, Kalamazoo, Grand Rapids, Evans, Muskegon		Tecumseh, New Haven, Warren, Oak Park, Ypsilanti, E-7 Mile	13
07/12/2012	Holland, Muskegon, Manistee			3
07/13/2012	Holland, Benzonia, Muskegon, Scottville, Manistee	Houghton Lake, Seney	Flint	8
07/14/2012	Holland		Flint	2
07/16/2012	Holland, Benzonia, Coloma, Cassopolis, Evans, Muskegon, Jenison, Scottville, Manistee	Houghton Lake	New Haven, Warren, Allen Park, E-7 Mile	14
07/17/2012	Holland, Coloma, Cassopolis, Muskegon			4
07/21/2012	Holland, Muskegon			2
07/22/2012	Holland, Muskegon		Harbor Beach	3
07/23/2012	Holland, Coloma, Cassopolis, Kalamazoo, Grand Rapids, Evans, Muskegon, Jenison	Bath Twp, Lansing	Flint, Otisville, Harbor Beach, Tecumseh, New Haven, Warren, Oak Park, Port Huron, Ypsilanti, E-7 Mile	20

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

Date	Monitors			Total
	Western Michigan	Central/Upper Michigan	Eastern Michigan	
07/25/2012	Manistee			1
08/02/2012	Coloma, Kalamazoo		New Haven, Warren, Oak Park, Port Huron, E-7 Mile	7
08/03/2012	Holland, Coloma, Cassopolis, Kalamazoo, Evans, Jenison	Bath Twp, Lansing	Flint, Otisville, Tecumseh, New Haven, Warren, Oak Park, Ypsilanti, E-7 Mila	16
08/04/2012	Benzonia, Muskegon			2
08/07/2012	Holland		New Haven, Port Huron, E-7 Mile	4
08/23/2012	Muskegon		Tecumseh, New Haven, Ypsilanti	4
08/24/2012	Holland, Coloma, Kalamazoo, Grand Rapids, Muskegon, Jenison, Manistee	Seney	Flint, Otisville, Harbor Beach, Tecumseh, New Haven, Warren, Oak Park, Ypsilanti, Allen Park, E-7 Mile	18
08/25/2012	Holland, Benzonia, Coloma, Cassopolis, Kalamazoo, Grand Rapids, Muskegon, Jenison, Manistee	Seney	Flint, Otisville, Harbor Beach, New Haven, Ypsilanti, E-7 Mile	16
08/26/2012			Flint	1
08/30/2012	Scottville, Manistee	Seney		3
08/31/2012	Holland, Grand Rapids, Evans, Scottville	Bath Twp, Lansing	Flint, Otisville, New Haven, Port Huron, E-7 Mile	11
09/12/2012	Benzonia			1
			TOTAL	328

May 19 and June 9, 2012, had the most number of monitor readings that exceeded the level of the standard; with 25 and 23 sites, respectively. Two Eastern Michigan monitor sites, New Haven and East 7 Mile, exceeded the level of the standard most often, on 17 and 16 occasions, respectively. Sites with the most exceedances in the western region of Michigan were Holland and Muskegon, with 26 and 23 each. The central/upper Michigan site with the most exceedances was Seney, with 12.

Figure 6.4: O_3 Levels in Detroit-Warren-Flint CSA from 2007-2012, (4th Highest 8-Hour O_3 Values)

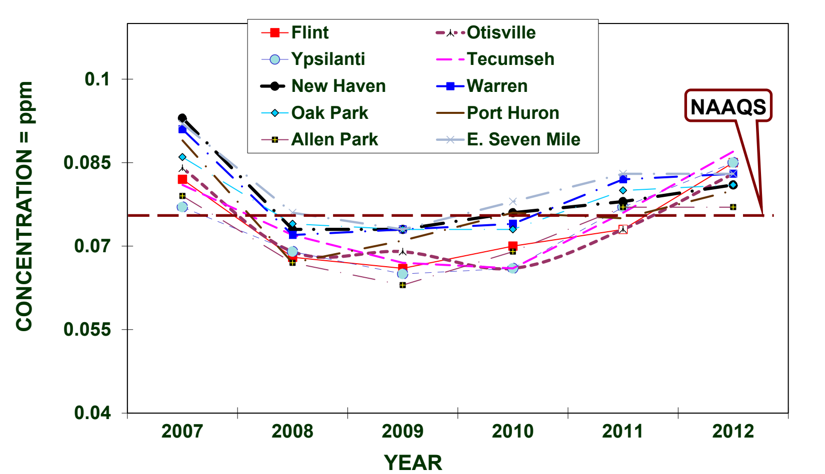
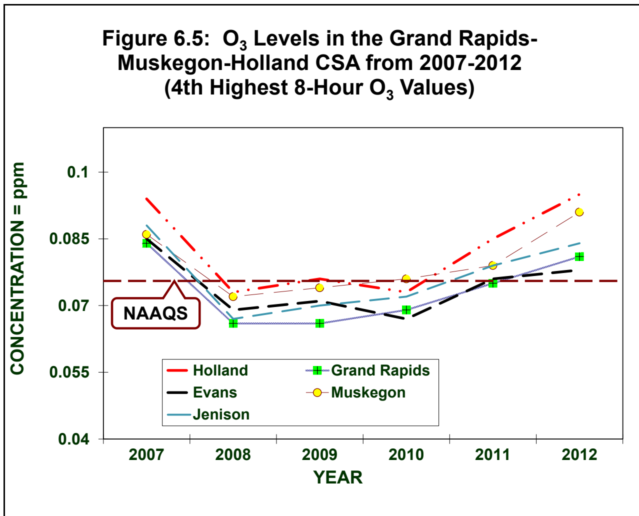
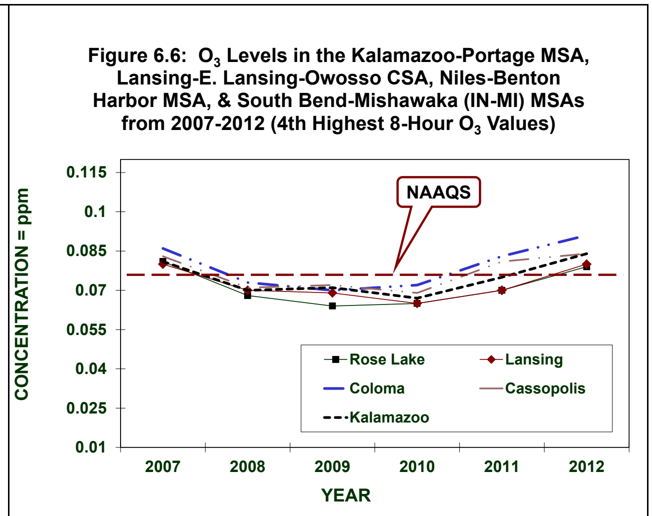


Figure 6.4 shows the 4th highest 8-hour O_3 values for southeast Michigan monitoring sites from 2007-2012. All ten sites during the 2012 monitoring season exceeded 0.075 ppm at least once. Except for Allen Park and Otisville, the other eight sites all violated the 3-year standard.





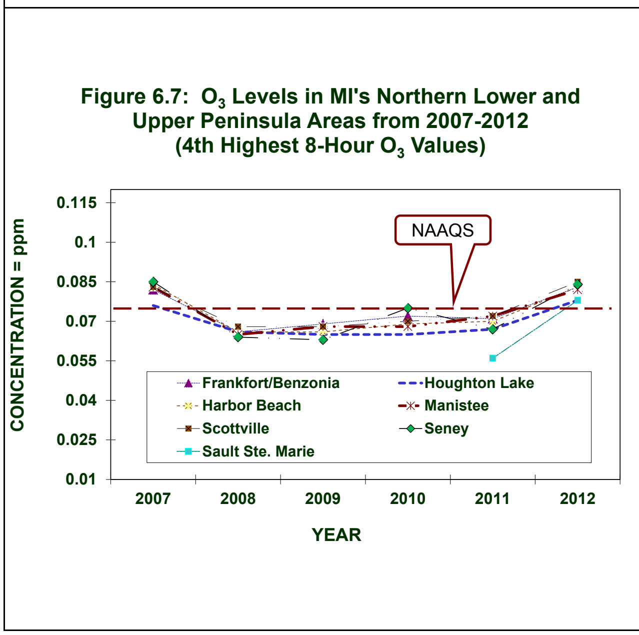


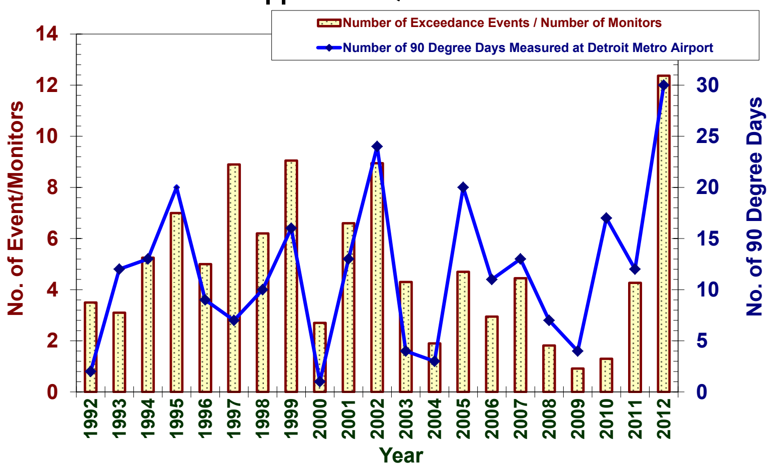
Figure 6.5 shows the 4th highest 8-hour O_3 values for Grand Rapids-Muskegon-Holland CSA. Five sites reached the 0.075 ppm standard during 2012 monitoring season, while just Grand Rapids, Muskegon and Holland violated the 3-year standard.

Figure 6.6 shows 4th highest 8-hour O_3 values for Kalamazoo-Portage MSA. All five sites reached the 0.075 ppm standard and also violated the 3-year standard.

Figure 6.7 shows 4th highest 8-hour O_3 values for Northern Lower Michigan and Upper Peninsula areas. All seven sites reached the 0.075 ppm standard, but only Frankfort and Scottville 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.

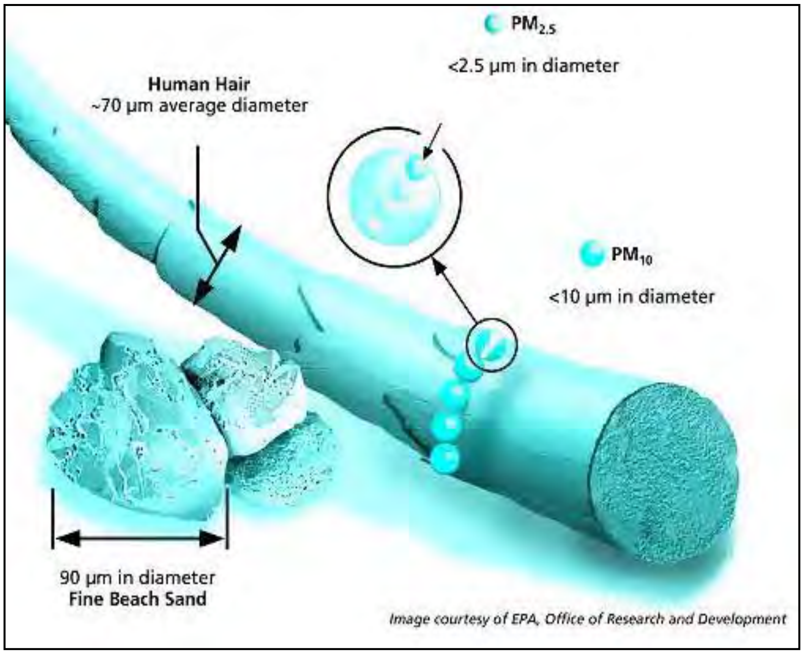
Figure 6.8: 8-Hour O_3 Level Events Exceeding the 0.075 ppm NAAQS from 1992-2012



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 2012, 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 is a general term used for a mixture of solid particles and liquid droplets found in the air, which is further categorized according to size. Large 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 15 µg/m^3, and a 98th percentile 24-hour average of 35 µg/m^3 over three years. Its sources and effects 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.

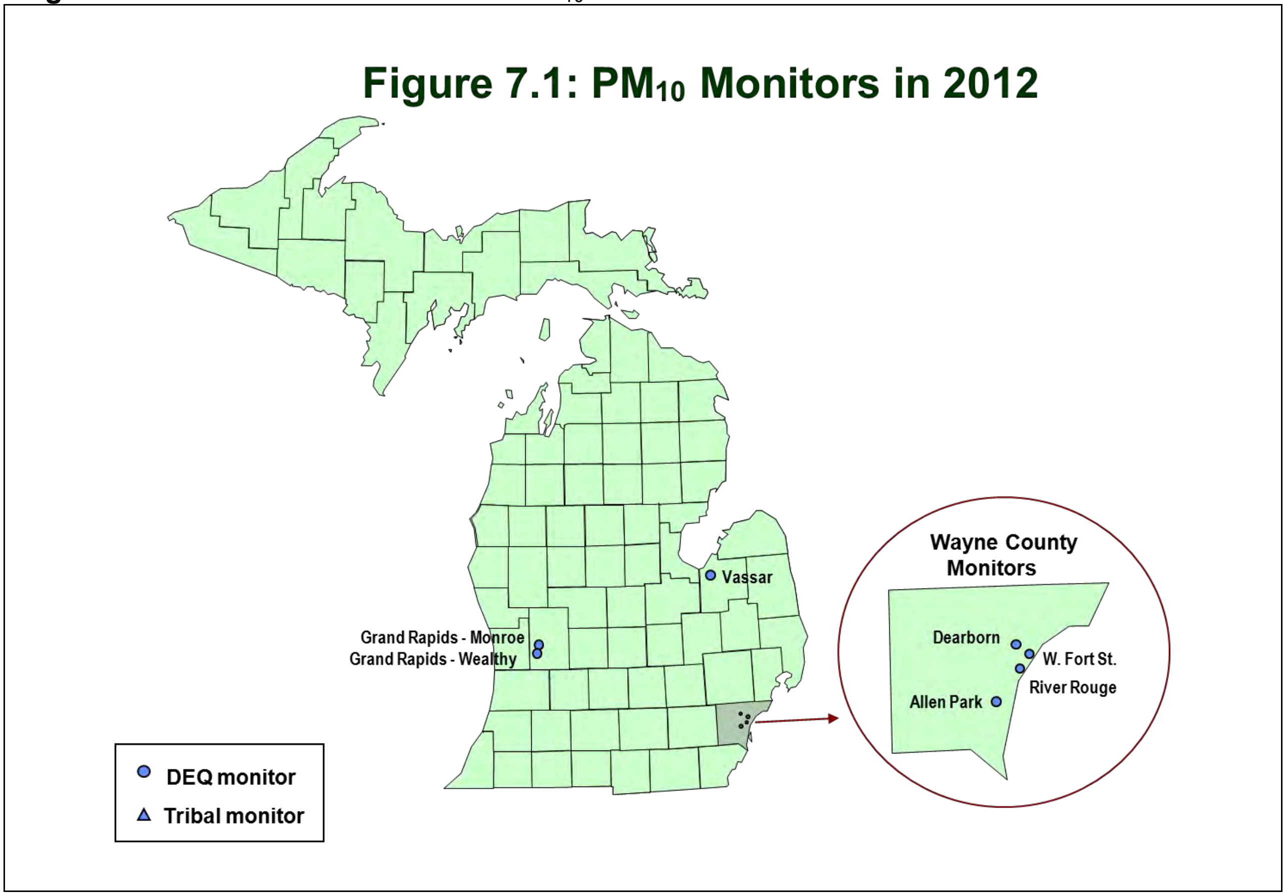
Effects: Exposure to PM affects breathing and the cellular defenses of the lungs, aggravates existing respiratory and cardiovascular ailments, and has been linked with heart and lung disease. Particle size is the major factor that determines which particles will enter the lungs and how deeply the particles 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 2012. 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.



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

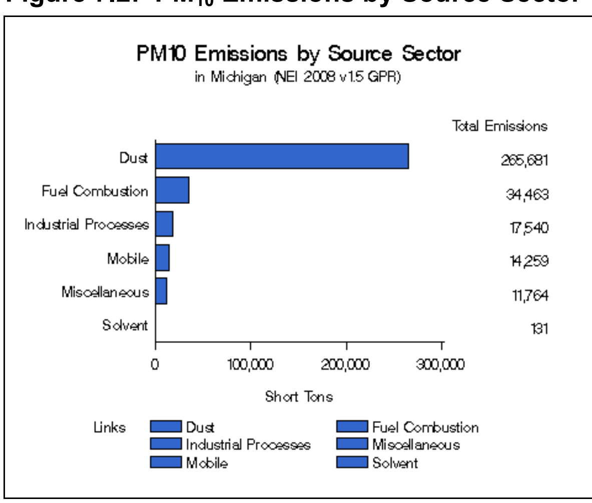


Figure 7.3: PM_{10} Emissions in 2008

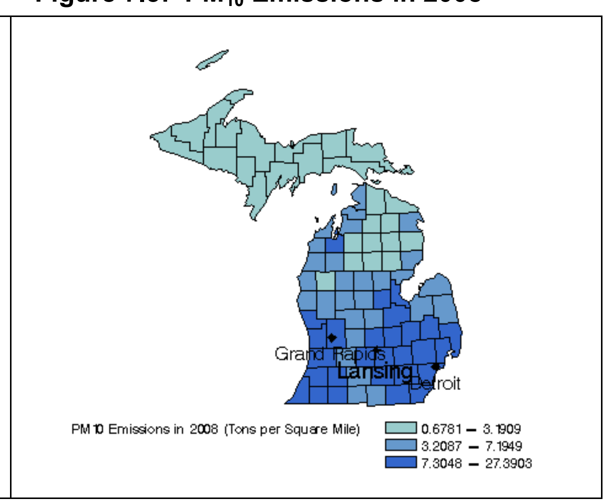
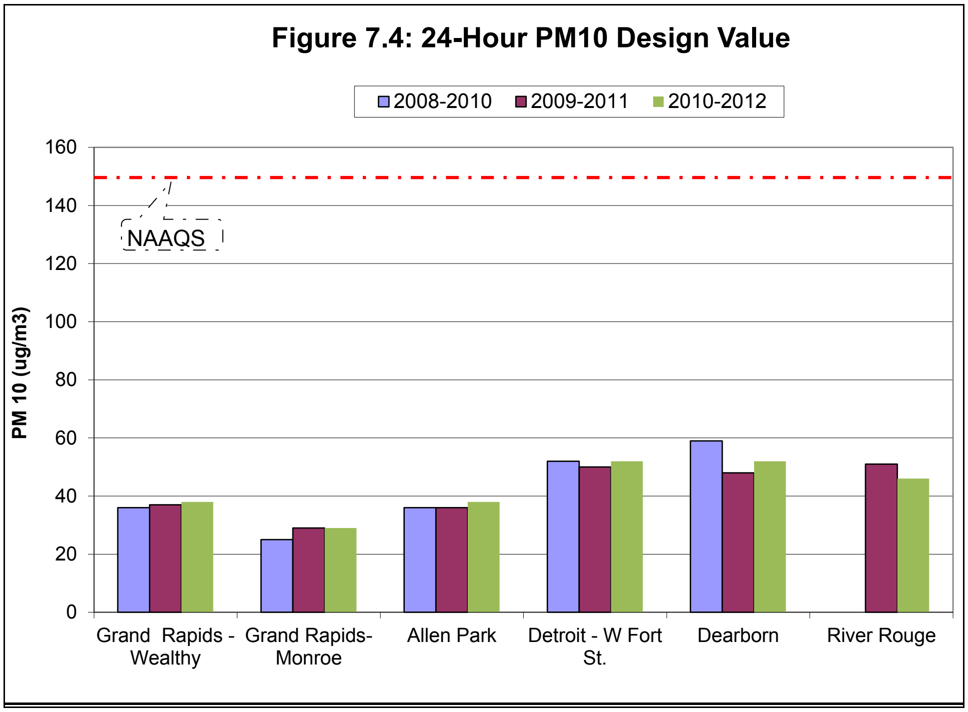


Figure 7.4 shows the PM_{10} levels in Michigan compared to the 24-hour average of 150 µg/m^3. This standard must not be exceeded on average more than once per year over a 3-year period. The design value is the 4th highest value over a 3-year period. The PM_{10} levels at all sites in Michigan are well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



$PM_{2.5}$

All Michigan counties from 2007-2010 met the now old annual $PM_{2.5}$ standard of 15 µg/m^3 and the 24-hour $PM_{2.5}$ standard of 35 µg/m^3. The EPA would have designated Michigan in attainment if, on December 14, 2012, the annual primary standard had not changed 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 $PM_{2.5}$ particulate network consists of the following components, which together provide a picture of the nature of PM within the state:

$PM_{2.5}$ FRM monitoring: The concentrations of $PM_{2.5}$ measured over a 24-hour time period are determined using the 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 (Tapered Element Oscillating Microbalance [TEOM]): 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.

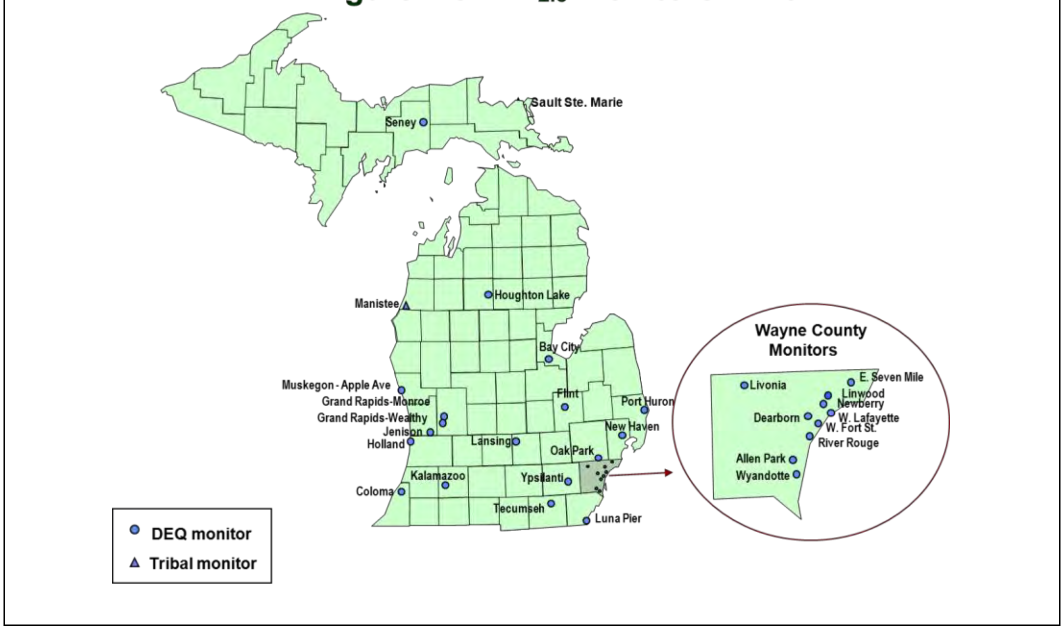


Figure 7.5: $PM_{2.5}$ Monitors in 2012

$PM_{2.5}$ 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. In addition, five $PM_{2.5}$ FRM monitoring sites are co-located with PM_{10} monitors to allow for $PM_{2.5}$ and PM_{10} comparisons[6]. 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 TEOM instruments. At least one continuous TEOM is required at a core monitoring $PM_{2.5}$ site in a metropolitan area with a population greater than one million. Both Detroit (Allen Park) and Grand Rapids (Monroe) meet this requirement[7]. 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, 13 of which also have TEOMS. The DEQ initially operated all TEOM units with an inlet temperature of 50ºC, but this high inlet temperature was volatilizing nitrate levels during the 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 on two types of filters – Teflon and nylon – over a 24-hour period. Each filter is analyzed by a different method to determine various components of $PM_{2.5}$. In 2008, the EPA changed the protocol for the SASS monitors by removing the quartz carbon

[6] 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].

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

channel and replacing it with an URG 3000 N sampler. The Dearborn and the Ypsilanti sites were changed over in 2008. The remaining sites were changed over in 2009. There are eight SASS monitors operating in Michigan; see **Table 1.3.**

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[8], 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 three elemental carbon/organic carbon (EC/OC) monitors in 2012.

- 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 2012, 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. These instruments are located at Dearborn, Detroit-Newberry, and Tecumseh.

$PM_{10-2.5}$

The 2006 amended air monitoring regulations specified that measurements of PM_{10}-$PM_{2.5}$ need to be added to the NCore sites[9]. 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 26 $PM_{2.5}$ FRM monitoring stations operating in 2012 and denotes which sites also have TEOM and/or SASS monitors in operation.

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

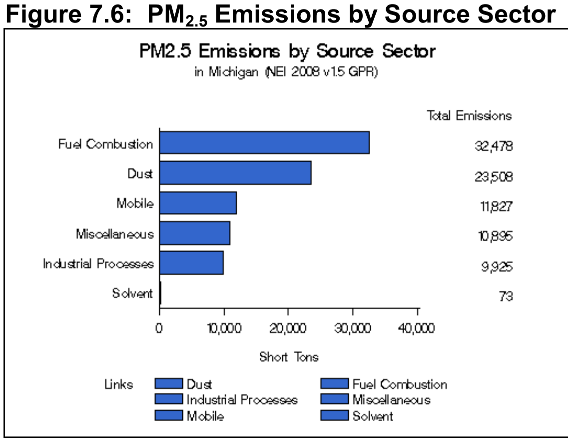
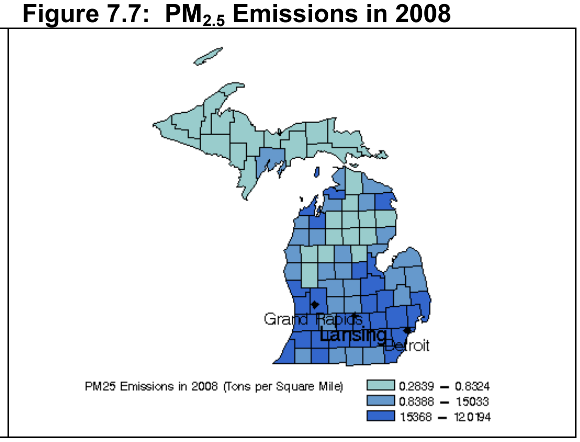


Figure 7.7: $PM_{2.5}$ Emissions in 2008



[8] 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

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

Table 7.1 provides the 2010-2012 annual mean $PM_{2.5}$ concentrations by individual monitoring stations[10]. Stations labeled #2 provide a precision estimate of the overall measurement and operate on a one in six sampling schedule. All other monitors sampled on a one-in-three-day schedule, except for Allen Park #1, which samples daily. The Allen Park #2 was moved to Dearborn #2 in January 2010.

Table 7.1: Three-Year Average of the Annual Mean PM2.5 Concentrations						
Areas	County	Monitoring Sites	2010	2011	2012	2010-2012 Mean
Detroit-Ann Arbor MI	Lenawee	Tecumseh	8.91	9.57	9.00	9.2
	Livingston					
	Macomb	New Haven	8.92	8.61	8.74	8.8
	Oakland	Oak Park	9.12	9.14	9.52	9.3
	St. Clair	Port Huron	8.94	9.14	9.37	9.2
	Washtenaw	Ypsilanti #1	10.91	9.74	9.20	10.0
		Ypsilanti #2	9.40	8.54	9.91	9.3
	Wayne	Allen Park #1	10.23	10.47	10.07	10.3
		Allen Park #2	*			
		Detroit- Linwood	9.85	10.08	10.00	10.0
		Detroit - E 7 Mile	9.89	9.43	9.90	9.7
		Detroit - W Fort	10.67	10.90	11.14	10.9
		Detroit - Newberry	10.04	10.59	10.00	10.2
		Detroit - W. Lafayette	10.05	10.49	10.14	10.2
		Wyandotte	9.36	8.93	9.31	9.2
		Dearborn #1	11.33	11.21	11.89	11.5
		Dearborn #2		11.23	12.30	11.8
		Livonia	9.16	9.47	9.62	9.4
Flint MI	Genesee	Flint	8.88	8.45	7.98	8.4
	Lapeer					
Grand Rapids, MI	Ottawa	Jenison	9.15	9.13	8.98	9.1
	Kent	Grand Rapids-Wealthy	9.63	9.46	9.64	9.6
		Grand Rapids #1	9.62	9.47	9.33	9.5
		Grand Rapids #2	10.04	9.25	9.36	9.6
Muskegon Co MI	Muskegon	Muskegon	8.26	8.40	8.81	8.5
Allegan Co MI	Allegan	Holland	8.50	8.44	8.51	8.5
Monroe Co MI	Monroe	Luna Pier	9.36	9.98	9.40	9.6
Kalamazoo- Battle Creek MI	Calhoun					
	Kalamazoo	Kalamazoo #1	9.31	9.01	9.52	9.3
		Kalamazoo #2	9.19	8.85	10.04	9.4
	Van Buren					
Lansing East Lansing MI	Ingham	Lansing	8.98	8.65	8.65	8.8
	Clinton					
	Eaton					
Benton Harbor MI	Berrien	Coloma	8.74	8.71	8.71	8.7
Bay Co MI	Bay	Bay City	8.16	7.67	7.73	7.9
Missaukee Co MI	Missaukee	Houghton Lake	5.94	6.16	5.92	6.0
Manistee Co MI	Manistee	Manistee	6.61	6.39	7.16	6.7
Chippewa Co MI	Chippewa	Sault Ste. Marie #1		6.37	6.30	
Chippewa Co MI	Chippewa	Sault Ste. Marie #2		6.53	6.37	

* moved to Dearborn

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

Table 7.2 is a detailed assessment of the 24-hour 98th percentile $PM_{2.5}$ concentrations for 2010-2012 showing Michigan's levels are below the 35 µg/m^3 standard (3-year average)[11].

Table 7.2: 98th Percentile PM2.5 Values Averaged over 3 Years						
Areas	County	Monitoring Sites	2010	2011	2012	2010-2012 Mean
Detroit-Ann Arbor MI	Lenawee	Tecumseh	22.3	23.9	26.6	24.3
	Livingston					
	Macomb	New Haven	25.5	24.1	22.2	23.9
	Oakland	Oak Park	27.1	23.4	25.2	25.2
	St. Clair	Port Huron	25.8	23.7	22.3	23.9
	Washtenaw	Ypsilanti #1	23.3	23.9	22.6	23.3
		Ypsilanti #2	22.4	18.8	21.8	21.0
	Wayne	Allen Park #1	27.8	25.3	23.2	25.4
		Allen Park #2	*			
		Detroit- Linwood	27.9	24.8	24.6	25.8
		Detroit - E 7 Mile	28.6	24.0	32.5	28.4
		Detroit - W Fort	26.6	25.1	24.5	25.4
		Detroit - Newberry	30.4	24.9	24.3	26.5
		Detroit - W. Lafayette	27.7	25.3	24.0	25.7
		Wyandotte	24.4	21.4	20.9	22.2
		Dearborn #1	28.6	29.9	24.3	27.6
		Dearborn #2	31.5	26.1	25.5	27.7
		Livonia	25.3	22.8	22.7	23.6
Flint MI	Genesee	Flint	24.7	20.7	21.2	22.2
	Lapeer					
Grand Rapids, MI	Ottawa	Jenison	22.7	23.5	27.2	24.5
	Kent	Grand Rapids-Wealthy	22.4	22.6	28.9	24.6
		Grand Rapids #1	24.3	22.8	26.0	24.4
		Grand Rapids #2	24.3	21.8	21.7	22.6
Muskegon Co MI	Muskegon	Muskegon	23.4	22.2	23.9	23.2
Allegan Co MI	Allegan	Holland	24.6	25.6	23.4	24.5
Monroe Co MI	Monroe	Luna Pier	26.3	23.5	23.7	24.5
Kalamazoo- Battle Creek MI	Calhoun					
	Kalamazoo	Kalamazoo #1	21.5	20.3	26.5	22.8
		Kalamazoo #2	20.8	17.4	24.5	20.9
	Van Buren					
Lansing East Lansing MI	Ingham	Lansing	23.7	20.6	24.3	22.9
	Clinton					
	Eaton					
Benton Harbor MI	Berrien	Coloma	23.3	20.5	21.6	21.8
Bay Co MI	Bay	Bay City	31.1	20.9	22	24.7
Missaukee Co MI	Missaukee	Houghton Lake	17.6	17.8	15.4	16.9
Manistee Co MI	Manistee	Manistee	21.9	17.5	16.8	18.7
Chippewa Co MI	Chippewa	Sault Ste. Marie #1		18.3	16.6	
Chippewa Co MI	Chippewa	Sault Ste. Marie #2		17.0	15.7	

*moved to Dearborn

[11] 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, which are currently designated as nonattainment for the $PM_{2.5}$ NAAQS, 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: Detroit-Warren-Flint CSA - (Wayne County Only) Annual Arithmetic Means for $PM_{2.5}$ from 2007-2012

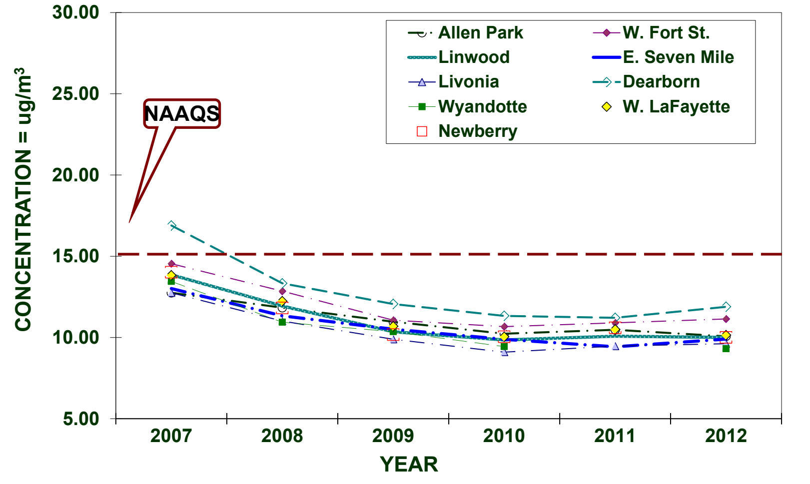


Figure 7.8 shows that 2012 levels in Wayne County remained below the standard. Historically, Dearborn has had the highest readings in the state.

Figure 7.9: Detroit-Warren-Flint CSA (without Wayne County) Annual Arithmetic Means for $PM_{2.5}$ from 2007-2012

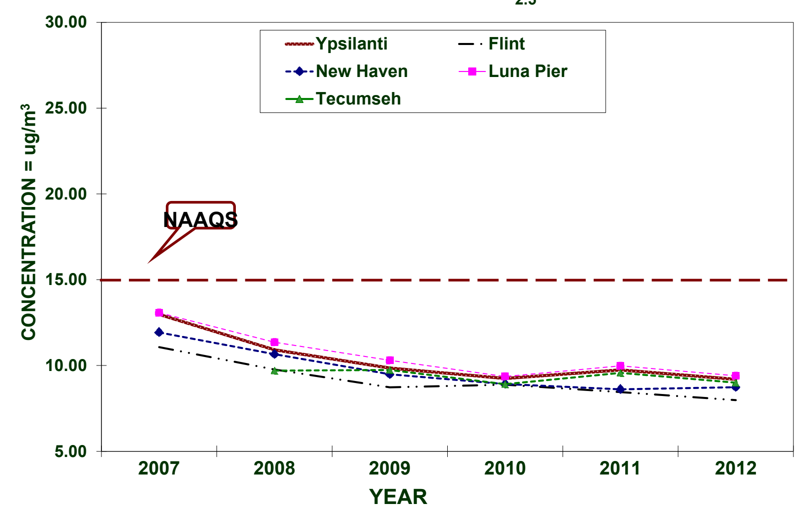


Figure 7.9 contains the remainder of those sites in the Detroit-Warren-Flint CSA that are outside of Wayne County. These sites also show readings in 2012 to be below the $PM_{2.5}$ NAAQS.

Figure 7.10: West MI - Grand Rapids-Muskegon-Holland CSA, Kalamazoo & Benton Harbor MSAs Annual Arithmetic Means for $PM_{2.5}$ from 2007-2012

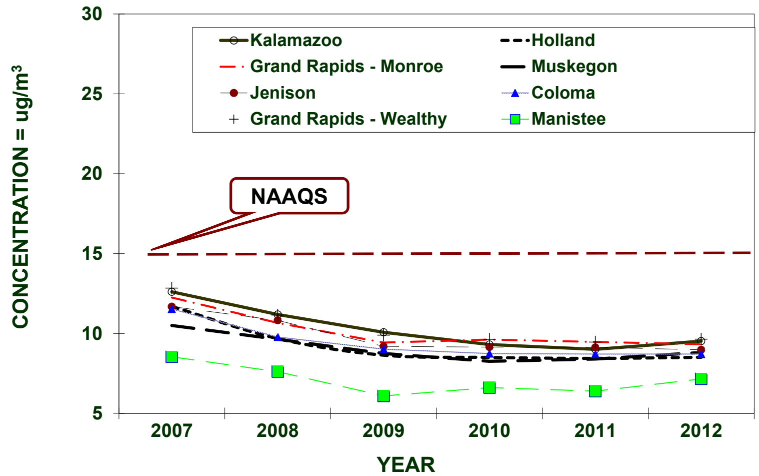


Figure 7.10 combines the $PM_{2.5}$ monitoring sites located in West Michigan-Grand Rapids-Muskegon-Holland CSA, Kalamazoo and Benton Harbor MSAs. All sites have been below the annual $PM_{2.5}$ NAAQS since 2004.

Figure 7.11: Lansing-E. Lansing CSA, Saginaw-Bay City CSA, Traverse City MiSA, & Cadillac MiSA Annual Arithmetic Means for $PM_{2.5}$ from 2007-2012

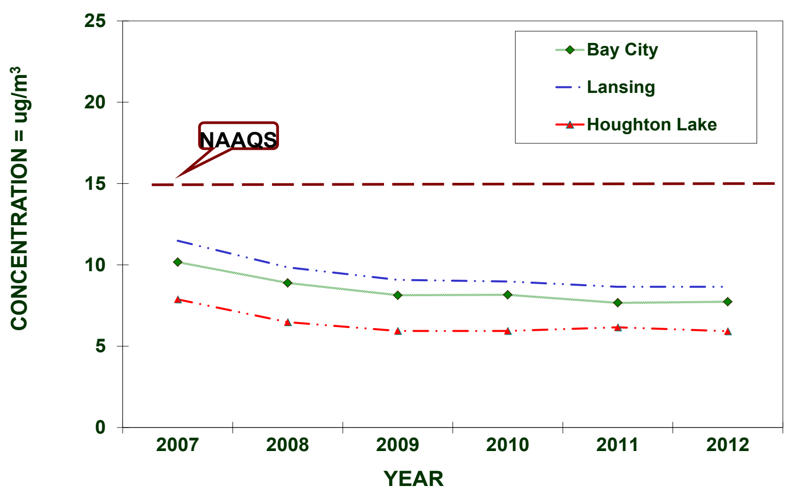


Figure 7.11 displays the remaining monitoring sites in the Lower Peninsula. All of these sites have 2012 levels well below the standard.

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 188 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, indoor, and 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 (aldehydes and ketones);
  - 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).[12]

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 2012. This table can also be found in **Appendix B** with the Air Toxics Monitoring Summary.

Table 8.1: 2012 Toxics Sampling Sites

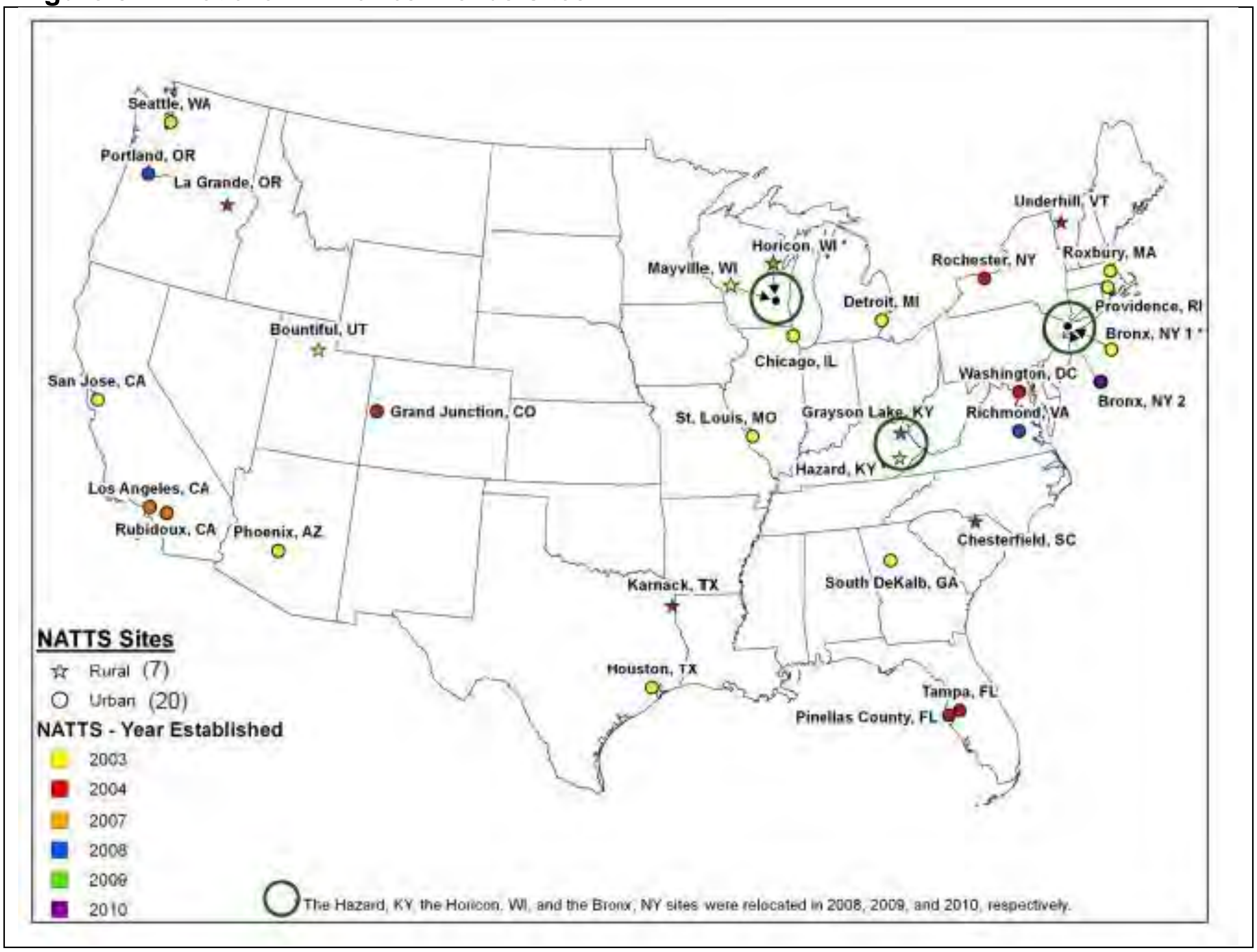
SITE NAME	VOC	Carbonyl	PAHs	Metals TSP	Metals PM_{10}	Hex Chrome	Speciated $PM_{2.5}$
Allen Park				x	x		x
Dearborn	x	x	x	x	x	x	x
Detroit W. Fort St	x	x		x	Mn		x
Detroit W. Jefferson				x			
Flint				Mn			
Grand Rapids				x			x
Belding- Merrick St.				x			
Belding- Reed St.				x			
Vassar				x	x		
East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

[12] 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 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 generally falls in the Good or Moderate range. An area will occasionally fall into the Unhealthy for Sensitive Groups range, but rarely reaches Unhealthy levels.

MIair also has an 'Actions to Protect Health' link: http://www.deqmiair.org/assets/AQIActionsToProtectHealth_2011.pdf which helps as an activity recommendations guide during the above 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 ($\mu g/m^3$) 24-Hour	OZONE (ppm) 8-Hour / 1-Hour	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, older adults, and children should reduce prolonged or heavy exertion.	Active children and adults, and people with lung disease such as asthma, should reduce prolonged or heavy outdoor exertion.	People with cardiovascular 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, older adults, and children should avoid prolonged or heavy exertion. Everyone else should limit prolonged exertion.	Active children and adults, and people with lung disease such as asthma, should avoid pro-longed or heavy exertion. Everyone else, especially children, should reduce prolonged outdoor exertion.	People with cardiovascular disease, such as angina, should limit moderate exertion and avoid sources of CO, such as heavy traffic.	Children, asthmatics, and people with heart or lung disease should limit outdoor exertion.	None
PURPLE: Very Unhealthy 201-300	People with heart or lung disease, older adults, and children should avoid all physical activity outdoors. Everyone else should avoid prolonged or heavy exertion.	Active children and adults, and people with respiratory disease such as asthma, should avoid all outdoor exertion. Everyone else, especially children should limit outdoor exertion.	People with cardiovascular 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 else should limit outdoor exertion.	Children and people with respiratory disease, such as asthma, should limit heavy outdoor exertion.
MAROON: Hazardous 301-500	Everyone should avoid any outdoor exertion; people with heart or lung disease, older adults, and children should remain indoors.	Everyone should avoid all outdoor exertion.	People with cardiovascular 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. Every-one else should avoid outdoor exertion.	Children and people with respiratory disease, such as asthma, should limit moderate or heavy 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 2012.

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

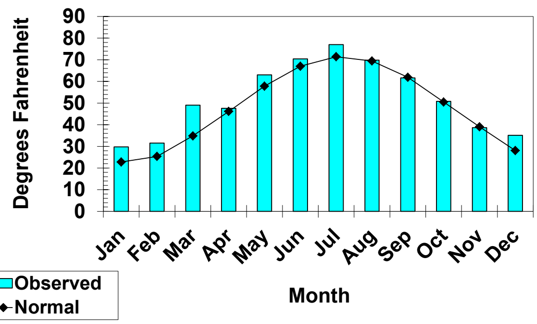


Figure 10.2: Northern Lower Peninsula Observed Average Daily Temperatures vs. Normal Average Daily Temperatures

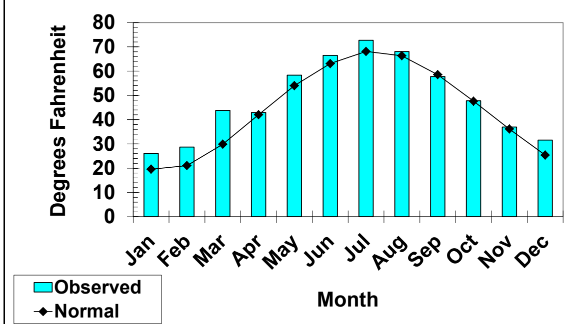


Figure 10.3: Upper Peninsula Observed Average Daily Temperatures vs. Normal Average Daily Temperatures

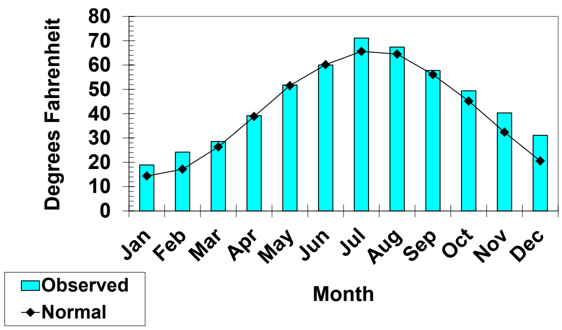


Figure 10.4: Southern Lower Peninsula Observed Monthly Precipitation vs. Normal Monthly Precipitation

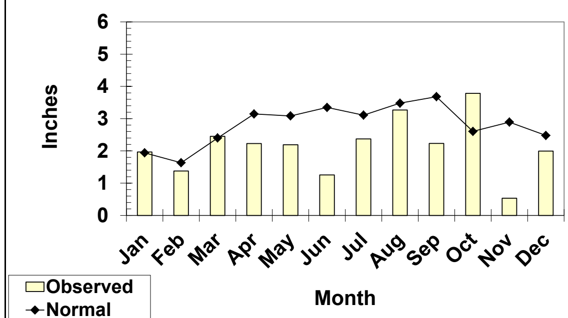


Figure 10.5: Northern Lower Peninsula Observed Monthly Precipitation vs. Normal Monthly Precipitation

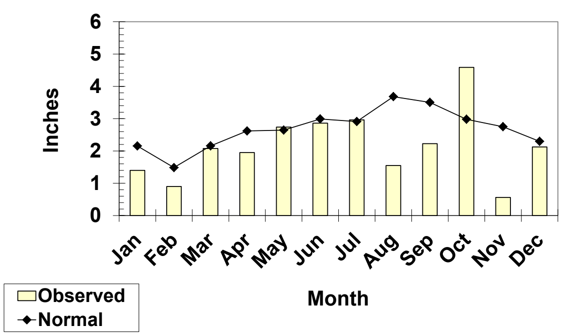
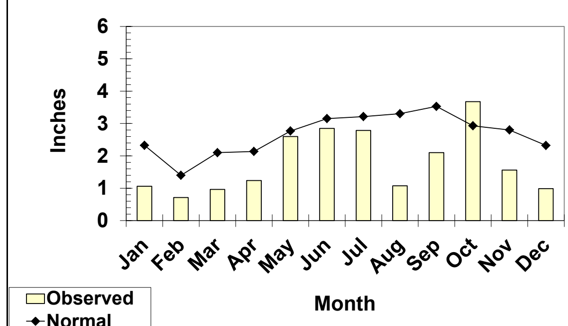


Figure 10.6: Upper Peninsula Observed Monthly Precipitation vs. Normal Monthly Precipitation



The weather plays a significant role in air quality, and can either help increase or decrease the amount of pollution in the air. *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 25 *Action!* Days declared during the summer of 2012.

Table 10.1: *Action!* Days declared during the summer of 2012

Location	Year	Number	Dates
Ann Arbor	2012	21	5/24, 5/27, 6/10, 6/15, 6/16, 6/20, 6/28, 6/29, 7/2, 7/3, 7/4, 7/5, 7/6, 7/7, 7/13, 7/16, 8/4, 8/24, 8/25, 8/26, 8/31
Benton Harbor	2012	21	5/24, 5/27, 6/9, 6/10, 6/16, 6/28, 6/29, 7/2, 7/3, 7/4, 7/5, 7/6, 7/7, 7/13, 7/15, 7/16, 7/17, 8/4, 8/24, 8/25, 8/31
Detroit	2012	21	5/24, 5/27, 6/10, 6/15, 6/16, 6/20, 6/28, 6/29, 7/2, 7/3, 7/4, 7/5, 7/6, 7/7, 7/13, 7/16, 8/4, 8/24, 8/25, 8/26, 8/31
Flint	2012	9	6/10, 6/15, 6/16, 6/28, 7/13, 8/4, 8/24, 8/25, 8/26
Grand Rapids	2012	25	5/24, 5/27, 6/9, 6/10, 6/15, 6/16, 6/19, 6/20, 6/28, 6/29, 7/2, 7/3, 7/4, 7/5, 7/6, 7/7, 7/13, 7/15, 7/16, 7/17, 8/4, 8/24, 8/25, 8/30, 8/31
Kalamazoo	2012	2	6/28, 8/31
Lansing	2012	1	6/28
Ludington	2012	18	5/24, 5/27, 6/9, 6/10, 6/15, 6/16, 6/20, 6/28, 7/2, 7/3, 7/4, 7/5, 7/6, 7/13, 7/16, 8/24, 8/25, 8/30

In **Figure 10.7**, one can see that Michigan had a warm front passing over the Lower Peninsula, with an occluded front to the north in the Upper Peninsula and Canada. Temperatures that day were record highs in the lower 90s with 40-60 percent humidity. Winds north of the front were calm, with very moderate southwesterly winds and scattered cloud cover south of the front. The weather conditions in the morning in southeast Michigan were equally hot and humid, with temperatures in the upper 80s, broken cloud coverage, and moderate southerly winds in the Lower Peninsula and easterly winds in the Upper Peninsula.

Figure 10.7: Surface Map of Weather Conditions on June 28, 2012

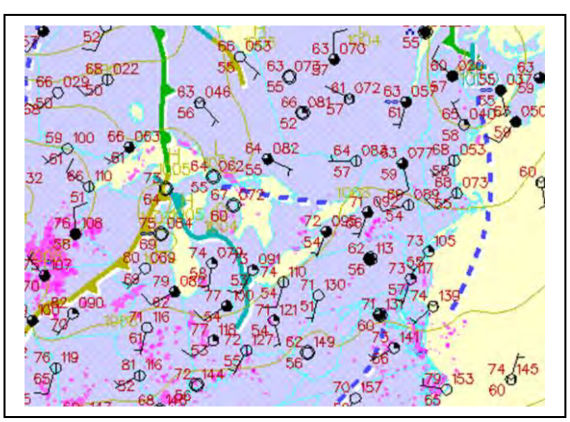


Figure 10.7 shows a surface map (courtesy of Unisys Weather: http://weather.unisys.com/) of the weather conditions on the evening of June 28, 2012.

APPENDIX A: CRITERIA POLLUTANT SUMMARY FOR 2012

Appendix A utilizes EPA's 2012 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 and has replaced the MASN number.

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 excursions 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 excursion 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 2012

Trace CO Measured in ppm

Site ID	POC	City	County	Year	# OBS	1-hr Highest Value	1-hr 2nd Highest Value	# > 35	8-hr Highest Value	8-hr 2nd Highest Value	# > 9
260810020	1	Grand Rapids	Kent	2012	6422	2.4	2.1	0	1.5	1.4	0
261630001	1	Allen Park	Wayne	2012	8155	2.3	2.1	0	1.3	1.2	0
261630093	1	Eliza Howell #1	Wayne	2012	7392	2.9	2.7	0	2.4	2.3	0
261630094	1	Eliza Howell #2	Wayne	2012	6941	2.6	2.6	0	2.5	2.2	0

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

Site ID	POC	City	County	Year	# OBS	Highest rolling 3-month Arith Mean	2nd Highest rolling 3-month Arith Mean	3rd Highest rolling 3-month Arith Mean	4th Highest rolling 3-month Arith Mean	# 3-month Means > .15	Highest Value (24 hr)	2nd Highest Value (24hr)
260290011	1	East Jordan	Charlevoix	2012	53	0.01	0.01	0.01	0.01	0	0.039	0.025
260670002	1	Belding- Reed St.	Ionia	2012	61	0.05	0.05	0.04	0.04	0	0.230	0.170
260670003	1	Belding- Merrick St.	Ionia	2012	61	0.06	0.05	0.05	0.05	0	0.169	0.156
260810020	1	Grand Rapids	Kent	2012	58	0.01	0.01	0.00	0.00	0	0.012	0.009
261250013	1	Oakland Co. Int'l Airport	Oakland	2012	37	0.02	0.02	0.02	0.02	0	0.088	0.057
261470031	1	Port Huron Rural St.	St. Clair	2012	10	Insufficient data to calculate 3-month mean.					0.099	0.030
261570001	1	Vassar	Tuscola	2012	61	0.03	0.03	0.03	0.03	0	0.201	0.185
261630001	1	Allen Park	Wayne	2012	60	0.01	0.00	0.00	0.00	0	0.011	0.010
261630033	1	Dearborn	Wayne	2012	60	0.01	0.01	0.01	0.01	0	0.044	0.036

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	2012	7996	46.0	39.0	7.19
261130001	1	Houghton Lake	Missaukee	2012	7581	17.0	16.0	1.39
261630019	2	Detroit - E. Seven Mile	Wayne	2012	8332	54.0	54.0	11.29
261630093	1	Eliza Howell #1	Wayne	2012	7575	78.0	55.0	18.67
261630094	1	Eliza Howell #2	Wayne	2012	8460	51.0	47.0	12.86

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	2012	7436	373.7	299.0	17.43
261630001	1	Allen Park	Wayne	2012	7066	262.4	257.5	22.80

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	2012	177	193	0.135	0.115	0.112	0.112	1	1	0
260190003	1	Benzonia	Benzie	2012	182	183	0.095	0.094	0.086	0.086	0	0	1
260210014	1	Coloma	Berrien	2012	183	183	0.149	0.124	0.116	0.114	1	1	0
260270003	2	Cassopolis	Cass	2012	176	183	0.127	0.123	0.096	0.093	1	1	1
260330901	1	Sault Ste. Marie	Chippewa	2012	180	183	0.088	0.087	0.087	0.083	0	0	3
260370001	2	Rose Lake	Clinton	2012	177	183	0.100	0.095	0.092	0.085	0	0	1
260490021	1	Flint	Genesee	2012	183	183	0.111	0.097	0.096	0.095	0	0	1
260492001	1	Otisville	Genesee	2012	182	183	0.107	0.100	0.099	0.092	0	0	1
260630007	1	Harbor Beach	Huron	2012	183	183	0.107	0.106	0.101	0.096	0	0	0
260650012	2	Lansing	Ingham	2012	182	183	0.091	0.091	0.091	0.086	0	0	1
260770008	1	Kalamazoo	Kalamazoo	2012	183	183	0.107	0.101	0.097	0.095	0	0	0
260810020	1	Grand Rapids	Kent	2012	183	183	0.101	0.097	0.097	0.089	0	0	0
260810022	1	Evans	Kent	2012	183	183	0.107	0.095	0.093	0.090	0	0	0
260910007	1	Tecumseh	Lenawee	2012	178	183	0.117	0.108	0.099	0.095	0	0	0
260990009	1	New Haven	Macomb	2012	182	183	0.123	0.098	0.096	0.094	0	0	0
260991003	1	Warren	Macomb	2012	172	183	0.118	0.092	0.092	0.089	0	0	2
261010933	1	Manistee	Manistee	2012	181	183	0.098	0.089	0.089	0.088	0	0	2
261050007	1	Scottville	Mason	2012	183	183	0.103	0.097	0.094	0.089	0	0	0
261130001	1	Houghton Lake	Missaukee	2012	181	183	0.089	0.087	0.087	0.084	0	0	0
261210039	1	Muskegon	Muskegon	2012	183	183	0.119	0.110	0.106	0.105	0	0	0
261250001	2	Oak Park	Oakland	2012	182	183	0.114	0.095	0.094	0.093	0	0	1
261390005	1	Jenison	Ottawa	2012	182	183	0.115	0.101	0.093	0.092	0	0	1
261470005	1	Port Huron	St .Clair	2012	183	183	0.119	0.090	0.087	0.087	0	0	0
261530001	1	Seney	Schoolcraft	2012	178	183	0.103	0.099	0.097	0.092	0	0	3
261610008	1	Ypsilanti	Washtenaw	2012	183	183	0.106	0.094	0.094	0.093	0	0	0
261630001	2	Allen Park	Wayne	2012	175	183	0.087	0.086	0.085	0.082	0	0	4
261630019	2	Detroit - E. Seven Mile	Wayne	2012	181	183	0.132	0.094	0.093	0.092	1	1	1

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	2012	97	177	0.103	0.102	0.101	0.095	26
260190003	1	Benzonia	Benzie	2012	99	182	0.084	0.084	0.083	0.083	13
260210014	1	Coloma	Berrien	2012	100	183	0.113	0.105	0.105	0.091	19
260270003	2	Cassopolis	Cass	2012	96	175	0.108	0.106	0.086	0.084	13
260330901	1	Sault Ste. Marie	Chippewa	2012	95	173	0.084	0.083	0.081	0.078	6
260370001	2	Rose Lake	Clinton	2012	96	176	0.092	0.086	0.085	0.079	9
260490021	1	Flint	Genesee	2012	100	183	0.094	0.091	0.086	0.085	14
260492001	1	Otisville	Genesee	2012	99	181	0.090	0.087	0.085	0.083	11
260630007	1	Harbor Beach	Huron	2012	100	183	0.096	0.094	0.094	0.083	10
260650012	2	Lansing	Ingham	2012	99	182	0.084	0.083	0.081	0.080	8
260770008	1	Kalamazoo	Kalamazoo	2012	99	182	0.102	0.093	0.085	0.084	13

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
260810020	1	Grand Rapids	Kent	2012	99	182	0.089	0.082	0.082	0.081	11
260810022	1	Evans	Kent	2012	99	181	0.085	0.084	0.083	0.078	11
260910007	1	Tecumseh	Lenawee	2012	97	177	0.100	0.099	0.089	0.087	14
260990009	1	New Haven	Macomb	2012	99	181	0.107	0.089	0.081	0.081	17
260991003	1	Warren	Macomb	2012	93	170	0.097	0.087	0.083	0.083	10
261010922	1	Manistee	Manistee	2012	98	179	0.084	0.083	0.082	0.082	12
261050007	1	Scottville	Mason	2012	99	182	0.088	0.088	0.088	0.085	10
261130001	1	Houghton Lake	Missaukee	2012	98	180	0.084	0.083	0.080	0.078	6
261210039	1	Muskegon	Muskegon	2012	100	183	0.103	0.094	0.093	0.091	23
261250001	2	Oak Park	Oakland	2012	93	171	0.102	0.088	0.085	0.081	12
261390005	1	Jenison	Ottawa	2012	99	182	0.090	0.086	0.084	0.084	12
261470005	1	Port Huron	St .Clair	2012	100	183	0.107	0.083	0.081	0.080	8
261530001	1	Seney	Schoolcraft	2012	97	177	0.091	0.089	0.089	0.084	12
261610008	1	Ypsilanti	Washtenaw	2012	100	183	0.091	0.088	0.085	0.085	13
261630001	2	Allen Park	Wayne	2012	96	176	0.095	0.078	0.078	0.077	5
261630019	2	Detroit - E. Seven Mile	Wayne	2012	99	182	0.113	0.087	0.085	0.083	16

$PM_{2.5}$ (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	2012	122	31.4	24.5	23.4	20.8	23.4	8.51
260170014	1	FRM	Bay City	Bay	2012	118	28.3	27.2	22.0	18.9	22.0	7.73
260210014	1	FRM	Coloma	Berrien	2012	119	29.3	28.1	21.6	21.5	21.6	8.71
260330901	1	FRM	Sault Ste. Marie	Chippewa	2012	113	20.1	17.6	16.6	15.6	16.6	6.30
260330901	2	FRM	Sault Ste. Marie	Chippewa	2012	35	15.7	14.2	14.0	13.1	15.7	6.37*
260490021	1	FRM	Flint	Genesee	2012	120	25.7	23.1	21.2	17.2	21.2	7.98
260650012	1	FRM	Lansing	Ingham	2012	119	30.0	25.4	24.3	21.4	24.3	8.65
260770008	1	FRM	Kalamazoo	Kalamazoo	2012	121	30.0	27.5	26.5	26.2	26.5	9.52
260770008	2	FRM	Kalamazoo	Kalamazoo	2012	58	26.2	24.5	21.6	18.8	24.5	10.04
260810007	1	FRM	Grand Rapids - Wealthy	Kent	2012	122	32.8	29.9	28.9	23.0	28.9	9.64
260810020	1	FRM	Grand Rapids - Monroe	Kent	2012	121	32.6	27.7	26.0	23.9	26.0	9.33
260810020	2	FRM	Grand Rapids - Monroe	Kent	2012	60	23.7	21.7	19.5	18.7	21.7	9.36
260910007	1	FRM	Tecumseh	Lenawee	2012	118	28.3	27.2	26.6	19.9	26.6	9.00
260990009	1	FRM	New Haven	Macomb	2012	121	25.7	25.7	22.2	19.7	22.2	8.74

*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	2012	116	31.5	18.5	16.8	16.4	16.8	7.16
261130001	1	FRM	Houghton Lake	Missaukee	2012	119	23.3	16.5	15.4	14.6	15.4	5.92
261150005	1	FRM	Luna Pier	Monroe	2012	119	31.2	30.5	23.7	22.0	12.7	9.40
261210040	1	FRM	Muskegon	Muskegon	2012	120	36.8	28.0	23.9	21.4	23.9	8.81
261250001	1	FRM	Oak Park	Oakland	2012	131	35.4	34.5	25.2	22.0	25.2	9.52
261390005	1	FRM	Jenison	Ottawa	2012	122	32.0	30.8	27.2	22.7	27.2	8.98
261470005	1	FRM	Port Huron	St. Clair	2012	121	32.2	25.8	22.3	21.0	22.3	9.37
261610008	1	FRM	Ypsilanti	Washtenaw	2012	113	33.5	29.5	22.6	22.1	22.6	9.20
261610008	2	FRM	Ypsilanti	Washtenaw	2012	60	33.0	21.8	21.5	20.6	21.8	9.91
261630001	1	FRM	Allen Park	Wayne	2012	359	38.0	34.8	33.2	32.3	23.2	10.07
261630015	1	FRM	Detroit - W. Fort	Wayne	2012	122	33.8	33.7	24.5	23.2	24.5	11.14
261630016	1	FRM	Detroit - Linwood	Wayne	2012	119	34.0	32.7	24.6	22.5	24.6	10.00
261630019	1	FRM	Detroit - E. Seven Mile	Wayne	2012	122	43.6	35.1	32.5	22.1	32.5	9.90
261630025	1	FRM	Livonia	Wayne	2012	121	35.6	34.6	22.7	21.9	22.7	9.62
261630033	1	FRM	Dearborn	Wayne	2012	118	38.8	38.5	24.3	23.2	24.3	11.89
261630033	2	FRM	Dearborn	Wayne	2012	60	38.1	25.5	23.8	21.7	25.5	12.30
261630036	1	FRM	Wyandotte	Wayne	2012	118	29.7	27.2	20.9	18.4	20.9	9.31
261630038	1	FRM	Detroit - Newberry.	Wayne	2012	117	35.9	31.5	24.3	22.2	24.3	10.00
261630039	1	FRM	Detroit – W. Lafayette	Wayne	2012	353	36.5	36.2	34.7	33.4	24.0	10.14

*Indicates the mean does not satisfy summary criteria

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

Site ID	POC	Monitor (with FDMS)	City	County	Year	# OBS	Highest Value	2nd Highest Value	3rd Highest Value	4th Highest Value	Wtd. Arith. Mean
260170014	3	TEOM	Bay City	Bay	2012	8542	78.0	56.0	53.0	50.0	8.65
260330901	3	BAM	Sault Ste. Marie	Chippewa	2012	4878	96.2	93.6	88.5	74.6	7.69*
260490021	3	TEOM	Flint	Genesee	2012	8584	84.2	71.0	67.0	67.0	9.10
260650012	5	TEOM	Lansing	Ingham	2012	8454	257.0	165.0	137.0	135.0	8.86
260770008	3	TEOM	Kalamazoo	Kalamazoo	2012	8540	92.0	84.0	78.0	64.0	9.61
260810020	3	TEOM	Grand Rapids	Kent	2012	7944	226.0	177.0	108.0	77.0	9.23
260910007	3	TEOM	Tecumseh	Lenawee	2012	8570	56.0	45.0	44.0	44.0	9.17
261130001	3	TEOM	Houghton Lake	Missaukee	2012	8388	85.0	53.0	50.0	48.0	7.14
261470005	3	TEOM	Port Huron	St. Clair	2012	8730	89.0	80.0	71.0	62.0	9.32
261530001	3	TEOM	Seney	Schoolcraft	2012	8318	160.0	93.0	91.0	87.0	6.11
261610008	3	TEOM	Ypsilanti	Washtenaw	2012	8718	83.0	72.0	55.0	54.0	9.71
261630001	3	TEOM	Allen Park	Wayne	2012	8161	221.0	211.0	205.0	195.0	10.44
261630033	3	TEOM	Dearborn	Wayne	2012	8585	399.0	374.0	196.0	97.0	11.84
261630038	3	TEOM	Detroit – 29th Street	Wayne	2012	8485	191.0	144.0	133.0	95.0	11.10
261630039	3	TEOM	Detroit – W. Lafayette	Wayne	2012	8625	90.0	83.0	80.0	82.0	10.73

*Indicates the mean does not satisfy summary criteria

PM_{10} (24-Hour) Measured in $\mu g/m^3$

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	2012	54	61	54	89	41	35	32	30	15.0
260810020	1	GRAV	Grand Rapids - Monroe	Kent	2012	56	61	56	92	29	29	28	27	12.7
261570001	1	GRAV	Vassar	Tuscola	2012	20	61	20	33	105	57	48	20	24.7*
261630001	1	GRAV	Allen Park	Wayne	2012	61	61	60	98	39	31	31	28	14.6
261630005	1	GRAV	River Rouge	Wayne	2012	55	61	54	89	44	38	35	33	19.1*
261630015	1	GRAV	Detroit - W. Fort	Wayne	2012	56	61	56	92	65	49	43	39	21.6*
261630033	1	GRAV	Dearborn	Wayne	2012	61	61	61	100	54	52	50	49	24.3
261630033	9	GRAV	Dearborn	Wayne	2012	59	61	59	97	54	52	49	46	24.6

*Indicates the mean does not satisfy summary criteria

PM_{10} 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
261630033	3	TEOM	Dearborn	Wayne	2012	7547	442	372	271	259	25.5

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	2012	8176	32.6	25.1	20.0	6.0	5.4	0	1.43
260810020	2	Grand Rapids	Kent	2012	8073	11.8	10.3	9.7	4.2	3.7	0	0.77
261390005	1	Jenison	Ottawa	2012	8663	20.9	18.3	16.1	3.9	3.9	0	0.71
261470005	1	Port Huron	St. Clair	2012	8684	327.0	89.1	73.6	36.9	19.0	0	3.03
261630001	1	Allen Park	Wayne	2012	8266	87.8	60.1	48.9	13.0	12.5	0	1.70
261630015	1	Detroit - W. Fort	Wayne	2012	8596	88.5	84.2	80.2	43.9	28.7	0	3.86

APPENDIX B: 2012 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 2012. 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 μg/m³ 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 2011. 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 2012, assuming daily samples below MDL were equal to 0.0 μg/m³.
- Average (ND=MDL/2): average air concentration in 2012, assuming daily samples below MDL were equal to one half MDL.
- MDL: Analytical MDL in units of μg/m³
- Max1: Highest daily air concentration during 2012
- Max2: Second highest daily air concentration during 2012
- Max3: Third highest daily air concentration during 2012
- μg/m³: 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			
Flint				Mn			
Grand Rapids				x			x
Belding- Merrick St.				x			
Belding- Reed St.				x			
Vassar				x	x		
East Jordan				x			
Houghton Lake							x
Luna Pier							x

Port Huron, Nat'l Guard Arm.							x
Port Huron, Rural St.				x			
Oakland Co. Airport				Pb			
River Rouge		x		x	Mn		
Tecumseh							x

VOC = volatile organic compound; SVOC = semi-volatile organic compound; TSP = total suspended particulate; PM_{10} = particulate matter with aerodynamic diameter less than 10 μm; Hex Chrome = hexavalent chromium (Cr+6); Mn = manganese; Pb = lead

APPENDIX B-1

Allen Park (261630001) 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	0.0014	0.0014	0.0000300	0.0082	0.00407	0.00392
Arsenic Pm10	61	61	0.00119	0.00119	0.0000400	0.00863	0.00389	0.00308
Cadmium (Tsp)	60	60	0.000163	0.000163	0.0000202	0.00046	0.0004	0.00039
Cadmium Pm10	61	61	0.000277	0.000277	0.0000300	0.00174	0.00158	0.00115
Chromium Pm10	61	61	0.00247	0.00247	0.000269	0.00402	0.00365	0.00348
Lead (Tsp) Lc Frm/Fem	60	60	0.0049	0.0049		0.0111	0.0101	0.0088
Lead Pm10 Lc	61	61	0.00372	0.00372		0.0116	0.00833	0.0075
Manganese (Tsp)	60	60	0.0257	0.0257	0.000242	0.0644	0.0599	0.0571
Manganese Pm10	61	61	0.0105	0.0105	0.000297	0.025	0.025	0.0237
Nickel (Tsp)	60	60	0.00181	0.00181	0.000129	0.00331	0.00292	0.0029
Nickel Pm10	61	61	0.00082	0.00082	0.000159	0.00178	0.00168	0.00167

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
1,1,2,2-Tetrachloroethane	63	2	0.00163	0.0615	0.124	0.0755	0.0275	0
1,1,2-Trichloroethane	63	0	0	0.0573	0.115	0	0	0
1,1-Dichloroethane	63	0	0	0.0304	0.0607	0	0	0
1,1-Dichloroethylene	63	0	0	0.0278	0.0555	0	0	0
1,2,4-Trichlorobenzene	63	5	0.00824	0.0834	0.163	0.252	0.111	0.0891
1,2,4-Trimethylbenzene	63	63	0.727	0.727	0.123	5.16	3.11	2.67
1,2-Dichlorobenzene	63	5	0.00754	0.0656	0.126	0.313	0.0721	0.0421
1,2-Dichloropropane	63	0	0	0.0439	0.0878	0	0	0
1,3,5-Trimethylbenzene	63	60	0.258	0.261	0.108	1.9	1.11	0.959
1,3-Butadiene	63	61	0.114	0.115	0.0243	0.701	0.266	0.25
1,3-Dichlorobenzene	63	2	0.00763	0.0774	0.144	0.457	0.024	0
1,4-Dichlorobenzene	63	25	0.022	0.0565	0.114	0.162	0.138	0.12
2,5-Dimethylbenzaldehyde	60	0	0	0.00822	0.0164	0	0	0
Acenaphthene	60	60	0.0125	0.0125	0.0000468	0.0964	0.0611	0.0523
Acenaphthylene	60	39	0.000616	0.000622	0.000031	0.00466	0.00273	0.00213
Acetaldehyde	60	60	1.74	1.74	0.0102	3.98	3.51	3.03
Acetone	60	60	4.36	4.36	0.0189	27.5	16.3	14.6
Acetonitrile	63	63	0.522	0.522	0.123	1.33	1.33	1.26
Acetylene	63	63	0.998	0.998	0.0767	7.01	2.53	1.96
Acrylonitrile	63	4	0.00972	0.03	0.0434	0.36	0.111	0.0977
Anthracene	60	57	0.000748	0.000749	0.0000414	0.00443	0.00259	0.00237
Arsenic (Tsp)	59	59	0.00169	0.00169	0.00003	0.00512	0.00344	0.00324
Arsenic Pm10	61	61	0.00143	0.00143	0.00004	0.00484	0.00311	0.00305
Barium (Tsp)	61	61	0.0306	0.0306	0.00129	0.0795	0.0751	0.0737
Barium Pm10	61	61	0.0149	0.0149	0.00159	0.0488	0.0339	0.0337

Dearborn (261630033) Concentrations in micrograms per cubic meter ($\mu g/m^3$)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Benzaldehyde	59	59	0.124	0.124	0.013	0.313	0.265	0.243
Benzene	63	63	0.907	0.907	0.195	3.99	2.8	2.25
Benzo[A]Anthracene	60	60	0.000209	0.000209	0.000051	0.000938	0.000807	0.000763
Benzo[A]Pyrene	60	58	0.000169	0.00017	0.0000635	0.000716	0.000533	0.000529
Benzo[B]Fluoranthene	60	60	0.000462	0.000462	0.0000476	0.00167	0.00138	0.00125
Benzo[G,H,I]Perylene	60	60	0.000204	0.000204	0.0000535	0.000824	0.000536	0.000505
Benzo[K]Fluoranthene	60	54	0.00013	0.000133	0.0000621	0.000452	0.000393	0.000377
Beryllium (Tsp)	61	61	0.0000852	0.0000852	0.00001	0.00024	0.00024	0.0002
Beryllium Pm10	61	53	0.0000241	0.0000248	0.0000111	0.00007	0.00006	0.00006
Bromochloromethane	63	0	0	0.037	0.0741	0	0	0
Bromodichloromethane	63	0	0	0.0704	0.141	0	0	0
Bromoform	63	3	0.00393	0.102	0.207	0.134	0.062	0.0517
Bromomethane	63	45	0.0308	0.0374	0.0466	0.0699	0.0621	0.0621
Butyraldehyde	60	60	0.393	0.393	0.00885	1.98	1.02	0.985
Cadmium (Tsp)	61	61	0.000417	0.000417	0.00002	0.00123	0.00121	0.00119
Cadmium Pm10	61	61	0.000322	0.000322	0.00003	0.00115	0.00106	0.00102
Carbon Disulfide	63	63	0.4	0.4	0.0436	11.4	0.872	0.617
Carbon Tetrachloride	63	63	0.707	0.707	0.151	1.04	0.918	0.818
Chlorobenzene	63	4	0.0117	0.0655	0.115	0.497	0.124	0.0921
Chloroethane	63	4	0.00641	0.0274	0.0449	0.243	0.0633	0.0554
Chloroform	63	62	0.845	0.846	0.0684	6.44	2.31	1.97
Chloromethane	63	63	1.27	1.27	0.0681	2.35	1.78	1.61
Chloroprene	63	1	0.000978	0.0223	0.0435	0.0616	0	0
Chromium (Tsp)	61	61	0.00582	0.00582	0.000218	0.0158	0.0156	0.0155
Chromium Pm10	61	61	0.00396	0.00396	0.000269	0.00706	0.00684	0.00611
Chromium Vi (Tsp)	62	58	0.0000484	0.0000486	0.00000364	0.000219	0.000154	0.000145
Chrysene	60	60	0.000484	0.000484	0.0000469	0.00165	0.00156	0.00152
Cis-1,2-Dichloroethene	63	0	0	0.0357	0.0714	0	0	0
Cis-1,3-Dichloropropene	63	0	0	0.034	0.0681	0	0	0
Cobalt (Tsp)	61	61	0.000287	0.000287	0.00001	0.00251	0.00051	0.0005
Cobalt Pm10	61	61	0.000186	0.000186	0.0000111	0.00107	0.00046	0.00034
Copper (Tsp)	61	61	0.151	0.151	0.00068	0.531	0.434	0.405
Copper Pm10	61	61	0.0498	0.0498	0.000836	0.173	0.14	0.116
Dibenzo[A,H]Anthracene	60	36	0.0000264	0.0000372	0.0000532	0.000148	0.0000943	0.0000882
Dibromochloromethane	63	6	0.00419	0.0736	0.153	0.102	0.0426	0.0426
Dichlorodifluoromethane	63	63	2.53	2.53	0.114	3.68	2.97	2.95
Dichloromethane	63	63	1.19	1.19	0.0799	6.08	3.93	3.79
Ethyl Acrylate	63	0	0	0.0287	0.0573	0	0	0
Ethylbenzene	63	62	0.526	0.526	0.0999	3.62	1.81	1.65
Ethylene Dibromide	63	1	0.00146	0.0657	0.131	0.0922	0	0
Ethylene Dichloride	63	53	0.0657	0.0708	0.0648	0.125	0.113	0.113
Fluoranthene	60	60	0.00545	0.00545	0.0000828	0.0341	0.0175	0.0169
Fluorene	60	60	0.0113	0.0113	0.000044	0.0791	0.0463	0.0387
Formaldehyde	60	60	3.43	3.43	0.0104	8.38	7.28	6.8
Freon 114	63	63	0.114	0.114	0.0839	0.154	0.147	0.133
Hexachlorobutadiene	63	3	0.00321	0.115	0.235	0.117	0.0533	0.032
Hexanaldehyde	60	59	0.16	0.16	0.00819	0.93	0.668	0.356
Indeno[1,2,3-Cd]Pyrene	60	59	0.000186	0.000186	0.0000616	0.000616	0.000569	0.000442

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)	61	61	1.54	1.54	0.00316	5.05	4.35	4.08
Iron Pm10	61	61	0.734	0.734	0.00389	2.46	2.16	1.89
Isovaleraldehyde	60	1	0.000412	0.00387	0.00705	0.0247	0	0
Lead (Tsp) Lc Frm/Fem	60	60	0.0125	0.0125		0.0448	0.0361	0.0296
Lead Pm10 Lc	61	61	0.00935	0.00935		0.0251	0.022	0.0209
M/P Xylene	63	63	1.59	1.59	0.161	14.9	5.99	4.99
Manganese (Tsp)	61	61	0.124	0.124	0.000241	0.374	0.37	0.341
Manganese Pm10	61	61	0.0425	0.0425	0.000297	0.132	0.127	0.123
Methyl Chloroform	63	45	0.0326	0.0482	0.109	0.109	0.0818	0.0764
Methyl Ethyl Ketone	60	60	0.462	0.462	0.0118	1.17	1.06	1.04
Methyl Isobutyl Ketone	63	63	0.294	0.294	0.0615	1.19	0.77	0.742
Methyl Methacrylate	63	0	0	0.0512	0.102	0	0	0
Methyl Tert-Butyl Ether	63	0	0	0.0198	0.0397	0	0	0
Molybdenum (Tsp)	61	61	0.000903	0.000903	0.00004	0.0026	0.00201	0.00165
Molybdenum Pm10	61	61	0.000675	0.000675	0.00005	0.002	0.00162	0.00147
Naphthalene (Tsp)	60	60	0.141	0.141	0.000193	0.455	0.351	0.343
Nickel (Tsp)	61	61	0.00596	0.00596	0.000129	0.223	0.00535	0.00525
Nickel Pm10	61	61	0.00128	0.00128	0.000158	0.00403	0.00353	0.00253
N-Octane	63	59	0.175	0.178	0.0935	0.776	0.402	0.402
O-Xylene	63	63	0.493	0.493	0.0869	3.13	1.85	1.53
Phenanthrene	60	60	0.0222	0.0222	0.0000435	0.189	0.0801	0.0784
Propionaldehyde	60	60	0.335	0.335	0.00713	0.741	0.646	0.606
Propylene	63	63	0.799	0.799	0.0568	3.72	2.34	1.36
Pyrene	60	60	0.00272	0.00272	0.0000812	0.0156	0.00762	0.00718
Styrene	63	51	0.306	0.315	0.102	2.42	1.78	1.44
Tert-Butyl Ethyl Ether	63	0	0	0.023	0.046	0	0	0
Tetrachloroethylene	63	61	0.414	0.416	0.136	5.37	3.55	1.74
Tolualdehydes	55	54	0.123	0.124	0.0241	0.265	0.251	0.236
Toluene	63	63	1.59	1.59	0.17	9.69	4.49	4.07
Trans-1,2-Dichloroethylene	63	1	0.0132	0.0366	0.0476	0.833	0	0
Trans-1,3-Dichloropropene	63	0	0	0.0363	0.0726	0	0	0
Trichloroethylene	63	15	0.0189	0.064	0.118	0.242	0.167	0.118
Trichlorofluoromethane	63	63	1.65	1.65	0.0843	5.17	2.62	2.17
Valeraldehyde	60	60	0.103	0.103	0.0106	0.342	0.247	0.187
Vanadium (Tsp)	61	61	0.00402	0.00402	0.00004	0.0121	0.0113	0.01
Vanadium Pm10	61	61	0.00183	0.00183	0.00005	0.00543	0.00518	0.00474
Vinyl Chloride	63	16	0.00649	0.017	0.0281	0.148	0.023	0.0204
Zinc (Tsp)	61	61	0.149	0.149	0.00081	0.69	0.459	0.397
Zinc Pm10	61	61	0.0966	0.0966	0.000996	0.367	0.294	0.276

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
1,1,2,2-Tetrachloroethane	29	0	0	0.382	0.764	0	0	0
1,1,2-Trichloroethane	29	0	0	0.497	0.995	0	0	0
1,1-Dichloroethane	29	0	0	0.139	0.277	0	0	0
1,1-Dichloroethylene	29	0	0	0.136	0.271	0	0	0
1,2,4-Trichlorobenzene	29	1	0.0621	0.834	1.6	1.8	0	0
1,2,4-Trimethylbenzene	29	8	0.363	0.6	0.655	2.6	1.7	1.2
1,2-Dichlorobenzene	29	0	0	0.357	0.714	0	0	0
1,2-Dichloropropane	29	0	0	0.265	0.53	0	0	0
1,3,5-Trimethylbenzene	29	1	0.0345	0.341	0.635	1	0	0
1,3-Butadiene	29	0	0	0.267	0.534	0	0	0
1,3-Dichlorobenzene	29	0	0	0.378	0.756	0	0	0
1,4-Dichlorobenzene	29	0	0	0.339	0.679	0	0	0
2,2,4-Trimethylpentane	29	5	0.126	0.294	0.406	1.6	0.65	0.5
2,5-Dimethylbenzaldehyde	30	0	0	0.00822	0.0164	0	0	0
Acetaldehyde	30	30	1.62	1.62	0.0107	4.34	2.5	2.49
Acetone	30	30	2.65	2.65	0.0184	4.58	4.3	4.27
Acetonitrile	29	0	0	0.55	1.1	0	0	0
Acrylonitrile	29	0	0	0.0728	0.146	0	0	0
Arsenic (Tsp)	61	61	0.00156	0.00156	0.00003	0.00453	0.00334	0.00318
Benzaldehyde	30	29	0.139	0.14	0.013	0.612	0.256	0.23
Benzene	29	29	0.813	0.813	0.219	1.7	1.4	1.3
Benzyl Chloride	29	0	0	0.396	0.791	0	0	0
Bromodichloromethane	29	0	0	0.55	1.1	0	0	0
Bromoform	29	0	0	0.85	1.7	0	0	0
Bromomethane	29	0	0	0.5	1	0	0	0
Butyraldehyde	30	29	0.278	0.278	0.00885	0.761	0.496	0.41
Cadmium (Tsp)	61	61	0.00033	0.00033	0.00002	0.00117	0.00113	0.0009
Carbon Tetrachloride	29	0	0	0.325	0.65	0	0	0
Chlorobenzene	29	0	0	0.365	0.729	0	0	0
Chloroethane	29	0	0	0.368	0.736	0	0	0
Chloroform	29	12	0.319	0.469	0.512	1.2	0.94	0.92
Chloromethane	29	28	0.898	0.909	0.6	1.7	1.7	1.4
Chloroprene	29	0	0	0.124	0.247	0	0	0
Cis-1,2-Dichloroethene	29	0	0	0.108	0.216	0	0	0
Cis-1,3-Dichloropropene	29	0	0	0.312	0.625	0	0	0
Crotonaldehyde	0	0						
Dibromochloromethane	29	0	0	0.745	1.49	0	0	0
Dichlorodifluoromethane	29	29	2.19	2.19	0.635	3.8	3.5	3.5
Dichloromethane	29	24	0.418	0.44	0.243	0.75	0.73	0.72
Ethylbenzene	29	3	0.107	0.427	0.714	1.2	1.1	0.79
Ethylene Dibromide	29	0	0	0.6	1.2	0	0	0
Ethylene Dichloride	29	0	0	0.208	0.416	0	0	0
Formaldehyde	30	30	3.11	3.11	0.0106	7.69	5.66	5.22
Freon 113	29	4	0.0962	0.366	0.626	0.78	0.71	0.66
Freon 114	29	0	0	0.855	1.71	0	0	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	29	1	0.0621	0.834	1.6	1.8	0	0
Hexanaldehyde	30	29	0.149	0.149	0.00819	1.04	0.438	0.225
Isovaleraldehyde	30	0	0	0.00352	0.00705	0	0	0
M/P Xylene	29	16	1.08	1.24	0.736	5.9	4.9	2.6
Manganese (Tsp)	61	61	0.0685	0.0685	0.00024	0.211	0.198	0.189
Manganese Pm10	61	61	0.026	0.026	0.000289	0.0911	0.0886	0.0747
Methyl Chloroform	29	0	0	0.276	0.552	0	0	0
Methyl Ethyl Ketone	29	29	1.28	1.28	0.12	2.5	2.4	2.3
Methyl Ethyl Ketone	30	29	0.389	0.389	0.0118	0.64	0.616	0.596
Methyl Isobutyl Ketone	29	9	0.389	0.564	0.51	2.3	2.2	1.5
Methyl Tert-Butyl Ether	29	0	0	0.103	0.206	0	0	0
N-Hexane	29	25	0.953	0.969	0.229	3.3	2.7	2.3
Nickel (Tsp)	61	61	0.00326	0.00326	0.000128	0.0139	0.0118	0.00829
O-Xylene	29	6	0.263	0.531	0.676	2.6	1.7	0.93
Propionaldehyde	30	30	0.303	0.303	0.00713	0.551	0.546	0.508
Styrene	29	0	0	0.252	0.503	0	0	0
Tetrachloroethylene	29	0	0	0.545	1.09	0	0	0
Tolualdehydes	26	25	0.137	0.138	0.0246	0.521	0.305	0.275
Toluene	29	27	1.96	1.98	0.46	13	4.3	4.2
Trans-1,2-Dichloroethylene	29	0	0	0.144	0.288	0	0	0
Trans-1,3-Dichloropropene	29	0	0	0.317	0.633	0	0	0
Trichloroethylene	29	0	0	0.257	0.515	0	0	0
Trichlorofluoromethane	29	29	1.21	1.21	0.506	1.9	1.9	1.8
Valeraldehyde	30	29	0.122	0.122	0.0106	0.617	0.236	0.166
Vinyl Chloride	29	0	0	0.302	0.604	0	0	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	0.00196	0.00196	0.00003	0.00579	0.00438	0.00423
Cadmium (Tsp)	60	60	0.000446	0.000446	0.0000203	0.00149	0.00139	0.00137
Manganese (Tsp)	60	60	0.145	0.145	0.000243	0.684	0.54	0.463
Nickel (Tsp)	60	60	0.00315	0.00315	0.000131	0.0145	0.00675	0.00583

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
2,5-Dimethylbenzaldehyde	59	0	0	0.00864	0.0172	0	0	0
Acetaldehyde	59	59	1.36	1.36	0.0109	4.42	2.9	2.78
Acetone	59	59	2.21	2.21	0.0191	7.22	5.48	5.08
Arsenic (Tsp)	58	58	0.00167	0.00167	0.00003	0.00709	0.0044	0.004
Benzaldehyde	58	48	0.106	0.107	0.0137	0.356	0.234	0.23
Butyraldehyde	59	49	0.215	0.216	0.0093	0.714	0.519	0.451
Cadmium (Tsp)	58	58	0.000442	0.000442	0.00002	0.00271	0.00173	0.00114
Crotonaldehyde	0	0						
Formaldehyde	59	59	3.26	3.26	0.0111	7.69	7.2	6.5
Hexanaldehyde	59	49	0.0852	0.0859	0.00854	0.283	0.201	0.193
Isovaleraldehyde	59	0	0	0.00367	0.00735	0	0	0
Manganese (Tsp)	58	58	0.0577	0.0577	0.000239	0.228	0.203	0.167
Manganese Pm10	60	60	0.0215	0.0215	0.000298	0.122	0.0856	0.079
Methyl Ethyl Ketone	59	49	0.368	0.369	0.0124	1.99	0.909	0.746
Nickel (Tsp)	58	58	0.00167	0.00167	0.000128	0.00782	0.00418	0.00357
Propionaldehyde	59	49	0.228	0.228	0.00749	0.665	0.618	0.516
Tolualdehydes	55	45	0.0957	0.0981	0.025	0.3	0.295	0.27
Valeraldehyde	58	48	0.0695	0.0705	0.0109	0.18	0.159	0.148

Flint (260490021) 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
Manganese (Tsp)	61	61	0.0103	0.0103	0.00024	0.0355	0.0253	0.0224

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	0.00107	0.00107	0.0000302	0.0038	0.00364	0.00292
Arsenic Pm10	20	20	0.000687	0.000687	0.00004	0.00215	0.00137	0.00136
Cadmium (Tsp)	61	61	0.00189	0.00189	0.0000202	0.0544	0.00778	0.00669
Cadmium Pm10	20	20	0.00334	0.00334	0.00003	0.0583	0.00324	0.00248
Lead (Tsp) Lc Frm/Fem	61	61	0.0216	0.0216		0.201	0.185	0.1
Manganese (Tsp)	61	61	0.0945	0.0945	0.000243	0.877	0.766	0.502
Manganese Pm10	20	20	0.0655	0.0655	0.000196	1	0.268	0.027
Nickel (Tsp)	61	61	0.00189	0.00189	0.000132	0.00515	0.00515	0.00418
Nickel Pm10	20	20	0.0149	0.0149	0.000263	0.163	0.0311	0.0288

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)	58	58	0.00119	0.00119	0.0000300	0.00443	0.00365	0.00301
Cadmium (Tsp)	58	58	0.000127	0.000127	0.0000202	0.00028	0.00024	0.00023
Chromium (Tsp)	58	58	0.00718	0.00718	0.00022	0.174	0.119	0.00416
Lead (Tsp) Lc Frm/Fem	58	58	0.00483	0.00483		0.0128	0.00954	0.00896
Manganese (Tsp)	58	58	0.0157	0.0157	0.000244	0.0496	0.0375	0.0303
Nickel (Tsp)	58	58	0.00431	0.00431	0.00013	0.0992	0.0673	0.00342

Belding - Merrick St. (260670003) 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	0.00322	0.00322	0.0000343	0.0964	0.0199	0.0168
Cadmium (Tsp)	61	61	0.00154	0.00154	0.0000284	0.0663	0.00783	0.00198
Chromium (Tsp)	61	61	0.00362	0.00362	0.000205	0.112	0.0086	0.00309
Lead (Tsp) Lc Frm/Fem	61	61	0.0363	0.0363		0.17	0.156	0.115
Manganese (Tsp)	61	61	0.0106	0.0106	0.000227	0.0365	0.0328	0.0282
Nickel (Tsp)	61	61	0.0028	0.0028	0.000124	0.0779	0.00757	0.00287

Belding - Reed St. (260670002) 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	0.00142	0.00142	0.0000377	0.0199	0.00718	0.00651
Cadmium (Tsp)	61	61	0.000865	0.000865	0.0000254	0.0282	0.00656	0.00146
Lead (Tsp) Lc Frm/Fem	61	61	0.0399	0.0399		0.23	0.17	0.139
Manganese (Tsp)	61	61	0.00869	0.00869	0.000227	0.0361	0.0196	0.0185
Nickel (Tsp)	61	61	0.0017	0.0017	0.000126	0.017	0.00955	0.00285

East Jordan (260290011) 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)	53	53	0.000707	0.000707	0.00003	0.00653	0.00332	0.00172
Cadmium (Tsp)	53	53	0.000137	0.000137	0.00002	0.00057	0.00048	0.00038
Lead (Tsp) Lc Frm/Fem	53	53	0.0056	0.0056		0.0394	0.0259	0.0209
Manganese (Tsp)	53	53	0.0265	0.0265	0.00024	0.201	0.149	0.0944
Nickel (Tsp)	53	53	0.00189	0.00189	0.000128	0.00436	0.00363	0.00354

Port Huron, Rural Street (261470031), 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)	10	10	0.00109	0.00109	0.00003	0.00344	0.002	0.00165
Cadmium (Tsp)	10	10	0.000605	0.000605	0.00002	0.00373	0.00091	0.00049
Lead (Tsp) Lc Frm/Fem	10	10	0.0166	0.0166		0.0995	0.0306	0.00863
Manganese (Tsp)	10	10	0.011	0.011	0.000235	0.0275	0.0246	0.0197
Nickel (Tsp)	10	10	0.0026	0.0026	0.000125	0.0118	0.00611	0.00178

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	80	0.0216	0.0247	0.0189	0.388	0.112	0.102
Ammonium Ion Pm2.5 Lc	121	118	0.941	0.941	0.0118	4.59	3.75	2.89
Antimony Pm2.5 Lc	120	46	0.00693	0.0182	0.0365	0.0701	0.0677	0.0455
Arsenic Pm2.5 Lc	120	66	0.000939	0.00136	0.00172	0.00805	0.00619	0.00461
Barium Pm2.5 Lc	120	22	0.00158	0.00622	0.0134	0.0536	0.0167	0.0146
Bromine Pm2.5 Lc	120	117	0.00426	0.00429	0.00157	0.0205	0.014	0.0121
Cadmium Pm2.5 Lc	120	33	0.00204	0.00765	0.0154	0.0198	0.0163	0.014
Calcium Pm2.5 Lc	120	119	0.0474	0.0474	0.00621	0.174	0.166	0.137
Cerium Pm2.5 Lc	120	15	0.000142	0.00389	0.0137	0.00222	0.00187	0.00187
Cesium Pm2.5 Lc	120	34	0.000948	0.00559	0.0156	0.00991	0.00712	0.00609
Chlorine Pm2.5 Lc	120	108	0.0129	0.0133	0.00717	0.156	0.121	0.0937
Chromium Pm2.5 Lc	120	107	0.00285	0.00296	0.00222	0.035	0.0124	0.0118
Cobalt Pm2.5 Lc	120	82	0.000502	0.000718	0.00138	0.00237	0.00196	0.00192
Copper Pm2.5 Lc	120	114	0.0079	0.00796	0.00198	0.034	0.033	0.0311
Ec Csn_Rev Unadjusted Pm2.5 Lc	121	121	0.417	0.417		1.42	1.41	1.32
Indium Pm2.5 Lc	120	24	0.0016	0.00927	0.0194	0.0315	0.021	0.0175
Iron Pm2.5 Lc	120	120	0.097	0.097	0.00195	0.332	0.298	0.226
Lead Pm2.5 Lc	120	81	0.00215	0.00276	0.00363	0.0132	0.0116	0.00968
Magnesium Pm2.5 Lc	120	55	0.00462	0.00828	0.014	0.12	0.0246	0.0244
Manganese Pm2.5 Lc	120	106	0.0024	0.00252	0.00185	0.00858	0.00854	0.00757
Nickel Pm2.5 Lc	120	75	0.000682	0.000957	0.00142	0.00735	0.00486	0.00452
Oc Csn_Rev Unadjusted Pm2.5 Lc	121	121	2.19	2.19		7.01	5.89	5.29
Phosphorus Pm2.5 Lc	120	1	0.00000583	0.00554	0.0112	0.0007	0	0
Potassium Ion Pm2.5 Lc	121	96	0.0447	0.0459	0.0128	1.18	0.191	0.185
Potassium Pm2.5 Lc	120	117	0.0649	0.0649	0.00726	1.23	0.234	0.214
Rubidium Pm2.5 Lc	120	32	0.000174	0.000889	0.00192	0.00177	0.00161	0.00152
Selenium Pm2.5 Lc	120	70	0.000897	0.00135	0.0022	0.00888	0.00514	0.00466
Silicon Pm2.5 Lc	120	117	0.0594	0.0595	0.0133	0.224	0.219	0.201
Silver Pm2.5 Lc	120	11	0.000456	0.00806	0.0167	0.0128	0.00701	0.00701
Sodium Ion Pm2.5 Lc	121	112	0.044	0.0444	0.0117	0.212	0.174	0.171
Sodium Pm2.5 Lc	120	94	0.0297	0.0343	0.0401	0.158	0.134	0.099
Strontium Pm2.5 Lc	120	51	0.00076	0.00148	0.0024	0.0214	0.00513	0.00467
Sulfate Pm2.5 Lc	121	121	1.96	1.96	0.00971	6.42	5.57	5.28
Sulfur Pm2.5 Lc	120	120	0.705	0.705	0.00793	2.26	1.98	1.93
Tin Pm2.5 Lc	120	18	0.00148	0.0121	0.0246	0.0315	0.0257	0.0198
Titanium Pm2.5 Lc	120	74	0.00192	0.00282	0.00472	0.0105	0.00899	0.00841
Total Nitrate Pm2.5 Lc	121	120	1.77	1.77	0.0123	12.5	10	7.65
Vanadium Pm2.5 Lc	120	59	0.000557	0.00139	0.00317	0.00456	0.00338	0.00338
Zinc Pm2.5 Lc	120	119	0.0149	0.0149	0.00238	0.112	0.0544	0.0467
Zirconium Pm2.5 Lc	120	27	0.000965	0.00378	0.00747	0.0178	0.0152	0.0152

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	60	48	0.0408	0.0425	0.0188	0.208	0.149	0.139
Ammonium Ion Pm2.5 Lc	60	54	1.07	1.07	0.013	4.83	3.26	3.16
Antimony Pm2.5 Lc	60	18	0.00769	0.0206	0.0374	0.0933	0.0489	0.042
Arsenic Pm2.5 Lc	60	34	0.00107	0.00145	0.00171	0.00455	0.00431	0.00408
Barium Pm2.5 Lc	60	22	0.00308	0.0067	0.0138	0.0357	0.0293	0.0243
Bromine Pm2.5 Lc	60	60	0.00636	0.00636	0.00161	0.0253	0.0243	0.0169
Cadmium Pm2.5 Lc	60	18	0.00148	0.00706	0.016	0.0128	0.0105	0.00935
Calcium Pm2.5 Lc	60	60	0.207	0.207	0.00621	1.15	0.926	0.806
Cerium Pm2.5 Lc	60	7	0.000121	0.0049	0.0144	0.00198	0.0014	0.0014
Cesium Pm2.5 Lc	60	19	0.00136	0.00559	0.0144	0.0132	0.00653	0.00606
Chlorine Pm2.5 Lc	60	60	0.0772	0.0772	0.00719	0.681	0.52	0.351
Chromium Pm2.5 Lc	60	51	0.00298	0.00315	0.00227	0.0611	0.0262	0.00688
Cobalt Pm2.5 Lc	60	40	0.00119	0.00143	0.0014	0.00479	0.00419	0.0041
Copper Pm2.5 Lc	60	59	0.0168	0.0168	0.00196	0.0585	0.0533	0.0471
Ec Csn_Rev Unadjusted Pm2.5 Lc	61	61	0.534	0.534		1.91	1.18	1.16
Indium Pm2.5 Lc	60	17	0.00235	0.00957	0.0199	0.0233	0.0174	0.014
Iron Pm2.5 Lc	60	60	0.453	0.453	0.00195	1.75	1.42	1.31
Lead Pm2.5 Lc	60	51	0.00607	0.00638	0.00359	0.0185	0.0168	0.0166
Magnesium Pm2.5 Lc	60	46	0.0273	0.0289	0.0136	0.116	0.114	0.103
Manganese Pm2.5 Lc	60	57	0.0152	0.0152	0.00188	0.0639	0.0514	0.0487
Nickel Pm2.5 Lc	60	39	0.000848	0.00111	0.0014	0.0159	0.00616	0.00293
Oc Csn_Rev Unadjusted Pm2.5 Lc	61	61	2.71	2.71		7.28	5.14	4.39
Phosphorus Pm2.5 Lc	60	2	0.000355	0.00587	0.0114	0.012	0.00927	0
Potassium Ion Pm2.5 Lc	60	46	0.051	0.0525	0.0137	0.375	0.183	0.141
Potassium Pm2.5 Lc	60	60	0.0986	0.0986	0.00704	0.397	0.324	0.247
Rubidium Pm2.5 Lc	60	24	0.000257	0.000873	0.00201	0.00169	0.00147	0.00128
Selenium Pm2.5 Lc	60	48	0.00162	0.00183	0.00214	0.00757	0.00524	0.0049
Silicon Pm2.5 Lc	60	60	0.141	0.141	0.0127	0.762	0.515	0.469
Silver Pm2.5 Lc	60	10	0.00063	0.00838	0.0178	0.00932	0.00699	0.00467
Sodium Ion Pm2.5 Lc	60	54	0.0646	0.0654	0.012	0.247	0.238	0.184
Sodium Pm2.5 Lc	60	53	0.0855	0.0881	0.0379	0.397	0.36	0.315
Strontium Pm2.5 Lc	60	31	0.00103	0.00161	0.0025	0.00769	0.00618	0.00501
Sulfate Pm2.5 Lc	60	60	2.09	2.09	0.009	5.98	5.75	4.91
Sulfur Pm2.5 Lc	60	60	0.877	0.877	0.00794	3.22	2.34	1.93
Tin Pm2.5 Lc	60	9	0.00211	0.0126	0.0245	0.0361	0.0256	0.0245
Titanium Pm2.5 Lc	60	41	0.00297	0.00371	0.00474	0.0191	0.014	0.013
Total Nitrate Pm2.5 Lc	60	60	1.91	1.91	0.0139	11.9	7.72	6.4
Vanadium Pm2.5 Lc	60	34	0.00125	0.0019	0.00321	0.00706	0.0049	0.0042
Zinc Pm2.5 Lc	60	60	0.0704	0.0704	0.00224	0.279	0.277	0.246
Zirconium Pm2.5 Lc	60	16	0.00105	0.00405	0.00825	0.0116	0.00816	0.00594

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	61	47	0.0309	0.0327	0.018	0.349	0.162	0.0924
Ammonium Ion Pm2.5 Lc	61	60	1.15	1.15	0.0098	4.36	3.15	2.98
Antimony Pm2.5 Lc	61	20	0.00764	0.0208	0.0377	0.0618	0.0549	0.0444
Arsenic Pm2.5 Lc	61	39	0.000845	0.00117	0.00154	0.00379	0.00362	0.00245
Barium Pm2.5 Lc	61	15	0.00199	0.00626	0.0116	0.0257	0.0167	0.0159
Bromine Pm2.5 Lc	61	61	0.00527	0.00527	0.00151	0.0232	0.0148	0.0119
Cadmium Pm2.5 Lc	61	15	0.00195	0.00806	0.0159	0.0198	0.0163	0.0129
Calcium Pm2.5 Lc	61	61	0.129	0.129	0.00647	1.75	0.591	0.384
Cerium Pm2.5 Lc	61	5	0.000203	0.00394	0.0107	0.00795	0.00152	0.00152
Cesium Pm2.5 Lc	61	11	0.000736	0.00601	0.014	0.0109	0.00773	0.00675
Chlorine Pm2.5 Lc	61	58	0.0327	0.0329	0.00711	0.222	0.188	0.173
Chromium Pm2.5 Lc	61	50	0.00193	0.00213	0.0023	0.0113	0.0102	0.00522
Cobalt Pm2.5 Lc	61	46	0.000974	0.00114	0.00135	0.00561	0.00373	0.00258
Copper Pm2.5 Lc	61	59	0.00872	0.00877	0.0019	0.0304	0.0247	0.0215
Ec Csn_Rev Unadjusted Pm2.5 Lc	59	59	0.525	0.525		1.95	1.28	1.09
Indium Pm2.5 Lc	61	10	0.001	0.00888	0.0191	0.0129	0.00936	0.00933
Iron Pm2.5 Lc	61	61	0.265	0.265	0.00185	1.72	1.28	1.12
Lead Pm2.5 Lc	61	46	0.00453	0.00491	0.00339	0.038	0.016	0.0145
Magnesium Pm2.5 Lc	61	35	0.0107	0.0136	0.0134	0.0937	0.0887	0.0669
Manganese Pm2.5 Lc	61	55	0.00668	0.00678	0.00183	0.0438	0.0349	0.0256
Nickel Pm2.5 Lc	61	40	0.000585	0.000818	0.00136	0.00491	0.00431	0.00366
Oc Csn_Rev Unadjusted Pm2.5 Lc	59	59	2.38	2.38		4.73	4.38	4.34
Phosphorus Pm2.5 Lc	61	3	0.00046	0.00621	0.0121	0.0114	0.00871	0.00795
Potassium Ion Pm2.5 Lc	61	48	0.0501	0.0514	0.011	0.282	0.227	0.143
Potassium Pm2.5 Lc	61	61	0.0816	0.0816	0.00725	0.396	0.319	0.269
Rubidium Pm2.5 Lc	61	17	0.000246	0.000963	0.00193	0.00268	0.00245	0.00156
Selenium Pm2.5 Lc	61	41	0.0014	0.00171	0.00202	0.00711	0.00678	0.00677
Silicon Pm2.5 Lc	61	60	0.107	0.107	0.0126	0.862	0.437	0.392
Silver Pm2.5 Lc	61	12	0.000734	0.00779	0.0163	0.00933	0.00735	0.00699
Sodium Ion Pm2.5 Lc	61	59	0.0532	0.0533	0.0115	0.207	0.144	0.125
Sodium Pm2.5 Lc	61	50	0.0486	0.0526	0.0382	0.204	0.145	0.13
Strontium Pm2.5 Lc	61	24	0.000656	0.00138	0.00238	0.00572	0.00304	0.00291
Sulfate Pm2.5 Lc	61	61	2.47	2.47	0.0101	8.49	6.94	6.45
Sulfur Pm2.5 Lc	61	61	0.877	0.877	0.00838	3.29	2.44	2.44
Tin Pm2.5 Lc	61	10	0.00201	0.0121	0.0242	0.0268	0.0257	0.0233
Titanium Pm2.5 Lc	61	30	0.00188	0.00307	0.00485	0.0317	0.00842	0.0071
Total Nitrate Pm2.5 Lc	61	61	1.89	1.89	0.0114	11.6	7.75	6.63
Vanadium Pm2.5 Lc	61	34	0.00111	0.00185	0.00332	0.00585	0.00525	0.00468
Zinc Pm2.5 Lc	61	61	0.0287	0.0287	0.00229	0.0939	0.0884	0.0841
Zirconium Pm2.5 Lc	61	10	0.000723	0.00354	0.00689	0.0109	0.00584	0.00583

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	59	41	0.0159	0.0189	0.0191	0.0912	0.0698	0.0585
Ammonium Ion Pm2.5 Lc	60	60	0.926	0.926	0.0115	3.56	3.2	2.72
Antimony Pm2.5 Lc	59	25	0.00994	0.0208	0.0363	0.0711	0.0478	0.0478
Arsenic Pm2.5 Lc	59	35	0.000885	0.00127	0.00175	0.00711	0.00676	0.00442
Barium Pm2.5 Lc	59	9	0.000804	0.00577	0.0147	0.0134	0.00781	0.00698
Bromine Pm2.5 Lc	59	58	0.00508	0.00509	0.0016	0.0222	0.0184	0.0149
Cadmium Pm2.5 Lc	59	19	0.00212	0.00765	0.0154	0.0245	0.0135	0.0134
Calcium Pm2.5 Lc	59	59	0.0443	0.0443	0.00619	0.157	0.118	0.0994
Cerium Pm2.5 Lc	59	6	0.0000849	0.00358	0.0158	0.00233	0.0014	0.00082
Cesium Pm2.5 Lc	59	15	0.000961	0.005	0.0151	0.0102	0.00758	0.0056
Chlorine Pm2.5 Lc	59	55	0.0153	0.0156	0.0073	0.0522	0.0517	0.0478
Chromium Pm2.5 Lc	59	41	0.00109	0.00144	0.00223	0.00404	0.00396	0.00388
Cobalt Pm2.5 Lc	59	34	0.000375	0.000689	0.00142	0.00221	0.0017	0.00119
Copper Pm2.5 Lc	59	49	0.00219	0.00238	0.00201	0.0143	0.0113	0.00916
Ec Csn_Rev Unadjusted Pm2.5 Lc	60	60	0.22	0.22		0.619	0.475	0.456
Indium Pm2.5 Lc	59	13	0.00182	0.00938	0.0195	0.0206	0.0175	0.0128
Iron Pm2.5 Lc	59	59	0.0458	0.0458	0.00201	0.134	0.126	0.0964
Lead Pm2.5 Lc	59	42	0.00393	0.00447	0.00365	0.0512	0.0269	0.0187
Magnesium Pm2.5 Lc	59	18	0.00254	0.0073	0.0141	0.0328	0.0163	0.014
Manganese Pm2.5 Lc	59	46	0.00102	0.00122	0.00189	0.0047	0.00417	0.00324
Nickel Pm2.5 Lc	59	43	0.000908	0.00111	0.00144	0.00539	0.00343	0.00336
Oc Csn_Rev Unadjusted Pm2.5 Lc	60	60	2.27	2.27		5.1	4.81	4.05
Phosphorus Pm2.5 Lc	59	7	0.00132	0.00624	0.0109	0.0529	0.0111	0.00796
Potassium Ion Pm2.5 Lc	60	46	0.0281	0.0291	0.0124	0.114	0.112	0.0817
Potassium Pm2.5 Lc	59	59	0.0498	0.0498	0.00723	0.149	0.129	0.125
Rubidium Pm2.5 Lc	59	14	0.00012	0.000861	0.00198	0.0014	0.00128	0.00117
Selenium Pm2.5 Lc	59	39	0.0009	0.00127	0.00222	0.0056	0.00326	0.0031
Silicon Pm2.5 Lc	59	58	0.05	0.0501	0.0131	0.169	0.138	0.129
Silver Pm2.5 Lc	59	6	0.000934	0.00891	0.0172	0.014	0.0128	0.012
Sodium Ion Pm2.5 Lc	60	55	0.0386	0.0391	0.0125	0.147	0.112	0.0926
Sodium Pm2.5 Lc	59	46	0.0328	0.0379	0.0394	0.144	0.117	0.098
Strontium Pm2.5 Lc	59	21	0.000843	0.00161	0.00245	0.0141	0.00873	0.00501
Sulfate Pm2.5 Lc	60	60	2.1	2.1	0.0103	8.21	6.54	5.54
Sulfur Pm2.5 Lc	59	59	0.744	0.744	0.00782	2.88	2.14	1.96
Tin Pm2.5 Lc	59	13	0.00276	0.0124	0.0242	0.0466	0.021	0.0198
Titanium Pm2.5 Lc	59	35	0.00133	0.00229	0.00471	0.00664	0.00431	0.00408
Total Nitrate Pm2.5 Lc	60	60	1.64	1.64	0.0122	9.41	6.53	4.82
Vanadium Pm2.5 Lc	59	39	0.00207	0.00261	0.00315	0.0126	0.0104	0.00909
Zinc Pm2.5 Lc	59	59	0.0238	0.0238	0.00229	0.173	0.0684	0.0681
Zirconium Pm2.5 Lc	59	14	0.000949	0.00402	0.00801	0.00932	0.00698	0.00688

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	60	41	0.0177	0.0208	0.0186	0.109	0.0676	0.0582
Ammonium Ion Pm2.5 Lc	60	58	0.982	0.982	0.011	3.41	3.05	2.94
Antimony Pm2.5 Lc	60	25	0.00949	0.0207	0.0386	0.0699	0.0489	0.0467
Arsenic Pm2.5 Lc	60	28	0.000693	0.0012	0.00181	0.00339	0.00315	0.00303
Barium Pm2.5 Lc	60	11	0.000506	0.0057	0.0145	0.00805	0.00491	0.00397
Bromine Pm2.5 Lc	60	59	0.00414	0.00416	0.0017	0.0148	0.0132	0.0125
Cadmium Pm2.5 Lc	60	14	0.00128	0.00775	0.0167	0.0116	0.0105	0.00944
Calcium Pm2.5 Lc	60	60	0.0421	0.0421	0.00591	0.211	0.113	0.104
Cerium Pm2.5 Lc	60	7	0.000167	0.00355	0.0155	0.00222	0.00187	0.00175
Cesium Pm2.5 Lc	60	15	0.000722	0.00518	0.0157	0.00759	0.00572	0.00466
Chlorine Pm2.5 Lc	60	50	0.0078	0.00845	0.00697	0.0505	0.0479	0.0358
Chromium Pm2.5 Lc	60	56	0.00214	0.00221	0.00227	0.018	0.0107	0.00825
Cobalt Pm2.5 Lc	60	33	0.000349	0.000663	0.0014	0.00199	0.00161	0.0016
Copper Pm2.5 Lc	60	48	0.00165	0.00186	0.00191	0.00755	0.00712	0.00507
Ec Csn_Rev Unadjusted Pm2.5 Lc	60	60	0.304	0.304		0.765	0.724	0.71
Indium Pm2.5 Lc	60	9	0.00106	0.0101	0.021	0.014	0.0105	0.0105
Iron Pm2.5 Lc	60	60	0.0761	0.0761	0.00195	0.302	0.243	0.174
Lead Pm2.5 Lc	60	41	0.00196	0.00253	0.00381	0.00956	0.00793	0.00711
Magnesium Pm2.5 Lc	60	19	0.00246	0.00684	0.0131	0.019	0.0185	0.0144
Manganese Pm2.5 Lc	60	53	0.00181	0.00192	0.00192	0.00657	0.00443	0.00425
Nickel Pm2.5 Lc	60	29	0.000542	0.000887	0.00138	0.00712	0.00455	0.00273
Oc Csn_Rev Unadjusted Pm2.5 Lc	60	60	2.15	2.15		7.79	3.97	3.69
Phosphorus Pm2.5 Lc	60	1	0.0000315	0.00544	0.011	0.00189	0	0
Potassium Ion Pm2.5 Lc	60	40	0.0294	0.0314	0.0122	0.168	0.111	0.102
Potassium Pm2.5 Lc	60	60	0.052	0.052	0.00646	0.16	0.13	0.114
Rubidium Pm2.5 Lc	60	9	0.000119	0.000993	0.00208	0.00152	0.00128	0.00128
Selenium Pm2.5 Lc	60	47	0.00268	0.00287	0.00215	0.0175	0.0173	0.0164
Silicon Pm2.5 Lc	60	60	0.0586	0.0586	0.0123	0.244	0.177	0.132
Silver Pm2.5 Lc	60	8	0.000573	0.00901	0.0194	0.00933	0.00583	0.00583
Sodium Ion Pm2.5 Lc	60	54	0.0539	0.0543	0.011	0.446	0.189	0.158
Sodium Pm2.5 Lc	60	48	0.0412	0.045	0.0366	0.18	0.15	0.13
Strontium Pm2.5 Lc	60	22	0.000705	0.00153	0.00261	0.0196	0.00233	0.00186
Sulfate Pm2.5 Lc	60	60	2.19	2.19	0.00973	9.55	4.94	4.45
Sulfur Pm2.5 Lc	60	60	0.758	0.758	0.00765	3.25	1.5	1.48
Tin Pm2.5 Lc	60	7	0.000821	0.0124	0.0256	0.0199	0.0101	0.00933
Titanium Pm2.5 Lc	60	37	0.00158	0.00246	0.00465	0.00757	0.00641	0.00605
Total Nitrate Pm2.5 Lc	60	59	1.87	1.87	0.0128	9.52	8.2	7.02
Vanadium Pm2.5 Lc	60	25	0.00056	0.00151	0.00315	0.00489	0.00362	0.00257
Zinc Pm2.5 Lc	60	60	0.0111	0.0111	0.00227	0.0378	0.0349	0.0297
Zirconium Pm2.5 Lc	60	11	0.000886	0.00486	0.00934	0.0151	0.0118	0.00455

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	61	38	0.0123	0.0155	0.0187	0.0617	0.0532	0.0455
Ammonium Ion Pm2.5 Lc	60	54	0.434	0.434	0.0138	2.02	2.01	1.77
Antimony Pm2.5 Lc	61	22	0.0078	0.0209	0.0397	0.0922	0.0665	0.0584
Arsenic Pm2.5 Lc	61	30	0.000436	0.000922	0.00171	0.00255	0.0021	0.0016
Barium Pm2.5 Lc	61	1	0.0000384	0.00559	0.0113	0.00234	0	0
Bromine Pm2.5 Lc	61	56	0.00224	0.00231	0.00164	0.00863	0.00602	0.00595
Cadmium Pm2.5 Lc	61	10	0.000765	0.00763	0.0168	0.014	0.007	0.00584
Calcium Pm2.5 Lc	61	59	0.0221	0.0222	0.00605	0.115	0.0934	0.0703
Cerium Pm2.5 Lc	61	3	0.0000459	0.00371	0.0103	0.00152	0.00093	0.00035
Cesium Pm2.5 Lc	61	11	0.000534	0.00554	0.0145	0.0063	0.00584	0.00374
Chlorine Pm2.5 Lc	61	41	0.00391	0.00513	0.00672	0.0481	0.0193	0.0119
Chromium Pm2.5 Lc	61	42	0.00108	0.00143	0.00229	0.00777	0.00407	0.00404
Cobalt Pm2.5 Lc	61	37	0.000258	0.000533	0.00135	0.00104	0.00092	0.00085
Copper Pm2.5 Lc	61	32	0.000457	0.00092	0.00187	0.00401	0.00203	0.00199
Ec Csn_Rev Unadjusted Pm2.5 Lc	60	59	0.0833	0.0847		0.312	0.197	0.175
Indium Pm2.5 Lc	61	13	0.00193	0.0107	0.0211	0.0315	0.021	0.0163
Iron Pm2.5 Lc	61	61	0.0218	0.0218	0.00183	0.0667	0.0626	0.0507
Lead Pm2.5 Lc	61	17	0.000472	0.00178	0.00364	0.0042	0.00409	0.00303
Magnesium Pm2.5 Lc	61	14	0.00214	0.00699	0.0128	0.0275	0.0193	0.014
Manganese Pm2.5 Lc	61	36	0.00066	0.00103	0.00184	0.00312	0.00252	0.00245
Nickel Pm2.5 Lc	61	20	0.000266	0.000703	0.00133	0.00939	0.00193	0.00098
Oc Csn_Rev Unadjusted Pm2.5 Lc	60	60	1.42	1.42		3.63	2.82	2.81
Phosphorus Pm2.5 Lc	61	0	0	0.0058	0.0116	0	0	0
Potassium Ion Pm2.5 Lc	60	35	0.0213	0.0247	0.0144	0.214	0.0661	0.0608
Potassium Pm2.5 Lc	61	61	0.0342	0.0342	0.00663	0.0948	0.0795	0.0765
Rubidium Pm2.5 Lc	61	11	0.00015	0.00101	0.00201	0.00176	0.00166	0.00111
Selenium Pm2.5 Lc	61	24	0.000318	0.000937	0.0021	0.00206	0.00202	0.00193
Silicon Pm2.5 Lc	61	54	0.0364	0.0371	0.0125	0.177	0.171	0.124
Silver Pm2.5 Lc	61	12	0.00141	0.00894	0.0189	0.0117	0.0105	0.0105
Sodium Ion Pm2.5 Lc	60	49	0.0392	0.0401	0.012	0.573	0.127	0.116
Sodium Pm2.5 Lc	61	35	0.0173	0.0261	0.0369	0.162	0.0923	0.0795
Strontium Pm2.5 Lc	61	19	0.000294	0.00117	0.00252	0.00665	0.00152	0.00105
Sulfate Pm2.5 Lc	60	60	1.35	1.35	0.00867	4.95	4.17	3.47
Sulfur Pm2.5 Lc	61	61	0.468	0.468	0.00799	1.93	1.39	1.32
Tin Pm2.5 Lc	61	17	0.00384	0.0134	0.0261	0.0268	0.0222	0.021
Titanium Pm2.5 Lc	61	24	0.000616	0.00205	0.00472	0.0063	0.00537	0.00385
Total Nitrate Pm2.5 Lc	60	60	0.818	0.818	0.0143	5.57	4.51	3.88
Vanadium Pm2.5 Lc	61	21	0.000198	0.00127	0.00325	0.00199	0.0014	0.00105
Zinc Pm2.5 Lc	61	60	0.00403	0.00406	0.00234	0.0121	0.012	0.0118
Zirconium Pm2.5 Lc	61	12	0.000618	0.00408	0.00889	0.00817	0.00689	0.00525

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	60	38	0.013	0.016	0.0179	0.106	0.0828	0.065
Ammonium Ion Pm2.5 Lc	60	58	0.91	0.911	0.0141	3.34	2.9	2.53
Antimony Pm2.5 Lc	60	19	0.00598	0.0198	0.0379	0.0523	0.042	0.0326
Arsenic Pm2.5 Lc	60	28	0.000664	0.00113	0.00169	0.00372	0.00263	0.00233
Barium Pm2.5 Lc	60	5	0.000245	0.00512	0.0139	0.00665	0.00456	0.00198
Bromine Pm2.5 Lc	60	55	0.00373	0.0038	0.00163	0.0124	0.0115	0.01
Cadmium Pm2.5 Lc	60	9	0.00123	0.00837	0.0165	0.028	0.0128	0.00698
Calcium Pm2.5 Lc	60	59	0.0259	0.0259	0.00608	0.125	0.0729	0.067
Cerium Pm2.5 Lc	60	7	0.0000718	0.0042	0.0144	0.00234	0.0007	0.00058
Cesium Pm2.5 Lc	60	11	0.000683	0.00574	0.0161	0.00804	0.00605	0.00537
Chlorine Pm2.5 Lc	60	47	0.0064	0.00733	0.00702	0.0589	0.0267	0.0234
Chromium Pm2.5 Lc	60	44	0.00162	0.00192	0.00228	0.0123	0.00836	0.00559
Cobalt Pm2.5 Lc	60	36	0.000276	0.00055	0.00138	0.00132	0.00116	0.00102
Copper Pm2.5 Lc	60	46	0.00133	0.00156	0.00187	0.0101	0.00493	0.00436
Ec Csn_Rev Unadjusted Pm2.5 Lc	61	61	0.17	0.17		0.432	0.385	0.371
Indium Pm2.5 Lc	60	9	0.00119	0.0096	0.0201	0.0151	0.0117	0.0117
Iron Pm2.5 Lc	60	60	0.0398	0.0398	0.0019	0.126	0.0948	0.0828
Lead Pm2.5 Lc	60	40	0.00164	0.00229	0.00369	0.00864	0.00664	0.00593
Magnesium Pm2.5 Lc	60	19	0.00225	0.00669	0.0132	0.0261	0.0249	0.0178
Manganese Pm2.5 Lc	60	50	0.00287	0.00303	0.00189	0.0296	0.0135	0.0124
Nickel Pm2.5 Lc	60	25	0.000309	0.000686	0.00136	0.00434	0.00294	0.00268
Oc Csn_Rev Unadjusted Pm2.5 Lc	61	61	1.89	1.89		4.14	3.42	3.35
Phosphorus Pm2.5 Lc	60	1	0.0000855	0.0057	0.0114	0.00513	0	0
Potassium Ion Pm2.5 Lc	60	44	0.0442	0.046	0.0144	0.813	0.215	0.111
Potassium Pm2.5 Lc	60	59	0.056	0.0561	0.00662	0.309	0.262	0.134
Rubidium Pm2.5 Lc	60	13	0.000149	0.000937	0.00202	0.00119	0.00117	0.00105
Selenium Pm2.5 Lc	60	38	0.00079	0.00115	0.00208	0.00675	0.00454	0.00356
Silicon Pm2.5 Lc	60	56	0.0447	0.0452	0.0122	0.214	0.172	0.125
Silver Pm2.5 Lc	60	2	0.0000835	0.00875	0.0178	0.00349	0.00152	0
Sodium Ion Pm2.5 Lc	60	53	0.0348	0.0353	0.0122	0.154	0.115	0.0938
Sodium Pm2.5 Lc	60	44	0.0266	0.0325	0.0371	0.176	0.0959	0.0835
Strontium Pm2.5 Lc	60	15	0.000334	0.00129	0.00251	0.00502	0.00361	0.00233
Sulfate Pm2.5 Lc	60	60	1.89	1.89	0.00872	6.95	4.7	3.79
Sulfur Pm2.5 Lc	60	59	0.702	0.702	0.0079	2.85	1.52	1.42
Tin Pm2.5 Lc	60	10	0.00189	0.0126	0.025	0.0257	0.0175	0.0152
Titanium Pm2.5 Lc	60	39	0.00146	0.00228	0.00471	0.0128	0.00513	0.0049
Total Nitrate Pm2.5 Lc	60	58	1.8	1.8	0.0137	9.31	7.59	5.62
Vanadium Pm2.5 Lc	60	21	0.000309	0.00136	0.00321	0.00264	0.00233	0.00186
Zinc Pm2.5 Lc	60	59	0.0108	0.0108	0.0023	0.0382	0.0381	0.0299
Zirconium Pm2.5 Lc	60	13	0.000604	0.00339	0.00803	0.00652	0.00581	0.00443

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	97	61	0.0173	0.0207	0.0188	0.466	0.078	0.0717
Ammonium Ion Pm2.5 Lc	98	97	0.905	0.905	0.0126	4.51	4.48	3.69
Antimony Pm2.5 Lc	97	28	0.00719	0.0209	0.0372	0.0653	0.0642	0.0605
Arsenic Pm2.5 Lc	97	57	0.000838	0.00123	0.00168	0.00583	0.00512	0.00386
Barium Pm2.5 Lc	97	15	0.00188	0.00628	0.0128	0.133	0.00968	0.0076
Bromine Pm2.5 Lc	97	92	0.00359	0.00363	0.00157	0.0134	0.0128	0.0122
Cadmium Pm2.5 Lc	97	19	0.00139	0.00777	0.0157	0.0128	0.0128	0.0116
Calcium Pm2.5 Lc	97	97	0.0414	0.0414	0.00626	0.232	0.192	0.148
Cerium Pm2.5 Lc	97	14	0.000131	0.00355	0.0127	0.00222	0.0021	0.00128
Cesium Pm2.5 Lc	97	19	0.000716	0.00568	0.0148	0.00817	0.0078	0.0056
Chlorine Pm2.5 Lc	97	84	0.0189	0.0195	0.00712	0.346	0.216	0.134
Chromium Pm2.5 Lc	97	83	0.00204	0.0022	0.00225	0.0268	0.0143	0.00694
Cobalt Pm2.5 Lc	97	58	0.000382	0.00067	0.00138	0.00189	0.00157	0.00135
Copper Pm2.5 Lc	97	91	0.00465	0.00472	0.00196	0.0475	0.0324	0.0183
Ec Csn_Rev Unadjusted Pm2.5 Lc	99	99	0.326	0.326		1.25	1.11	0.903
Indium Pm2.5 Lc	97	19	0.00179	0.00974	0.0196	0.028	0.0199	0.0163
Iron Pm2.5 Lc	97	97	0.0779	0.0779	0.00192	0.357	0.331	0.257
Lead Pm2.5 Lc	97	68	0.00218	0.00274	0.00357	0.0112	0.0091	0.00852
Magnesium Pm2.5 Lc	97	43	0.00556	0.00927	0.0138	0.208	0.0385	0.0217
Manganese Pm2.5 Lc	97	82	0.00245	0.0026	0.00185	0.0162	0.0109	0.00811
Nickel Pm2.5 Lc	97	47	0.000429	0.000795	0.0014	0.0063	0.00457	0.00449
Oc Csn_Rev Unadjusted Pm2.5 Lc	99	99	2.38	2.38		7.63	6.99	5.71
Phosphorus Pm2.5 Lc	97	1	0.0000703	0.00568	0.0113	0.00682	0	0
Potassium Ion Pm2.5 Lc	98	79	0.0631	0.0644	0.0136	2.64	0.27	0.16
Potassium Pm2.5 Lc	97	97	0.0829	0.0829	0.00721	2.64	0.195	0.176
Rubidium Pm2.5 Lc	97	30	0.000235	0.000936	0.00194	0.00161	0.00141	0.00131
Selenium Pm2.5 Lc	97	54	0.000537	0.001	0.00216	0.00362	0.00306	0.00304
Silicon Pm2.5 Lc	97	96	0.0658	0.0658	0.0131	0.947	0.212	0.184
Silver Pm2.5 Lc	97	19	0.000875	0.00813	0.017	0.0128	0.0105	0.00935
Sodium Ion Pm2.5 Lc	98	89	0.0393	0.0396	0.0119	0.153	0.148	0.135
Sodium Pm2.5 Lc	97	69	0.0265	0.0325	0.0393	0.215	0.135	0.127
Strontium Pm2.5 Lc	97	36	0.00125	0.00202	0.00242	0.0439	0.0156	0.0137
Sulfate Pm2.5 Lc	98	98	1.76	1.76	0.0101	5.33	4.72	4.48
Sulfur Pm2.5 Lc	97	97	0.617	0.617	0.00803	1.97	1.69	1.62
Tin Pm2.5 Lc	97	16	0.00204	0.0125	0.0246	0.0281	0.0269	0.0198
Titanium Pm2.5 Lc	97	61	0.00223	0.00311	0.00475	0.0314	0.0106	0.00934
Total Nitrate Pm2.5 Lc	98	98	1.72	1.72	0.0131	10.5	10.4	9.88
Vanadium Pm2.5 Lc	97	37	0.000345	0.00137	0.00321	0.00355	0.00292	0.00222
Zinc Pm2.5 Lc	97	97	0.0118	0.0118	0.00234	0.0591	0.0473	0.0471
Zirconium Pm2.5 Lc	97	15	0.000688	0.0038	0.00761	0.0158	0.00841	0.00816

Appendix C: 2012 AQI Pie Charts

Appendix C contains pie charts that were created to show the AQI values for each of Michigan's 2012 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 O3 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

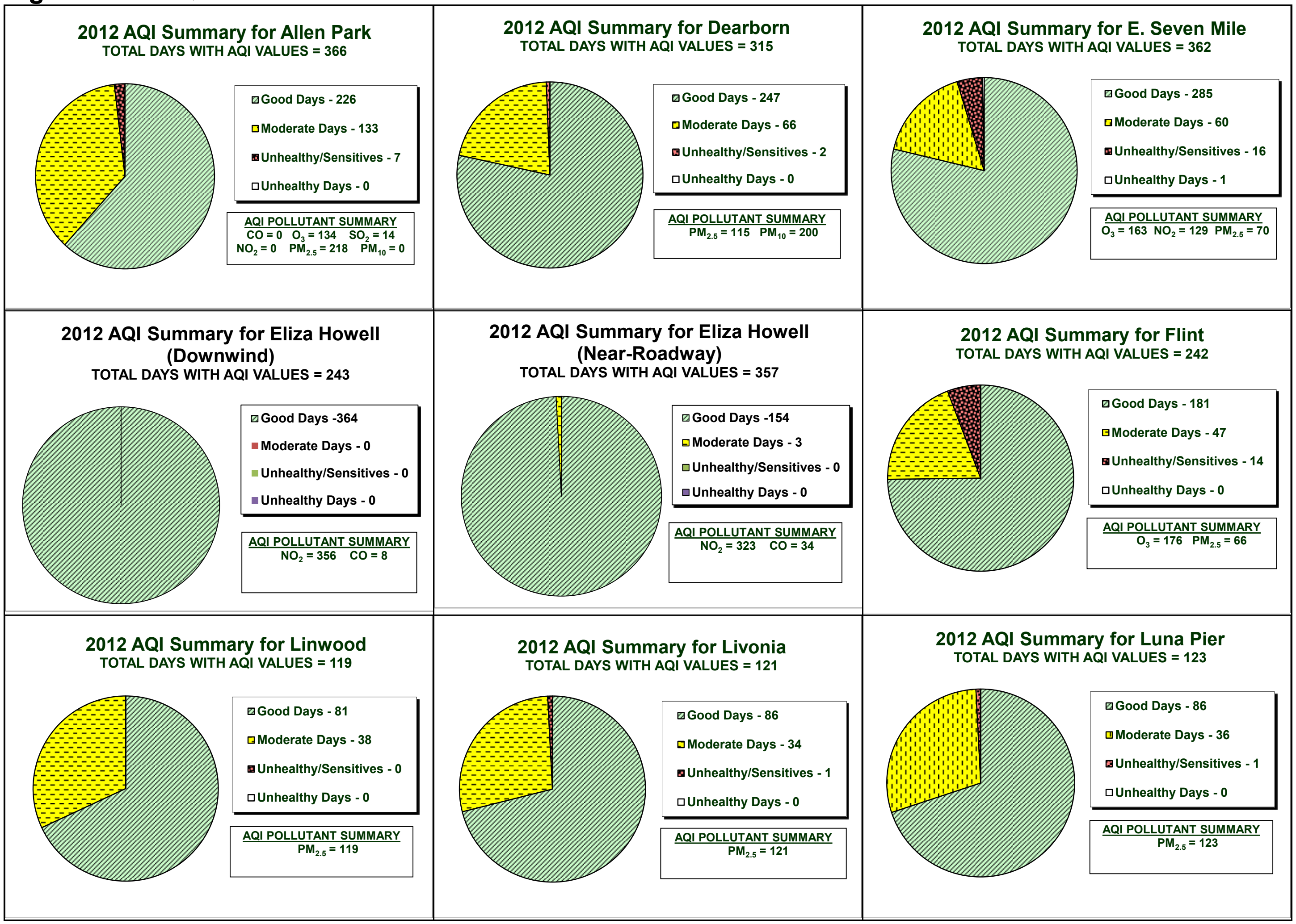


Figure C1, continued: AQI Summaries for Detroit-Warren-Flint-CSA

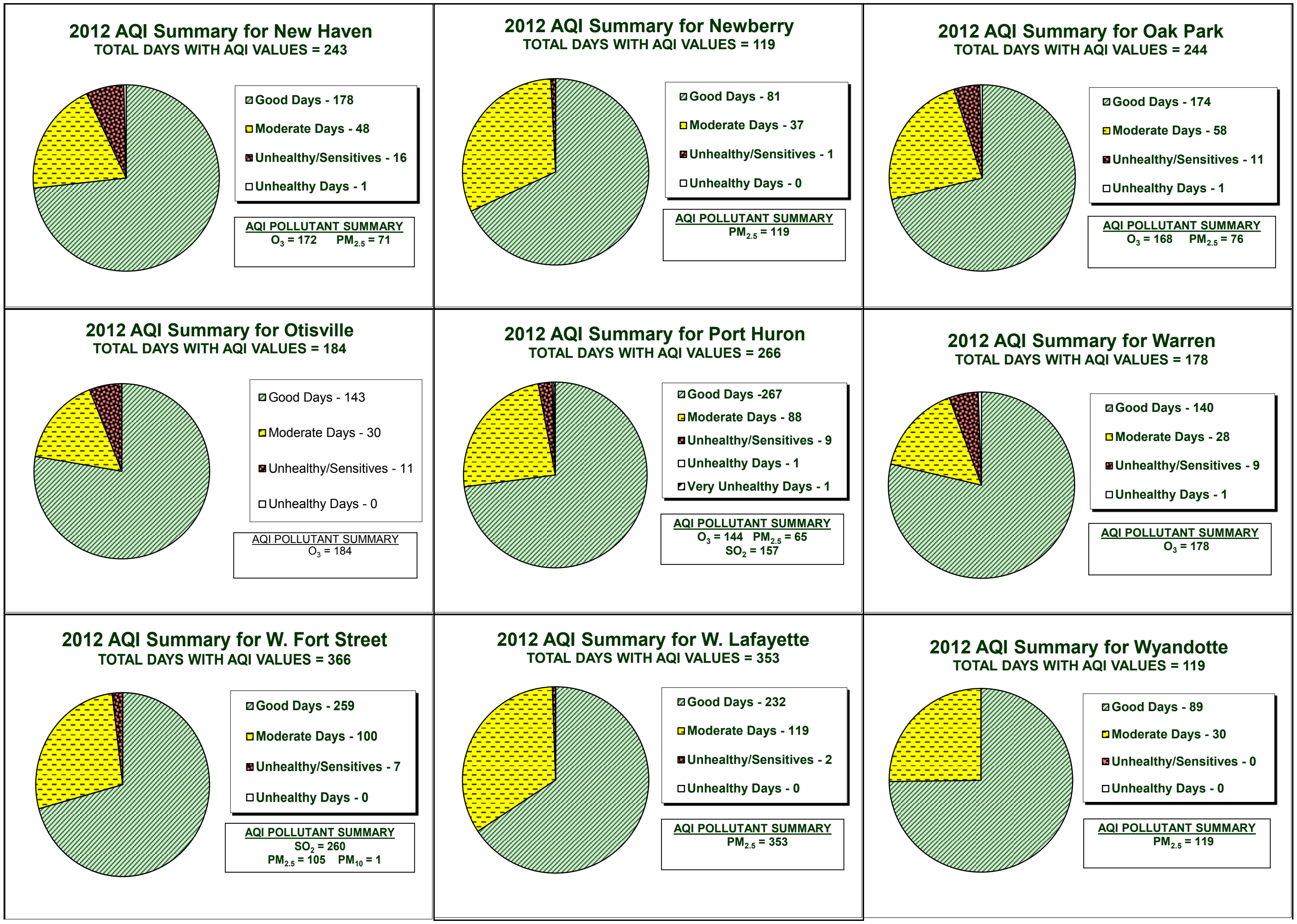


Figure C1, continued: AQI Summaries for Detroit-Warren-Flint-CSA

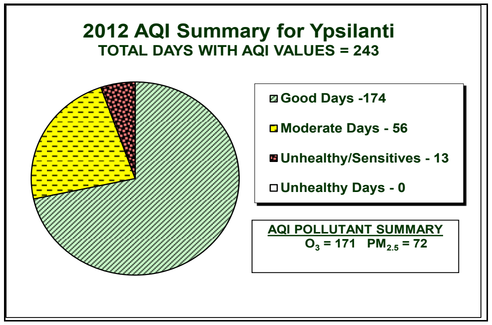
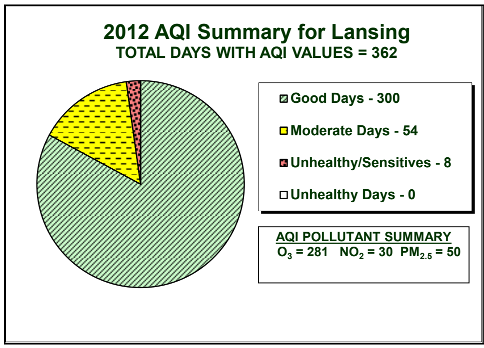


Figure C2: AQI Summaries for Lansing-East Lansing-Owosso CSA



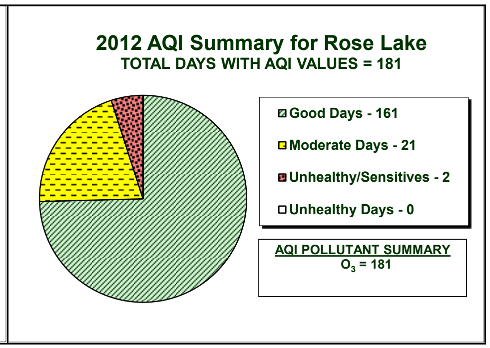


Figure C3: AQI Summary for Saginaw-Bay City-Saginaw Twp North CSA

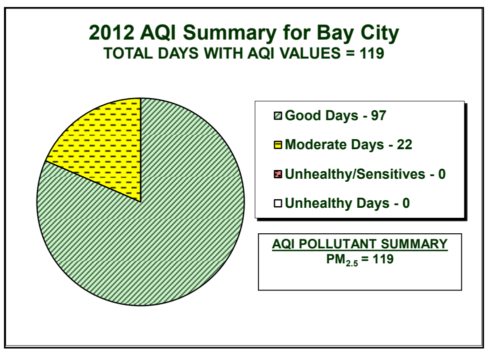


Figure C4: AQI Summaries for Grand Rapids-Muskegon-Holland CSA

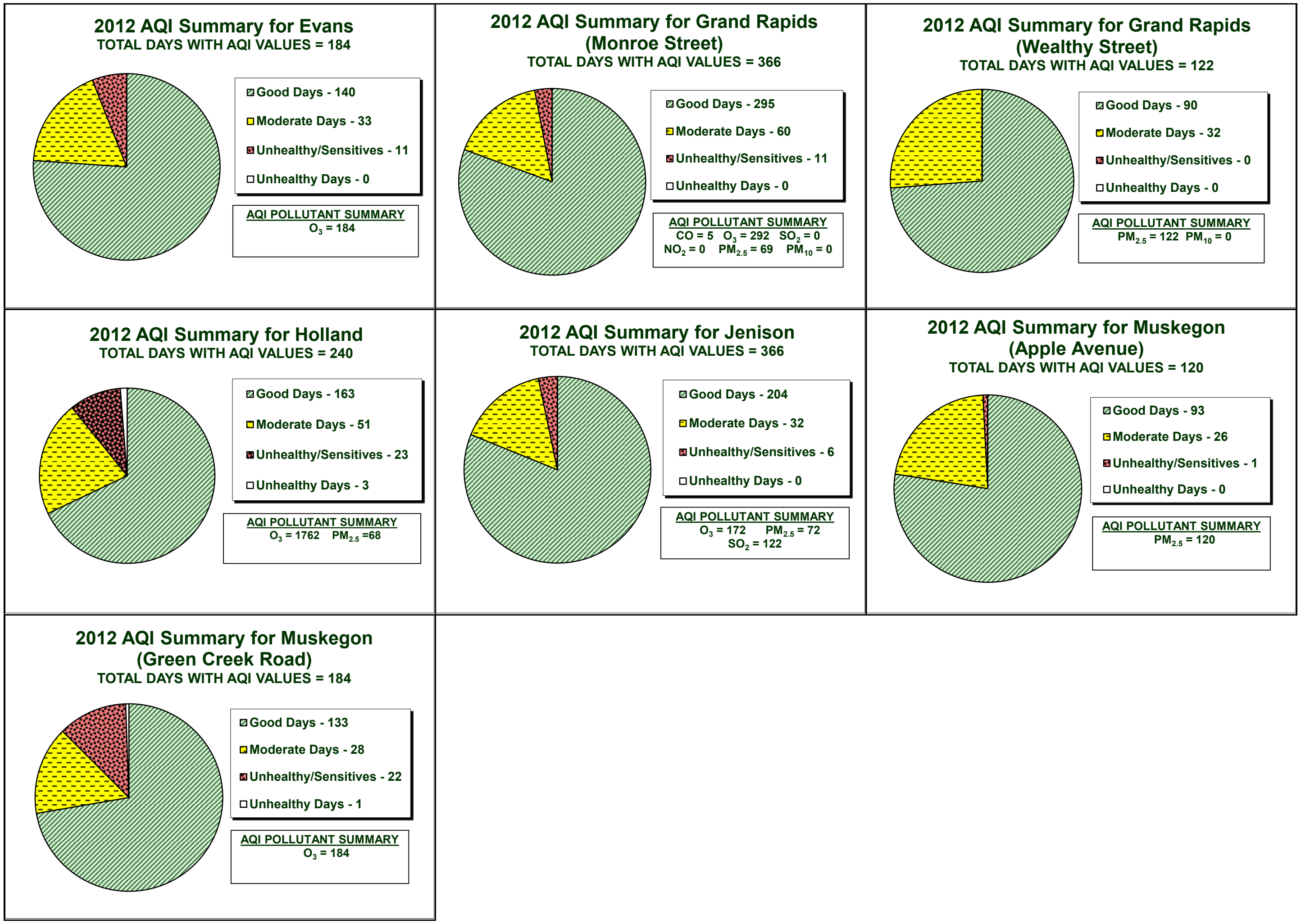
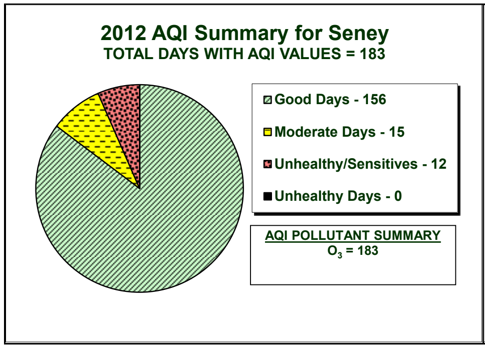


Figure C5: AQI Summary for Upper Peninsula



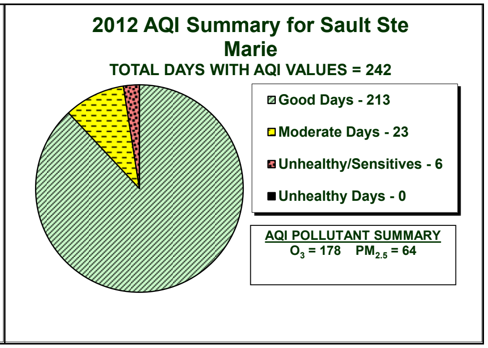
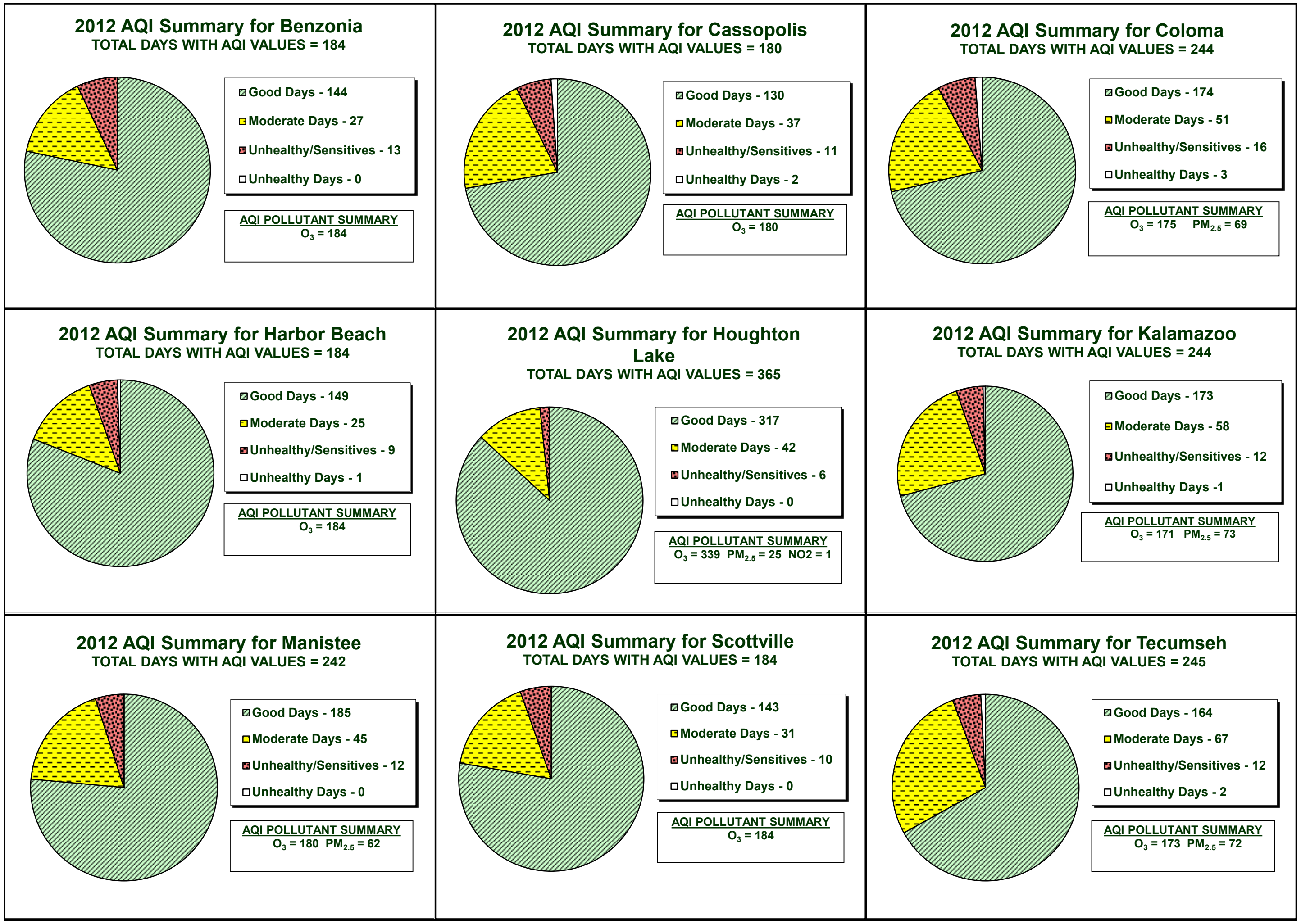


Figure C6: AQI Summaries for Michigan's Other Lower Peninsula Areas



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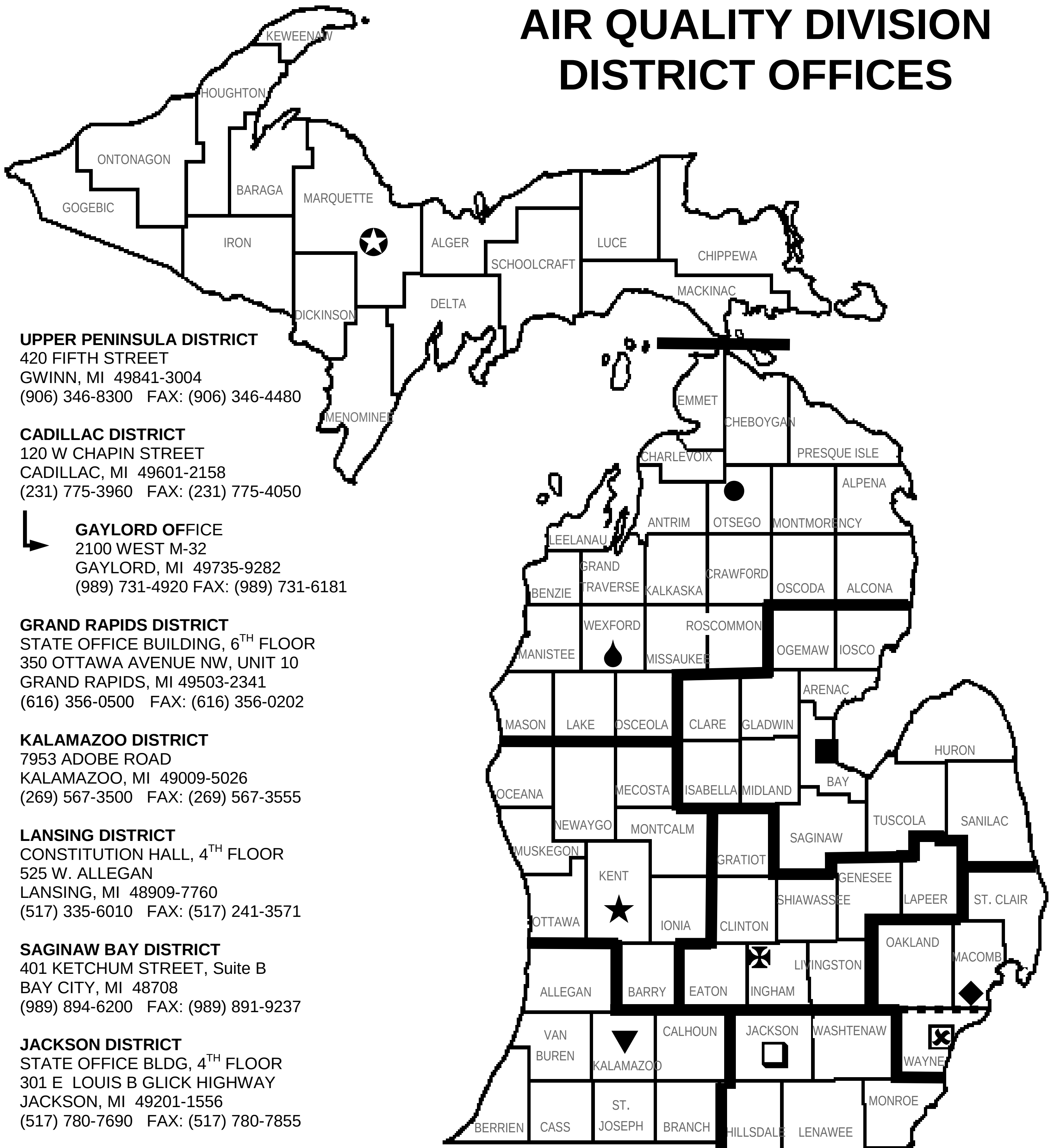

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