2015 Annual Air Quality Report

Michigan

DEQ Department of Environmental Quality

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Cover Photos: Top – Barn near West Branch, and Lower Right – Au Sable River in Iosco County, Courtesy of Andrew Kent, Lower Left – Ostego Lake State Park, Courtesy of Becky Radulski

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APPENDICES

2015 Air Quality Report

Introduction

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

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

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

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

- Michigan's monitoring requirements for 2015,
- Attainment/nonattainment status,
- Monitoring site locations (tables show all the monitors active in 2015), and
- Air quality trends from 2010-2015 broken down by location.[1]

The 2015 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 2015 air quality data, air quality trends, overview of the monitoring network (available in much greater detail in the 2016 Network Review)[3], air toxics monitoring program, and other AQD programs, such as MIair and Emissions Inventory[4].

[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 https://www3.epa.gov/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/documents/deq/deq-aqd-toxics-2016_Air_Mon_Network_Review_489490_7.pdf
[4] Online information about criteria pollutants and air toxics, along with this and previous annual air quality reports, are available via the AQD's website at http://www.michigan.gov/deq/0,4561,7-135-3310_4195---,00.html

Chapter 1: Background Information

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

National Ambient Air Quality Standards (NAAQS)

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

In addition, the NAAQS have various averaging times to address health impacts. Short averaging times reflect the potential for acute (immediate) effects, whereas long-term averaging times are designed to protect against chronic (long term) 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 2015. 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 2015 for Criteria Pollutants

Pollutant	Primary (health-related)		Secondary (welfare-related)	
	Level	Averaging Time	Level	Averaging Time
Carbon Monoxide (CO)	9 ppm ($10\ mg/m^3$)	8-hour average, not to be exceeded more than once per year *(1971)*	None*	
	35 ppm ($40\ mg/m^3$)	1-hour average, not to be exceeded more than once per year *(1971)*		
Lead (Pb)	$0.15\ \mu g/m^3$	Maximum rolling 3-month average *(2008)*	Same as Primary	
Nitrogen Dioxide (NO_2)	0.053 ppm ($100\ \mu g/m^3$)	Annual mean *(1971)*	Same as Primary	
	0.100 ppm	98^{th} percentile of 1-hr average, averaged over 3-years *(2010)*	None	
Particulate Matter (PM_{10})	$150\ \mu g/m^3$	24-hour average, not to be exceeded more than once per year over 3 years *(1987)*	Same as Primary	
Particulate Matter ($PM_{2.5}$)	$12.0\ \mu g/m^3$	Annual mean, averaged over 3 years *(2012)*	$15.0\ \mu g/m^3$	Annual mean
	$35\ \mu g/m^3$	98^{th} percentile of 24-hour concentration, averaged over 3 years *(2006)*	Same as Primary	
Ozone (O_3)	0.075 ppm†	Annual 4^{th} highest 8-hour daily max averaged over 3 years *(2008)*	Same as Primary	
Sulfur Dioxide (SO_2)	0.075 ppm	99^{th} percentile of 1-hour daily max averaged over 3 years *(2010)*	0.5 ppm	3 hours

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

†EPA changed the standard to 0.070 after the 2015 ozone season, so 2015 ozone data is based on the 0.075 ppm standard.

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

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

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

*****_98th percentile daily maximum 1-hour value_ is the value below which nominally 98 percent of all daily maximum 1-hour concentration values fall, using the ranking and selection method specified in section 5.2 of appendix S of CFR Part 50.

****** _98th percentile_ is the daily value out of a year of $PM_{2.5}$ monitoring data below which 98 percent of all daily values fall using the ranking and selection method specified in section 4.5(a) of appendix N of CFR Part 50.

*******_99th percentile daily maximum 1-hour value_ is the value below which nominally 99 percent of all daily maximum 1-hour concentration values fall, using the ranking and selection method specified in section 5 of appendix T of CFR Part 50.

†EPA changed the standard to 0.070 after the 2015 ozone season, so 2015 ozone data is based on the 0.075 ppm standard.

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

Michigan Air Sampling Network

The Michigan Air Sampling Network (MASN) is operated by the DEQ's AQD, along with other governmental agencies. For instance, the O_3 and $PM_{2.5}$ monitors in Manistee County and Chippewa County are tribal monitors handled by the Little River Band of Ottawa Indians and the Inter-tribal Council of Michigan, respectively. **Figure 1.1** shows the 2015 MASN monitoring

[5] Most recent Network Reviews found online at: http://www.michigan.gov/documents/deq/deq-aqd-toxics-2016_Air_Mon_Network_Review_489490_7.pdf

sites. **Figures 1.2** and **1.3** are pictures of two monitoring stations; one at Port Huron and the other at Houghton Lake, respectively.

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 provide real-time hourly data, and $PM_{2.5}$ chemical speciation monitors determine the chemical composition of $PM_{2.5}$. The MASN data is also used to provide timely reporting to the DEQ's air quality reporting web page (discussed in **Chapter 9**). The types of monitoring conducted in 2015 and the MASN locations are shown in **Table 1.3.**

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

The **Near Road-NO_2 Monitoring network** will focus on vehicle emissions and how they disperse near roadways. In 2011 Michigan took over EPA's pre-existing near-roadway site at Eliza Howell Park in Detroit. A second near road site was added in Livonia in January 2015. Data from these sites are discussed further in **Chapters 2** and **5.**

Figure 1.1: 2015 MASN Monitoring Sites

Figure 1.2: Port Huron Monitoring Site

Figure 1.3: Houghton Lake Monitoring Site

Table 1.3 Types of Monitoring Conducted in 2015 and MASN Location

Area	AIRS ID	Site Name	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				√		√	√	√+E						√			√
	260990009	New Haven				√		√								√	√	√	
	260991003	Warren				√													
	261250001	Oak Park				√		√								√			
	261470005	Port Huron				√		√	√		√					√			
	261470031	Port Huron-Rural St.													√@+Pb				
	261610008	Ypsilanti				√		√	√							√			√
	261630001	Allen Park	√*		√	√	√	√	√	√+A		√			√@+Pb	√	√		√
	261630005	River Rouge					√							√	√@	√			
	261630015	Detroit-W. Fort St.					√	√		√	√		√	√	√@	√	√		√
	261630016	Detroit-Linwood						√											
	261630019	Detroit-E. Seven Mile		√		√		√								√	√		√
	261630025	Livonia						√								√	√		√
	261630027	Detroit-W. Jefferson													√@				
	261630033	Dearborn					√	√	√	√+EA			√	√	√ + Pb	√	√		√
	261630036	Wyandotte						√											
	261630039	Detroit-W. Lafayette						√	√							√			
	261630093	Eliza Howell-Near Roadwa	√	√												√			
	261630094	Eliza Howell-Downwind	√	√												√	√		√
	261630095	Livonia-Near Roadway	√	√				√								√	√		√
Flint	260490021	Flint				√		√	√							√			√
	260492001	Otisville				√										√			
Grand Rapids	261390005	Jenison				√										√			
	261390011	West Olive									√					√			
	260810007	Grand Rapids-Wealthy						√											
	260810020	Grand Rapids-Monroe	√*		√	√	√	√	√	√		√			√@+Pb	√			√
	260810022	Evans				√										√			
Lansing/East Lansing	260650012	Lansing		√		√		√	√		√					√			√
	260370001	Rose Lake				√													
Monroe Co	261150006	Sterling State Park						√			√					√			
Huron Co	260630007	Harbor Beach				√										√			
Bay Co	260170014	Bay City						√	√							√			
MissaukeeCo	261130001	Houghton Lake		√		√		√	√							√			√
Allegan Co	260050003	Holland				√		√								√	√	√	√
Benzie Co	260190003	Benzonia				√													
Berrien Co	260210014	Coloma				√		√								√			
Cass Co	260270003	Cassopolis				√										√			
Kalamazoo Co	260770008	Kalamazoo				√		√	√							√			
Manistee Co	261010922	Manistee $				√		√								√		√	√
Mason Co	261050007	Scottville				√										√			
Muskegon Co	261210039	Muskegon-Green				√										√			
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				

√ = Data Collected
= Mn only
@ = Mn, As, Cd, Ni
Pb = Lead
$ = Tribal monitor
* = Trace CO monitor
E = EC/OC monitor
A = Aethalometer monitor

Quality Assurance

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

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

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

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

Long-term Trends

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

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

Due to the vast availability of historical data, criteria pollutant data from Southeast Michigan are shown in **Figures 1.4** through **1.9.** These figures show how the ambient levels and the standards for these pollutants have changed over the last 35 plus years. Since this area is highly industrialized it is a good indicator of the Air Quality improvement for the rest of the state.

Figure 1.4 shows the ozone levels at the Detroit E. 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 and to 0.070 at the end of 2015. Since the final rule of the 2015 NAAQS became effective after the 2015 ozone season, the 2015 data is evaluated based on the 2008 standard.

Figure 1.4: Historical Ozone at DEQ's Detroit E. Seven Mile Site

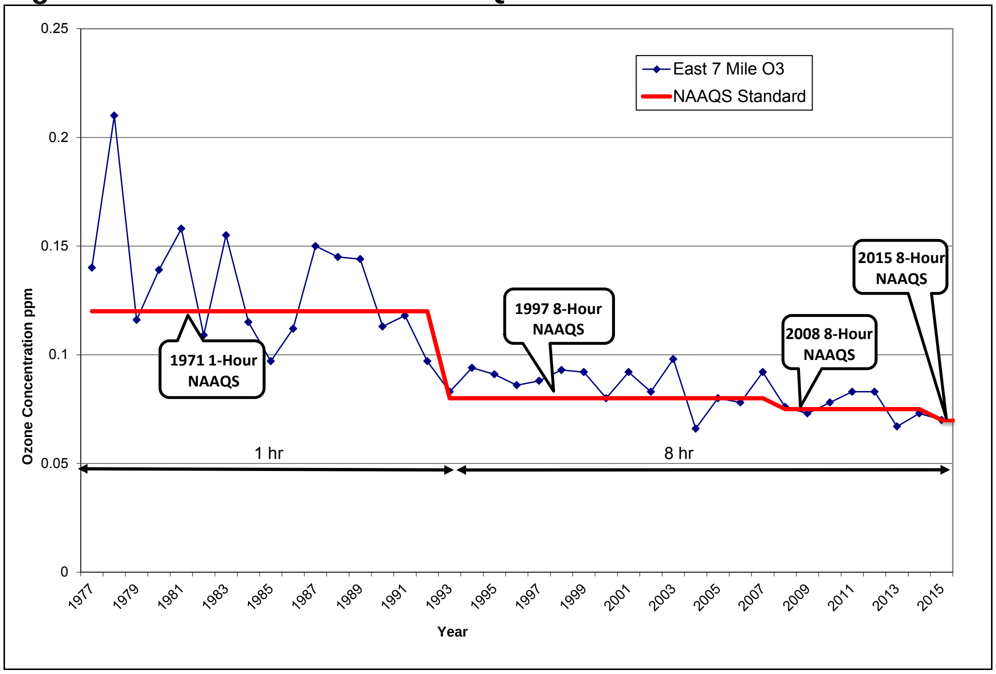


Figure 1.5 shows the SO_2 trend for the old annual standard and the new 1-hour standard for W. Fort Street (SWHS) in Detroit. In 2010, the EPA changed the standard from an annual average to 99th percentile of a 1-hour standard in which the SO_2 concentration cannot exceed 0.075 ppm averaged over 3 years.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

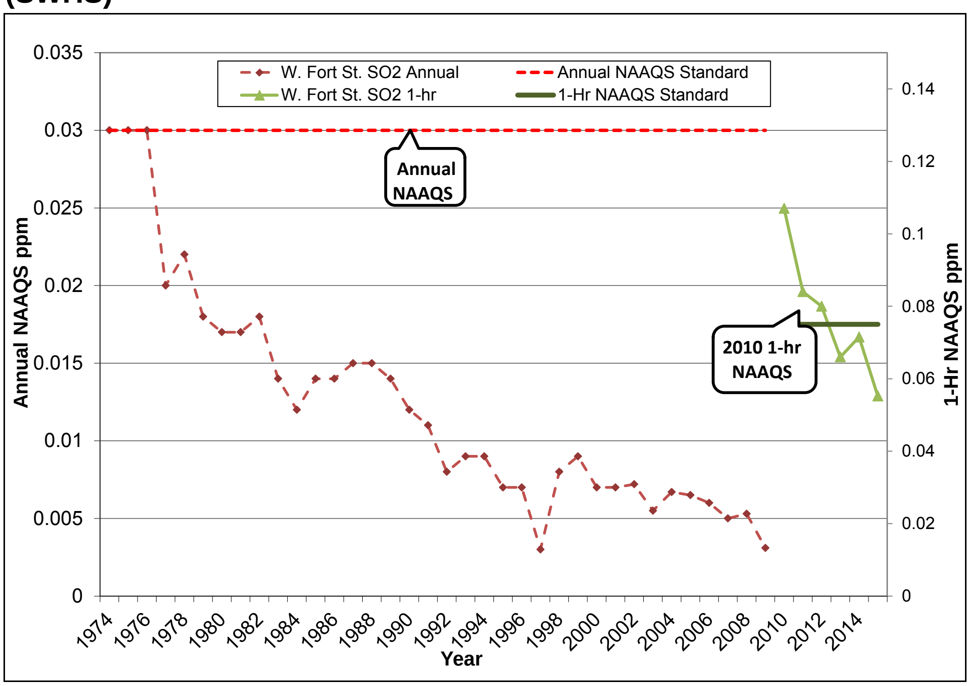


Figure 1.6 shows the CO trend at Allen Park to be well below the 1-hour standard of 35 ppm, which has remained unchanged since 1971.

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

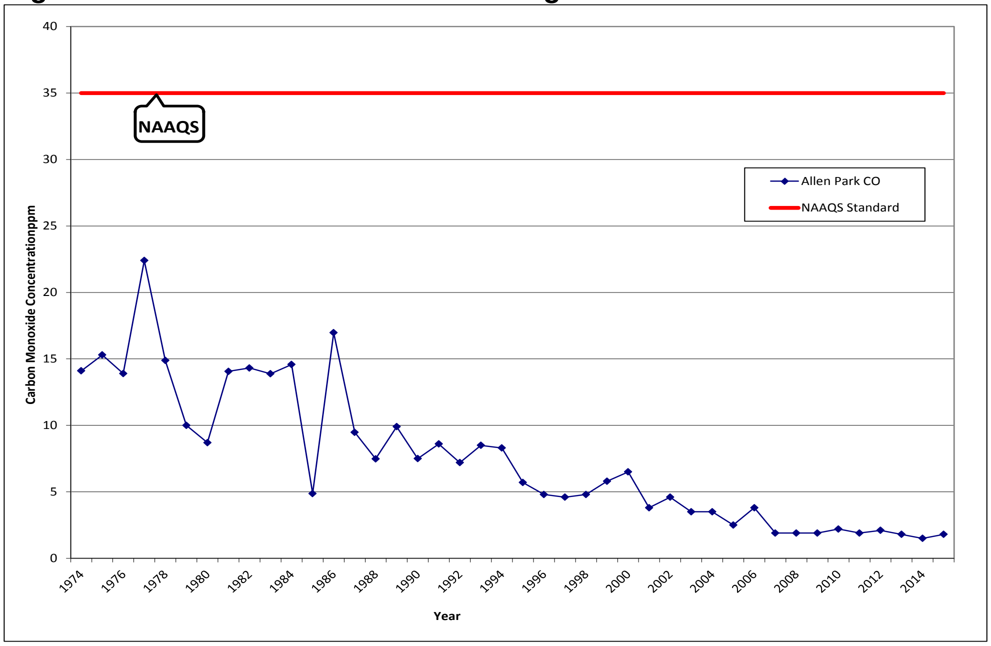


Figure 1.7 shows the trend for lead at Dearborn. Lead is of concern because lead is harmful to the neurological development of children. The largest decrease in lead in the air is due to the removal of lead in gasoline. By 1975, most newly manufactured vehicles no longer required leaded gasoline, and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

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

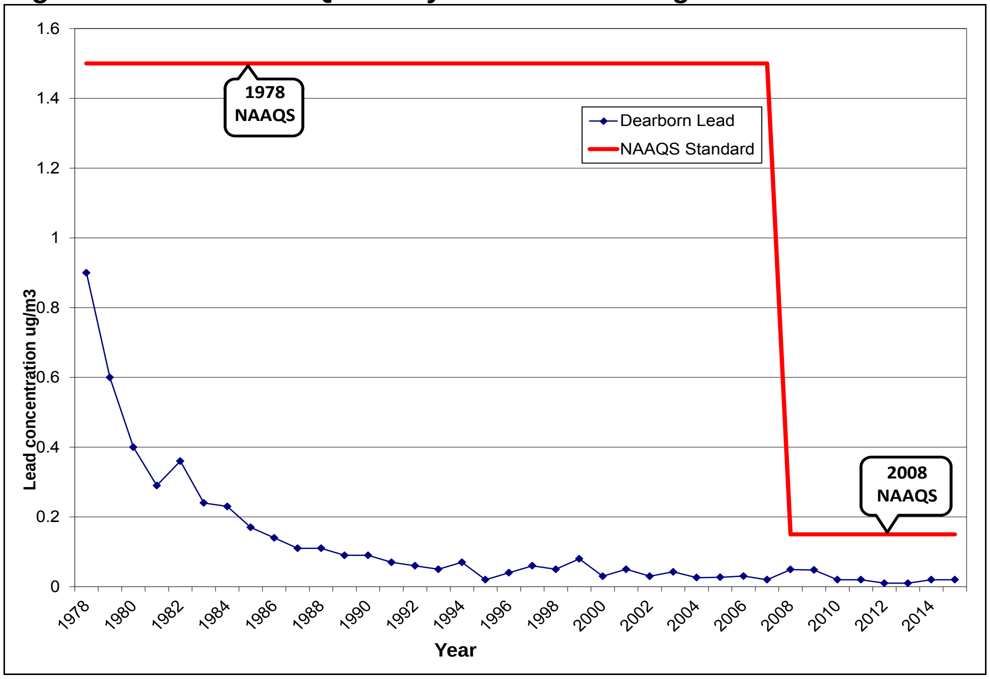


Figure 1.8 shows the trend for NO_2. NO_2 has been well below the annual standard of 53 ppb, and shows a downward trend. In 2010, EPA added a 1-hour standard of the 98^{th} percentile not to exceed 100 ppb averaged over three years. One-hour NO_2 concentrations in Michigan have also maintained well below the standard.

Figure 1.8: Historical Annual NO_2 at E. Seven Mile Road.

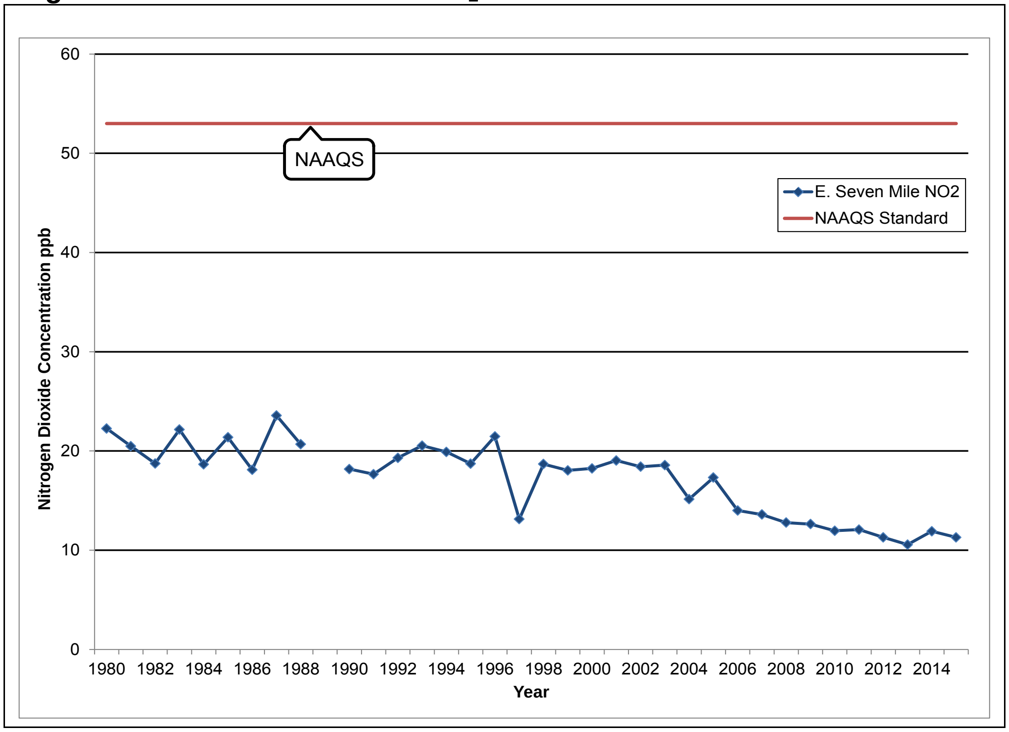
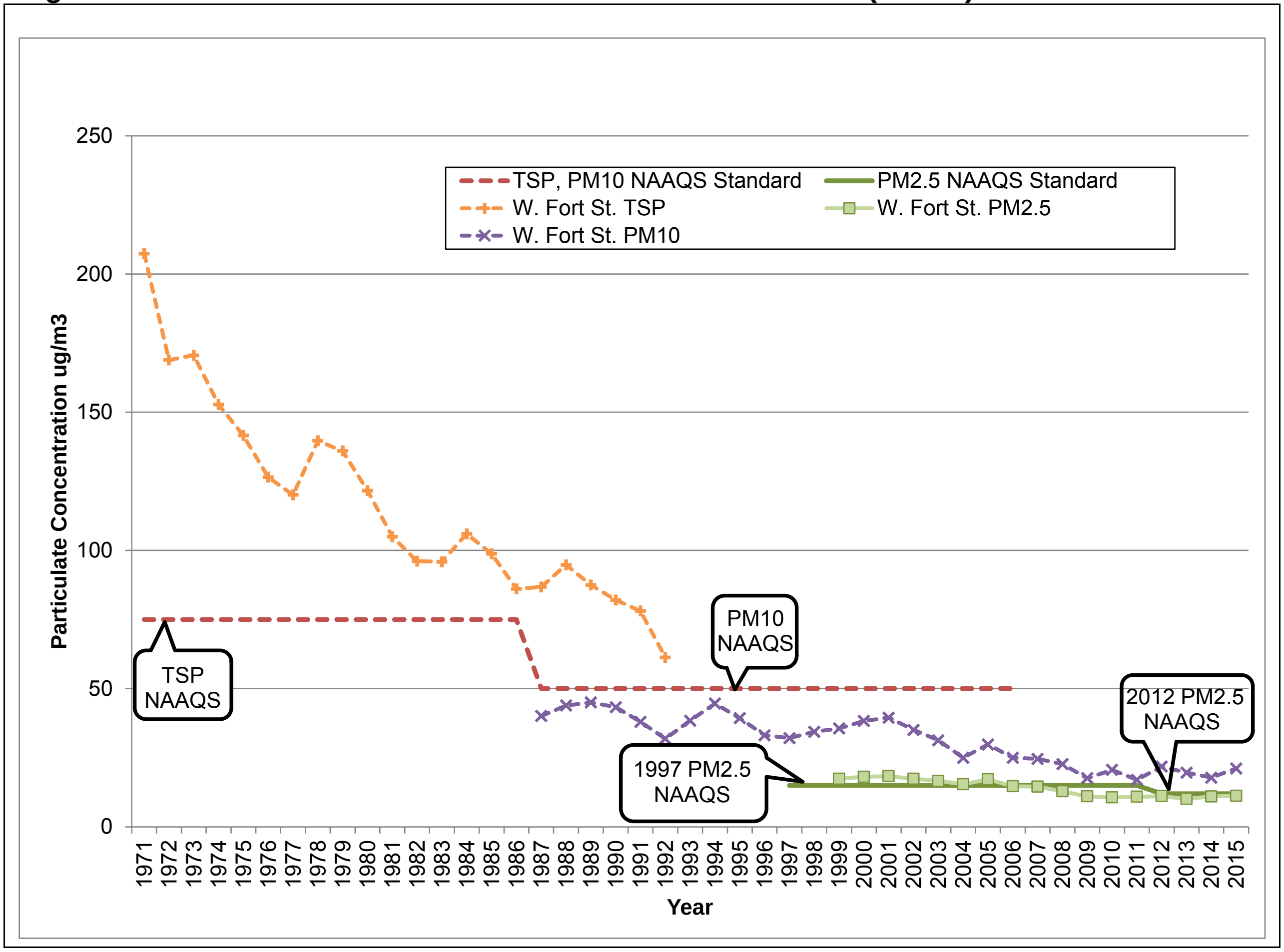


Figure 1.9 shows the trends for particulate matter. In 1971 EPA promulgated an annual and 24-hour particulate standard based on total suspended particulates (TSP). In 1987, EPA changed the standard to PM_{10}. Health studies indicated that particles smaller than 10 microns affects respiration. In 1997 EPA added additional NAAQS for a smaller particle fraction size, $PM_{2.5}$, which can get deeper into the lungs and possibly into the blood stream. In 2006, EPA revoked the PM_{10} annual standard but kept the PM_{10} 24-hour standard. The $PM_{2.5}$ 24-hour standard was also reduced from 65 $\mu g/m^3$ to 35 $\mu g/m^3$. In 2012, EPA again reduced the annual standard from 15 $\mu g/m^3$ to 12 $\mu g/m^3$. Particulate trends show that particulate concentrations have decreased and the state is in compliance for all particulate NAAQS; however, Michigan has had non-attainment issues in Southeast Michigan for TSP, PM_{10} and $PM_{2.5}$.

Figure 1.9: Historical Annual Particulate Matter at W. Fort St. (SWHS).



Chapter 2: Carbon Monoxide (CO)

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

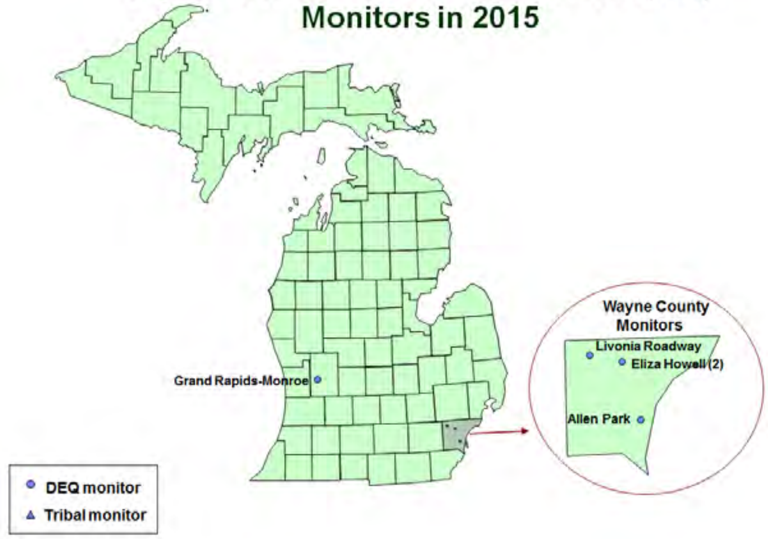
Sources: CO is given off whenever fuel or other carbon-based materials are burned. Outdoor exposure sources include automobile exhaust, industrial processes (metal processing and chemical production), and non-vehicle fuel combustion. Natural sources include volcanos, forest fires and photochemical reactions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

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

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

Figure 2.1 shows the location of each CO monitor that ran in 2015. The Eliza Howell Park and Livonia sites are required under the Near-Roadway Network. A second downwind site at Eliza Howell Park a comparison to the near-roadway sites The other two sites, Grand Rapids and Allen Park, are where trace CO (lower detection levels 1 ppm-50 ppb) are being monitored as part of the NCore Network.

Figure 2.1: Trace Carbon Monoxide (CO) Monitors in 2015



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

Figure 2.2: CO Emissions by Source Sector

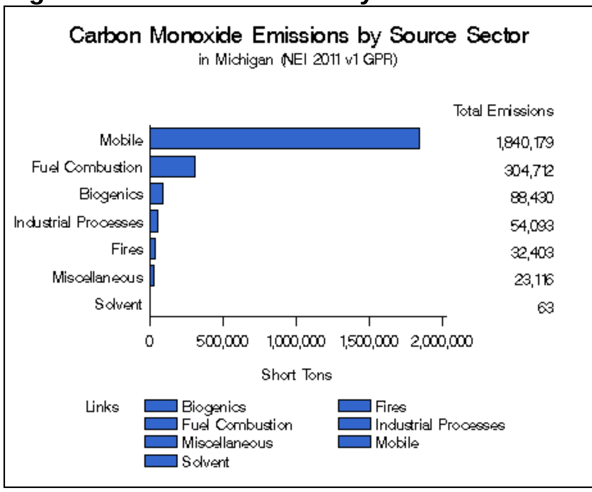
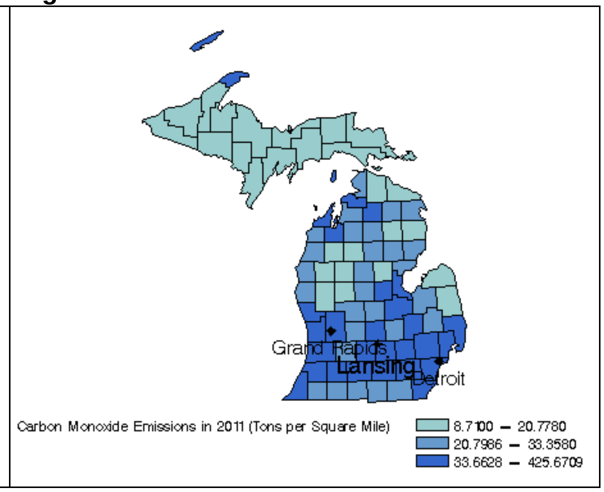


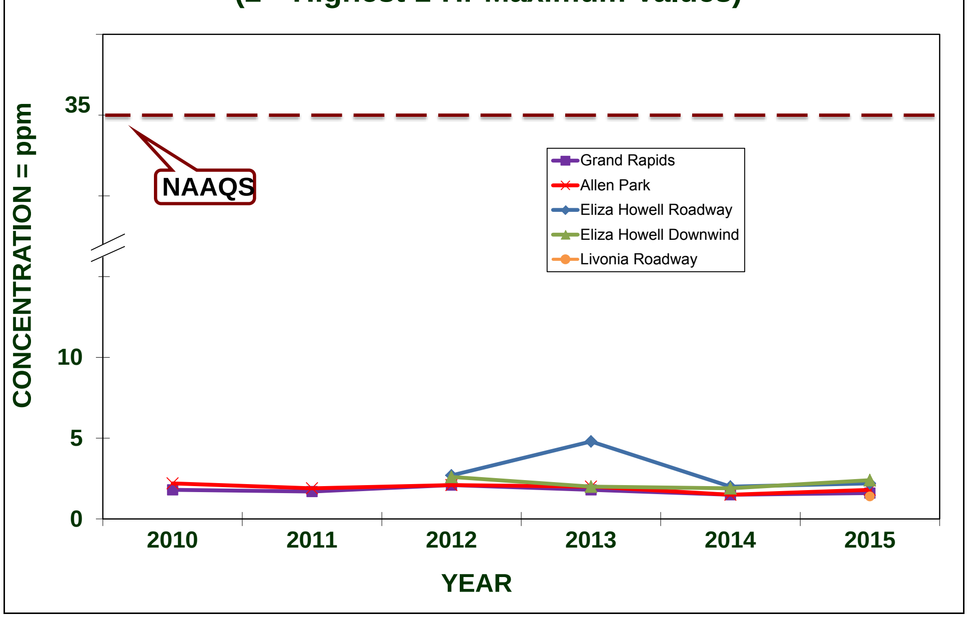
Figure 2.3: CO Emissions in 2011



Near-roadway Monitoring: On August 31, 2011, the EPA approved design changes to part of the CO ambient monitoring network. This network, now referred to as the near-roadway network, is focused on high traffic urban roads in Core-based Statistical Areas (CBSAs) with more than one million people. The DEQ took over two of the EPA's pre-existing, near-roadway sites at Eliza Howell Park, Detroit in June 2011. And in January 2015 the Livonia near road site also started sampling.

Figure 2.4 provides the maximum second highest 1-hour CO level trends for Michigan from 2010-2015, which demonstrates that there have not been any exceedances of the 1-hour CO NAAQS.

Figure 2.4: CO Levels in MI from 2010-2015
(2^{nd} 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 combustion. On November 12, 2008, the EPA lowered the Pb NAAQS from a maximum quarterly average of 1.5 µg/m^3 to a 3-month rolling average of 0.15 µg/m^3. Its sources and effects are as follows:

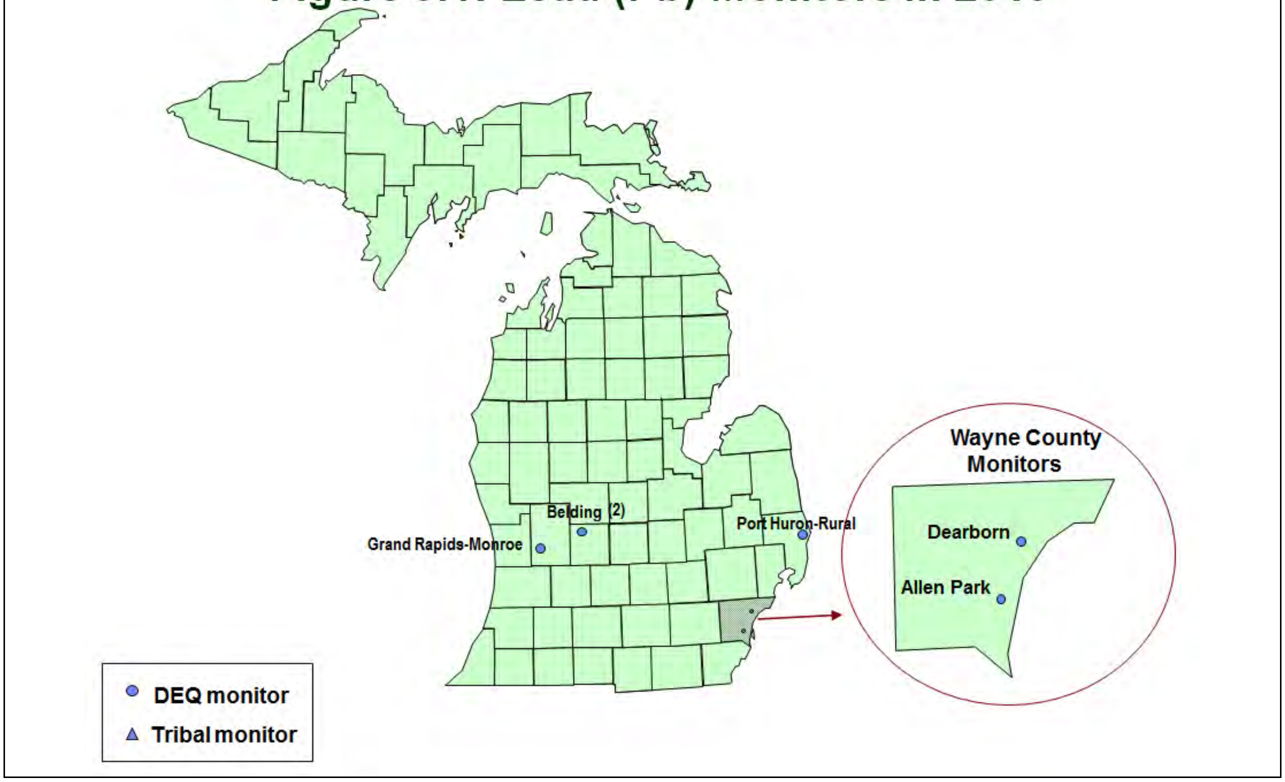
Sources: With the phase-out of leaded gas in the 1970s, the major sources of lead emissions have been due to ore and metals processing and piston-engine aircraft operating on leaded aviation fuel. Other industrial sources include lead acid battery manufacturers, waste incinerators and utilities. The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

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

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

Figure 3.1 shows the location of the Lead monitors in the MASN in 2015.

Figure 3.1: Lead (Pb) Monitors in 2015



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

Figure 3.2: Lead Emissions by Source Sector

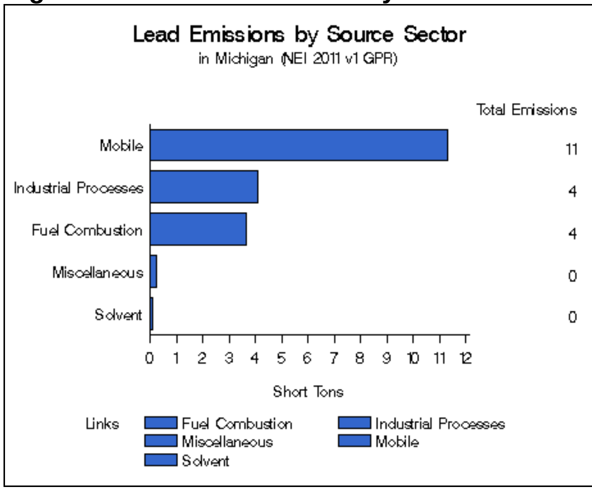
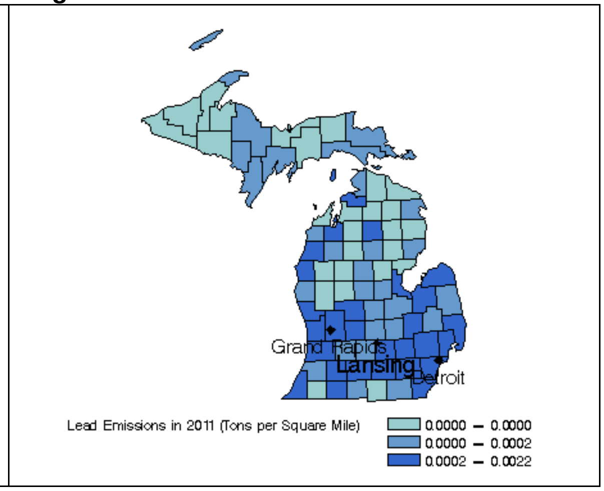


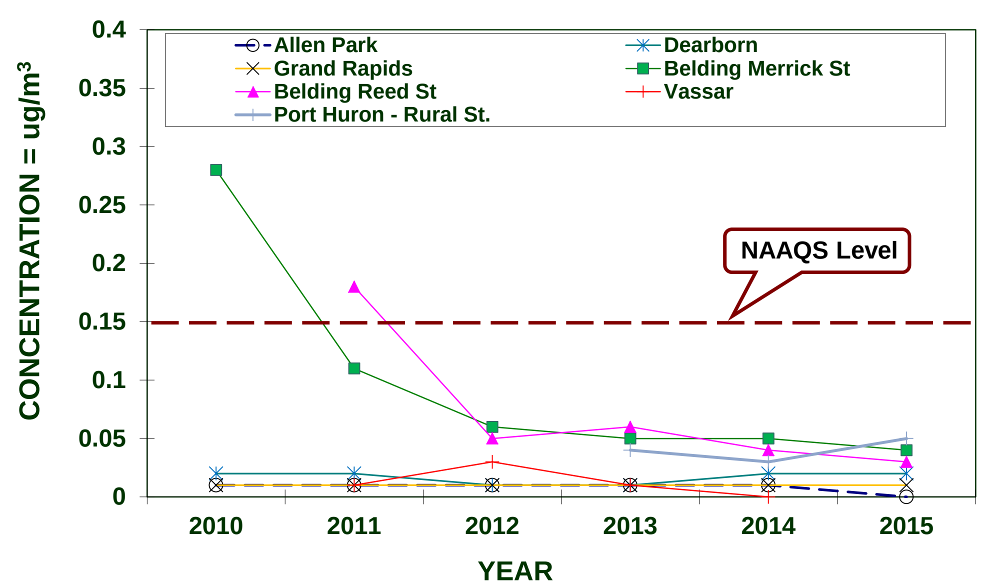
Figure 3.3: Lead Emissions in 2011



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

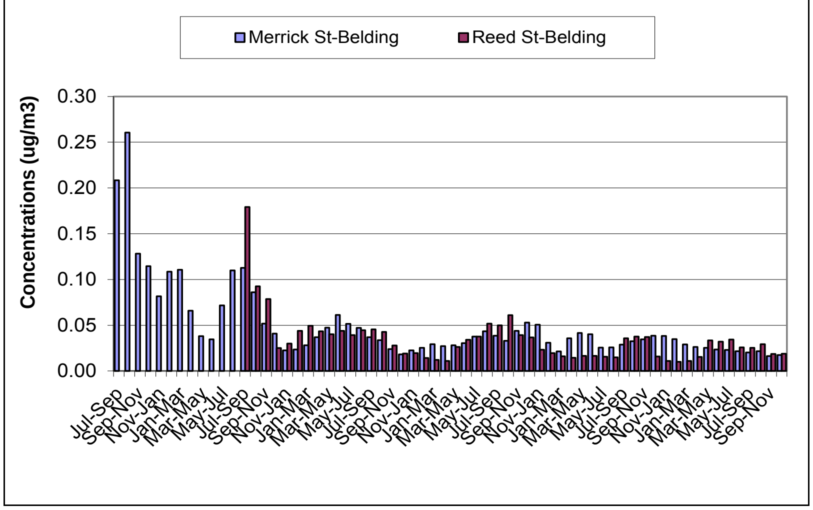
Figure 3.4 shows the maximum 3-month rolling average values for Lead from 2010 to 2015.

Figure 3.4: Lead Levels in Michigan from 2010-2015 (Maximum 3-Month Average Values)



As part of the 2008 lead NAAQS standard, the DEQ is required to monitor near stationary lead sources emitting more than 1/2 ton per year. DEQ currently has three point-source lead monitoring sites Rural St. in Port Huron (started November 2012); Merrick St. in Belding (started January 2010) and Reed St. in Belding (started July 2011). The Merrick St. monitor located in Belding recorded a violation of the new health standard in 2010, as shown in **Figure 3.5.** Hence a second site, Reed St., was added in July 2011 at Belding which also recorded a violation in 2011. Values for both the sites have been below the NAAQS for the past four years.

Figure 3.5: 2010-2015 Belding Air Lead Levels



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

Chapter 4: Sulfur Dioxide (SO_2)

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

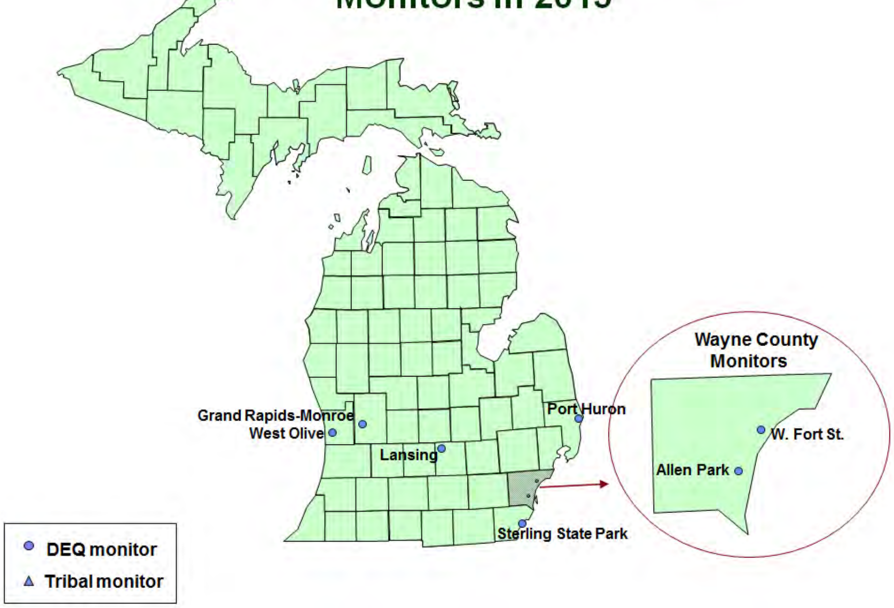
Sources: Coal-burning power plants are the largest source of SO_2 emissions. Other sources include petroleum refineries, ore smelters, pulp and paper mills, steel mills and non-road transportation sources. SO_2 and particulate matter are often emitted together.

Effects: Exposure to elevated levels can affect breathing, cause respiratory illnesses, aggravate existing cardiovascular and pulmonary diseases, and alter the body's immune system. SO_2 and NO_X together are the major precursors to acid rain and are associated with the acidification of soils, lakes, and streams; as well as 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 that ran in 2015. The two NCore Sites, Allen Park and Grand Rapids, have trace SO_2 monitors that have lower detection limits than traditional monitors.

Figure 4.1: Sulfur Dioxide (SO_2) Monitors in 2015



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

Figure 4.2: SO_2 Emissions by Source Sector

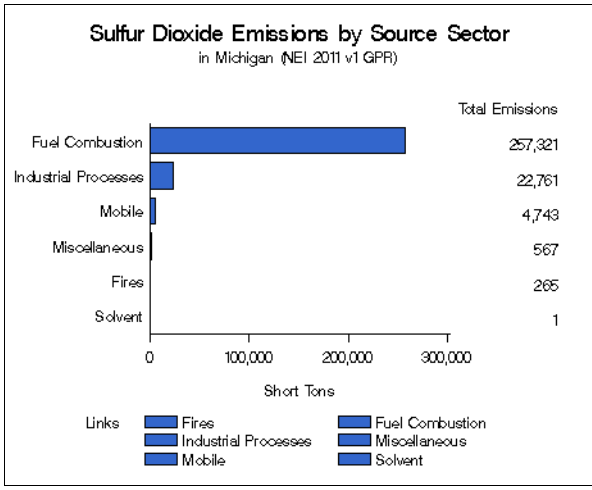
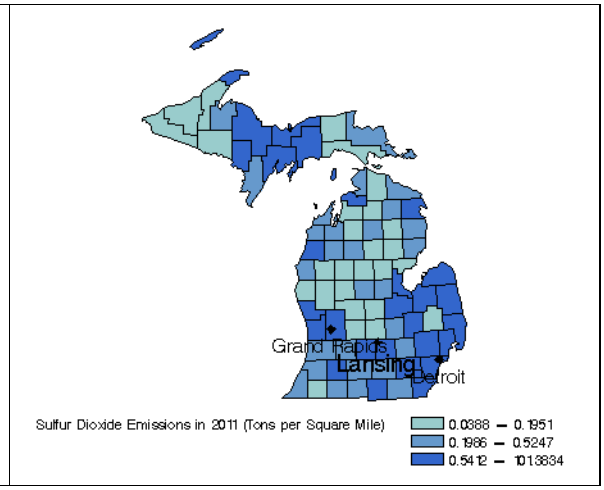


Figure 4.3: SO_2 Emissions in 2011



Historically, Michigan had been in attainment for SO_2 since 1982 with levels consistently well below the annual SO_2 NAAQS. However, in 2010 EPA changed the SO_2 NAAQS to a 1-hour standard which showed the SO_2 monitor at W. Fort Street (SWHS) in Detroit did not meet the new NAAQS. SO_2 concentrations have decrease at this site and are currently under the NAAQS.

The NCore sites, Grand Rapids and Allen Park, monitor for trace SO_2. For trend purposes, all SO_2 data are graphed together in **Figure 4.4**. Jenison and Port Huron were added to the SO_2 network in December 2011, and Sterling State Park in Monroe County was added to the SO_2 network in December 2012**.** The Jenison monitor was shut down January 1, 2014 and later moved to West Olive which started sampling January 2015.

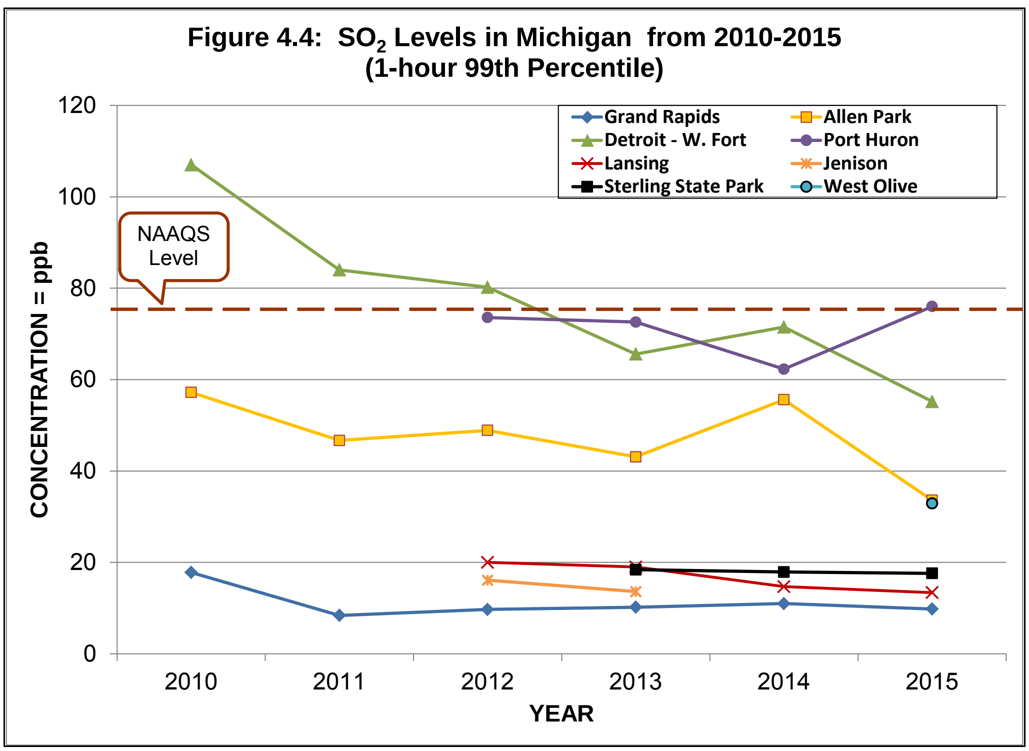


Figure 4.4: SO_2 Levels in Michigan from 2010-2015 (1-hour 99th Percentile)

Chapter 5: Nitrogen Dioxide (NO_2)

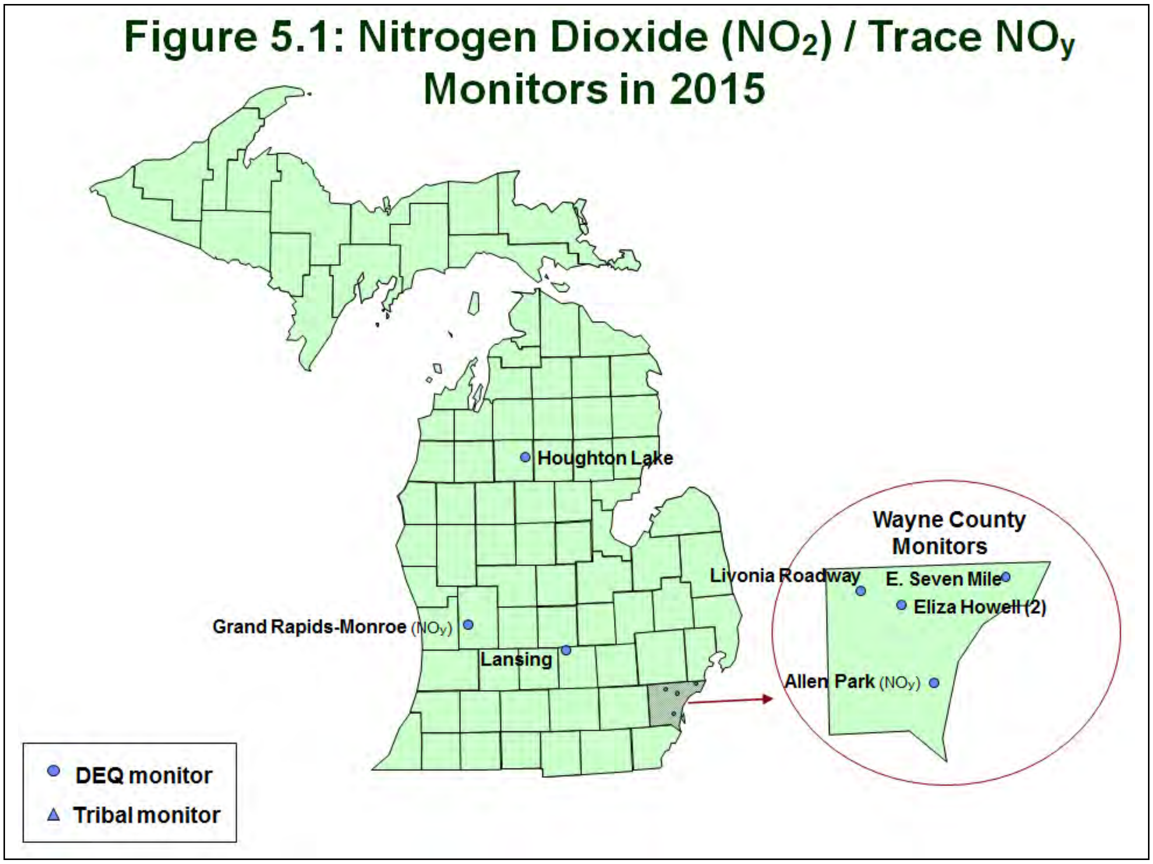
Nitrogen Dioxide is a reddish-brown, highly reactive gas formed through oxidation of nitric oxide (NO). Upon dilution, it becomes yellow or invisible. High concentrations produce a pungent odor and lower levels have an odor similar to bleach. NO_x is term used to describe the sum of NO, NO_2, and other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

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

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

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

Figure 5.1 shows the location of all NO_2 monitors that operated in 2015. The E. Seven Mile monitor in Detroit is a downwind urban scale site that measures NO_2. The Detroit Eliza Howell (near roadway and downwind sites) and Livonia sites measure NO_2 in a near road environment. The NCore sites, Grand Rapids and Allen Park, monitor trace NO_Y, which includes NO_x, nitric acid and organic and inorganic nitrates (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.



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

Figure 5.2: NO_2 Emissions by Source Sector

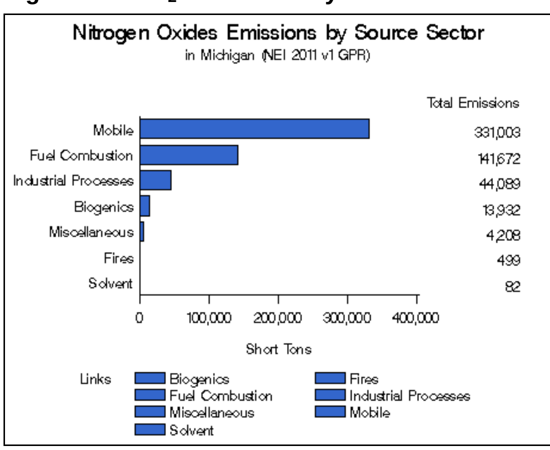
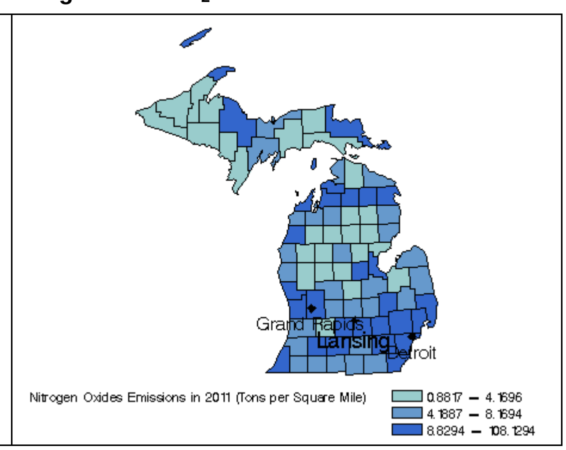
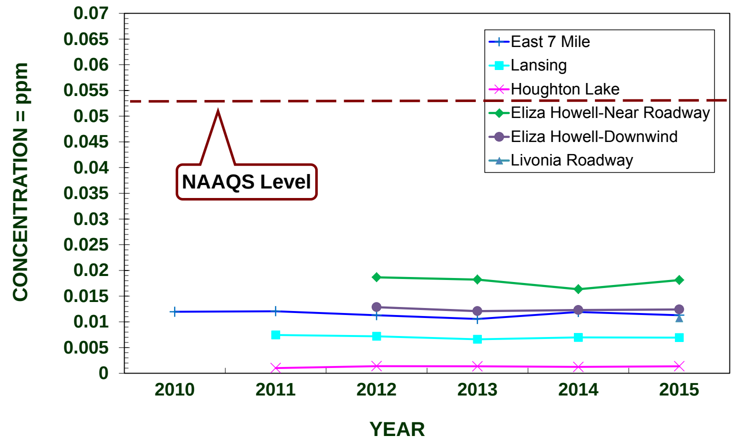


Figure 5.3: NO_2 Emissions in 2011



Michigan's 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, when EPA lowered the NO_2 NAAQS in 2010, they designated Michigan as unclassifiable/attainment, since the existing NO_2 network did not provide adequate evidence that the NAAQS was met in all areas; however, there were no violations of the NO_2 standard. Thus, unclassifiable/attainment better reflects the current air quality conditions.

Figure 5.4: NO_2 Levels in MI from 2010-2015 (Annual Arithmetic Mean)*

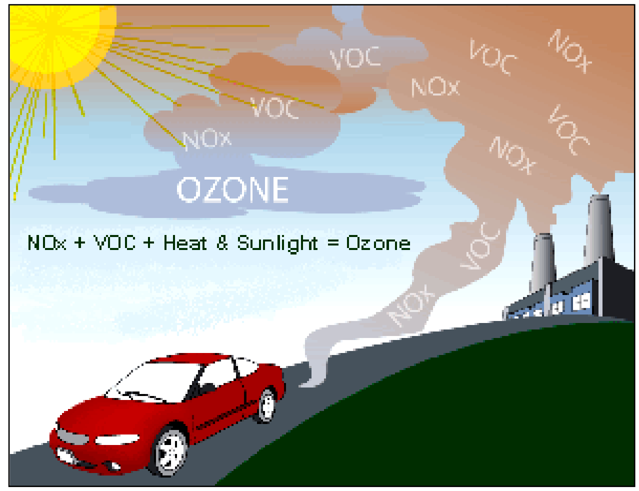


*Since Allen Park and Grand Rapids are monitoring NO_Y, those sites are not included in graph.

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

Chapter 6: Ozone (O_3)

Ground-level O_3 is created by reactions involving nitrogen oxides (NO_X) and volatile organic compounds (VOCs), or hydrocarbons, in the presence of sunlight as the illustration to the right depicts (image courtesy of the EPA). These reactions usually occur during the hot summer months as ultraviolet radiation from the sun initiates a sequence of photochemical reactions. In Earth's upper atmosphere (the stratosphere) O_3 helps by absorbing much of the sun's ultraviolet radiation, but in the lower atmosphere (the troposphere), ozone is an air pollutant. O_3 is also a key ingredient of urban smog and can 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. It is a 3-year average of the 4th highest daily maximum 8-hour average concentration that must not exceed 0.075 ppm. After the end of the 2015 Ozone season, the standard was again revised and now must not exceed 0.070ppm. The sources and effects of ozone follow:



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

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

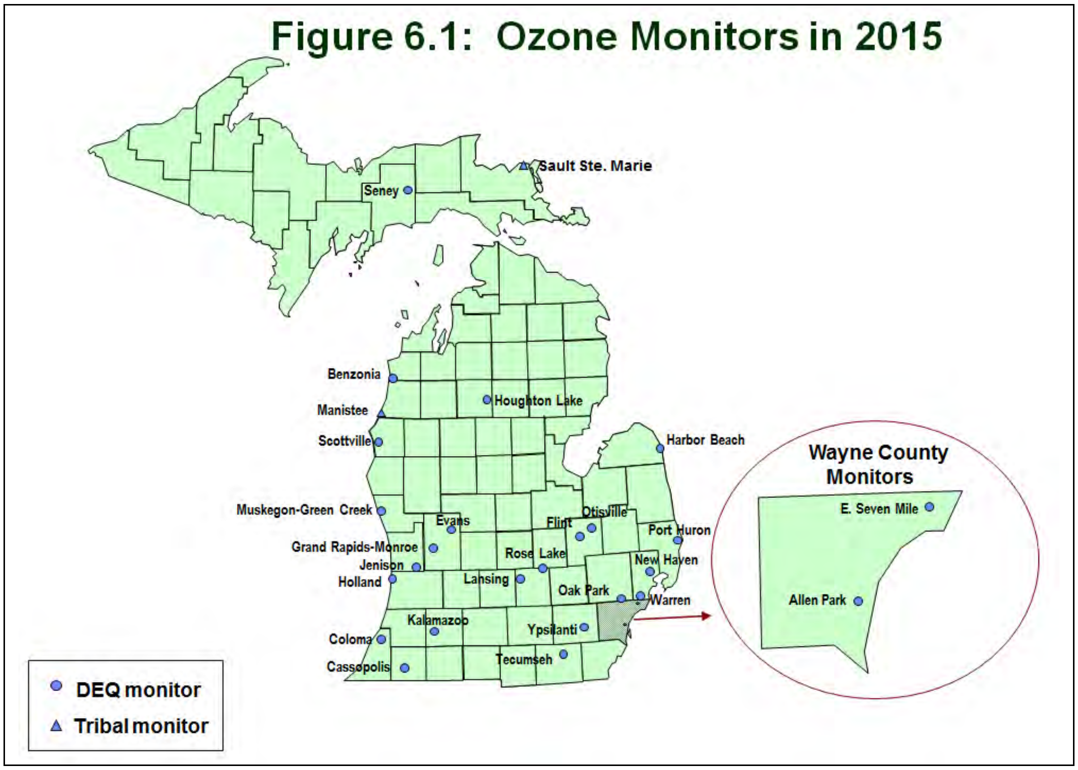


Figure 6.1: Ozone Monitors in 2015

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

Figure 6.2: VOC Emissions by Source Sector

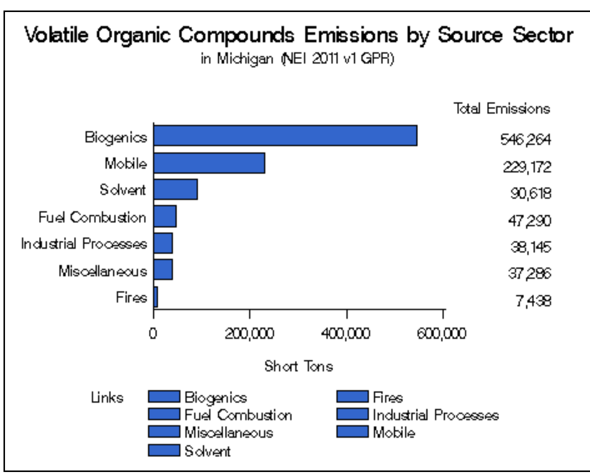
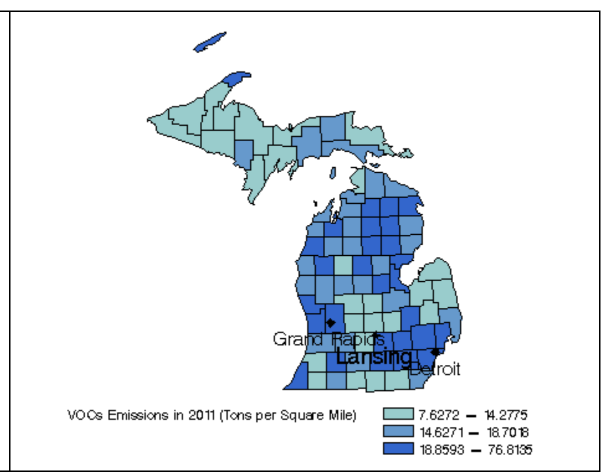


Figure 6.3: VOC Emissions in 2011



The EPA revised the primary 8-hour ozone NAAQS to 0.075 ppm in March 2008, which became effective May 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. In 2015 all ozone monitors in the state were below the

2008 NAAQS level of 0.075, but several monitors violated the new 2012 standard of 0.070. Designations for the new standard have not been made yet, but it is likely that Michigan will have some areas showing nonattainment for the 2012 standard (see **Table 6.1**).

The O_3 monitoring season in Michigan is currently from April 1 through September 30, the hottest portion of the year. Starting in 2017, the ozone season will be extended to March 1 through October 31, based on the 2015 NAAQS. During this time O_3 monitoring data is available for the public via the AQD's web site (discussed in **Chapter 9**). However year round O_3 monitoring is done at the following four sites: Allen Park, Grand Rapids, Houghton Lake and Lansing. This data helps in attainment designations and urban air quality and population exposure assessments.

Figure 6.1 shows all O_3 air quality monitors active in Michigan at the beginning of the 2015 ozone season.

Table 6.1: 3-year Average of the 4th Highest 8-hour Ozone Values from 2011-2013, 2012-2014, and 2013-2015 (concentrations in ppm). Numbers in Bold Indicate 3-year Averages Over the 2008 Ozone Standard of 0.075ppm.

Areas	County	Monitor Sites	2011-2013	2012-2014	2013-2015
Detroit-Ann Arbor	Lenawee	Tecumseh	0.075	0.073	0.065
	Macomb	New Haven	**0.077**	0.074	0.071
		Warren	**0.077**	0.072	0.066
	Oakland	Oak Park	**0.076**	0.071	0.066
	St. Clair	Port Huron	0.075	0.074	0.072
	Washtenaw	Ypsilanti	0.075	0.073	0.066
	Wayne	Allen Park	0.072	0.068	0.064
		Detroit-East 7 Mile	**0.077**	0.074	0.070
Flint	Genesee	Flint	0.074	0.072	0.066
		Otisville	0.074	0.072	0.067
Grand Rapids	Ottawa	Jenison	**0.077**	0.075	0.068
	Kent	Grand Rapids	0.074	0.071	0.067
		Evans	0.074	0.070	0.066
Muskegon Co	Muskegon	Muskegon	**0.081**	**0.079**	0.074
Allegan Co	Allegan	Holland	**0.086**	**0.083**	0.075
Huron	Huron	Harbor Beach	0.072	0.071	0.065
Kalamazoo-Battle Creek	Kalamazoo	Kalamazoo	0.075	0.073	0.067
Lansing-East Lansing	Ingham	Lansing	0.072	0.070	0.065
	Clinton	Rose Lake	0.071	0.069	0.064
Benton Harbor	Berrien	Coloma	**0.082**	**0.079**	0.073
Benzie Co	Benzie	Benzonia	0.074	0.073	0.068
Cass Co	Cass	Cassopolis	**0.078**	0.073	0.068
Chippewa Co	Chippewa	Sault Ste. Marie	0.067	0.065	0.059
Mason Co	Mason	Scottville	0.075	0.074	0.068
Missaukee Co	Missaukee	Houghton Lake	0.070	0.070	0.064
Manistee Co	Manistee	Manistee	0.074	0.072	0.067
Schoolcraft Co	Schoolcraft	Seney	0.072	0.073	0.068

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

Table 6.2: 2015 West Michigan Ozone Season

Daily High Temperature Range			2015 WEST MICHIGAN OZONE SEASON											
			April		May		June		July		August		September	
			Days	O_3 Days	Days	O_3 Days	Days	O_3 Days	Days	O_3 Days	Days	O_3 Days	Days	O_3 Days
	>=	95	0	0	0	0	0	0	0	0	0	0	0	0
90	<=	94	0	0	0	0	0	0	1	0	1	0	0	0
85	<=	89	0	0	1	0	0	0	10	1	4	0	4	0
80	<=	84	0	0	6	0	9	0	10	0	10	0	9	0
75	<=	79	1	0	5	0	13	0	6	0	9	0	7	0
70	<=	74	1	0	7	0	6	0	3	0	3	0	6	0
65	<=	69	7	0	4	0	2	0	1	0	3	0	2	0
60	<=	64	8	0	3	0	0	0	0	0	1	0	2	0
55	<=	59	6	0	3	0	0	0	0	0	0	0	0	0
50	<=	54	3	0	2	0	0	0	0	0	0	0	0	0
49	<=		4	0	0	0	0	0	0	0	0	0	0	0
	Totals		**30**	**0**	**31**	**0**	**30**	**0**	**31**	**1**	**31**	**0**	**30**	**0**

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

For West Michigan there were no O_3 exceedance days except for one day in July when ozone exceeded 0.075 ppm at two or more ozone monitors. The temperatures for those days were between 85^0F and 89^0F.

Table 6.3: 2015 Southeast Michigan Ozone Season

Daily High Temperature Range			2015 SOUTHEAST MICHIGAN OZONE SEASON											
			April		May		June		July		August		September	
			Days	O_3 Days	Days	O_3 Days	Days	O_3 Days	Days	O_3 Days	Days	O_3 Days	Days	O_3 Days
	>=	95	0	0	0	0	0	0	0	0	0	0	0	0
90	<=	94	0	0	0	0	1	0	4	0	1	0	4	0
85	<=	89	0	0	3	0	1	0	10	1	9	0	3	0
80	<=	84	0	0	9	0	11	0	8	0	8	0	6	0
75	<=	79	3	0	9	0	8	0	7	0	10	0	9	0
70	<=	74	0	0	1	0	7	0	1	0	0	0	4	0
65	<=	69	7	0	4	0	2	0	1	0	3	0	3	0
60	<=	64	10	0	3	0	0	0	0	0	0	0	1	0
55	<=	59	2	0	1	0	0	0	0	0	0	0	0	0
50	<=	54	5	0	1	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**	**0**	**30**	**0**	**31**	**1**	**31**	**0**	**30**	**0**

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

For Southeast Michigan there were no O_3 exceedance days except for one day in July when ozone exceeded 0.075 ppm at two or more ozone monitors. The temperature for that day was between 85^0F and 89^0F.

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

Table 6.4: 8-hour Exceedance Days (>0.075 ppm) and Locations

Date	Monitors with Exceedances of the Ozone Standard			Total
	Western Michigan	Central/Upper Michigan	Eastern Michigan	
05/07/2015	Manistee	Seney		2
06/10/2015	Cassopolis			1
07/06/2015			Harbor Beach, New Haven, E. Seven Mile	3
07/12/2015			Harbor Beach	1
07/17/2015	Holland			1
07/24/2015	Holland, Grand Rapids, Muskegon, Jenison			4
08/17/2015	Muskegon			1
09/01/2015			New Haven	1
09/02/2015			Port Huron	1
09/03/2015	Coloma			1
09/16/2015		Seney		1
09/17/2015			Port Huron	1
			TOTAL	18

On June 6, 2015 there were three monitors and on June 24, 2015 there were four monitor readings that exceeded the level of the standard. Sites with the most exceedances in the western region of Michigan were Holland and Muskegon with two each. The central/upper Michigan site with the most exceedance was Seney with two. New Haven, Harbor Beach and Port Huron each had two exceedances in eastern Michigan.

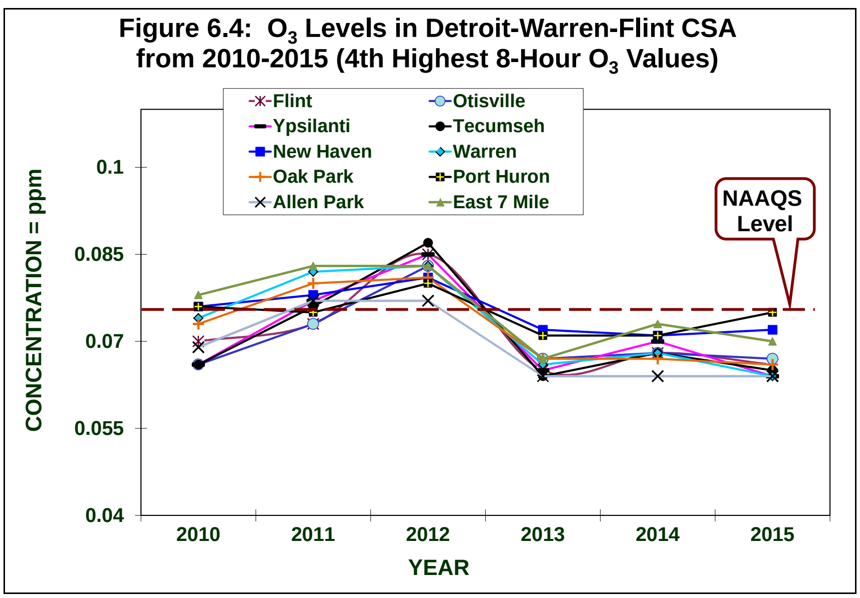


Figure 6.4 shows the 4th highest 8-hour O_3 values for Southeast Michigan monitoring sites from 2010-2015. No sites violated the 3-year standard.

Figure 6.5: O_3 Levels in the Grand Rapids-Muskegon-Holland CSA from 2010-2015 (4th Highest 8-Hour O_3 Values)

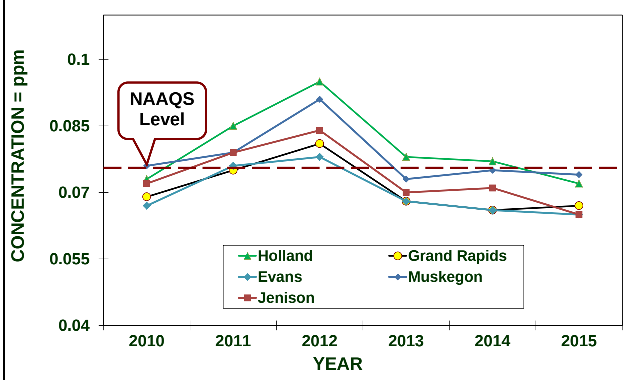


Figure 6.6: O_3 Levels in the Kalamazoo-Portage MSA, Lansing-E. Lansing-Owosso CSA, Niles-Benton Harbor MSA, & South Bend-Mishawaka (IN-MI) MSAs from 2010-2015 (4th Highest 8-Hour O_3 Values)

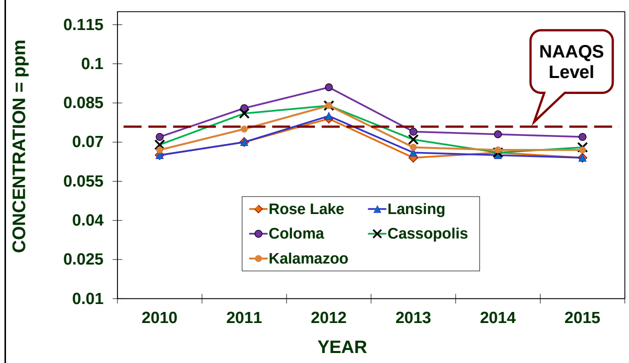


Figure 6.7: O_3 Levels in MI's Northern Lower and Upper Peninsula Areas from 2010-2015 (4th Highest 8-Hour O_3 Values)

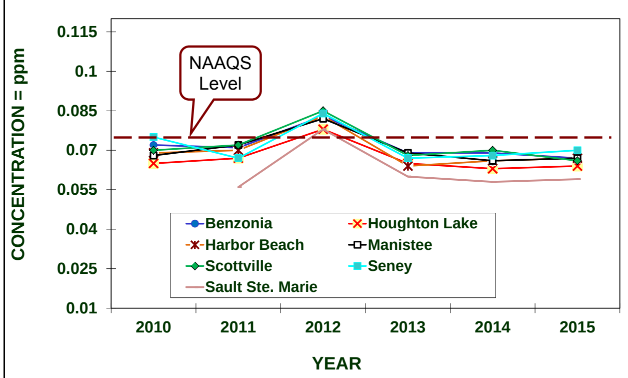
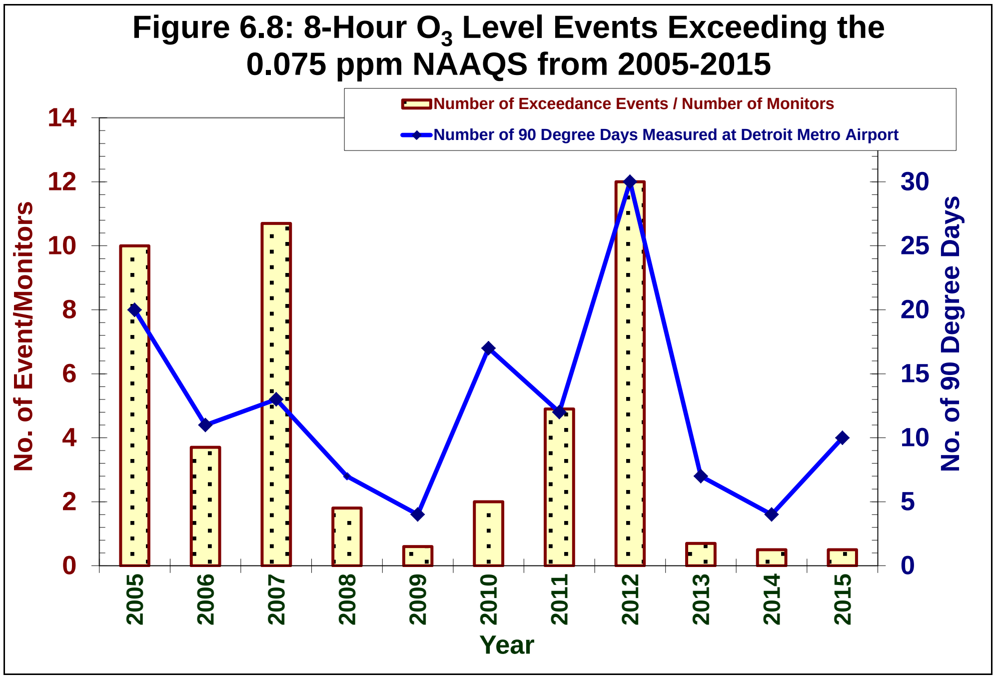


Figure 6.5 shows the 4th highest 8-hour O_3 values for Grand Rapids-Muskegon-Holland CSA. No sites violated the 3-year standard.

Figure 6.6 shows 4th highest 8-hour O_3 values for Mid-Michigan. No sites violated the 3-year standard.

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

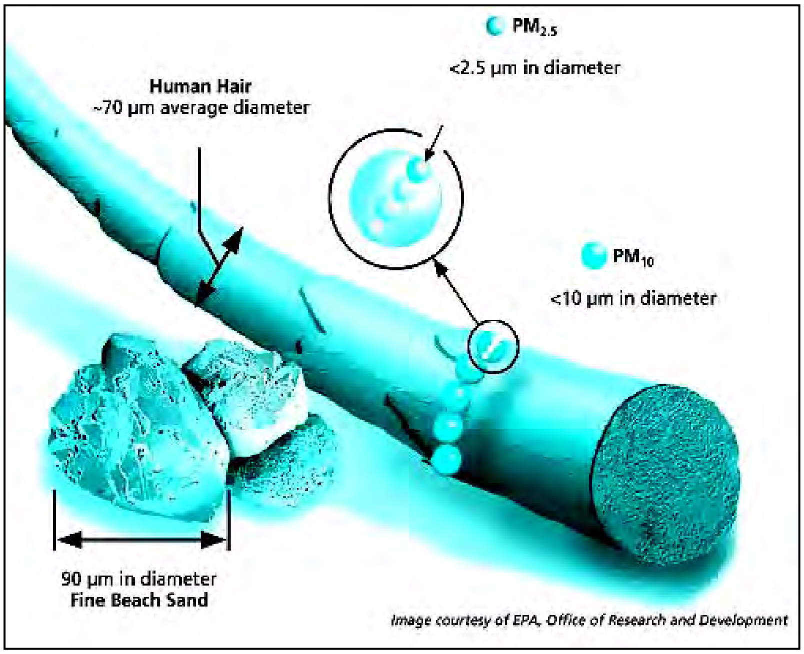
Figure 6.8 shows 8-hour O_3 readings ≥ 0.075 ppm with the number of 90°F days (≥ 90°F) measured at the Detroit Metropolitan Airport. The total number of southeastern Michigan-area 8-hour readings above 0.075 ppm was divided by the number of monitors that were in operation each year to provide a relative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



This comparison shows the influence of temperature with respect to elevated O_3 levels. Over the past 10 years, a typical summer would have an average of 12.5 days with the maximum daily temperature exceeding 90°F. Over the time period from 2005 through 2015, the highest number of 90°F days occurred in 2012 (30 days), while the lowest number occurred in 2009 and 2014 (four days).

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

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



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

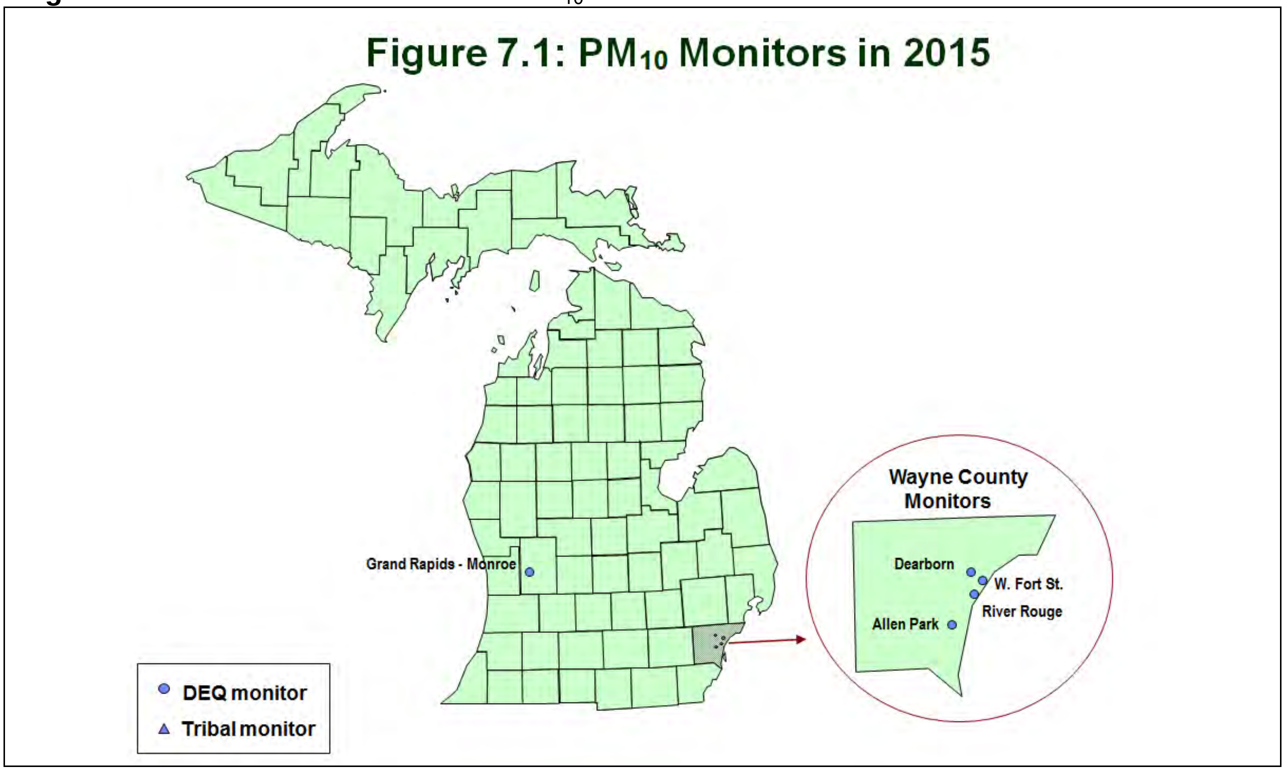
Effects: Exposure to PM affects breathing and the cellular defenses of the lungs, aggravates existing respiratory and cardiovascular ailments, and has been linked with heart and lung disease. Smaller particles (PM_{10} or smaller) pose the greatest problems, because they can penetrate deep in the lungs and possibly into the bloodstream. 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: People with heart or lung disease, the elderly, and children are at highest risk from exposure to PM.

PM_{10}

Since October 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 2015. These monitors are located mostly in the state's largest populated urban areas: four in the Detroit area and one in Grand Rapids. The PM_{10} monitor in Vassar was shut down at the end of 2014 due to the factory, the source of the emissions, being shut down. 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

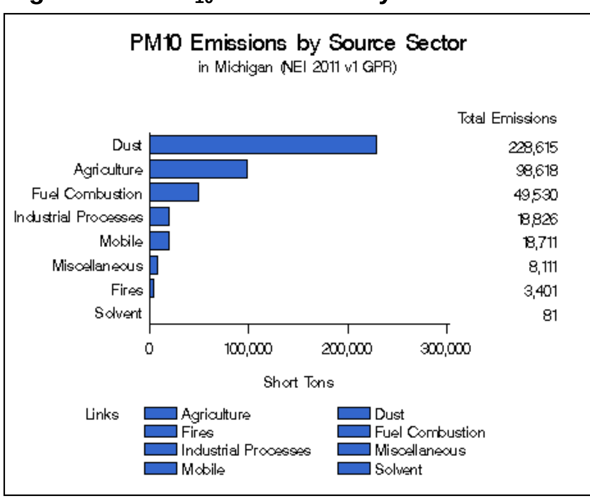


Figure 7.3: PM_{10} Emissions in 2011

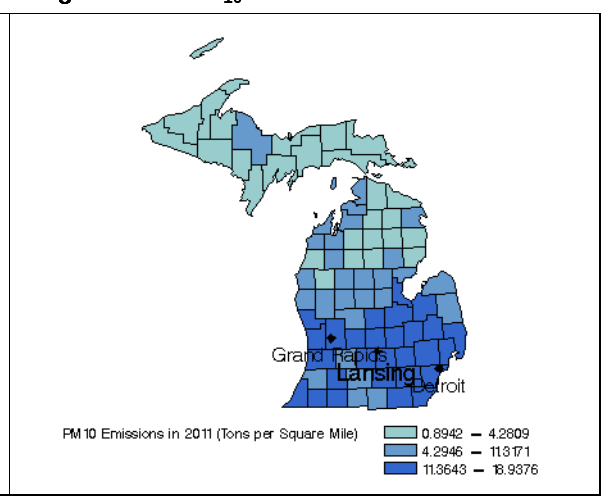
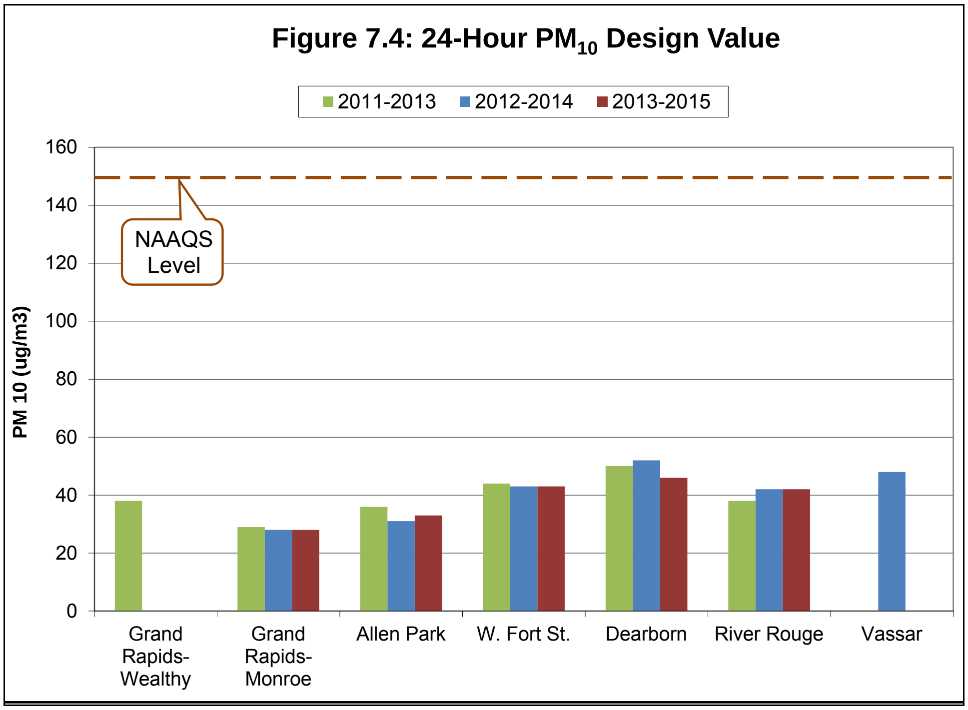


Figure 7.4 shows the PM_{10} levels in Michigan compared to the 24-hour average of 150 µg/m^3. This standard must not be exceeded on average more than once per year over a 3-year period. The design value is the 4^{th} highest value over a 3-year period. The PM_{10} levels at all sites in Michigan are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



$PM_{2.5}$

All Michigan counties from 2010-2014 met the 1997 annual $PM_{2.5}$ standard of 15 µg/m^3 and the 2006 24-hour $PM_{2.5}$ standard of 35 µg/m^3. The EPA designated Michigan in attainment of these standards in August 2013. In December 2012, the EPA revised the annual primary standard to 12 µg/m^3 while the annual secondary standard remained at 15 µg/m^3. The primary and secondary 24-hour standard remained as 35 µg/m^3. In December 2014, EPA determined that no area in Michigan violated the 2012 standard and the state was classified and unclassifiable/attainment.

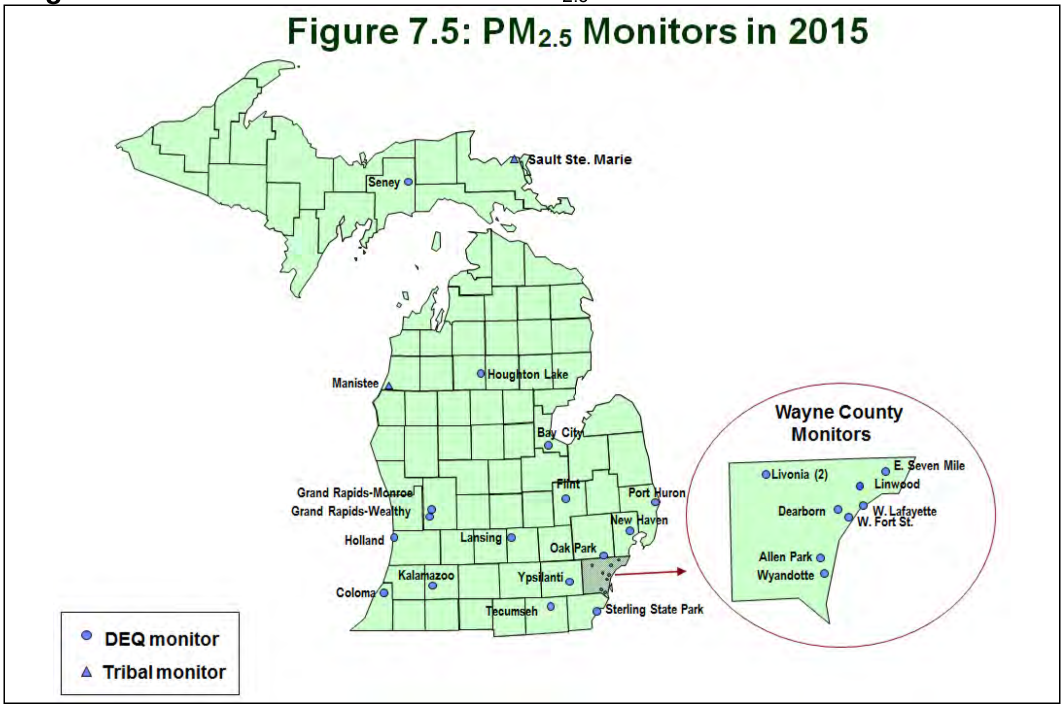
Fine particulate matter ($PM_{2.5}$) is measured using three techniques: Federal Reference Method (FRM), Continuous Methods, and Chemical Speciation Methods. These methods are described in more detail below.

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

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

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

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



$PM_{2.5}$ FRM Monitoring Network: $PM_{2.5}$ FRM monitors are deployed to characterize background or regional $PM_{2.5}$ transport collectively from upwind sources. A $PM_{2.5}$ monitor was added to the new near-roadway site in Livonia the started in January 2015.

Four $PM_{2.5}$ 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, Dearborn, Allen Park, and Detroit's W. Fort Street (SWHS) station.

Continuous $PM_{2.5}$ Network: Short-term measurements of $PM_{2.5}$ or PM_{10} are updated on an hourly basis using Tapered Element Oscillating Microbalance (TEOM) instruments. At least one continuous TEOM is required at the NCore $PM_{2.5}$ monitoring site in a metropolitan area with a population greater than one million. Both Detroit (Allen Park) and Grand Rapids (Monroe) meet this requirement[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 over a 24-hour period and analyzed to determine various components of $PM_{2.5}$. There were eight SASS monitors operating in Michigan; see **Table 1.3.** Houghton Lake, Port Huron and Sterling State Park were shut down Jan 24th, 2015 due to lack

[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].

of funding. 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 two elemental carbon/organic carbon (EC/OC) monitors in 2015.

- 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 2015, the DEQ's aethalometers were located at Allen Park and Dearborn.
- The EC/OC instruments measure elemental carbon, using pyroloysis coupled with a nondispersive infrared detector to separate the elemental and organic carbon fractions. Instruments are located at Dearborn and Tecumseh.

$PM_{10-2.5}$

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 $PM_{2.5}$ FRM monitoring stations operating in 2015 and denotes which sites also have TEOM, SASS, Aethalometer or EC/OC 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

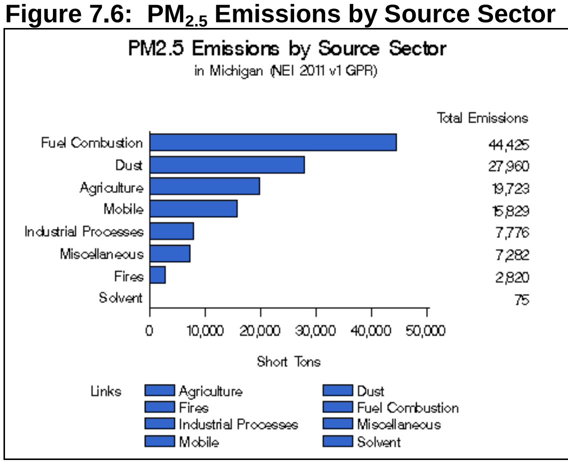
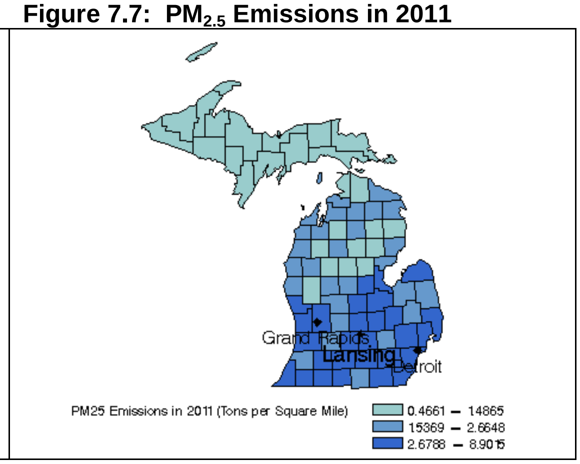


Figure 7.7: $PM_{2.5}$ Emissions in 2011



[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 can be found at https://www3.epa.gov/pm/actions.html.

Table 7.1 provides the 3-year average of the annual mean $PM_{2.5}$ concentrations for 2013-2015. Michigan's levels are below the 12 μg/m³ primary standard[10]. Stations labeled #2 provide a precision estimate of the overall measurement and operate on a one in six sampling schedule. All other monitors are sampled on a one-in-three-day schedule, except for Allen Park #1 and Detroit – W. Lafayette, which sample daily.

Table 7.1: 3-year Average of the Annual Mean $PM_{2.5}$ Concentrations

Areas	County	Monitoring Sites	2013	2014	2015	2013-2015 Mean
Detroit-Ann Arbor	Lenawee	Tecumseh	7.93	8.78	8.58	8.4
	Livingston					
	Macomb	New Haven	7.95	9.10	9.73	8.9
	Oakland	Oak Park	8.38	9.33	9.37	9.0
	St. Clair	Port Huron	8.44	9.40	9.51	9.1
	Washtenaw	Ypsilanti #1	8.64	9.79	9.56	9.3
		Ypsilanti #2	9.18	9.37	9.08	9.2
	Wayne	Allen Park	9.49	10.13	9.66	9.8
		Detroit-Linwood	8.86	9.74	10.18	9.6
		Detroit-East 7 Mile	8.71	9.64	9.79	9.4
		Detroit-W. Fort	10.11	10.99	11.26	10.8
		Detroit-W. Lafayette	9.34	9.68	9.12	9.4
		Wyandotte	8.00	9.71	8.62	8.8
		Dearborn #1	11.01	11.77	11.50	11.4
		Dearborn #2	10.80	11.64	11.65	11.4
		Livonia	8.67	9.46	9.31	9.2
		Livonia-Roadway			9.53	
Flint	Genesee	Flint	7.44	8.92	8.16	8.2
	Lapeer					
Grand Rapids	Ottawa	Jenison	8.09			
	Kent	Grand Rapids-Wealthy	8.99	9.91	9.37	9.4
		Grand Rapids #1	8.38	9.49	9.30	9.1
		Grand Rapids #2	8.80	9.30	10.37	9.4
Muskegon Co	Muskegon	Muskegon	9.95*			
Allegan Co	Allegan	Holland	7.82	8.68	7.88	8.1
Monroe Co	Monroe	Luna Pier	9.71*			
		Sterling State Park	8.91*	9.03*	9.26	9.1
Kalamazoo-Battle Creek	Calhoun					
	Kalamazoo	Kalamazoo #1	8.27	9.64	8.90	8.9
		Kalamazoo #2	8.79	9.45	9.34	9.1
	Van Buren					
Lansing-East Lansing	Ingham	Lansing	7.58	9.38	8.56	8.5
	Clinton					
	Eaton					
Benton Harbor	Berrien	Coloma	7.97	8.49	8.15	8.2
Bay Co	Bay	Bay City	7.47	8.17	7.74	7.8
Missaukee Co	Missaukee	Houghton Lake	5.49	5.62	5.59	5.6
Manistee Co	Manistee	Manistee	6.45	6.16	6.37	6.3
Chippewa Co	Chippewa	Sault Ste. Marie #1	6.04	6.23	5.79*	6.1
		Sault Ste. Marie #2	6.21	5.67	6.18*	6.0

*Indicates mean does not meet completeness criteria.

[10] For comparison to the standard, the average annual means is rounded to the nearest 0.1 μg/m³.

Table 7.2 is a detailed assessment of the 24-hour 98th percentile $PM_{2.5}$ concentrations for 2013-2015 showing Michigan's levels are below the 35 μg/m^3 standard (3-year average)[11].

Table 7.2: 98th Percentile $PM_{2.5}$ Values Averaged over 3 Years						
Areas	County	Monitoring Sites	2013	2014	2015	2013-2015 Mean
Detroit-Ann Arbor	Lenawee	Tecumseh	16.8	22.8	25.2	22
	Livingston					
	Macomb	New Haven	18.3	27.0	31.6	26
	Oakland	Oak Park	18.9	23.3	29.6	24
	St. Clair	Port Huron	18.9	25.2	28.7	24
	Washtenaw	Ypsilanti #1	18.5	24.5	25.9	23
		Ypsilanti #2	18.9	23.7	20.6	21
	Wayne	Allen Park	22.8	26.4	23.1	24
		Detroit-Linwood	20.0	23.6	27.1	24
		Detroit-East 7 Mile	19.9	22.0	25.6	23
		Detroit-W. Fort St.	21.2	23.8	27.1	24
		Detroit-Newberry	10.2*			
		Detroit-W. Lafayette	22.0	25.5	22.4	23
		Wyandotte	17.7	25.6	21.1	22
		Dearborn #1	24.1	26.5	28.1	26
		Dearborn #2	20.8	26.7	24.7	24
		Livonia	19.6	25.7	26.8	24
		Livonia-Roadway			25.2	
Flint	Genesee	Flint	16.6	24.3	22.3	21
	Lapeer					
Grand Rapids	Ottawa	Jenison	18.2			
	Kent	Grand Rapids-Wealthy	19.0	24.3	25.5	23
		Grand Rapids #1	18.3	23.0	25.6	22
		Grand Rapids #2	18.7	26.9	24.3	23
Muskegon Co	Muskegon	Muskegon	18*			
Allegan Co	Allegan	Holland	17.7	23.4	21.2	21
Monroe Co	Monroe	Luna Pier	9.7*			
		Sterling State Park	19.5*	23.9*	25.7	23
Kalamazoo-Battle Creek	Calhoun					
	Kalamazoo	Kalamazoo #1	17.7	23.9	22.3	21
		Kalamazoo #2	17.9	30.6	21.3	23
	Van Buren					
Lansing-East Lansing	Ingham	Lansing	17.4	22.1	24.5	21
	Clinton					
	Eaton					
Benton Harbor	Berrien	Coloma	17.4	19.8	19.4	19
Bay Co	Bay	Bay City	16	21.1	23.3	20
Missaukee Co	Missaukee	Houghton Lake	17.1	16.3	17.9	17
Manistee Co	Manistee	Manistee	18.2	17.3	19.3	18
Chippewa Co	Chippewa	Sault Ste. Marie #1	14.4	15.3	15.8	15
		Sault Ste. Marie #2	15.5	12.7	16.4	15

*Indicates mean does not meet completeness criteria.

[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 clarity, the monitoring sites within the Detroit-Warren-Flint CSA have been broken down into two graphs. **Figure 7.8** shows those sites in Wayne County, and **Figure 7.9** shows the remaining counties within the CSA.

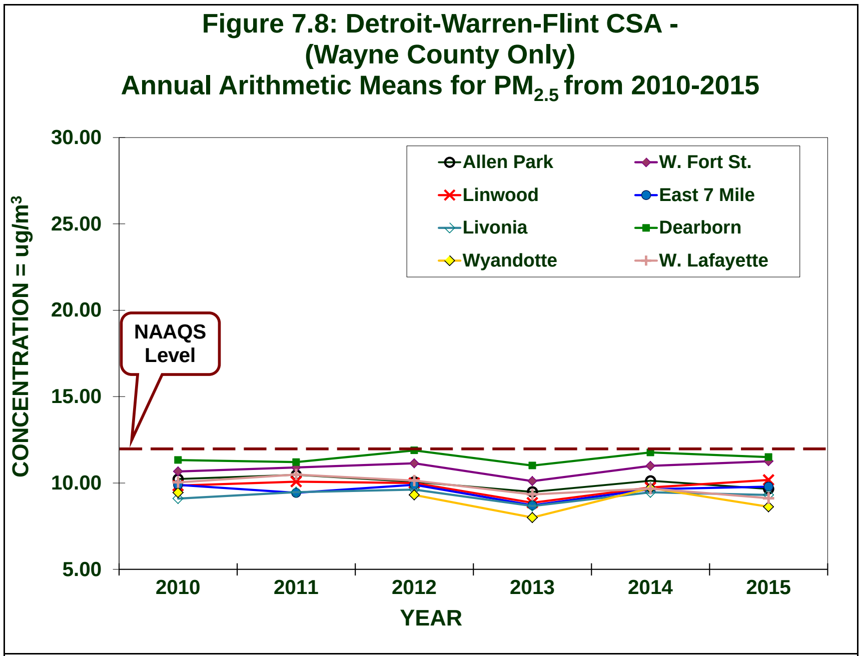


Figure 7.8 shows that 2015 levels in Wayne County remained below the $PM_{2.5}$ NAAQS standard. Historically, Dearborn has had the highest readings in the state.

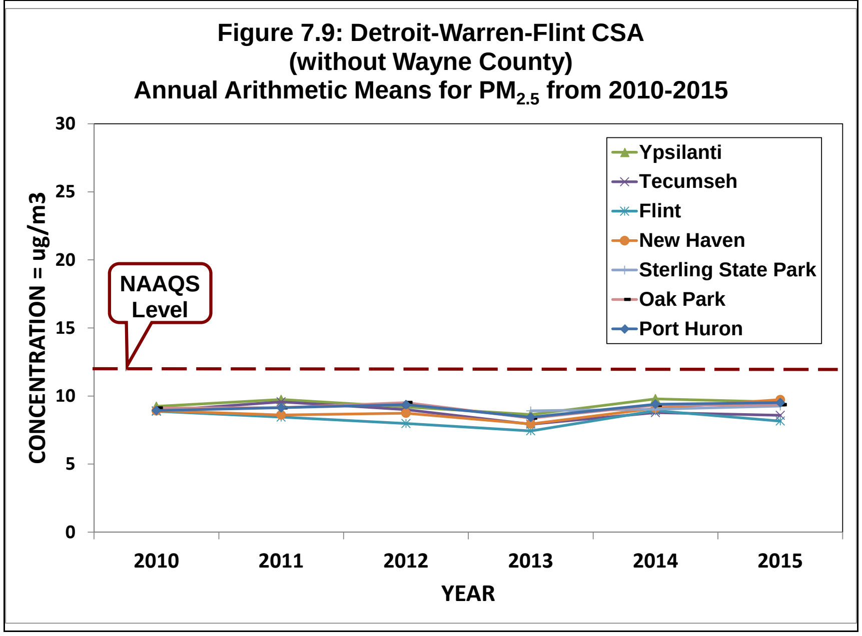


Figure 7.9 contains the remainder of those sites in the Detroit-Warren-Flint CSA that are outside of Wayne County. These sites also show readings in 2015 to be below the $PM_{2.5}$ NAAQS.

Figure 7.10: West MI - Grand Rapids-Muskegon-Holland CSA, Kalamazoo & Benton Harbor MSAs Annual Arithmetic Means for $PM_{2.5}$ from 2010-2015

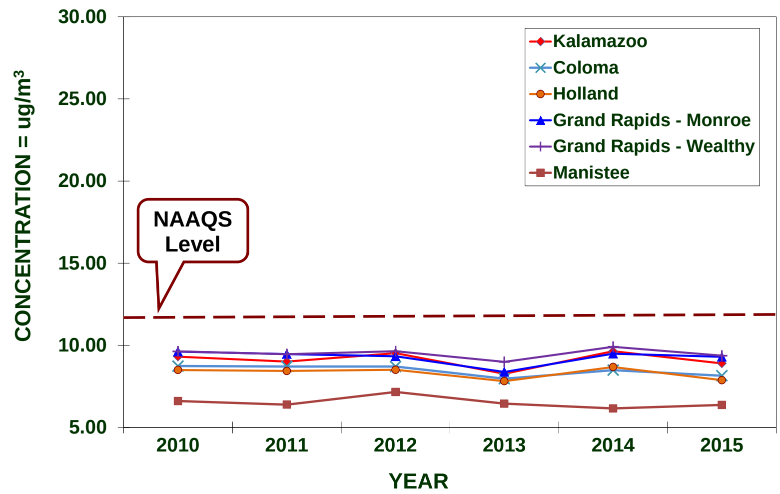


Figure 7.10 combines the $PM_{2.5}$ monitoring sites located in West Michigan-Grand Rapids-Muskegon-Holland CSA, Kalamazoo and Benton Harbor MSAs. All sites are below the annual $PM_{2.5}$ NAAQS.

Figure 7.11: Lansing-E. Lansing CSA, Saginaw-Bay City CSA, Cadillac MiSA & Upper Peninsula Annual Arithmetic Means for $PM_{2.5}$ from 2010-2015

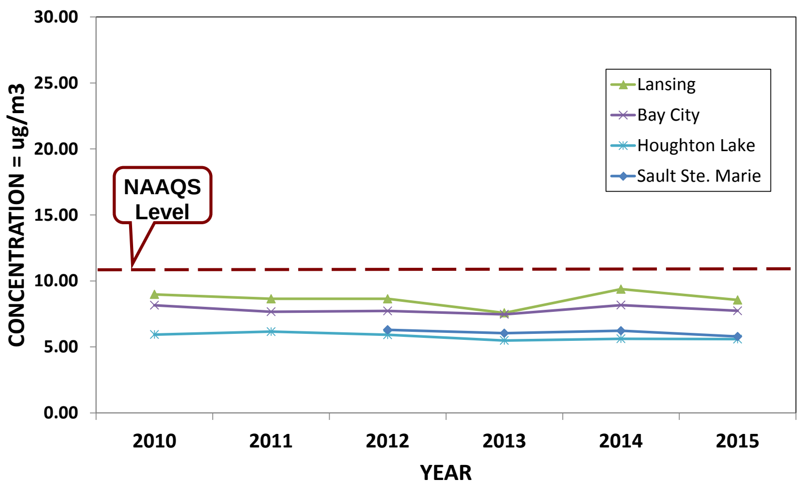


Figure 7.11 displays the remaining monitoring sites in the Northern Lower and Upper Peninsula. All of these sites are below the annual $PM_{2.5}$ NAAQS standard.

Chapter 8: Toxic Air Pollutants

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

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

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

Population most at risk: People with asthma, children, and the elderly are at the highest risk from exposure to air toxics**.**

Air Toxics can be categorized as:

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

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

For example:

- Some initiatives have targeted those substances that are *persistent, bioaccumulative and toxic* (PBT), such as mercury, which accumulates in body tissues.
- The EPA has developed an Integrated *Urban Air Toxics Strategy* with a focus on 30 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 2015. This table can also be found in **Appendix B** with the Air Toxics Monitoring Summary.

The PM2.5 speciation network was reduced due to EPA funding cuts. In January 2015, DEQ shutdown three monitors at Houghton Lake in Missaukee County, Sterling State Park in Monroe County and Port Huron in St. Clair County.

Table 8.1: 2015 Toxics Sampling Sites

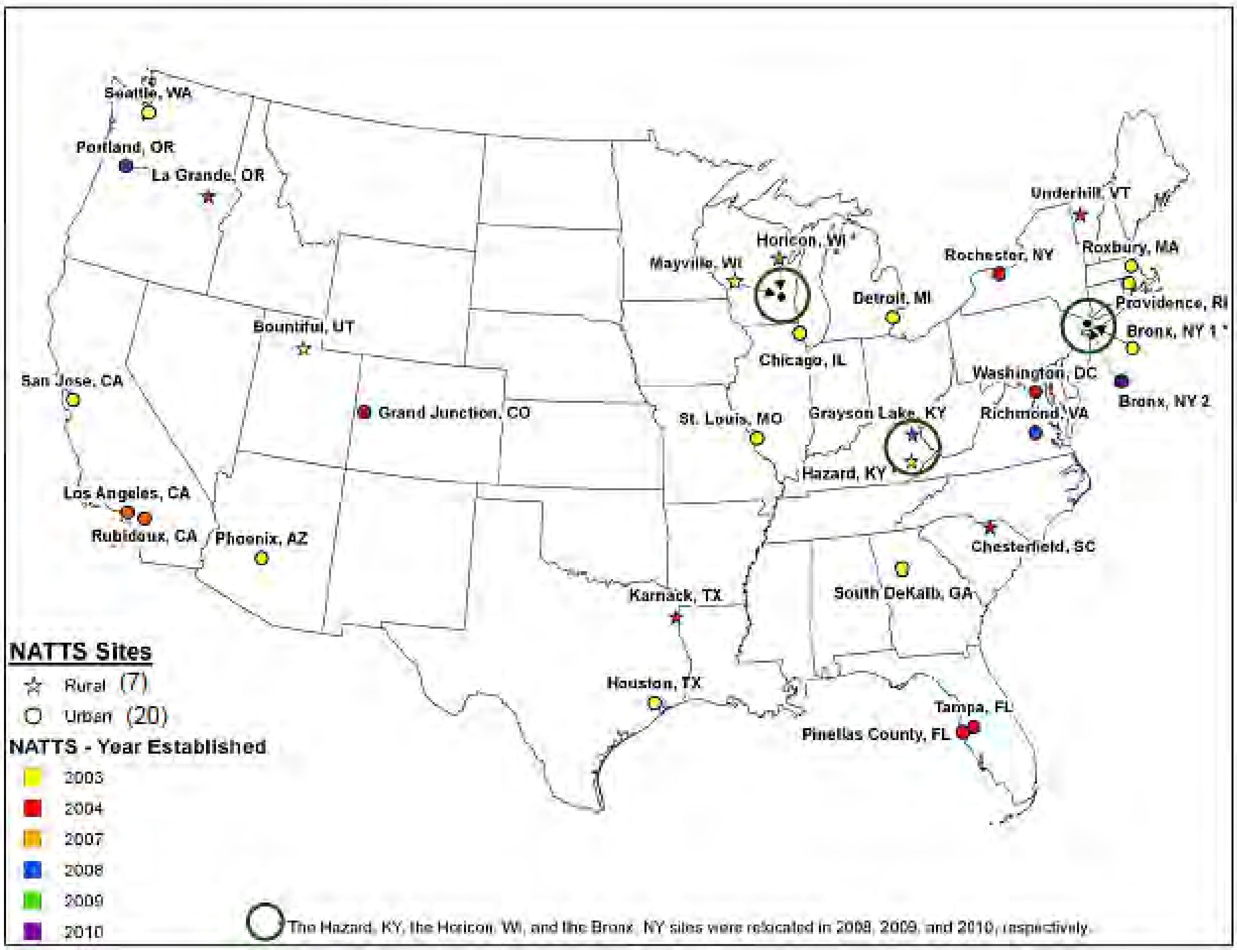
SITE NAME	VOC	Carbonyl	PAHs	Metals TSP	Metals PM_{10}	Speciated $PM_{2.5}$
Allen Park				x	x	x
Dearborn	x	x	x	x	x	x
Detroit-W. Fort St.	x	x		x	Mn	x
Detroit-W. Jefferson				x		
Grand Rapids-Monroe				x		x
Belding-Merrick St.				x		
Belding-Reed St.				x		
Port Huron-Rural St.				x		
River Rouge		x		x	Mn	
Tecumseh						x

[12] EPA’s Air Toxics Website – Urban Strategy is located at https://www.epa.gov/urban-air-toxics/urban-air-toxic-pollutants.

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 and trace metals on a once every six day sampling schedule. Hexavalent chromium is no longer required at NATTS sites and data collection was discontinued July 2013. The Dearborn NATTS site measures trace metals as TSP, $PM_{10,}$ and $PM_{2.5}$.

Figure 8.1: National Air Toxics Trends Sites.



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

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

Air Quality Index

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

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

MIair includes an 'Actions to Protect Health' link: http://www.deqmiair.org/assets/AQIActionsToProtectHealth_2011.pdf which contains activity recommendations based on the 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 learn more about this program, select the **MIair** button from Michigan's Air Quality page www.michigan.gov/air. To receive notices chose the 'Air Quality Notification' tab and click the 'Enroll in AQI EnviroFlash' link. Michigan's EnviroFlash network has the potential to reach up to 98% of the state's population.

AIRNow

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

Table 9.1: AQI Colors and Health Statements

AQI Color, Category & Value	PARTICULATE MATTER (µg/m3) 24-hour	OZONE (ppm) 8-hour / 1-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, Children, and Older adults should reduce prolonged or heavy exertion.	People with heart or lung disease, Children & older adults, and People who are active outdoors should reduce prolonged or heavy exertion.	People with heart disease, such as angina, should limit heavy exertion and avoid sources of CO, such as heavy traffic.	People with asthma should consider limiting outdoor exertion.	None
RED: Unhealthy 151- 200	People with heart or lung disease, Children, and Older adults should avoid prolonged or heavy exertion. Everyone should reduce prolonged or heavy exertion.	People with heart or lung disease, Children & older adults, and People who are active outdoors should avoid prolonged or heavy exertion. Everyone should reduce prolonged or heavy exertion.	People with heart disease, such as angina, should reduce moderate exertion and avoid sources of CO, such as heavy traffic.	Children, Asthmatics, and People with heart or lung disease should reduce outdoor exertion.	None
PURPLE: Very Unhealthy 201- 300	People with heart or lung disease, Children, and Older adults should avoid all physical exertion outdoors. Everyone else should limit outdoor exertion.	People with heart or lung disease, Children & older adults, and People who are active outdoors should avoid all physical exertion outdoors. Everyone else should limit outdoor exertion.	People with heart disease, such as angina, should avoid exertion and sources of CO, such as heavy traffic.	Children, Asthmatics, and People with heart or lung disease should avoid outdoor exertion; Everyone should reduce outdoor exertion.	Children and People with respiratory disease, such as asthma, should reduce outdoor exertion.
MAROON: Hazardous 301- 500	People with heart or lung disease, Children, and Older adults should remain indoors. Everyone should avoid prolonged or heavy exertion.	People with heart or lung disease, Children, and Older adults should remain indoors. Everyone should avoid all outdoor exertion.	People with heart disease, such as angina, should avoid exertion and sources of CO, such as heavy traffic. Everyone else should limit heavy exertion.	Children, Asthmatics, and People with heart or lung disease should remain indoors. Everyone should avoid outdoor exertion.	Children and People with respiratory disease, such as asthma, should avoid outdoor exertion.

Chapter 10: Meteorological Information

Figures 10.1 through **10.3** shows average daily temperatures and **Figures 10.4** through **10.6** shows total monthly precipitation amounts 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 2015.

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

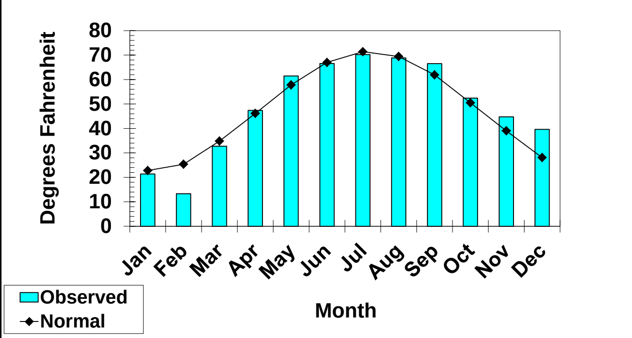


Figure 10.2: Northern Lower Peninsula Observed Average Daily Temperatures vs. Normal Average Daily Temperatures

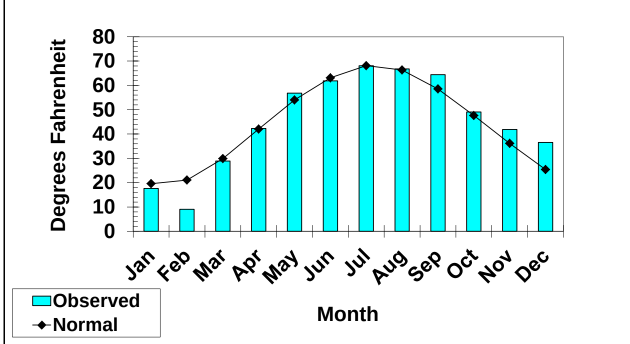


Figure 10.3: Upper Peninsula Observed Average Daily Temperatures vs. Normal Average Daily Temperatures

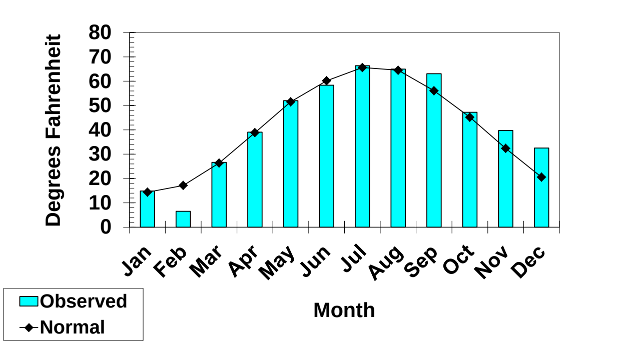


Figure 10.4: Southern Lower Peninsula Observed Monthly Precipitation vs. Normal Monthly Precipitation

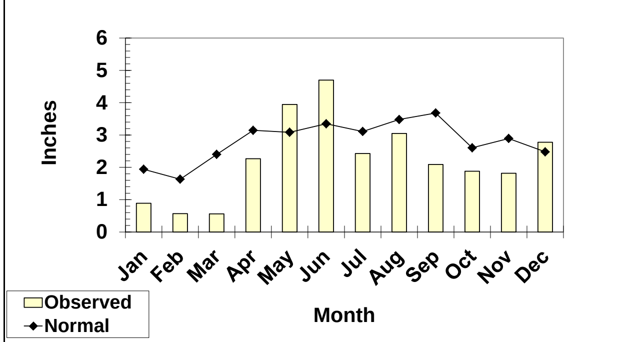


Figure 10.5: Northern Lower Peninsula Observed Monthly Precipitation vs. Normal Monthly Precipitation

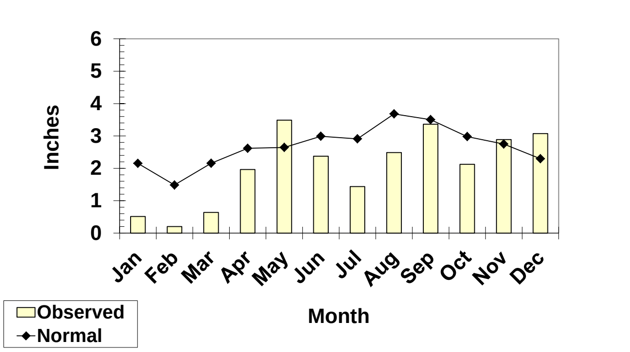
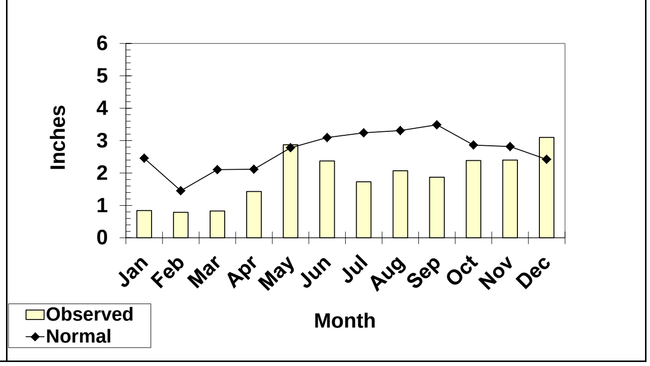


Figure 10.6: Upper Peninsula Observed Monthly Precipitation vs. Normal Monthly Precipitation



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

Table 10.1 Shows that there were only four *Action!* Days declared during the summer of 2015.

Table 10.1: *Action!* Days Declared During Summer 2015

Location	Year	Number	Dates
Benton Harbor	2015	1	7/18
Grand Rapids	2015	4	7/18, 8/16, 8/17, 9/6
Ludington	2015	4	7/18, 8/16, 8/17, 9/6

Appendix A: Criteria Pollutant Summary for 2015

Appendix A utilizes EPA's 2015 Air Quality System (AQS) Quick Look Report Data to present a summary of ambient air quality data collected for the criteria pollutants at monitoring locations throughout Michigan. Concentrations of non-gaseous pollutants are generally given in $\mu g/m^3$ and in ppm for gaseous pollutants. The following define some of the terms listed in the **Appendix A** reports.

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

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

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

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

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

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

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

CRITERIA POLLUTANT SUMMARY FOR 2015

CO Measured in ppm

Site ID	POC	City	County	Year	# OBS	1-hr Highest Value	1-hr 2nd Highest Value	1-hr OBS > 35	8-hr Highest Value	8-hr 2nd Highest Value	8-hr OBS > 9
260810020	1	Grand Rapids	Kent	2015	8244	1.6	1.6	0	1.2	1.2	0
261630001	1	Allen Park	Wayne	2015	8219	1.9	1.8	0	1.2	1.1	0
261630093	1	Eliza Howell - Roadway	Wayne	2015	8404	2.3	2.2	0	2.2	1.7	0
261630094	1	Eliza Howell - Downwind	Wayne	2015	8156	2.5	2.4	0	2.2	1.7	0
261630095	1	Livonia - Roadway	Wayne	2015	8295	1.4	1.4	0	1.3	1.2	0

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

Site ID	POC	City	County	Year	# OBS	Highest rolling 3-month Arith Mean	Highest Value (24 hr)	2nd Highest Value (24hr)
260670002	1	Belding - Reed St.	Ionia	2015	60	0.03	0.292	0.167
260670003	1	Belding - Merrick St.	Ionia	2015	57	0.04	0.085	0.081
260810020	1	Grand Rapids	Kent	2015	59	0.01	0.017	0.015
261470031	1	Port Huron Rural St.	St. Clair	2015	60	0.05	0.180	0.161
261630001	1	Allen Park	Wayne	2015	58	0.00	0.011	0.007
261630033	1	Dearborn	Wayne	2015	59	0.02	0.084	0.046

NO_2 Measured in ppb

Site ID	POC	City	County	Year	# OBS	1-Hr Highest Value	1-Hr 2nd Highest Value	98th Percentile 1-hr	Annual Arith Mean
260650012	1	Lansing	Ingham	2015	6843	43.0	41.0	38.0	6.94
261130001	1	Houghton Lake	Missaukee	2015	8049	17.0	11.0	7.0	1.37
261630019	2	Detroit - E. Seven Mile	Wayne	2015	8431	57.0	53.0	45.0	11.29
261630093	1	Eliza Howell - Roadway	Wayne	2015	8564	59.0	65.0	50.0	18.13
261630094	1	Eliza Howell - Downwind	Wayne	2015	8684	54.0	50.0	47.0	12.42
261630095	1	Livonia – Roadway	Wayne	2015	8315	54.0	54.0	48.0	10.66

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	2015	8194	229.8	186.5	14.50
261630001	1	Allen Park	Wayne	2015	7060	209.8	208.3	20.41

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	2015	183	183	0.101	0.089	0.089	0.080	0	0	0
260190003	1	Benzonia	Benzie	2015	183	183	0.085	0.081	0.076	0.072	0	0	0
260210014	1	Coloma	Berrien	2015	182	183	0.093	0.086	0.085	0.080	0	0	1
260270003	2	Cassopolis	Cass	2015	180	183	0.085	0.079	0.075	0.075	0	0	1
260330901	1	Sault Ste. Marie	Chippewa	2015	168	183	0.075	0.073	0.070	0.064	0	0	0
260370001	2	Rose Lake	Clinton	2015	182	183	0.074	0.069	0.068	0.067	0	0	1
260490021	1	Flint	Genesee	2015	183	183	0.077	0.073	0.071	0.068	0	0	0
260492001	1	Otisville	Genesee	2015	181	183	0.078	0.078	0.072	0.071	0	0	0
260630007	1	Harbor Beach	Huron	2015	183	183	0.099	0.095	0.083	0.078	0	0	0
260650012	2	Lansing	Ingham	2015	182	183	0.069	0.069	0.068	0.068	0	0	1
260770008	1	Kalamazoo	Kalamazoo	2015	177	183	0.076	0.073	0.073	0.071	0	0	0
260810020	1	Grand Rapids	Kent	2015	183	183	0.081	0.080	0.078	0.072	0	0	0
260810022	1	Evans	Kent	2015	183	183	0.079	0.071	0.071	0.069	0	0	0
260910007	1	Tecumseh	Lenawee	2015	183	183	0.075	0.071	0.070	0.070	0	0	0
260990009	1	New Haven	Macomb	2015	183	183	0.104	0.094	0.090	0.081	0	0	0
260991003	1	Warren	Macomb	2015	183	183	0.081	0.076	0.073	0.072	0	0	0
261010922	1	Manistee	Manistee	2015	183	183	0.086	0.082	0.079	0.077	0	0	0
261050007	1	Scottville	Mason	2015	183	183	0.077	0.076	0.075	0.072	0	0	0
261130001	1	Houghton Lake	Missaukee	2015	182	183	0.085	0.070	0.068	0.068	0	0	1
261210039	1	Muskegon	Muskegon	2015	177	183	0.104	0.093	0.086	0.084	0	0	2
261250001	2	Oak Park	Oakland	2015	179	183	0.087	0.082	0.076	0.073	0	0	1
261390005	1	Jenison	Ottawa	2015	162	183	0.080	0.077	0.075	0.072	0	0	0
261470005	1	Port Huron	St .Clair	2015	181	183	0.094	0.092	0.090	0.089	0	0	2
261530001	1	Seney	Schoolcraft	2015	183	183	0.088	0.080	0.079	0.078	0	0	0
261610008	1	Ypsilanti	Washtenaw	2015	183	183	0.074	0.074	0.072	0.071	0	0	0
261630001	2	Allen Park	Wayne	2015	170	183	0.079	0.077	0.076	0.075	0	0	7
261630019	2	Detroit - E. Seven Mile	Wayne	2015	180	183	0.092	0.084	0.081	0.079	0	0	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	2015	100	183	0.084	0.079	0.075	0.072	2
260190003	1	Benzonia	Benzie	2015	100	183	0.073	0.072	0.069	0.067	0
260210014	1	Coloma	Berrien	2015	99	182	0.078	0.074	0.073	0.072	1
260270003	2	Cassopolis	Cass	2015	98	180	0.078	0.074	0.069	0.068	1
260330901	1	Sault Ste. Marie	Chippewa	2015	92	168	0.065	0.064	0.063	0.059	0
260370001	2	Rose Lake	Clinton	2015	99	182	0.070	0.066	0.065	0.064	0
260490021	1	Flint	Genesee	2015	100	183	0.074	0.070	0.068	0.066	0
260492001	1	Otisville	Genesee	2015	98	180	0.073	0.067	0.067	0.067	0
260630007	1	Harbor Beach	Huron	2015	99	182	0.079	0.078	0.068	0.067	2
260650012	2	Lansing	Ingham	2015	98	180	0.068	0.066	0.065	0.064	0

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

Site ID	POC	City	County	Year	% OBS	Valid Days Measured	Highest Value	2nd Highest Value	3rd Highest Value	4th Highest Value	Day Max > 0.075
260770008	1	Kalamazoo	Kalamazoo	2015	96	176	0.071	0.070	0.070	0.067	0
260810020	1	Grand Rapids	Kent	2015	99	182	0.076	0.072	0.068	0.067	1
260810022	1	Evans	Kent	2015	99	182	0.073	0.066	0.065	0.065	0
260910007	1	Tecumseh	Lenawee	2015	100	183	0.067	0.065	0.065	0.065	0
260990009	1	New Haven	Macomb	2015	100	183	0.079	0.076	0.072	0.072	2
260991003	1	Warren	Macomb	2015	96	176	0.066	0.065	0.065	0.064	0
261010922	1	Manistee	Manistee	2015	99	182	0.076	0.072	0.069	0.067	1
261050007	1	Scottville	Mason	2015	100	183	0.072	0.068	0.067	0.066	0
261130001	1	Houghton Lake	Missaukee	2015	98	180	0.071	0.069	0.066	0.064	0
261210039	1	Muskegon	Muskegon	2015	96	175	0.089	0.077	0.075	0.074	2
261250001	2	Oak Park	Oakland	2015	96	175	0.075	0.072	0.072	0.066	0
261390005	1	Jenison	Ottawa	2015	86	158	0.077	0.066	0.066	0.065	1
261470005	1	Port Huron	St .Clair	2015	98	179	0.078	0.076	0.075	0.075	2
261530001	1	Seney	Schoolcraft	2015	100	183	0.080	0.076	0.071	0.070	2
261610008	1	Ypsilanti	Washtenaw	2015	100	183	0.067	0.067	0.065	0.064	0
261630001	2	Allen Park	Wayne	2015	92	168	0.069	0.069	0.066	0.064	0
261630019	2	Detroit - E. Seven Mile	Wayne	2015	97	178	0.080	0.074	0.072	0.070	1

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

Site ID	POC	Monitor	City	County	Year	# OBS	Highest Value	2nd Highest Value	3rd Highest Value	4th Highest Value	98%	Wtd. Arith. Mean
260050003	1	FRM	Holland	Allegan	2015	116	23.6	22.5	21.2	20.3	21.2	7.88
260170014	1	FRM	Bay City	Bay	2015	117	25.9	23.5	23.3	22.5	23.3	7.74
260210014	1	FRM	Coloma	Berrien	2015	117	28.2	23.0	19.4	19.1	19.4	8.15
260330901	1	FRM	Sault Ste. Marie	Chippewa	2015	68	18.7	15.8	12.4	11.5	15.8	5.79*
260330901	2	FRM	Sault Ste. Marie	Chippewa	2015	44	16.4	16.4	13.7	12.0	16.4	6.18*
260490021	1	FRM	Flint	Genesee	2015	118	24.9	23.2	22.3	20.9	22.3	8.16
260650012	1	FRM	Lansing	Ingham	2015	116	34.3	32.1	24.5	21.7	24.5	8.56
260770008	1	FRM	Kalamazoo	Kalamazoo	2015	112	30.5	26.5	22.3	20.7	22.3	8.90
260770008	2	FRM	Kalamazoo	Kalamazoo	2015	59	30.5	21.3	18.2	17.9	21.3	9.34
260810007	1	FRM	Grand Rapids - Wealthy	Kent	2015	113	58.5	26.6	25.5	25.0	25.5	9.37
260810020	1	FRM	Grand Rapids - Monroe	Kent	2015	116	50.5	26.3	25.6	24.0	25.6	9.30
260810020	2	FRM	Grand Rapids - Monroe	Kent	2015	57	51.0	24.3	22.2	20.7	24.3	10.37
260910007	1	FRM	Tecumseh	Lenawee	2015	120	31.1	30.4	25.2	20.3	25.2	8.58
260990009	1	FRM	New Haven	Macomb	2015	117	82.0	32.3	31.6	24.0	31.6	9.73

*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	2015	119	20.5	20.4	19.3	19.0	19.3	6.37
261130001	1	FRM	Houghton Lake	Missaukee	2015	114	27.3	18.3	17.9	17.7	17.9	5.59
261150006	1	FRM	Sterling State Park	Monroe	2015	118	35.5	29.4	25.7	25.4	25.7	9.26
261250001	1	FRM	Oak Park	Oakland	2015	117	52.2	29.8	29.6	23.6	29.6	9.37
261470005	1	FRM	Port Huron	St. Clair	2015	118	34.3	33.4	28.7	27.3	28.7	9.51
261610008	1	FRM	Ypsilanti	Washtenaw	2015	117	31.1	30.6	25.9	25.7	25.9	9.56
261610008	2	FRM	Ypsilanti	Washtenaw	2015	60	25.3	20.6	20.2	19.0	20.6	9.08
261630001	1	FRM	Allen Park	Wayne	2015	334	35.1	34.2	31.9	29.3	23.1	9.66
261630015	1	FRM	Detroit - W. Fort	Wayne	2015	120	37.6	32.0	27.1	25.0	27.1	11.26
261630016	1	FRM	Detroit - Linwood	Wayne	2015	117	35.2	31.5	27.1	25.4	27.1	10.18
261630019	1	FRM	Detroit - E. Seven Mile	Wayne	2015	116	32.0	30.3	25.6	23.4	25.6	9.79
261630025	1	FRM	Livonia	Wayne	2015	119	31.3	30.2	26.8	24.6	26.8	9.31
261630033	1	FRM	Dearborn	Wayne	2015	119	36.3	36.2	28.1	27.4	28.1	11.50
261630033	2	FRM	Dearborn	Wayne	2015	58	26.0	24.7	24.7	22.5	24.7	11.65
261630036	1	FRM	Wyandotte	Wayne	2015	110	37.0	32.2	21.1	18.1	21.1	8.62
261630039	1	FRM	Detroit - W. Lafayette	Wayne	2015	341	37.3	30.5	27.5	26.2	22.4	9.12
261630095	1	FRM	Livonia-Roadway	Wayne	2015	112	31.5	31.1	25.2	22.0	25.2	9.53

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

Site ID	POC	Monitor	City	County	Year	# OBS	Highest Value	2nd Highest Value	3rd Highest Value	4th Highest Value	Wtd. Arith. Mean
260170014	3	TEOM	Bay City	Bay	2015	8495	157.0	57.0	54.0	53.0	8.56
260330901	3	BAM	Sault Ste. Marie	Chippewa	2015	8050	70.8	58.3	57.5	56.4	8.59
260490021	3	TEOM	Flint	Genesee	2015	8312	286.0	192.0	163.0	71.0	8.89
260650012	5	TEOM	Lansing	Ingham	2015	8521	154.0	137.0	126.0	120.0	8.93
260770008	3	TEOM	Kalamazoo	Kalamazoo	2015	8497	82.0	76.0	70.0	69.0	9.19
260810020	3	TEOM	Grand Rapids	Kent	2015	8310	330.0	227.0	198.0	153.0	9.38
260910007	3	TEOM	Tecumseh	Lenawee	2015	7958	123.0	107.0	92.0	88.0	8.94
261130001	3	TEOM	Houghton Lake	Missaukee	2015	8139	55.0	55.0	49.0	44.0	7.23
261470005	3	TEOM	Port Huron	St. Clair	2015	8673	76.0	72.0	68.0	66.0	9.23
261530001	3	TEOM	Seney	Schoolcraft	2015	8649	50.0	49.0	42.0	40.0	6.19
261610008	3	TEOM	Ypsilanti	Washtenaw	2015	8636	237.0	175.0	99.0	95.0	9.28
261630001	3	TEOM	Allen Park	Wayne	2015	8221	245.0	141.0	117.0	117.0	10.60
261630033	3	TEOM	Dearborn	Wayne	2015	8363	319.0	78.0	75.0	63.0	11.47
261630039	3	TEOM	Detroit – W. Lafayette	Wayne	2015	8581	64.0	57.0	56.0	56.0	10.01
261630039	3	BAM	Detroit – W. Lafayette	Wayne	2015	7579	73.6	65.1	63.6	62.7	11.84

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

Site ID	POC	Monitor	City	County	Year	# OBS	# Req.	Valid Days	% OBS	Highest Value	2^{nd} Highest Value	3^{rd} Highest Value	4^{th} Highest Value	Wtd Arith Mean
260810020	1	GRAV	Grand Rapids - Monroe	Kent	2015	54	60	54	90	92	29	28	28	16.8
261630001	1	GRAV	Allen Park	Wayne	2015	58	60	57	95	37	35	30	29	16.8
261630005	1	GRAV	River Rouge	Wayne	2015	57	60	57	95	46	40	38	35	20.5
261630015	1	GRAV	Detroit - W. Fort St.	Wayne	2015	58	60	58	97	58	49	37	36	21.1
261630033	1	GRAV	Dearborn	Wayne	2015	60	60	60	100	52	46	46	44	25.1
261630033	9	GRAV	Dearborn	Wayne	2015	30	30	28	93	50	48	44	37	26.0

PM_{10} TEOM (1-Hour) Measured in $\mu g/m^3$

Site ID	POC	Monitor	City	County	Year	# OBS	Highest Value	2^{nd} Highest Value	3^{rd} Highest Value	4^{th} Highest Value	Wtd. Arith. Mean
261630033	3	TEOM	Dearborn	Wayne	2015	8593	258	224	197	190	22.8

SO_2 Measured in ppb

Site ID	POC	City	County	Year	# OBS	1-hr Highest Value	1-hr 2^{nd} Highest Value	99^{th} %ile 1-hr	24-hr Highest Value	24-hr 2^{nd} Highest Value	OBS >0.5	Arith Mean
260650012	1	Lansing	Ingham	2015	8187	18.8	14.1	13.4	3.9	3.5	0	0.87
260810020	2	Grand Rapids	Kent	2015	8256	13.9	10.7	9.8	3.0	2.6	0	0.69
261150006	1	Sterling State Park	Monroe	2015	7083	18.7	18.2	17.6	12.1	3.8	0	0.98*
261390011	1	West Olive	Ottawa	2015	7968	53.6	53.1	32.9	12.1	10.6	0	0.77
261470005	1	Port Huron	St. Clair	2015	8383	100.5	97.8	76.0	22.1	21.2	0	2.29
261630001	1	Allen Park	Wayne	2015	7770	60.6	44.5	33.6	13.5	10.6	0	1.18*
261630015	1	Detroit - W. Fort St.	Wayne	2015	8358	73.0	64.3	55.2	44.8	18.5	0	2.28

*Indicates the mean does not satisfy summary criteria

Appendix B: 2015 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 2015. At each monitoring site, air samples were taken over a 24-hour period (midnight to midnight). These air samples represent the average air concentration during that 24-hour period. The frequency of air samples collected is typically done once every 6 or 12 days. Sometimes the sampled air concentration is lower than the laboratory's analytical method detection level (MDL). When the concentration is lower than the MDL, two options are used to estimate the air concentration. The calculation of the minimum average ("Average (ND=0)") uses 0.0 $\mu g/m^3$ for a value less than the MDL. In the calculation of the maximum average ("Average (ND=MDL/2)") the MDL divided by 2 (i.e., ½ the MDL) is substituted for air concentrations less than the MDL.

Table B shows the monitoring stations and what types of air toxics were monitored at each station in 2015. 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 2015, assuming daily samples below MDL were equal to 0.0 $\mu g/m^3$.
- Average (ND=MDL/2): average air concentration in 2015, assuming daily samples below MDL were equal to one half the MDL.
- MDL: Analytical MDL in units of $\mu g/m^3$
- Max1: Highest daily air concentration during 2015
- Max2: Second highest daily air concentration during 2015
- Max3: Third highest daily air concentration during 2015
- $\mu g/m^3$: Micrograms per cubic meter (1,000,000 μg = 1 g)

Table B: Monitoring Stations and Types of Air Samples Collected						
	Appendix B-1					Appendix B-2
Site Name	**VOC**	**Carbonyl**	**PAHs**	**Metals TSP**	**Metals PM_{10}**	**Speciated PM2.5**
Allen Park				x	x	x
Dearborn	x	x	x	x	x	x
Detroit-W. Fort St.	x	x		x	Mn	x
Detroit-W. Jefferson				x		
Grand Rapids-Monroe				x		x
Belding-Merrick St.				x		
Belding-Reed St.				x		
Port Huron-Rural St.				x		
River Rouge		x		x	Mn	
Tecumseh						x

VOC = volatile organic compound; PAHs = polycyclic aromatic hydrocarbon; TSP = total suspended particulate; PM_{10} = particulate matter with aerodynamic diameter less than 10 µm; Mn = manganese;

APPENDIX B-1

Allen Park (261630001) Concentrations in micrograms per cubic meter (µg/m³)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Arsenic (Tsp) Stp	58	58	0.00185	0.00185	8.86E-06	0.00853	0.00722	0.00489
Arsenic Pm10 Stp	58	58	0.00161	0.00161	9.98E-06	0.00689	0.00624	0.00565
Cadmium (Tsp) Stp	58	58	0.000173	0.000173	9.72E-06	0.00036	0.00033	0.00032
Cadmium Pm10 Stp	58	58	0.000329	0.000329	1.17E-05	0.00106	0.001	0.0009
Lead (Tsp) Lc Frm/Fem	58	58	0.00419	0.00419	0	0.0118	0.00712	0.00668
Lead Pm10 Lc	58	58	0.003	0.003	0	0.0106	0.00543	0.00521
Manganese (Tsp) Stp	58	58	0.0211	0.0211	5.76E-05	0.0617	0.0482	0.042
Manganese Pm10 Stp	58	58	0.00875	0.00875	6.84E-05	0.0241	0.0201	0.0186
Nickel (Tsp) Stp	58	58	0.00115	0.00115	5.33E-05	0.00197	0.00194	0.00194
Nickel Pm10 Stp	58	58	0.000788	0.000788	6.47E-05	0.00187	0.00135	0.00131

Dearborn (261630033) Concentrations in micrograms per cubic meter (µg/m³)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
1,1,2,2-Tetrachloroethane	60	0	0	0.0618	0.124	0	0	0
1,1,2-Trichloroethane	60	0	0	0.0464	0.0928	0	0	0
1,1-Dichloroethane	60	0	0	0.0304	0.0607	0	0	0
1,1-Dichloroethylene	60	0	0	0.0159	0.0317	0	0	0
1,2,4-Trichlorobenzene	12	0	0	0.186	0.371	0	0	0
1,2,4-Trimethylbenzene	60	60	0.627	0.627	0.103	3.94	1.94	1.89
1,2-Dichlorobenzene	60	0	0	0.0721	0.144	0	0	0
1,2-Dichloropropane	60	0	0	0.0393	0.0786	0	0	0
1,3,5-Trimethylbenzene	60	58	0.205	0.207	0.103	1.35	0.664	0.644
1,3-Butadiene	60	60	0.0925	0.0925	0.031	0.257	0.219	0.215
1,3-Dichlorobenzene	60	0	0	0.0752	0.15	0	0	0
1,4-Dichlorobenzene	60	19	0.0146	0.0681	0.156	0.0721	0.0661	0.0601
2,5-Dimethylbenzaldehyde	66	0	0	0.00548	0.011	0	0	0
Acenaphthene (Tsp) Stp	66	58	0.00909	0.0091	0.000275	0.0328	0.0291	0.0289
Acenaphthylene (Tsp) Stp	66	43	0.000413	0.000429	8.43E-05	0.00315	0.00128	0.00121
Acetaldehyde	66	66	1.77	1.77	0.0101	3.06	2.88	2.83
Acetone	66	66	3	3	0.0291	6.2	5.58	5.41
Acetonitrile	60	60	0.683	0.683	0.0521	2.55	1.9	1.58
Acetylene	60	60	1.09	1.09	0.0213	3.07	2.95	2.43
Acrylonitrile	60	3	0.00235	0.0198	0.0369	0.0847	0.0304	0.026
Anthracene (Tsp) Stp	66	66	0.000617	0.000617	9.10E-05	0.00271	0.00189	0.00146
Arsenic (Tsp) Stp	86	86	0.00217	0.00217	8.63E-06	0.00657	0.00655	0.00546
Arsenic Pm10 Stp	90	90	0.00187	0.00187	9.99E-06	0.00721	0.0065	0.00527

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
Barium (Tsp) Stp	86	86	0.025	0.025	0.0004	0.163	0.155	0.0425
Barium Pm10 Stp	90	90	0.0158	0.0158	0.00052	0.193	0.164	0.028
Benzaldehyde	66	66	0.17	0.17	0.013	0.365	0.278	0.26
Benzene	60	60	0.797	0.797	0.125	1.95	1.48	1.45
Benzo[A]Anthracene (Tsp) Stp	66	66	0.000192	0.000192	0.000103	0.000534	0.000494	0.000481
Benzo[A]Pyrene (Tsp) Stp	66	65	0.000186	0.000196	0.000167	0.000585	0.000451	0.000438
Benzo[B]Fluoranthene (Tsp) Stp	66	66	0.000381	0.000381	0.000116	0.00106	0.000779	0.00076
Benzo[G,H,I]Perylene (Tsp) Stp	66	66	0.000236	0.000236	8.61E-05	0.000711	0.000599	0.000544
Benzo[K]Fluoranthene (Tsp) Stp	66	43	0.000103	0.000134	0.000124	0.000354	0.000314	0.000304
Beryllium (Tsp) Stp	86	84	8.37E-05	8.38E-05	5.69E-06	0.00027	0.00023	0.0002
Beryllium Pm10 Stp	90	84	2.15E-05	2.18E-05	7.04E-06	5.00E-05	5.00E-05	5.00E-05
Bromochloromethane	60	0	0	0.0397	0.0794	0	0	0
Bromodichloromethane	60	0	0	0.0603	0.121	0	0	0
Bromoform	60	1	0.000688	0.0871	0.176	0.0413	0	0
Bromomethane	60	57	0.0392	0.04	0.035	0.0738	0.0699	0.0583
Butyraldehyde	66	66	0.356	0.356	0.00885	1.28	1.04	0.785
Cadmium (Tsp) Stp	86	86	0.000364	0.000364	9.33E-06	0.00171	0.00098	0.00078
Cadmium Pm10 Stp	90	90	0.000281	0.000281	1.18E-05	0.00098	0.00073	0.00068
Carbon Disulfide	60	60	0.268	0.268	0.0374	7.63	0.511	0.43
Carbon Tetrachloride	60	60	0.666	0.666	0.0629	0.818	0.812	0.786
Chlorobenzene	60	12	0.0158	0.0489	0.0829	0.106	0.101	0.101
Chloroethane	60	58	0.124	0.125	0.0237	0.362	0.335	0.269
Chloroform	60	60	0.517	0.517	0.0781	1.19	1.15	1.01
Chloromethane	60	60	1.32	1.32	0.0227	1.67	1.63	1.62
Chloroprene	60	0	0	0.0217	0.0435	0	0	0
Chromium (Tsp) Stp	86	86	0.00718	0.00718	0.000132	0.0166	0.0158	0.0147
Chromium Pm10 Stp	90	90	0.00349	0.00349	0.000165	0.00902	0.00746	0.0062
Chrysene (Tsp) Stp	66	66	0.00048	0.00048	8.71E-05	0.00121	0.000983	0.000881
Cis-1,2-Dichloroethene	60	1	0.00622	0.0336	0.0555	0.373	0	0
Cis-1,3-Dichloropropene	60	0	0	0.0386	0.0772	0	0	0
Cobalt (Tsp) Stp	86	86	0.000267	0.000267	1.92E-05	0.00069	0.00061	0.00056
Cobalt Pm10 Stp	90	90	0.000133	0.000133	2.81E-05	0.00048	0.0003	0.0003
Copper (Tsp) Stp	86	86	0.0511	0.0511	0.000229	0.274	0.232	0.152
Copper Pm10 Stp	90	90	0.0418	0.0418	0.000286	0.143	0.124	0.111
Dibenzo[A,H]Anthracene (Tsp) Stp	66	65	3.94E-05	4.62E-05	0.000113	9.86E-05	8.99E-05	7.85E-05
Dibromochloromethane	60	1	0.000283	0.0548	0.111	0.017	0	0
Dichlorodifluoromethane	60	60	2.68	2.68	0.0396	3.35	3.26	3.11
Dichloromethane	60	60	1.81	1.81	0.066	15.4	4.48	3.96
Ethyl Acrylate	60	2	0.00205	0.0238	0.045	0.0819	0.041	0
Ethylbenzene	60	60	0.366	0.366	0.0825	2.16	1.43	0.864
Ethylene Dibromide	60	0	0	0.0692	0.138	0	0	0
Ethylene Dichloride	60	58	0.0683	0.0691	0.0526	0.109	0.0971	0.0971
Fluoranthene (Tsp) Stp	66	66	0.00455	0.00455	0.000233	0.0175	0.0173	0.0153
Fluorene (Tsp) Stp	66	63	0.0082	0.0082	0.000608	0.025	0.0245	0.0241
Formaldehyde	66	66	3.33	3.33	0.0139	6.91	6.25	5.8
Freon 114	60	60	0.117	0.117	0.0559	0.14	0.133	0.133

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
Hexachlorobutadiene	12	0	0	0.181	0.363	0	0	0
Hexanaldehyde	66	66	0.135	0.135	0.00819	0.307	0.262	0.262
Indeno[1,2,3-Cd]Pyrene (Tsp) Stp	66	65	0.000214	0.00022	0.000106	0.000476	0.000438	0.000425
Iron (Tsp) Stp	86	86	1.6	1.6	0.00311	3.52	3.36	3.25
Iron Pm10 Stp	90	90	0.681	0.681	0.00388	2.34	1.52	1.45
Isovaleraldehyde	66	0	0	0.00705	0.0141	0	0	0
Lead (Tsp) Lc Frm/Fem	86	86	0.013	0.013	0	0.084	0.0465	0.0369
Lead Pm10 Lc	90	90	0.0105	0.0105	0	0.0969	0.0501	0.0482
M/P Xylene	60	60	1.07	1.07	0.122	7.34	4.52	2.8
Manganese (Tsp) Stp	86	86	0.11	0.11	5.60E-05	0.319	0.301	0.249
Manganese Pm10 Stp	90	90	0.0313	0.0313	6.88E-05	0.0708	0.0694	0.0679
Methyl Chloroform	60	38	0.0172	0.0302	0.0709	0.0382	0.0382	0.0327
Methyl Ethyl Ketone	66	66	0.468	0.468	0.00885	1	0.956	0.891
Methyl Isobutyl Ketone	60	60	0.228	0.228	0.0574	0.697	0.549	0.479
Methyl Methacrylate	60	2	0.00233	0.0577	0.115	0.119	0.0205	0
Methyl Tert-Butyl Ether	60	1	0.0003	0.0251	0.0505	0.018	0	0
Molybdenum (Tsp) Stp	86	86	0.00111	0.00111	1.21E-05	0.00916	0.00471	0.00292
Molybdenum Pm10 Stp	90	90	0.000919	0.000919	1.44E-05	0.00898	0.00436	0.00267
Naphthalene (Tsp) Stp	66	66	0.117	0.117	0.000382	0.312	0.306	0.267
Nickel (Tsp) Stp	86	86	0.00243	0.00243	5.23E-05	0.0184	0.00612	0.00576
Nickel Pm10 Stp	90	90	0.00162	0.00162	6.42E-05	0.0153	0.00676	0.00525
N-Octane	60	60	0.259	0.259	0.0794	0.706	0.5	0.486
O-Xylene	60	60	0.378	0.378	0.0695	1.39	1.04	1
Phenanthrene (Tsp) Stp	66	66	0.0186	0.0186	0.000329	0.0836	0.0551	0.0545
Propionaldehyde	66	66	0.326	0.326	0.00713	0.57	0.551	0.546
Propylene	60	60	0.695	0.695	0.0551	1.65	1.3	1.26
Pyrene (Tsp) Stp	66	66	0.00216	0.00216	0.000114	0.00741	0.00567	0.00565
Styrene	60	60	1.2	1.2	0.0682	8.9	3.1	2.64
Tert-Butyl Ethyl Ether	60	0	0	0.0167	0.0334	0	0	0
Tetrachloroethylene	60	59	0.179	0.179	0.0949	0.475	0.42	0.366
Tolualdehydes	64	64	0.154	0.154	0.0197	0.383	0.31	0.251
Toluene	60	60	1.39	1.39	0.0678	6.48	3.41	3.19
Trans-1,2-Dichloroethylene	60	0	0	0.0238	0.0476	0	0	0
Trans-1,3-Dichloropropene	60	0	0	0.0477	0.0953	0	0	0
Trichloroethylene	60	11	0.0108	0.0482	0.0913	0.107	0.086	0.0699
Trichlorofluoromethane	60	60	1.5	1.5	0.0449	2.19	1.83	1.8
Valeraldehyde	66	66	0.0927	0.0927	0.00705	0.211	0.169	0.155
Vanadium (Tsp) Stp	86	86	0.00406	0.00406	1.92E-05	0.0106	0.00974	0.00902
Vanadium Pm10 Stp	90	90	0.00159	0.00159	2.37E-05	0.00516	0.00497	0.00399
Vinyl Chloride	60	5	0.00111	0.0105	0.0204	0.0179	0.0153	0.0128
Zinc (Tsp) Stp	86	86	0.143	0.143	0.0011	0.478	0.466	0.43
Zinc Pm10 Stp	90	90	0.0824	0.0824	0.00136	0.364	0.36	0.285

Detroit, W. Fort St. (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	30	0	0	0.16	0.32	0	0	0
1,1,2-Trichloroethane	30	0	0	0.0482	0.0965	0	0	0
1,1-Dichloroethane	30	0	0	0.085	0.17	0	0	0
1,1-Dichloroethylene	30	0	0	0.0753	0.151	0	0	0
1,2,4-Trichlorobenzene	30	0	0	0.662	1.32	0	0	0
1,2,4-Trimethylbenzene	30	4	0.071	0.201	0.301	0.69	0.48	0.48
1,2-Dichlorobenzene	30	0	0	0.181	0.362	0	0	0
1,2-Dichloropropane	30	1	0.0467	0.577	1.1	1.4	0	0
1,3,5-Trimethylbenzene	30	0	0	0.119	0.238	0	0	0
1,3-Butadiene	30	0	0	0.06	0.12	0	0	0
1,3-Dichlorobenzene	30	0	0	0.14	0.28	0	0	0
1,4-Dichlorobenzene	30	0	0	0.19	0.38	0	0	0
2,2,4-Trimethylpentane	30	5	0.0927	0.152	0.142	0.64	0.61	0.57
Acetaldehyde	30	30	1.74	1.74	0	3.02	2.98	2.82
Acetone	30	30	2.3	2.3	0	4.72	4.48	4.28
Acetonitrile	30	13	0.266	0.406	0.492	0.78	0.75	0.67
Acrylonitrile	30	0	0	0.391	0.783	0	0	0
Arsenic (Tsp) Stp	58	58	0.00222	0.00222	8.74E-06	0.0131	0.006	0.00486
Benzaldehyde	30	30	0.117	0.117	0	0.305	0.226	0.198
Benzene	30	30	0.846	0.846	0.0937	2.7	1.6	1.6
Bromodichloromethane	30	0	0	0.0748	0.15	0	0	0
Bromoform	30	0	0	0.171	0.342	0	0	0
Bromomethane	30	0	0	0.11	0.22	0	0	0
Cadmium (Tsp) Stp	58	58	0.000349	0.000349	9.60E-06	0.00231	0.00092	0.00086
Carbon Tetrachloride	30	1	0.0143	0.122	0.222	0.43	0	0
Chlorobenzene	30	0	0	0.101	0.201	0	0	0
Chloroethane	30	0	0	0.06	0.12	0	0	0
Chloroform	30	28	0.642	0.646	0.12	1	0.99	0.87
Chloromethane	30	30	1.08	1.08	0.155	1.3	1.3	1.3
Chloroprene	30	0	0	0.055	0.11	0	0	0
Cis-1,2-Dichloroethene	30	0	0	0.0603	0.121	0	0	0
Cis-1,3-Dichloropropene	30	0	0	0.065	0.13	0	0	0
Dibromochloromethane	30	0	0	0.145	0.291	0	0	0
Dichlorodifluoromethane	30	30	2.26	2.26	0.249	2.8	2.8	2.8
Dichloromethane	30	29	0.593	0.598	0.344	0.92	0.91	0.8
Ethylbenzene	30	2	0.0377	0.173	0.29	0.6	0.53	0
Ethylene Dibromide	30	0	0	0.146	0.292	0	0	0
Ethylene Dichloride	30	0	0	0.095	0.19	0	0	0
Formaldehyde	30	30	3.27	3.27	0	10.5	7.18	6.47
Freon 113	30	0	0	0.11	0.22	0	0	0
Freon 114	30	0	0	0.17	0.34	0	0	0
Hexachlorobutadiene	30	0	0	0.443	0.886	0	0	0
Hexanaldehyde	30	25	0.122	0.122	0	0.877	0.26	0.23

Detroit, W. Fort St. (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
M/P Xylene	30	9	0.448	0.702	0.725	2.6	2.3	1.7
Manganese (Tsp) Stp	58	58	0.0608	0.0608	5.62E-05	0.597	0.122	0.119
Manganese Pm10 Stp	57	57	0.0172	0.0172	6.81E-05	0.0418	0.0418	0.0347
Methyl Chloroform	30	0	0	0.105	0.21	0	0	0
Methyl Ethyl Ketone	30	23	1.13	1.26	1.1	2.5	1.9	1.7
Methyl Isobutyl Ketone	30	4	0.363	0.732	0.851	5	2.7	2
Methyl Tert-Butyl Ether	30	0	0	0.0948	0.19	0	0	0
N-Hexane	30	19	0.878	0.893	0.0856	3.4	3	2.4
Nickel (Tsp) Stp	58	58	0.00278	0.00278	5.19E-05	0.036	0.00468	0.0045
O-Xylene	30	7	0.136	0.261	0.326	0.81	0.69	0.67
Propionaldehyde	30	30	0.329	0.329	0	0.564	0.564	0.555
Styrene	30	0	0	0.378	0.756	0	0	0
Tetrachloroethylene	30	0	0	0.115	0.23	0	0	0
Tolualdehydes	30	1	0.0016	0.0016	0	0.048	0	0
Toluene	30	29	1.25	1.25	0.436	3.1	2.6	2.4
Trans-1,2-Dichloroethylene	30	0	0	0.0738	0.148	0	0	0
Trans-1,3-Dichloropropene	30	0	0	0.0443	0.0886	0	0	0
Trichloroethylene	30	0	0	0.0808	0.162	0	0	0
Trichlorofluoromethane	30	30	1.2	1.2	0.23	1.5	1.5	1.5
Valeraldehyde	30	30	0.161	0.161	0	0.425	0.325	0.303
Vinyl Chloride	30	0	0	0.0648	0.13	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) Stp	59	59	0.00243	0.00243	8.85E-06	0.00879	0.00737	0.00567
Cadmium (Tsp) Stp	59	59	0.0004	0.0004	9.69E-06	0.00115	0.001	0.00092
Manganese (Tsp) Stp	59	59	0.122	0.122	5.75E-05	0.511	0.473	0.412
Nickel (Tsp) Stp	59	59	0.00285	0.00285	5.37E-05	0.00934	0.00834	0.00622

River Rouge (261630005) Concentrations in micrograms per cubic meter (µg/m³)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Acetaldehyde	30	30	1.99	1.99	0	3.66	3.08	3.06
Acetone	30	30	2.59	2.59	0	4.95	4.75	4.28
Arsenic (Tsp) Stp	59	59	0.00218	0.00218	8.73E-06	0.0153	0.00853	0.00553
Benzaldehyde	30	30	0.152	0.152	0	0.366	0.305	0.259
Cadmium (Tsp) Stp	59	59	0.000372	0.000372	9.58E-06	0.00113	0.00105	0.00089
Formaldehyde	30	30	4.93	4.93	0	8.72	7.28	7.04
Hexanaldehyde	30	30	0.628	0.628	0	2.1	1.98	1.72
Manganese (Tsp) Stp	59	59	0.0545	0.0545	5.61E-05	0.161	0.133	0.121
Manganese Pm10 Stp	58	58	0.0179	0.0179	7.00E-05	0.0505	0.0431	0.0407
Nickel (Tsp) Stp	59	59	0.00153	0.00153	5.25E-05	0.00443	0.00356	0.00315
Propionaldehyde	30	30	0.386	0.386	0	0.736	0.701	0.632
Tolualdehydes	30	2	0.00204	0.00204	0	0.0406	0.0206	0
Valeraldehyde	30	30	0.314	0.314	0	0.81	0.632	0.575

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) Stp	59	59	0.00141	0.00141	9.03E-06	0.00923	0.0046	0.00429
Cadmium (Tsp) Stp	59	59	0.000136	0.000136	9.88E-06	0.00094	0.00033	0.00031
Lead (Tsp) Lc Frm/Fem	59	59	0.00437	0.00437	0	0.0174	0.0159	0.0098
Manganese (Tsp) Stp	59	59	0.0126	0.0126	5.81E-05	0.0352	0.0254	0.0245
Nickel (Tsp) Stp	59	59	0.0011	0.0011	5.36E-05	0.00214	0.00207	0.00186

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) Stp	57	57	0.0012	0.0012	8.71E-06	0.00891	0.00602	0.00311
Cadmium (Tsp) Stp	57	57	0.000185	0.000185	9.55E-06	0.00084	0.00075	0.00054
Lead (Tsp) Lc Frm/Fem	57	57	0.0225	0.0225	0	0.0855	0.0812	0.0795
Manganese (Tsp) Stp	57	57	0.00915	0.00915	5.63E-05	0.0263	0.0207	0.0203
Nickel (Tsp) Stp	57	57	0.000805	0.000805	5.22E-05	0.002	0.00164	0.00123

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) Stp	60	60	0.00117	0.00117	8.71E-06	0.00815	0.00427	0.00405
Cadmium (Tsp) Stp	60	60	0.000179	0.000179	9.55E-06	0.00088	0.00064	0.00049
Lead (Tsp) Lc Frm/Fem	60	60	0.0218	0.0218	0	0.292	0.167	0.154
Manganese (Tsp) Stp	60	60	0.00823	0.00823	5.63E-05	0.0203	0.0169	0.0162
Nickel (Tsp) Stp	60	60	0.000774	0.000774	5.22E-05	0.00139	0.00119	0.00118

Port Huron-Rural St. (261470031) Concentrations in micrograms per cubic meter (µg/m^3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Arsenic (Tsp) Stp	60	60	0.00154	0.00154	0.00000875	0.0111	0.00598	0.00549
Cadmium (Tsp) Stp	60	60	0.000529	0.000529	0.00000958	0.00274	0.00231	0.00172
Lead (Tsp) Lc Frm/Fem	60	60	0.0327	0.0327	0	0.18	0.162	0.138
Manganese (Tsp) Stp	60	60	0.00996	0.00996	0.0000568	0.0222	0.0199	0.0197
Nickel (Tsp) Stp	60	60	0.00116	0.00116	0.000052	0.0044	0.00223	0.00204

APPENDIX B-2

Allen Park (261630001), 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	119	97	0.0245	0.0269	0.0215	0.183	0.14	0.133
Ammonium Ion Pm2.5 Lc	119	118	0.918	0.918	0.0115	5.99	5.16	3.71
Antimony Pm2.5 Lc	119	30	0.00424	0.0194	0.0402	0.0734	0.0421	0.0397
Arsenic Pm2.5 Lc	119	59	0.000943	0.0014	0.0018	0.00747	0.00695	0.00595
Barium Pm2.5 Lc	119	65	0.00826	0.0128	0.0194	0.243	0.0404	0.0345
Bromine Pm2.5 Lc	119	111	0.00399	0.0041	0.00186	0.016	0.0122	0.0112
Cadmium Pm2.5 Lc	119	27	0.00155	0.00842	0.0176	0.0256	0.021	0.0152
Calcium Pm2.5 Lc	119	119	0.0428	0.0428	0.00744	0.155	0.09	0.0899
Cerium Pm2.5 Lc	119	13	0.000982	0.00899	0.0191	0.0695	0.0318	0.00373
Cesium Pm2.5 Lc	119	47	0.0029	0.00822	0.0174	0.0227	0.019	0.0185
Chlorine Pm2.5 Lc	105	104	0.0601	0.0601	0.00703	0.466	0.421	0.358
Chromium Pm2.5 Lc	119	85	0.00199	0.00239	0.00259	0.0328	0.0215	0.0152
Cobalt Pm2.5 Lc	119	77	0.000509	0.000835	0.00157	0.00241	0.0022	0.00214
Copper Pm2.5 Lc	119	112	0.00922	0.00929	0.00303	0.123	0.0502	0.0389
Ec Csn_Rev Unadjusted Pm2.5 Lc Tot	106	105	0.413	0.413	0	1.12	0.844	0.785
Indium Pm2.5 Lc	119	57	0.00501	0.0104	0.0215	0.0396	0.0279	0.0268
Iron Pm2.5 Lc	119	119	0.109	0.109	0.00445	0.302	0.283	0.253
Lead Pm2.5 Lc	119	79	0.00253	0.00319	0.00471	0.0234	0.0175	0.0142
Magnesium Pm2.5 Lc	119	83	0.0159	0.0189	0.0174	0.444	0.0783	0.0681
Manganese Pm2.5 Lc	119	103	0.00208	0.0023	0.0025	0.0102	0.00849	0.00614
Nickel Pm2.5 Lc	119	98	0.00099	0.00114	0.00145	0.00963	0.00701	0.00448
Oc Csn_Rev Unadjusted Pm2.5 Lc Tot	106	106	2.55	2.55	0	9.13	6.35	5.89
Phosphorus Pm2.5 Lc	119	14	0.0000144	0.00554	0.0113	0.00122	0.00006	0.00005
Potassium Ion Pm2.5 Lc	119	116	0.11	0.11	0.0189	4.68	0.32	0.199
Potassium Pm2.5 Lc	119	119	0.0918	0.0918	0.00768	4.28	0.183	0.174
Rubidium Pm2.5 Lc	119	55	0.00048	0.00111	0.00247	0.00786	0.0042	0.00247
Selenium Pm2.5 Lc	119	77	0.00123	0.00166	0.00241	0.00684	0.00639	0.00602
Silicon Pm2.5 Lc	119	119	0.0607	0.0607	0.0127	0.479	0.255	0.187
Silver Pm2.5 Lc	119	14	0.000533	0.00876	0.0185	0.0117	0.0105	0.00816
Sodium Ion Pm2.5 Lc	119	119	0.11	0.11	0.00937	0.984	0.396	0.362
Sodium Pm2.5 Lc	119	93	0.0567	0.0621	0.0398	0.402	0.35	0.345
Strontium Pm2.5 Lc	119	51	0.00136	0.00219	0.00298	0.0948	0.00921	0.00379
Sulfate Pm2.5 Lc	119	118	1.75	1.75	0.00677	6.1	6.04	5.98
Sulfur Pm2.5 Lc	119	119	0.614	0.614	0.00848	2.13	2.12	2.04
Tin Pm2.5 Lc	119	20	0.00166	0.0123	0.0261	0.0256	0.0224	0.021
Titanium Pm2.5 Lc	119	83	0.00413	0.00488	0.00471	0.255	0.014	0.0092
Total Nitrate Pm2.5 Lc	119	119	1.93	1.93	0.0142	16	12.3	9.38
Vanadium Pm2.5 Lc	119	59	0.000535	0.00136	0.00322	0.0028	0.00278	0.00245
Zinc Pm2.5 Lc	119	119	0.0141	0.0141	0.00233	0.0541	0.046	0.0448
Zirconium Pm2.5 Lc	119	20	0.000848	0.00523	0.012	0.0191	0.0104	0.00933

Dearborn (261630033), Speciated $PM_{2.5}$ (µg/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	58	49	0.0319	0.0341	0.0219	0.203	0.0963	0.0859
Ammonium Ion Pm2.5 Lc	58	57	0.973	0.973	0.0108	3.86	3.47	3.37
Antimony Pm2.5 Lc	58	14	0.00423	0.0185	0.0378	0.0501	0.0374	0.0326
Arsenic Pm2.5 Lc	58	38	0.00123	0.00157	0.00175	0.00901	0.00373	0.00373
Barium Pm2.5 Lc	58	26	0.00931	0.014	0.0166	0.171	0.0342	0.0342
Bromine Pm2.5 Lc	58	57	0.00479	0.0048	0.0017	0.013	0.0127	0.00967
Cadmium Pm2.5 Lc	58	14	0.00108	0.00714	0.016	0.0105	0.00934	0.00883
Calcium Pm2.5 Lc	58	58	0.09	0.09	0.00737	0.315	0.22	0.213
Cerium Pm2.5 Lc	58	4	0.000421	0.00749	0.0161	0.0203	0.00222	0.00105
Cesium Pm2.5 Lc	58	26	0.00496	0.00985	0.0154	0.0304	0.0267	0.0237
Chlorine Pm2.5 Lc	53	52	0.0645	0.0645	0.00724	0.256	0.202	0.175
Chromium Pm2.5 Lc	58	36	0.00119	0.00166	0.00246	0.00951	0.00653	0.00416
Cobalt Pm2.5 Lc	58	56	0.00156	0.0016	0.00152	0.00416	0.00416	0.00355
Copper Pm2.5 Lc	58	57	0.0115	0.0116	0.00289	0.0841	0.0614	0.0452
Ec Csn_Rev Unadjusted Pm2.5 Lc Tot	54	54	0.575	0.575	0	1.89	1.52	1.41
Indium Pm2.5 Lc	58	23	0.00551	0.0116	0.02	0.0327	0.0292	0.0292
Iron Pm2.5 Lc	58	58	0.384	0.384	0.00384	1.96	1.14	0.859
Lead Pm2.5 Lc	58	50	0.00883	0.00918	0.00424	0.0824	0.0531	0.0448
Magnesium Pm2.5 Lc	58	49	0.0278	0.0294	0.0173	0.301	0.256	0.0634
Manganese Pm2.5 Lc	58	57	0.00858	0.0086	0.00226	0.0298	0.0293	0.0217
Nickel Pm2.5 Lc	58	41	0.00101	0.00124	0.0015	0.0189	0.00477	0.0025
Oc Csn_Rev Unadjusted Pm2.5 Lc Tot	54	54	2.95	2.95	0	6.83	5.82	5.49
Phosphorus Pm2.5 Lc	58	6	0.000107	0.00552	0.0111	0.00278	0.00231	0.00059
Potassium Ion Pm2.5 Lc	58	58	0.137	0.137	0.0165	3.29	0.234	0.192
Potassium Pm2.5 Lc	58	58	0.132	0.132	0.00832	3.34	0.242	0.234
Rubidium Pm2.5 Lc	58	23	0.000378	0.00106	0.00222	0.00484	0.00185	0.00164
Selenium Pm2.5 Lc	58	45	0.00162	0.00188	0.00244	0.00655	0.00548	0.00489
Silicon Pm2.5 Lc	58	58	0.0847	0.0847	0.0138	0.485	0.206	0.185
Silver Pm2.5 Lc	58	7	0.000629	0.00786	0.0166	0.0109	0.00933	0.00583
Sodium Ion Pm2.5 Lc	58	58	0.105	0.105	0.00967	0.285	0.242	0.237
Sodium Pm2.5 Lc	58	50	0.0882	0.0919	0.0426	0.283	0.261	0.25
Strontium Pm2.5 Lc	58	29	0.00177	0.00244	0.00269	0.0677	0.0041	0.00385
Sulfate Pm2.5 Lc	58	58	2.01	2.01	0.00595	5.22	4.44	4.29
Sulfur Pm2.5 Lc	58	58	0.689	0.689	0.0085	1.96	1.64	1.48
Tin Pm2.5 Lc	58	11	0.00262	0.0123	0.0249	0.0396	0.0385	0.0175
Titanium Pm2.5 Lc	58	30	0.00196	0.00312	0.00477	0.0149	0.0107	0.0084
Total Nitrate Pm2.5 Lc	58	58	2.1	2.1	0.0128	9.59	7.19	7.04
Vanadium Pm2.5 Lc	58	29	0.000623	0.00143	0.00321	0.00358	0.00272	0.0026
Zinc Pm2.5 Lc	58	58	0.0571	0.0571	0.00238	0.281	0.274	0.17
Zirconium Pm2.5 Lc	58	9	0.00695	0.0108	0.0101	0.364	0.00812	0.00793

Detroit, W Fort St. (N. Delray-SWHS) (261630015), 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	55	46	0.0717	0.0735	0.0223	2.47	0.0918	0.0873
Ammonium Ion Pm2.5 Lc	55	54	1.09	1.09	0.0105	3.98	3.58	3.52
Antimony Pm2.5 Lc	55	13	0.00362	0.0186	0.0385	0.0315	0.0269	0.0247
Arsenic Pm2.5 Lc	55	33	0.00122	0.00162	0.00179	0.00666	0.00548	0.00421
Barium Pm2.5 Lc	55	32	0.0117	0.0145	0.0186	0.148	0.0666	0.0446
Bromine Pm2.5 Lc	55	53	0.00469	0.00478	0.0018	0.0133	0.0118	0.0111
Cadmium Pm2.5 Lc	55	16	0.00213	0.00801	0.0166	0.0174	0.0117	0.0117
Calcium Pm2.5 Lc	55	55	0.16	0.16	0.00747	3.53	0.398	0.249
Cerium Pm2.5 Lc	55	2	0.00298	0.0103	0.0184	0.0949	0.0688	0
Cesium Pm2.5 Lc	55	25	0.0044	0.00989	0.0171	0.0568	0.0287	0.0205
Chlorine Pm2.5 Lc	49	48	0.0616	0.0616	0.00718	0.288	0.26	0.219
Chromium Pm2.5 Lc	55	37	0.000947	0.00137	0.00252	0.00907	0.00603	0.00333
Cobalt Pm2.5 Lc	55	44	0.00116	0.00133	0.00156	0.0123	0.00324	0.00262
Copper Pm2.5 Lc	55	52	0.00925	0.00932	0.00311	0.049	0.0229	0.0216
Ec Csn_Rev Unadjusted Pm2.5 Lc Tot	48	48	0.534	0.534	0	1.21	1.09	0.939
Indium Pm2.5 Lc	55	18	0.00369	0.0101	0.0207	0.0338	0.0222	0.0198
Iron Pm2.5 Lc	55	55	0.289	0.289	0.00429	2.51	1.11	1.05
Lead Pm2.5 Lc	55	49	0.00553	0.00592	0.00457	0.0333	0.0266	0.0223
Magnesium Pm2.5 Lc	55	51	0.0265	0.0274	0.018	0.34	0.19	0.0769
Manganese Pm2.5 Lc	55	55	0.00647	0.00647	0.0024	0.0703	0.0248	0.0197
Nickel Pm2.5 Lc	55	40	0.000738	0.000966	0.00151	0.00453	0.00374	0.00298
Oc Csn_Rev Unadjusted Pm2.5 Lc Tot	48	48	2.66	2.66	0	7.13	5.9	5.89
Phosphorus Pm2.5 Lc	55	7	0.0012	0.00638	0.0109	0.0644	0.00092	0.0002
Potassium Ion Pm2.5 Lc	55	55	0.115	0.115	0.0175	1.75	0.346	0.23
Potassium Pm2.5 Lc	55	55	0.124	0.124	0.00831	1.8	0.913	0.297
Rubidium Pm2.5 Lc	55	24	0.000582	0.0012	0.00237	0.00526	0.00486	0.00337
Selenium Pm2.5 Lc	55	44	0.00166	0.00187	0.00253	0.00837	0.00733	0.00586
Silicon Pm2.5 Lc	55	55	0.214	0.214	0.0136	6.86	0.241	0.224
Silver Pm2.5 Lc	55	10	0.000775	0.00753	0.0173	0.0128	0.0056	0.00466
Sodium Ion Pm2.5 Lc	55	55	0.096	0.096	0.00964	0.257	0.252	0.239
Sodium Pm2.5 Lc	55	48	0.0534	0.0569	0.0424	0.225	0.18	0.156
Strontium Pm2.5 Lc	55	26	0.00198	0.0026	0.00282	0.0378	0.0338	0.0065
Sulfate Pm2.5 Lc	55	55	2.32	2.32	0.00619	7.52	5.4	4.65
Sulfur Pm2.5 Lc	55	55	0.766	0.766	0.00845	2.46	1.79	1.52
Tin Pm2.5 Lc	55	13	0.00208	0.0117	0.0257	0.0245	0.021	0.0175
Titanium Pm2.5 Lc	55	33	0.0051	0.00609	0.00473	0.185	0.0197	0.00795
Total Nitrate Pm2.5 Lc	55	55	2.11	2.11	0.013	9.83	8.25	6.5
Vanadium Pm2.5 Lc	55	33	0.000918	0.00158	0.00317	0.00419	0.00385	0.00384
Zinc Pm2.5 Lc	55	55	0.0314	0.0314	0.00239	0.194	0.173	0.111
Zirconium Pm2.5 Lc	55	12	0.00151	0.00516	0.0112	0.0235	0.0231	0.00935

Tecumseh (260910007), 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	40	0.0172	0.0212	0.0223	0.175	0.121	0.0674
Ammonium Ion Pm2.5 Lc	60	57	0.852	0.852	0.0121	3.6	3.54	2.99
Antimony Pm2.5 Lc	60	20	0.00685	0.0201	0.0386	0.0595	0.0583	0.0478
Arsenic Pm2.5 Lc	60	32	0.000693	0.00114	0.0018	0.00653	0.00385	0.00265
Barium Pm2.5 Lc	60	16	0.005	0.0104	0.0178	0.0954	0.0642	0.0507
Bromine Pm2.5 Lc	60	58	0.00344	0.00351	0.00178	0.0146	0.012	0.00816
Cadmium Pm2.5 Lc	60	16	0.00172	0.00799	0.0165	0.0257	0.0175	0.014
Calcium Pm2.5 Lc	60	57	0.0297	0.0298	0.00736	0.175	0.145	0.069
Cerium Pm2.5 Lc	60	7	0.00381	0.00914	0.0175	0.165	0.0445	0.0133
Cesium Pm2.5 Lc	60	14	0.00156	0.00761	0.0165	0.0164	0.0163	0.0133
Chlorine Pm2.5 Lc	54	42	0.0188	0.0197	0.00712	0.0918	0.0848	0.08
Chromium Pm2.5 Lc	60	30	0.000822	0.00148	0.00249	0.00848	0.00546	0.00341
Cobalt Pm2.5 Lc	60	33	0.000355	0.000723	0.00155	0.00161	0.00148	0.00132
Copper Pm2.5 Lc	60	35	0.00135	0.00189	0.00303	0.0436	0.00412	0.00282
Ec Csn_Rev Unadjusted Pm2.5 Lc Tot	54	53	0.19	0.19	0	0.723	0.58	0.355
Indium Pm2.5 Lc	60	23	0.00389	0.0103	0.0208	0.035	0.0209	0.0163
Iron Pm2.5 Lc	60	60	0.0521	0.0521	0.00408	0.125	0.113	0.111
Lead Pm2.5 Lc	60	36	0.00158	0.00232	0.00447	0.0156	0.00705	0.00664
Magnesium Pm2.5 Lc	60	42	0.0104	0.013	0.0176	0.142	0.0477	0.0432
Manganese Pm2.5 Lc	60	49	0.00361	0.00386	0.00235	0.04	0.0245	0.0241
Nickel Pm2.5 Lc	60	36	0.000314	0.000642	0.0015	0.00134	0.00124	0.00118
Oc Csn_Rev Unadjusted Pm2.5 Lc Tot	54	54	2.14	2.14	0	8.33	4.68	4.39
Phosphorus Pm2.5 Lc	60	6	0.0000463	0.00538	0.0109	0.0019	0.00071	0.00005
Potassium Ion Pm2.5 Lc	60	59	0.11	0.111	0.0187	2.56	0.195	0.128
Potassium Pm2.5 Lc	60	59	0.0922	0.0923	0.00823	2.37	0.158	0.135
Rubidium Pm2.5 Lc	60	29	0.00044	0.000988	0.00234	0.00398	0.0032	0.00237
Selenium Pm2.5 Lc	60	42	0.000813	0.00121	0.00251	0.00343	0.00277	0.0027
Silicon Pm2.5 Lc	60	59	0.0596	0.0598	0.0136	0.364	0.296	0.248
Silver Pm2.5 Lc	60	6	0.000539	0.0082	0.0175	0.0175	0.00699	0.00422
Sodium Ion Pm2.5 Lc	60	59	0.0776	0.0777	0.00986	0.315	0.243	0.189
Sodium Pm2.5 Lc	60	38	0.0306	0.0396	0.042	0.166	0.158	0.115
Strontium Pm2.5 Lc	60	27	0.00089	0.00162	0.00279	0.0309	0.00338	0.00224
Sulfate Pm2.5 Lc	60	59	1.63	1.63	0.00608	4.16	4.15	4.13
Sulfur Pm2.5 Lc	60	59	0.571	0.571	0.00841	1.41	1.33	1.33
Tin Pm2.5 Lc	60	9	0.00136	0.012	0.0257	0.0245	0.0176	0.014
Titanium Pm2.5 Lc	60	33	0.0014	0.00246	0.00473	0.0106	0.00779	0.0077
Total Nitrate Pm2.5 Lc	60	59	1.81	1.81	0.0135	9.16	7.31	6.81
Vanadium Pm2.5 Lc	60	28	0.000399	0.00126	0.00318	0.00194	0.00186	0.00186
Zinc Pm2.5 Lc	60	59	0.0137	0.0137	0.00238	0.102	0.0638	0.0516
Zirconium Pm2.5 Lc	60	5	0.00044	0.00523	0.0112	0.0151	0.00594	0.0021

Grand Rapids-Monroe St. (260810020), 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	103	84	0.0293	0.0313	0.0208	0.223	0.183	0.156
Ammonium Ion Pm2.5 Lc	104	103	0.855	0.855	0.013	5.08	4.79	3.7
Antimony Pm2.5 Lc	103	28	0.00628	0.0207	0.0384	0.0562	0.055	0.0549
Arsenic Pm2.5 Lc	103	57	0.000924	0.00125	0.00168	0.0093	0.00702	0.0049
Barium Pm2.5 Lc	103	42	0.00797	0.0108	0.00957	0.458	0.0515	0.0269
Bromine Pm2.5 Lc	103	102	0.00354	0.00356	0.00153	0.0131	0.0106	0.0101
Cadmium Pm2.5 Lc	103	18	0.00101	0.00759	0.0157	0.0128	0.0117	0.0105
Calcium Pm2.5 Lc	103	102	0.0657	0.0658	0.00644	0.91	0.485	0.399
Cerium Pm2.5 Lc	103	9	0.000185	0.00378	0.0078	0.00385	0.0035	0.0028
Cesium Pm2.5 Lc	103	29	0.00259	0.00595	0.00971	0.0506	0.0339	0.0243
Chlorine Pm2.5 Lc	103	90	0.0589	0.0594	0.00696	0.798	0.491	0.389
Chromium Pm2.5 Lc	103	66	0.00326	0.00368	0.00226	0.0397	0.0362	0.0211
Cobalt Pm2.5 Lc	103	69	0.00044	0.000669	0.00137	0.00235	0.00169	0.00168
Copper Pm2.5 Lc	103	87	0.00465	0.00482	0.00206	0.173	0.0109	0.0107
Ec Csn_Rev Unadjusted Pm2.5 Lc Tot	105	104	0.331	0.331	0	1.2	0.901	0.719
Indium Pm2.5 Lc	103	37	0.00343	0.0101	0.0205	0.0372	0.0315	0.0256
Iron Pm2.5 Lc	103	103	0.0854	0.0854	0.00189	0.327	0.242	0.206
Lead Pm2.5 Lc	103	56	0.00145	0.0022	0.00328	0.0195	0.00749	0.00721
Magnesium Pm2.5 Lc	103	70	0.0184	0.0206	0.0137	0.718	0.0766	0.0433
Manganese Pm2.5 Lc	103	85	0.00216	0.00231	0.00178	0.0106	0.0102	0.00925
Nickel Pm2.5 Lc	103	76	0.000966	0.00116	0.0014	0.00832	0.00558	0.00485
Oc Csn_Rev Unadjusted Pm2.5 Lc Tot	105	105	2.44	2.44	0	9.94	6.33	6.08
Phosphorus Pm2.5 Lc	103	0	0	0.0058	0.0116	0	0	0
Potassium Ion Pm2.5 Lc	104	101	0.148	0.148	0.0133	8.96	0.254	0.23
Potassium Pm2.5 Lc	103	103	0.125	0.125	0.00772	7.31	0.238	0.153
Rubidium Pm2.5 Lc	103	36	0.000275	0.000908	0.00194	0.00208	0.00191	0.00188
Selenium Pm2.5 Lc	103	58	0.000539	0.00102	0.0022	0.00277	0.00222	0.00217
Silicon Pm2.5 Lc	103	102	0.0826	0.0827	0.0138	0.554	0.37	0.334
Silver Pm2.5 Lc	103	15	0.000813	0.00875	0.0187	0.0117	0.0117	0.0105
Sodium Ion Pm2.5 Lc	104	104	0.0863	0.0863	0.0107	0.675	0.583	0.548
Sodium Pm2.5 Lc	103	70	0.0326	0.0399	0.0389	0.284	0.251	0.183
Strontium Pm2.5 Lc	103	33	0.00181	0.0026	0.00244	0.152	0.00328	0.00283
Sulfate Pm2.5 Lc	104	104	1.56	1.56	0.00494	11.2	6.86	5.57
Sulfur Pm2.5 Lc	103	103	0.542	0.542	0.00827	3.4	2.15	2.04
Tin Pm2.5 Lc	103	10	0.000884	0.0121	0.025	0.0199	0.0163	0.0128
Titanium Pm2.5 Lc	103	68	0.00264	0.00347	0.00483	0.0171	0.013	0.0125
Total Nitrate Pm2.5 Lc	104	104	1.71	1.71	0.0144	11.8	9.57	8.72
Vanadium Pm2.5 Lc	103	43	0.000385	0.00134	0.00331	0.00453	0.00326	0.00316
Zinc Pm2.5 Lc	103	102	0.00957	0.00958	0.00222	0.0502	0.0275	0.0255
Zirconium Pm2.5 Lc	103	13	0.000536	0.00475	0.00922	0.00935	0.00842	0.00594

Appendix C: 2015 AQI Pie Charts

Appendix C contains pie charts that were created to show the AQI values for each of Michigan's 2015 monitoring sites and includes the total number of days measurements were taken, along with the pollutant distribution of the AQI values for those measurements. It is important to note that not all pollutants are measured at each site. In fact, some sites only obtain AQI measurements for that portion of the year corresponding to the ozone season; therefore, the number of days for each site may not be equivalent to 365. **Figures C.1** through **C.4** are grouped by Consolidated Statistical Area (CSA). CSAs are geographic regions based on population and employment data that the US Census compiles. They are defined by the US Office of Management and Budget. More information on CSAs can be found on the US Census Website: www.census.gov **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

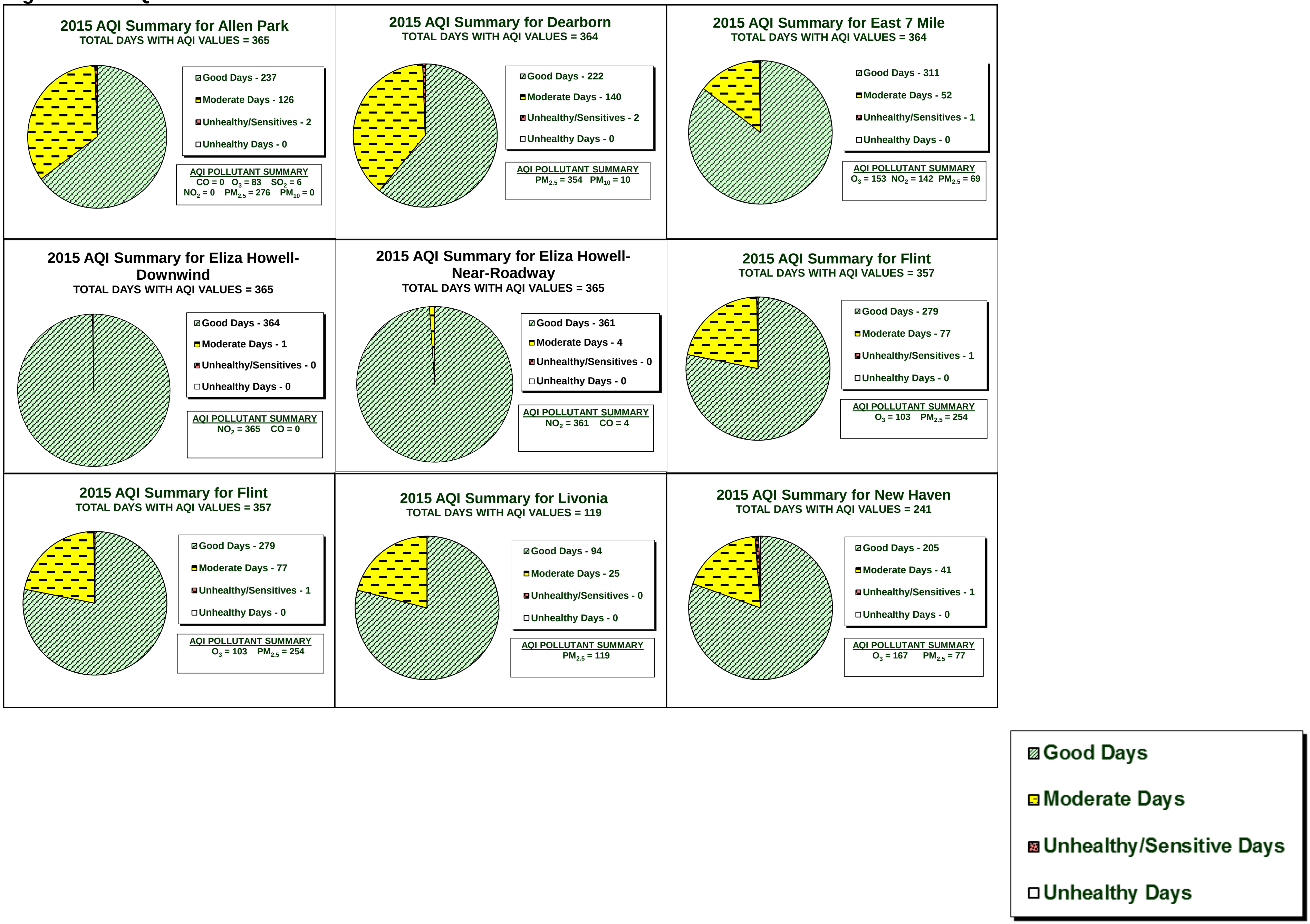


Figure C1, continued: AQI Summaries for Detroit-Warren-Flint-CSA

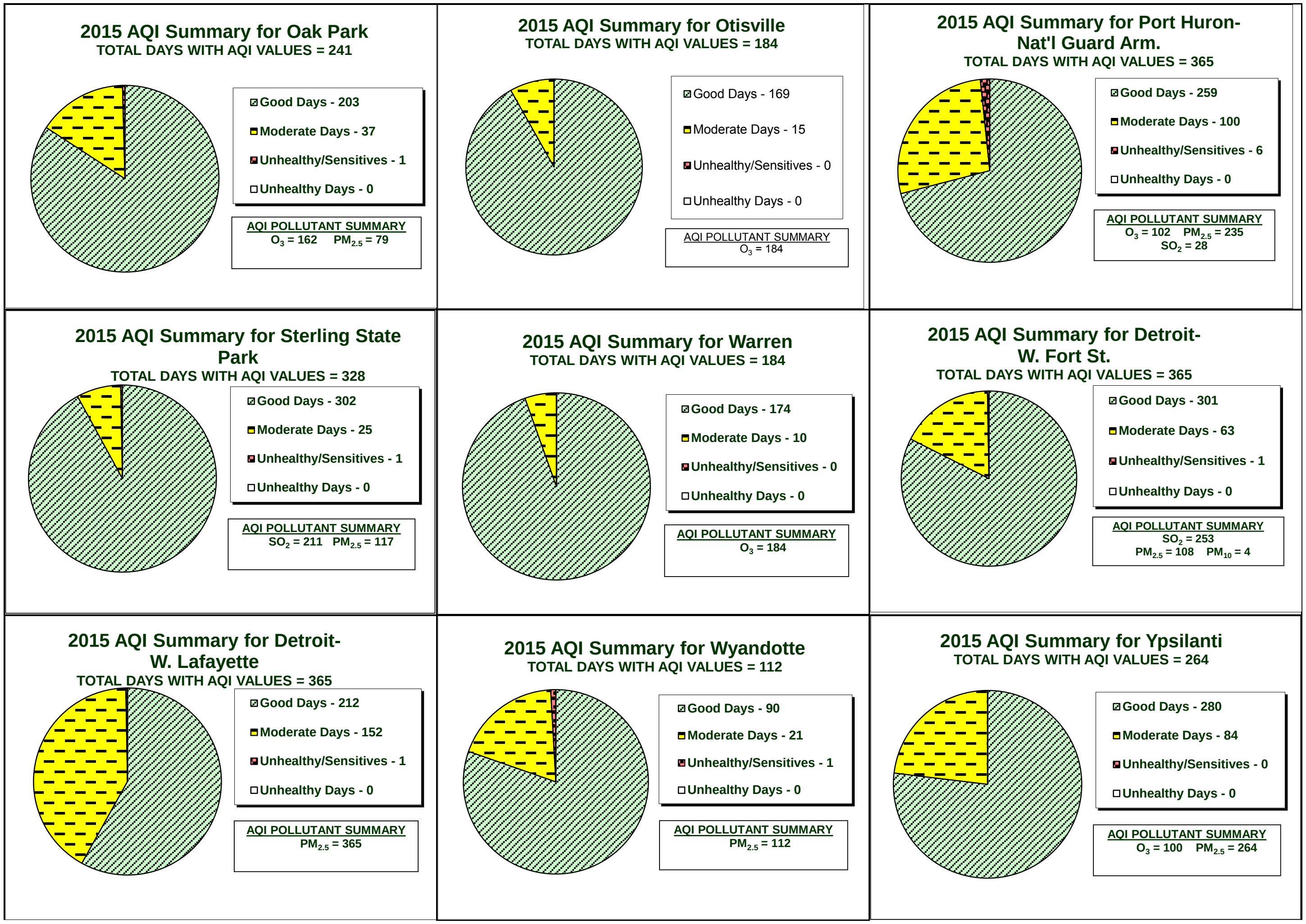
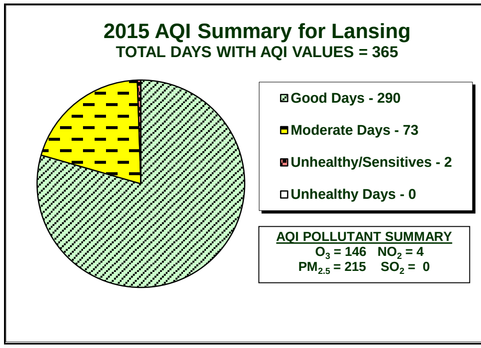


Figure C2: AQI Summaries for Lansing-East Lansing-Owosso CSA



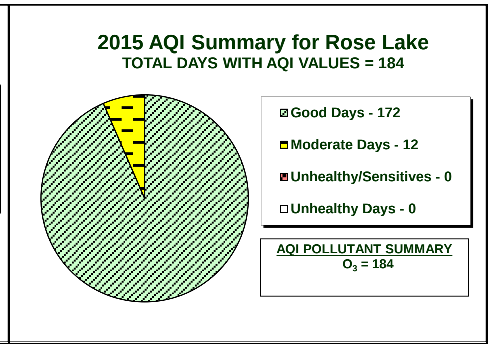


Figure C3: AQI Summary for Saginaw-Bay City-Saginaw Twp North CSA

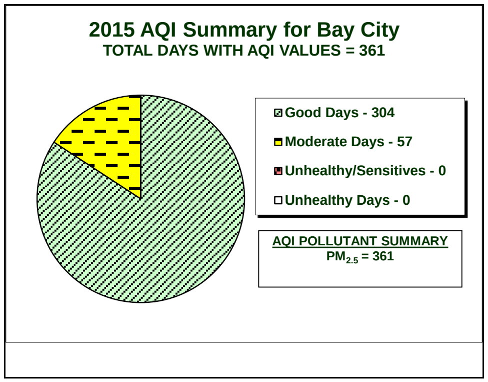
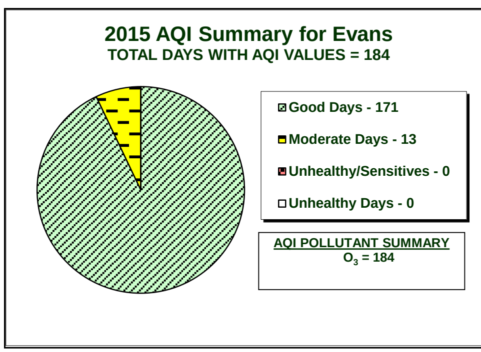
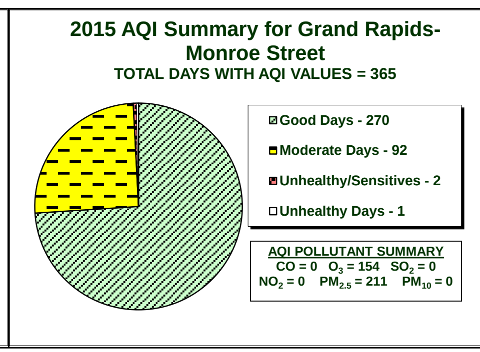
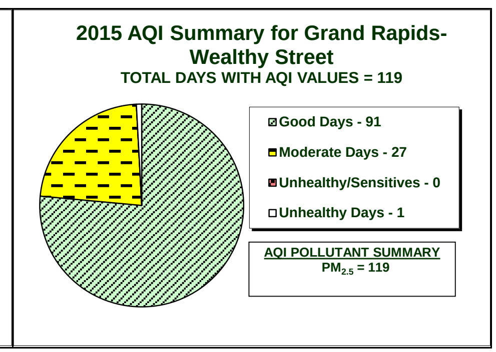
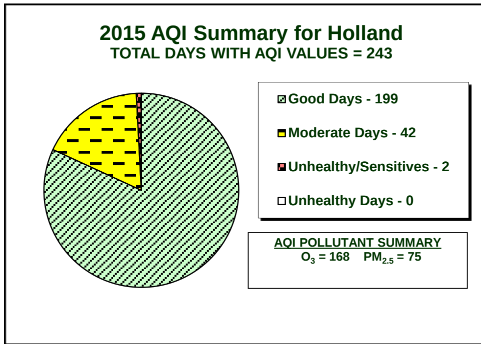


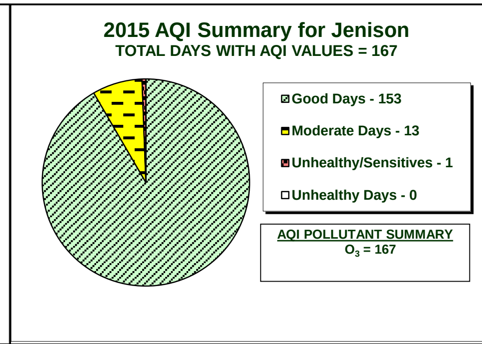
Figure C4: AQI Summaries for Grand Rapids-Muskegon-Holland CSA

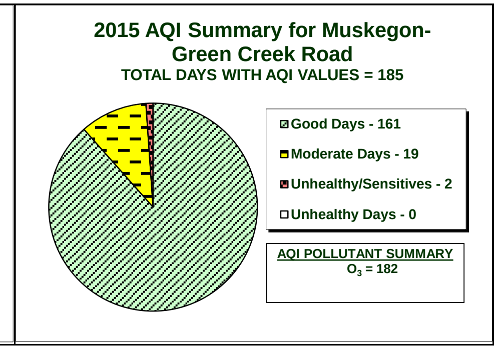












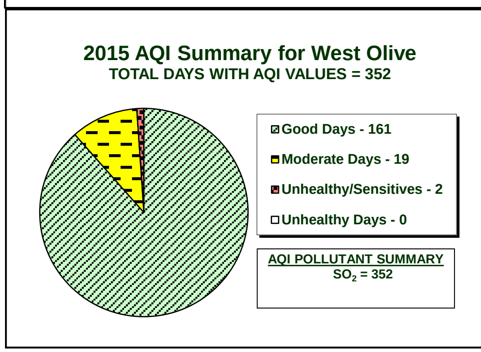
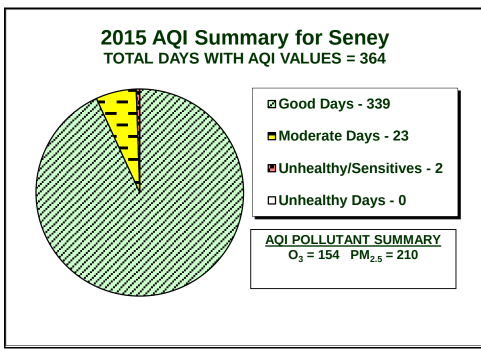


Figure C5: AQI Summary for Upper Peninsula



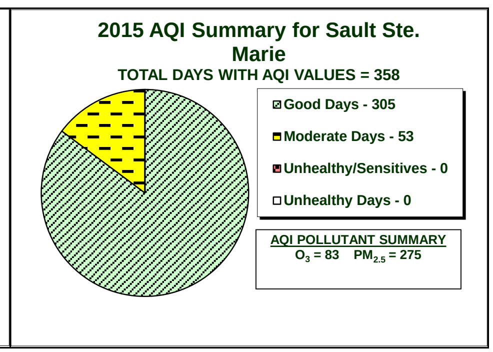
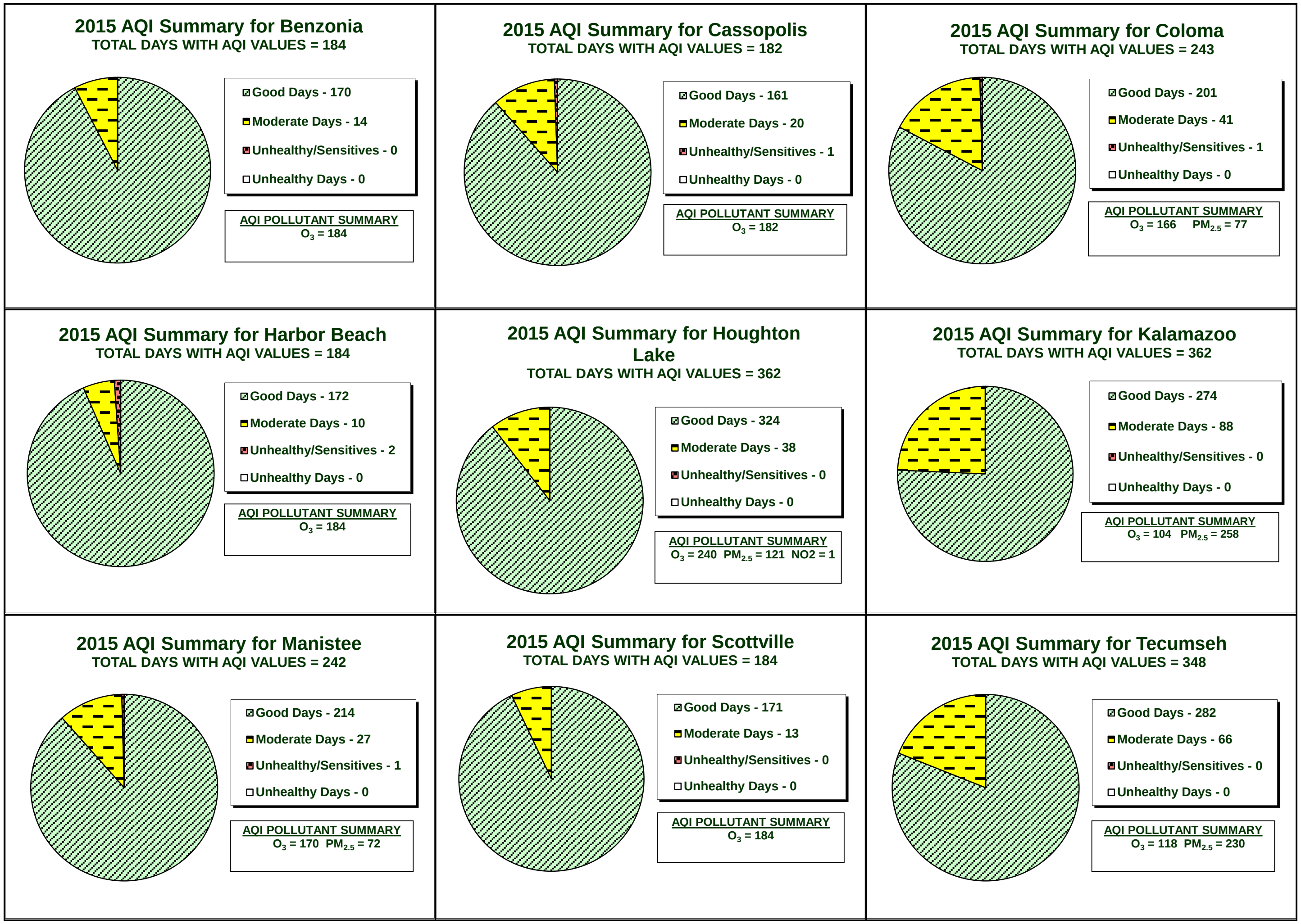


Figure C6: AQI Summaries for Michigan's Other Lower Peninsula Areas



Appendix D: NAAQS Changes

<table>
<tr><th></th><th>1971</th><th>1978</th><th>1979</th><th>1987</th><th>1997</th><th>2006</th><th>2008</th><th>2010</th><th>2012</th><th>2015</th></tr>
<tr><td>CO</td><td colspan="10">1-hour maximum not to exceed 35 ppm more than once in a year.
8-hour maximum not to exceed 9 ppm more than once in a year.</td></tr>
<tr><td>Lead</td><td></td><td colspan="5">Calendar quarter average of 1.5 $\mu g/m^3$ not to be exceeded.</td><td colspan="4">3-month average of 0.15 $\mu g/m^3$ not to be exceeded.</td></tr>
<tr><td>NO2</td><td colspan="7">Annual average of 53 ppb or less.</td><td colspan="3">98th percentile of the 1-hour concentration averaged over 3 years is 100 ppb or less.</td></tr>
<tr><td>SO2</td><td colspan="7">24-Hour concentration of 0.14 ppm not exceeded more than once per year.
Annual average of 0.03 ppm or less.</td><td colspan="3">1-hour average of 99th percentile is 75 ppb or less, averaged over 3 years. Previous revoked.</td></tr>
<tr><td>Ozone</td><td colspan="2"><u>Total photochemical oxidants</u>:
1-hour max of 0.08 ppm not exceeded once per year</td><td colspan="2">1-hour maximum concentration is 0.12 ppm one or less hour per year</td><td colspan="2">4^{th} highest daily maximum 8-hour concentration averaged over 3 year is 0.08 ppm or less</td><td colspan="3">4^{th} highest daily maximum 8-hour concentration averaged over 3 year is 0.075 ppm or less</td><td>4^{th} highest daily maximum 8-hour concentration averaged over 3 year is 0.070 ppm or less</td></tr>
<tr><td>TSP & PM10</td><td colspan="3"><u>TSP</u>: 24-hour average not to exceed 260 $\mu g/m^3$ more than once per year.
Annual geometric mean of 75 $\mu g/m^3$.</td><td colspan="2"><u>PM10</u>: 24-hour average not to exceed 150 $\mu g/m^3$ more than once per year on average over a 3-year period.
Annual mean of 50 $\mu g/m^3$ or less average over 3 years.</td><td colspan="5">Annual average revoked.
24-hour average retained.</td></tr>
<tr><td>PM2.5</td><td colspan="4"></td><td>Annual mean of 15.0 $\mu g/m^3$ or less average over 3 years.
98^{th} percentile of 24-hour average of 65 $\mu g/m^3$ or less averaged over 3 years</td><td colspan="3">Annual mean retained.
98^{th} percentile of 24-hour average of 35 $\mu g/m^3$ or less averaged over 3 years.</td><td colspan="2">Annual mean of 12.0 $\mu g/m^3$ or less average over 3 years.
98^{th} percentile of 24-hour average retained.</td></tr>
</table>

Appendix E: Acronyms and Their Definitions

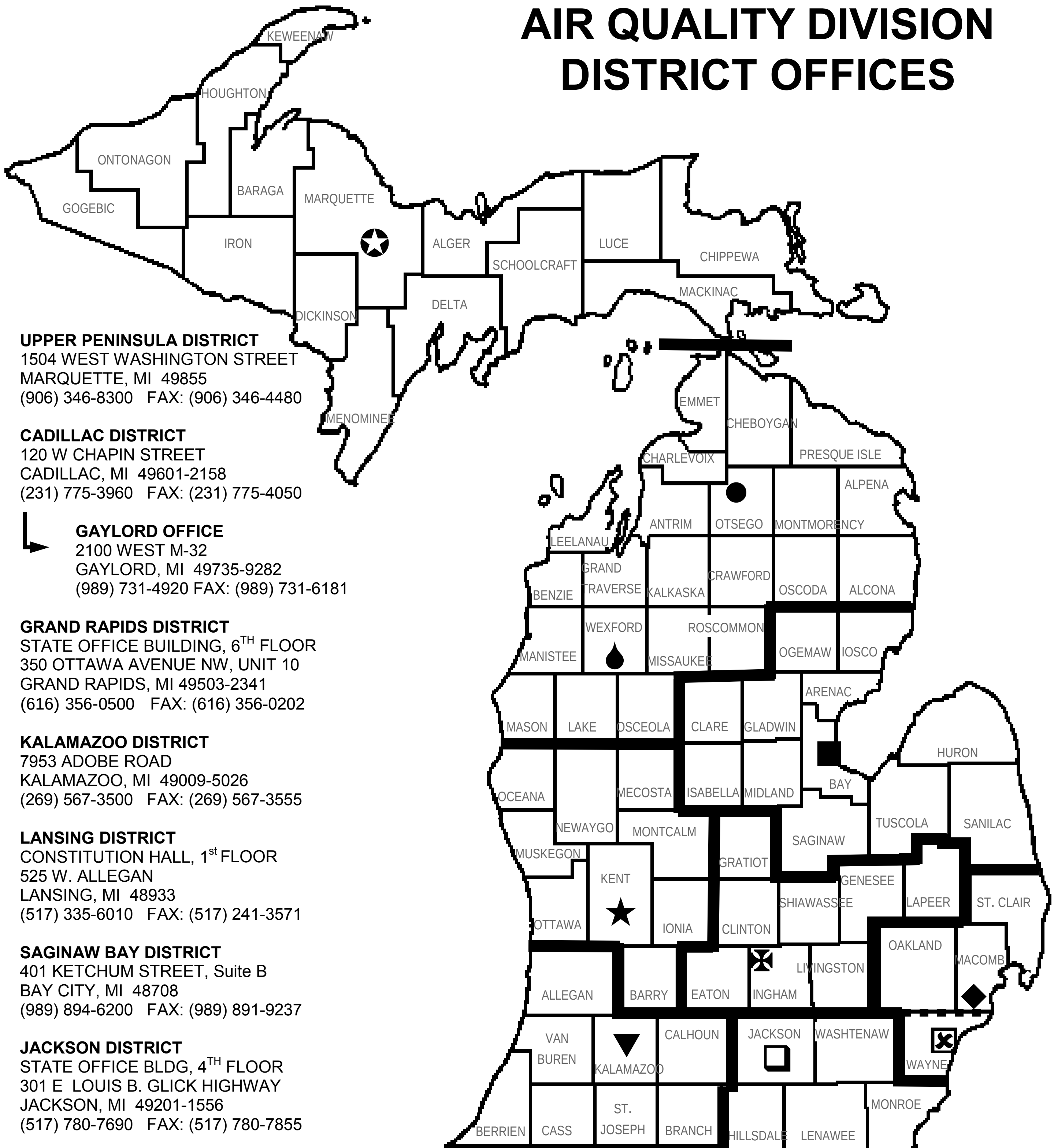
>	Greater than
<	Less than
≥	Greater than or equal to
≤	Less than or equal to
%	Percent
$\mu g/m^3$	Micrograms per cubic meter
µm	micrometer
AIRS ID	Aerometric Information Retrieval System Identification Number
AMU	Air Monitoring Unit
AQD	Air Quality Division
AQES	Air Quality Evaluation Section
AQI	Air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

Appendix E: Acronyms and Their Definitions, Continued

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

MICHIGAN DEPARTMENT ENVIRONMENTAL QUALITY
AIR QUALITY DIVISION

AIR QUALITY DIVISION DISTRICT OFFICES



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