



Michigan 2009 Air Quality Report



Department of
NATURAL RESOURCES
and ENVIRONMENT

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Cover Photos courtesy of Mary Mello.



Mackinac Bridge, Lower Peninsula (looking north) on the Lake Huron side of the Straits of Mackinac, September 2008



Sunset, Upper Peninsula on the Lake Michigan side of the Straits of Mackinac, September 2008



Grand Hotel on Mackinac Island, Lake Huron, September 2008



Whitefish Point Lighthouse, Upper Peninsula on Lake Superior, September 2008

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Appendix A	Criteria Pollutant Summary for 2009
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2009 Air Quality Report

Introduction

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

One or more NAAQS have been established for the six criteria pollutants that are monitored by the Department of Natural Resources and Environment (DNRE) Air Quality Division (AQD). These criteria pollutants are:

- Carbon monoxide (CO),
- Lead (Pb),
- Nitrogen dioxide (NO₂),
- Ozone (O₃),
- Particulate matter smaller than 10 and 2.5 microns in diameter (PM₁₀ and PM_{2.5} respectively)
- Sulfur dioxide (SO₂).

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

- Michigan's monitoring requirements for 2009,
- Attainment/nonattainment status,
- Monitoring site locations (tables show all the monitors active in 2009),
- Air quality trends from 2004-2009 broken down by location.¹

The actual 2009 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

The purpose of this report is to provide a snapshot of Michigan's 2009 air quality data, air quality trends, overview of the monitoring network (available in much greater detail in the 2010 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 EPA's Air Quality Subsystem Quick Look Report Data.

² A fact sheet entitled What is an Air Contaminant/Pollutant? is available on the DNRE's website at <http://www.deq.state.mi.us/documents/deq-ead-caap-airconfs.pdf>.

³ Available on online at http://www.michigan.gov/deq/0,1607,7-135-3310_4195-230649--,00.html

⁴ Online information about criteria pollutants and air toxics, along with this and previous annual air quality reports, are available via the AQD's website at <http://www.michigan.gov/degair> under "Spotlight."

Chapter 1: Background Information

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

NAAQS

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

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

NAAQS have been established for CO, Pb, NO₂, O₃, PM, and SO₂. **Table 1.1** lists the primary and secondary NAAQS, averaging time, and concentration level for each criteria pollutant in effect in 2009. The concentrations are listed as parts per million (ppm), micrograms per cubic meter (µg/m³), and/or milligrams per cubic meter (mg/m³).

Table 1.1: NAAQS in Effect during 2009 for Criteria Pollutants

Pollutant	Primary (health-related)		Secondary (welfare-related)	
	Level	Averaging Time	Level	Averaging Time
Carbon Monoxide (CO)	9 ppm (10 mg/m ³)	2 nd highest 8-hour	None	
	35 ppm (40 mg/m ³)	2 nd highest 1-hour		
Lead (Pb)	0.15 µg/m ³	Maximum 3-month average	Same as Primary	
Nitrogen Dioxide (NO ₂)	0.053 ppm (100 µg/m ³)	Annual arithmetic mean	Same as Primary	
Particulate Matter (PM ₁₀)	150 µg/m ³	24-hour	Same as Primary	
Particulate Matter (PM _{2.5})	15.0 µg/m ³	Annual arithmetic mean	Same as Primary	
	35 µg/m ³	98 th percentile 24-hour averaged over 3 years	Same as Primary	
Ozone (O ₃)	0.075 ppm	4 th highest 8-hour daily max. averaged over 3 years	Same as Primary	
Sulfur Dioxide (SO ₂)	0.03 ppm (80 µg/m ³)	Annual arithmetic mean	0.5 ppm	3-hour
	0.14 ppm (365 µg/m ³)	24-hour		

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

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

POLLUTANT	CRITERIA FOR COMPLIANCE
CO	Compliance with the CO standard is met when the 35 ppm 1-hour average standard and/or the 9 ppm 8-hour average standard is not exceeded more than once per year.
Pb	Compliance with the Pb standard is met when daily values collected for 3 consecutive months are averaged and do not exceed the 0.15 $\mu\text{g}/\text{m}^3$ standard.
NO ₂	Compliance is met when the annual arithmetic mean concentration does not exceed the 0.053 ppm standard.
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	PM₁₀ : The 24-hour PM ₁₀ primary and secondary standards are met when the expected number of days per calendar year above 150 $\mu\text{g}/\text{m}^3$ is equal or less than one.
	PM_{2.5} : The PM _{2.5} annual and secondary standards are met when the annual arithmetic mean concentration is less than or equal to 15 $\mu\text{g}/\text{m}^3$. The 24-hour PM _{2.5} primary and secondary standards are met when the 3-year average of the 98 th percentile 24-hour concentration is less than or equal to 35 $\mu\text{g}/\text{m}^3$.
SO ₂	To determine compliance, the annual average concentration shall not exceed 0.03 ppm, the 24-hour average concentration shall not exceed 0.14 ppm more than once per calendar year, and the 3-hour average concentration shall not exceed 0.5 ppm more than once per calendar year.

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

Michigan Air Sampling Network

The Michigan Air Sampling Network (MASN) is operated by the DNRE's AQD, along with other governmental agencies. For instance, the O₃ and PM_{2.5} monitor in Manistee County is handled by the Little River Band of Ottawa Indians. **Figure 1.1** shows the 2009 MASN monitoring sites. **Figures 1.2** and **1.3** are pictures of two monitoring stations in Holland and W. Fort Street (Southwestern High School) in Detroit, respectively.

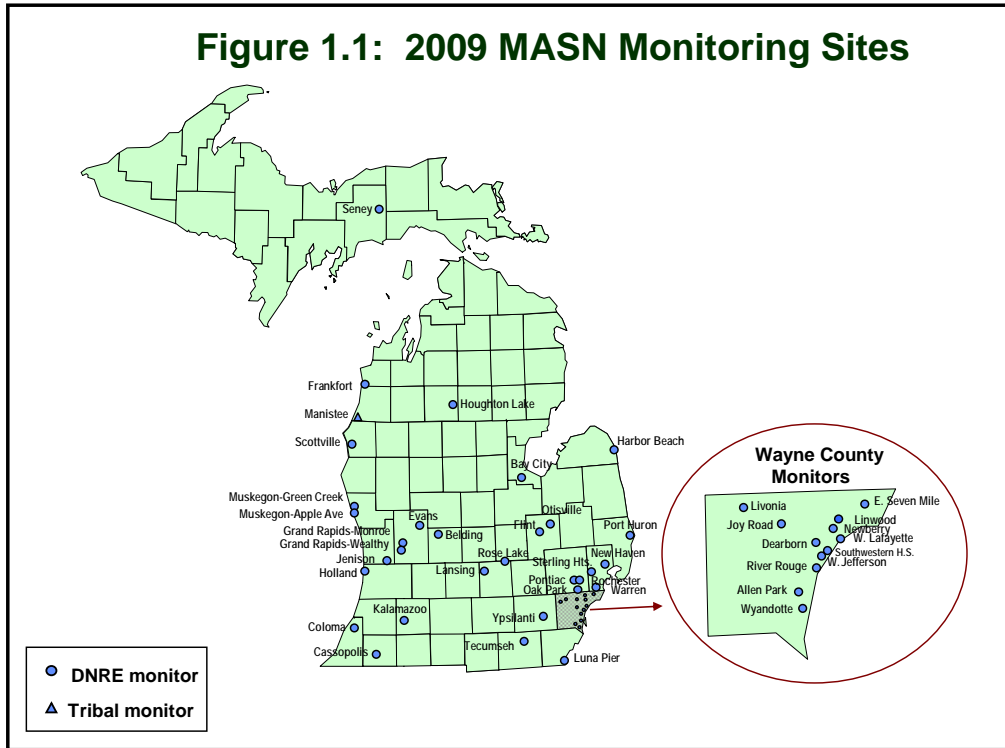


Figure 1.2 - Holland



Figure 1.3 – W. Fort Street



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 PM concentrations over a 24-hour period, and high volume samplers for Pb. In addition, continuous $PM_{2.5}$ and PM_{10} monitors are used to provide real-time hourly data, and $PM_{2.5}$ chemical speciation monitors determine the chemical composition of $PM_{2.5}$ and help characterize background levels. The MASN data is also used to provide timely reporting to the DNRE's air quality reporting web page (discussed in **Chapter 9**). The types of monitoring conducted in 2009 and the MASN locations are shown in **Table 1.3**.

Table 1.3 Types of Monitoring Conducted in 2009 and MASN Location

Area	AIRS ID	Site Name	Trace CO	NO ₂	Trace NO _y	O ₃	PM ₁₀	PM _{2.5}	PM _{2.5}	TEOM	PM _{2.5}	Speciation	SO ₂	Trace SO ₂	VOC	Carbonyls	Trace Metals	Wind	Speed & Direction,	Temp.	Relative Humidity	Solar Radiation	Barometric Pressure	
Detroit-Ann Arbor	260910007	Tecumseh			√			√				√							√				√	
	260990009	New Haven			√			√											√				√	
	260991003	Warren			√																			
	261250001	Oak Park			√														√					
	261470005	Port Huron			√			√	√	√									√					
	261610008	Ypsilanti			√			√	√	√									√				√	
	261630001	Allen Park	√		√	√	√	√	√	√	√		√				√@		√				√	
	261630005	River Rouge														√	√@		√					
	261630015	Detroit- W Fort S					√	√			√	√	√	√	√	√	√@		√		√			√
	261630016	Detroit- Linwood						√																
	261630019	Detroit- E Seven Mile		√		√		√												√				√
	261630025	Livonia						√											√		√			√
	261630027	Detroit-W Jefferson																√@						
	261630033	Dearborn					√	√	√	√	√				√	√	√ + Pb		√		√			√
	261630036	Wyandotte						√																
	261630038	Detroit- Newberry						√	√											√				
	261630039	Detroit W. Lafayette						√	√											√				
	Flint	260490021	Flint			√		√	√									√#		√				
260492001		Otisville			√														√					
Grand Rapids	261390005	Jenison			√		√												√					
	260810007	Grand Rapids - Wealthy					√	√																
	260810020	Grand Rapids - Monroe	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√@		√					√
	260810022	Evans			√														√					
Lansing/East Lansing	260650012	Lansing			√		√	√											√					√
	260370001	Rose Lake			√																			
Monroe Co	261150005	Luna Pier					√				√													
Huron Co	260630007	Harbor Beach				√													√					
Bay Co	260170014	Bay City					√	√											√					
Missaukee Co	261130001	Houghton Lake			√	√	√	√	√	√									√					√
Allegan Co	260050003	Holland			√		√												√					√
Benzie Co	260190003	Frankfort			√																			
Berrien Co	260210014	Coloma			√		√												√					
Cass Co	260270003	Cassopolis			√														√					
Kalamazoo Co	260770008	Kalamazoo			√		√	√																
Manistee Co	261010922	Manistee +			√		√												√				√	√
Mason Co	261050007	Scottville			√														√					
Muskegon Co	261210038	Muskegon - Green			√														√					
	261210040	Muskegon - Apple Ave						√																
Schoolcraft Co	261530001	Seney Nat'l Wildlife			√			√											√		√	√	√	√
√ = Data Collected																								
# = Mn only																								
@ = Mn, As, Cd, Ni																								
+= Operated by the Little River Band of Ottawa Indians																								

The MASN is designed to meet the EPA's national ambient air quality monitoring requirements, is used to measure and determine which areas are meeting the NAAQS for the six criteria pollutants, and provides real-time air quality measurements for AIRNOW and MIAir (see **Chapter 9**). In 2006, the EPA amended its air monitoring requirements to include more collocated monitors. The amended air monitoring requirements will also add National Core (NCore) sites that will be multi-pollutant in nature, which will enhance the understanding of how

the various forms of air pollution are related and how it is transported. Information on the effects of the 2006 amended monitoring requirements is discussed by criteria pollutant in **Chapters 2 through 7**.

Quality Assurance

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

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

Quality assurance checks are conducted by the 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.

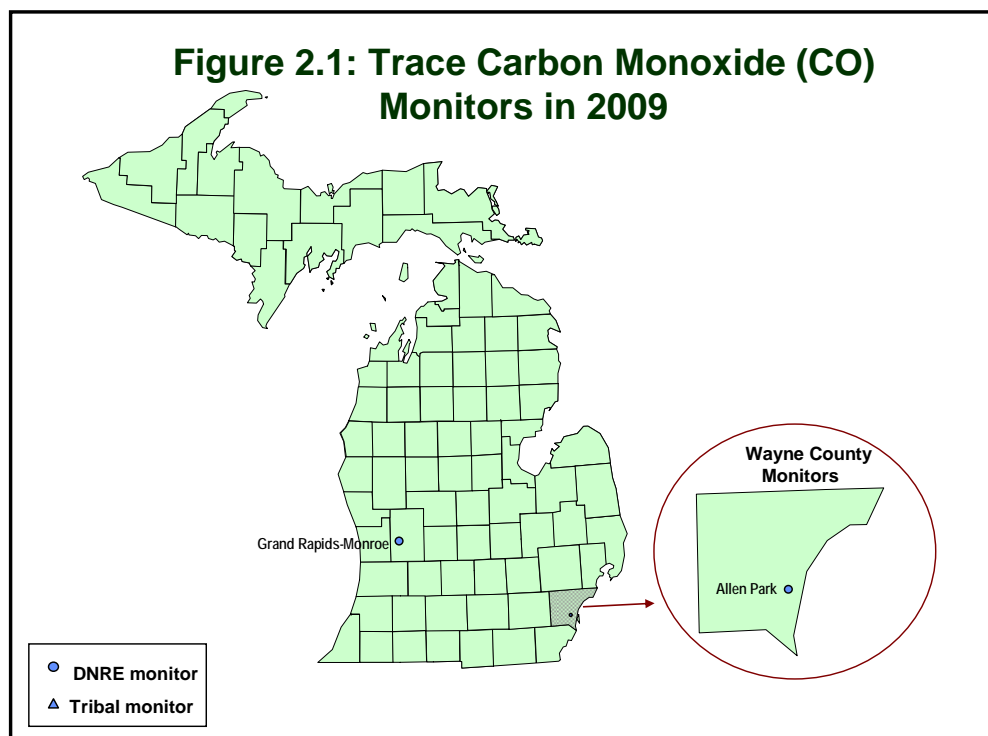
External audits are conducted annually by the EPA. The EPA conducts Performance Evaluation Program (PEP) audits for PM_{2.5} samplers and the National Performance Audit Program (NPAP) for the gaseous monitors. The EPA also conducts program-wide Technical Systems Audits every three to five years to evaluate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

Chapter 2: Carbon Monoxide (CO)

Carbon monoxide is a colorless, odorless and poisonous gas formed during incomplete burning of fuel. Levels peak during colder months primarily due to cold temperatures that affect combustion efficiencies of engines. It has a standard of 9 ppm for the 2nd highest 8-hour average and 35 ppm for the 2nd highest 1-hour average. Its sources and effects are as follows:

- **Sources:** Outdoor exposure sources are automobile exhaust, industrial processes (metal processing and chemical production), non-vehicle fuel combustion, and natural sources, such as forest fires. Indoor exposure sources are wood stoves, gas ranges with continuous pilot flame ignition, unvented gas or kerosene heaters, and cigarette smoke.
- **Effects:** CO enters the bloodstream through the lungs, where it displaces oxygen delivered to the organs and tissues. Elevated levels can cause visual impairment, interfere with mental acuity by reducing learning ability and manual dexterity, and can decrease work performance in the completion of complex tasks. CO alters atmospheric photochemistry that contributes to the formation of ground-level O₃, which can trigger serious respiratory problems.
- **Population most at risk:** Those who suffer from cardiovascular (heart and respiratory) disease are most at risk for exposure to elevated levels of CO. People with angina and peripheral vascular disease are especially at risk as their circulatory systems are already compromised and less efficient at carrying oxygen. However, elevated CO levels can also affect healthy people.

Figure 2.1 shows the location of each CO monitor. Traditional CO monitoring is no longer required. However, for the NCore Network, that must be operational by 2011, trace CO monitoring is required. Therefore, trace CO is monitored at Grand Rapids and Allen Park.



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

Figure 2.2

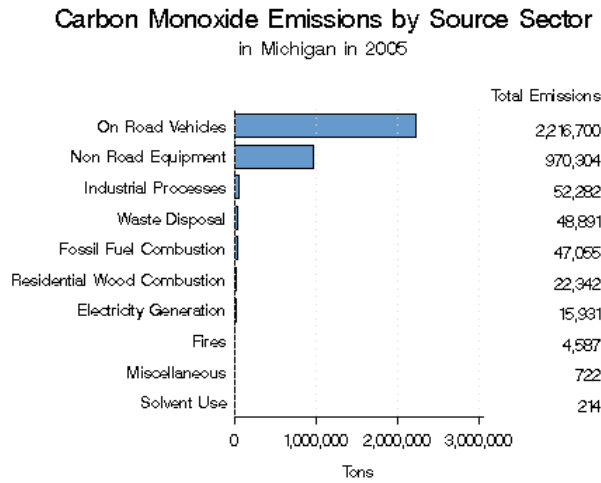


Figure 2.3

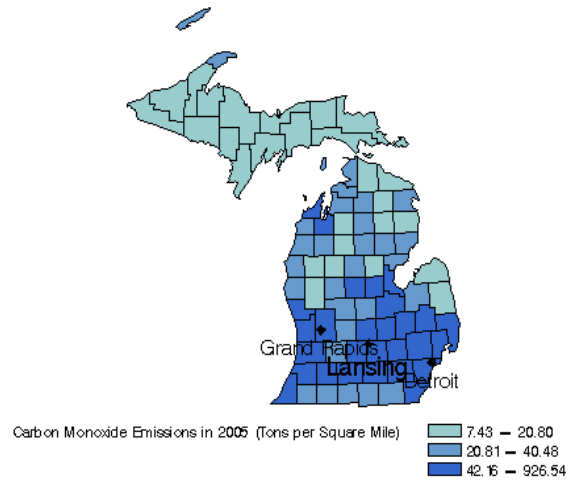
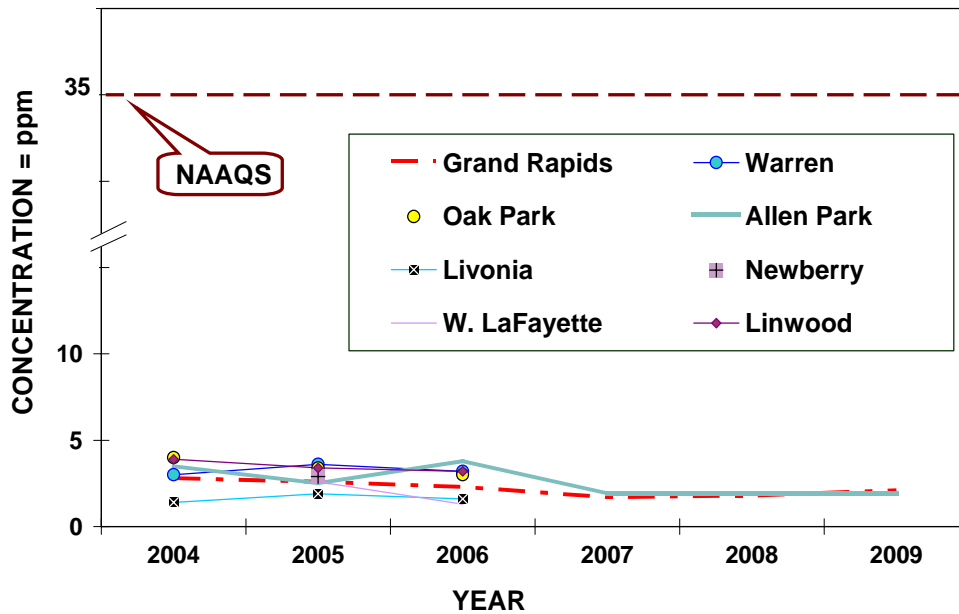


Figure 2.4 provides the maximum second highest 1-hour CO level trends for Michigan from 2004-2009, which demonstrates that there have not been any exceedances of the 1-hour CO NAAQS.

Figure 2.4: CO Levels in MI from 2004-2009
(2nd Highest 1-Hr Maximum Values)

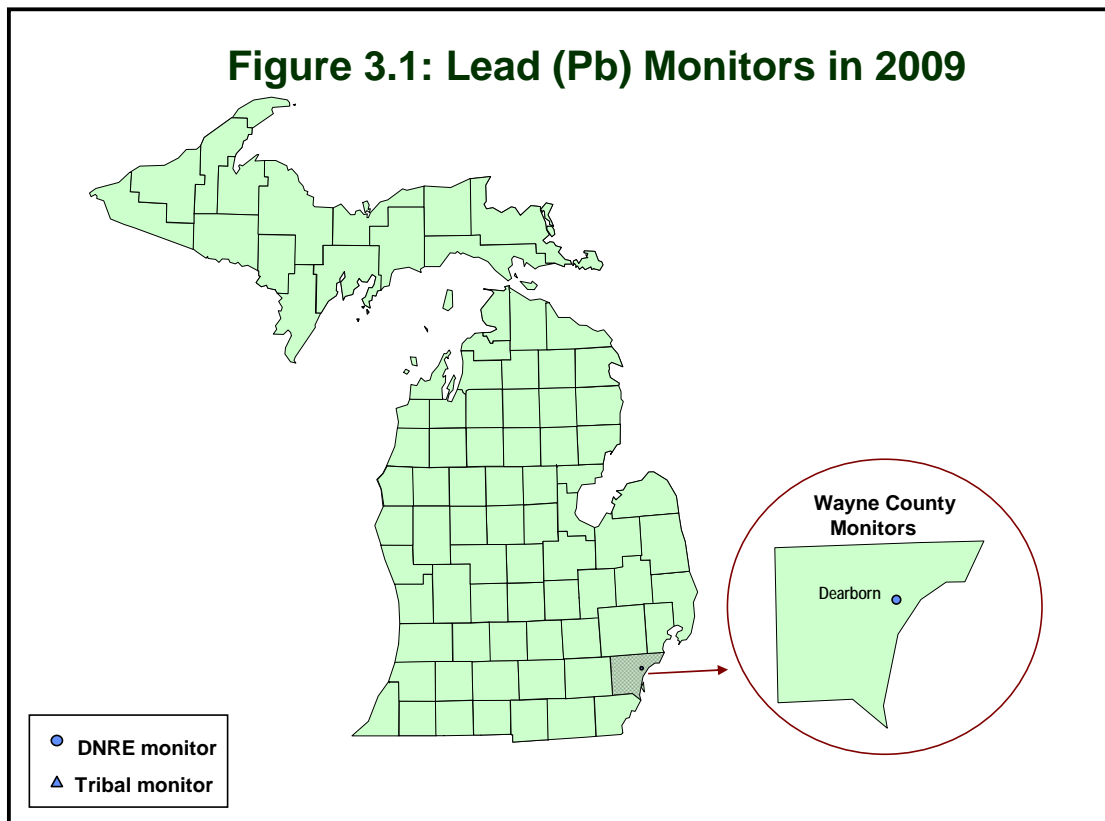


Chapter 3: Lead (Pb)

Lead is a highly toxic metal found in coal, oil, and waste oil. It is also found in municipal solid waste and sewage sludge incineration and may be released to the atmosphere during their combustion. Its sources and effects are as follows:

- **Sources:** With the phase-out of leaded gas in the 1970s, the major sources of Pb emissions are industrial and combustion sources. The highest air concentrations of Pb are found near smelters and battery manufacturers (Pb acid batteries, Pb oxide/pigments). Other industrial sources include Pb glass, Portland cement, and solder production.
- **Effects:** Exposure occurs through the inhalation or ingestion of Pb in food, water, soil, or dust particles. Pb primarily accumulates in the body's blood, bones, and soft tissues, and adversely affects the kidneys, liver, nervous system, and other organs.
- **Population most at risk:** Fetuses and children are most at risk as low levels of Pb may cause central nervous system damage. Excessive Pb exposure during the early years of life is associated with lower IQ scores and neurological impairment (seizures, mental retardation, and behavioral disorders). Even at low doses, Pb exposure is associated with changes in fundamental enzymatic, metabolic, and homeostatic mechanisms in the body, and Pb may be a factor in high blood pressure and subsequent heart disease.

Figure 3.1 shows the location of the one Pb monitor in the state.



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

Figure 3.2

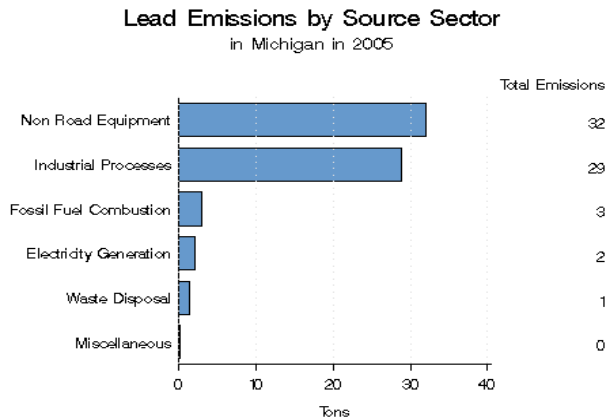
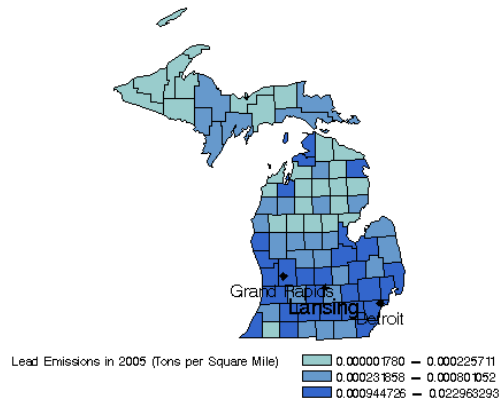


Figure 3.3

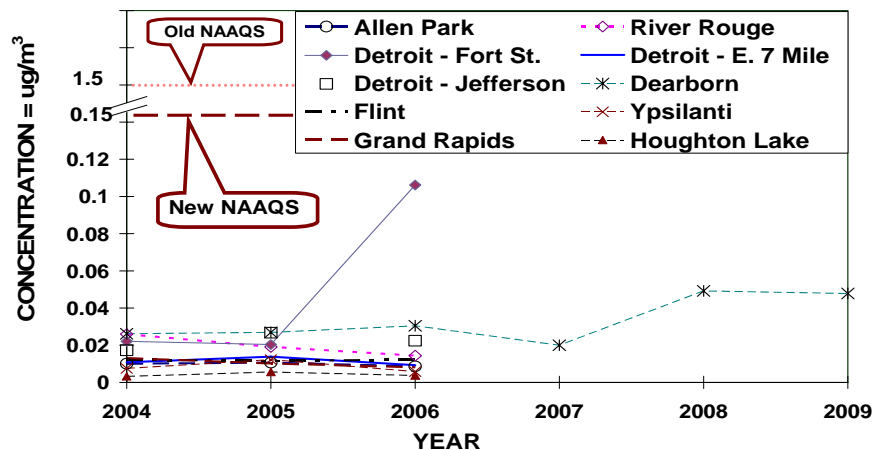


On November 12, 2008, the EPA modified the Pb NAAQS by reducing the level of the standard from a maximum quarterly average of $1.5 \mu\text{g}/\text{m}^3$ to a 3-month rolling average of $0.15 \mu\text{g}/\text{m}^3$. The monitoring network design has been modified to consist of both source-oriented monitors as well as population-oriented monitors. For details of the new Pb network that has begun in 2010, see Michigan’s 2010 Annual Ambient Air Monitoring Network Review.

Ambient Pb levels in Michigan have been well below the old NAAQS of $1.5 \mu\text{g}/\text{m}^3$ as well as the new NAAQS of $0.15 \mu\text{g}/\text{m}^3$. The Dearborn site is part of the National Air Toxics Trend Sites (NATTS) program and monitors Pb and other trace metals, both as total suspended particulate (TSP), PM_{10} and $\text{PM}_{2.5}$. Pb measurements as $\text{PM}_{2.5}$ are made throughout the $\text{PM}_{2.5}$ speciation network.

Figure 3.4 provides the maximum Quarterly Pb level values.

Figure 3.4: Pb Levels in Michigan from 2004-2009 (Maximum Quarterly Values)

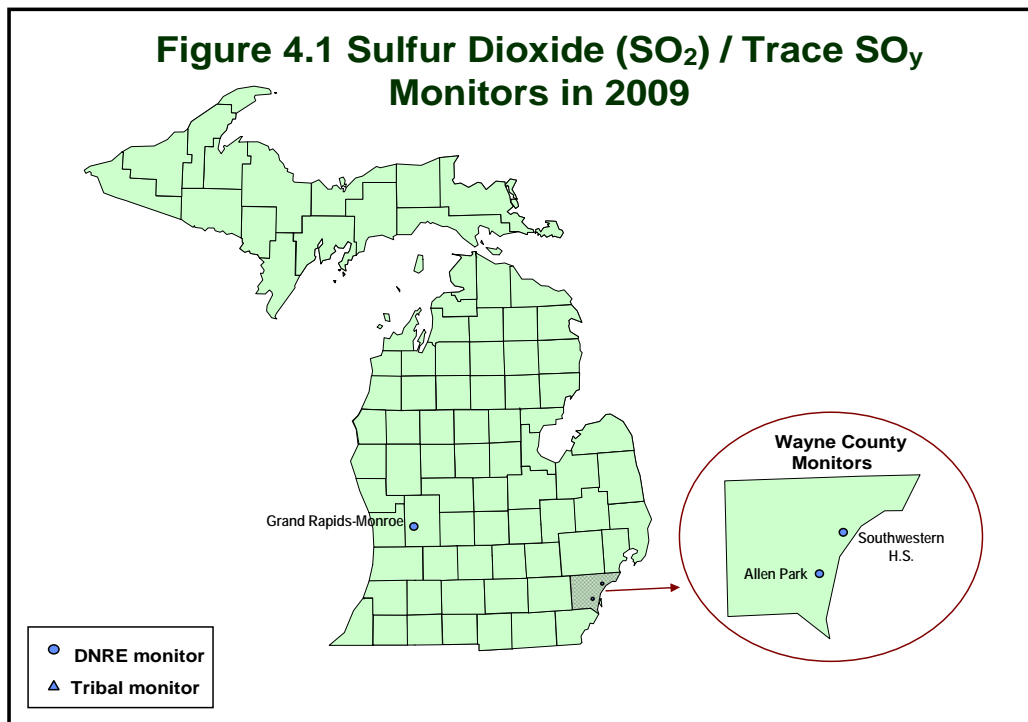


Chapter 4: Sulfur Dioxide (SO₂)

Sulfur dioxide is a colorless gas formed by the burning of sulfur-containing material. Odorless at typical ambient concentrations, SO₂ can react with other atmospheric chemicals to form sulfuric acid. When sulfur-bearing fuel is burned, the sulfur is oxidized to form SO₂, which then reacts with other pollutants to form aerosols. In liquid form, it is found in clouds, fog, rain, aerosol particles, and in surface films on these particles. It is a major precursor to PM_{2.5}. The primary standard for SO₂ is an annual mean of 0.03 ppm and 0.14 ppm for the 2nd highest 24-hour average. The secondary standard 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 SO₂ emissions. SO₂ is also emitted from smelters, petroleum refineries, pulp and paper mills, transportation sources, and steel mills. Other sources include residential, commercial and industrial space heating. SO₂ and PM are often emitted together.
- **Effects:** Exposure to elevated levels aggravates existing cardiovascular and pulmonary disease. SO₂ and PM together may cause respiratory illness, alteration of the body's defense and clearance mechanisms, and aggravation of existing cardiovascular disease. SO₂ and NO_x together are the major precursors to acid rain, associated with the acidification of soils, lakes, and streams and accelerated corrosion of buildings and monuments.
- **Population most at risk:** Asthmatics, children, and the elderly are especially sensitive to SO₂ 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 on the concentration, SO₂ may also cause symptoms in people who do not have asthma.

Figure 4.1 shows the location of each SO₂ monitor.



Figures 4.2 – 4.3 show SO₂ emission sources and SO₂ emissions by county (courtesy of EPA’s State and County Emission Summaries).

Figure 4.2

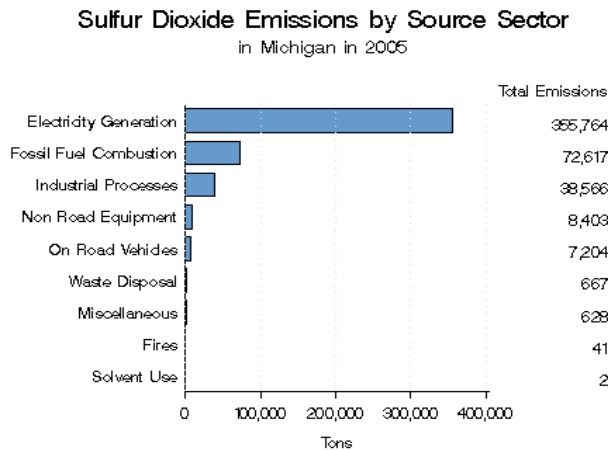
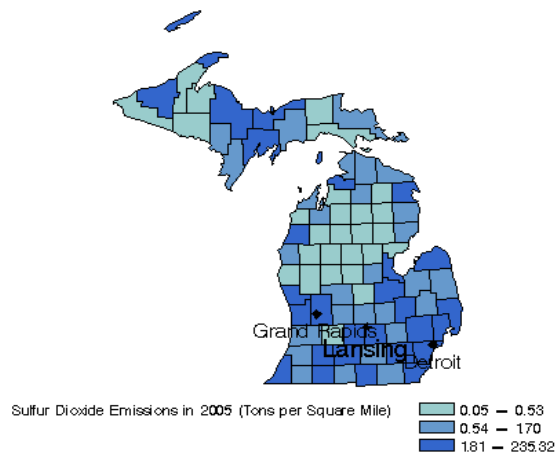
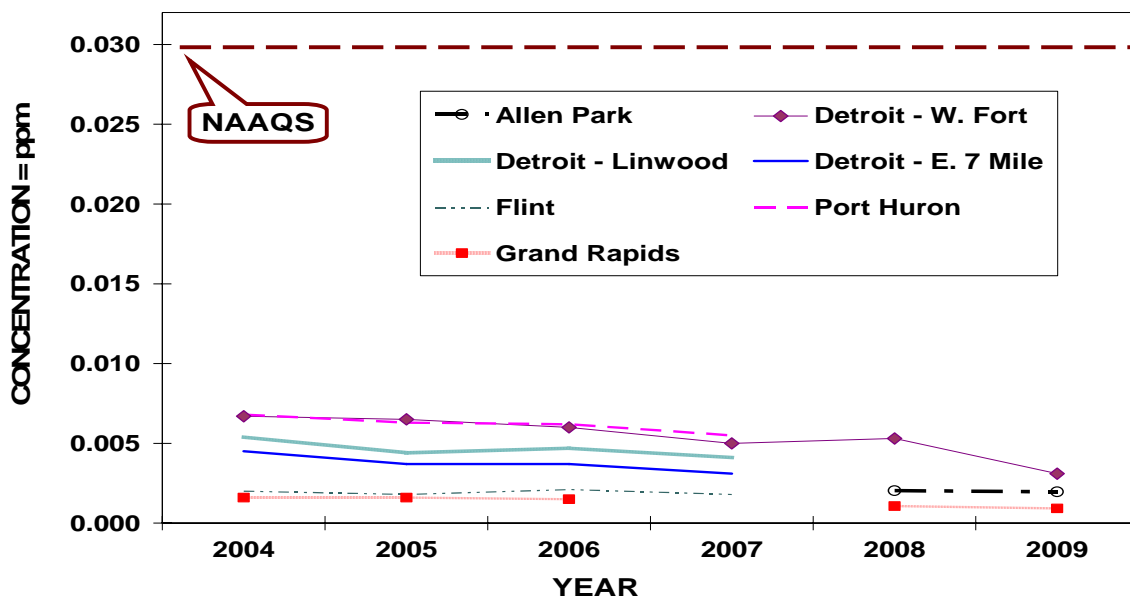


Figure 4.3



Michigan has been in attainment for SO₂ since 1982 with levels consistently well below the SO₂ NAAQS. The SO₂ monitor at W. Fort Street (Southwestern High School) in Detroit is located in the old nonattainment area for SO₂ and is important for trend level studies having been active for more than 32 years. However, for the NCore Network, that must be operational by 2011, trace SO₂ monitoring is required. Trace SO₂ is monitored at the Grand Rapids and Allen Park NCore sites. For trend purposes, the W. Fort Street, Allen Park and Grand Rapids SO₂ monitors are shown in Figure 4.4.

Figure 4.4: SO₂ Levels in Michigan from 2004-2009 (Annual Arithmetic Mean)

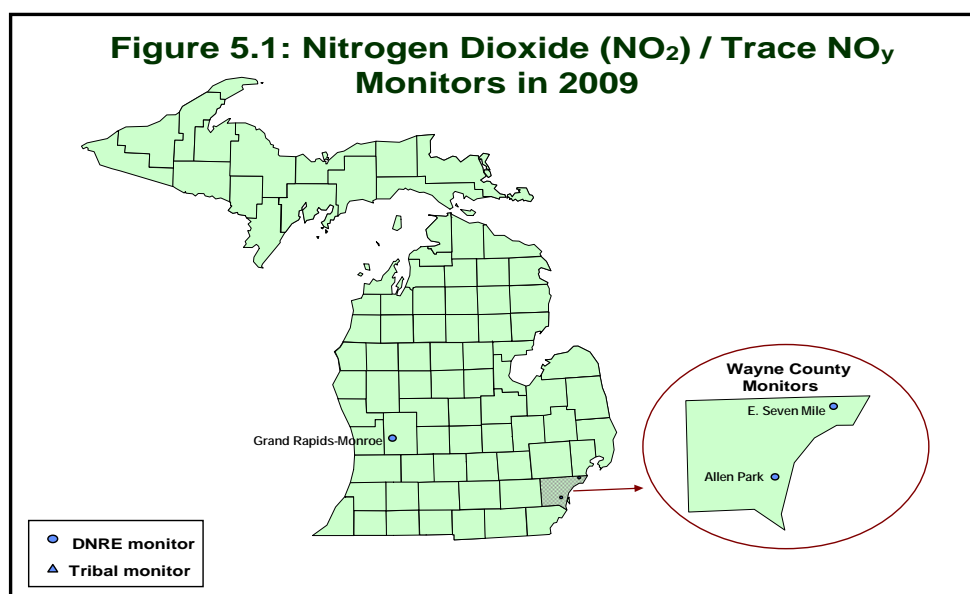


Chapter 5: Nitrogen Dioxide (NO₂)

Nitrogen Dioxide is a reddish-brown, highly reactive gas formed through oxidation of nitric oxide (NO). Upon dilution, it becomes yellow or invisible. High concentrations produce a pungent odor and lower levels have an odor similar to bleach. NO_x is the term used to describe the sum of NO, NO₂, and other nitrogen oxides. NO_x can lead to the formation of O₃ and NO₂, and can react with other substances in the atmosphere to form acidic products that are deposited in rain (acid rain), fog, snow, or as PM. The standard for NO₂ is an annual mean of 0.053 ppm. Its sources and effects are as follows:

- **Sources:** NO_x compounds and their transformation products occur both naturally and as a result of human activities. Natural sources of NO_x are lightning, biological and abiological processes in soil, and stratospheric intrusion. Ammonia and other nitrogen compounds produced naturally are important in the cycling of nitrogen through the ecosystem. The major sources of man-made (anthropogenic) NO_x emissions, which account for a large majority of all nitrogen inputs to the environment, come from high-temperature combustion processes (such as those occurring in automobiles and power plants). Home heaters and gas stoves produce substantial amounts of NO₂ in indoor settings.
- **Effects:** Exposure to NO₂ occurs through the respiratory system, irritating the lungs. Short-term NO₂ exposures (i.e. less than 3 hours) can produce coughing and changes in airway responsiveness and pulmonary function. Evidence suggests that long-term exposures to NO₂ 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 NO₂. Nitrate particles and NO₂ can block the transmission of light, thus causing visibility impairment. Deposition of nitrogen can lead to fertilization, eutrophication, or acidification of terrestrial, wetland, and aquatic systems.
- **Population most at risk:** Individuals with pre-existing respiratory illnesses and asthmatics are more sensitive to the effects of NO₂ than the general population. Short-term NO₂ exposure can increase respiratory illnesses in children.

Figure 5.1 shows the location of each NO₂ monitor.



The E. Seven Mile monitor in Detroit is a downwind urban scale site that measures NO₂. The Grand Rapids and Allen Park sites monitor trace NO_y, which began in early January 2008 as part of the NCore program (only NO₂ monitors can be used for attainment/nonattainment purposes, however).

Figures 5.2 – 5.3 show NO₂ emission sources and NO₂ emissions by county (courtesy of EPA’s State and County Emission Summaries).

Figure 5.2

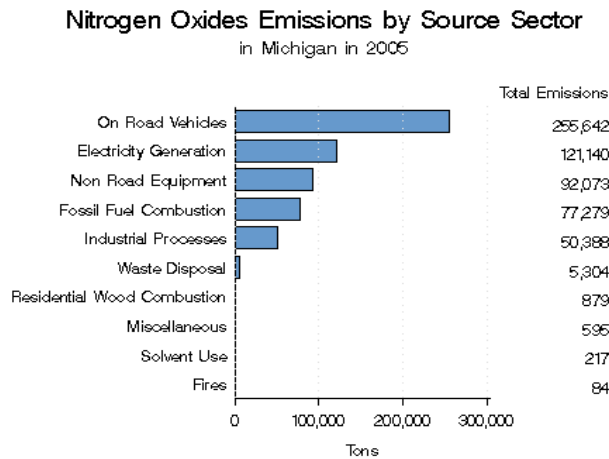
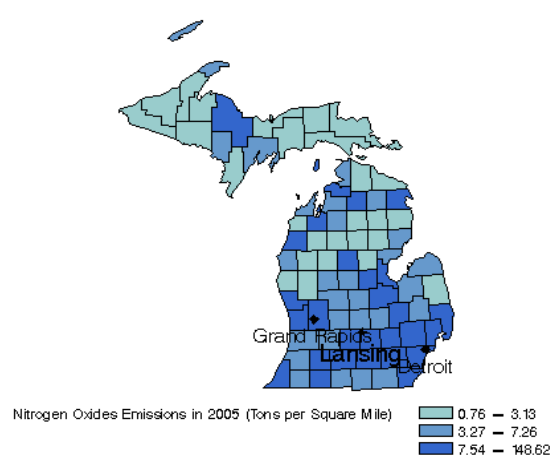
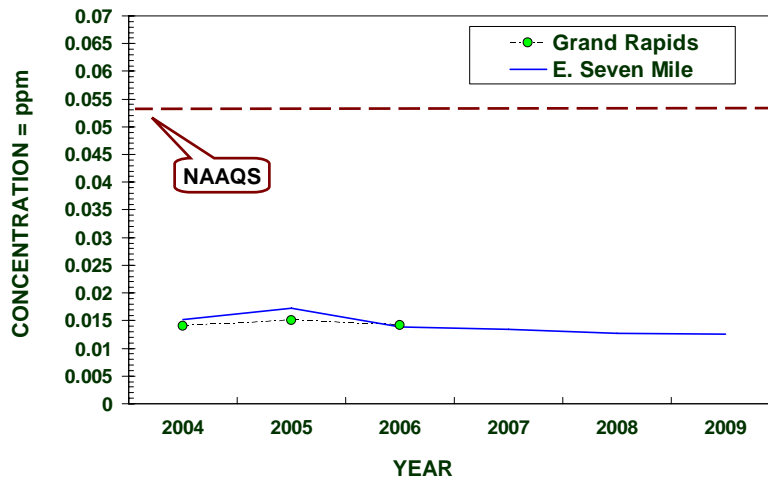


Figure 5.3



Michigan ambient NO₂ levels have always been well below the NAAQS. Since March 3, 1978, all areas in Michigan have been in attainment for NO₂. As shown in Figure 5.4, all monitoring sites have had an annual NO₂ concentration at less than half of the 0.053 ppm NAAQS.

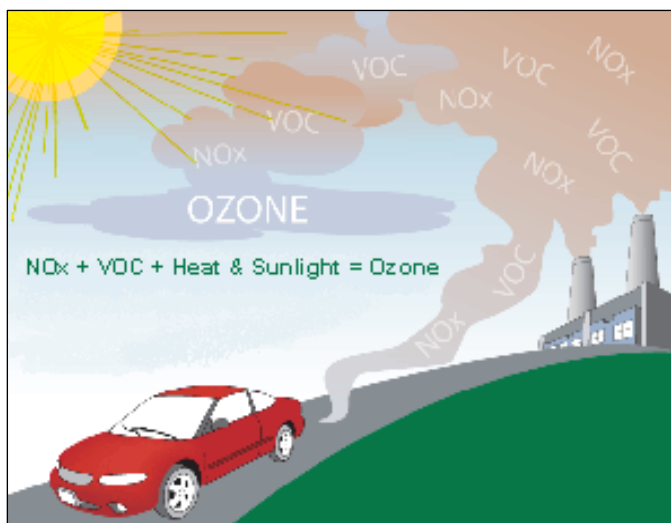
Figure 5.4: NO₂ Levels in MI from 2004-2009
(Annual Arithmetic Mean)



Even though there are no nonattainment areas for NO₂ in Michigan and monitoring for attainment purposes is not required, monitors continue to operate to support photochemical model validation work.

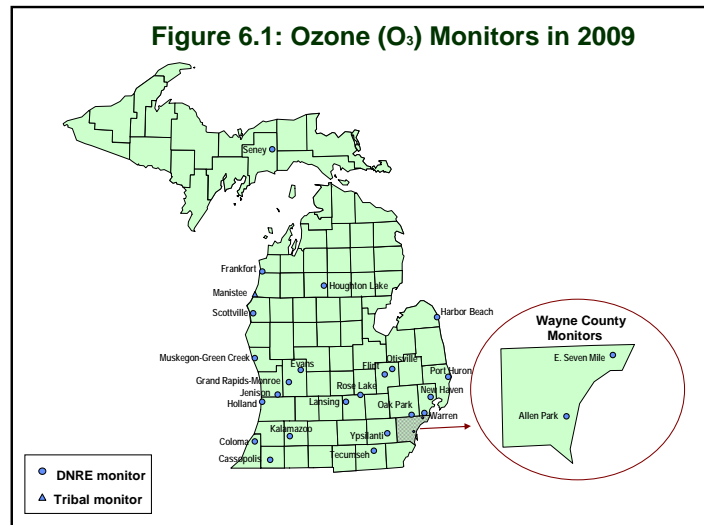
Chapter 6: Ozone (O₃)

Ground-level O₃ is created by photochemical 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 EPA). These reactions usually occur during the hot summer months as ultraviolet radiation from the sun initiates a sequence of photochemical reactions. O₃ is also a key ingredient of urban smog. In the Earth's lower atmosphere (also known as the troposphere), ozone is an air pollutant. Ground level ozone can also be transported hundreds of miles under favorable meteorological conditions. Ozone levels are often higher in rural areas than in cities due to transport to regions downwind from the actual emissions of ozone forming air pollutants. Shoreline monitors along Lake Michigan often measure high ozone concentrations due to transport from upwind states. Its sources and effects are as follows:



- **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 O₃ can also be transported hundreds of miles under favorable meteorological conditions. 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 O₃ exposure can irritate a person's airways, reduce lung function, aggravate asthma and chronic lung diseases like emphysema and bronchitis, and inflame and damage the cells lining the lungs. Other effects include increased respiratory related hospital admissions with symptoms such as chest pain, shortness of breath, throat irritation, and cough. O₃ 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. O₃ also impacts vegetation and the forest ecosystem, including agricultural crop and forest yield reductions, diminished resistance to pest and pathogens, and reduced survivability of tree seedlings.
- **Population most at risk:** Individuals most susceptible to the effects of O₃ 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 each O₃ monitor.



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

Figure 6.2

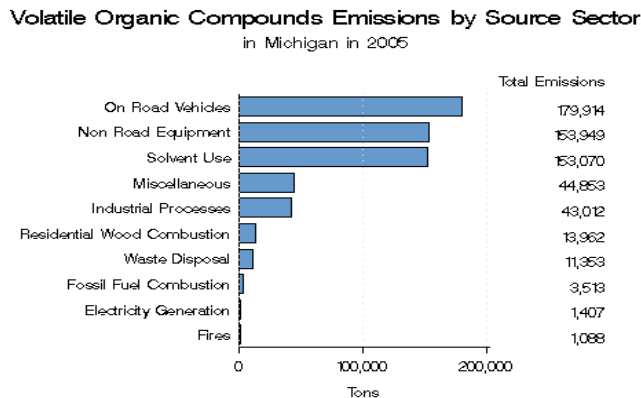
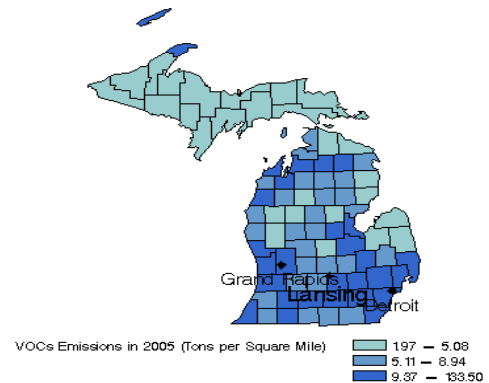


Figure 6.3



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

Nonattainment designations are assigned to areas that exceed the NAAQS, or contribute to exceedances in a nearby area. The EPA planned to make attainment and nonattainment designations for this standard no later than March 12, 2010, however, the EPA decided to re-evaluate the standard instead. Attainment and nonattainment designations for the 0.08 ppm standard were made in 2004. Twenty-five counties were designated nonattainment. Only one county in West Michigan, Allegan, remains nonattainment for ozone.

The O₃ monitoring season in Michigan is from April 1 through September 30, during which time O₃ monitoring data is available for the public via the AQD’s website (discussed in **Chapter 9**). This data helps in attainment designation applications, to assess urban air quality, and population exposure.

Table 1.3 from **Chapter 1** shows all 26 O₃ air quality monitors active in Michigan at the beginning of 2009. It is important to note that under the 2006 amended air monitoring regulations, MSA boundaries have been modified and population totals tied to measurements of ambient air quality have increased. Basically, the amended regulations state that any monitors with a design value, using the most recent three years of data greater than or equal to 85% of the O₃ NAAQS, have a higher probability of violating the standard. Therefore, more monitors could be required in these MSAs.⁵

Table 6.1 shows the three year average of the 4th highest 8-hour ozone values from 2006-2009.

Table 6.1: Three-Year Average of the 4th Highest 8-Hr O₃ Values from 2006-2009							
Areas	County	Monitoring Sites	2006	2007	2008	2009	
Detroit-Ann Arbor, MI	Lenawee	Tecumseh	0.077	0.079	0.076	0.073	
	Livingston						
	Macomb	New Haven	0.082	0.086	0.081	0.079	
		Warren	0.079	0.086	0.080	0.078	
		Oakland	Oak Park	0.075	0.079	0.077	0.077
		St. Clair	Port Huron	0.080	0.085	0.078	0.075
		Washtenaw	Ypsilanti	0.077	0.079	0.074	0.070
		Wayne	Allen Park	0.070	0.075	0.071	0.069
			E 7 Mile	0.075	0.083	0.082	0.080
Flint, MI	Genesee	Flint	0.075	0.078	0.074	0.072	
		Otisville	0.077	0.080	0.076	0.074	
	Lapeer						
Grand Rapids, MI	Ottawa	Jenison	0.079	0.086	0.079	0.075	
	Kent	Grand Rapids	0.078	0.083	0.077	0.072	
		Evans	0.079	0.082	0.078	0.075	
Muskegon Co, MI	Muskegon	Muskegon	0.083	0.087	0.083	0.077	
Allegan Co, MI	Allegan	Holland	0.088	0.093	0.086	0.081	
Huron Co, MI	Huron	Harbor Beach	0.073	0.078	0.074	0.072	
Kalamazoo- Battle Creek, MI	Calhoun						
	Kalamazoo	Kalamazoo	0.072	0.077	0.073	0.074	
	Van Buren						
Lansing East-Lansing, MI	Ingham	Lansing	0.074	0.078	0.074	0.073	
	Clinton	Rose Lake	0.073	0.077	0.073	0.071	
	Eaton						
Benton Harbor, MI	Berrien	Coloma	0.080	0.084	0.078	0.076	
Benzie Co, MI	Benzie	Frankfort	0.080	0.083	0.076	0.072	
Cass Co, MI	Cass	Cassopolis	0.079	0.081	0.076	0.075	
Mason Co, MI	Mason	Scottville	0.077	0.081	0.076	0.073	
Missaukee Co, MI	Missaukee	Houghton Lake	0.073	0.074	0.072	0.069	
Manistee Co, MI	Manistee	Manistee		0.083	0.077	0.072	
Schoolcraft Co, MI	Schoolcraft	Seney	0.078	0.082	0.075	0.070	

⁵ Additional information is available in Michigan's 2006 Ambient Air Monitoring Network Review Final Report at <http://www.deq.state.mi.us/documents/deq-aqd-air-aqe-Monitoring-Network-Review-final-9-607.pdf>

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

Table 6.2

Daily High		2009 WEST MICHIGAN OZONE SEASON											
Temperature		April		May		June		July		August		September	
Range		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					1	1						
90	<= 94					1	1			1			
85	<= 89	1				4				5			
80	<= 84			2	2	6		11		11		5	
75	<= 79	2		5		8		13		6		13	
70	<= 74	2		7		4		4		2		6	
65	<= 69	3		9		5		2		5		3	
60	<= 64	5		5		1		1		1			
55	<= 59	2		3								3	
50	<= 54	6											
49	<=	9											
Totals		30	0	31	2	30	2	31	0	31	0	30	0
Days:		Number of days during month when daily high temperature falls within specified temperature range.											
O₃ Days:		Number of days, during specified temperature range, when two or more area monitors exceeded 0.075 ppm.											

Table 6.3

Daily High		2009 SOUTHEAST MICHIGAN OZONE SEASON											
Temperature		April		May		June		July		August		September	
Range		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												
90	<= 94					2	1			2			
85	<= 89	2				1		2		8	1	1	
80	<= 84	2		2		8		11		9		9	
75	<= 79	1		4		8		11		5		10	
70	<= 74	1		7		5		6		3		6	
65	<= 69	4		13		5		1		4		1	
60	<= 64	2		5		1						2	
55	<= 59	6										1	
50	<= 54	8											
49	<=	4											
Totals		30	0	31	0	30	1	31	0	31	1	30	0
Days:		Number of days during month when daily high temperature falls within specified temperature range.											
O₃ Days:		Number of days, during specified temperature range, when two or more area monitors exceeded 0.075 ppm.											

There were two days in May and two days in June where ozone exceeded 0.075 ppm at two or more monitors in West Michigan. The respective temperatures for those days were between 80F – 84F, and above 90F. There was one day in June and one day in August where ozone exceeded 0.075 ppm at two or more monitors in Southeast Michigan. The respective temperatures for those days were between 90F – 94F, and between 85F – 89F. **Table 6.4** gives a breakdown of those days and the specific monitors that went over the standard in the western, central/upper, and eastern portions of the state.

Table 6.4

Date	Monitors			Total
	Western Michigan	Central/Upper Michigan	Eastern Michigan	
5/20/2009	Holland, Benzonia, Muskegon, Scottville, Manistee	Seney		6
5/21/2009	Holland, Coloma, Grand Rapids, Evans, Muskegon, Jenison		New Haven	7
6/5/2009	Holland			1
6/24/2009	Holland, Jenison		New Haven, Warren, East-7 Mile	5
6/25/2009	Cassopolis, Kalamazoo		Tecumseh	3
8/14/2009			Harbor Beach, Oak Park	2

May 21, 2009 had the most number of monitor readings exceeding the standard. Six out of seven of these monitors were in the western portion of Michigan. Out of all the locations during the spring and summer season, the Holland monitor exceeded the level of the standard four times, compared to two times for Muskegon and New Haven, and one time for the rest of the monitors.

NOTE: Even though several monitors exceeded the standard on particular days, the following graphs show that the 3-year average for ozone did not exceed the NAAQS.

Figure 6.4: O₃ Levels in Detroit-Warren-Flint CSA from 2004-2009 (4th Highest 8-Hour O₃ Values)

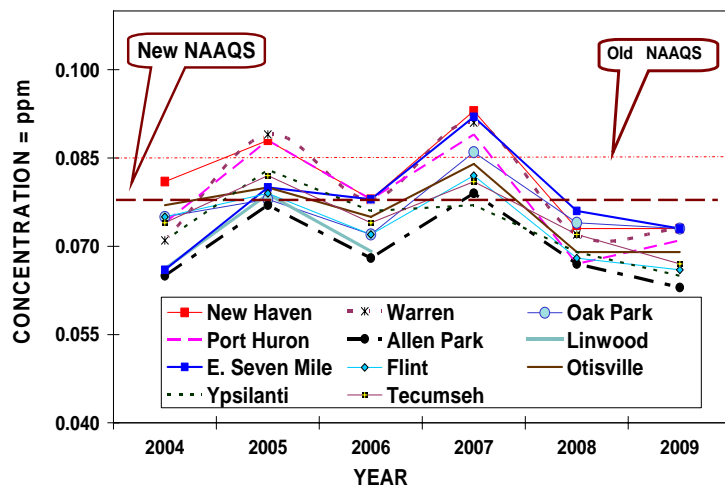


Figure 6.4 shows the 4th highest 8-hour O₃ values for all of Michigan’s monitoring sites in Southeast Michigan from 2004-2009. During the 2009 monitoring season, none of the 26 O₃ monitoring sites registered readings at or above the current 8-hour O₃ value of 0.075 ppm (4th highest value).

