Ground-level Ozone

Clean Air Act

In 1970 the Clean Air Act was established by the U.S. Congress to protect public health and welfare from different types of air pollution caused by a diverse array of pollution sources. At that time, Congress also created the U.S. Environmental Protection Agency (EPA) and gave it jurisdiction over the law. In 1990, the Clean Air Act was revised and expanded. Under the Clean Air Act, EPA sets limits on certain air pollutants, including how much can be in the air anywhere in the United States. The Clean Air Act also gives EPA the authority to limit stationary-source emissions of air pollutants.

States are required to develop State Implementation Plans (SIPs) that outline how each state will control air pollution under the Clean Air Act. A SIP is a collection of the regulations, programs, and policies that a state will use to clean up polluted areas.

EPA implements a variety of programs under the Clean Air Act that focus on:
1) Reducing ambient concentrations of air pollutants that cause smog, haze, acid rain, and other problems;
2) Reducing emissions of toxic air pollutants that are known to, or are suspected of, causing cancer or other serious health effects;
3) Phasing out production and use of chemicals that destroy stratospheric ozone.

These pollutants come from both stationary sources (such as chemical plants, gas stations, and power plants) and mobile sources (such as cars, trucks, and planes). There are six common “criteria pollutants” (so named because EPA regulates them by developing human health-based and/or environmentally-based criteria for setting permissible levels). The criteria pollutants are particulate matter (PM), ground-level ozone (O_3), carbon monoxide (CO), sulfur oxides (SO_x), nitrogen oxides (NO_x), and lead (Pb). Of the six criteria pollutants, particulate matter and ground-level ozone are the most widespread health threats to people in Minneapolis.

The Clean Air Act identifies two types of national ambient air quality standards (NAAQS) for the six criteria pollutants. Primary standards set limits to protect public health, including the health of at-risk populations such as people with pre-existing heart or lung disease, children, and older adults. Secondary standards set limits to protect public welfare, including protection against visibility impairment, damage to animals, crops, vegetation, and buildings.

Ground-level Ozone

Ground-level ozone is a primary component of smog. Ground-level ozone is not emitted directly, but is created in the air on hot, sunny days by a chemical reaction between volatile organic compounds (VOCs) and NO_x. VOCs are released by cars burning gasoline, petroleum refineries, chemical manufacturing plants, and other industrial facilities. The solvents used in paints and other consumer and business products contain VOCs. Examples of common VOCs in Minneapolis are benzene and formaldehyde, which are both automobile tailpipe emissions, and tetrachloroethylene, which is also known as PERC, a common dry-cleaning solvent. In addition to contributing to ozone formation, each VOC has its own associated health risks. NO_x is produced when cars and other sources burn fuels such as gasoline, coal, or oil.

Ozone concentrations typically peak in the afternoon and are highest in the summer, when daylight hours are long and temperatures are high. In Minnesota, ozone is highest from May through September. The highest ozone concentrations in the Twin Cities metro are found in suburban and rural locations downwind from city centers; outside the urban core areas of Minneapolis and St. Paul. This is due to “ozone scavenging.” In urban areas with an abundance of NO_x from vehicle emissions, the NO_x reacts quickly with, and removes, ozone. The NO_x that does not “scavenge” ozone will drift downwind, combine with VOCs, and produce ground-level ozone in the downwind location. Ozone can also be transported long distances by wind.

Levels of ozone are dependent on the amount of VOCs and NO_x in the air as well as weather conditions including sunlight, temperature, and wind speed and direction. High temperatures increase ozone formation and with rising temperatures due to climate change, the risk of ozone exposure increases. Ground-level ozone is a concern to human health. Repeated exposure can make people more susceptible to respiratory infections and lung inflammation and it also can aggravate pre-existing respiratory diseases, such as asthma. Ozone destroys tissue and is damaging to vegetation and the urban canopy.

On Nov. 25, 2014, EPA proposed to strengthen the National Ambient Air Quality Standards (NAAQS) for ground-level ozone. The current primary and secondary standards are 75 parts per billion (ppb). Based on an extensive body of scientific evidence, EPA's Clean Air Scientific Advisory Committee (CASAC) is proposing to update both the primary ozone standard, to protect public health, and the secondary standard, to protect the public welfare. Both standards would be 8-hour standards set within a range of 65 to 70 ppb, although EPA is taking comment on levels for the health standard as low as 60 ppb. EPA will issue a final decision by October 1, 2015.

Attainment / Nonattainment

The NAAQS, shown in Table 1, are not static. EPA must review each standard every five years, in order to ensure that each standard continues to provide adequate protection of human health and the environment. Recent reviews have resulted in revision of many of the standards, making them more stringent.

Table 1. National Ambient Air Quality Standards

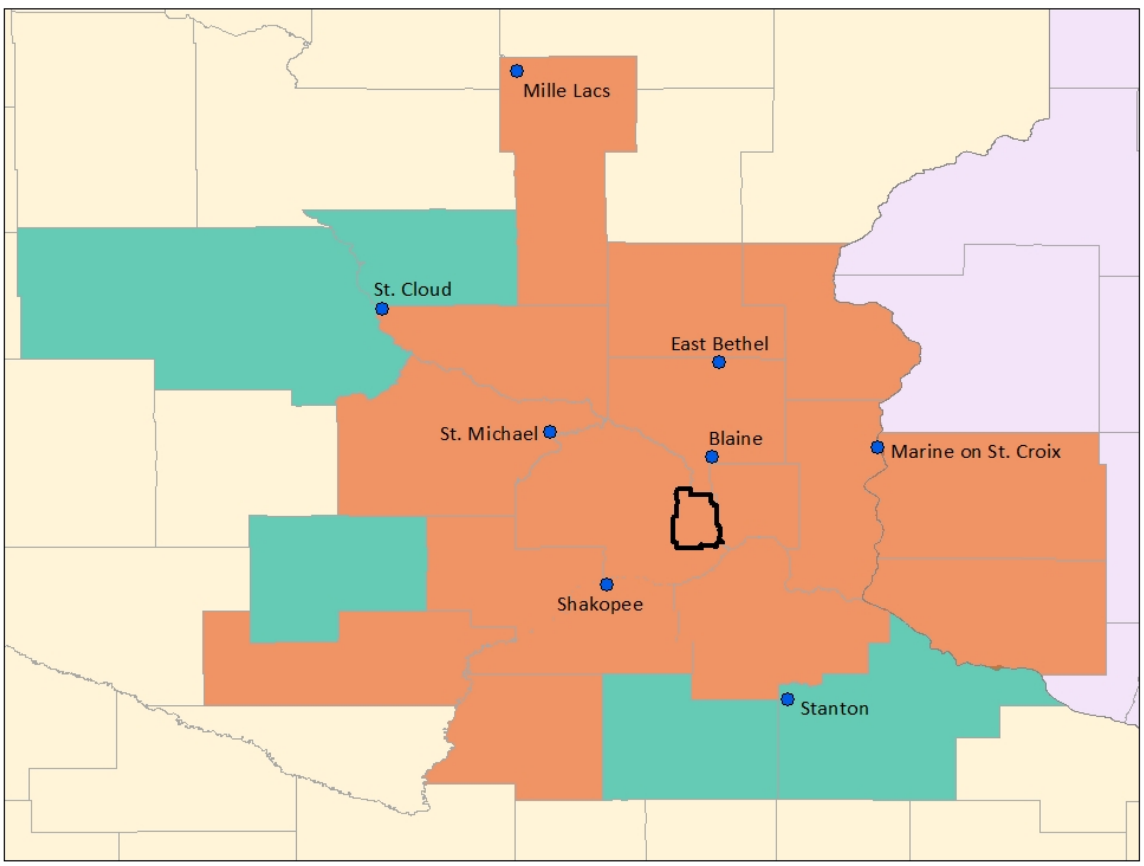
Pollutant	Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide	primary	8-hour	9 ppm	Not to be exceeded more than once per year
Carbon Monoxide	primary	1-hour	35 ppm	Not to be exceeded more than once per year
Lead	primary and secondary	Rolling 3 month average	0.15 $\mu g/m^3$	Not to be exceeded
Nitrogen Dioxide	primary	1-hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
Nitrogen Dioxide	primary and secondary	Annual	53 ppb (2)	Annual Mean
Ozone	**primary and secondary**	**8-hour**	**75 ppb**	**Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years**
Particulate matter	**$PM_{2.5}$ primary**	**Annual**	**12 $\mu g/m^3$**	**annual mean, averaged over 3 years**
Particulate matter	**$PM_{2.5}$ secondary**	**Annual**	**15 $\mu g/m^3$**	**annual mean, averaged over 3 years**
Particulate matter	**$PM_{2.5}$ primary and secondary**	**24-hour**	**35 $\mu g/m^3$**	**98th percentile, averaged over 3 years**
Particulate matter	PM_{10} primary and secondary	24-hour	150 $\mu g/m^3$	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide	primary	1-hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
Sulfur Dioxide	secondary	3-hour	500 ppb	Not to be exceeded more than once per year

For a state or local government to establish compliance with the NAAQS, measurements of the actual air quality must be made. To obtain these measurements the Minnesota Pollution Control Agency (MPCA) has established stationary monitoring networks with instrumentation complying with federal specifications. From these measurements, MPCA determines whether a given location is attaining the air quality standard. If a geographic area has air quality that is cleaner than the primary standard, that area is considered to be in attainment for that pollutant; if that area does not meet the primary standard, the area is designated to be a nonattainment area.

The Clean Air Act requirements are comprehensive and cover many different pollution sources and a variety of clean-up methods to reduce common air pollutants. Many of the clean-up requirements involve large industrial sources (power plants, chemical producers, and petroleum refineries), as well as motor vehicles (cars, trucks, and buses). Also, in nonattainment areas, controls are generally required for smaller pollution sources, such as gasoline stations and paint shops.

Because ozone is formed through a complex chemical reaction that involves transport of pollutants over a large area, ozone nonattainment areas tend to be quite large. The starting point for the nonattainment area would be the “core-based statistical area” as shown in Figure 1, which includes all the counties that are economically and socially tied to the violating metropolitan area. Based on modeling, the area could be reduced or changed, but the area must contain all sources that are causing or contributing to the violation. For example, if people are commuting into Minneapolis from St. Cloud and vehicles are considered a culpable source, St. Cloud could be included in the Twin Cities nonattainment area if that commuting is considered a contributing factor.

Figure 1. Core-Based Statistical Area and MPCA Ozone Monitors

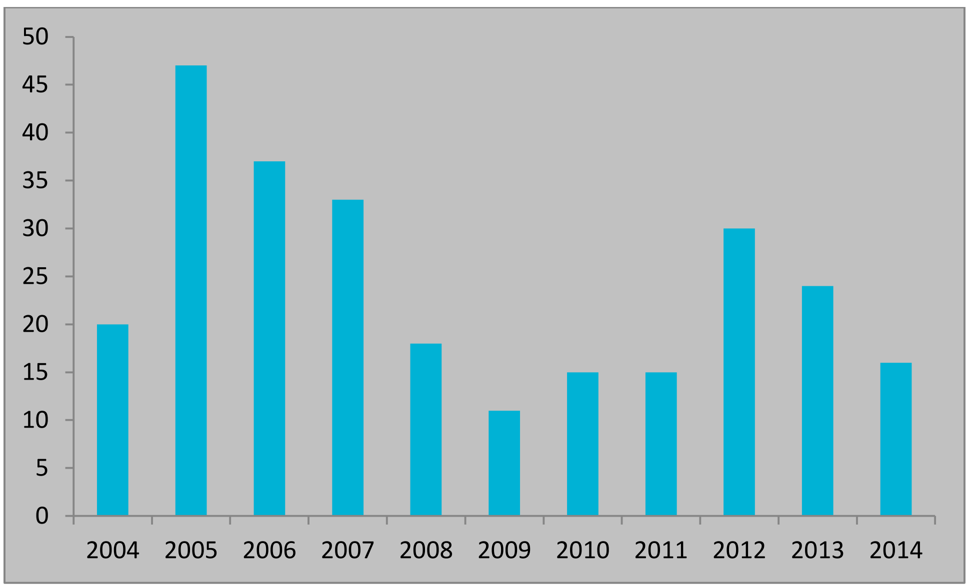


What this means for Minneapolis

Annually, the Twin Cities metropolitan area may experience several days that exceed the current primary standard of 75 ppb for ozone. However, due to the form of the standard (3-year average of the annual 4th-highest value), the Twin Cities metropolitan area currently attains the NAAQS for ozone. The range of levels that CASAC has recommended for the updated standards includes lower levels at which human health may be impacted. While the EPA is likely not going to adopt this lower limit for the new ozone standard, it is important to the Minneapolis Health Department to continue to look at our ozone levels in relation to the most conservative health level.

Figure 2 shows the number of days that the Twin Cities exceeded the lower CASAC ozone human-health based recommendation of 60 ppb. Counts are based on the EPA defined Minnesota ozone season, which runs from April 1st through October 31st for a total of 214 days annually. Daily values are based on the maximum 8-hour average concentration at each site. The site with the highest 8-hour average is used to represent the day's concentration. Not all sites have concentration data for each day. The sites included in these counts are Blaine, East Bethel, Hastings, Shakopee, Stanton, St. Michael, and Marine on St. Croix. In 2013, the MPCA added an ozone monitor to the near-road monitoring site in Minneapolis. Ozone monitoring results from the Minneapolis ozone monitoring site are included in these results beginning in 2013. Because the Minneapolis ozone monitor is new and does not yet have three years of complete data it does not have a design value and is not included on the above map.

Figure 2. Days Exceeding Lower CASAC Ozone Human-Heath Based Recommendation of 60 ppb



Substances that are emitted directly from sources are called primary pollutants. Pollutants that are created through chemical reactions among the primary pollutants and the constituents of the unpolluted atmosphere are called secondary pollutants. Ground-level ozone, or smog, is a secondary pollutant. With the knowledge that each secondary pollutant arises from specific chemical reactions involving specific primary pollutants, we must control secondary pollutants, such as ground-level ozone, by controlling how much of each primary pollutant is emitted.

In Minneapolis, VOCs (one precursor to ground-level ozone) are emitted from commercial sources such as gasoline stations, printing shops, and auto body and maintenance shops. They are also emitted from non-commercial sources such as motor vehicles, house painting, gasoline powered lawn and garden equipment, and common household cleaners and solvents.

Through their SIPs, states and tribes do much of the planning to reduce air pollutants to allowable levels. One of the major initiatives Congress added to the Clean Air Act in 1990 is the operating permit program for larger industrial and commercial sources that release pollutants into the air. States and tribes use a permit system as part of their plan to make sure pollution sources meet their goals to clean up the air.

The values that classify an area as marginal, moderate, serious, severe, and extreme for nonattainment are known as design values and will be proposed by the EPA and finalized as part of the implementation rulemaking. If the Twin Cities area was to go into nonattainment under the new proposal, it would likely be in the marginal classification. For moderate and marginal nonattainment areas, if a facility emits 100 tons per year or more of either NOx or VOCs than it is considered a major source. According to the Minnesota Pollution Control Agency's 2014 emissions inventory for permitted facilities in Minneapolis, there are no facilities that emit more than 100 tons of VOCs. There are three facilities that emit more than 100 tons of NOx. The University of Minnesota emits 169.3 tons/year, NRG Energy Center Minneapolis LLC emits 255.5 tons/year, and Covanta Hennepin Energy Resource Company LP emits 529.5 tons/year.

If the Twin Cities area went into nonattainment, new large facilities as well as existing large facilities that make major modifications would be subject to nonattainment new source review (NNSR). NNSR requires emission offsets and the installation of equipment that achieves the lowest achievable emission rate (LAER). Small businesses that were not previously regulated may be subject to new rules, such as auto body shops. Regulatory agencies will need more resources to enforce new standards. There will be additional costs to businesses in Minneapolis that fall under regulatory requirements as well as "red tape" for expanding business in Minneapolis. The Minnesota Chamber of Commerce conducted a study of Milwaukee in 1998, when the city had been designated as a non-attainment area. The study found that the cost of that designation was $189 million to $266 million dollars per year (in 1998 dollars), according to Mike Robertson, an environmental policy consultant for the chamber and co-chair of Clean Air Minnesota.

What is the Minneapolis Health Department doing to reduce ground-level ozone?

As a member of the Clean Air Minnesota partnership, the City of Minneapolis is displaying leadership in reducing ground-level ozone by implementing initiatives aimed at controlling the primary pollutants involved in the formation of ozone, with a focus on VOCs. Minneapolis has one of the cleanest public fleets in the nation, provides regional leadership in support of multimodal transportation options and has multiple programs to improve the urban forest. Energy efficiency and renewable energy efforts through its Clean Energy Partnership and as part of the City's Climate Action Plan also benefit air quality. The Minneapolis Health Department's Air Quality in Minneapolis: A Neighborhood Approach study is focused on determining 'hot-spots' of VOC emissions at a finer scale that is often missed at the MPCA monitoring sites for criteria pollutants. Through the department's Green Business Matching Grant program this information is used to focus VOC reduction efforts. After identifying pollution sources, Health Department staff work in partnership with local businesses to reduce or eliminate these sources. By the end of this year, the Green Business Matching Grant Program will have reduced 30,000lbs of emissions annually in Minneapolis. Sources such as auto shops and dry cleaners may individually emit less than 10 tons per year, but collectively emit many tons of pollution. The department is successfully working with both large and small sources in the city to reduce pollution.

6/15/15

Information for this document was taken from EPA's website as well as personal communications with MPCA staff.