City of Philadelphia
Department of Public Health
Air Management Services

Philadelphia's Air Quality Report 2023

Executive Summary[1]

This report focuses on the air quality of the City of Philadelphia, as presented by the Philadelphia Department of Public Health, Air Management Services, the local air pollution control agency for the City of Philadelphia. As an urban area, Philadelphia faces many of the same pollution challenges as other densely populated areas, such as emissions from vehicles and industries. The information contained in this report reviews Philadelphia's air quality for the calendar year 2023 and reports how the City's air compared with the National Ambient Air Quality Standards (NAAQS). This report covers the following criteria pollutants: **ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, particulate matter,** and **lead**. It also provides an overview of **hazardous air pollutants (HAPs),** also referred to as **air toxics**.

In general, long-term trends show many air pollutants in Philadelphia to be decreasing. In 2023, Philadelphia attained the NAAQS for all pollutants, except for ozone. In Summer 2023, smoke from large-scale wildfires significantly impacted air quality in Philadelphia Region and other parts of the US, and increased the number of bad air quality days for particulate matter and ozone. Under the EPA Exceptional Events Rule, state and local air agencies may propose to exclude the wildfire-impacted air quality data from being used in determination of NAAQS attainment. These proposals are subject to EPA approval. If these data were excluded, Philadelphia would have experienced 98 Good days, 260 Moderate days, and 7 Unhealthy for Sensitive Groups days (Code Orange, 5 from $PM_{2.5}$ and 2 from ozone) in 2023. Without excluding data impacted by the wildfires, in 2023 Philadelphia experienced a total of 83 Good days by AQI values, 268 Moderate days, 9 Unhealthy for Sensitive Groups (Code Orange) days, 3 Unhealthy days, 1 Very Unhealthy day, and 1 Hazardous day.

In 2023, AMS continued the Philadelphia Air Quality Survey. This project has 48 street level, neighborhood-oriented air sampling sites throughout the City to sample the ambient air for $PM_{2.5}$, $PM_{2.5}$ speciation, NO_2, SO_2, and O_3.

For further information, please visit the Air Management Services website at: https://www.phila.gov/departments/department-of-public-health/about-us/contact-us/ or contact us at: 215-685-7580.

Cherelle Parker, Mayor
Frank A. Franklin, Ph.D., J.D., M.P.H., Interim Health Commissioner

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[1] Cover photo by Leo Serrat on Unsplash

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Introduction

The Philadelphia Department of Public Health, Air Management Services (AMS) is responsible for the prevention, abatement, and control of air pollution and air pollution nuisances; achieving and maintain the National Ambient Air Quality Standards (NAAQS) in Philadelphia; and protecting the health and quality of life of the Philadelphia community from the adverse effects of air contaminants and noise.

AMS implements the environmental protection mandates contained in city, state, and federal regulations; reviews construction and operating permits for compliance with air regulations, standards, and guidelines; develops emission inventories for large stationary sources; operates and maintains a citywide air sampling network to continuously monitor Philadelphia's air; routinely inspects pollution sources; services citywide complaints of air pollution, asbestos, and noise; issues violations; conducts enforcement actions; and advances voluntary emissions reductions.

Air Monitoring Network

The City of Philadelphia is served by a network of ten air monitoring sites located throughout the City that measure the criteria pollutants: ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter (PM_{10} and $PM_{2.5}$), and lead (Pb). Four of the sites also measure air toxics, such as formaldehyde, benzene, and carbon tetrachloride. Many of the measurements are made in "real time", meaning that the measurements show pollution levels as they occur, instead of after the fact. The map on Page 6 shows the location of air monitors and the pollutants measured at each monitoring location. AMS measures air quality for several reasons:
- To ensure that long-term goals and targets to reduce levels of air pollution are being met.
- To provide information to the public as to how good or bad the air quality is in Philadelphia.
- To ensure attainment with standards set forth by the United States Environmental Protection Agency (EPA).

An air monitoring network plan (AMNP) has been made available to the public annually starting in the year 2007. The most recent AMNP is located on the AMS reports and documents website:
https://www.phila.gov/documents/air-management-reports-and-documents/.

This monitoring network is designed and established following requirements and protocols set forth by EPA, specified in Title 40 Part 58 of the Code of Federal Regulations.

Figure 1.1 – 2023 Philadelphia Air Monitoring Network
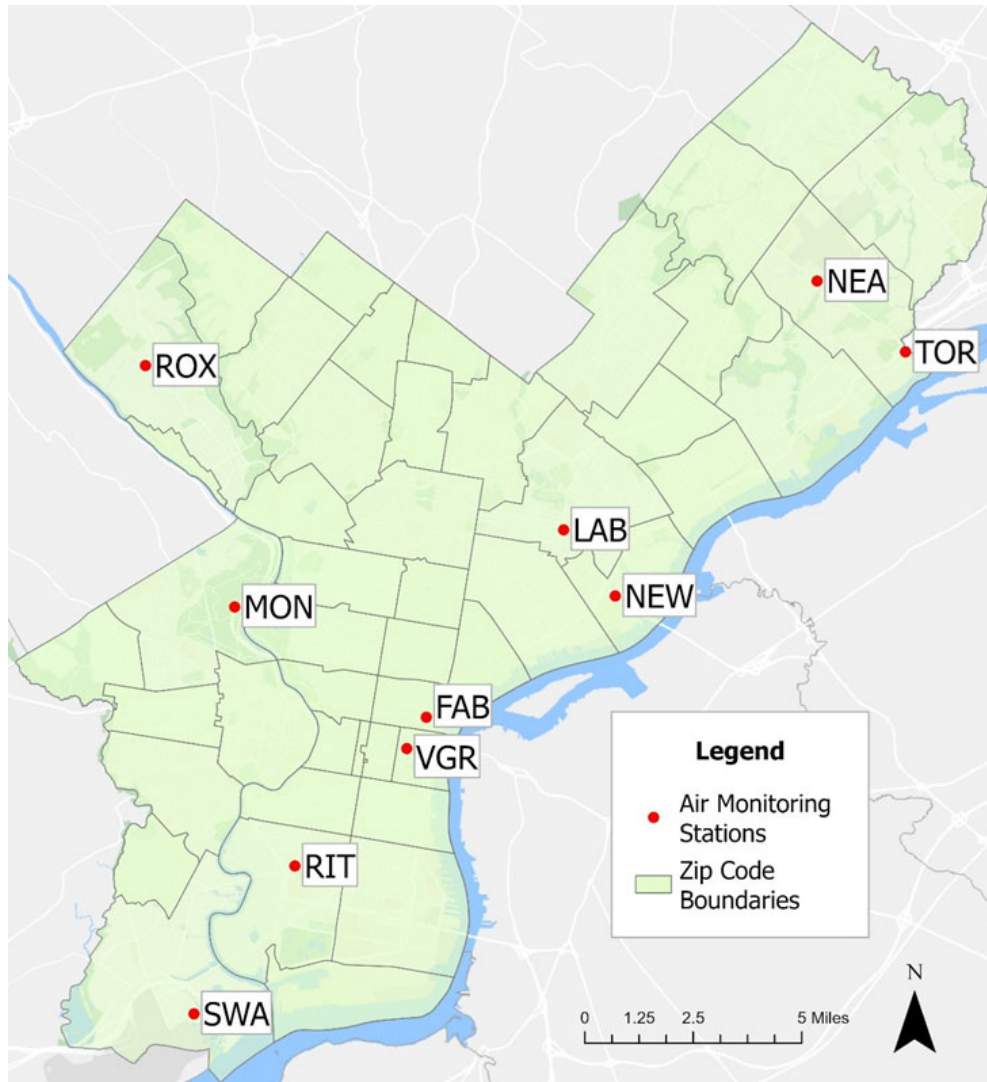
AQS Site Code	AMS Site	Address	CO	SO₂	Ozone	NO₂	NOy/NO	PM₁₀	PM₂.₅	Speciated PM₂.₅	PM Coarse	Black Carbon / Ultrafine PM	Carbonyls	PAMS VOC	TSP Metals (Be, Cr, Mn, Ni, As, Cd, Pb)	Toxics TO15	MET	AMS Site
421010004	LAB	1501 E. Lycoming St			X				X									LAB
421010014	ROX	Eva & Dearnley Sts											X			X		ROX
421010024	NEA	Grant Ave & Ashton Rd			X													NEA
421010048	NEW	2861 Lewis St	X	X	X	X	X	X	X	X	X		X	X		X	X	NEW
421010055	RIT	24th & Ritner Sts		X					X	X			X		X	X		RIT
421010057	FAB	3rd & Spring Garden Sts							X									FAB
421010063	SWA	8200 Enterprise Ave											X			X		SWA
421010075	TOR	4901 Grant Ave & James St	X			X			X								X	TOR
421010076	MON	I-76 & Montgomery Drive	X			X			X			X			X		X	MON
(not in AQS)	VGR	6th & Arch Sts		X					X								X	VGR

Table 1 – Site Summary Table

AMS Site	Address	Statement of Purpose
LAB	1501 E. Lycoming St	Built in 1964, this monitor assesses the City's impact on ozone precursors and is a designated Photochemical Assessment Monitoring Station (PAMS) site. New monitoring methods are often evaluated on this site.
ROX	Eva St & Dearnley St	As a periphery site, this site is used for measuring Air Toxics and Carbonyls.
NEA	Grant Ave & Ashton Rd	As a periphery site, this site is best for measuring ozone in the City, because as a secondary pollutant, ozone requires some time to form (longer time periods allow precursor emissions to distribute more uniformly across a region, and thus allow ozone concentrations to develop more uniformly across subregions and even large-scale regions). There are fewer "hot spots" as ozone is not directly emitted from combustion activities as other pollutants are.
NEW	2861 Lewis St	This site was one of the few sites that was originally established to measure the impact of specific industrial facilities which are now closed. Today, the monitors conduct continuous particulate monitoring and provide information about the nearby wastewater treatment plant. As of October 2, 2013, the NCore site has been moved to this site from Baxter water treatment plant (BAX).
RIT	24th St & Ritner St	This site was selected to help assess the impact of the petroleum refinery on the local community. The area was identified by air quality modeling.
FAB	3rd St & Spring Garden St	This site was established to monitor high levels of fine particulates in the City based on EPA Region III's air quality modeling of air toxics in Philadelphia. It shows high levels of fine particulate created by vehicle traffic.
SWA	8200 Enterprise Ave	This site was established to measure air toxics, carbonyls, and metals. Fine particulates may also be monitored. EPA Region III modeling analysis has shown that areas near the airport have high levels of aldehydes, a type of carbonyl.
TOR	4901 Grant Ave & James St.	This site was established as the 1st near-road NO_2 monitor in the Philadelphia-Camden-Wilmington, PA-NJ-DE-MD Metropolitan Statistical Area.
MON	I-76 & Montgomery Drive	This site was established as the 2nd near-road monitor in the Philadelphia-Camden-Wilmington, PA-NJ-DE-MD Metropolitan Statistical Area.
VGR	6th St & Arch St	EPA's Village Green Air Monitoring Station. Utilizes solar and wind turbine power as energy sources. Sited to increase community awareness of environmental conditions.

Quality Assurance

The Air Management Services Laboratory's main responsibility is to provide accurate data on the quality of the City's air, as it can lead to various health concerns. Pollutants in the atmosphere are measured to answer several questions such as:

- Are the National Ambient Air Quality Standards being met in Philadelphia?
- How close or how far away is the city from achieving the projected goals for these standards?
- Which pollutants are getting worse (increasing in concentration) or improving (decreasing in concentration)?

Many of the measurements require detecting very small amounts of a pollutant, often expressed as parts per million (ppm) or parts per billion (ppb). To illustrate this: imagine a million yellow balls, all the same size, with several red balls in the middle of them; the challenge is to find those red balls and then be able to count them. The instruments used to measure air pollutants need to be reliable in identifying the pollutant and accurate in making the measurement every time. The primary way to check if the instruments are giving accurate measurements is to send a sample of air which has a known amount (concentration) of a pollutant and compare the instrument's concentration measurement to known correct concentration. Adjustments (calibration) can then be made to an instrument to give a better measurement. If the equipment is off by a significant margin, the instrument needs to be repaired or replaced. The EPA and the AMS Laboratory have standard operating procedures on how accurate and reliable measurements need to be to answer the questions being asked. The instruments that are currently used are much more reliable than those available many years ago. Steps to assure good data quality include:

- Automated calibration,
- Manual calibration conducted by chemists,
- Review of the data by an experienced QA engineer or scientist.

The system is geared towards public safety; for example, a few measurements can be enough to identify a problem in meeting the NAAQS, but many good measurements over a period of time (often three years) as well as additional types of analysis are needed to "demonstrate compliance" with the corresponding pollutant's standard on the NAAQS.

The EPA's regulations on establishing an air monitoring network are found in Title 40 – Protection of Environment in the Code of Federal Regulations Part 58 – Ambient Air Quality Surveillance[2]. A comprehensive technical systems audit (TSA) by EPA occurs at least once every three years to evaluate an ambient air quality monitoring program. AMS' last TSA occurred September 2021 and was expected again in 2023. The TSA included on-site interviews with program personnel, evaluations of ambient air monitoring sites and

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[2] https://www.ecfr.gov/cgi-bin/text-idx?SID=af0f262c08e4f8aad56a91c70e0ce294&mc=true&tpl=/ecfrbrowse/Title40/40cfr58_main_02.tpl

laboratories operated by the agency, and a review of quality assurance and data processing procedures. AMS follows EPA's guidance in the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II[3], dedicated to the Ambient Air Quality Surveillance Program and the data collection activities inherent to that program. Additionally, workshops are provided annually to staff as an opportunity to interact with and learn from nearby state and local monitoring agency program representatives as well as expert speakers. Participants share experiences meeting challenges with new air quality monitoring technology, updated data analysis and quality assurance methods, and revised regulatory requirements. AMS staff regularly attend trainings and workshops held by the Mid-Atlantic Regional Air Management Association (MARAMA), which can be found on the MARAMA website[4].

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[3] https://www3.epa.gov/ttn/amtic/files/ambient/pm25/qa/Final%20Handbook%20Document%201_17.pdf
[4] https://marama.org/events/

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Air Quality Index

The Air Quality Index (AQI) is a color-coding system for air quality used by government agencies across the United States. Daily pollution levels for five pollutants (ground-level ozone, particulate matter, carbon monoxide, sulfur dioxide, and nitrogen dioxide) are converted into a score ranging from 1 to 500. A level of 101 generally corresponds to the National Ambient Air Quality Standard for each pollutant, and an "Action Day" occurs when the AQI for any pollutant exceeds 100. The color coded AQI is shown in Figure 2.1.

Figure 2.1 – Color Coded AQI

Unhealthy for Sensitive Groups – 101 to 150 ORANGE
Members of sensitive groups may experience health effects. The general public is less likely to be affected.

Moderate – 51 to 100 YELLOW
Air quality is acceptable. However, there may be a risk for some people, particularly those who are unusually sensitive to air pollution.

Good – 0 to 50 GREEN
Air quality is satisfactory, and air pollution poses little or no risk.

Air Quality Index

Unhealthy – 150 to 200 RED
Some members of the general public may experience health effects. Members of sensitive groups may experience more serious health effects.

Very Unhealthy – 201 to 300 PURPLE
Health alert: The risk of health effects is increased for everyone.

Hazardous – 300 and higher MAROON
Health warning of emergency conditions: everyone is more likely to be affected.

Action days are more likely to occur in the summer months but can happen any time of the year. On these days, the public is advised to take precautions to protect themselves and their families from health effects and do their part to reduce pollution. For example, on a Code Orange day, children, seniors, and those with respiratory ailments (sensitive groups) are advised to minimize prolonged outdoor exposure. On a Red or Purple day, all residents are advised to limit outdoor activity. Red and purple days are uncommon. The highest of the five pollutant scores is reported as the overall air quality rating for Philadelphia for a given day.

Action Days are reported through print, radio, television, online media, and by local and regional air agencies. Current air quality conditions in Philadelphia can be found on the website: https://www.phila.gov/services/mental-physical-health/environmental-health-hazards/air-quality/.

- **2023 Exceptional Events**

In Summer 2023, smokes from large-scale wildfires, mostly in Canada, significantly impacted air quality in Philadelphia Region and other parts of the US, and increased the number of bad air quality days for particulate matter and ozone. The impacted days can be identified by air monitoring data, wildfire and weather records, PA DEP's air quality modeling, and other evidence. Under the EPA Exceptional Events Rule (https://www.epa.gov/air-quality-analysis/treatment-air-quality-monitoring-data-influenced-exceptional-events), state and local air agencies may propose to exclude the wildfire-impacted air quality data from being used in determination of NAAQS attainment. These proposals are subject to EPA approval.

The daily AQI values for 2023, as shown in Figure 3.1[5], were retrieved from EPA database after the 2024 EPA update of $PM_{2.5}$ FEM data[6] but **before** exclusion of data impacted by exceptional events. Figure 3.1 also reflects the most recent changes in EPA AQI breakpoints (pollutant concentration cut-offs) that are consistent with the 2015 ozone standards and the 2024 $PM_{2.5}$ standards.

Without excluding data impacted by the wildfires, in 2023 Philadelphia experienced a total of 83 Good days by AQI values, 268 Moderate days, 9 Unhealthy for Sensitive Groups (Code Orange) days, 3 Unhealthy days, 1 Very Unhealthy day, and 1 Hazardous day.

Based on the EPA Exceptional Events Rule described above, PA DEP and AMS were considering to exclude air quality data for days significantly impacted by the 2023 wildfire smokes. This would remove ozone data on June 1, June 2, June 29 and June 30; $PM_{2.5}$ data on June 6, June 7, June 8, June 29, and June 30; and PM_{10} data on June 6, June 7, and June 8. If these data were excluded, Philadelphia would have experienced 98 Good days, 260 Moderate days, and 7 Unhealthy for Sensitive Groups days (Code Orange, 5 from $PM_{2.5}$ and 2 from ozone) in 2023. PA received a deferral for the proposed exceptional events for Ozone on June 1, 2, 29, and 30 with recent communication from EPA. EPA states that the Ozone non-attainment status for Pennsylvania is extended and removing effect of EE for ozone will not have any regulatory impact. Since the NAAQS standard for PM2.5 is lowered to 9 ug/m3, removing impact of EE may not have any regulatory significance since Philadelphia would be in non-attainment with out the considering the effect of EE.

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[5] https://www.epa.gov/outdoor-air-quality-data/air-data-tile-plot. Downloaded June 6, 2024.
[6] https://www.federalregister.gov/documents/2024/05/16/2024-10750/update-of-pm25-data-from-t640t640x-pm-mass-monitors#:~:text=DATES%3A,Regional%20office%20with%20any%20questions.

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Figure 3.1 – Daily AQI Values for 2023

Daily AQI Values in 2023
Philadelphia County, PA

(including Exceptional Events data)

gray outline indicates AirNow data source

Good (<= 50 AQI) 83 days
Moderate (51-100 AQI) 268 days
Unhealthy for Sensitive Groups (101-150 AQI) 9 days
Unhealthy (151-200 AQI) 3 days
Very Unhealthy (201-300 AQI) 1 days
Hazardous (>=301 AQI) 1 days
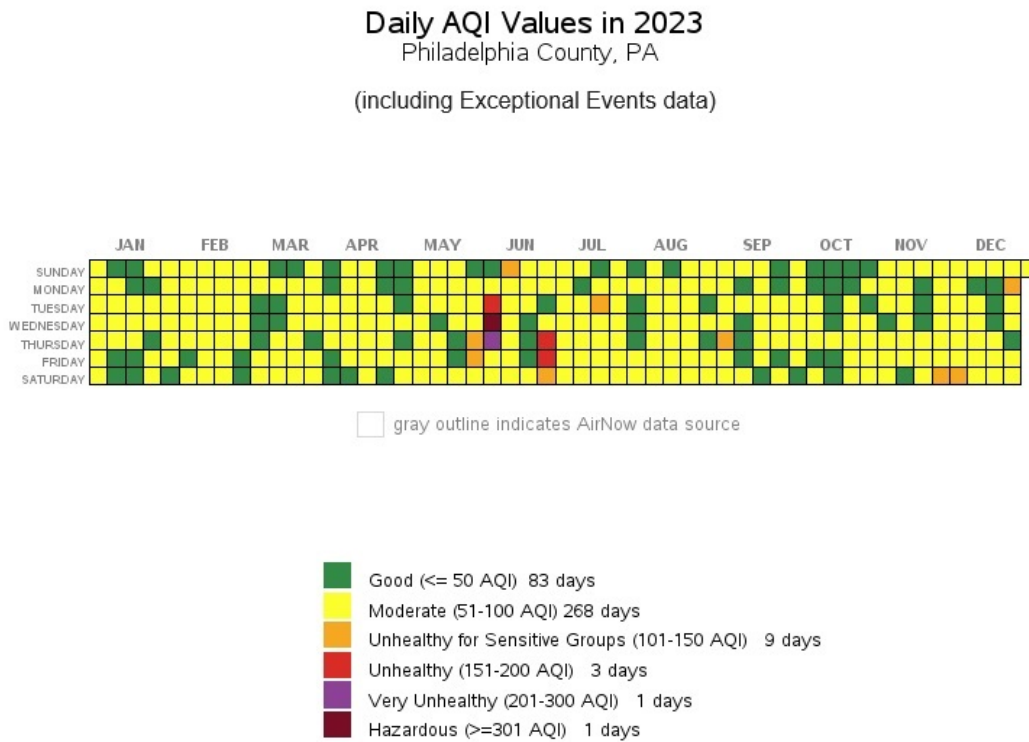
Source: U.S. EPA AirData <https://www.epa.gov/air-data>
Generated: June 6, 2024

Figure 3.2 shows an annual summary of the number of good, moderate, and unhealthy air quality days in Philadelphia based on monitoring conducted by AMS since 1993 [7]. Note that in this chart:

1) The 2023 AQI data reflects the tentative treatment of exceptional events data as described above. This is subject to EPA approval.
2) The AQI's reflect the recent EPA update of $PM_{2.5}$ FEM data (see Footnote 6).

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[7] https://www.epa.gov/outdoor-air-quality-data/air-quality-index-report. Downloaded June 11, 2024.

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3) All historic AQI values have been standardized with the current EPA AQI breakpoints and are consistent with the EPA 2015 ozone standards and the 2024 PM$_{2.5}$ standards.

Figure 3.2 – Philadelphia Annual AQI Summary
(Red color indicates Code Orange, Code Red and worse air quality days combined)

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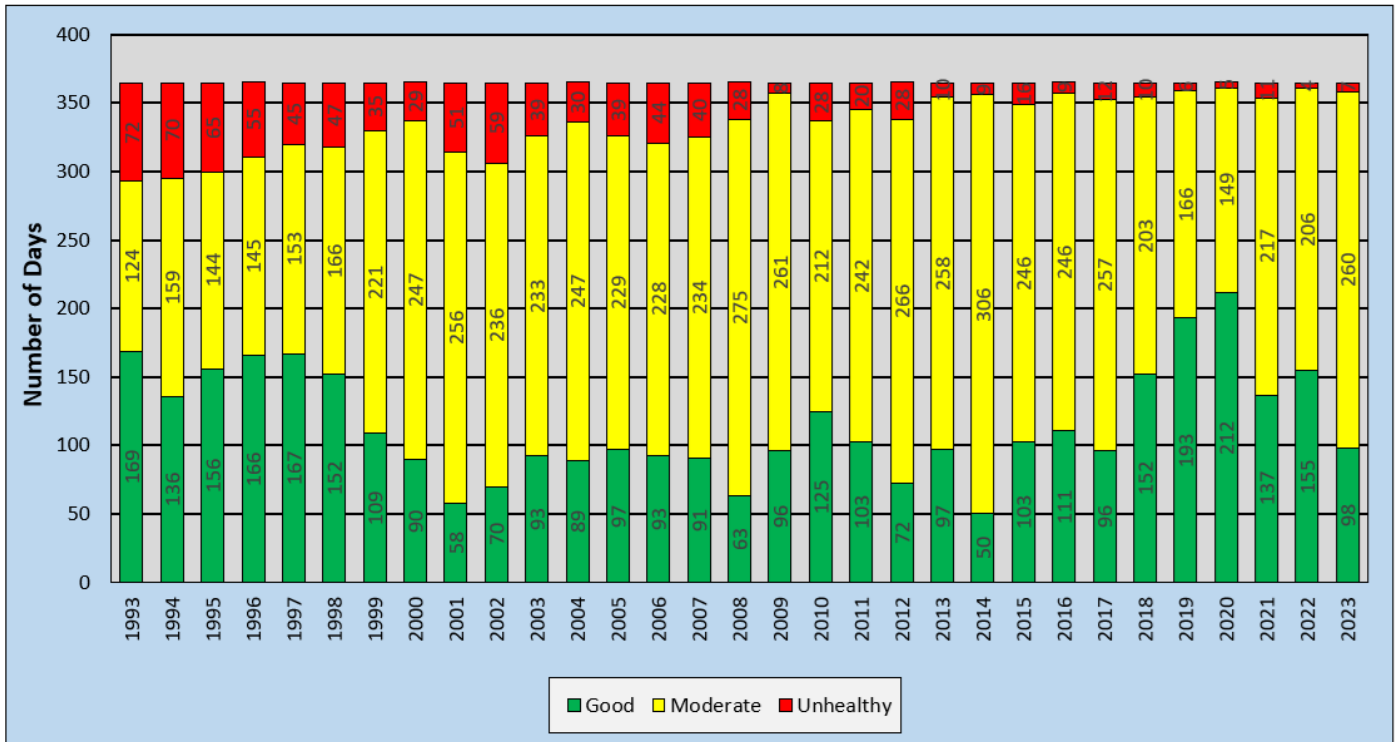
National Ambient Air Quality Standards

The Clean Air Act (CAA), which was last amended in 1990, requires EPA to set NAAQS for pollutants considered harmful to public health and the environment. The CAA identifies two types of national ambient air quality standards. Primary standards provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

The EPA has set NAAQS for six criteria air pollutants: carbon monoxide, sulfur dioxide, nitrogen dioxide, lead, particulate matter ("dust" or "soot"), and ozone. Periodically, the standards are reviewed and may be revised. The current standards are listed here: https://www.epa.gov/criteria-air-pollutants/naaqs-table. A history of the standard for each criteria pollutant is shown in Appendix C. Units of measure for the standards are parts per million (ppm) by volume, parts per billion (ppb) by volume, and micrograms per cubic meter of air ($\mu g/m^3$).

In 2023, Philadelphia was in attainment for all criteria pollutants, except for ozone. The recently promulgated EPA $PM_{2.5}$ standards[8] set the annual average concentration standard at 9.0 $\mu g/m^3$. EPA will issue new determinations of $PM_{2.5}$ attainment status by 2026 according to this standard.

The Pollutants AMS Measures

The following pages provide information on the health effects, sources, and trends of pollutants measured in Philadelphia. Included are the six pollutants, commonly called criteria pollutants, for which EPA has established NAAQS, as well as pollutants identified as being toxic or hazardous. Each of the criteria pollutants is graphed to show the historical trends compared with national standards. The graphs identify the range of values ("MIN / MAX RANGE") and with a solid black line for the mean of all recorded levels. It is important to note the mean, as it factors out extreme levels, and thereby provides a better indication of general air quality levels. In addition, Appendix B provides tables of historical data downloaded from EPA's Air Quality System data mart.

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[8] https://www.govinfo.gov/content/pkg/FR-2024-03-06/pdf/2024-02637.pdf

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Ozone (O₃)

NAAQS:
- The 3-year average of the annual fourth-highest daily maximum 8-hour average O_3 concentration is less than or equal to 0.070 ppm

Figure 4.1 – Ozone Monitoring Map
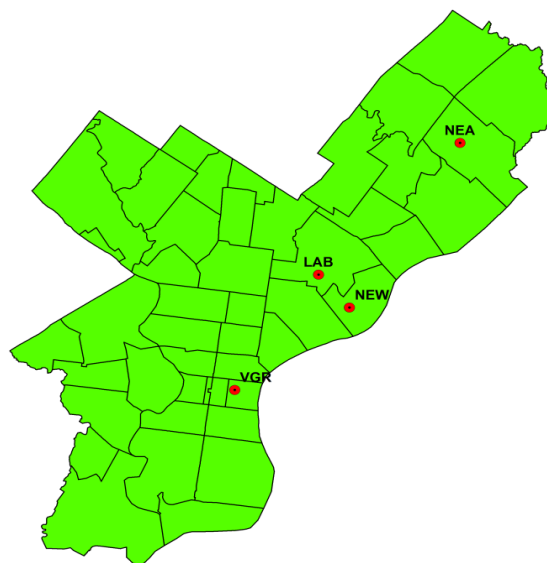
Ground level ozone (the primary constituent of smog) is the pollutant most often responsible for unhealthy air quality in the Philadelphia region. Ozone is not emitted into the atmosphere directly but is formed by chemical reactions between other pollutants. Specifically, Volatile Organic Compounds (VOCs) and Nitrogen Oxides (NO_x) react to create ozone in the presence of heat and sunlight. Ozone levels are consistently higher during the summer months.

VOCs are organic (i.e., carbon-containing) compounds that evaporate readily, such as gasoline vapors and paint fumes. NO_x stands for two compounds, nitric oxide (NO) and nitrogen dioxide (NO_2). Some VOCs are considerably more reactive in the atmosphere than others, and the reactivity of a VOC influences how quickly ozone forms. A compound that reacts in a few minutes to produce ozone will have a much greater impact near its source than one that reacts more slowly. Thus, ozone can form at various distances downwind of a VOC source due to the speed of these chemical reactions.

There are four categories of emission sources from human activity that produce VOC and NO_x:
- Point sources – Large utilities, industrial facilities, and other operations.

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- Nonpoint sources – Commercial, solvent use, waste disposal, and other smaller sources.
- Nonroad sources – Construction and agricultural equipment, recreational boats, lawnmowers, and other mobile sources.
- Onroad sources – Cars, trucks, buses, and motorcycles.

Figure 4.2 shows NO_x and VOC emissions from all source categories for Philadelphia County for 2020. The EPA's 2020 National Emission Inventory (NEI) is the most recent national air emissions inventory.

Figure 4.2 – 2020 NO_x and VOC Emissions from All Sources[9]

2020 NOx Emissions in Philadelphia (tons):

Total:	10,541		
Point	Nonpoint	Nonroad	Onroad
957.8	4,783.9	1,112.0	3,687.7
9.1%	45.4%	10.5%	35.0%

2020 VOC Emissions in Philadelphia (tons):

Total:	15,555		
Point	Nonpoint	Nonroad	Onroad
530.6	11,375.2	1,194.4	2,454.8
3.4%	73.1%	7.7%	15.8%

Over the years, emissions from point sources have been decreasing steadily, while nonpoint and onroad sources emit large percentages of NO_x and VOC in Philadelphia.

Emissions of VOC and NO_x may be carried by wind currents while reacting to produce high ozone levels hundreds of miles from their sources. In the eastern United States during the summer months, ground level ozone is frequently high over wide areas containing several states. This phenomenon is caused by ozone and its precursors traveling via wind currents across great distances.

In any discussion of ozone, it is important to distinguish between the effects of ozone at the ground and ozone high in the atmosphere. An advertisement might use the slogan "good up high, bad nearby," to describe ozone. Up high, in what's called the ozone layer (about 20 to 25 kilometers above sea level), ozone is essential to the health of nearly every living thing because it protects the Earth from harmful ultraviolet (UV) light. Near the ground, ozone reacts with buildings, plants, animals, and people, and is one of the most irritating, harmful components of smog.

[9] www.epa.gov/air-emissions-inventories/2020-nei-supporting-data-and-summaries. Downloaded July 21, 2023.

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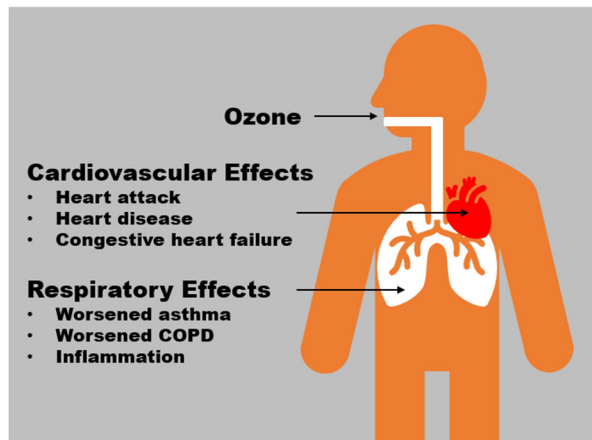
People who are very young, the elderly, or those who have chronic lung problems such as asthma are particularly sensitive to ground level ozone. EPA concluded that ozone pollution causes respiratory harm such as worsened asthma, worsened COPD, and inflammation; may cause reproductive and developmental harm as well as harm to the central nervous system; and likely to cause cardiovascular harm such as heart attacks, heart disease, and congestive heart failure.[10]

In 2023, as seen in Figure 4.1, there were four ozone monitoring sites: LAB, NEA, NEW, and VGR. The ozone monitor at VGR is used to demonstrate the capabilities of new real-time monitoring technology using solar power for residents and citizen scientists to learn about local air quality. The real-time data is available here: http://villagegreen.airnowtech.org/welcome?siteID=24292. Data from the VGR monitor is not used for comparison to the NAAQS or AQI.

As discussed in the "2023 Exceptional Events" section on Page 11, large-scale wildfires significantly increased the number of bad air quality days for particulate matter and ozone. Without excluding air quality data impacted by the wildfires, the 4th highest daily maximum 8-hour ozone in Philadelphia was 0.072 ppm at the Northeast Airport (NEA) site, with a corresponding design value of 0.071 for year 2023.

If the exceptional events data were to be excluded, the 4th highest daily maximum 8-hour ozone in Philadelphia would be 0.068 ppm in 2023, and the 2021-2023 three-year ozone design value would be 0.07 ppm. Figures 4.3 and 4.4 shows Ozone trends for all sites and Ozone design values at NEA including the effect of EE. The NEA monitoring site usually has the highest ozone design value in Philadelphia.

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[10] U.S. Environmental Protection Agency, Integrated Science Assessment for Ozone and Related Photochemical Oxidants, 2013. EPA/600/R-10/076F.

Figure 4.3 – Ozone Trends for the 4th Highest Daily Maximum 8-Hour Concentration for All Sites
(2023 Exceptional Events data tentatively excluded, pending EPA approval)
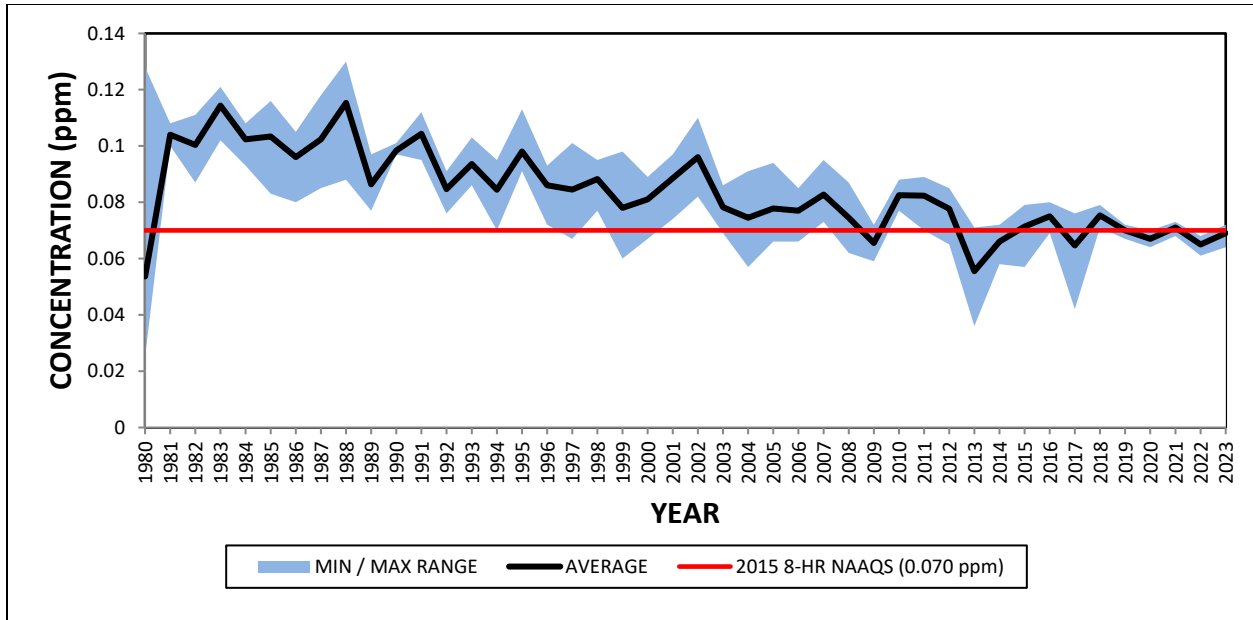
Figure 4.4 – Ozone Design Value at NEA Monitoring Site (AQS ID 421010024)

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Carbon Monoxide (CO)

Figure 5.1 – CO Monitoring Map
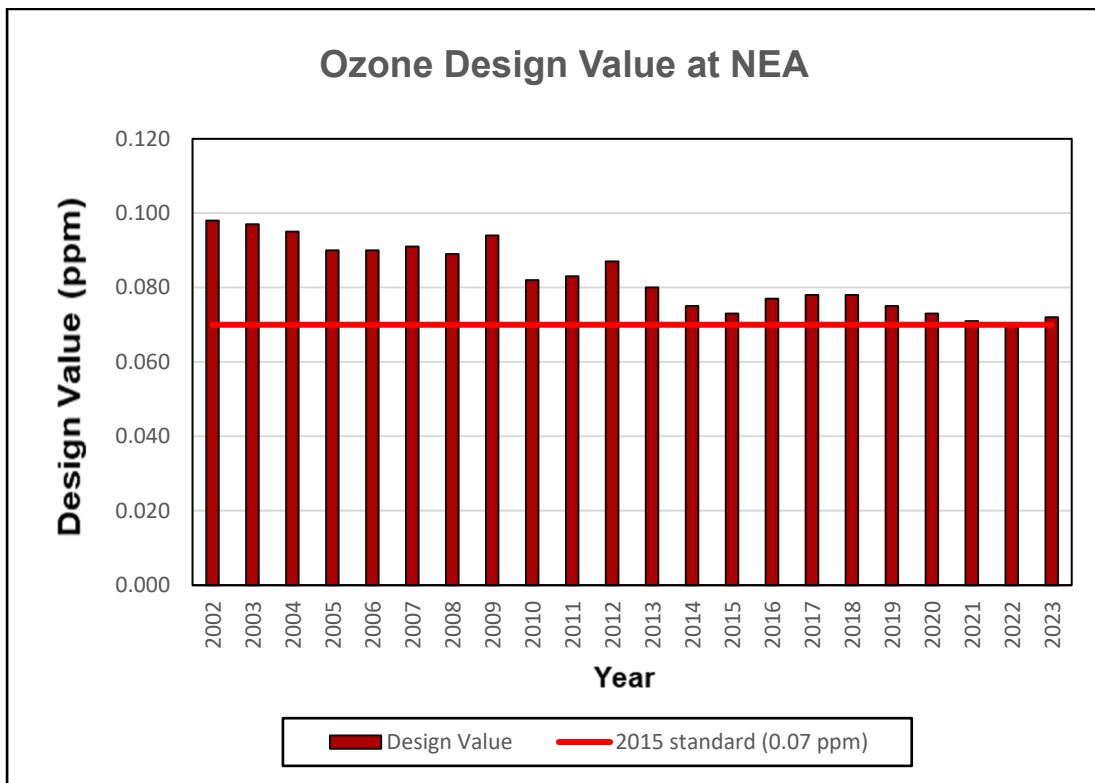
NAAQS:

- 9 parts per million for an 8-hour average concentration (2nd highest) not to be exceeded more than once per year.
- 35 parts per million for a 1-hour average concentration not to be exceeded more than once per year.
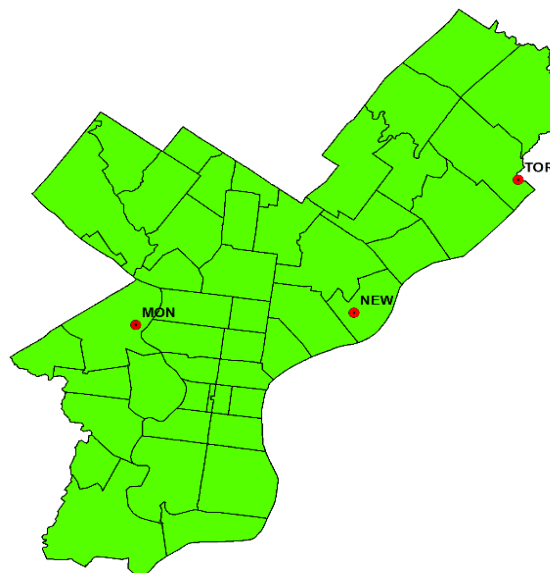
Carbon monoxide (CO) is colorless, odorless, and at high concentrations a poisonous gas. It is formed when the carbon in fuels is not burned completely. The major source of CO is motor vehicle emissions. Other sources of CO include residential, industrial, and natural processes. Weather greatly affects CO levels, and peak CO concentrations typically occur during the colder months of the year.

Carbon monoxide enters the bloodstream and reduces oxygen delivery to the body's organs and tissues. The health threat from carbon monoxide is most serious for those who suffer from cardiovascular disease. Exposure to elevated CO levels is associated with impairment of vision, reduced work capacity, reduced manual dexterity, poor learning ability, and difficulty in performing complex tasks. At very high levels, carbon monoxide can be fatal.

Over a forty-year period, there has been a continued reduction in carbon monoxide levels. This is mainly the result of federal requirements for cleaner automobiles and fuel and state inspection/maintenance programs.

Figures 5.2 and 5.3 on the following page show the trends for the CO 8-hour concentration and 1-hour concentration, respectively, in Philadelphia.

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Figure 5.2 – CO Trends for the 2ⁿᵈ Highest 8-Hour Average Concentration
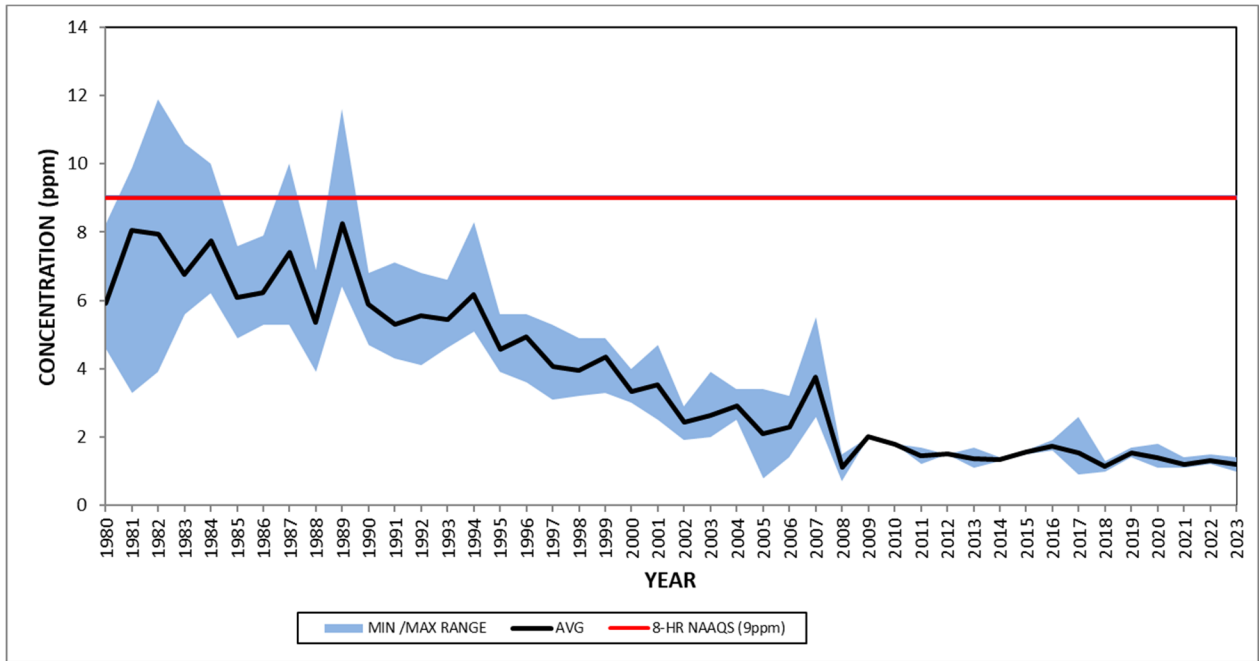
Figure 5.3 – CO Trends for the Highest 1-Hour Average Concentration

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Nitrogen Dioxide (NO$_2$)
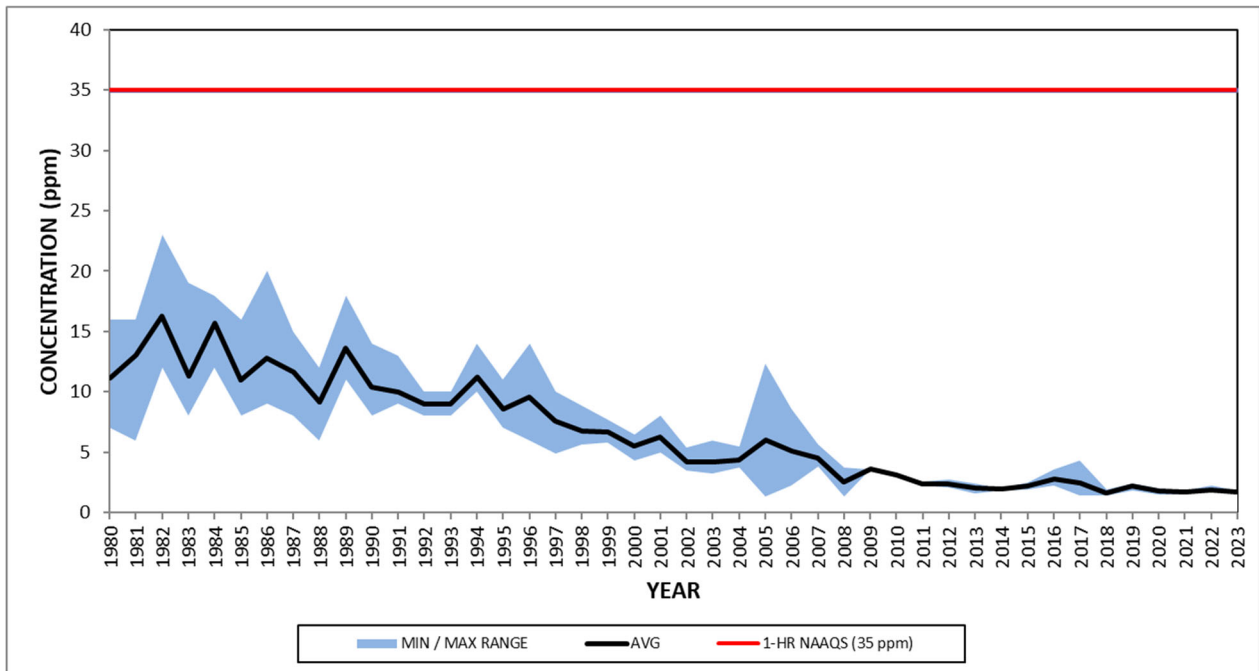
Figure 6.1 – NO$_2$ Monitoring Map

NAAQS:
- The annual average concentration is less than or equal to 53 ppb.
- The 3-year average of the annual 98th percentile of the daily maximum 1-hour average concentration is less than or equal to 100 ppb.
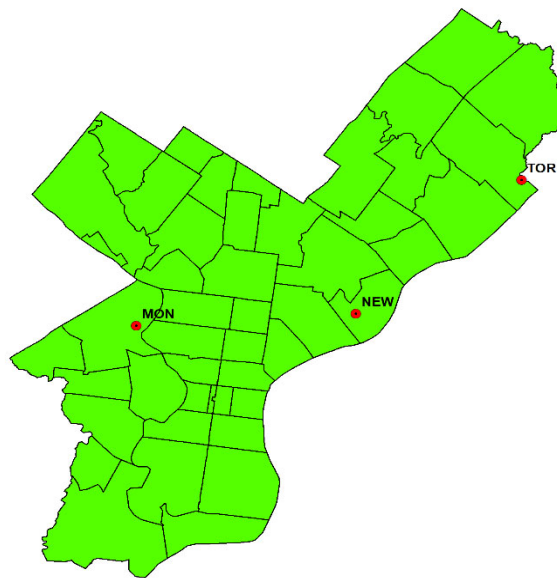
Nitrogen dioxide is a light brown gas that is an important component of urban haze. The compound is created primarily from fuel combustion in motor vehicles, utilities, and industrial sources.

Nitrogen dioxide can irritate the lungs and lower resistance to respiratory infections such as influenza. Nitrogen oxides (NO$_X$) are an important precursor to both ozone and acid rain and can affect both land and water ecosystems. They contribute to the formation of fine particulate matter, haze, and reductions in visibility.

Ambient levels of nitrogen dioxide in Philadelphia are significantly below the NAAQS, showing a sustained downward trend over time.

Figures 6.2 and 6.3 show the NO$_2$ trends for annual average and daily maximum of one-hour concentrations, respectively.

Figure 6.2 – NO₂ Trends for Annual Average Concentration
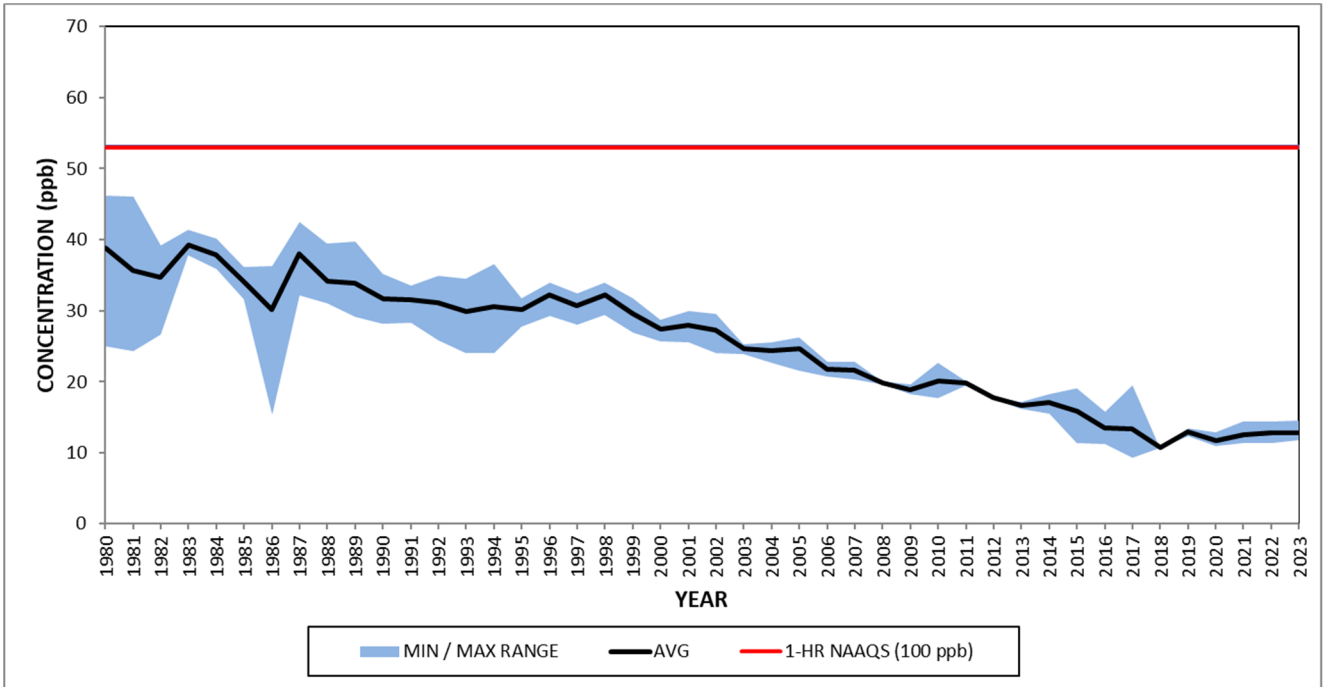
Figure 6.3 – NO₂ Trends for 98th Percentile Daily Maximum 1-Hour Concentration

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Sulfur Dioxide (SO$_2$)
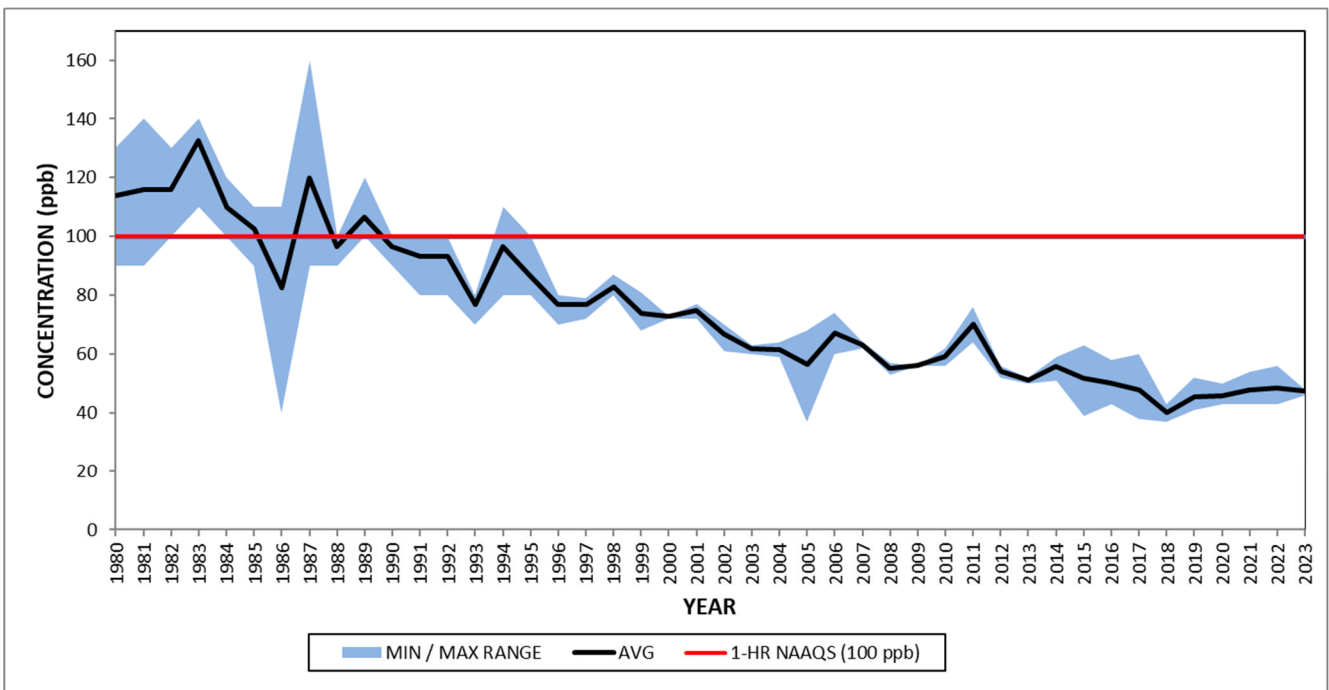
Figure 7.1 – SO$_2$ Monitoring Map

NAAQS:
- The 3-year average of the annual 99th percentile of the daily maximum 1-hour average concentrations is less than or equal to 75 ppb.
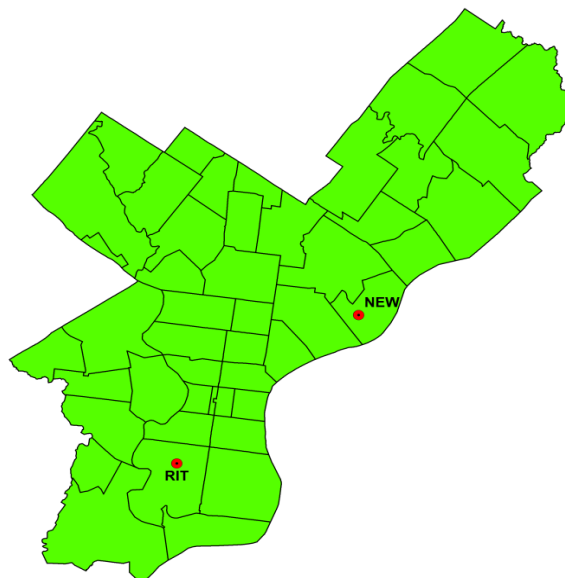
Sulfur dioxide is emitted from the burning of fuels that contain sulfur. Industrial grade fuel oils are the primary source in Philadelphia.

The major health concerns associated with exposure to high concentrations of SO$_2$ include effects on breathing, respiratory illness, alterations in the lungs' defenses, and aggravation of existing respiratory and cardiovascular disease. Together, SO$_2$ and NO$_X$ are the major ingredients of acid rain. SO$_2$ also plays a significant role in the formation of fine particulate matter.

SO$_2$ levels in Philadelphia are well within air quality standards and show a slow, continued improvement over time. This is mainly due to industry, businesses, and homes changing to fuels with lower sulfur content such as natural gas.

In 2023, the NEW and RIT sites were operating as the monitoring sites for SO$_2$ as seen in Figure 7.1.

The following graph, Figure 7.2, shows the trends for the one-hour SO$_2$ concentration for Philadelphia.

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Figure 7.2 – SO₂ Trends for 99ᵗʰ Percentile Daily Maximum 1-Hour Average Concentration
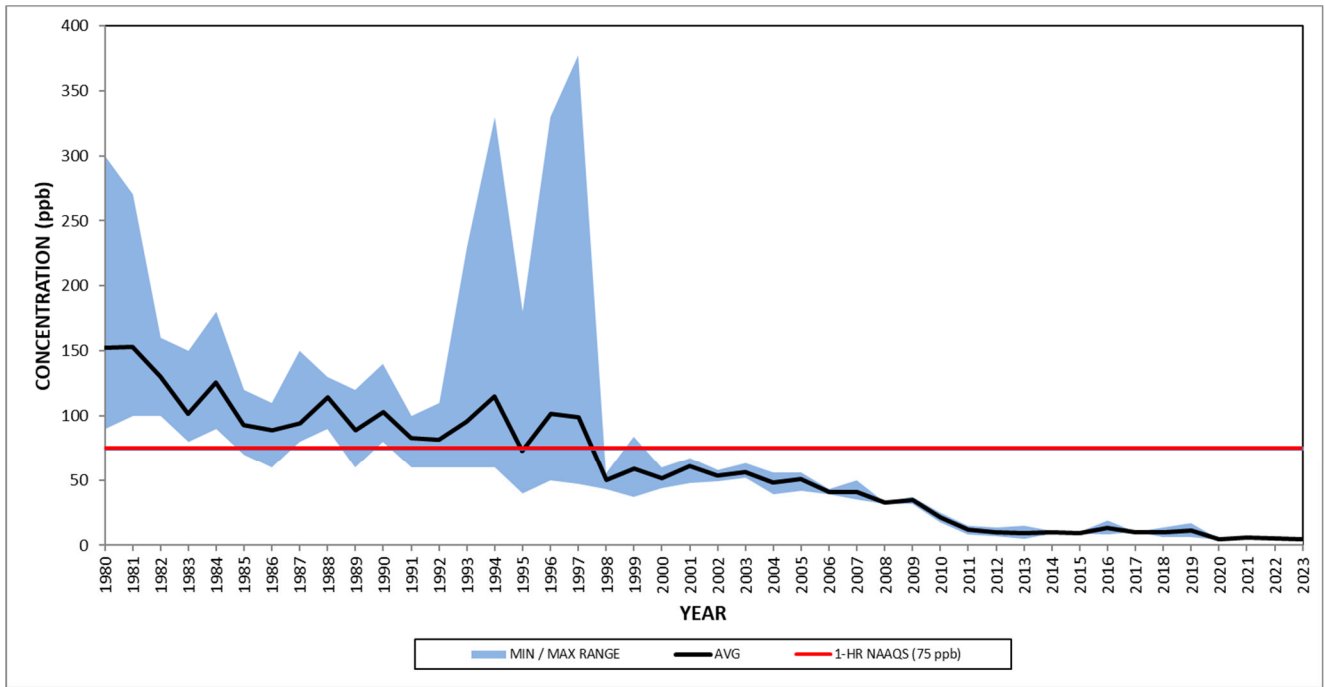
Lead (Pb)

NAAQS:
- The maximum arithmetic rolling 3-month mean concentration for a 3-year period is less than or equal to 0.15 µg/m3 micrograms per cubic meter.

The processing of metals is the major source of lead emissions to the atmosphere. Lead does not travel over great distances in the air and so concentrations vary, with the highest levels near specific industrial sites.

Lead is a metal that is highly toxic when inhaled or ingested. Lead accumulates in the blood, bone, and soft tissue and may affect the kidneys, liver, nervous system, and other organs. It also can cause learning difficulties in children.

Ambient lead levels have been decreasing throughout the city due to the elimination of leaded gasoline and greater control of emissions from companies that produce, or process lead compounds.

Prior to 1998, lead levels in certain parts of the city were once extremely high due to the concentration of industries in the areas near Castor and Delaware Avenues. The levels of lead in these areas have drastically improved and are now comparable to the rest of the city.

On October 15, 2008, the EPA strengthened its regulation for lead. The standard was revised from the 1978 standard of 1.5 µg/m^3 to a level that is 10 times more stringent, 0.15 µg/m^3, with a different averaging time. For the previous standard, the averaging time used a quarterly average while the new standard uses a rolling 3-month average. The revision is based on more than 6000 studies performed since 1990 on the health effects of high lead concentrations in the bloodstream. The studies show that adverse effects from lead in the blood occur at a much lower level than previously thought. Figure 8.1 shows the trends for the 2008 lead standard.

As of January 1, 2017, Total Suspended Particulate Lead monitor was shutdown at NEW site. Philadelphia has no sources that emit 0.5 or more tons of Pb per year.

On 4/28/2017, EPA approved Philadelphia AMS' waiver of the requirement for a source-oriented Lead-TSP monitor in Philadelphia effective 1/1/17.

Figure 8.1 – Lead Trends (Maximum) Rolling 3-Month Average

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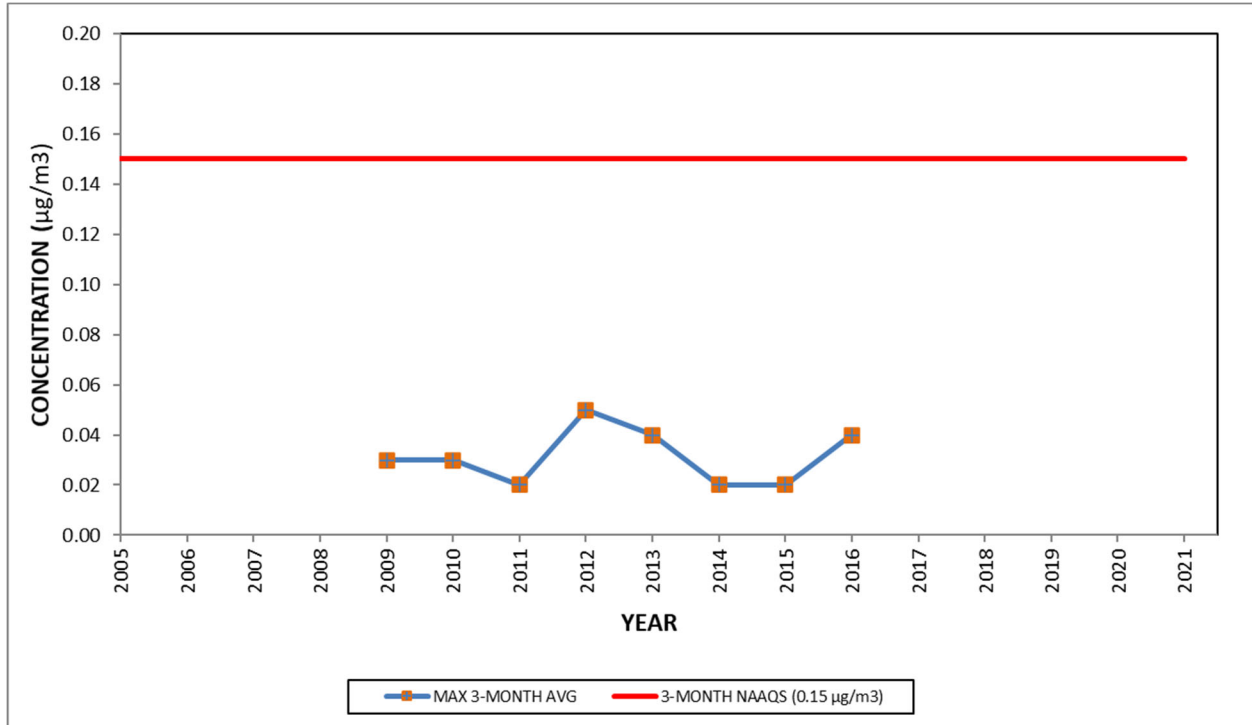
Particulate Matter (PM$_{10}$, PM$_{2.5}$)

Particulate matter is the general term used for a mixture of solid particles and liquid droplets found in the air. These particles come in a wide range of sizes and originate from stationary, mobile, and natural sources.

Figure 9.1 – Size Comparisons for PM Particles

PM$_{10}$ and PM$_{2.5}$ refer to small particulates that measure less than 10 micrometers (0.00001 meters) and 2.5 micrometers (0.0000025 meters) in diameter, respectively. In addition to health problems, particulate matter can cause reduced visibility, soiling, and damage to materials such as buildings. Particles of this size remain airborne for long periods of time and disperse in uniform concentrations across wide areas, crossing geographic boundaries [11].
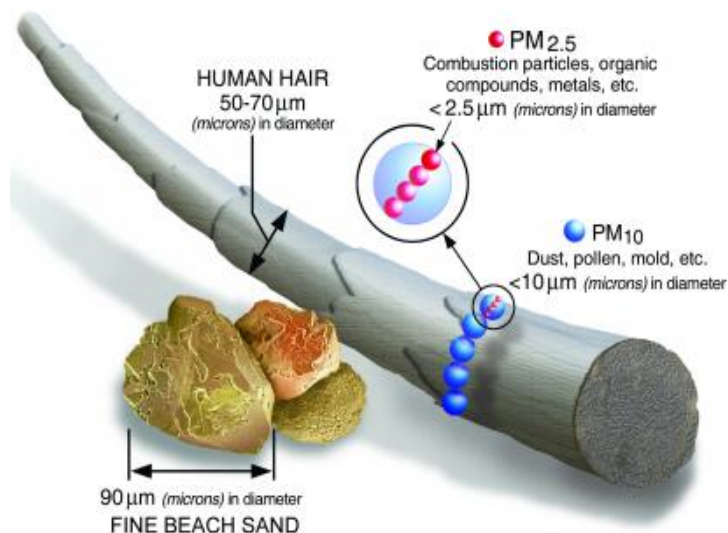
In 1997, the EPA set a separate standard for PM$_{2.5}$. Particles in the PM$_{2.5}$ size range can travel deeply into the respiratory tract, reaching the lungs. Exposure to fine particles can cause short-term health effects such as eye, nose, throat, and lung irritation, coughing, sneezing, runny nose, and shortness of breath. Exposure to fine particles can also affect lung function and worsen medical conditions such as asthma and heart disease. Scientific studies have linked increases in daily PM$_{2.5}$ exposure with increased respiratory and cardiovascular hospital admissions, emergency department visits and deaths. Recent studies suggest that long term exposure to particulate matter may be associated with increased rates of bronchitis and reduced lung function.

Particles come in a wide variety of shapes and sizes, which affect their impacts on human health and the environment. Bigger particles, such as dust, are easier to see and can cause problems, but smaller particles are likely to be worse for our health.

Fine particles are treated as though they are a single pollutant, but fine particles come from many different sources and are composed of many different compounds. Fortunately, these compounds fall into a few dominant categories: sulfates, nitrates, ammonium compounds, soil, organic carbon compounds, and elemental carbon. Water is nearly always an important and variable part of PM, and sea salt is often significant near the coast. Given the complex composition of PM, it is no surprise that its chemistry is also complex. Particles may be dry or wet. When the wind blows hard enough, soil, silt, and sand can be lifted from the surface. Human activities such as mining, construction, plowing, and driving on unpaved roads also lift particles into the air. Soot, also referred to

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[11] EPA: www.epa.gov/pm-pollution/particulate-matter-pm-basics#PM

as black carbon or elemental carbon, is emitted directly by diesel engines and forest fires, among other sources. Most individual particles are likely mixtures of different substances, the products of growing by collisions with other particles and by taking on gases.

PM$_{10}$

Figure 10.1 – PM$_{10}$ Monitoring Map

NAAQS:

- 150 µg/m3 for a daily 24-hour average concentration not to be exceeded more than once per year on average over a 3-year period.
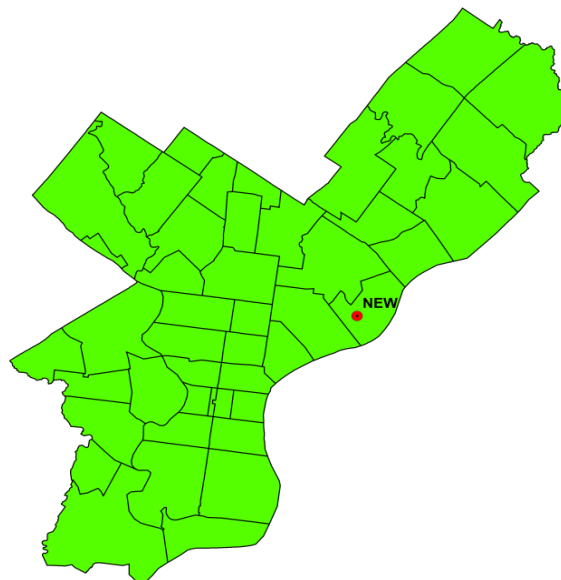
Particulate matter levels have been decreasing due to regulations limiting the amount of emissions allowed and the change to cleaner fuels, for example, switching from oil to natural gas by industry, businesses, and homes.

During the mid-1990s, particulate emissions from several sources around Castor and Delaware Avenues caused extremely high-localized measurements and the levels were many times higher than those measured at other city locations. Specific actions to abate these sources have resulted in air quality that now meets the national standards and are now comparable to levels in the rest of the city.

The EPA revoked the annual standard for PM$_{10}$ on December 17, 2006, due to a lack of evidence linking health problems to long-term exposure to coarse particle pollution.

Philadelphia currently has one PM$_{10}$ monitoring site, NEW. See Figure 10.1.

As discussed in the "2023 Exceptional Events" section on Page 11, large-scale wildfires significantly increased the number of bad air quality days for particulate matter and ozone. Without excluding air quality data impacted by the wildfires, the highest 24-hour average PM$_{10}$ concentration was 281 µg/m^3, which occurred on June 7, 2023.

If the exceptional events data were excluded (pending EPA approval), the highest 24-hour average PM$_{10}$ concentration would be 100 µg/m$^{3.}$ Figure 10.2 shows the trends for PM$_{10}$ for the maximum 24-hour average concentration in the city including the effect of the exceptional events.

Figure 10.2 – PM$_{10}$ Trends for the Highest 24-Hour Average Concentration for All Monitoring Sites
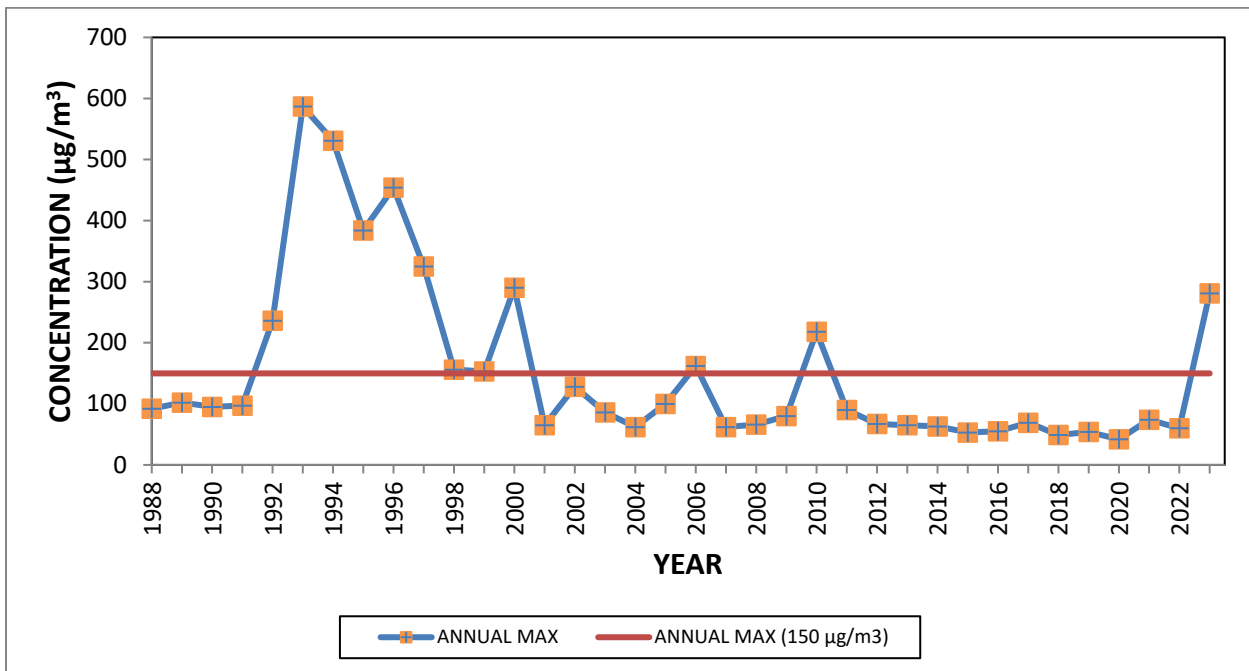
PM_{2.5}

NAAQS:

- The 3-year average of the annual arithmetic mean concentration is less than or equal to 12.0 µg/m3.
- The 3-year average of the 98th percentile 24-hour concentration is less than or equal to 35 µg/m3.

Figure 11.1 – PM_{2.5} Monitoring Map
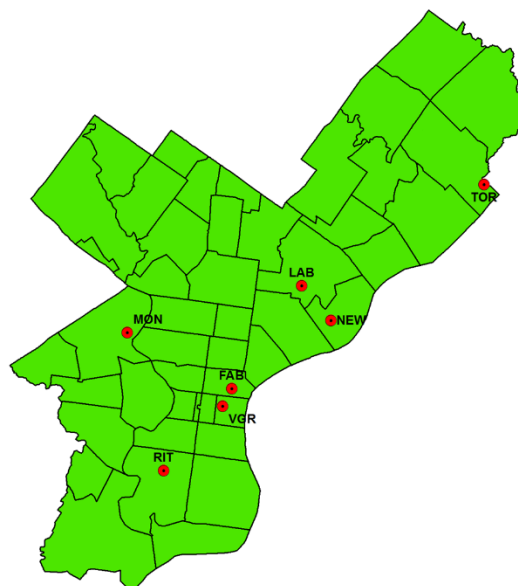
PM_{2.5} consists of those particles that are less than 2.5 micrometers in diameter. They are also referred to as "fine" particles. Fine particles result from fuel combustion from motor vehicles, power generation, and industrial facilities, as well as from residential fireplaces and wood stoves. A significant amount of fine particles are also formed in the atmosphere by the transformation of gaseous emissions such as SO_2, NO_X, VOCs, and ammonia.

Fine particles can accumulate in the respiratory system and are associated with numerous health effects such as premature death, respiratory symptoms and disease, and decreased lung function. Sensitive groups that appear to be at the greatest risk for such effects include children, seniors, and individuals with cardiopulmonary disease or respiratory ailments such as asthma.

In 2023, there were seven PM_{2.5} monitoring sites in the network. Data from the VGR site is not used for comparison with the NAAQS.

As discussed in the **2023 Exceptional Events** section on Page 11, large-scale wildfires significantly increased the number of bad air quality days for particulate matter and ozone. Without excluding air quality data impacted by the wildfires, the citywide highest 98th percentile average 24 hr PM_{2.5} concentration was 36.2 µg/m^3, and the citywide annual mean was 11.7 µg/m^3.

Figures 11.2 and 11.3 show the trends for the 24-hour concentration and the annual mean, respectively, with exceptional events data treatment.

Figure 11.2 – PM₂.₅ Trends for 98ᵗʰ Percentile 24-Hour Concentration (Data from EPA-Air Now Website)
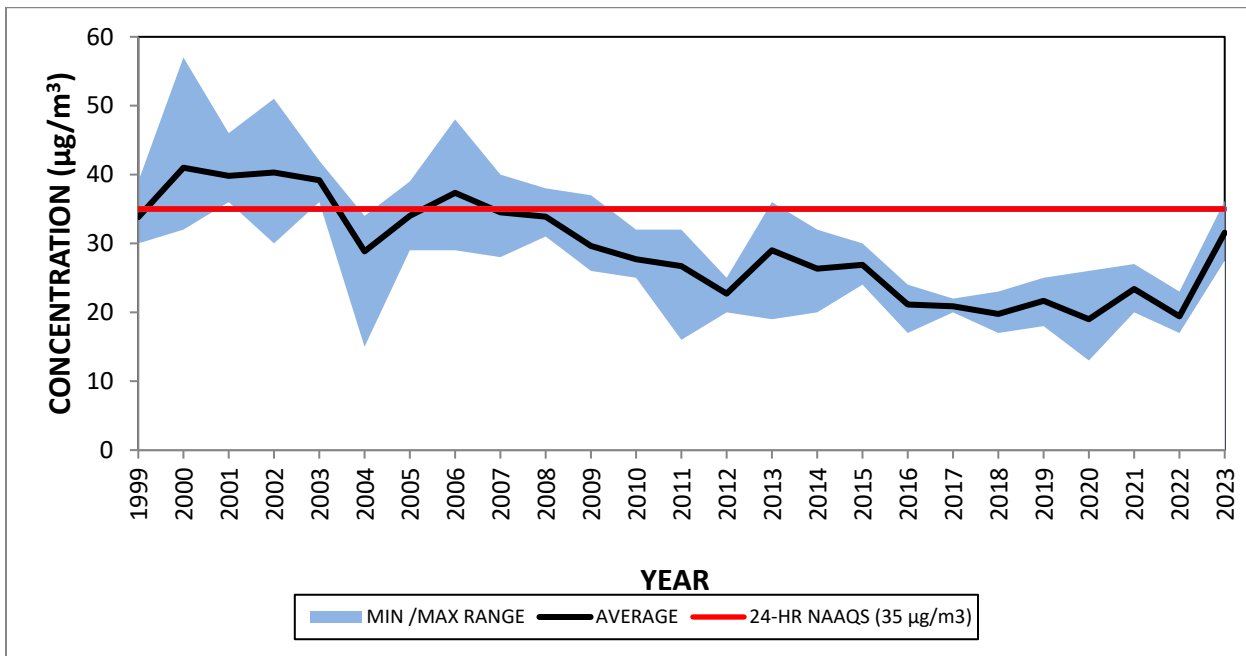
Figure 11.3 – PM₂.₅ Trends for Annual Mean Concentration
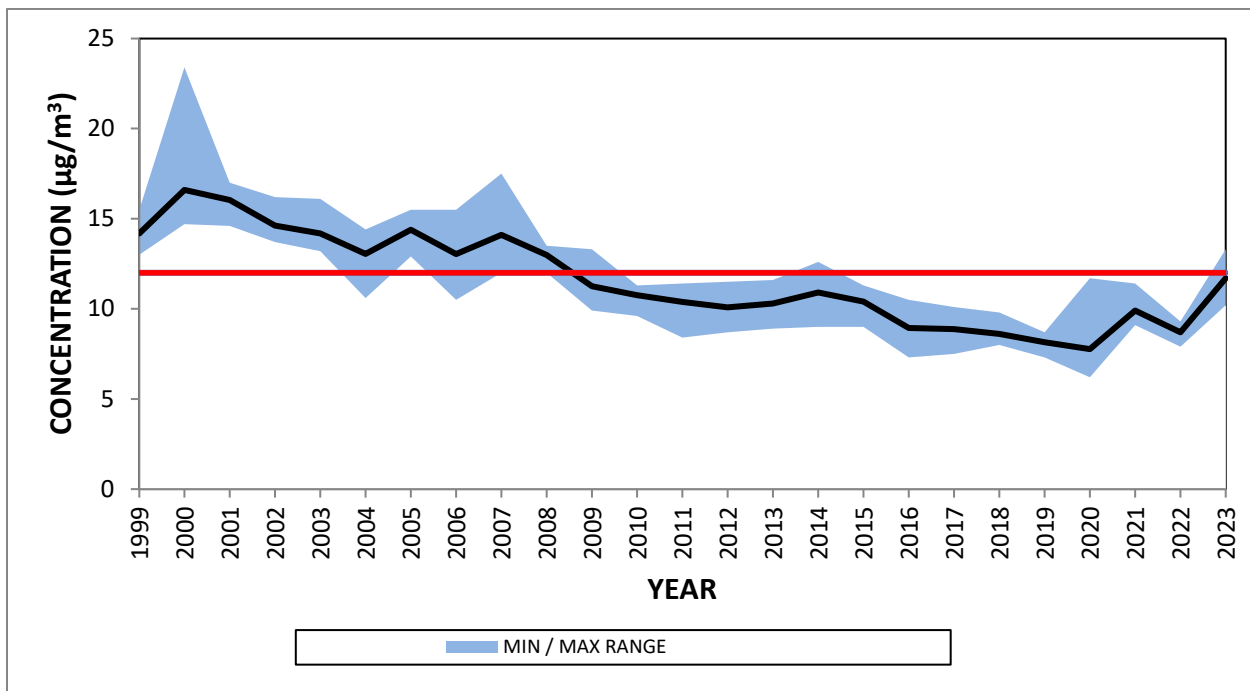
Air Toxics

Air toxics, also referred to as toxic air contaminants or hazardous air pollutants (HAPs), are substances that cause adverse health effects or environmental damage. The Federal Clean Air Act Amendments (CAAA) of 1990 list 188 pollutants or chemical groups as HAPs. Examples of air toxics include heavy metals (such as beryllium), organic chemicals (such as formaldehyde), polycyclic organic matter (POM, which are formed primarily by combustion), benzene (which is found in gasoline), pesticides, and asbestos. HAPs are emitted from stationary sources (large industrial facilities), nonpoint sources (dry cleaners, gas stations, and other small facilities), as well as mobile sources (cars, trucks and buses).

Figure 12.1 – Air Toxics Monitoring Map
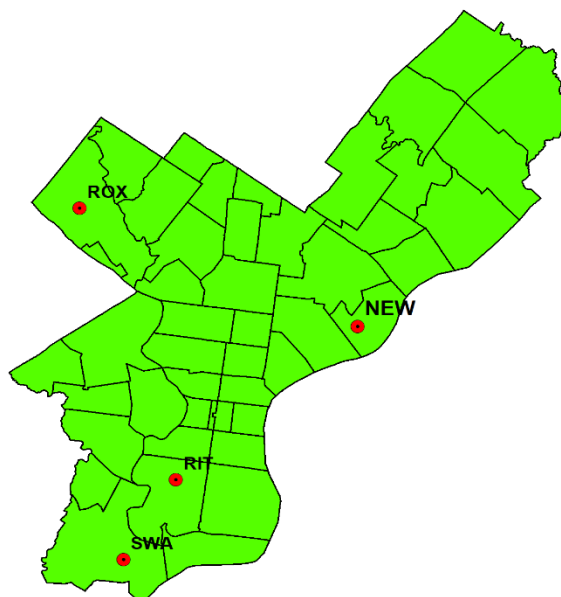
In 2023, AMS monitored air toxics at 4 locations as seen in Figure 12.1. AMS monitors approximately 61 VOCs, 7 carbonyl compounds, and 59 hydrocarbons. Three different sampling methods are employed to obtain their concentrations in ambient air. VOCs are collected in 6-liter stainless steel canisters every six days and analyzed via Gas Chromatography/Mass Spectrometry. The carbonyls are also collected every six days on a cartridge and analyzed using an Ultra High Performance Liquid Chromatograph. The hydrocarbons are collected and analyzed hourly every day via auto-Gas Chromatography.

There is less information known about the health impact from the 188 HAPs than there are for criteria pollutants, and no national ambient air quality standards exist for them. However, a number of these pollutants are known or suspected to be carcinogenic, and there is no known "safe concentration." The danger posed by toxics is often referred to in terms of risk. Risk is defined as the likelihood of a negative outcome from a certain level of a specific chemical, or the measure of a chance that health problems will occur. For example, many toxics cause cancer, while others cause respiratory problems, birth defects, neurological or immune response problems, and other health concerns. Toxics have varying degrees of danger, and some will cause harm with a very small amount of the substance while others require large amounts to have a negative effect. A cancer risk level of "one in a million" implies a likelihood that up to one person out of one million equally exposed people would contract cancer if exposed continuously (24 hours per day) to the specific concentration over 70 years (an assumed lifetime). This risk is calculated as additional (or incremental) to those cancer cases that would usually occur in an unexposed population of one million people.

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AMS is helping to reduce HAPs in Philadelphia by enforcing Federal, State, and locally mandated programs that limit emissions from stationary and area sources. Many toxic emissions have been reduced by regulations designed to bring Philadelphia into compliance with the NAAQS for Ozone. In addition, Philadelphia enforces the National Emission Standards for Hazardous Air Pollutants (NESHAPs), a program designed to reduce emissions from existing major and area sources, as well as New Source Performance Standards (NSPS), which limit toxic emissions from new sources. In 2010, Air Management Regulation XIV – Control of Emissions from Dry Cleaning Facilities was promulgated. This regulation restricted the use of perchloroethylene (PERC) in dry cleaning facilities that share a common wall with businesses or residences. Since 2010, ambient concentrations of PERC have been decreasing.

Air Management Regulation VI is Philadelphia's local regulation for control of emissions of various air toxics. This regulation was amended to further strengthen it in 2022. The AMR VI amendment was finalized in 2023 and implementation was to start on January 1, 2024.

In addition, AMS is currently working with other City departments to enforce Mayor's Executive Order 1-07 which requires all public works and demolition contracts to use clean diesel technology. This program is expected to significantly reduce particulate matter, hydrocarbons, and carbon monoxide from diesel vehicles contracted by the City, resulting in substantial annual health benefits.

The EPA's Air Toxics Screening Assessment (AirToxScreen) is a screening tool to provide communities with information about health risks from air toxics. AirToxScreen is EPA's ongoing comprehensive evaluation of air toxics in the U.S. The activities include expansion of air toxics monitoring, improving and periodically updating emission inventories, improving national- and local-scale modeling, continued research on health effects and exposures to both ambient and indoor air, and improvement of assessment tools. The latest version of the tool is the 2019 AirToxScreen. Air toxics were assessed for either lifetime cancer risk or non-cancer hazard due to inhalation at census tract level.

The goal of AirToxScreen is to identify air toxics which are of greatest potential concern, in terms of contribution to population risk. The results are used to establish strategies, priorities, and programs to reduce air toxics emissions.

The results of the 2019 AirToxScreen for Philadelphia County are summarized below:
- Total air toxics cancer risk was approximately 30 in one million population.
- By source category, secondary formation accounted for 45.8% of cancer risk and onroad mobile sources accounted for 11.3%. Point sources accounted for just 4% (see Figure 12.2).
- The pollutants contributing most to cancer risk were formaldehyde (52.5%), carbon tetrachloride (10.7%), and benzene (10.5%) (see Figure 12.3).

Figure 12.2 – Source Category Contribution to 2019 AirToxScreen Cancer Risk

Source Category	Percentage
Secondary Formation	45.8%
Nonroad Sources	15.2%
Onroad Sources	11.3%
Background	10.7%
Nonpoint Sources	7.4%
Biogenics	4.8%
Point Sources	4.0%
Fire	

Other 8.35%
Background Cancer Risk 8.73%
Nonpoint Cancer Risk 16.35%
Nonroad Cancer Risk 6.06%
Onroad Cancer Risk 9.44%
Secondary Cancer Risk 51.08%

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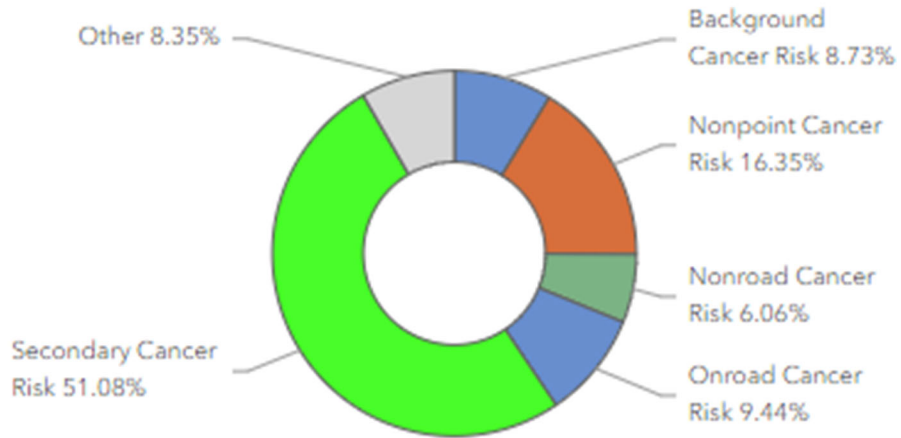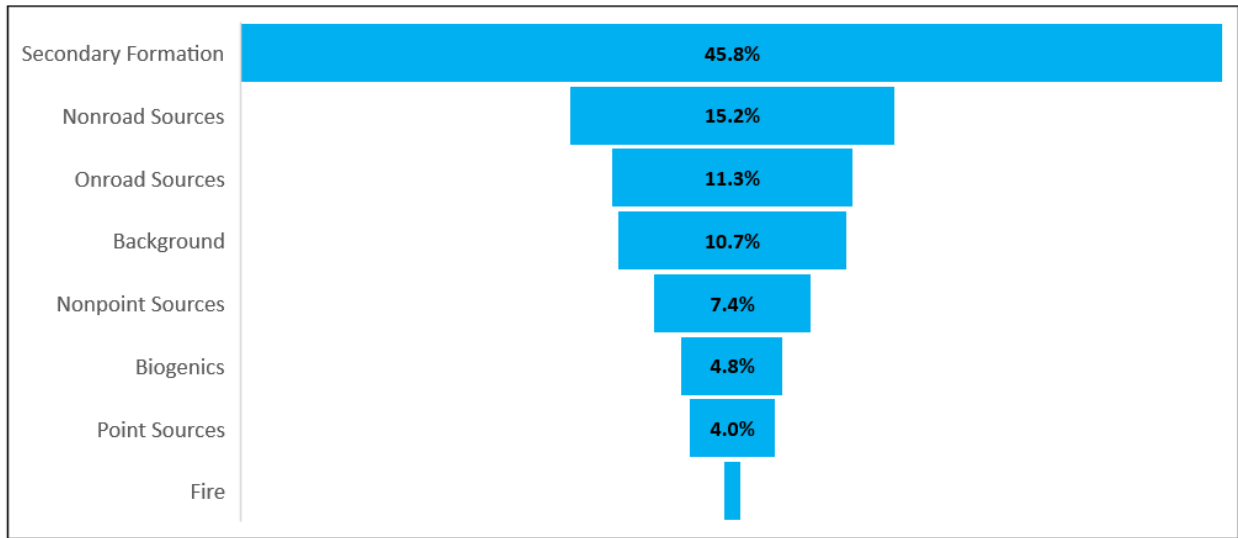
Figure 12.3 – HAP Contributions to 2019 AirToxScreen Cancer Risk

FORMALDEHYDE	52.5%
CARBON TETRACHLORIDE	10.7%
BENZENE	10.5%
NAPHTHALENE	7.1%
ACETALDEHYDE	6.0%
1,3-BUTADIENE	3.1%
ETHYLENE OXIDE	2.5%
Other HAPs	7.5%

Other 14.92%
Acetaldehyde Cancer Risk 5.71%
Benzene Cancer Risk 7.15%
Naphthalene Cancer Risk 5.74%
Carbon Tetrachloride Cancer Risk 8.74%
Formaldehyde Cancer Risk 57.75%
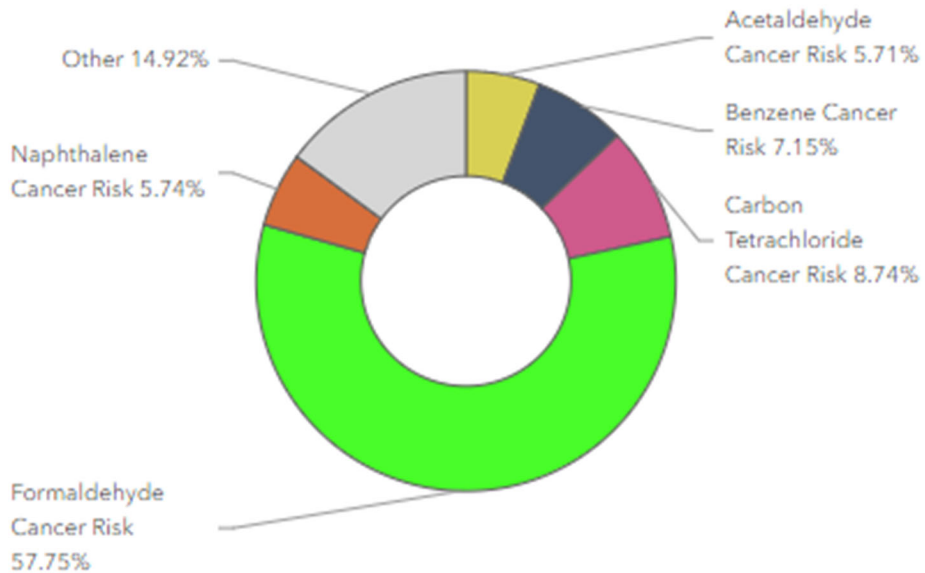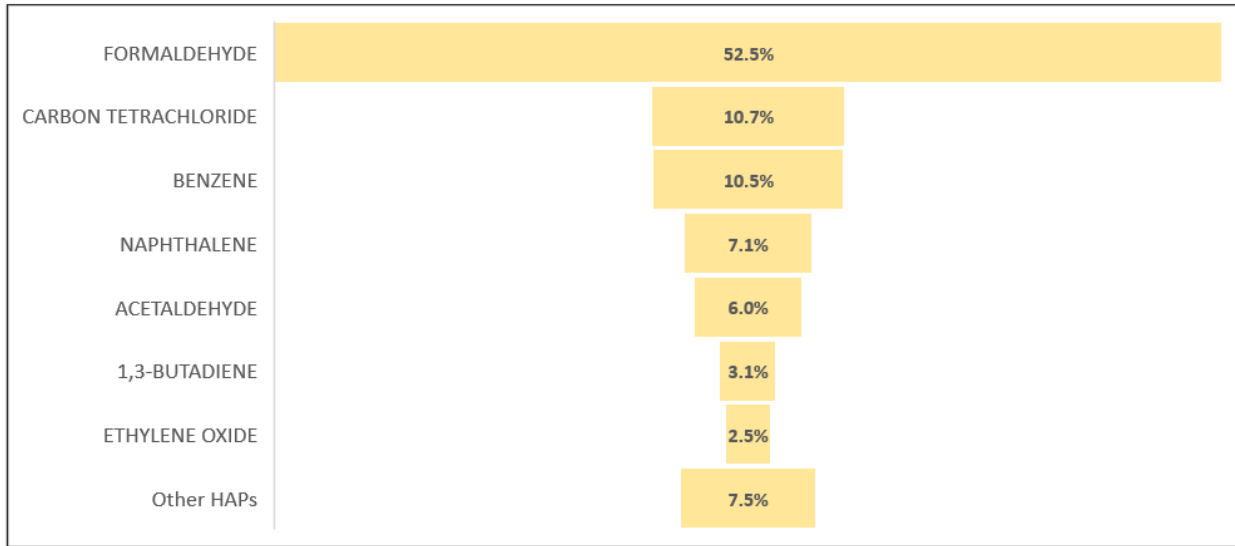
Addition information for the 2019 EPA AirToxScreen can be found here:
https://www.epa.gov/AirToxScreen/2019-airtoxscreen-assessment-results#nationwide

Figure 12.4 shows the 2023 annual mean concentrations for formaldehyde, carbon tetrachloride, and benzene measured by AMS at four monitoring sites (ROX, NEW, RIT, and SWA). The first two HAPs (i.e. formaldehyde and carbon tetrachloride) had the highest contribution to air toxics cancer risk in Philadelphia according to the 2019 AirToxScreen assessment.

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Figure 12.4 – 2023 Mean Concentrations for Formaldehyde and Carbon Tetrachloride
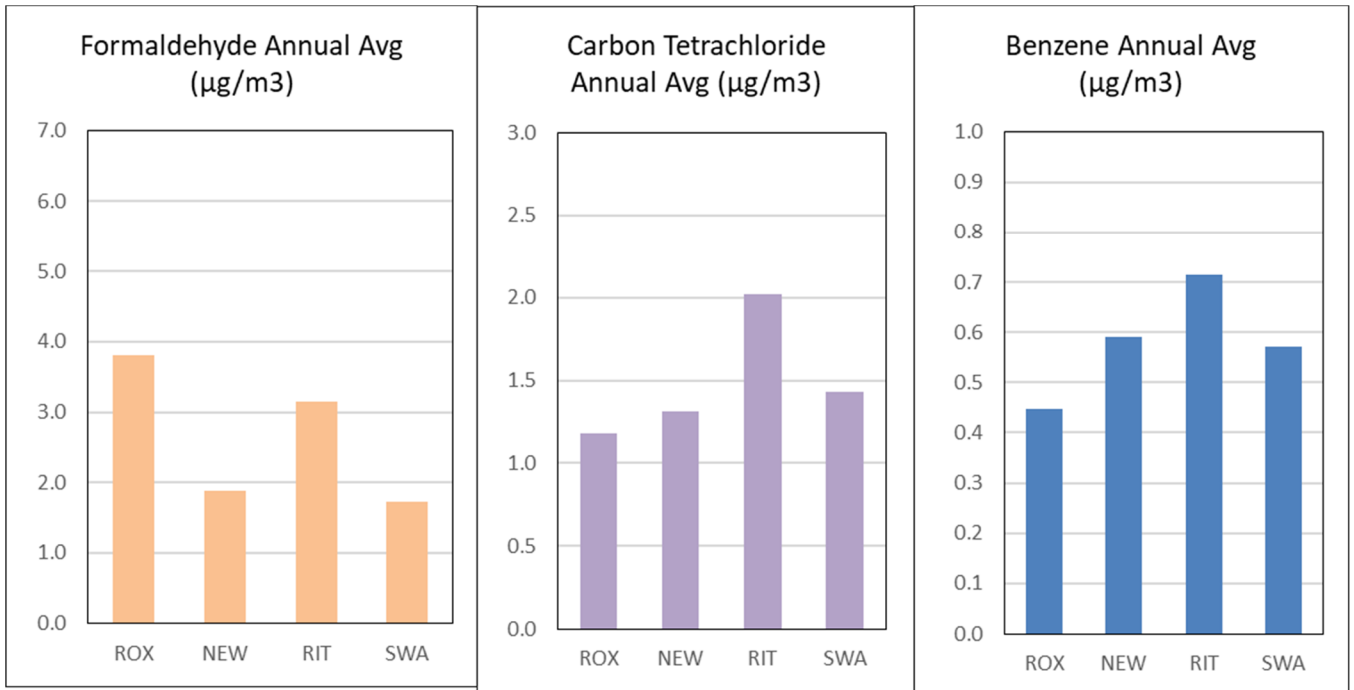
Data for air toxics can be found on the EPA websites https://www.epa.gov/outdoor-air-quality-data/monitor-values-report-hazardous-air-pollutants or https://aqs.epa.gov/aqsweb/airdata/download_files.html.

Philadelphia Air Quality Survey

In 2023, AMS continued to collect monitoring data from the Philadelphia Air Quality Survey (PAQS). Initially this project set up 50 street level, neighborhood-oriented air sampling sites throughout the City to measure the ambient air for $PM_{2.5}$, NO_2, SO_2, and O_3. Field sampling started in May 2018. The samplers also contain meteorological sensors. Minor adjustments to site locations were made in 2019; currently 48 sampling sites are maintained, as shown in Figure 13.1. PAQS captures seasonal changes and neighborhood-to-neighborhood spatial variances in air quality. The data results may serve as a basis for future work, including: providing policy recommendations for reducing pollution from congested traffic, diesel vehicles and wintertime fuel burning; analyzing the relations between air quality and land use characteristics in different neighborhoods; and studying public health impact of air pollution in the City. At the end of 2023, this project completed 90 two-week sampling sessions. For the period from December 1, 2022 through November 30, 2023, the citywide all-sites $PM_{2.5}$ average concentration was 10.3 µg/m^3. Note that this includes data from June 2023 when multiple large-scale wildfires in North America caused widespread air quality deterioration over the course of several weeks. See "2023 Exceptional Events" section on Page 11. If the data in June 2023 were excluded, the 12-month (12/1/2022 - 11/30/2023) citywide average $PM_{2.5}$ concentration would be 8.2 µg/m^3. Additional information regarding PAQS is provided in the latest version of the Philadelphia Air Monitoring Network Plan and the PAQS project report (https://www.phila.gov/documents/air-management-reports-and-documents/).

Figure 13.1 – PAQS Site Map

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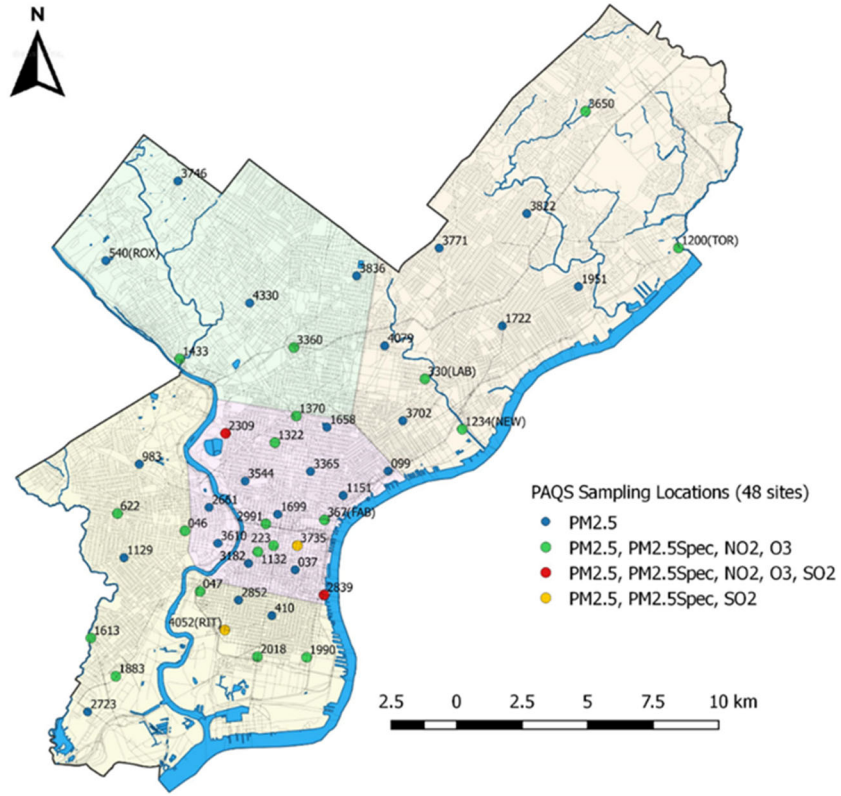
Appendix A: Websites

https://www.airnow.gov/ - The AQI (Air Quality Index) tells you how clean the air is and whether it will affect your health. Through AirNow, EPA, NOAA, NPS, state, and local agencies work together to report current and forecast conditions for ozone and particle pollution.

www.airqualitypartnership.org – Ground level ozone and particle pollution forecasts.

www.atsdr.cdc.gov – Agency for Toxic Substances and Disease Registry: public health statements on specific toxics and the effects of exposure.

https://www.enviroflash.info/ – Sign up for air quality forecasts.

https://www.dep.pa.gov/ - Pennsylvania Department of Environmental Protection.

www.epa.gov – U.S. Environmental Protection Agency.

https://www.epa.gov/outdoor-air-quality-data – EPA's AQS (Air Quality System) database for air monitoring data.

https://echo.epa.gov/ – EPA's ECHO (Enforcement & Compliance History Online) database for compliance inspections conducted by EPA or state/local government, violations, enforcement actions, and penalties assessments in response to environmental law violations.

www.lungusa.org – American Lung Association website: Information on lung health, air pollution, and related matters.

https://www.phila.gov/departments/department-of-public-health/about-us/contact-us/ – Philadelphia Department of Public Health, Air Management Services.

www.phila.gov/services/mental-physical-health/environmental-health-hazards/air-quality/ – Philadelphia's Air Quality Website, provides the most up-to-date information about the air quality in Philadelphia and lets you know what you should do to protect your health if the air quality is unhealthy.

Appendix B: Air Quality Data Tables[12]

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[12] Data downloaded from EPA's AirData website (https://www.epa.gov/outdoor-air-quality-data/monitor-values-report).

Table 2 – Ozone 4th Highest Daily Maximum 8-Hour Concentrations (ppm)

Year	421010004-1	421010004-2	421010014-1	421010019-1	421010021-1	421010023-1	421010024-1	421010026-1	421010027-1	421010029-1	421010048-1	421010136-1	421011002-1
1980	0.032		0.113	0.037	0.032	0.062	0.128	0.025	0.026	0.028			
1981			0.1				0.108						
1982			0.111			0.087	0.103						
1983			0.12			0.102	0.121						
1984			0.106			0.093	0.108						
1985			0.111			0.083	0.116						
1986			0.103			0.08	0.105						
1987			0.104			0.085	0.118						
1988			0.13			0.088	0.128						
1989			0.085			0.097	0.077						
1990			0.097			0.097	0.101						
1991			0.106			0.095	0.112						
1992			0.087			0.076	0.091						
1993	0.086		0.092			0.09	0.097					0.103	
1994	0.08		0.095			0.07	0.092					0.085	
1995	0.091		0.096				0.113					0.092	
1996	0.087		0.093				0.092					0.072	
1997	0.067		0.096				0.101					0.074	
1998	0.077		0.095				0.093					0.088	
1999	0.073		0.081				0.06					0.098	
2000	0.067		0.086				0.089					0.082	
2001	0.074		0.097				0.097					0.086	
2002	0.082		0.098				0.11					0.094	
2003	0.069		0.084				0.086					0.074	

2004	0.057		0.077			0.091					0.073	
2005	0.066		0.083			0.094					0.068	
2006	0.066		0.076			0.085					0.081	
2007	0.073		0.081			0.095					0.082	
2008	0.062					0.087						
2009	0.059					0.072						
2010	0.077					0.088						
2011	0.07					0.089						0.088
2012	0.065					0.085						0.083
2013	0.047					0.068				0.036		0.071
2014	0.058					0.072				0.068		
2015	0.057					0.079				0.078		
2016	0.069					0.08				0.076		
2017	0.042					0.076				0.076		
2018		0.071				0.079				0.076		
2019		0.067				0.071				0.072		
2020		0.064				0.070				0.067		
2021		0.068				0.073				0.073		
2022		0.061				0.068				0.066		
2023		0.060				0.068				0.068		

(2023 Exceptional Events data tentatively excluded, pending EPA approval)

Table 3 – Carbon Monoxide 2nd Highest 8-Hour Average Concentrations (ppm)

Year	421010004-1	421010004-2	421010014-1	421010019-1	421010021-1	421010024-1	421010026-1	421010026-2	421010027-1	421010029-1	421010029-2	421010045-1	421010046-1	421010047-1	421010048-1	421010051-1	421010075-1	421010076-1	421011002-1
1980	7.1	4.6		4.9	6.8	5.5		5.3	5.8		5	8.2							
1981	9.9		3.3				7.4		9.3	9.4		9.5	7.6						
1982	9.9		3.9						11.9	7		7.9	7.6	7.3					
1983	6.6								10.6	6.1		6.1	5.6	5.6					
1984	9.5								10	6.3		7.8	6.6	6.2					
1985	6.8								7.6	5.1		6.3	4.9	5.8					
1986	6.3								7.9	5.3			5.3	6.3					
1987	7.8								10	7.3			5.3	5.4		8.7			
1988	5.9								6.3	4.9			3.9	4.3		6.9			
1989	11.6								6.4	6.9				6.9		9.5			
1990	6.8								6.4	4.7				5.4		6.1			
1991	5.6								7.1	4.4				4.3		5.1			
1992	6.4								6.8	5				4.1		5.4			
1993	6.6								4.6	5.6				5		5.4			
1994	8.3									5.1				5.4		5.9			
1995	4.5								4.8	4.1				3.9		5.6			
1996	5.6								5.4	4.5				3.6		5.6			
1997	5.3								5	3.3				3.1		3.6			
1998	4.6								4.9	3.2				3.3		3.8			
1999	4.9								4.9	4.4				3.3		4.2			
2000	3.3								4	3				3					
2001	4								4.7	2.9				2.5					
2002	2.9								2.9	2				1.9					
2003	2.4								3.9	2.2				2					

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Year																			
2004	3.1								3.4	2.5				2.7					
2005	2.1								3.4	0.8				2.1					
2006	2.3								3.2					1.4					
2007	2.6								3.2					5.5					
2008	1.5													0.7					
2009	2																		
2010	1.8																		
2011	1.7																		1.2
2012	1.5																		1.5
2013	1.7													1.1					1.3
2014	1.3													1.3			1.4		
2015	1.6													1.5			1.6		
2016	1.9													1.7			1.6		
2017	0.9													1.4			1.2	2.6	
2018														1			1.3	1.1	
2019														1.7			1.5	1.4	
2020														1.1			1.8	1.3	
2021														1.1			1.4	1.1	
2022														1.2			1.5	1.2	
2023														1			1.4	1.2	

Table 4 – Carbon Monoxide Highest 1-Hour Average Concentrations (ppm)

Year	AQS SITE ID - POC																		
	421010004-1	421010004-2	421010014-1	421010019-1	421010021-1	421010024-1	421010026-1	421010026-2	421010027-1	421010029-1	421010029-2	421010045-1	421010046-1	421010047-1	421010048-1	421010051-1	421010075-1	421010076-1	421011002-1
1980	14	8		7	11	8		11	15		10	16							
1981	14		6				12		16	15		16	12						
1982	18		12						23	14		15	13	19					

Year																		
1983	10							19	11		11	9	8					
1984	17							17	18		18	12	12					
1985	12							16	11		10	8	9					
1986	10							12	13			9	20					
1987	12							15	13			8	9		13			
1988	9							12	8			6	9		11			
1989	18							11	12				11		16			
1990	10							11	8				9		14			
1991	10							13	9				9		9			
1992	9							10	8				8		10			
1993	9							9	10				8		9			
1994	14								11				10		10			
1995	8							7	8				9		11			
1996	10							10	8				6		14			
1997	10							10	6.4				4.9		6.4			
1998	7.6							8.9	5.8				5.8		5.6			
1999	7.7							6.9	6				5.8		7			
2000	6.5							6.5	4.3				4.7					
2001	5.7							8	6.4				5					
2002	5.4							4.5	3.5				3.5					
2003	3.7							6	3.8				3.2					
2004	4.6							5.5	3.7				3.7					
2005	3.8							6.5	1.3				12.3					
2006	4.4							8.6					2.2					
2007	3.8							4.2					5.6					
2008	3.7												1.3					
2009	3.6																	
2010	3.1																	
2011	2.6																	2.2
2012	2.7																	2.1

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Year																
2013	2.4												2.1			1.6
2014	2												1.8	2		
2015	2.1												2.5	1.9		
2016	3.6												2.6	2.2		
2017	1.4												2.3	1.9	4.3	
2018													1.4	1.9	1.5	
2019													2.3	2.4	1.8	
2020													1.5	2	1.8	
2021													1.7	1.8	1.5	
2022													2.2	1.8	1.8	
2023													1.7	1.8	1.7	

Table 5 – Nitrogen Dioxide Annual Average Concentrations (ppb)

	AQS SITE ID - POC										
Year	421010004-3	421010022-1	421010023-2	421010024-1	421010026-2	421010027-1	421010029-2	421010047-1	421010048-1	421010075-1	421010076-1
1980	40.89			25.02	46.18	45.82	36.19				
1981	37.4	34.24		24.32	46.12		36.19				
1982	33.05	37.1		26.62			39.23	37.64			
1983	38.15	41.34					39.7	37.87			
1984	38.1	35.82					37.34	40.16			
1985	33.71	31.67					34.34	36.21			
1986	33.28		15.32				36.34	35.67			
1987	32.12						39.28	42.55			
1988	31.06						31.93	39.41			
1989	29.11						32.86	39.74			
1990	28.14						31.91	35.19			
1991	28.35						32.59	33.55			

Year										
1992	25.82					32.55	34.93			
1993	24.06					31.22	34.51			
1994	24.01					31.06	36.56			
1995	27.73					31.01	31.81			
1996	29.34					33.35	33.92			
1997	27.99					32.44	31.76			
1998	29.47					33.37	34			
1999	26.99					30.23	31.75			
2000	25.66					27.94	28.69			
2001	25.59					28.32	29.95			
2002	24.09					28.1	29.48			
2003	23.97					24.69	25.23			
2004	22.73					24.69	25.58			
2005	21.57					26.11	26.29			
2006	20.72						22.81			
2007	20.35						22.8			
2008	19.6						20.03			
2009	18.25						19.59			
2010	17.66						22.61			
2011	20.12						19.56			
2012	17.91						17.6			
2013	16.18						17.17			
2014	17.45						18.31		15.51	
2015	18.15						19.07		14.69	11.32
2016	15.73								13.55	11.28
2017	19.55								11.35	9.36
2018									10.69	10.76
2019								12.32	13.43	13.11
2020								10.98	12.89	11.45
2021								11.39	14.36	11.93

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			11.38	14.47	12.57
2022			11.38	14.47	12.57
2023			11.81	14.58	12.12

Table 6 – Nitrogen Dioxide 98th Percentile Daily Maximum 1-Hour Concentrations (ppb)

Year	AQS SITE ID - POC										
	421010004-3	421010022-1	421010023-2	421010024-1	421010026-2	421010027-1	421010029-2	421010047-1	421010048-1	421010075-1	421010076-1
1980	130			90	120	130	100				
1981	110	140		90	130		110				
1982	110	120		100			130	120			
1983	140	140					140	110			
1984	120	100					100	120			
1985	100	110					110	90			
1986	90		40				110	90			
1987	90						160	110			
1988	100						90	100			
1989	100						100	120			
1990	100						90	100			
1991	100						80	100			
1992	80						100	100			
1993	70						80	80			
1994	80						100	110			
1995	80						80	100			
1996	70						80	80			
1997	72						79	79			
1998	80						87	81			
1999	68						81	72			

2000	73					72	73			
2001	72					77	75			
2002	61					70	69			
2003	62					63	60			
2004	64					59	61			
2005	64					37	68			
2006	74						60			
2007	62						64			
2008	57						53			
2009	56						56			
2010	62						56			
2011	76						64			
2012	56						52			
2013	52						50			
2014	59						57		51	
2015	63						56		49	39
2016	58								49	43
2017	60								45	38
2018									37	43
2019						41			43	52
2020						43			44	50
2021						43			46	54
2022						43			46	56
2023						46			48	48

Table 7 – Sulfur Dioxide 99th Percentile Daily Maximum 1-Hour Average Concentrations (ppb)

Year	42010004-4	42010004-5	42010014-1	42010019-1	42010020-1	42010021-1	42010022-1	42010022-2	42010023-2	42010023-3	42010024-1	42010026-2	42010026-3	42010027-1	42010029-2	42010029-3	42010047-1	42010048-1	42010048-2	42010055-1	42010136-1	42011002-1
1980	160		120	150	120	90	300	180	160	140	110	170	110	150	170							
1981	140	120					270		100				140	130	170							
1982	120						130		100					120	160		150					
1983	90						130		80		80			80	150	100	100					
1984	120						180		90		100			130	140		120					
1985	100						100		70		70			100	90		120					
1986	80						110		80		60			100	90		100					
1987	90						150		80		80			90	90		80					
1988	100						130		110		90			110	130		130					
1989	80						100		80		60			80	100		120					
1990	90						110		90		80			100	110		140					
1991	70						100		90		60			70	100		90					
1992	80						100		60		60			80	110		80					
1993	80						110		60		70			60	90		80	230				80
1994	80						90		80		60				100		90	330				90
1995	60						80				50			50	60		60	180				40
1996	60						100				50			60	70		90	330				50
1997	54						87				56			47	65		54	377				52
1998	53						53				48			48	55		52	43				50
1999	58						73				37			51	54		84	53				60
2000	44						56								60							45
2001	48						60								67							67
2002	49														58							53
2003	52														63							53
2004	47														56					39	51	

Year																		
2005	51												55		42	56		
2006	40														43	39		
2007	38														35	50		
2008	33														32			
2009	37														32			
2010	18														25			
2011	13														15			8
2012	7														14			8
2013	8													15	9			5
2014	11													9	10			
2015														9	10			
2016														19	8			
2017														10	10			
2018														14	6			
2019														17	6			
2020														5	4			
2021														6	6			
2022														4	7			
2023														5	4			

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Table 8 – Lead (Maximum) Rolling 3-Month Averages (µg/m³)

Year	421010004-5	421010014-1	421010047-1	421010048-1	421010055-1	421010063-1	421010076-1	421010136-1	421010449-1	421011002-1
						AQS SITE ID - POC					
2009									0.03	
2010									0.03	
2011									0.02	0.02
2012										0.05
2013				0.02						0.04
2014				0.02						
2015				0.02						
2016				0.04						
2017										
2018										
2019										
2020										
2021										
2022										
2023										

Table 9 – PM$_{10}$ Highest 24-Hour Average Concentrations (µg/m^3)

Year	421010003-1	421010004-1	421010004-2	421010037-1	421010038-1	421010047-1	421010048-1	421010048-2	421010049-1	421010136-1	421010149-1	421010449-1	421010449-2	421010649-1	421010649-2
1988	65	83		76	92	91									
1989		96		97	102	96									
1990		72		79	95	87									
1991		85	87	76	97	84									
1992		54		59	101	129					236				
1993		81		59	105	116			103		587	162			
1994		95		83	94	84			143	83	531	186			
1995		64		68		82			90	107	384	233			
1996		87		54		86			129	63	454	247			
1997		76		117		136			78	113	308	325		288	
1998		60		130		82			63	104	73	130		156	
1999		73		57		24			36	45	111	153		56	
2000		43		73						36	165	290		44	
2001		61		62						61	65	61	64	61	
2002		66		128						72	122	68	99	106	
2003		82		86						63		86		77	
2004		62		55						52		58		52	
2005		57		67						48		79		100	
2006		132								37		93		162	161
2007		44										37		61	62
2008		53										43		64	66
2009		49										41		80	78
2010		57										67		218	151
2011		46										59		64	90
2012		67										61			
2013		29					65					36			
2014							63					30			
2015							53								
2016							55								
2017							69								
2018							49								
2019								54							
2020								42							
2021								74							
2022								60							
2023								100							

(2023 Exceptional Events data tentatively excluded, pending EPA approval)

Table 10 – PM$_{2.5}$ 98th Percentile 24-Hour Concentrations (µg/m^3)

Year	421010003-1	421010004-1	421010004-2	421010004-5	421010014-1	421010020-1	421010024-1	421010027-1	421010047-1	421010047-3	421010047-4	421010048-1	421010048-3	421010048-4	421010048-5	421010048-6	421010052-1	421010055-1	421010055-2	421010055-3	421010056-1	421010057-1	421010057-2	421010057-3	421010057-4	421010075-1	421010075-2	421010076-1	421010076-2	421010136-1	421011002-1	421011002-3
1999		39				30	33		33																					34		
2000		41				32	38	57	39																					39		
2001		40				36	37		40																					46		
2002		41			30	40	38		39								51													43		
2003		40			39	39	39		42																					36		
2004		34			15	29	33		32																					30		
2005	29	36				33	36		39																					31		
2006	29	38	36				35		48												0									38		
2007		35	36				34		40		38											33		28						32		
2008		35	33				31		38		33							35				33		33								
2009		26	34				26		37		29							29				28		28								
2010		28	25				25		32		27							29				28										
2011			24						32		28							31				31									25	16
2012		21					24		22									25				23									20	24
2013			35						26	22	34	36	35					35		25		19		33							24	24
2014		20	25						28	26		26	28					31						32		21						
2015		25	27						24			26	26					30				27		27		30						
2016		17	24									19	22					22				22		22		21						
2017		22	21									22	20					20				20		22		20						
2018		19	21									17	20					21				18		23		19						
2019												25	23					22				18		22		20						
2020												19	14	26	23	13		18	18			20	17			19	25	16	19			
2021				20								21		27	24			25				25				23		22				

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Year																							
2022	20			18	20	20		17		17		23	20		
2023	26			20		28		28		24		29	24		

(2023 Exceptional Events data tentatively excluded, pending EPA approval)

Table 11 – PM$_{2.5}$ Annual Mean Concentrations (µg/m^3)

	AQS SITE ID - POC																															
Year	421010003-1	421010004-1	421010004-2	421010004-5	421010014-1	421010020-1	421010024-1	421010027-1	421010047-1	421010047-3	421010047-4	421010048-1	421010048-3	421010048-4	421010048-5	421010048-6	421010052-1	421010055-1	421010055-2	421010055-3	421010056-1	421010057-1	421010057-2	421010057-3	421010057-4	421010075-1	421010075-2	421010076-1	421010076-2	421010136-1	421011002-1	421011002-3
1999		0				0	0		0																					0		
2000		0				0	0	0	0																					0		
2001		16.5				0	14.6		17																					16.7		
2002		14.8			0	14.4	14.3		0								0													14.4		
2003		14.8			0	13.7	0		0																					0		
2004		13.9			0	0	12.8		0																					12.7		
2005	0	0				0	0		0																					0		
2006	0	0	13.2				0		0												0									0		
2007		13.7	0				0		14.4		0													0		0				0		
2008		13	12.5				12		13.5		13.2							13.5				13.3		12.9								
2009		10.9	11.3				9.9		11.1		11.1							11.3				11.1		0								
2010		10.7	0				9.6		10.9		10.9							11.3				10.9										
2011			8.9						11.3		11.4							11.4				11.4								9.9	0	
2012			0						10.2		10.1							10.3				10.1								8.7	0	
2013			0						0	0	0	0	0					0		0		0		0							0	0
2014		0	0						0	11.3		0	11.1									0		12.1				0				
2015		0	10.3						0			10.3	10.1							11.2				11	10.7			0				
2016		0	0									0	9.8							10.5				9.4	9.4				8.2			

Year																	
2017	0	0		0	9				10				0		0		0
2018	8.1	0		8	0				9.8				8		9.7		8.7
2019				7.9	8.3				8.4				7.3		8.7		8.3
2020				7.1	0	0	0	0	0	0	0	0		0	0	0	0
2021			0	9.1		0	9.6		10.1			9.7			10		9.3
2022			8.8	8.4		9	9.5		7.9			0			9.3		8.6
2023			11.0	9.7			10.6		10.3			9.4			11.8		8.8

(2023 Exceptional Events data tentatively excluded, pending EPA approval)

Table 12 – AQS Site ID information

AQS Site ID	Address
421010003	Community Health Services; 500 S Broad Street
421010004	1501 E. Lycoming Ave.
421010014	Roxy Water Pump Station; Eva & Dearnley Streets
421010019	Fire Boat Station; Allegheny Ave & Del River
421010020	Ford Rd-Belmont Ave Water Treat Plant
421010021	Island Rd, East of Airport Circle PHL Int Airport
421010022	Defense Support Center; 20th & Oregon Ave
421010023	SE Sewage Plant; Front & Packer Streets
421010024	Grant & Ashton Roads; Phila NE Airport
421010026	Broad & Spruce Streets; Mobile Trailer
421010027	S W Corner Broad & Butler
421010029	20th & Race Streets
421010037	13th Street & Montgomery Avenue
421010038	4415 Almond (Near Orthodox Street)
421010045	1421 Arch Street
421010046	1206 Chestnut Street
421010047	500 South Broad Street-Parking Lot (CHS)
421010048	3000 Lewis St. (Near Bath St.), Philadelphia, Pa. 19137
421010049	Richmond St. & Wheatsheaf Lane
421010051	323 Race Street
421010052	1439 East Passyunk Avenue
421010055	24th & Ritner Streets
421010056	2851 Island Ave, Eastwick Free Library
421010057	240 Spring Garden Street
421010063	8200 Enterprise Ave
421010075	4901 Grant Avenue & James Street, Philadelphia, Pa. 19114
421010076	4100 Montgomery Drive
421010136	Amtrak, 5917 Elmwood Avenue
421010149	Castor & Carbon Streets on PGW Property
421010449	Castor & Delaware Avenues
421010649	Water Dept. Newpcp Lagoon Area (NEL)
421011002	5200 Pennypack Park, Philadelphia, Pa. 19136

(This table includes historical monitoring sites no longer in operation)

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Appendix C: History of the National Ambient Air Quality Standard

Table 13 – History of the National Ambient Air Quality Standards for Carbon Monoxide[13]

Final Rule/Decision	Primary/ Secondary	Indicator	Averaging Time	Level	Form
1971 36 FR 8186 Apr 30, 1971	Primary and Secondary	CO	1-Hour period	35 ppm	Maximum, not to be exceeded more than once in a year[14]
			8-hour period	9 ppm	Maximum, not to be exceeded more than once in a year
1985 50 FR 37484 Sept 13, 1985	Primary standards retained, without revision; secondary standards revoked.				
1994 59 FR 38906 Aug 1, 1994	Primary standards retained, without revision.				
2011 76 FR 54294 Aug 31, 2011	Primary standards retained, without revision.				

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[13] https://www.epa.gov/co-pollution/table-historical-carbon-monoxide-co-national-ambient-air-quality-standards-naaqs
[14] Second highest, non-overlapping 8-hour average concentration.

Table 14 – History of the NAAQS for Pb-TSP (Lead in total suspended particles)[15]

Final Rule/Decision	Primary/ Secondary	Indicator	Averaging Time	Level	Form
1978 43 FR 46246 Oct 5, 1978	Primary and Secondary	Pb-TSP	Calendar Quarter	1.5 µg/m^3	Not to be exceeded
1991	Agency released multimedia "Strategy for Reducing Lead Exposures"				
2008 73 FR 66964 Nov 12, 2008	Primary and Secondary	Pb-TSP	3-month period	0.15 µg/m^3	Not to be exceeded
2016 81 FR 71906 Oct 18, 2016	Primary and secondary standards retained, without revision.				

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[15] https://www.epa.gov/lead-air-pollution/table-historical-lead-pb-national-ambient-air-quality-standards-naaqs

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Table 15 – History of the NAAQS for Nitrogen Dioxide[16]

Final Rule/Decision	Primary/ Secondary	Indicator	Averaging Time	Level	Form
1971 36 FR 8186 Apr 30, 1971	Primary and Secondary	NO_2	Annual	53 ppb[17]	Annual arithmetic average
1985 50 FR 25532 Jun 19, 1985	Primary and secondary NO_2 standards retained, without revision.				
1996 61 FR 52852 Oct 8, 1996	Primary and secondary NO_2 standards retained, without revision.				
2010 75 FR 6474 Feb 9, 2010	Primary	NO_2	1 hour	100 ppb	98th percentile, 1-hour daily maximum, averaged over 3 years[18]
		Primary annual NO_2 standard retained, without revision.			
2012 77 FR 20218 April 3, 2012	Secondary	Existing secondary NO_2 standard (annual) retained, without revision.			
2018 83 FR 17226 April 18, 2018	Primary	Existing primary NO_2 standards retained, without revision.			

[16] https://www.epa.gov/no2-pollution/table-historical-nitrogen-dioxide-national-ambient-air-quality-standards-naaqs
[17] The official level of the annual NO2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard.
[18] The form of the 1-hour standard is the 3-year average of the 98th percentile of the yearly distribution of 1-hour daily maximum NO2 concentrations.

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Table 16 – History of the NAAQS for Ozone[19]

Final Rule/Decision	Primary/ Secondary	Indicator	Averaging Time	Level	Form
1971 36 FR 8186 Apr 30, 1971	Primary and Secondary	Total photochemical oxidants	1 hour	0.08 ppm	Not to be exceeded more than one hour per year
1979 44 FR 8202 Feb 8, 1979	Primary and Secondary	O_3	1 hour	0.12 ppm	Attainment is defined when the expected number of days per calendar year, with maximum hourly average concentration greater than 0.12 ppm, is equal to or less than 1
1993 58 FR 13008 Mar 9, 1993	EPA decided that revisions to the standards were not warranted at the time				
1997 62 FR 38856 Jul 18, 1997	Primary and Secondary	O_3	8 hours	0.08 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
2008 73 FR 16483 Mar 27, 2008	Primary and Secondary	O_3	8 hours	0.075 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
2015 80 FR 65292 Oct 26, 2015	Primary and Secondary	O_3	8 hours	0.070 ppm	Annual fourth-highest daily maximum 8-hour average concentration, averaged over 3 years

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[19] https://www.epa.gov/ozone-pollution/table-historical-ozone-national-ambient-air-quality-standards-naaqs

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Table 17 – History of the NAAQS for Particulate Matter[20]

Final Rule/Decision	Primary/ Secondary	Indicator[21]	Averaging Time	Level	Form
1971 36 FR 8186 Apr 30, 1971	Primary	TSP	24 hour	260 µg/m³	Not to be exceeded more than once per year
1971 36 FR 8186 Apr 30, 1971	Primary	TSP	Annual	75 µg/m³	Annual geometric mean
1971 36 FR 8186 Apr 30, 1971	Secondary	TSP	24 hour	150 µg/m³	Not to be exceeded more than once per year
1971 36 FR 8186 Apr 30, 1971	Secondary	TSP	Annual	60 µg/m³	Annual geometric mean
1987 52 FR 24634 Jul 1, 1987	Primary and Secondary	PM$_{10}$	24 hour	150 µg/m³	Not to be exceeded more than once per year on average over a 3-year period
1987 52 FR 24634 Jul 1, 1987	Primary and Secondary	PM$_{10}$	Annual	50 µg/m³	Annual arithmetic mean, averaged over 3 years
1997 62 FR 38652 Jul 18, 1997	Primary and Secondary	PM$_{2.5}$	24 hour	65 µg/m³	98th percentile, averaged over 3 years
1997 62 FR 38652 Jul 18, 1997	Primary and Secondary	PM$_{2.5}$	Annual	15.0 µg/m³	Annual arithmetic mean, averaged over 3 years [3, 4]
1997 62 FR 38652 Jul 18, 1997	Primary and Secondary	PM$_{10}$	24 hour	150 µg/m³	Initially promulgated 99th percentile, averaged over 3 years; when 1997 standards for PM10 were vacated, the form of 1987 standards remained in place (not to be exceeded more than once per year

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[20] https://www.epa.gov/pm-pollution/table-historical-particulate-matter-pm-national-ambient-air-quality-standards-naaqs
[21] TSP = Total Suspended Particles

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					on average over a 3-year period) [5]
1997 62 FR 38652 Jul 18, 1997	Primary and Secondary	PM$_{10}$	Annual	50 µg/m^3	Annual arithmetic mean, averaged over 3 years
2006 71 FR 61144 Oct 17, 2006	Primary and Secondary	PM$_{2.5}$	24 hour	35 µg/m^3	98th percentile, averaged over 3 years [6]
2006 71 FR 61144 Oct 17, 2006	Primary and Secondary	PM$_{2.5}$	Annual	15.0 µg/m^3	Annual arithmetic mean, averaged over 3 years [2,7]
2006 71 FR 61144 Oct 17, 2006	Primary and Secondary	PM$_{10}$	24 hour	150 µg/m^3	Not to be exceeded more than once per year on average over a 3-year period
2012 78 FR 3085 Jan 15, 2013	Primary	PM$_{2.5}$	Annual	12.0 µg/m^3	Annual arithmetic mean, averaged over 3 years [2,7]
2012 78 FR 3085 Jan 15, 2013	Secondary	PM$_{2.5}$	Annual	15.0 µg/m^3	Annual arithmetic mean, averaged over 3 years [2,7]
2012 78 FR 3085 Jan 15, 2013	Primary and Secondary	PM$_{2.5}$	24 hour	35 µg/m^3	98th percentile, averaged over 3 years [6]
2012 78 FR 3085 Jan 15, 2013	Primary and Secondary	PM$_{10}$	24 hour [8]	150 µg/m^3	Not to be exceeded more than once per year on average over a 3-year period
2024	Primary	PM$_{2.5}$	Annual	9.0 µg/m^3	Annual arithmetic mean, averaged over 3 years [2,7]