Massachusetts 2023 Air Quality Report

September 2024

Department of Environmental Protection
Bureau of Air and Waste
Division of Air and Climate Programs
Air Assessment Branch
Wall Experiment Station
37 Shattuck Street
Lawrence, Massachusetts 01843

ACKNOWLEDGEMENTS

This 2023 Air Quality Report was prepared by the Massachusetts Department of Environmental Protection (MassDEP), Air Assessment Branch (AAB), which collects representative samples of ambient air for several pollutants at monitoring stations located across the Commonwealth. All samples are collected in a precise and scientifically sound manner to properly characterize the quality of the air in the Commonwealth.

The photo on the cover is a view of the Weymouth monitoring station at 59 Monatiquot Street, Weymouth, MA.

This report is available on MassDEP's web site at

www.mass.gov/eea/agencies/massdep/air/quality/air-monitoring-reports-and-studies.html

Questions about this report may be directed to:

Sean Dunn
Air Assessment Branch
Wall Experiment Station
Lawrence, MA 01843-1343
email: sean.m.dunn@mass.gov

Table of Contents

List of Abbreviations

AAB ....Air Assessment Branch
AQS ....Air Quality System
AQI ....Air Quality Index
BC.........................Black Carbon
BP.........................Barometric Pressure
CAA ....Clean Air Act
CFR ....Code of Federal Regulations
CO ....Carbon Monoxide
CO_2 ....Carbon Dioxide
FEM ....Federal Equivalent Method
FRM......................Federal Reference Method
EPA.......................United States Environmental Protection Agency
IMPROVE ....Interagency Monitoring of Protected Visual Environments
MassDEP ....Massachusetts Department of Environmental Protection
NAAQS ....National Ambient Air Quality Standards
NATTS ....National Air Toxics Trends Station
NCore...................National Core Monitoring Network
NO ....Nitric Oxide
NO_x......................Nitrogen Oxides
NO_y..............................Total Reactive Oxidized Nitrogen
NO_2 ....Nitrogen Dioxide
NO_3 ....Nitrate
O_3 .... Ozone
PAH ....Polycyclic Aromatic Hydrocarbon
PAMS ....Photochemical Assessment Monitoring Stations
Pb.........................Lead
ppb.......................parts per billion by volume
ppm......................parts per million by volume
$PM_{2.5}$ ....Particulate matter ≤ 2.5 microns aerodynamic diameter
PM_{10}.....................Particulate matter ≤ 10 microns aerodynamic diameter
PRECIP.................Precipitation
QA/QC.................Quality Assurance and Quality Control
REL ....Relative Humidity
SIP ....State Implementation Plan
SO_2 ....Sulfur Dioxide
SO_4 ....Sulfate
SUN ....Solar Radiation
TEMP...................Temperature
TOTAL UV............Ultraviolet radiation
TSA.......................Technical Systems Audit
$\mu g/m^3$ ....micrograms per cubic meter
VOCs ....Volatile Organic Compounds
WS/WD ....Wind Speed/Wind Direction
WSv/WDv.............Wind Speed Vector/Wind Direction Vector

Section 1 – Ambient Air Monitoring Program

1.1 - Program Overview

Introduction

The Massachusetts Department of Environmental Protection (MassDEP) is responsible for monitoring outdoor air quality in Massachusetts, and for developing plans and regulatory programs to reduce emissions of pollutants that adversely affect public health, welfare, and the environment.

MassDEP's Air Assessment Branch (AAB) operates a network of air monitoring stations throughout the Commonwealth. During 2023, MassDEP operated 24 monitoring stations located in 19 cities and towns. MassDEP also received data from the Wampanoag Tribe of Gay Head (Aquinnah), which operates an air monitoring station on Martha's Vineyard.

MassDEP submits ambient air quality data to the national Air Quality System (AQS) database that is administered by the U.S. Environmental Protection Agency (EPA). Continuous monitoring data is sent to the AirNow website, https://www.airnow.gov/, which reports data from all U.S. monitoring stations. MassDEP's MassAir Online website provides air quality information and allows users to click on a map of the state to find current air quality data from the MassDEP continuous air monitoring network. MassAir Online is found at www.mass.gov/eea/agencies/massdep/air/quality/. EPA also makes historical AQS data for all U.S. monitoring stations available at https://www.epa.gov/outdoor-air-quality-data.

Why is Air Quality Data Collected?

Ambient air quality data is used for several purposes, including to:

- Provide information about air quality to the public;
- Provide short-term and long-term information regarding air pollution and public health;
- Verify compliance with National Ambient Air Quality Standards (NAAQS);
- Assess the effectiveness of current air pollution control regulations and programs;
- Support development of policies and regulations aimed at reducing air pollution;
- Support long-term trend analysis and special research; and
- Fulfill requirements to report ambient air quality data to EPA.

What is Monitored?

MassDEP monitors parameters in the following categories:

Criteria pollutants for which EPA has established NAAQS. The criteria pollutants monitored are:

- sulfur dioxide (SO_2)
- ozone (O_3)
- carbon monoxide (CO)
- nitrogen dioxide (NO_2)
- lead (Pb)

- particulate matter ≤10 microns (PM_{10})
- particulate matter ≤ 2.5 microns ($PM_{2.5}$)

Non-criteria pollutants do not have NAAQS but can contribute to the formation of ozone and particulate matter and/or be toxic. The non-criteria pollutants monitored include:

- nitric oxide (NO)
- total nitrogen oxides (NOx)
- total reactive oxidized nitrogen (NOy)
- volatile organic compounds (VOCs) – ozone precursors and reaction product chemicals
- black carbon (i.e., soot)
- toxics – health-relevant VOCs, semi-volatile organic compounds (SVOCs), carbonyls and metals
- speciated particulates - elements (e.g., metals), sulfates, nitrates, and carbon (total and organic)

Meteorological parameters monitored include:

- wind speed/wind direction (WS/WD) and vector (WSv/WDv)
- relative humidity (REL)
- temperature (TEMP)
- barometric pressure (BP)
- solar radiation (SUN)
- precipitation (PRECIP)
- ultraviolet radiation (TOTAL UV)

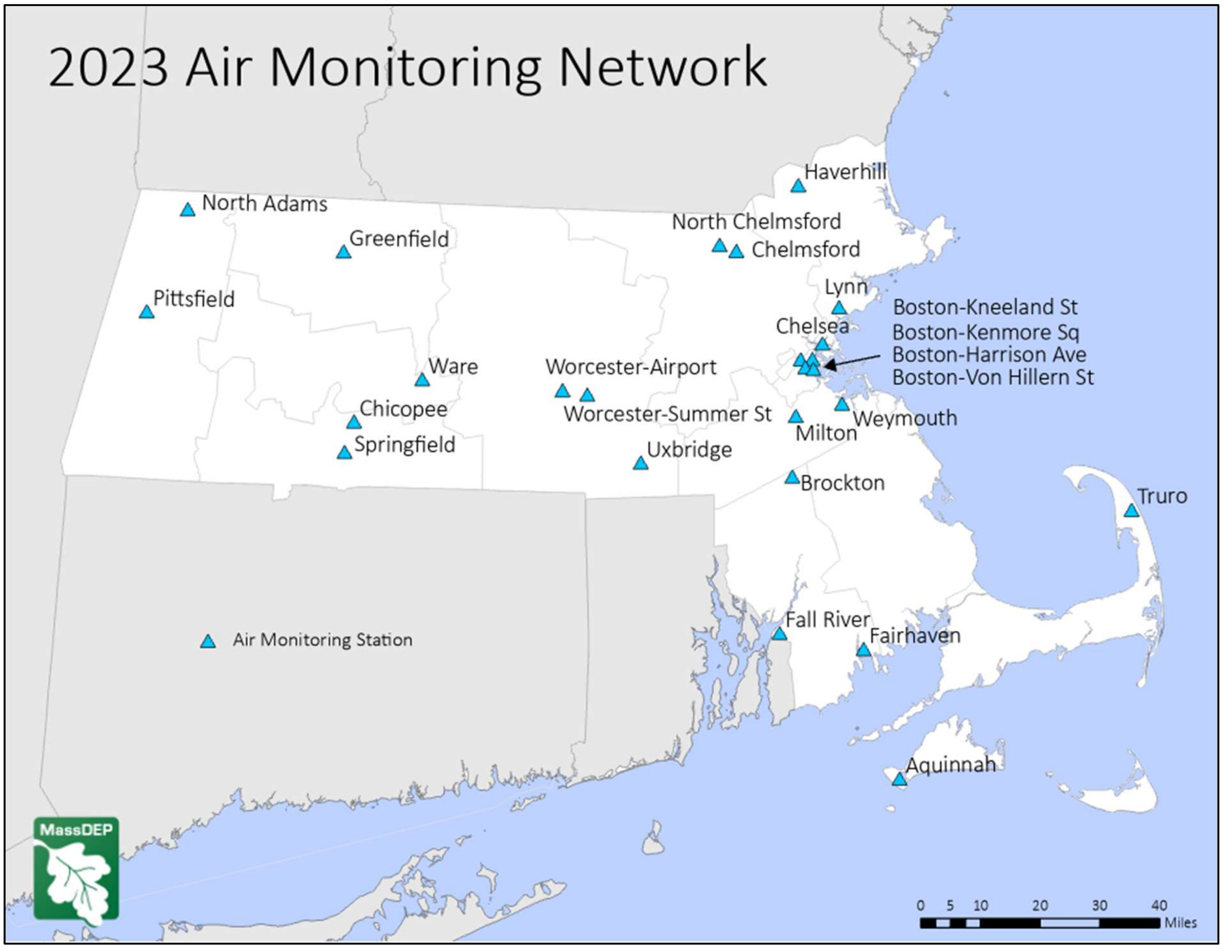
Monitoring Station Locations

Monitoring stations are sited to provide data for various purposes and must meet EPA siting criteria. Some are located where maximum pollutant concentrations are expected, while others are positioned in areas that will provide data that is representative of larger geographical areas. Local topography and pollutant source areas are factors that determine how well a particular monitor's location will represent a region.

Networks of monitors are located throughout the state. These networks are designed to reflect pollutant concentrations for all of Massachusetts. Section III of this report contains data summaries for each pollutant measured and maps showing the monitor locations for each network. Appendix A contains a list of monitoring stations.

The map on page 7 shows Massachusetts cities and towns where air monitors were located during 2023.

Air Monitor Locations



1.2 - National Ambient Air Quality Standards (NAAQS)

Below are the current NAAQS for criteria pollutants set by EPA. Primary Standards are designed to protect public health, including the health of sensitive populations such as asthmatics, children, and the elderly. Secondary Standards are designed to protect public welfare, including protection against decreased visibility, damage to crops, vegetation, and buildings.

On February 7, 2024, EPA lowered the primary annual NAAQS for fine particulate matter ($PM_{2.5}$) from 12 micrograms per cubic meter (μg/m^3) to 9 μg/m^3. EPA retained the existing 24-hour $PM_{2.5}$ (35 μg/m^3) and secondary $PM_{2.5}$ (15 μg/m^3) standards.

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
			1-hour	35 ppm	
Lead		primary and secondary	Rolling 3-month average	0.15 μg/m^3	Not to be exceeded
Nitrogen Dioxide		primary	1-hour	100 ppb	98th percentile of 1-hr daily maximum concentrations, averaged over 3 years
		primary and secondary	Annual	53 ppb	Annual Mean
Ozone		primary and secondary	8-hour	0.070 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
Particle Pollution	$PM_{2.5}$	primary	Annual	9 μg/m^3	annual mean, averaged over 3 years
		secondary	Annual	15 μg/m^3	annual mean, averaged over 3 years
		primary and secondary	24-hour	35 μg/m^3	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24-hour	150 μg/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-hr daily maximum concentrations, averaged over 3 years
		secondary	3-hour	0.5 ppm	Not to be exceeded more than once per year

μg/m^3 = micrograms per cubic meter
ppm = parts per million
ppb = parts per billion

1.3 - Pollutant Health Effects and Sources

Ozone (O_3)

- Tropospheric O_3 (ground-level) and Stratospheric O_3 (upper atmosphere) are the same chemical compound, just found at different places in the atmosphere. Stratospheric O_3, found at greater than 30,000 feet above the surface of the earth, is beneficial to all life because it filters out the sun's harmful UV radiation before it reaches the earth's surface. Ground-Level O_3 on the other hand is a health and environmental problem. This report pertains exclusively to ground-level O_3.
- O_3 is a respiratory irritant that can reduce lung function and resistance to infection. It can cause asthma attacks, nasal congestion, and throat irritation. It can inflame and damage (possibly permanently) cells that line the lungs and aggravate chronic lung diseases. In addition, several studies have found a strong link between increases in ground-level O_3 and increased risk of premature death.
- O_3 is toxic to vegetation, inhibiting growth and causing leaf damage.
- O_3 deteriorates materials such as rubber and fabrics.
- Ground-level O_3 is unique in that it is formed by the reactions that occur between certain precursor pollutants in the presence of intense, high-energy sunlight during the hot summer months. The complexity of the process and the amount of time needed to complete these reactions can result in the buildup of ground-level ozone concentrations far downwind from the original source of the precursors.
- Sources of ground-level O_3 precursors, i.e., nitrogen oxides and hydrocarbons, include motor vehicles, lawn and garden equipment, power plants and other industrial sources.

Carbon Monoxide (CO)

- CO binds with hemoglobin in the blood, reducing the amount of oxygen carried to organs and tissues.
- Symptoms of high CO exposure include shortness of breath, chest pain, headaches, confusion, and loss of coordination. The health threat is most severe for those with cardiovascular disease.
- Motor vehicle emissions are the largest source of CO, which is produced from incomplete combustion of carbon in fuels.
- Industrial processes and non-transportation fuel combustion (e.g., boilers, lawn and garden equipment) also are sources of CO.

Sulfur Dioxide (SO_2)

- SO_2 combines with water vapor to form acidic aerosols harmful to the respiratory tract, aggravating symptoms associated with lung diseases such as asthma and bronchitis.
- SO_2 is a primary contributor to acid deposition. Impacts of acid deposition include acidification of lakes and streams, damage to vegetation, damage to materials, and diminution of visibility.
- SO_2 is a product of fuel combustion (e.g., the burning of coal and oil that contains sulfur). Sources include power plants and business and residential sources burning heating oil.

Nitrogen Dioxide (NO_2)

- NO_2 lowers resistance to respiratory infections and aggravates symptoms associated with asthma and bronchitis.
- NO_2 contributes to acid deposition. Impacts of acid deposition include acidification of lakes and streams, damage to vegetation, damage to materials, and diminution of visibility.
- NO_2 and nitric oxide (NO) contribute to the formation of ozone.
- NO_2 is formed from the oxidation of NO. Major sources of NO are fuel combustion, space heating, power plants and motor vehicles.

Particulate Matter (PM_{10} and $PM_{2.5}$)

- Particulate matter is tiny airborne particles or aerosols, which include dust, dirt, soot, smoke, and liquid droplets. Fine particulate matter (mostly below 2.5 microns in size) are not only the result of direct emissions but can be formed in the atmosphere by chemical reactions involving gaseous pollutants.
- The numbers 2.5 and 10 refer to the particle size (equal to or less than that size), measured in microns, which are collected by the monitors. Several thousand $PM_{2.5}$ particles could fit on the period at the end of this sentence.
- The small size of these particles allows easy entry into the human respiratory system. Long-term exposure causes the particles to accumulate in the lungs and affects breathing and produces respiratory symptoms. The small particles can migrate through the lungs and into the circulatory system and potentially produce cardio-vascular symptoms, as well as impacts from toxic components contained in the particulate matter.
- Particulate matter causes soiling and corrosion of materials.
- Particulate matter contributes to atmospheric haze that degrades visibility.
- Sources of particulates include wood smoke, industrial process emissions, motor vehicles, incinerators, power plants, and other fuel combustion sources.

Lead (Pb)

- Lead is an elemental metal that is found in nature.
- Exposure to lead can occur by inhalation or ingestion with food, water, soil or dust particles.
- Children, infants, and fetuses are the most susceptible to the effects of lead exposure.
- Lead causes intellectual disability, brain damage, and liver disease. It may be a factor in high blood pressure and damages the nervous system.
- Lead enters the atmosphere from the incineration of lead containing materials and from the manufacture and processing of lead containing products or materials like storage batteries, smelting and removal of lead-containing paint.

1.4 - Monitoring Network Description

The following describes the ambient air monitoring network in 2023.

Network Size	▪ 25 Monitoring Stations (24 operated by MassDEP and 1 by the Wampanoag Tribe) ▪ 20 cities and towns with monitoring stations
Number of Continuous Monitors	Continuous monitors measure air quality 24 hours per day. The data are reported as hourly averages. ▪ Criteria pollutant monitors measure pollutants for which NAAQS have been set. ❑ 3 – Trace-level CO monitors ❑ 11 – NO_2, NO and NOx monitors ❑ 18 – O_3 monitors (1 Tribal) ❑ 6 – Trace-level SO_2 monitors ❑ 19 – Continuous $PM_{2.5}$ (1 collocated) ❑ 3 – Continuous PM_{10} ▪ Meteorological monitors track weather conditions. ❑ 14 – Barometric pressure ❑ 14 – Relative humidity ❑ 14 – Solar radiation ❑ 14 – Temperature ❑ 13 – Wind speed/wind direction ❑ 1 – Wind speed vector/wind direction vector ❑ 1 – Precipitation ❑ 1 – Ultraviolet radiation ▪ Other Monitors ❑ 3 – Total Reactive Oxidized Nitrogen (NO/NOy) ❑ 1 – Photochemical assessment monitoring station (PAMS). PAMS monitors measure VOCs using an automated gas chromatograph (auto-GC) on an hourly basis during the summer. ❑ 7 – Black Carbon
Number of Intermittent Monitors	Intermittent monitors collect discrete samples for a specific time period. The samples are collected every day, every third day, or every sixth day. The data are averaged in 3-hour or 24-hour intervals. ▪ Criteria pollutant monitors measure pollutants that have NAAQS. ❑ 1 – PM_{10} monitors ❑ 5 – $PM_{2.5}$ Federal Reference Method monitors ▪ Non-criteria pollutant monitors measure pollutants that do not have NAAQS. ❑ 4 – VOCs and carbonyls ❑ 2 – Speciation. These monitors measure for $PM_{2.5}$, nitrates, and organics ❑ 1 – PM_{10} for metals analysis

1.5 - Attainment Status Summary

The federal Clean Air Act (CAA) contains timeframes and milestones for states to meet and maintain NAAQS for criteria pollutants, which include carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter, and sulfur dioxide. EPA sets NAAQS at levels to protect public health and the environment. The EPA must review each NAAQS every five years and may update the standards based on new scientific information as well as establish new monitoring requirements. Each state is required to monitor the ambient air to determine whether it meets each standard.

If the air quality in a geographic area meets or is cleaner than the national standard, it is called an attainment area (designated "Unclassifiable/Attainment"); areas that do not meet the national standard are called nonattainment areas. In some cases, EPA is not able to determine an area's status after evaluating the available information and those areas are designated "unclassifiable." Air quality in Massachusetts meets all of the criteria pollutant NAAQS.

If monitoring shows that the air quality does not meet a standard, the state must develop and implement pollution control strategies to attain that standard. Once air quality meets a standard, a state must develop a plan to maintain that standard while accounting for future economic and emissions growth. Taken together, these plans and control strategies constitute the State Implementation Plan (SIP).

Carbon Monoxide

Monitored levels of CO in Massachusetts meet the CO standards. Prior to the mid-1980s, Massachusetts was in nonattainment of the CO standards. However, with the adoption of numerous control programs, CO emissions significantly decreased and monitored levels of CO met the standards beginning in 1987. Massachusetts is designated as Unclassifiable/Attainment for the CO standards. Based on EPA's most recent review of the CO standards, in August 2011 EPA retained the existing primary CO standards of 9 ppm measured over 8 hours, and 35 ppm measured over 1 hour. Since EPA did not change the standards, no new designation process was triggered.

Lead

Monitored levels of lead in Massachusetts meet the lead standards. In October 2009, EPA lowered the lead standards (primary and secondary) from 1.5 $\mu g/m^3$ to 0.15 $\mu g/m^3$ averaged over a rolling 3-month period. In November 2011, EPA designated all of Massachusetts as Unclassifiable/Attainment for the 2009 standard. Based on EPA's most recent review of the lead standards, in September 2016 EPA retained the existing lead standards. Since EPA did not change the standards, no new designation process was triggered.

Nitrogen Dioxide

Monitored levels of NO_2 in Massachusetts meet the NO_2 standards. In January 2010, EPA established a new 1-hour NO_2 standard of 100 ppb and new near-road monitoring requirements. In January 2012, EPA designated all of Massachusetts as Unclassifiable/Attainment for the 2010 standard. Based on EPA's most recent review of the NO2 standards, in April 2018, EPA retained the existing primary NO2 standard of 100 ppb measured over 1 hour, and an annual primary and secondary standard of 53 ppb averaged over 1 year. Since EPA did not change the standards, no new designation process was triggered.

Sulfur Dioxide

Monitored levels of SO_2 in Massachusetts meet the SO_2 standards. Based on EPA's most recent review of the SO_2 standards, in June 2010 EPA established a new 1-hour SO_2 standard of 75 ppb. In December 2018, EPA designated all of Massachusetts as Unclassifiable/Attainment for the 2010 standard.

Particulate Matter

There are standards for two types of particulate matter: PM_{10} and $PM_{2.5}$. Monitored levels of PM_{10} and $PM_{2.5}$ in Massachusetts meet the respective standards. Based on EPA's most recent review of the PM standards, in February 2024 EPA lowered the primary annual $PM_{2.5}$ standard from 12 $\mu g/m^3$ to 9 $\mu g/m^3$. EPA retained the 24-hour $PM_{2.5}$ (35 $\mu g/m^3$) and secondary $PM_{2.5}$ (15 $\mu g/m^3$) standards. Monitored levels of $PM_{2.5}$ meet the new 9 $\mu g/m^3$ standard. All states, including Massachusetts, must submit a designation recommendation to EPA by February 7, 2025, and EPA will issue designations for the new standard by February 6, 2026.

Ozone

In 1979, EPA established an ozone standard (0.12 ppm) based on the maximum 1-hour ozone concentration that occurred each day during the ozone monitoring season. Massachusetts was designated as Nonattainment with this standard.

In 1997, EPA established new 8-hour ozone standards (0.08 ppm) that were designed to be more representative of exposure over time, rather than just the maximum concentration (the 1-hour standard was revoked in 2005). Massachusetts was designated as Nonattainment for these standards at that time. Through a combination of state and regional controls, Massachusetts' air quality attained the 1997 standards by the 2009 attainment deadline.

In 2009, EPA lowered the 8-hour ozone standards to 0.075 ppm. In April 2012, EPA designated Dukes County as Nonattainment for the 2009 ozone standards and designated the remainder of Massachusetts as Unclassifiable/Attainment. Dukes County attained the 2009 ozone standard by the 2015 attainment deadline.

In 2015, EPA lowered the 8-hour ozone standards to 0.070 ppm. In December 2017, EPA designated all of Massachusetts as Unclassifiable/Attainment for the 2015 standard. Based on EPA's most recent review of the ozone standards, in December 2020 EPA retained the existing ozone standards. Since EPA did not change the standards, no new designation process was triggered.

1.6 - Daily Ozone and PM Forecasts

MassDEP provides the public with daily air quality forecasts for ozone from April through September and for fine particles all year-round using weather maps and meteorological factors to predict whether or not conditions will result in elevated pollution levels. The daily air quality forecasts are available from www.mass.gov/eea/agencies/massdep/air/quality/. EPA web sites that contain regional and national pollution forecasts using data that is provided by participating states are located at www.epa.gov/region01/airquality/forecast.html and http://airnow.gov/. The table below describes the ratings used in the daily air quality forecasts.

Air Quality Index (AQI): Ozone		
Index Values	**Levels of Health Concern**	**Cautionary Statements**
0-50	Good	None
51-100	Moderate	Unusually sensitive people should consider reducing prolonged or heavy exertion outdoors.
101-150	Unhealthy for Sensitive Groups	Active children and adults, and people with lung disease, such as asthma, should reduce prolonged or heavy exertion outdoors.
151-200	Unhealthy	Active children and adults, and people with lung disease, such as asthma, should avoid prolonged or heavy exertion outdoors. Everyone else, especially children, should reduce prolonged or heavy exertion outdoors.
201-300	Very Unhealthy	Active children and adults, and people with lung disease, such as asthma, should avoid all outdoor exertion. Everyone else, especially children, should avoid prolonged or heavy exertion outdoors.

Air Quality Index (AQI): Particle Pollution		
Index Values	**Levels of Health Concern**	**Cautionary Statements**
0-50	Good	None
51-100	Moderate	Unusually sensitive people should consider reducing prolonged or heavy exertion.
101-150	Unhealthy for Sensitive Groups	People with heart or lung disease, older adults, and children should reduce prolonged or heavy exertion.
151-200	Unhealthy	People with heart or lung disease, older adults, and children should avoid prolonged or heavy exertion. Everyone else should reduce prolonged or heavy exertion.
201-300	Very Unhealthy	People with heart or lung disease, older adults, and children should avoid all physical activity outdoors. Everyone else should avoid prolonged or heavy exertion.

Section 2 – Massachusetts Air Quality Data Summaries

2.1 - Ozone Summary

2023 Ozone Data Summary

MassDEP operated 17 ozone monitors during 2023. The Wampanoag Tribe operated one ozone monitor in Aquinnah on Martha's Vineyard. The ozone monitoring season in Massachusetts begins on March 1st and ends on September 30th. In 2023, there were ten days when the 8-hour ozone standard of 0.070 ppm was exceeded in Massachusetts. Based on the most recent three years of data (2021–2023), no monitoring locations violated the 0.070 ppm standard.

While ozone concentrations have trended downward over the past several decades due to air pollution control programs, ozone concentrations vary each year due to varying weather patterns. In general, the chemical reactions that produce elevated ozone concentrations occur when high energy sunlight (present on hot summer days) facilitates the react of ozone "precursor" pollutants – VOCs and NOx, which results in ozone formation. Typically, Massachusetts ozone exceedances occur when a high-pressure area well south of New England creates a broad southwesterly airflow which contains precursors from the upwind coastal urban corridor to New England. This is where reactions in the atmosphere result in elevated levels of ozone. This typical pattern also moves slowly, promoting heat wave conditions that can last several days, allowing pollutants to build up.

Difference Between Ozone Exceedances and Violations

An ozone exceedance occurs when monitored ozone concentrations exceed the ozone NAAQS. Ozone monitoring data is collected as an hourly average of continuous data which is then used to determine the highest 8-hour average value for the day. An exceedance of the 8-hour standard is an 8-hour averaged value that is greater than 0.070 ppm. An ozone exceedance occurs when a monitor records ambient levels of ozone above the standard. Monitoring an ozone exceedance does not mean that a violation of the ozone standard has occurred, because a violation of an ozone standard (as opposed to an exceedance) is based on three-year averages of data at each monitor.

An ozone violation of the 8-hour standard is determined using the annual 4th-highest daily maximum eight-hour ozone value at each monitor. A violation requires a three-year average of the annual 4th-highest daily maximum eight-hour value that is greater than 0.070 ppm. In other words, the eight-hour values for each day during a year for a specific monitor are ranked from highest to lowest. Then, the 4th-highest value for three consecutive years is averaged. If the three-year average is greater than 0.070 ppm, a violation of the 8-hour standard has occurred at that monitoring site.

Ozone Exceedance Days and Total Exceedance Trends

Figure 1 shows the number of 8-hour exceedance days and the total number of exceedances for the past ten years. Note that years 2014 and 2015 show what exceedances would have been had the 0.070 ppm 8-hour standards been in effect. Figure 2 shows the most recent ozone design values (i.e., the 4th highest

8-hour ozone value averaged over three years) relative to the 2015 ozone NAAQS. Figure 2 displays only monitoring sites with at least three years of data, which is a requirement to calculate design values.

Figure 1
8-hour Ozone Exceedance Days and Total Exceedances 2014-2023
Exceedances Based on 0.070 ppm 8-hour Standard

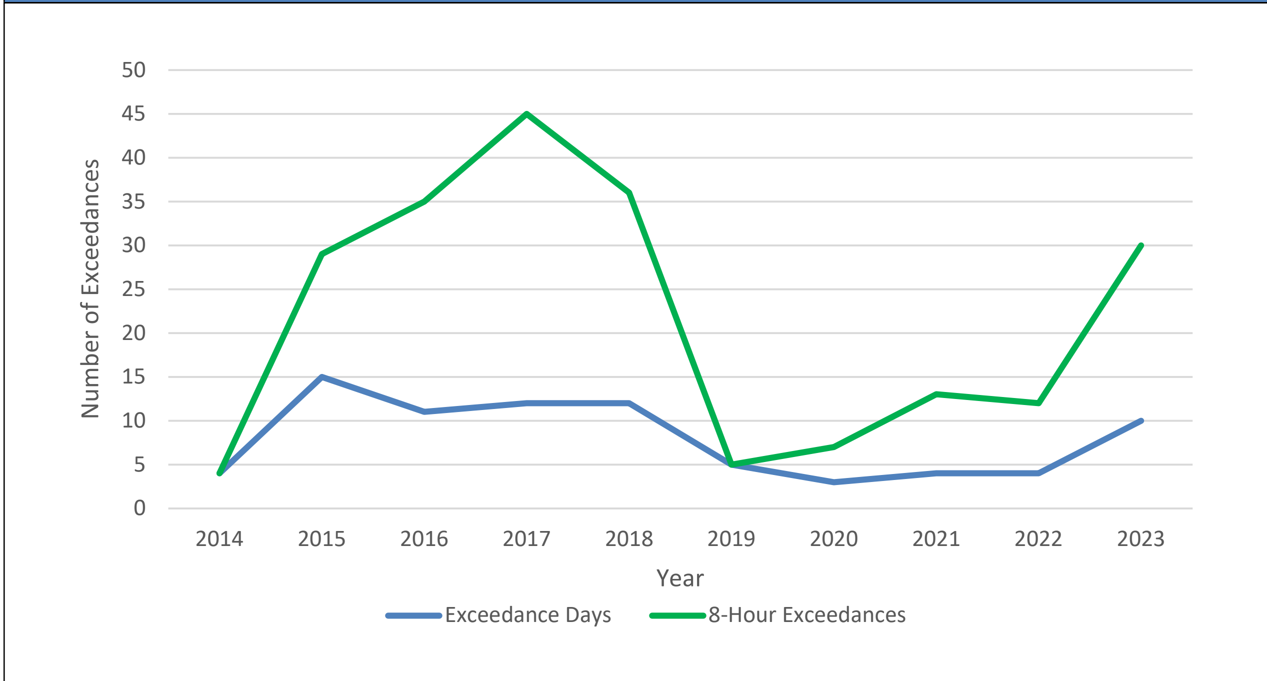
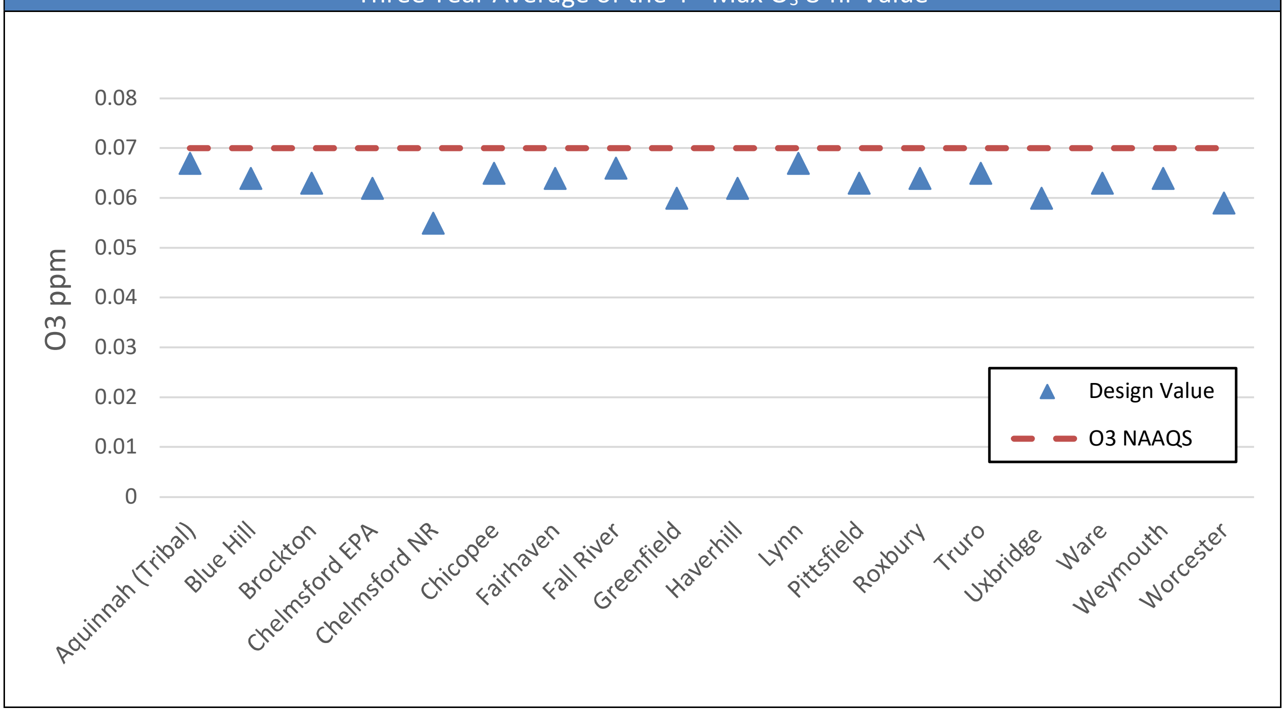


Figure 2
Ozone Design Values (2021-2023)
Three Year Average of the 4th Max O_3 8-hr Value



A summary of the data collected during the 2023 ozone season (March 1 – September 30) is shown below (in parts per million).

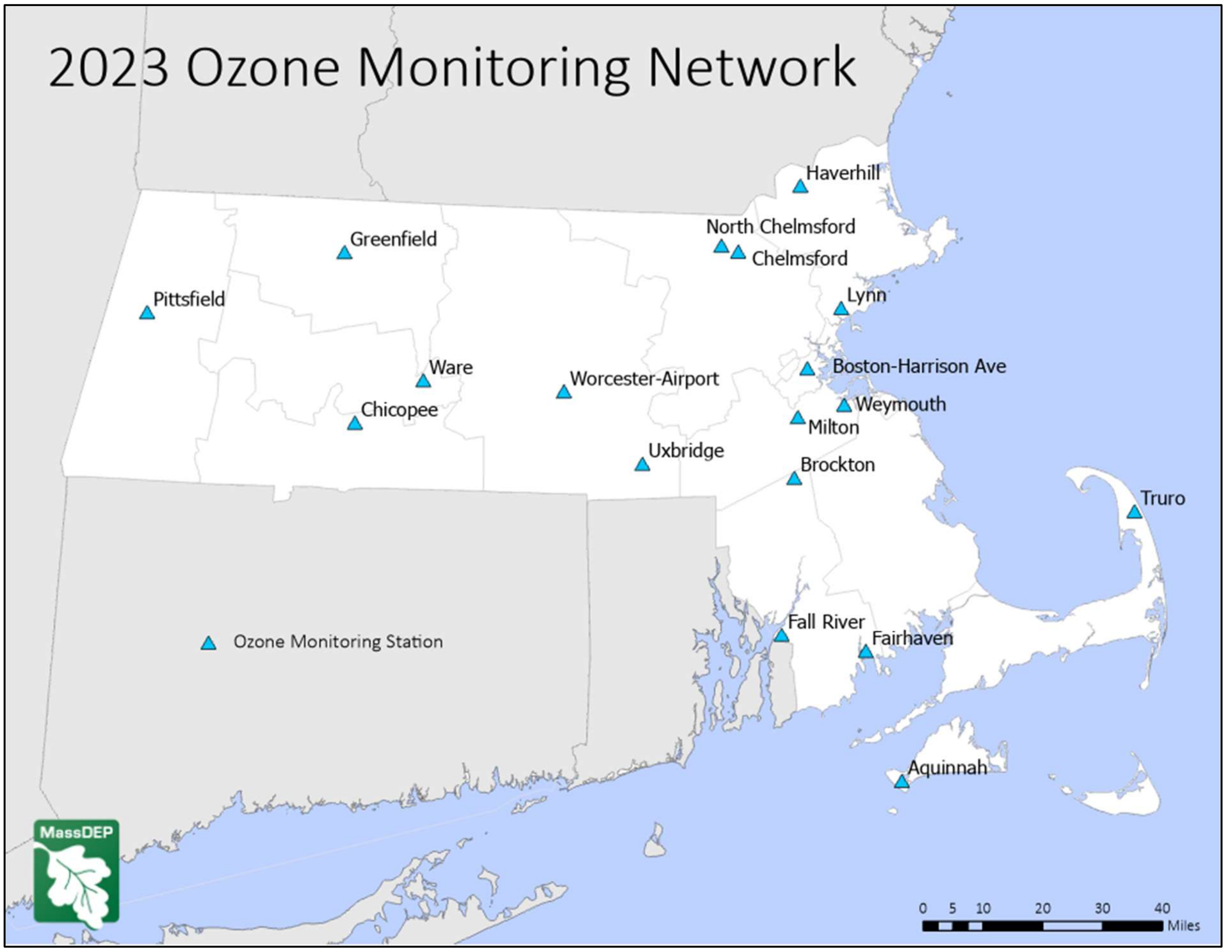
O_3 2023 CITY	COUNTY	ADDRESS	1ST MAX 8-HR	2ND MAX 8-HR	3RD MAX 8-HR	4TH MAX 8-HR	8-HR MAX>0.070 STD
Aquinnah (Tribal)	Dukes	Herring Creek Drive	0.080	0.074	0.074	0.073	5
Boston	Suffolk	Harrison Avenue	0.066	0.065	0.065	0.064	0
Brockton	Plymouth	Clinton Street	0.072	0.071	0.070	0.065	2
Chelmsford EPA	Middlesex	Technology Drive	0.071	0.068	0.067	0.065	1
Chelmsford NR	Middlesex	Manning Road	0.063	0.059	0.057	0.055	0
Chicopee	Hampden	Anderson Road	0.085	0.081	0.075	0.065	3
Fairhaven	Bristol	School Street	0.078	0.076	0.071	0.069	3
Fall River	Bristol	Globe Street	0.080	0.079	0.076	0.070	3
Greenfield	Franklin	Barr Avenue	0.083	0.065	0.063	0.063	1
Haverhill	Essex	Washington Street	0.068	0.066	0.065	0.062	0
Lynn	Essex	Parkland Avenue	0.072	0.070	0.069	0.068	1
Milton	Norfolk	Canton Avenue	0.081	0.076	0.072	0.071	4
Pittsfield	Berkshire	Silver Lake Blvd	0.081	0.068	0.066	0.065	1
Truro	Barnstable	Collins Road	0.082	0.073	0.071	0.066	3
Uxbridge	Worcester	E. Hartford Ave	0.071	0.067	0.064	0.062	1
Ware	Hampshire	Skyline Drive	0.074	0.074	0.066	0.064	2
Weymouth	Norfolk	Monatiquot Street	0.069	0.069	0.067	0.065	0
Worcester	Worcester	Airport Drive	0.060	0.059	0.055	0.054	0

Standard: 8-hour = 0.070 ppm

1^{st}, 2^{nd}, 3^{rd}, 4^{th} MAX 8-HR = Maximum 8-hour Value for the 1^{st}, 2^{nd}, 3^{rd} and 4^{th} Highest Day

8-HR MAX > 0.070 STD = Number of Measured Daily 8-hour Maximum Values Greater Than the 0.070 ppm 8-hour Standard

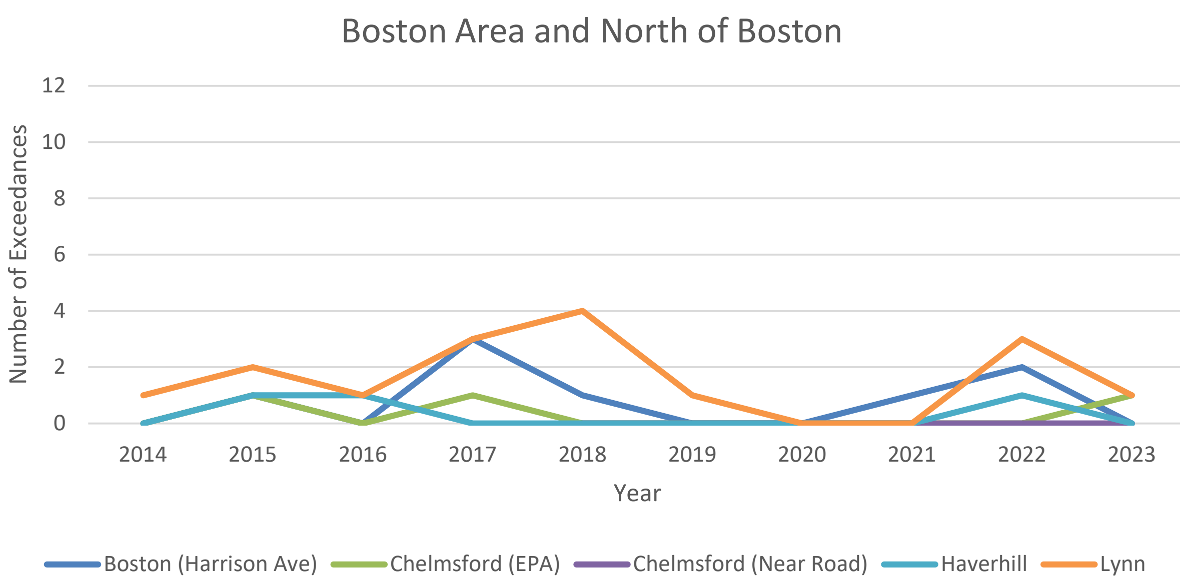
Ozone Monitor Locations



8-hour Ozone Exceedance Trends

Figure 3 shows the trend for each ozone monitor for the past ten years based on the 0.070 ppm 8-hour standard.

Figure 3
8-hour Ozone Exceedance Trends 2014 – 2023
Exceedances Based on 0.070 ppm 8-hour Standard



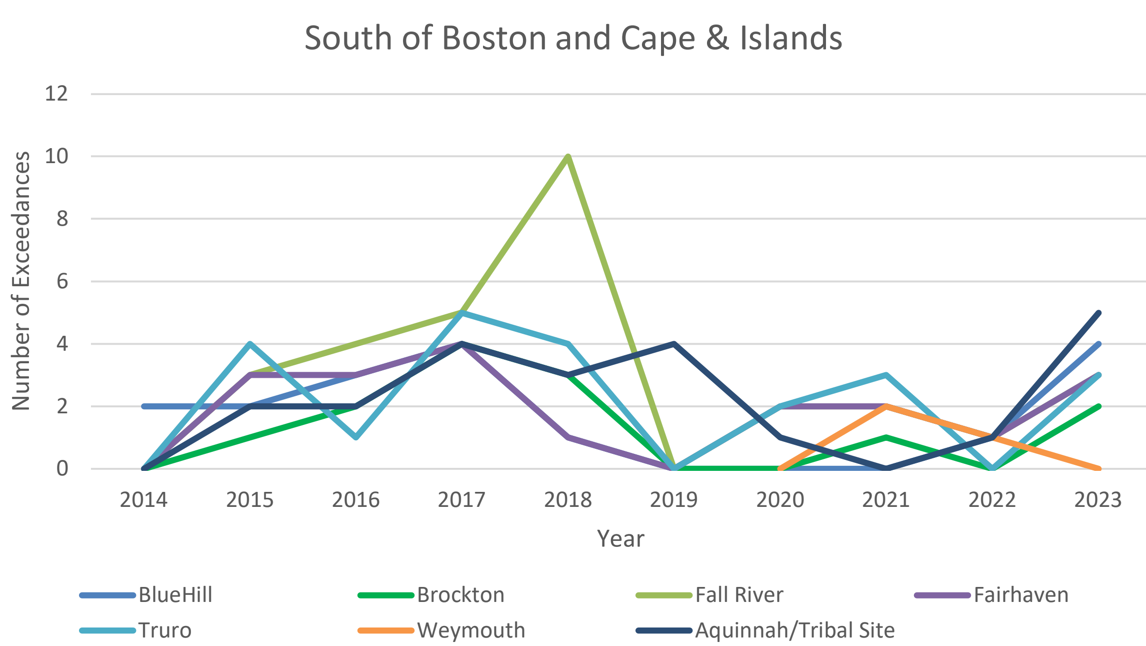
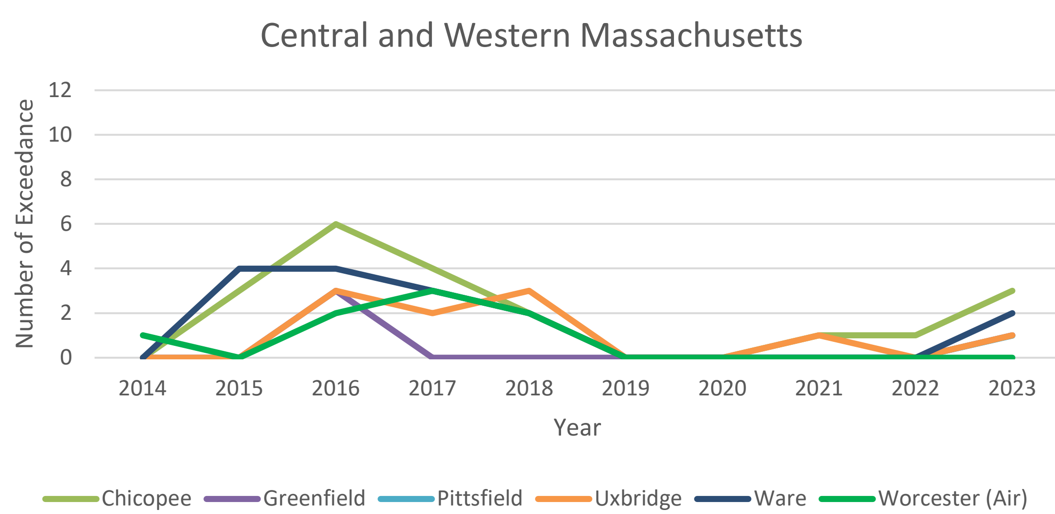


Figure 3 (cont.)
8-hour Ozone Exceedance Trends 2014 – 2023
Exceedances Based on 0.070 ppm 8-hour Standard



2.2 - Particulate Matter 2.5 Microns ($PM_{2.5}$) Summary

During 2023, MassDEP operated five filter based Federal Reference Method (FRM) $PM_{2.5}$ monitors and 19 continuous Federal Equivalent Method (FEM) $PM_{2.5}$ monitors. FRM monitors require the manual set-up and collection of filters that measure 24-hour samples every three or six days. The filters are weighed prior to placement in the field and then weighed again after the sample is collected to determine the amount of $PM_{2.5}$ collected on the filter. Continuous FEM monitors measure $PM_{2.5}$ on an hourly basis. MassDEP operates FRM and FEM monitors side-by-side at some locations for comparison.

In 2023, there were nine days when the 24-hour $PM_{2.5}$ standard (35 µg/m^3) was exceeded. The exceedances were due to smoke traveling to Massachusetts from wildfires in Canada. Despite these exceedances, based on the most recent three years of data (2021–2023), no monitoring locations violated the 35 µg/m^3 standard. Figure 4 shows the number of 24-hour $PM_{2.5}$ exceedance days and the total number of exceedances for the past ten years.

MassDEP monitors $PM_{2.5}$ using FEM Teledyne T640 and T640x monitors. In April 2023, EPA approved a modification of the FEM designation for the T640 and T640x monitors to address a positive bias in the method and to make the T640/T640x instruments more comparable with FRM monitors. In March 2024, EPA provided notice of its plan to update historic $PM_{2.5}$ data collected since 2017 by applying a Network Data Alignment methodology equation. More information about the method modification and data update is available on EPA's AQS Memos – Monitoring and Policy website (https://www.epa.gov/aqs/aqs-memos-monitoring-and-policy).

In May 2024, EPA completed the historical Network Data Alignment update, which generally resulted in lower $PM_{2.5}$ monitored levels and published revised design values. MassDEP used the updated data in this report. Since EPA's updated $PM_{2.5}$ values are slightly lower than previously reported values, Figure 4 shows two fewer total exceedances in 2021 than previous versions of this report.

Figure 5 shows the most recent 3-year design values (three-year average of 2021 -2023 98th percentile 24-hour values). No $PM_{2.5}$ monitors exceeded the previous (12 µg/m^3) or new standard (9 µg/m^3). Figure 5 displays only monitoring sites with at least three years of data, which is a requirement to calculate design values.

PM2.5 Monitor Locations

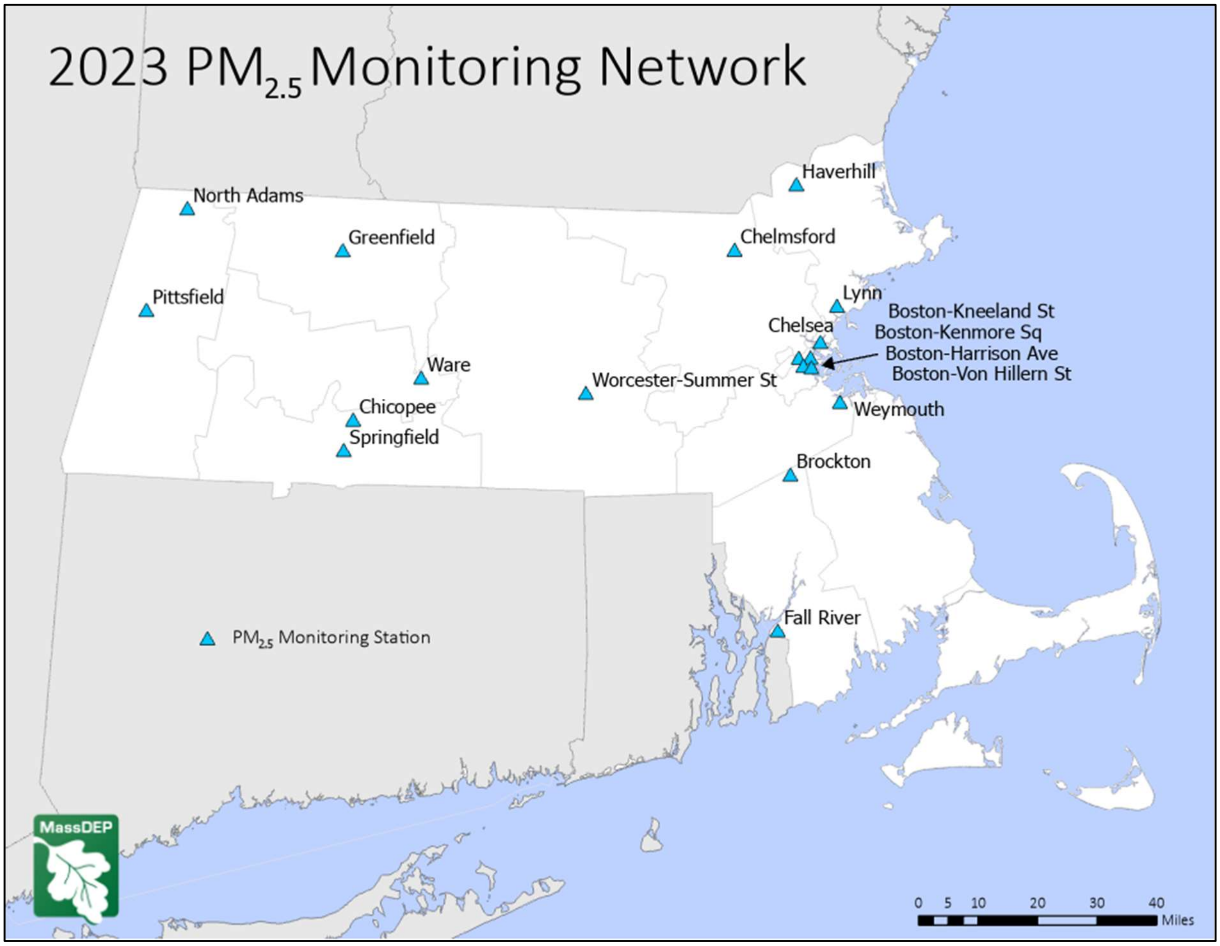


Figure 4
24-hour $PM_{2.5}$ Exceedance Days and Total Exceedances 2014-2023
Exceedances Based on 35 µg/m³ 24-hour Standard

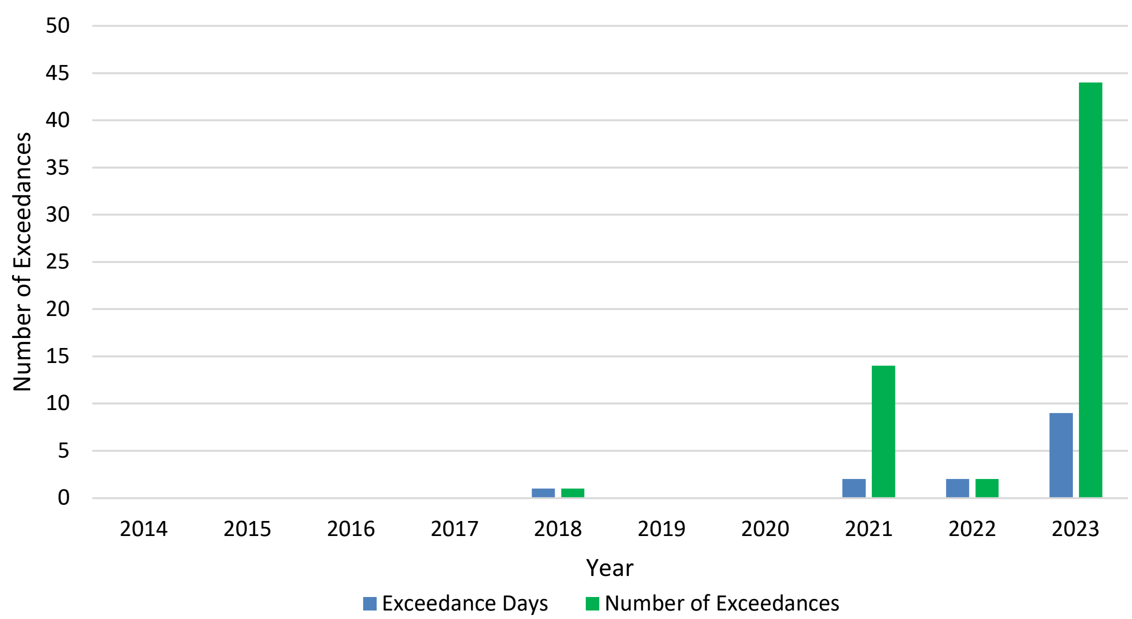
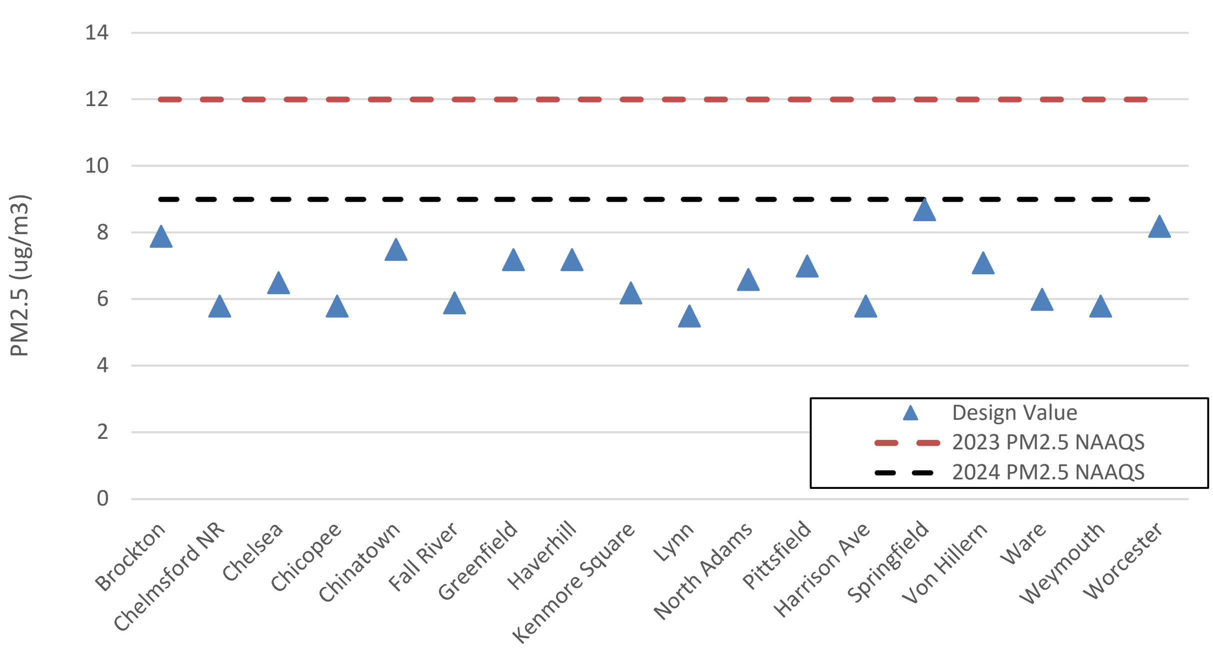


Figure 5
PM2.5 Design Values (2021-2023)
Three Year Average



2023 $PM_{2.5}$ FEM Data Summary

A summary of the 2023 $PM_{2.5}$ FEM data is shown below (in µg/m^3).

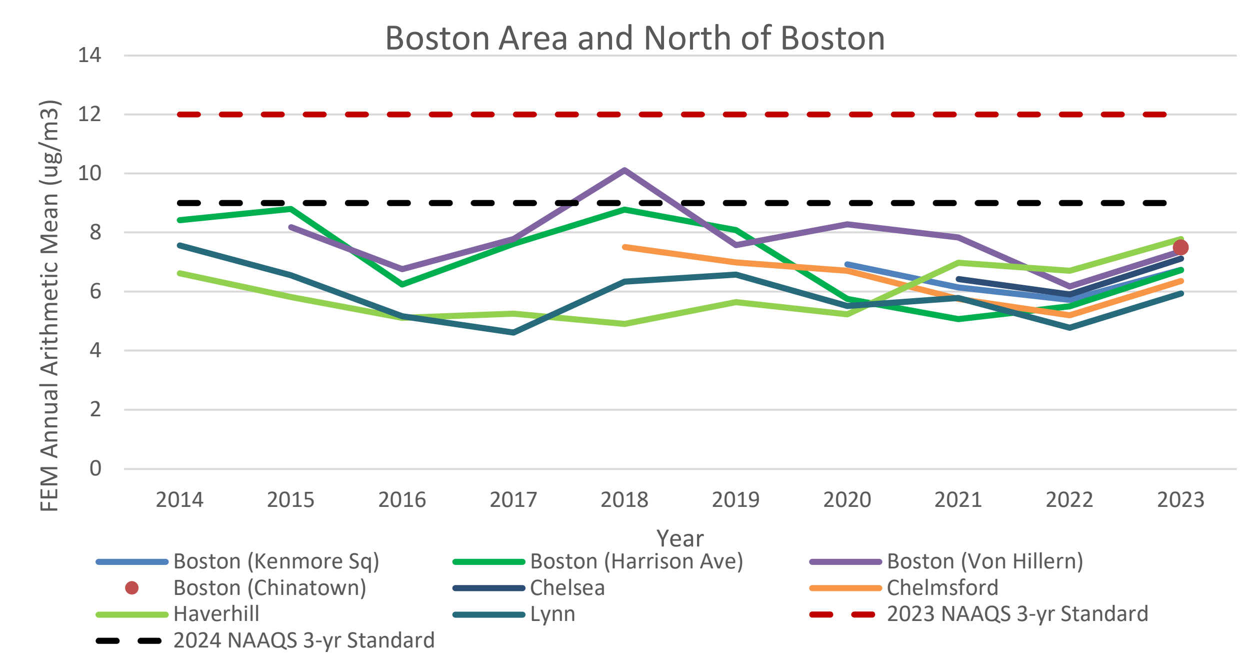
FEM 2023 CITY	COUNTY	ADDRESS	1ST MAX 24-HR	2ND MAX 24-HR	3RD MAX 24-HR	4TH MAX 24-HR	98TH PECENTILE 24-HR	ARITH MEAN
Boston	Suffolk	Kenmore Sq	32.5	32.4	29.1	27.6	17.6	6.73
Boston	Suffolk	Harrison Ave	33.0	32.4	35.1	26.6	18.4	6.72
Boston	Suffolk	Von Hillern St	34.2	32.5	30.0	29.6	19.5	7.36
Boston	Suffolk	Kneeland St	32.4	30.1	29.9	28.4	24.4	7.49
Brockton	Plymouth	Clinton Street	39.5	39.3	33.7	27.7	22.4	6.68
Chelsea	Suffolk	Willow St	30.9	30.1	29.0	28.0	19.6	7.12
Chelmsford	Middlesex	Manning Road	32.0	30.1	28.5	27.5	17.8	6.36
Chicopee	Hampden	Anderson Road	56.6	56.4	50.3	46.9	22.0	6.49
Fall River	Bristol	Globe Street	49.0	47.6	41.1	35.6	25.4	6.56
Greenfield	Franklin	Barr Avenue	58.3	48.5	40.9	40.2	28.6	7.77
Haverhill	Essex	Washington St	36.0	32.6	25.6	21.5	19.2	7.78
Lynn	Essex	Parkland Ave	29.6	26.2	24.2	24.2	17.3	5.93
North Adams	Berkshire	Holden Street	63.0	55.7	53.9	45.4	26.5	7.66
Pittsfield	Berkshire	Silver Lake Blvd	81.3	71.1	63.2	52.5	23.9	6.97
Springfield	Hampden	Liberty Street	49.5	49.0	48.3	43.1	23.6	8.91
Ware	Hampshire	Skyline Drive	49.3	46.0	44.9	39.7	21.9	5.92
Weymouth	Norfolk	Monatiquot St	32.6	32.3	29.7	26.0	20.9	6.34
Worcester	Worcester	Summer Street	52.9	52.2	40.5	32.4	21.0	7.03

2023 NAAQS: Annual Mean = 12.0 µg/m^3
2024 NAAQS: Annual Mean = 9.0 µg/m^3
Primary and Secondary NAAQS: 24-hour (98th percentile) = 35 µg/m^3
Secondary NAAQS: Annual Mean = 15.0 µg/m^3
* = Collocated monitors
1st, 2nd, 3rd, 4th 24-HR MAX = First, Second, Third, and Fourth highest 24-hour values for the year
98th PERCENTILE 24-HR = 98th Percentile value for the year
ARITH MEAN = Annual mean

PM$_{2.5}$ FEM Trends

Figure 6 shows trends of the annual arithmetic mean for each PM$_{2.5}$ FEM monitor over the past 10 years relative to the applicable 2023 standard (12 µg/m^3) and the new 2024 standard (9 µg/m^3).

Figure 6
PM$_{2.5}$ Trends 2014– 2023
FEM Annual Arithmetic Mean



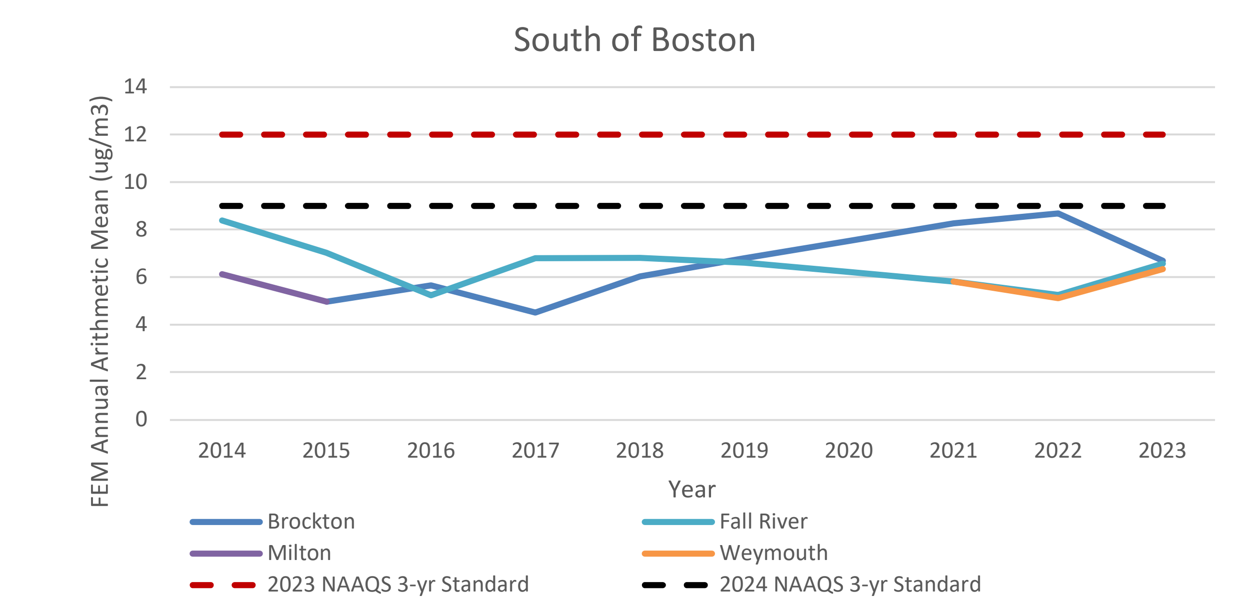
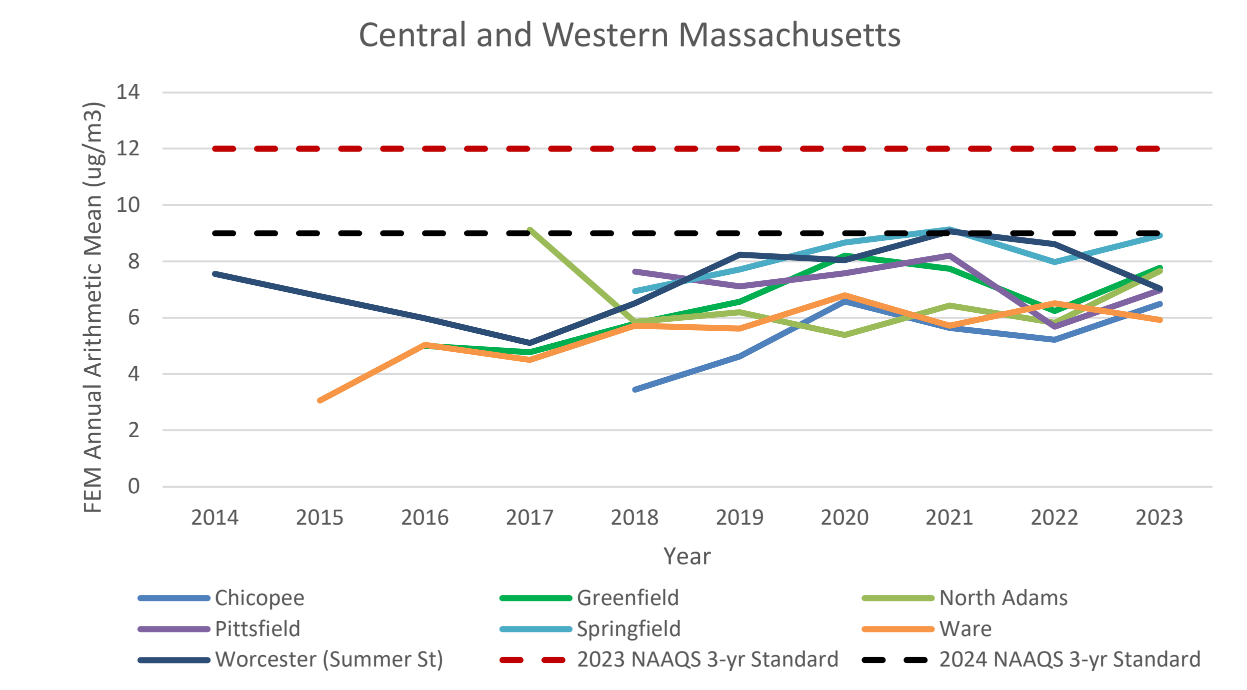


Figure 6 (cont.)
$PM_{2.5}$ Trends 2014– 2023
FEM Annual Arithmetic Mean



2023 $PM_{2.5}$ FRM Data Summary

A summary of the 2023 $PM_{2.5}$ FRM data is shown below (in µg/m^3). All values are well below applicable NAAQS (12 µg/m^3). In the table below, Pittsfield shows a value exceeding the new standard (9 µg/m^3); however, the Pittsfield FRM monitor was discontinued in July 2023 which resulted in a partial data set for an annual mean value. MassDEP continues to monitor $PM_{2.5}$ using an FEM monitor which is discussed above and is well below the new standard.

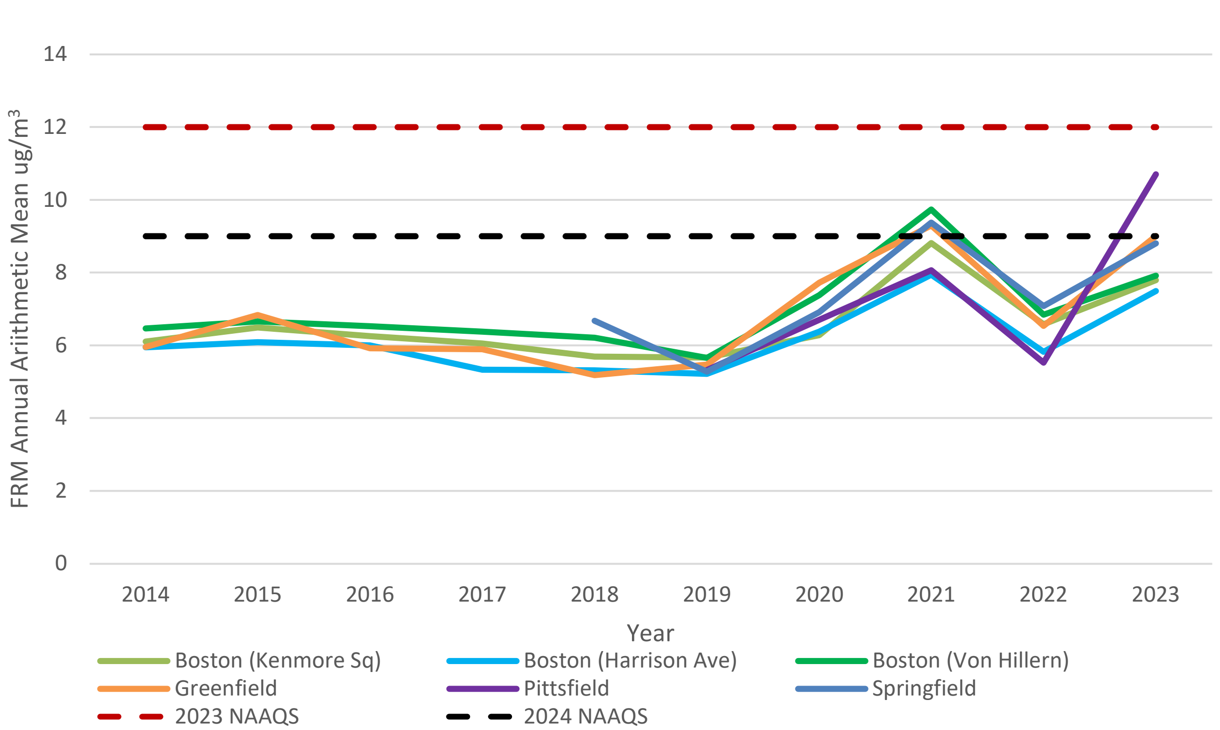
$PM_{2.5}$ FRM 2023			1ST	2ND	3RD	4TH	98TH	
			MAX	MAX	MAX	MAX	PECENTILE	ARITH
CITY	COUNTY	ADDRESS	24-HR	24-HR	24-HR	24-HR	24-HR	MEAN
Boston	Suffolk	Kenmore Square	31.1	24.4	23.1	22.9	24.4	7.79
Boston	Suffolk	Harrison Avenue	32.1	24.7	23.2	19.0	23.2	7.49
Boston	Suffolk	Von Hillern Street	26.6	14.8	13.4	13.2	14.8	7.91
Greenfield	Franklin	Barr Avenue	34.2	29.4	24.4	22.0	29.4	9.00
Pittsfield	Berkshire	Silver Lake Blvd	52.1	35.8	19.9	18.4	52.1	10.70
Springfield	Hampden	Liberty Street	29.6	19.1	16.6	15.6	29.6	8.80

Primary NAAQS: Annual Mean = 12.0 µg/m^3
Primary and Secondary NAAQS: 24-hour (98th percentile) = 35 µg/m^3
Secondary NAAQS: Annual Mean = 15.0 µg/m^3
* = Collocated monitors
1st, 2nd, 3rd, 4th 24-HR MAX = First, Second, Third, and Fourth highest 24-hour values for the year
98th PERCENTILE 24-HR = 98th Percentile value for the year
ARITH MEAN = Annual mean

$PM_{2.5}$ FRM Trends

Figure 7 shows trends of the annual arithmetic mean for each $PM_{2.5}$ FRM monitor over the past 10 years relative to the applicable 2023 standard (12 µg/m³) and the new 2024 standard (9 µg/m³).

Figure 7
$PM_{2.5}$ Trends 2014 – 2023
FRM Annual Arithmetic Mean



2.3 - Particulate Matter 10 Microns (PM_{10}) Summary

2023 PM_{10} Data Summary

A summary of the 2023 PM_{10} data is shown below (in µg/m^3). MassDEP operated two types of PM_{10} monitors in 2023, filter based FRM types and continuous FEM types. In May 2023, MassDEP replaced the non-continuous FRM units, which require laboratory analysis, with FEM types which produce continuous data. However, Boston continues to run FRM PM_{10} for metals analysis and quality assurance. The first table below presents FRM data and the second table presents FEM data. All values are well below applicable NAAQS for both FRM and FEM types.

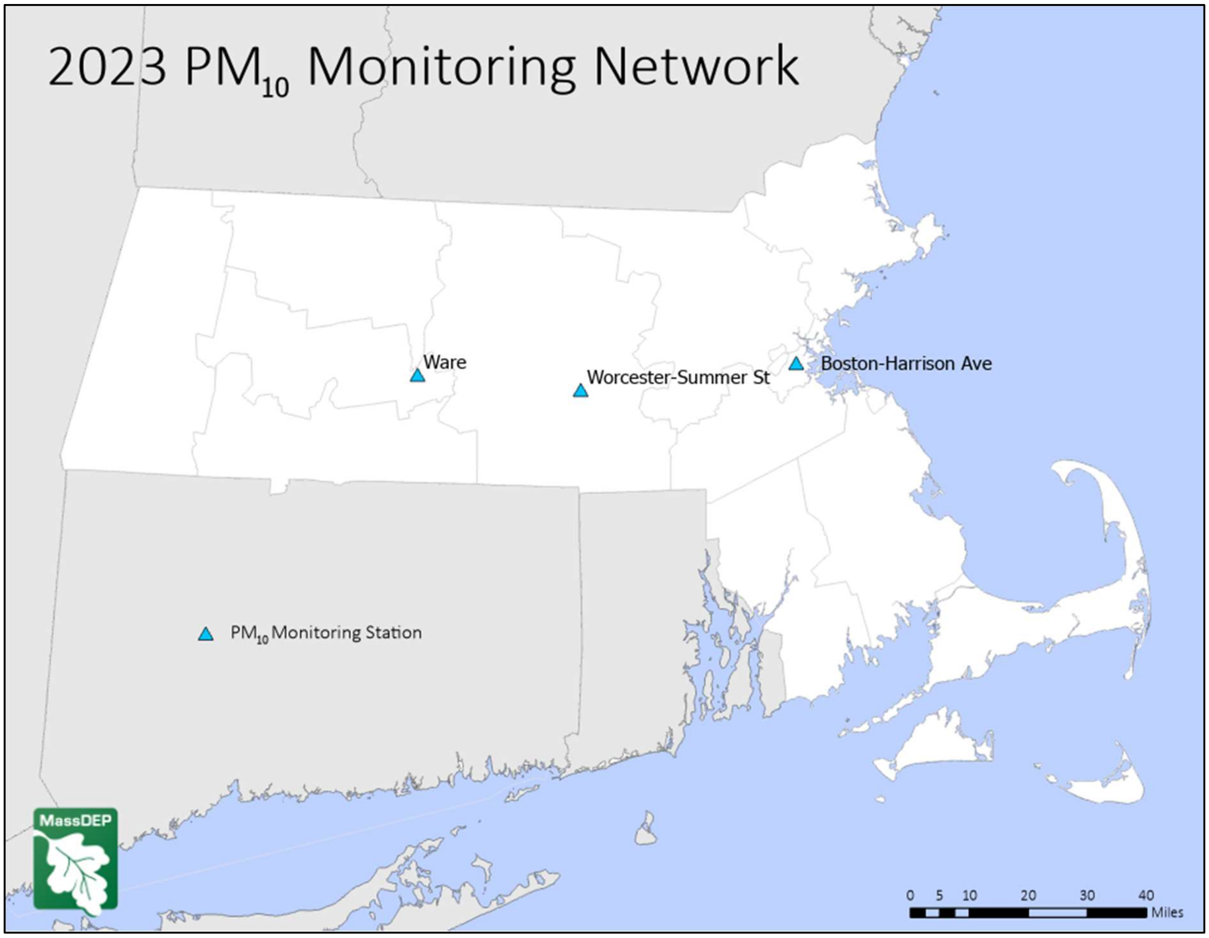
PM_{10} 2023 FRM CITY	COUNTY	ADDRESS	1ST MAX 24-HR	2ND MAX 24-HR	3RD MAX 24-HR	4TH MAX 24-HR	DAYS MAX >STD	ARITH MEAN
Boston	Suffolk	Harrison Avenue	37	27	24	22	0	13.0
Boston	Suffolk	Harrison Avenue*	30	26	22	22	0	12.8
Ware	Hampshire	Skyline Drive	18	10	10	8	0	7.0
Worcester	Worcester	Summer St	29	23	15	15	0	12.7

Primary and Secondary NAAQS: 24-hour = 150 µg/m^3
* = Collocated monitors
1st, 2nd, 3rd, 4th 24-HR MAX = First, Second, Third and Fourth highest 24-hour values for the year
ARITH MEAN = Annual mean

PM_{10} 2023 FEM CITY	COUNTY	ADDRESS	1ST MAX 24-HR	2ND MAX 24-HR	3RD MAX 24-HR	4TH MAX 24-HR	DAYS MAX >STD	ARITH MEAN
Boston	Suffolk	Harrison Avenue	50	47	47	46	0	14.6
Ware	Hampshire	Skyline Drive	71	62	57	55	0	11.0
Worcester	Worcester	Summer St	74	74	63	59	0	15.2

Primary and Secondary NAAQS: 24-hour = 150 µg/m^3
1st, 2nd, 3rd, 4th 24-HR MAX = First, Second, Third and Fourth highest 24-hour values for the year
ARITH MEAN = Annual mean

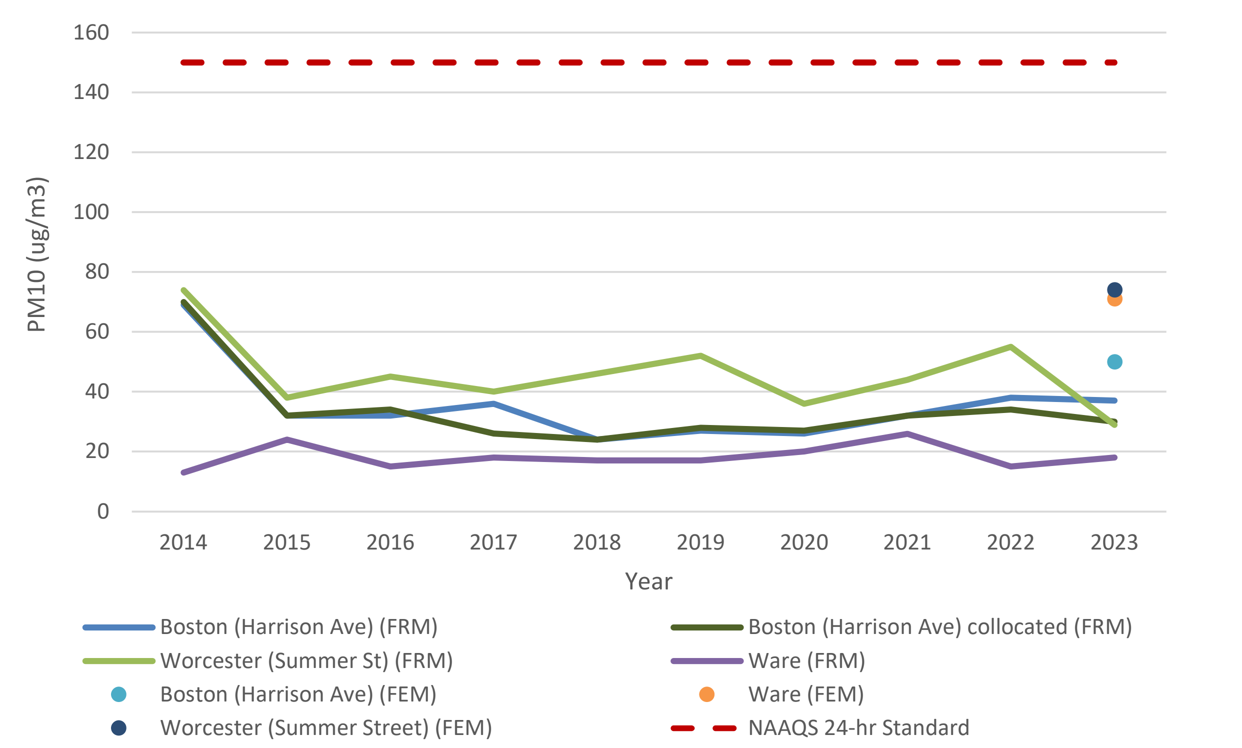
PM_{10} Monitor Locations



PM_{10} Trends

Figure 8 shows the 2023 calendar year 24-hour maximum concentration for each FRM and FEM PM_{10} monitor relative to the 24-hour standard of 150 µg/m^3.

Figure 8
PM_{10} Trends 2014 – 2023
24-Hour Calendar Year Maximum



2.4 - Nitrogen Dioxide (NO_2) Summary

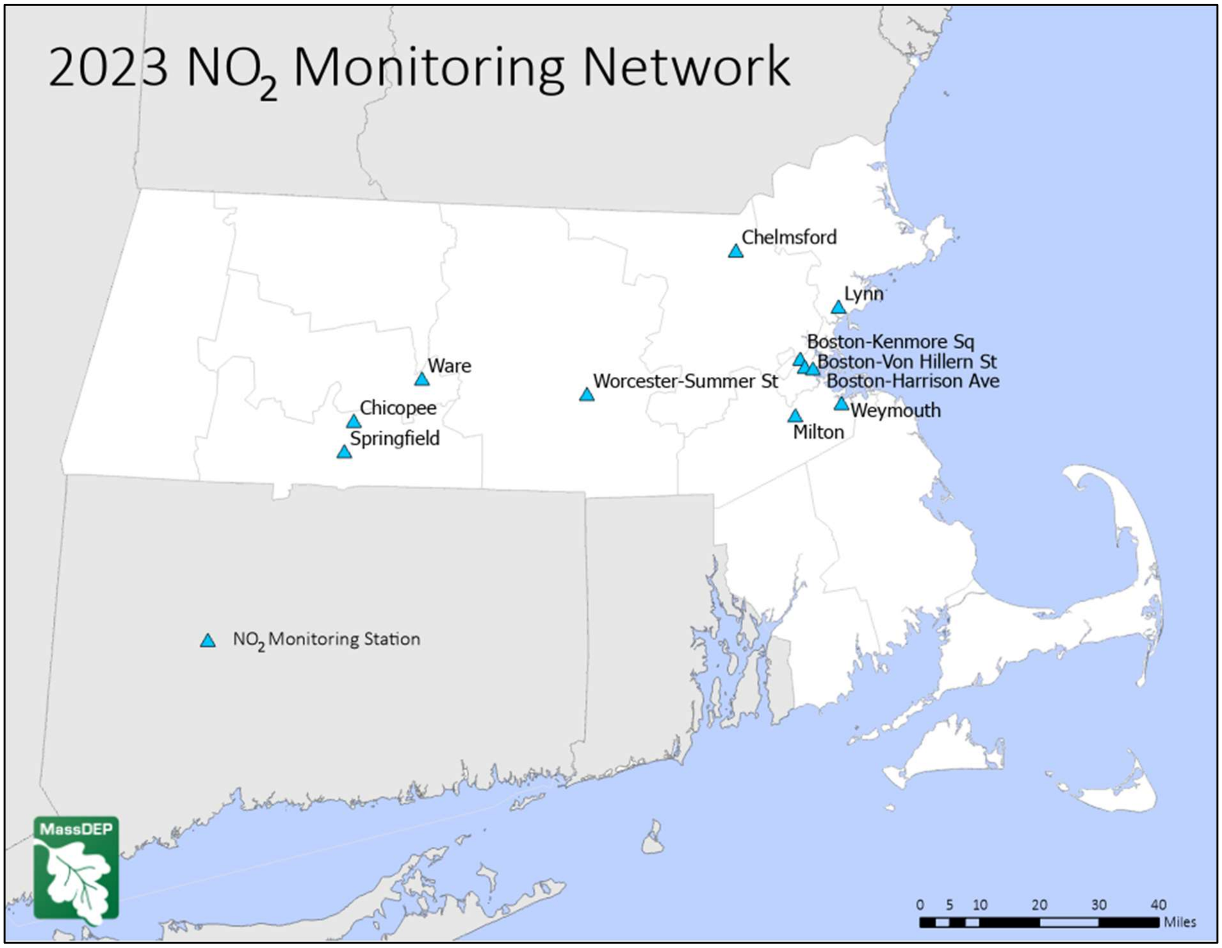
2023 NO_2 Data Summary

A summary of the 2023 NO_2 data is shown below (in parts per billion). MassDEP operated eleven NO_2 monitors during 2023. All values are well below applicable NAAQS.

NO_2 2023 CITY	COUNTY	ADDRESS	1ST MAX 1-HR	2ND MAX 1-HR	98TH PECENTILE VALUE	ARITH MEAN
Boston	Suffolk	Kenmore Square	60.0	49.0	45.0	11.33
Boston	Suffolk	Harrison Avenue	49.0	48.0	42.0	8.77
Boston	Suffolk	Von Hillern Street	59.0	49.0	43.0	11.49
Chelmsford	Middlesex	Manning Road	51.0	49.0	40.0	10.17
Chicopee	Hampden	Anderson Road	37.0	36.0	31.0	4.58
Lynn	Essex	Parkland Avenue	42.4	40.8	33.3	4.58
Milton	Norfolk	Canton Avenue	30.0	24.0	20.0	3.28
Springfield	Hampden	Liberty Street	51.0	50.0	41.0	9.51
Ware	Hampshire	Skyline Drive	34.0	21.0	16.0	1.54
Weymouth	Norfolk	Monatiquot Street	33.0	33.0	30.0	4.89
Worcester	Worcester	Summer Street	47.0	45.0	41.0	9.15

Primary NAAQS: 1-hour = 100 ppb
Primary and Secondary NAAQS: Annual mean = 53 ppb
1^{st}, 2^{nd} MAX 1-HR = First and Second Highest 1-hour Value
ARITH MEAN = Annual Mean

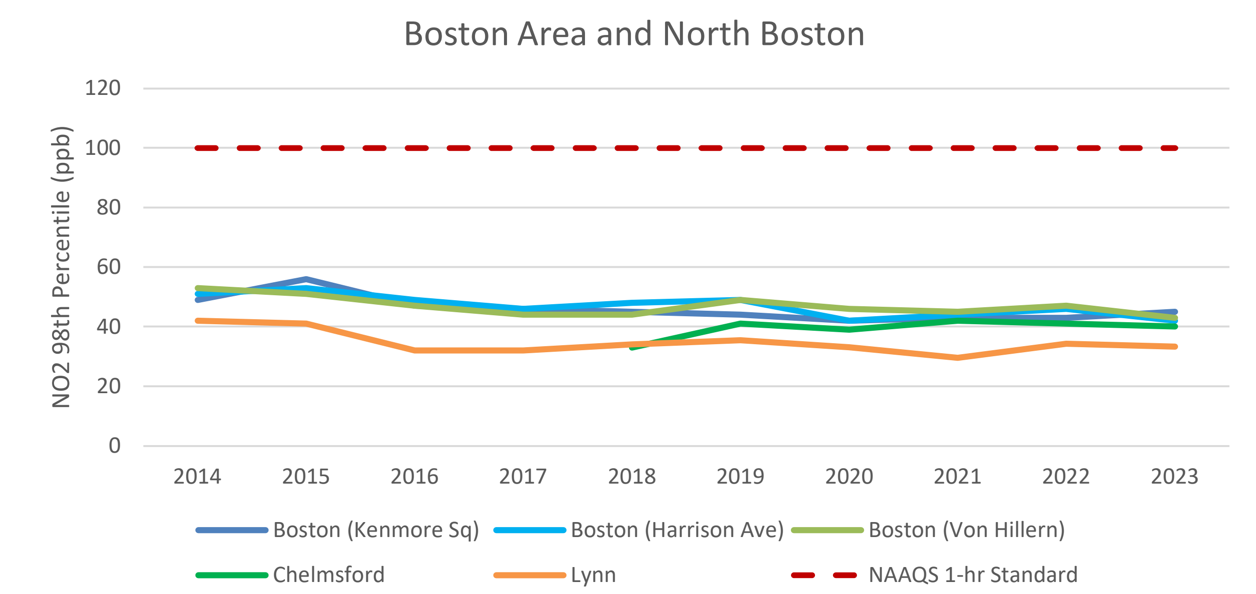
Nitrogen Dioxide Monitor Locations

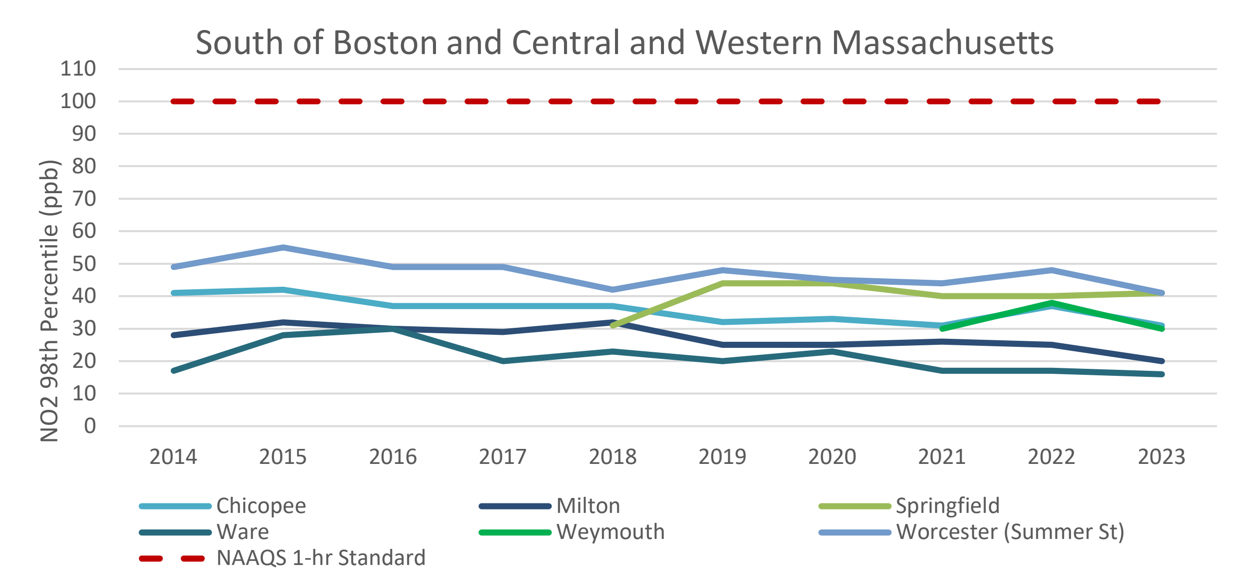


NO_2 Trends

Figure 9 shows the trend of the 1-hour 98th percentile annual average for each NO_2 monitor over the past 10 years relative to the 1-hour standard of 100 ppb.

Figure 9
Nitrogen Dioxide Trends 2014 – 2023
1-hour 98th Percentile Annual Average





2.5 - Sulfur Dioxide (SO_2) Summary

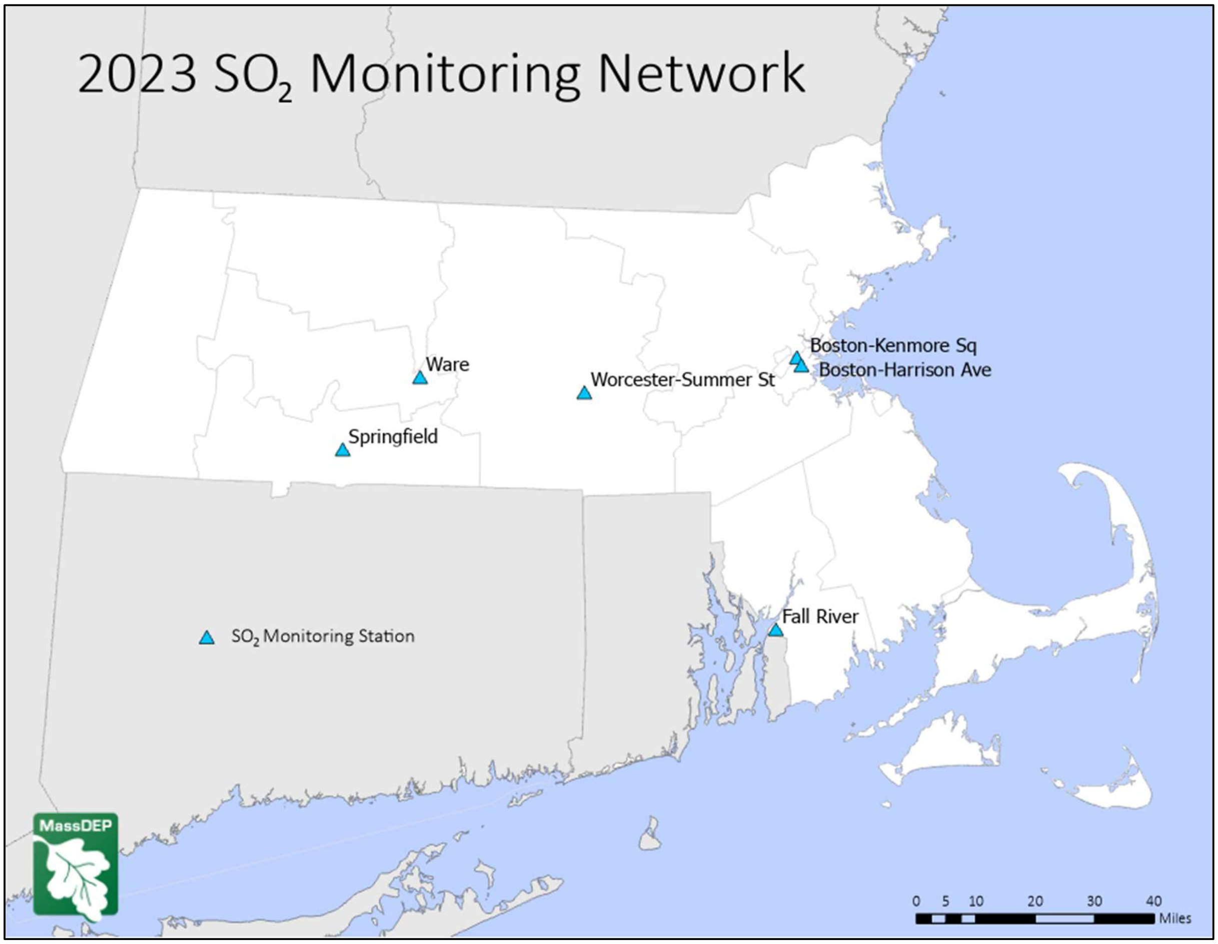
2023 SO_2 Data Summary

A summary of the 2023 SO_2 data is shown below (in parts per billion). MassDEP operated six SO_2 monitors during 2023. All values are well below applicable NAAQS.

SO_2 2023 CITY	COUNTY	ADDRESS	1ST MAX 1-HR	2ND MAX 1-HR	99TH PCTL 1-HR	ARITH MEAN	1ST MAX 24-HR	2ND MAX 24-HR
Boston	Suffolk	Kenmore Square	2.6	2.1	1.6	0.18	1.0	0.8
Boston	Suffolk	Harrison Avenue	2.2	1.7	1.6	0.26	1.0	0.8
Fall River	Bristol	Globe Street	3.4	2.8	2.6	0.38	1.1	1.1
Springfield	Hampden	600 Liberty Street	2.8	2.6	1.5	0.20	1.1	1.0
Ware	Hampshire	Skyline Drive	1.5	1.5	1.3	0.22	0.9	0.8
Worcester	Worcester	Summer Street	2.3	2.2	2.1	0.38	1.1	0.9

Primary NAAQS: 1-hour = 75 ppb
Secondary NAAQS: 3-hour = 0.5 ppm (500 ppb)
1st, 2nd MAX 1-HR = First and Second highest 1-hour value
99th PCTL 1-HR = 99th Percentile of the 1-hour maximum value
ARITH MEAN = Annual mean
1st, 2nd MAX 24-HR = First and Second highest 24-hour value

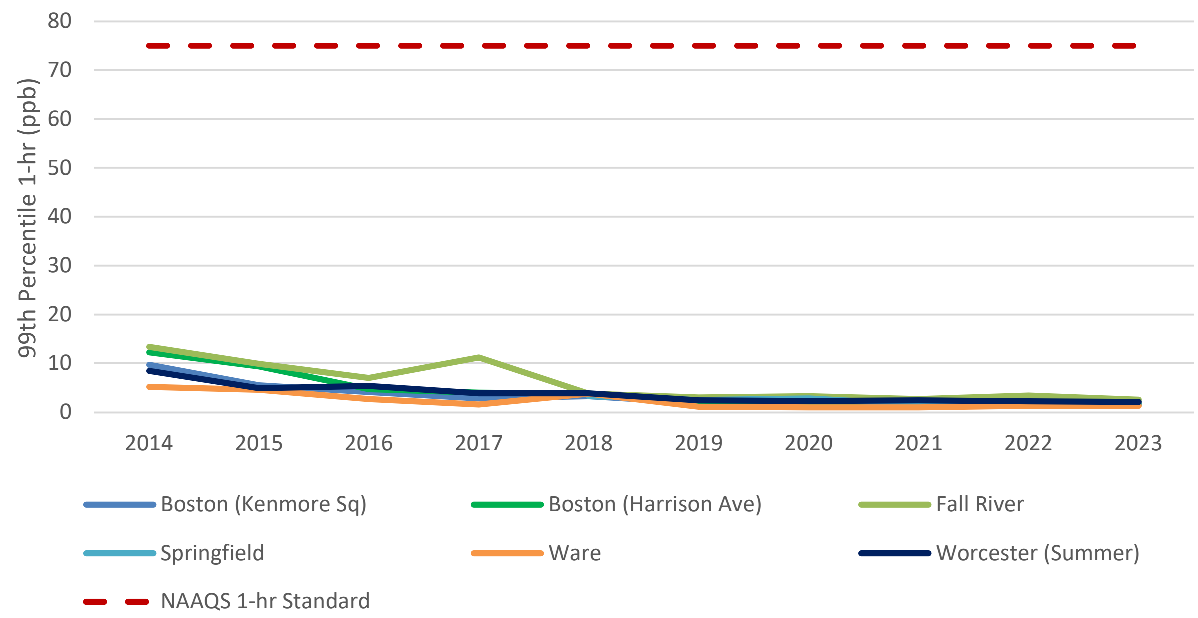
Sulfur Dioxide Monitor Locations



SO_2 Trends

Figure 10 shows the trend of the 1-hour 99th percentile for each SO_2 monitor for the past 10 years relative to the 1-hour standard of 75 ppb.

Figure 10
Sulfur Dioxide Trends 2014 – 2023
1-hour 99th Percentile Annual Average



2.6 - Carbon Monoxide (CO) Summary

2023 CO Data Summary

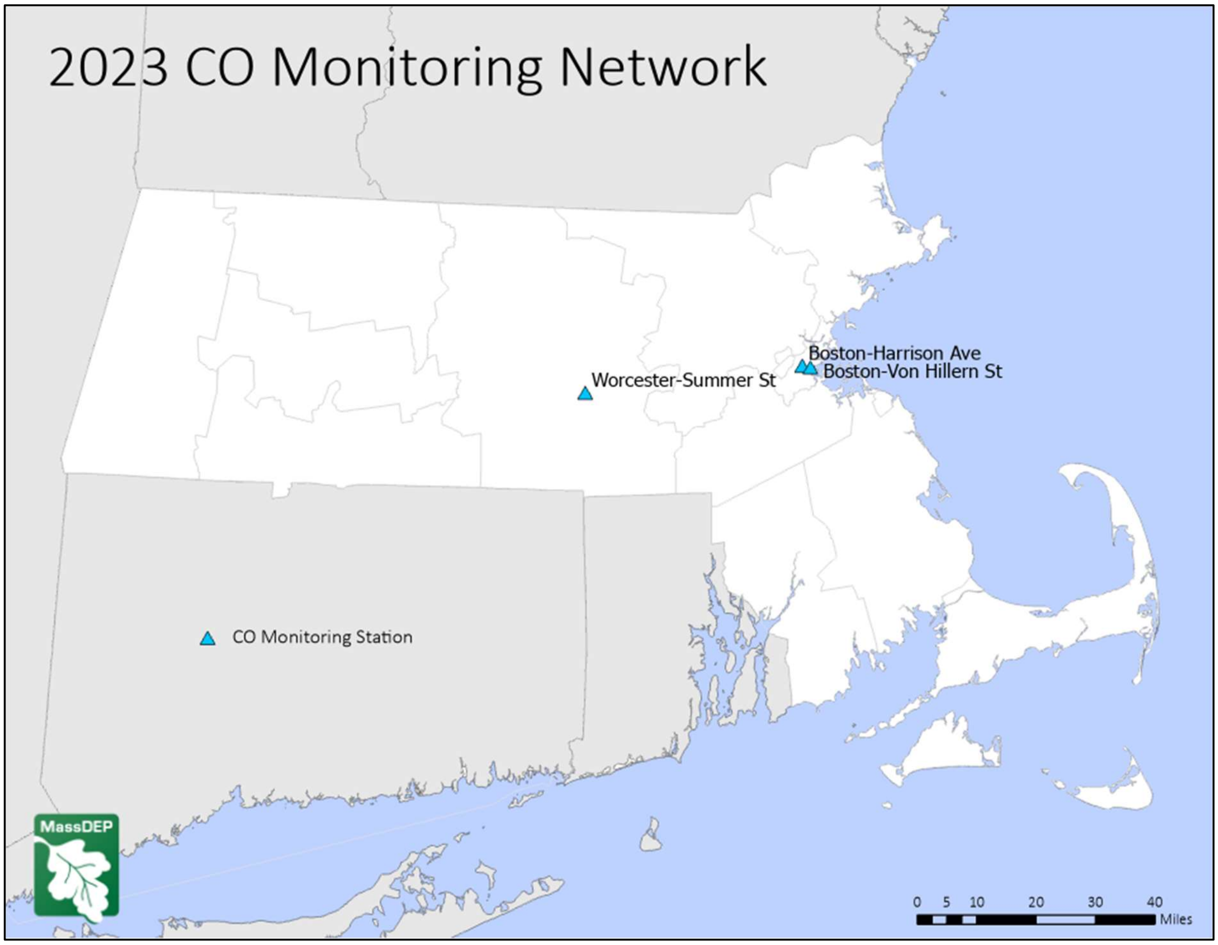
A summary of the 2023 CO data is shown below (in parts per million). MassDEP operated three CO monitors during 2023. All values are well below applicable NAAQS.

CO 2023 CITY	COUNTY	ADDRESS	1ST MAX 1-HR	2ND MAX 1-HR	1ST MAX 8-HR	2ND MAX 8-HR
Boston	Suffolk	Harrison Avenue	1.322	1.147	0.9	0.9
Boston	Suffolk	Von Hillern Street	1.493	1.438	1.0	1.0
Worcester	Worcester	Summer Street	1.913	1.394	1.1	1.1

Primary NAAQS:
- 8-hour = 9 ppm
- 1-hour = 35 ppm

1st, 2nd MAX 1-HR = First and Second highest 1-hour value
1st, 2nd MAX 8-HR = First and Second highest 8-hour value

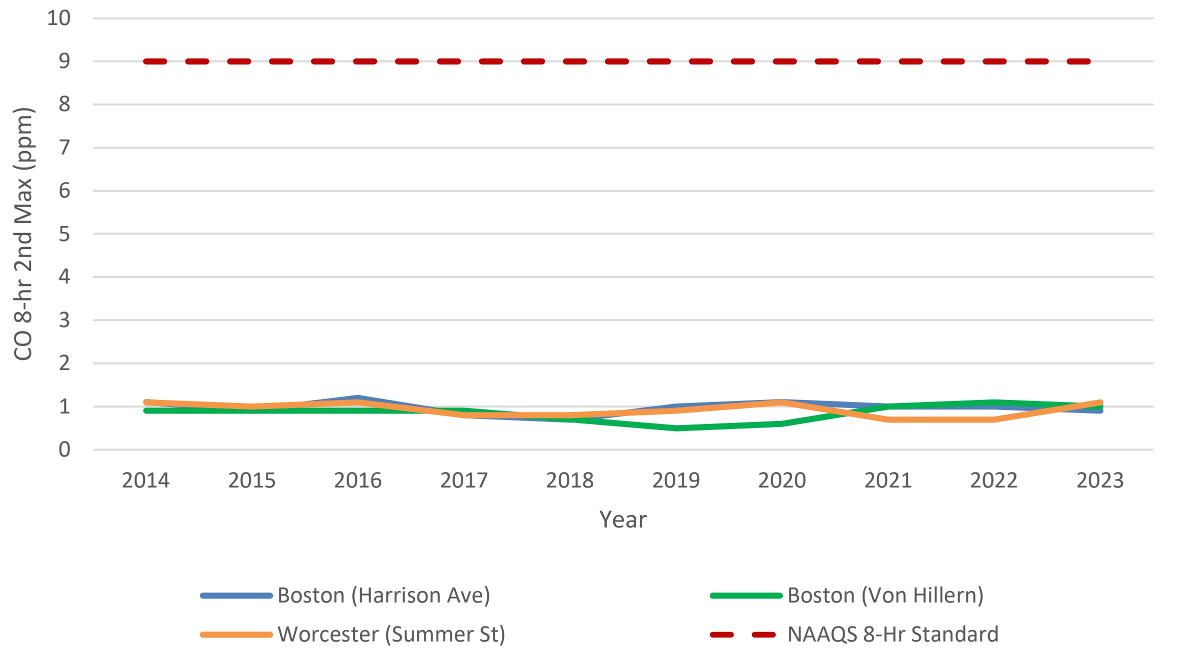
Carbon Monoxide Monitor Locations



CO Trends

Figure 11 shows the trend of the 2nd maximum 8-hour average for each CO monitor over the past 10 years relative to the 8-hour standard of 9 ppm.

Figure 11
Carbon Monoxide Trends 2014 – 2023
2nd Maximum 8-hour Values



2.7 - Speciation

MassDEP collects $PM_{2.5}$ samples at Boston (Harrison Avenue) and Chicopee as part of EPA's Chemical Speciation network (CSN). The CSN is a complement to the $PM_{2.5}$ monitoring network and its objectives include the assessment of trends, developing emission control strategies, aiding in the interpretation of health studies by linking health effects to $PM_{2.5}$ constituents, and identifying air pollution sources that affect the area around the monitoring station.

Speciation involves analysis of particulate matter to determine its chemical composition and to identify air pollution sources that affect the area around the monitoring station. Pollutants analyzed include elements (e.g., metals), sulfates, nitrates, and carbon (total and organic). Speciation samples are sent to UC Davis Air Quality Research Center for analysis and reporting.

2.8 - Interagency Monitoring of Protected Visual Environments (IMPROVE)

IMPROVE is a nationwide program designed to assess air quality at rural locations where air pollution may affect visibility over long distances (e.g., mountain ranges or scenic vistas). During 2023, the National Park Service operated an IMPROVE sampler at the Truro monitoring site, and the Wampanoag Tribe operated an IMPROVE sampler at its Martha's Vineyard monitoring site. These samplers acquire $PM_{2.5}$ filter samples for speciation analysis to determine effects on visibility. Data can be viewed at the IMPROVE web site at http://vista.cira.colostate.edu/improve/Data/data.htm.

2.9 - Quality Assurance and Quality Control (QA/QC)

To ensure that all air quality data is of acceptable and consistent quality, MassDEP has developed standard operating procedures (SOPs) based on federal requirements that include quality control and quality assurance protocols that systematically assess the entire sample collection and data handling system on an ongoing basis. Ambient air monitoring quality assurance requirements are contained in the Federal Regulations at 40 CFR Part 58, Appendix A – E. Each year MassDEP certifies compliance with the federal requirements. A few of the considerations that affect sample collection data quality are:

- Site Placement
- Intake Probe Material
- Intake Probe Height
- Shelter Conditions
- Spacing from roadways and trees

For data analysis, there are quantitative statistics and qualitative descriptors used to interpret the degree of acceptability and utility of data. Examples of these data quality indicators are:

- Representativeness
- Precision and Bias
- Detectability
- Completeness
- Comparability

MassDEP's Air Assessment Branch maintains a Quality Control Group that reviews daily and historical monitored data for validity, tracks precision results, finalizes hourly values, and submits air data and quality results to EPA's database in. Computer software tools, report queries, and "eyes on" data reviews all are used to validate data before it is submitted to EPA.

There also is a Quality Assurance Group that ensures samples are collected correctly and conducts performance audits throughout the air monitoring network to verify data validity. The EPA also conducts its own performance audits on MassDEP samplers and every three years conducts a thorough Technical Systems Audit (TSA). The latest TSA was conducted in 2022.

Section 3 – PAMS/Air Toxics Monitoring

3.1 - Photochemical Assessment Monitoring Station (PAMS) Monitoring

Ground-level ozone is a secondary pollutant and is not emitted directly to the atmosphere from a stack or tailpipe, but forms in the atmosphere from the photochemical reactions of other pollutants such as VOCs and NOx. The PAMS program was established to gather information on the ozone formation process to help agencies identify effective ozone pollution control strategies. In 2023, MassDEP operated one PAMS station in Lynn.

Instruments at the Lynn site measure pollutants and meteorological parameters that are specific to the photochemical processes by which ozone is created in the atmosphere at ground level. In addition to the relevant NAAQS pollutants (e.g., ozone, NO_2), the Lynn site monitors VOCs every six days throughout the year and on an hourly basis during the hottest part of the summer (June, July, and August). Meteorology is a critical component of ozone formation, and the Lynn PAMS site has a full complement of meteorological sensors including wind speed, wind direction, temperature, relative humidity, barometric pressure, solar radiation, ultraviolet radiation, precipitation, and atmospheric mixing heights.

3.2 - Air Toxics Monitoring

Toxic air pollutants are known or suspected to cause cancer or other serious health effects. Air toxics include certain VOCs and toxic metals (e.g., arsenic, cadmium). The Boston (Harrison Avenue) monitoring site is designated as a National Air Toxics Trends Station (NATTS) and monitors multiple toxic air pollutants, including VOCs, carbonyls, metals, black carbon and polycyclic aromatic hydrocarbons (PAHs). Data from this site is compared with data from a network of similar sites across the country to identify transport, trends, and site-specific characteristics of these pollutants. Note that mercury is no longer included in lab analysis, due to its unique chemical properties. Mercury is not a required analysis and has been detected only at trace levels over the past decade. The table below summarizes the 2023 data.

2023 Boston (Harrison Ave, Roxbury)		
Metals	**Max Value (µg/m^3)**	**Mean (µg/m^3)**
Antimony	0.00461	0.001537
Arsenic	0.00120	0.000352
Beryllium	0.00002	0.000003
Cadmium	0.00025	0.000058
Chromium	0.01460	0.005273
Cobalt	0.00038	0.000123
Lead	0.00530	0.001940
Manganese	0.01540	0.004326
Nickel	0.00217	0.000802
Selenium	0.00054	0.000194

MassDEP monitors VOCs in Boston (Harrison Ave), Chelsea, Lynn, and Weymouth. The table below summarizes 24-hour concentrations of target VOCs measured at these locations in 2023.

Compound	Boston		Chelsea		Lynn		Weymouth	
	Max	Mean	Max	Mean	Max	Mean	Max	Mean
formaldehyde*	3.50	2.22	3.20	1.62	3.00	1.88	3.00	1.46
acetaldehyde*	1.45	0.77	1.95	0.76	1.05	0.54	1.65	0.66
chloromethane	0.72	0.57	0.70	0.56	0.75	0.56	0.67	0.58
vinyl chloride	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,3-butadiene	0.07	0.02	0.10	0.02	0.05	0.01	0.03	0.01
butane	2.95	0.86	38.78	3.53	2.55	0.52	7.25	1.03
ethylene oxide	1.20	0.11	0.55	0.08	0.85	0.08	1.45	0.13
bromomethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
chloroethane	0.01	0.01	0.03	0.01	0.03	0.01	0.01	0.01
acrolein	0.33	0.11	0.30	0.11	0.30	0.15	0.37	0.10
trichlorofluoromethane	0.35	0.22	0.26	0.21	0.26	0.21	0.27	0.21
acrylonitrile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
pentane	14.14	0.59	5.70	1.12	0.68	0.20	1.16	0.32
1,1-dichloroethene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
dichloromethane**	7.31	1.04	0.65	0.12	0.13	0.09	0.34	0.10
trans-1,2-dichloroethene	0.70	0.02	0.25	0.02	0.60	0.03	6.54	0.26
1,1-dichloroethane	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00
methyl-t-butyl ether	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
methyl ethyl ketone	2.75	0.40	1.05	0.31	0.83	0.25	1.15	0.36
hexane	0.23	0.09	0.90	0.24	0.18	0.06	0.32	0.10
chloroform	0.03	0.02	0.04	0.02	0.03	0.02	0.03	0.02
1,2-dichloroethane	0.02	0.02	0.03	0.02	0.02	0.01	0.02	0.01
1,1,1-trichloroethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
benzene	0.42	0.18	0.55	0.20	0.32	0.14	0.30	0.12
carbon tetrachloride	0.10	0.08	0.11	0.08	0.10	0.08	0.10	0.08
cyclohexane	0.12	0.04	0.35	0.11	0.50	0.05	0.10	0.04
1,2-dichloropropane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
trichloroethylene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2,2,4-trimethylpentane	0.24	0.09	0.55	0.13	0.18	0.05	0.19	0.07
heptane	0.13	0.05	0.77	0.13	0.11	0.03	0.14	0.06
cis-1,3-dichloropropene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
trans-1,3-dichloropropene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,1,2-trichloroethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
toluene	0.70	0.27	1.06	0.35	0.57	0.29	0.46	0.19
1,2-dibromoethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
octane	0.05	0.02	0.50	0.07	0.13	0.02	0.11	0.05
tetrachloroethylene	0.20	0.02	0.05	0.01	0.05	0.01	0.00	0.00
1,1,1,2-tetrachloroethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

chlorobenzene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ethylbenzene	0.10	0.04	0.23	0.06	0.10	0.02	0.08	0.03
m&p-xylenes	0.28	0.11	0.65	0.17	0.30	0.07	0.26	0.10
bromoform	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00
styrene	0.03	0.01	0.10	0.01	0.08	0.03	0.03	0.01
1,1,2,2-tetrachloroethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
o-xylene	0.10	0.04	0.25	0.07	0.11	0.03	0.09	0.04
alpha-pinene	0.16	0.04	0.13	0.03	0.21	0.05	0.24	0.05
1,3,5-trimethylbenzene	0.02	0.01	0.06	0.01	0.03	0.00	0.02	0.01
1,2,4-trimethylbenzene	0.07	0.03	0.18	0.04	0.11	0.02	0.06	0.02
m-dichlorobenzene	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00
p-dichlorobenzene	0.02	0.00	0.02	0.01	0.02	0.00	0.02	0.00
o-dichlorobenzene	0.00	0.00	0.01	0.00	0.01	0.00	0.01	0.00
n-butylbenzene	0.01	0.00	0.02	0.00	0.01	0.00	0.01	0.00
1,2,4-trichlorobenzene**	0.01	0.00	0.27	0.02	0.01	0.00	0.02	0.00
naphthalene**	0.02	0.01	0.09	0.01	0.03	0.01	0.03	0.01

* Partial data set (January – June)
** Flagged in AQS - Identification of the analyte is acceptable; however, the reported value is an estimate.

Appendix A

2023 Monitoring Stations

City/Town	Address	Parameters Monitored
AQUINNAH*	HERRING CREEK RD	O3, IMPROVE
BOSTON	125 KNEELAND ST	PM2.5
BOSTON	KENMORE SQUARE	NO2, NO, NOx, SO2, PM2.5
BOSTON	1159 HARRISON AVENUE	O3, NO2, NO, NOx, NOy, SO2, CO, PM2.5, PM10, PM Coarse, PM2.5 Speciation, Black Carbon, Toxics, Carbonyls, WS/WD, WSv/WDv, TEMP, SUN, REL, BP
BOSTON	19 VON HILLERN ST	NO2, NO, NOx, CO, PM2.5, Black Carbon, WS/WD, TEMP, SUN, REL, BP
BROCKTON	170 CLINTON ST	O3, PM2.5
CHELMSFORD	11 TECHNOLOGY DR	O3
CHELMSFORD	5 MANNING RD	NO2, NO, NOx, PM2.5, O3, Black Carbon
CHELSEA	75 WILLOW ST	PM2.5, VOCS, Carbonyls
CHICOPEE	ANDERSON RD	O3, NO2, NO, NOx, PM2.5, PM2.5 speciation, WS/WD, TEMP, SUN, REL, BP
FAIRHAVEN	30 SCHOOL ST	O3, WS/WD, TEMP, SUN, REL, BP
FALL RIVER	659 GLOBE ST	O3, SO2, PM2.5
GREENFIELD	16 BARR AVE	O3, PM2.5, Black Carbon, WS/WD, TEMP, SUN, REL, BP
HAVERHILL	685 WASHINGTON ST	O3, PM2.5, WS/WD, TEMP, SUN, REL, BP
LYNN	390 PARKLAND AVE	O3, NO2, NOy, PM2.5, VOCs, Carbonyls, WS/WD, TEMP, SUN, REL, BP, PRECIP, TOTAL UV
MILTON	1904 CANTON AVENUE	O3, NO2, NO, NOx, TEMP, SUN, REL, BP
NORTH ADAMS	86 HOLDEN STREET	PM2.5, Black Carbon
PITTSFIELD	25 SILVER LAKE DR	O3, PM2.5, Black Carbon, WS/WD, TEMP, SUN, REL, BP
SPRINGFIELD	600 LIBERTY STREET	NO2, NO, NOx, SO2, PM2.5, Black Carbon
TRURO	6 COLLINS ROAD	O3, WS/WD, TEMP, SUN, REL, BP, IMPROVE
UXBRIDGE	366 E. HARTFORD AVE	O3, WS/WD, TEMP, SUN, REL, BP
WARE	36 SKYLINE DRIVE	O3, NO2, NO, NOx, NOy, SO2, PM2.5, PM10, WS/WD, TEMP, SUN, REL, BP
WEYMOUTH	59 MONATIQUOT ST	O3, NO2, NO, NOx, PM2.5, WS/WD, TEMP, SUN, REL, BP, VOCS, Carbonyls
WORCESTER	375 AIRPORT DRIVE	O3, WS/WD, TEMP, SUN, REL, BP
WORCESTER	SUMMER STREET	NO2, NO, NOx, SO2, CO, PM2.5, PM10

*Tribal Site