NEW YORK STATE | Department of Environmental Conservation

NEW YORK STATE

Ambient Air Monitoring Program

June 10, 2020

BUREAU OF AIR QUALITY SURVEILLANCE
DIVISION OF AIR RESOURCES
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

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Executive Summary

This document is prepared as part of the requirements specified in the Monitoring Regulations 40 CFR Parts 53 and 58. All monitoring networks operated by the Bureau of Air Surveillance, Division of Air Resources were evaluated to determine if they meet the monitoring objectives as defined by the regulations. Considerations were given to: population and geographical coverage; air quality trends; attainment classification; emissions inventory; parameters monitored; special purpose monitors; health related and scientific research; external data users; new and proposed regulations; quality assurance; technology; personnel and training.

As a whole, New York has one of the most comprehensive and robust ambient air monitoring programs in the nation. New York meets or exceeds current monitoring requirements in nearly all instances. There are an adequate number of monitoring stations in populated areas, including where sensitive subgroups reside. Networks for criteria and non-criteria pollutants meet specified monitoring objectives. The toxics analytical laboratory has proven to be one of the best in the country, as demonstrated by NATTS Assessments, data produced for the LISTOS project, and several community scale efforts. New York is amongst the first to deploy new monitoring technology in the network. Staff routinely communicate findings via publication in peer reviewed scientific journals and present these data at technical conferences.

The monitoring network has been consolidated over the past five years to better utilize resources and eliminate redundancy in parameters in terms of sites and sampling frequency. One emerging issue that requires serious consideration is the aging of current monitoring staff. To address this matter, program management needs to recruit young professionals into the organization to replace retiring staff.

Table of Contents

Introduction

The U.S. Environmental Protection Agency (EPA) finalized Revisions to Ambient Air Monitoring Regulations 40 CFR Parts 53 and Part 58 on October 17, 2006. As required by §58.10(d), "the State, or where applicable local, agency shall perform and submit to the EPA Regional Administrator an assessment of the air quality surveillance system every 5 years to determine, at a minimum, if the network meets the monitoring objectives defined in appendix D to this part whether new sites are needed, whether existing sites are no longer needed and can be terminated, and whether new technologies are appropriate for incorporation into the ambient air monitoring network." The first such assessment was submitted to the EPA on July 1, 2010. This document is prepared and submitted along with the 2020 Annual Monitoring Network Plan (AMNP) to fulfill these requirements.

New York State Ambient Air Monitoring Networks

The Division of Air Resources, New York State Department of Environmental Conservation (NYSDEC) operates 58 monitoring sites statewide for the measurement of criteria and non-criteria contaminants. A site map depicting monitor locations is shown in Figures 1 and 2. The continuous monitoring network is comprised of 28 ozone (O_3), 18 sulfur dioxide (SO_2), eleven oxides of nitrogen (NO_x/NO_y), 9 carbon monoxide (CO), 28 continuous $PM_{2.5}$ (TEOMs) and five TAPI T640 ($PM_{2.5}$, PM_{10}, PMcoarse), two speciated carbon, six black carbon (aethalometer), two speciated mercury, four particulate sulfate, two size distribution ultrafine particle counter, and 12 meteorological data stations. In addition, there are manual sampling networks in place for the measurement of $PM_{2.5}$ (22 FRM, 8 Speciation), PM_{10} (5), toxics (11 VOCs, 10 carbonyls, 2 PAHs), non-FRM lead (1), PM_{10} metals (2), and acid deposition (7). New York's ambient air monitoring program is one of the most robust and comprehensive operations in the country. Detailed information about the monitoring networks is provided in the 2020 MNP.

The objectives of New York's ambient air monitoring networks are to:

(a) Provide air pollution data to the general public in a timely manner;
(b) Provide data to determine compliance with ambient air quality standards and to develop emission control strategies; and
(c) Support air pollution research studies.

Using our monitoring data, the NYSDEC meteorologists provide daily Air Quality Index (AQI) forecasts and health advisories when warranted to the public through the news media as well as the Department's website, on which up to the hour air quality measurements from all continuous monitoring sites are posted. Ozone and $PM_{2.5}$ data are electronically transmitted hourly to the EPA's AIRNow. Annual or more frequent reports for all other monitored parameters are available on our website. (https://www.dec.ny.gov/chemical/34985.html)

Data from our monitors for the criteria pollutants are used for comparing an area's air pollution levels against the National Ambient Air Quality Standards (NAAQS) to determine attainment status classification. In addition, the data are utilized for the development of attainment and maintenance plans, evaluation of the regional air quality models used in developing emission strategies, and the tracking of trends in air pollution abatement control measures aimed at improving air quality. In monitoring locations near major air pollution sources, source-oriented monitoring data provide insight into how well industrial sources are controlling their pollutant emissions.

Our monitoring data have been used to supplement data collected by researchers working on health effects assessments and atmospheric processes, and for monitoring methods development work. Collaborations with external researchers have culminated in the publication of significant findings in peer-reviewed scientific journal articles in many instances. A listing of publications and presentations can be found in the AMNP.

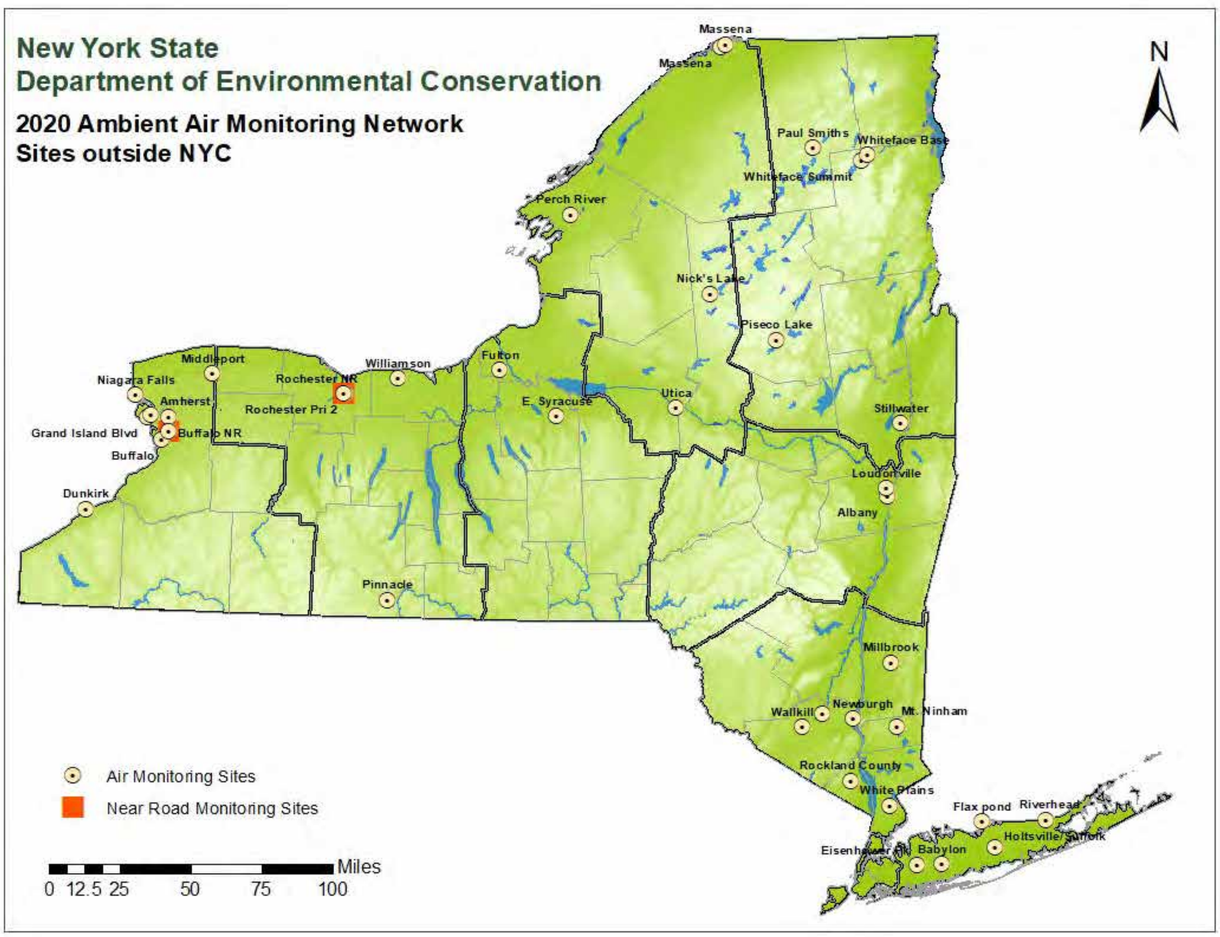


Figure 1 Location Map of Monitoring Sites in New York State Outside of New York City

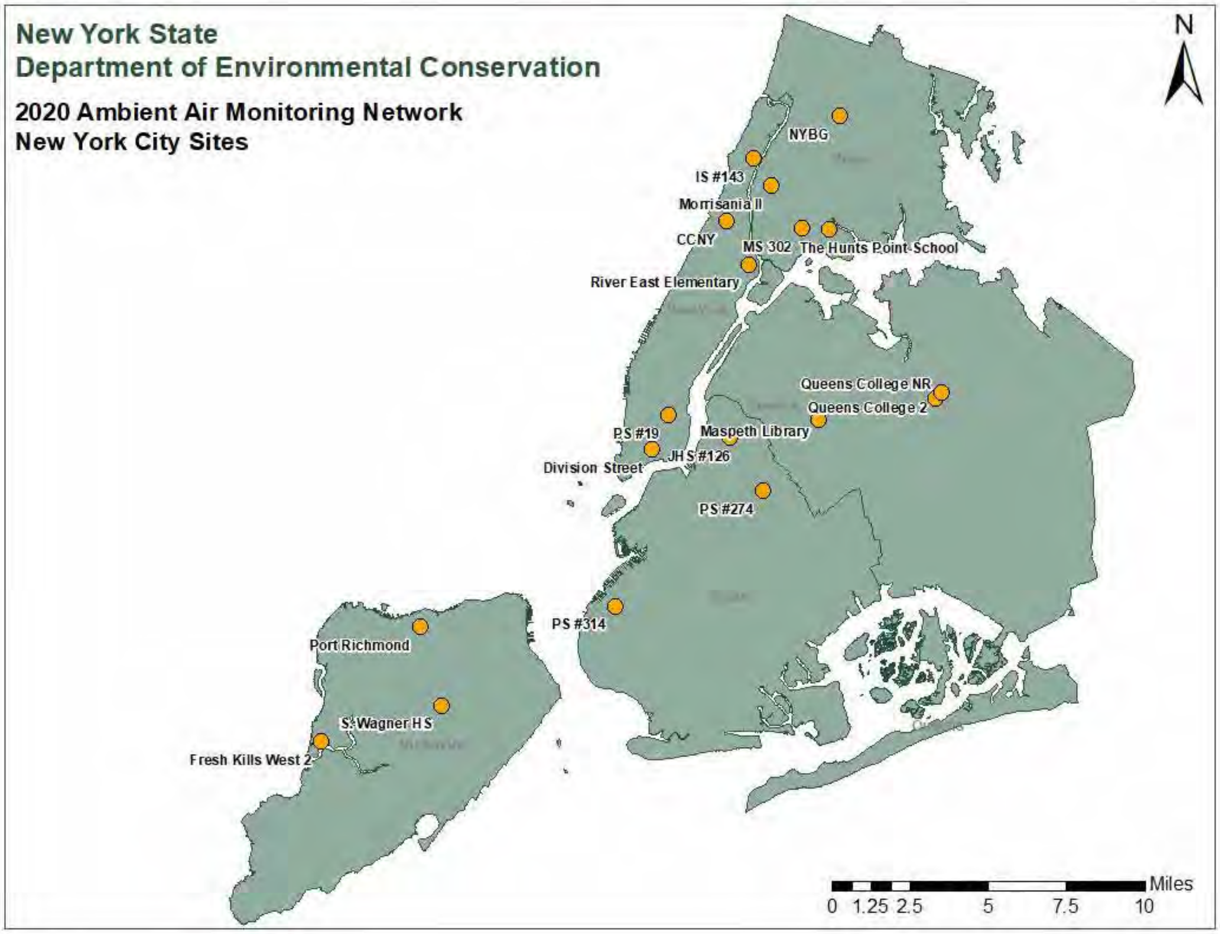


Figure 2 Location Map of Monitoring Sites in New York City

In accordance to requirements specified in the Monitoring Regulations 40 CFR Parts 53 and 58, annually the monitoring agency is required to evaluate "if the network meets the monitoring objectives defined in appendix D to this part, whether new sites are needed, whether existing sites are no longer needed and can be terminated, and whether new technologies are appropriate for incorporation into the ambient air monitoring network." With EPA's approval, the number of monitoring sites has grown from 55 in 2015 to 58 currently.

Population

The 2010 Census lists the state population for New York as 19,378,102. According to Census Bureau estimates the NY state population in 2018 totaled 19,530,351, the fourth most populous state in the nation. The population change in the previous eight-year period indicates a net increase of 152,249 for the entire state. A Census Bureau estimated population breakdown of major Metropolitan Statistical Areas (MSAs) is provided in Table 1 below. The state saw a modest growth overall in the eight-year period, mostly in the downstate areas at the expense of the western MSAs, and some small declines in some upstate MSAs.

Table 1 Population of Major Metropolitan Statistical Areas in New York

MSA	2010	2018*	Difference	%
Albany-Schenectady-Troy	870,716	883,169	12,453	1%
Binghamton	251,725	240,219	-11,506	-5%
Buffalo-Cheektowaga-Niagara Falls	1,135,509	1,130,152	-5,357	0%
Elmira	88,830	84,254	-4,576	-5%
Glens Falls	128,923	125,462	-3,461	-3%
Ithaca	101,564	102,793	1,229	1%
Kingston	182,493	178,599	-3,894	-2%
New York-Newark-Jersey City NY-NJ-PA Metro Area	19,567,410	19,979,477	412,067	2%
Dutchess County-Putnam County NY Metro Division	397,198	392,610	-4,588	-1%
Nassau County-Suffolk County NY Metro Division	2,832,882	2,839,436	6,554	0%
New York-Jersey City-White Plains NY-NJ Metro Division	13,866,159	14,242,759	376,600	3%
Rochester	1,079,671	1,071,082	-8,589	-1%
Syracuse	662,577	650,502	-12,075	-2%
Utica-Rome	299,397	291,410	-7,987	-3%
Watertown-Fort Drum	116,229	111,755	-4,474	-4%
State Total	**19,378,102**	**19,530,351**	**152,249**	**1%**

*Census Bureau estimation

Environmental Justice Areas

Environmental justice (EJ) is defined as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

Environmental justice efforts focus on improving the environment in communities, specifically minority and low-income communities, and addressing disproportionate adverse environmental impacts that may exist in those communities.

A map of potential EJ areas in the State is shown in Figure 4. In our network, there are 21 air monitors, 14 of which are downstate, sited within areas designated as such. The number of air monitoring sites located in potential EJ areas is commensurate with the population percentage residing therein. In the populous downstate area, 67% of the network monitors are located in potential EJ areas, where 52% of the population lives. Table 2 lists potential EJ monitors in the network.

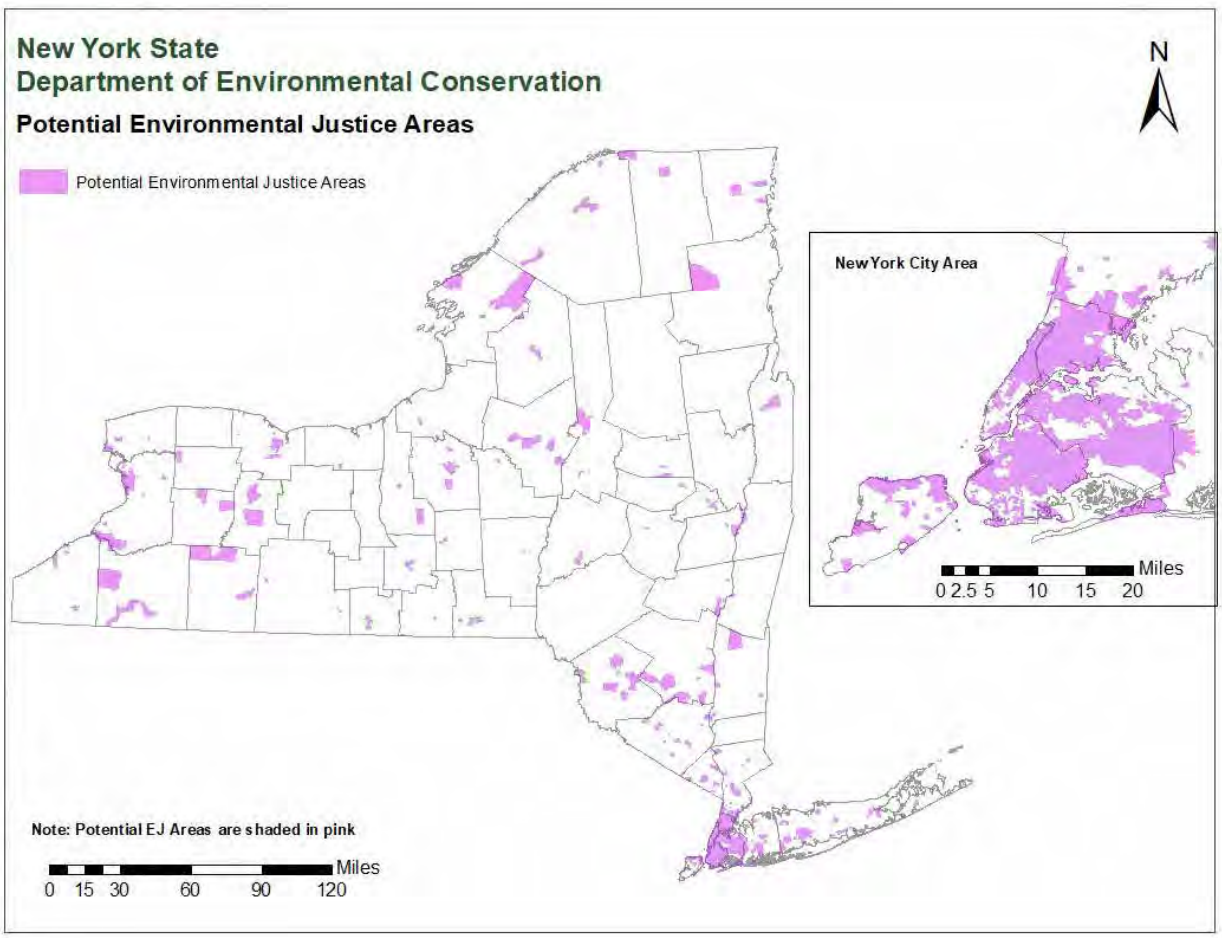


Figure 3 Potential Environmental Justice Areas in New York State

Table 2 Monitoring Sites Located in Potential EJ Areas

DEC Region	AIRS #	DEC #	Site Name	County	Location
2	36-005-0080	7094-05	Morrisania II	Bronx	Family Care Ctr, 1225-57 Gerard Ave
2	36-005-0083	7094-06	NYBG Pfizer Lab	Bronx	200th St. & Southern Blvd.
2	36-005-0110	7094-07	IS 52	Bronx	681 Kelly St., E 156th St.
2	36-005-0112	7094-08	IS 74	Bronx	730 Bryant Avenue
2	36-047-0052	7095-07	PS 314	Kings	330 59th St.
2	36-047-0118	7095-98	PS 274	Kings	800 Bushwick Ave
2	36-061-0079	7093-08	JHS 45	New York	2351 1st Avenue
2	36-061-0115	7093-15	IS 143	New York	511 W 182nd St.
2	36-061-0134	7093-24	Division Street	New York	Division Street
2	36-061-0135	7093-25	CCNY	New York	160 Convent Avenue
2	36-081-0124	7096-15	Queens College II	Queens	DEC Monitoring Building
2	36-085-0067	7097-01	Susan Wagner	Richmond	1200 Manor Road
2	36-085-0055	7097-03	Port Richmond	Richmond	364 Port Richmond Avenue
3	36-071-0002	3502-04	Newburgh	Orange	Public Safety Building
4	36-001-0005	0101-13	Albany	Albany	Albany County Health Department
4	36-001-0012	0101-33	Loudonville	Albany	Reservoir
6	36-065-2001	3202-01	Utica	Oneida	Utica Health Dept
9	36-029-0005	1401-18	Buffalo	Erie	Off Dingens St., near Weiss
9	36-063-7001	3102-26	Niagara Falls	Niagara	Packard Ct Comm Center

Sensitive Sub-Populations

Children, the elderly, and people with underlying health issues may be more susceptible to the deleterious effects associated with air pollution and are considered to be under the sensitive sub-population category. Fourteen monitoring sites in the network are located on public school grounds, where attending students are of grade school to university age.

Citizens groups often approach the Department to request studies in areas where they believe there are high incidences of health-related problems due to air pollution, such as asthma, respiratory diseases, and cancer clusters. Where possible, we try to accommodate concerned citizens by providing air quality data from nearby monitoring sites. For example, data from IS 143 has been provided to the Lower Washington Heights Neighborhood Association. We have established special purpose monitors in the Buffalo area, as well as in Albany in response to community concerns.

Air Quality in New York State

Statewide concentration trends for all criteria contaminants are provided in the pollutant-specific discussion below. There has been no contravention of the NAAQS for all criteria pollutants in the entire state except for ozone in the New York City metropolitan area and SO_2 in a small portion of northern St. Lawrence County. Since the SO_2 contravention is related to two site specific monitors and will be addressed in the forthcoming (Round 4) designation process for the 2010 1-hr SO_2 NAAQS, considerations in this report are given for ozone only.

The Air Quality Index (AQI) is an index for reporting daily air quality. It was created as an easy way to correlate levels of different pollutants to one scale to show the public how clean or polluted the air is, and what associated health effects might be of concern. When levels of ozone and/or fine particles are expected to exceed an AQI value of 100, an Air Quality Health Advisory is issued alerting sensitive groups to take necessary precautions.

As an alternative to using the actual pollutant concentrations, one can assess air quality by using the number of AQI days that are unhealthy for sensitive groups (AQI>100) as a metric. The following table shows the number of unhealthy AQI days for ozone during the last three years based on the current NAAQS. Also listed is the three-year average, which serves to lessen the influence of year-to-year variations in meteorology.

The three-year average number in Table 4 is a good indicator of the severity of ozone pollution in the monitored area. It appears that ground level ozone pollution in the Northeast has remained stable over the past three years as demonstrated by the number of violation days shown in Table 3 below.

Table 3. Days with Ozone Violation in Northeastern States

State	Number of Violation Days		
	2016	2017	2018
Connecticut	21	10	17
Delaware	5	4	3
District of Columbia	1	1	3
Maryland	14	8	4
Massachusetts	7	6	5
New Jersey	12	12	13
New York	11	10	10
Pennsylvania	13	11	13
Rhode Island	3	5	5

Table 4 Days AQI>100 for Ozone Based on 24-hr Monitoring Data

MSA/Micropolitan	Days O_3 AQI>100 (24 hr)			3 year average
Site	2016	2017	2018	
New York-White Plains				
CCNY	1	1	4	2.0
Pfizer Lab	1	2	4	2.3
IS 52	1	2	2	1.7
Queens College	2	4	3	3.0
Susan Wagner	4	2	0	2.0
Fresh Kills West	0	0	4	1.3
White Plains	3	0	4	2.3
Mt. Ninham	3	0	1	1.3
Rockland	3	0	1	1.3
Buffalo-Niagara Falls				
Amherst	1	1	0	0.7
Middleport	1	0	0	0.3
Nassau-Suffolk				
Babylon	2	4	3	3.0
Holtsville	2	2	4	2.7
Flax pond	0	0	2	0.7
Riverhead	4	4	1	3.0
Albany-Schenectady-Troy				
Loudonville	1	0	0	0.3
Stillwater	1	0	1	0.7
Syracuse				
East Syracuse	1	0	0	0.3
Fulton	0	0	0	0.0
Poughkeepsie-Newburgh-Middletown				
Millbrook	2	0	1	1.0
Valley Central	0	0	1	0.3
Rochester				
Rochester	1	0	0	0.3
Williamson	2	0	0	0.7
Watertown-Fort Drum				
Perch River	1	0	0	0.3
Jamestown-Dunkirk-Fredonia				
Dunkirk	2	2	1	1.7
Corning				
Pinnacle State Park	1	0	0	0.3
Essex County				
Whiteface Summit	0	0	0	0.0
Whiteface Base	0	0	0	0.0
Hamilton County				
Piseco Lake	0	0	0	0.0

National Ambient Air Quality Standards

EPA is required to set National Ambient Air Quality Standards (NAAQS) for wide-spread pollutants considered harmful to public health and the environment that are emitted from numerous and diverse sources. The Clean Air Act established two types of national air quality standards. Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against visibility impairment, damage to animals, crops, vegetation, and buildings. The Clean Air Act requires periodic review of the science upon which the standards are based and the standards themselves. Listed in Table 5 below are the NAAQS for six principal pollutants, which are called "criteria" pollutants. Monitoring data from our networks are used for comparison against these standards to determine attainment designations and classifications.

Table 5 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 $\mu g/m^3$ [1]	Not to be exceeded
Nitrogen Dioxide		primary	1-hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		primary and secondary	Annual	53 ppb [2]	Annual Mean
Ozone		primary and secondary	8-hour	0.070 ppm [3]	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
Particle Pollution	$PM_{2.5}$	primary	Annual	12.0 $\mu g/m^3$	annual mean, averaged over 3 years
		secondary	Annual	15.0 $\mu g/m^3$	annual mean, averaged over 3 years
		primary and secondary	24-hour	35 $\mu g/m^3$	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24-hour	150 $\mu g/m^3$	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide		primary	1-hour	75 ppb [4]	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		secondary	3-hour	0.5 ppm	Not to be exceeded more than once per year

(1) In areas designated nonattainment for the Pb standards prior to the promulgation of the current (2008) standards, and for which implementation plans to attain or maintain the current (2008)

standards have not been submitted and approved, the previous standards (1.5 µg/m3 as a calendar quarter average) also remain in effect.

(2) The level of the annual NO2 standard is 0.053 ppm. It is shown here in terms of ppb for the purposes of clearer comparison to the 1-hour standard level.

(3) Final rule signed October 1, 2015, and effective December 28, 2015. The previous (2008) O3 standards additionally remain in effect in some areas. Revocation of the previous (2008) O3 standards and transitioning to the current (2015) standards will be addressed in the implementation rule for the current standards.

(4) The previous SO2 standards (0.14 ppm 24-hour and 0.03 ppm annual) will additionally remain in effect in certain areas: (1) any area for which it is not yet 1 year since the effective date of designation under the current (2010) standards, and (2)any area for which an implementation plan providing for attainment of the current (2010) standard has not been submitted and approved and which is designated nonattainment under the previous SO2 standards or is not meeting the requirements of a SIP call under the previous SO2 standards (40 CFR 50.4(3)). A SIP call is an EPA action requiring a state to resubmit all or part of its State Implementation Plan to demonstrate attainment of the required NAAQS.

Except for ozone, all other criteria contaminants meet the NAAQS in New York State. EPA has designated the New York-Northern New Jersey-Long Island, NY-NJ-CT area as nonattainment for the 2008 and 2015 ozone standards. This area consists of the New York counties of Bronx, Kings, Nassau, New York, Queens, Richmond, Rockland, Suffolk, and Westchester.

Two areas have been designated as “unclassifiable”: Orange County for the 2008 lead NAAQS, and Monroe County for the 2010 SO_2 NAAQS. Each area has demonstrated compliance with the respective NAAQS since being designated.

2018 ozone design values are provided in Table 6.

Table 6 2018 Design Values for New York Ozone Sites

MSA/Micropolitan	Annual 8 hr 4th Maximum, ppm			2018 Design Value (3 year average of annual 4th max)
Site	2016	2017	2018	
New York-White Plains				
CCNY	0.071	0.070	0.077	**0.073**
Pfizer Lab	0.070	0.069	0.077	**0.072**
IS 52	0.069	0.069	0.071	0.070
Queens College	0.071	0.079	0.073	**0.074**
Susan Wagner	0.077	0.072		**0.075**
Fresh Kills West			0.077	**0.077**
White Plains	0.075	0.072	0.078	**0.075**
Mt. Ninham	0.071	0.07	0.066	0.069
Rockland	0.073	0.066	0.072	0.070
Buffalo-Niagara Falls				
Amherst	0.074	0.066	0.069	0.070
Middleport	0.070	0.062	0.069	0.067
Nassau-Suffolk				
Babylon	0.073	0.077	0.074	**0.075**
Holtsville	0.073	0.071	0.076	**0.073**
Flax pond			0.074	
Riverhead	0.078	0.076	0.072	**0.075**
Albany-Schenectady-Troy				
Loudonville	0.068	0.061	0.064	0.064
Stillwater	0.067	0.060	0.067	0.065
Syracuse				
East Syracuse	0.067	0.064	0.066	0.066
Fulton	0.061	0.063	0.067	0.064
Poughkeepsie-Newburgh-Middletown				
Millbrook	0.071	0.063	0.065	0.066
Valley Central	0.064	0.059	0.064	0.062
Rochester				
Rochester	0.067	0.067	0.071	0.068
Williamson	0.067	0.065	0.071	0.067
Watertown-Fort Drum				
Perch River	0.067	0.066	0.068	0.067
Jamestown-Dunkirk-Fredonia				
Dunkirk	0.069	0.066	0.071	0.069
Corning				
Pinnacle State Park	0.062	0.058	0.064	0.061
Essex County				
Whiteface Summit	0.067	0.066	0.066	0.066
Whiteface Base	0.068	0.060	0.066	0.065
Hamilton County				
Piseco Lake	0.061	0.064	0.063	0.063

Consideration of Meteorological Conditions

Wind data in the form of wind roses for multiple years of hourly data from the NYSDEC air monitoring sites were examined and compared to similar plots for nearby National Weather Service (NWS) and MESONET weather observation sites. Many of our air monitoring sites are not in ideal locations for measuring wind, since they are sometimes subject to effects from obstructions. Preliminary analysis suggest that the wind speed and direction are of a lower quality than both the MESONET and the NWS pages. Thus, while the data will continue to be collected, it will only be submitted to AQS as necessary, and with appropriate data quality indicators.

NYSDEC meteorologists regularly use a wide variety of sources for important upper air information and other real-time meteorological data, including stagnation data, for use in forecasting and SIP decision making. They include the following, among many others:

- NOAA/NWS/NCEP Model Analyses and Forecasts website
- NOAA Air Resources Lab READY website
- NOAA Air Quality Forecast Guidance
- Proprietary air quality modeling done by a contractor for a consortium of states
- Environment Canada cloud forecasts
- University at Albany Meteorology website
- Mesonet webpage

Emissions Inventories

Emissions inventories are the basis for numerous efforts including trends analysis, regional and local scale air quality modeling, regulatory impact assessments, and human exposure modeling.
In general emissions arise from the following source categories:

- Point sources – Point sources are large, stationary (non-mobile), identifiable sources of emissions that release pollutants into the atmosphere.
- Area sources - Area sources collectively represent individual sources that have not been inventoried as specific point, mobile, or biogenic sources. These individual sources are typically too small, numerous, or difficult to inventory using the methods for the other classes of sources.
- Mobile source (on-road and off-road) – A motor vehicle, non-road engine or non-road vehicle.
- Biogenic sources (natural) – Biogenic emissions are all pollutants emitted from non-anthropogenic sources.

Accurate accounting of emissions inventory is vital in the development of pollution reduction strategies. It also supports the selection of proper site locations for the intended monitoring objectives.

Tables 7 through 9 below are compiled from EPA's National Emission Inventory database showing emissions for various pollutants in New York and upwind states. The inventory is updated every three years. The 2014 database is still under preparation. Here PMcon and VOC denote condensable particulate matter and volatile organic compounds, respectively.

Table 7 2011 Summary of Emissions (tons/yr) for Selected States

State	CO	NH_3	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Delaware	127,571	5,784	30,378	15,194	5,655	13,891	45,797
Maryland	772,295	26,894	168,928	77,595	31,103	71,945	263,570
Michigan	2,182,070	65,902	461,298	422,026	122,816	273,632	939,089
New Jersey	950,805	8,331	169,922	51,413	27,200	18,008	288,138
New York	1,995,767	51,521	397,316	291,350	94,275	115,001	801,213
Ohio	2,735,840	105,763	603,111	468,057	158,871	680,421	754,168
Pennsylvania	1,969,471	81,078	573,331	275,270	110,614	398,659	822,530
Virginia	1,361,785	52,584	324,501	196,989	70,856	107,821	1,075,075
West Virginia	521,868	12,084	177,603	124,505	41,207	122,785	516,981

Table 8 2014 Summary of Emissions (tons/yr) for Selected States

State	CO	NH_3	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Delaware	136,709	7,281	28,441	15,085	4,335	4,347	42,529
Maryland	741,579	16,307	141,787	117,444	32,684	48,696	266,590
Michigan	1,829,336	42,007	396,801	285,717	85,490	185,572	873,924
New Jersey	921,612	16,403	157,845	54,738	30,643	11,482	278,320
New York	1,954,957	33,337	339,610	233,864	82,905	52,967	795,393
Ohio	1,934,936	70,513	446,562	660,090	156,802	376,897	668,163
Pennsylvania	1,772,654	48,634	502,636	282,663	112,003	330,097	925,876
Virginia	1,493,638	32,278	285,528	268,991	81,022	77,209	1,080,291
West Virginia	538,838	8,581	190,329	114,519	41,604	113,499	585,509

The difference between 2008 and 2011 is tabulated in Table 9.

Table 9 Difference (2011-2014) of Emissions (tons/yr) for Selected States

State	CO	NH_3	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Delaware	(9,138)	(1,497)	1,937	109	1,320	9,544	3,268
Maryland	30,716	10,587	27,141	(39,849)	(1,581)	23,249	(3,020)
Michigan	352,734	23,895	64,497	136,309	37,326	88,060	65,165
New Jersey	29,193	(8,072)	12,077	(3,325)	(3,443)	6,526	9,818
New York	40,810	18,184	57,706	57,486	11,370	62,034	5,820
Ohio	800,904	35,250	156,549	(192,033)	2,069	303,524	86,005
Pennsylvania	196,817	32,444	70,695	(7,393)	(1,389)	68,562	(103,346)
Virginia	(131,853)	20,306	38,973	(72,002)	(10,166)	30,612	(5,216)
West Virginia	(16,970)	3,503	(12,726)	9,986	(397)	9,286	(68,528)

Federal and New York State cap and trade regulations have proved effective in significantly controlling NO_x and SO_2 emissions, as have state and local regulations for sulfur content in fuels.

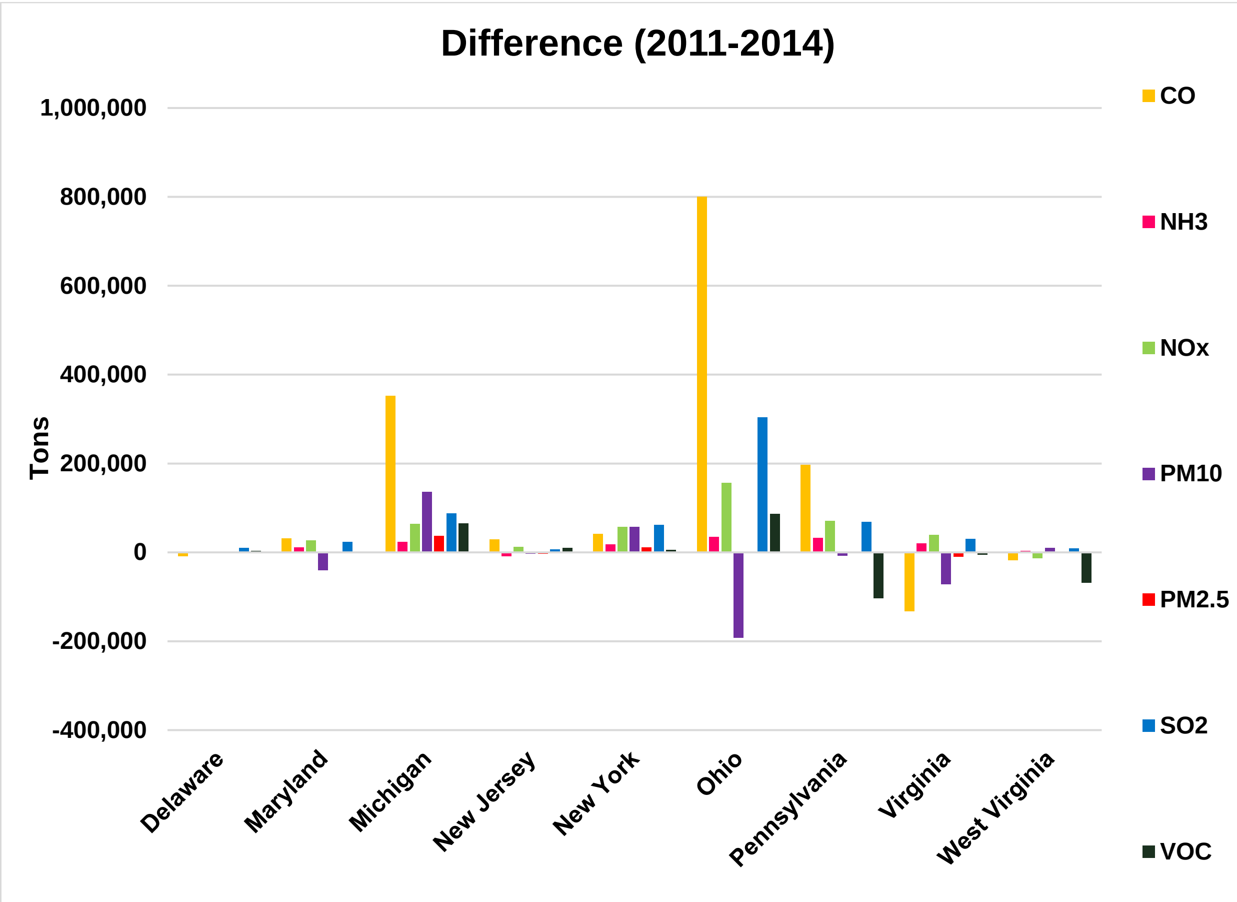


Figure 4 Difference (2008-2011) of Emissions (tons/yr) for Selected States

Pollutant Specific Discussion

Ozone

Currently, the minimum number of ozone monitors required in an MSA ranges from zero (for an area with a population of at least 50,000 and under 350,000 and no recent history of an ozone design value greater than 85 percent of the level of the NAAQS) to four (for an area with a population greater than 10 million and an ozone design value greater than 85 percent of the level of the NAAQS). Design values are especially helpful when the standard is exceedance-based (e.g. 24-hour $PM_{2.5}$) because they are expressed as a concentration instead of an exceedance count, thereby allowing a direct comparison to the level of the standard. Because these requirements apply at the MSA level, large urban areas consisting of multiple MSAs can be required to have more than four monitors.

MSA population[1,2]	Most recent 3 year design value concentrations ≥85% of any O_3 NAAQS[3]	Most recent 3 year design value concentrations <85% of any O_3 NAAQS[3,4]
>10 million	4	2
4 - 10 million	3	1
350,000 - <4 million	2	1
50,000 - <350,000[5]	1	0

[1] Minimum monitoring requirements apply to the Metropolitan Statistical Area (MSA).
[2] Population based on latest available census figures.
[3] The ozone (O_3) National Ambient Air Quality Standards (NAAQS) levels and forms are defined in 40 CFR part 50.
[4] These minimum monitoring requirements apply in the absence of a design value.
[5] Metropolitan Statistical Areas (MSA) must contain an urbanized area of 50,000 or more population.

Figure 6 shows the trend line for the current 8-hr standard.

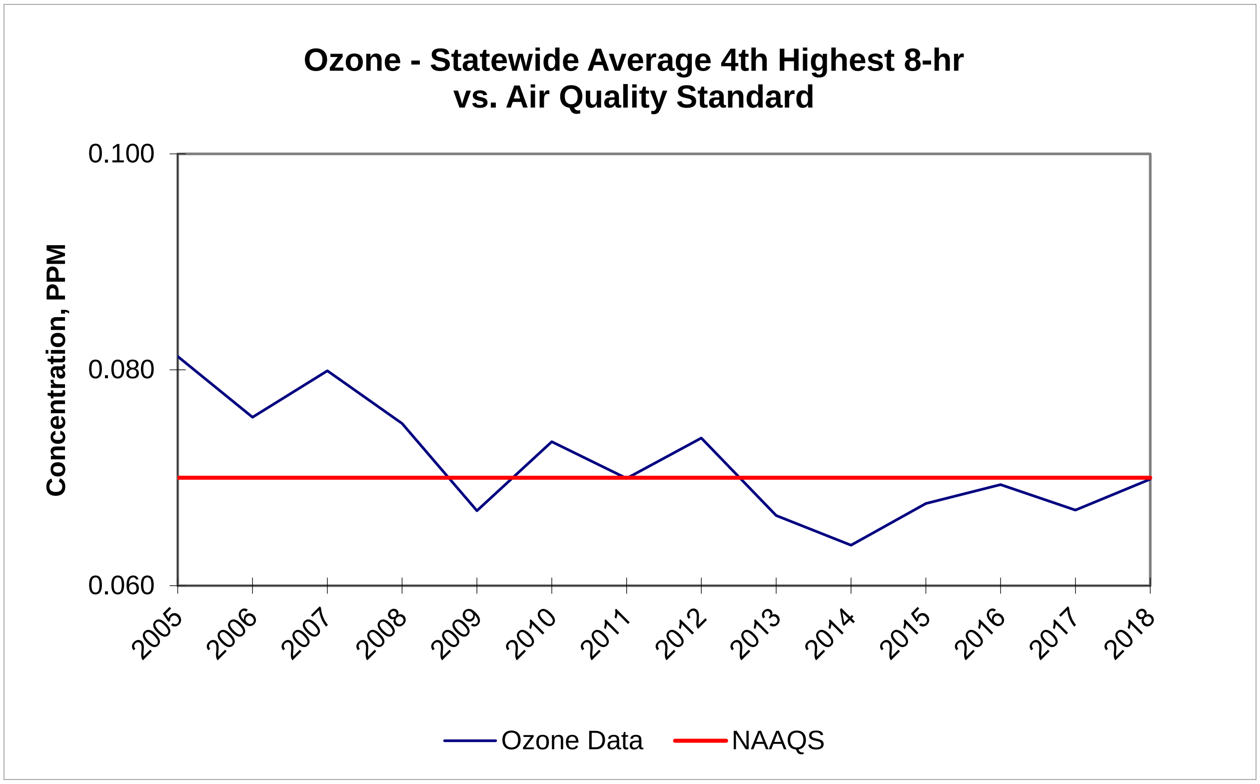


Figure 5 Statewide Trend for Annual 8-hr Ozone Levels

Since the 2015 assessment, the ozone network has increased by one monitor. Table 10 below lists each monitoring site, county, and the intended attainment status designated by the EPA based on three years' data from 2016-2018, against the 8-hr standard of 0.070 ppm, as well as the 2016-2018 design value. A location map of ozone sites is shown in Figure 6. Of note, the Susan Wagner monitor was temporarily relocated to Freshkills due to on-site construction. Sites with an asterisk do not have enough 2016 - 2018 data to develop a design value.

Table 10 Listing of Site Locations and Attainment Status* for the Ozone Network

Site	County	Attainment (2016 2018) 0.070 ppm 8 hr std.	Design Value (2016 2018) ppm
Babylon	Suffolk	no	0.074
Holtsville	Suffolk	no	0.073
Riverhead	Suffolk	no	0.075
Flax Pond	Suffolk	*	0.074
City College of NY (CCNY)	New York	no	0.072
Pfizer Lab	Bronx	no	0.072
IS 52	Bronx	yes	0.069
Queens College	Queens	no	0.074
Susan Wagner	Richmond	*	0.074
Freshkills	Richmond	*	0.077
White Plains	Westchester	no	0.075
Valley Central	Orange	yes	0.062
Rockland	Rockland	yes	0.070
Millbrook	Dutchess	yes	0.066
Mt. Ninham	Putnam	yes	0.069
Loudonville	Albany	yes	0.064
Stillwater	Saratoga	yes	0.064
Whiteface Summit	Essex	yes	0.066
Whiteface Base Lodge	Essex	yes	0.064
Piseco Lake	Hamilton	yes	0.062
Perch River	Jefferson	Yes*	0.067
East Syracuse	Onondaga	yes	0.065
Fulton	Oswego	yes	0.063
Rochester	Monroe	yes	0.068
Williamson	Wayne	yes	0.067
Pinnacle State Park	Steuben	yes	0.061
Dunkirk	Chautauqua	no	0.068
Amherst	Erie	yes	0.069
Middleport	Niagara	yes	0.067

- *Even though a monitor in a county is in attainment of the standard, the county can be designated nonattainment because it is part of a larger area that includes the county that has a nonattaining monitor.

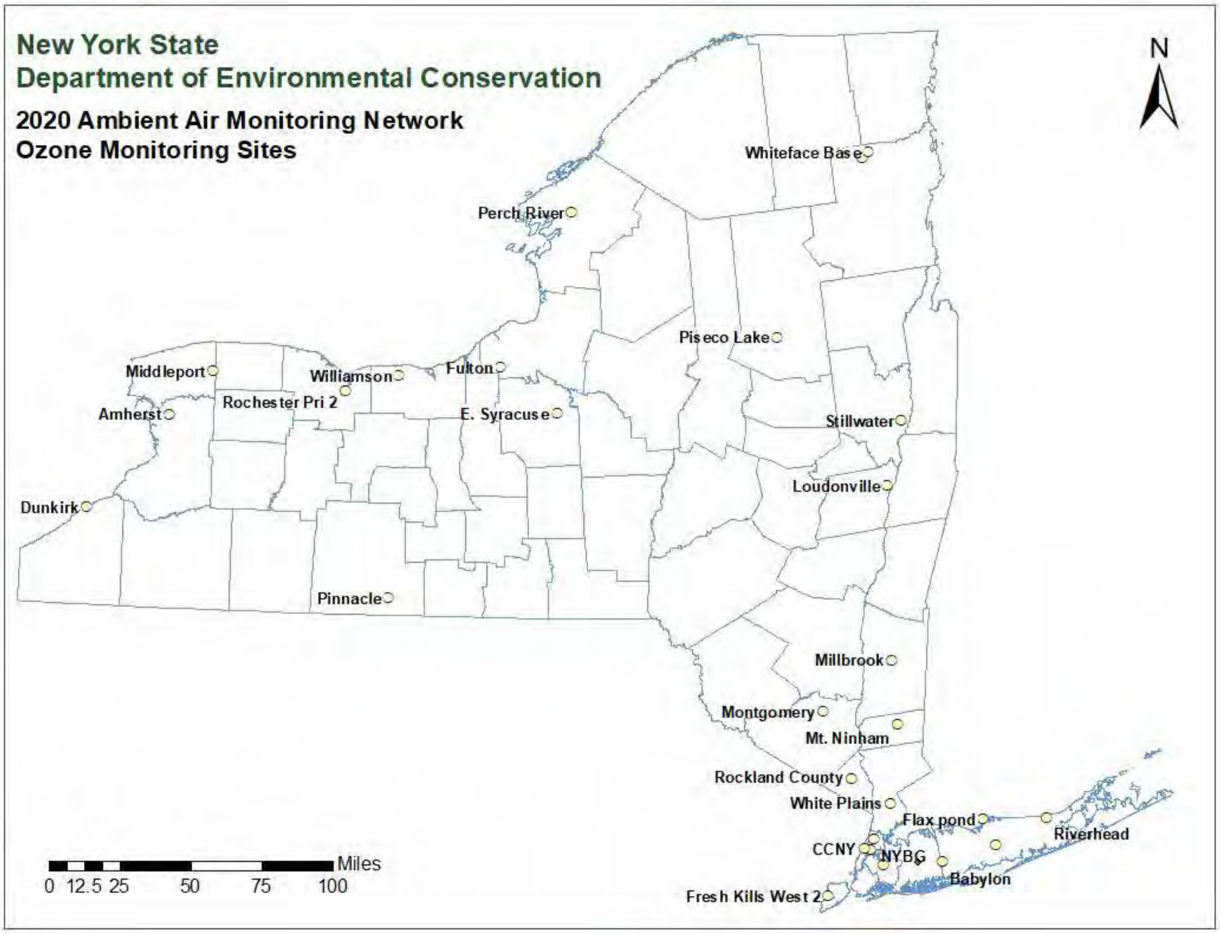


Figure 6 Location Map of Ozone Monitoring Sites in New York State

The current network has 28 monitors sited at various locations statewide in order to meet the monitoring objectives specified in Appendix D to Part 58.
The last three years' data demonstrate that all monitors outside the New York City metropolitan area are in attainment of the current 0.070 ppm standards. EPA is currently reviewing the ozone NAAQS and is not expected to revise the level of the standards.

Fine Particulate Matter ($PM_{2.5}$)

A historic trend of the statewide annual $PM_{2.5}$ levels is presented in Figure 7 below. The annual NAAQS for $PM_{2.5}$ is set at 12 µg/m^3, while the 24-hr standard is 35 µg/m^3. Based on the most current three consecutive years of monitoring data 2016-2018, all areas in the State are in attainment status.

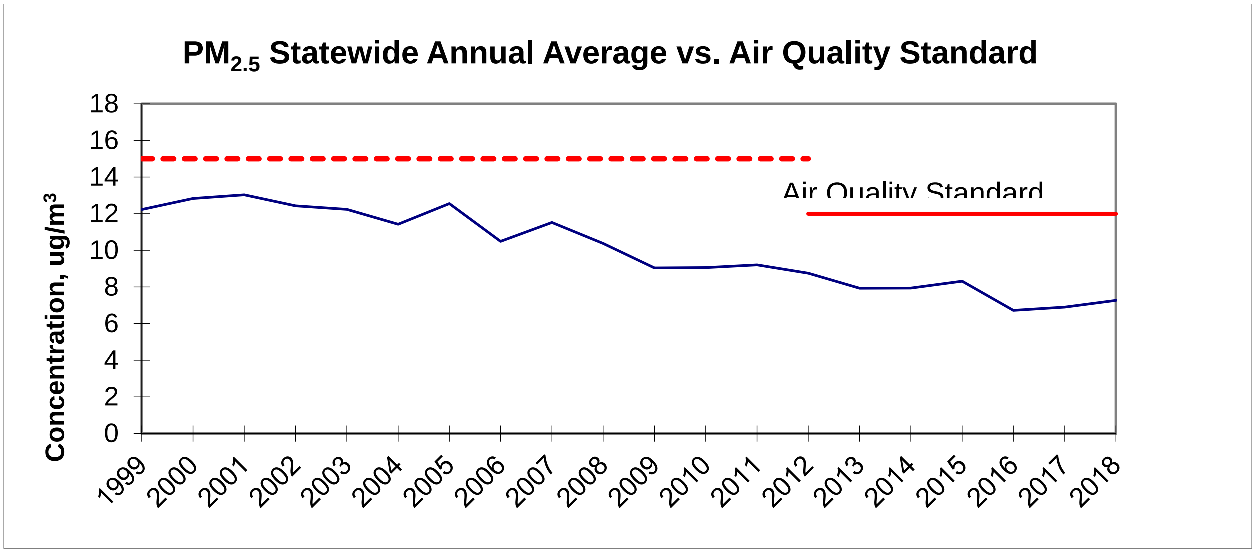


Figure 7 Statewide Trend for PM2.5 Annual Averages

The EPA has designated the State of New York as being in attainment for the 2012 $PM_{2.5}$ standards based on 2011-2013 monitoring data. Table 11 below lists each FRM site, county, and the 2016-2018 design values for the annual and 24-hr standards. As mentioned above, only the FRM data are used for attainment determination. The continuous $PM_{2.5}$ network complements the FRM network and provides data for AIRNow and AQI forecasting. Location maps of $PM_{2.5}$ FRM and TEOM monitors are shown in Figures 8, 9 and 10, respectively.

Table 11 Listing of Site Locations and Design Values* for PM2.5 Networks

Site	FRM	FEM	TEOM	County	Design Value ('16 '18) µg/m³	
					annual	24 hr
Eisenhower Park			ü	Nassau	n/a	n/a
Babylon	ü			Suffolk	6.7	15
Holtsville			ü	Suffolk	n/a	n/a
Morrisania II			ü	Bronx	n/a	n/a
NY Botanical Garden	ü		ü	Bronx	8.1	20
IS 52	ü	ü		Bronx	6.9	17
IS 74			ü	Bronx	n/a	n/a
JHS 126	ü			Kings	7.8	17
PS 314			ü	Kings	n/a	n/a
PS 274			ü	Kings	n/a	n/a
JHS 45	ü			New York	7.6	18
PS 19	ü		ü	New York	9.5†	23†
Division Street	ü		ü	New York	9.1	19
IS 143			ü	New York	n/a	n/a
City College of NY			ü	New York	n/a	n/a
Queens College	ü	ü		Queens	7.0	18
Queens College Near-Road	ü		ü	Queens	8.0	18
Maspeth Library			ü	Queens	n/a	n/a
Port Richmond	ü			Richmond	7.4	18
Fresh Kills West			ü	Richmond	n/a	n/a
White Plains			ü	Westchester	n/a	n/a
Newburgh	ü		ü	Orange	6.2	14
Rockland			ü	Rockland	n/a	n/a
Albany	ü	ü		Albany	6.9	17
Loudonville	ü			Albany	5.8	15
Whiteface Base	ü		ü	Essex	3.6	11
Utica			ü	Oneida	n/a	n/a
E. Syracuse	ü	ü		Onondaga	5.1	14
Rochester	ü	ü		Monroe	6.8	16
Rochester Near-Road	ü		ü	Monroe	6.2	16
Pinnacle State Park	ü	ü		Steuben	4.7	12
Dunkirk	ü			Chautauqua	6.2	15
Amherst	ü			Erie	6.5	15
Buffalo	ü			Erie	7.2	17
Buffalo Near-Road	ü		ü	Erie	7.2	116
Tonawanda II			ü	Erie	n/a	n/a
Grand Island Blvd			ü	Erie	n/a	n/a

† data capture <75% in one quarter or more

- *Even though a monitor in a county is in attainment of the standard, the county can be designated nonattainment because it is part of a larger area that includes the county that has a nonattaining monitor.

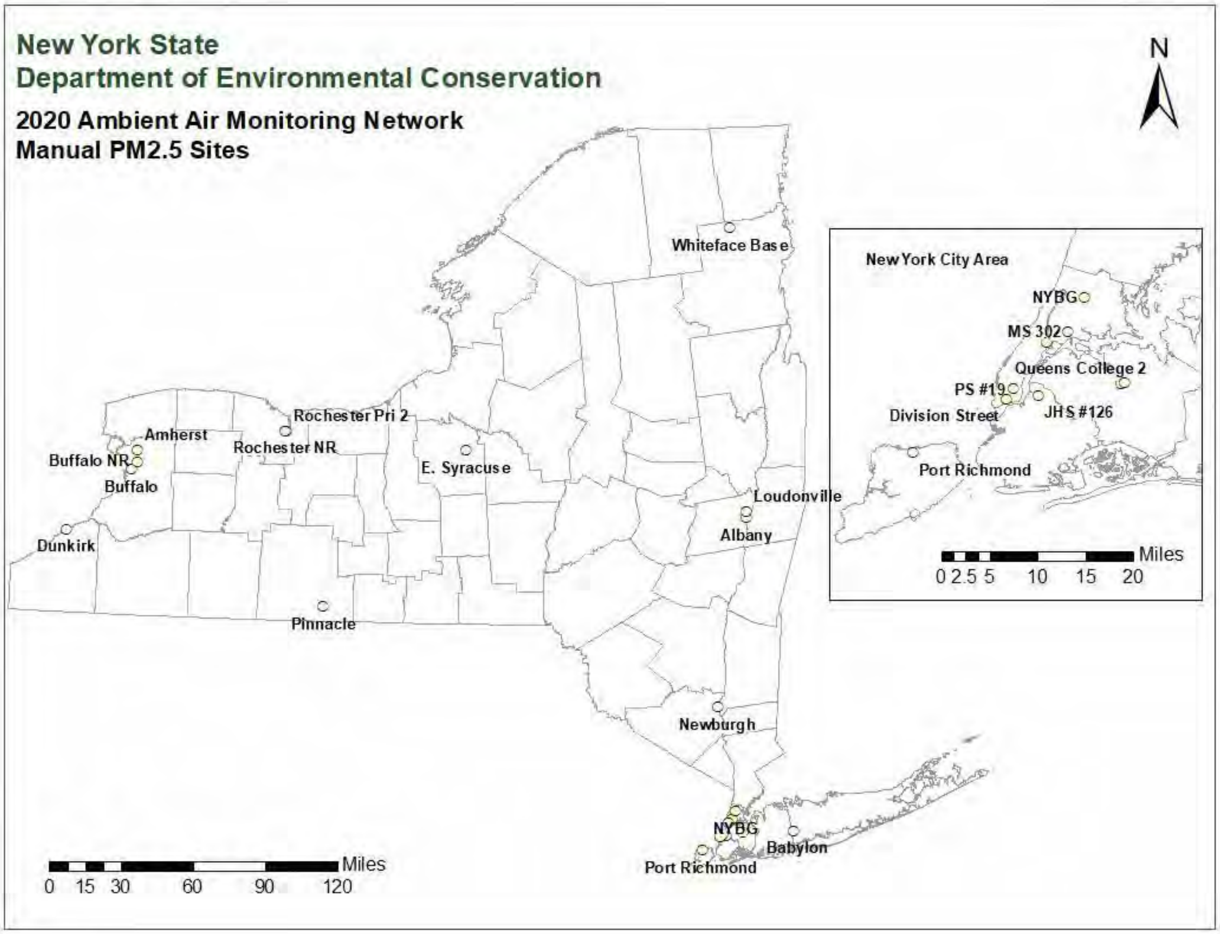


Figure 8 Location Map of Manual PM2.5 (FRM) Monitoring Sites Outside NYC

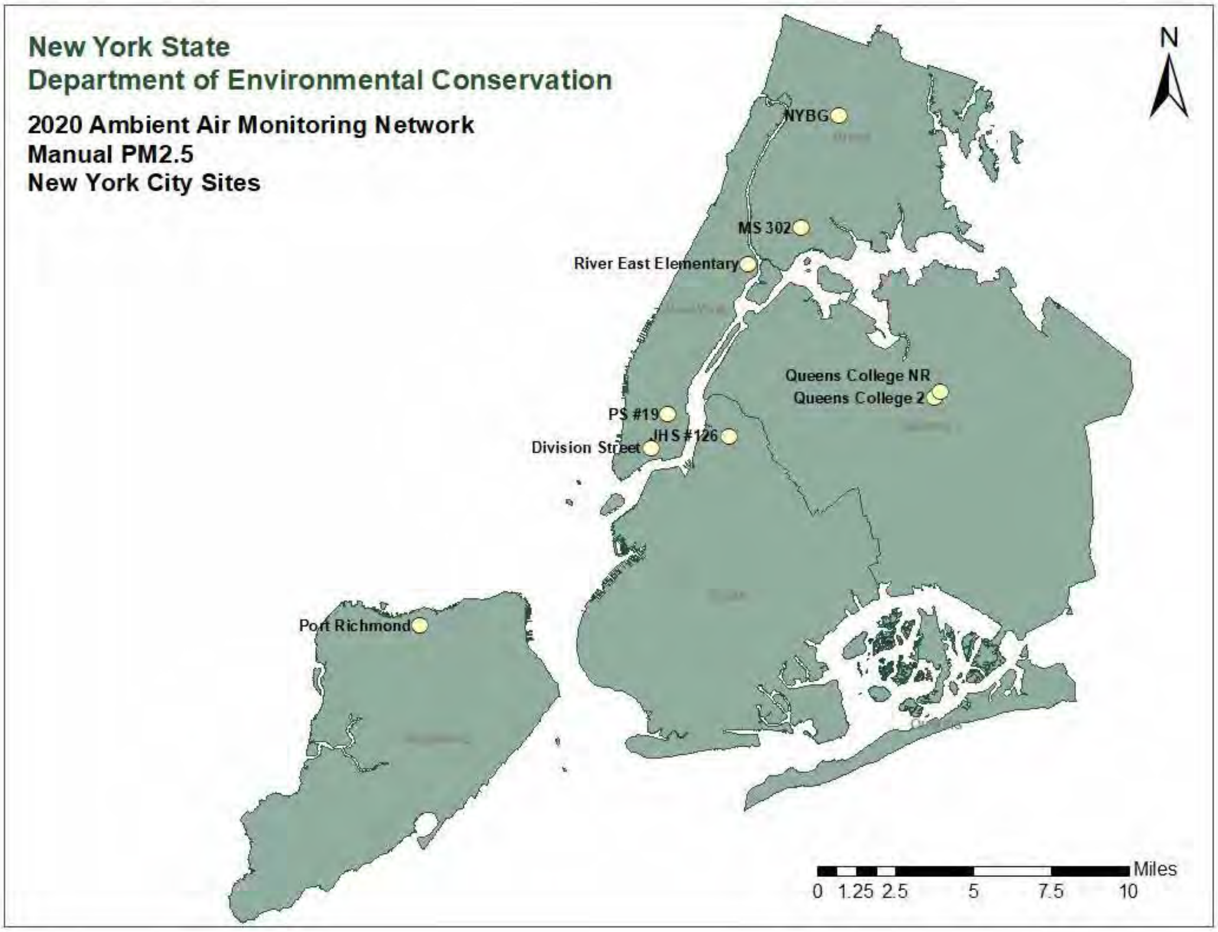


Figure 9 Location Map of Manual PM2.5 (FRM) Monitoring Sites in New York City

For $PM_{2.5}$ currently there are 22 FRM monitors in the manual network, and 28 sites in the continuous network.

The NYSDEC utilizes standard $PM_{2.5}$ TEOMs to provide data for near real-time reporting and forecasting purposes. This data is adjusted on-site via a non-linear equation in the site data logger. The equation uses the historical regional correlation between filter based measurements and the TEOM and the Julian day to adjust the data to more closely emulate filter based measurements. Five different data adjustments are used in different areas of the State. Since each adjustment is based on the variation of the comparison between filter based and continuous data over the course of a year, the day to day accuracy of the adjustment is not as good as when examined over a longer period.

Data Quality Objectives (DQOs) set forth for the comparison of the adjusted TEOM values to collocated FRM measurements are: (a) within +/- 10% total bias and (b) above 0.9 for correlation (0.81 r^2). These DQOs are met when considering data collected over the course of a year. Our approach, however, does not accurately predict the day to day variability between the filter based and continuous instruments. Our adjustment method cannot account for individual meteorological events or the component mix found in air masses at each monitoring site thus the data adjustment is less accurate for individual sample days.

The NYSDEC also operates some of the newest continuous mass monitors which have undergone Federal Equivalent Method (FEM) designation. The Department has been evaluating the technological improvements that have led to the current $PM_{2.5}$ continuous FEMs for more than 10 years. The Thermo Scientific 1405-DF FEM performed better than the other instruments in on-site deployments at urban locations in the state. The instrument uses a difference calculation to obtain mass concentration over time and it did not perform as well in areas where PM concentrations were lower. Currently, the 1405 DFs are being replaced with TAPI T640 FEMs. These are deployed at (IS 52, Queens College, Albany, East Syracuse, Rochester, and Pinnacle State Park) to simultaneously measure $PM_{2.5}$, PM Coarse (PM_{10} - $PM_{2.5}$) and PM_{10} mass concentrations. The performance of the T640 is still undergoing evaluation and the DEC is making a recommendation to EPA and to the manufacturer to compensate for drift in the optical bench temperature. It has yet to be seen if the T640 will meet all FEM Class 3 Equivalency requirements in NY State. The T640s FEM data are being submitted with the Parameter Code 88101.

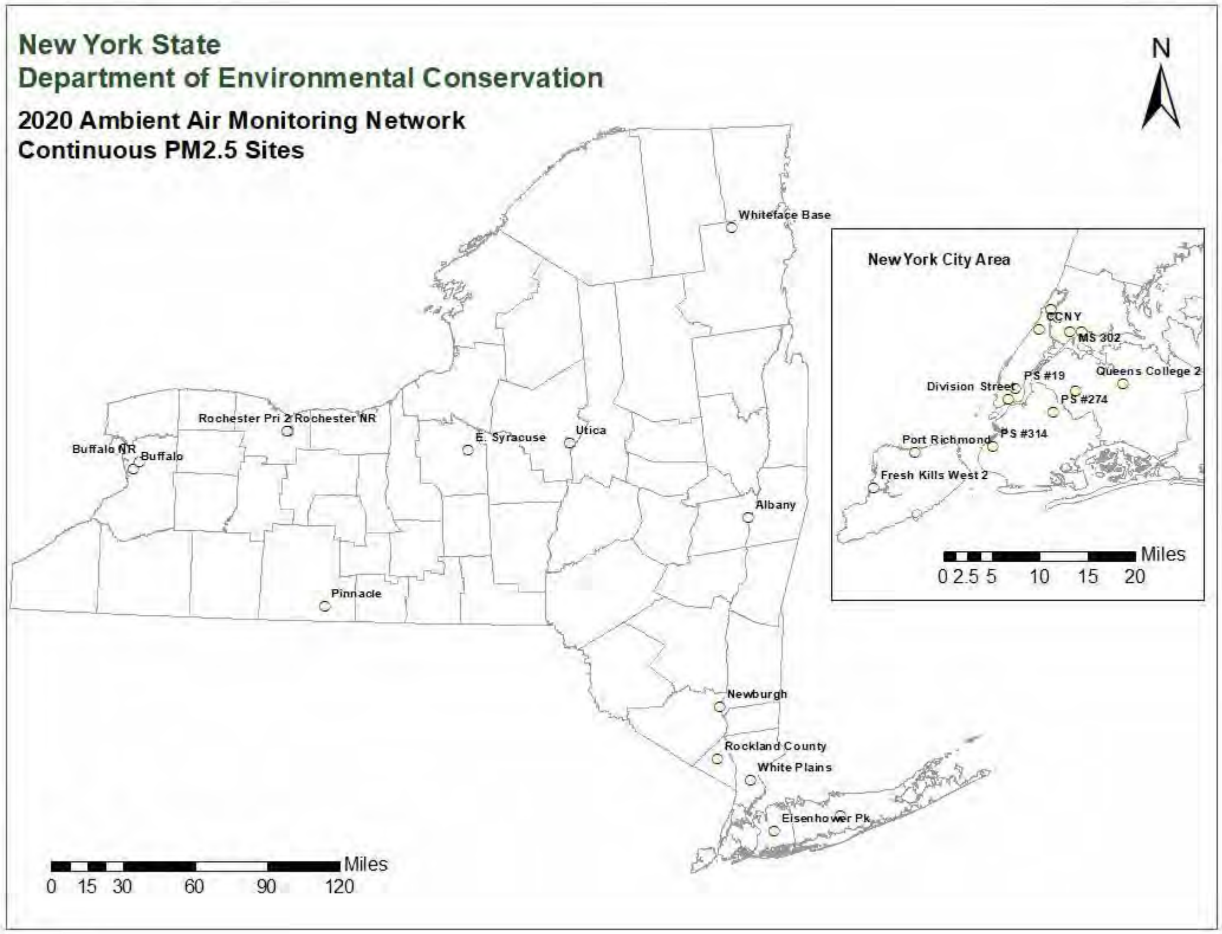


Figure 10 Location Map of Continuous PM2.5 (TEOM) Monitoring Network

Inhalable Particulate (PM_{10})

A historic trend of the statewide annual PM_{10} levels is presented in Figure 13 below. The 24-hr NAAQS for PM_{10} is set at 150 µg/m^3.

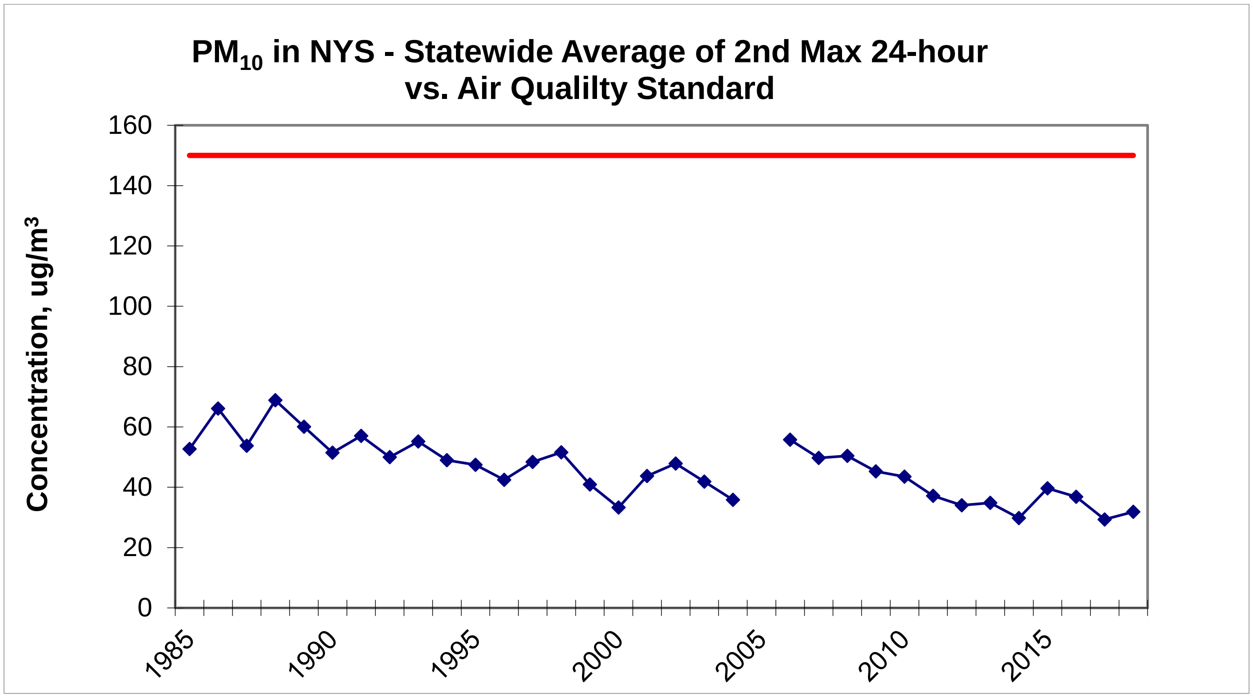


Figure 11 Statewide Annual Trend for 24-hr PM10 Levels

Table 13 below lists each PM_{10} site, county, and the attainment status against the 24-hr standard of 150 µg/m^3. There is a reduction of two monitors in the network compared to the last assessment five years ago.

Table 12 Site Locations and Attainment Status for the FRM PM_{10} Network

Site	County	Attainment
Division Street	New York	yes
IS 52†	Bronx	yes
Queens College	Queens	yes
Rochester†	Monroe	yes
Buffalo	Erie	yes

†NATTS site, PM_{10} metals analysis

Figure 13 shows a location map of the low-volume PM_{10} sampling sites in the State.

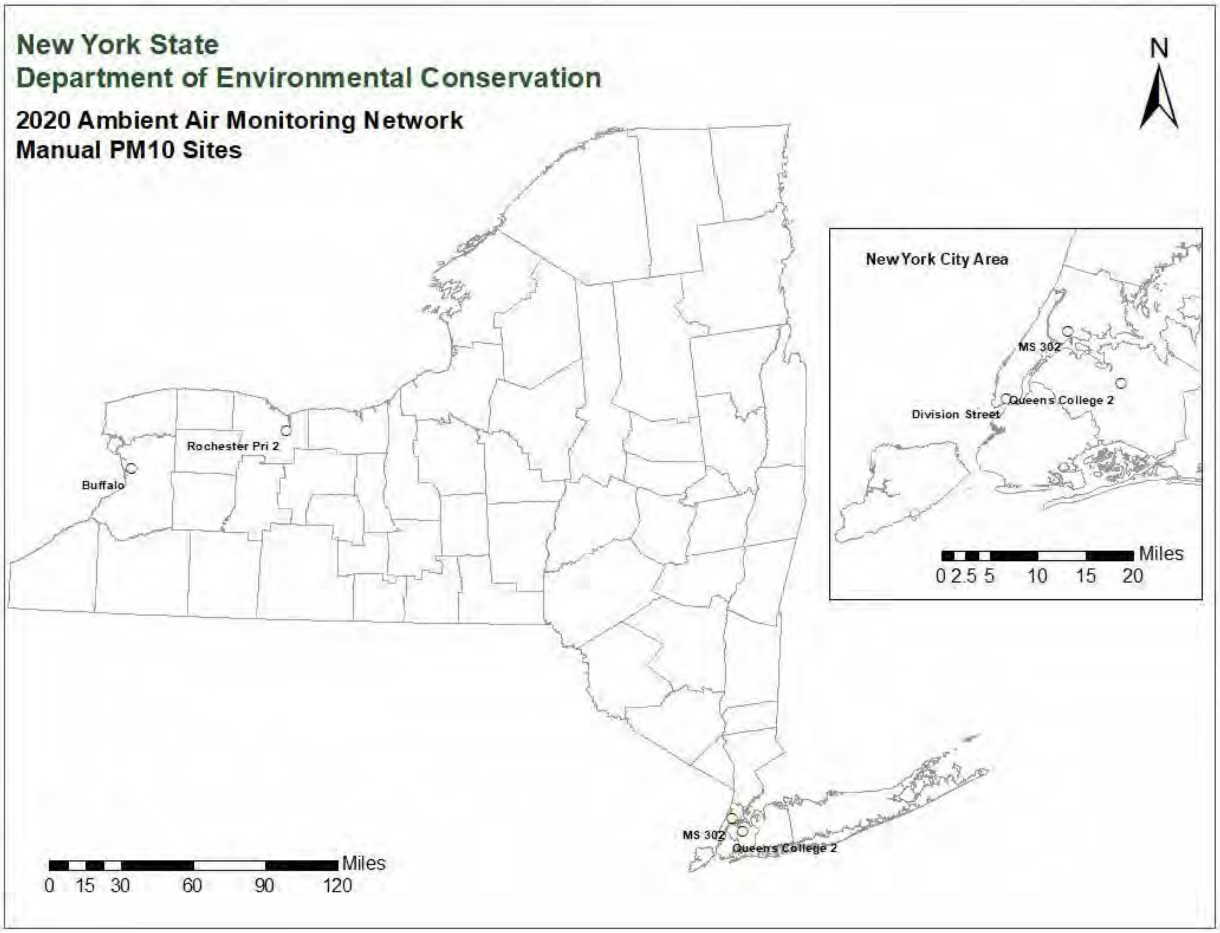


Figure 12 Site Location Map of Manual PM10 Monitoring Network

Chemical Speciation Network Sites

In addition to the FRM $PM_{2.5}$ mass measurement network a chemical speciation network (CSN) consisting of eight $PM_{2.5}$ sites across the State that provide a first order characterization of the metals, major ions, and carbon constituents of $PM_{2.5}$ was established as part of the monitoring requirements and principles set forth in 40 CFR Part 58, Ambient Air Quality Surveillance for Particulate Matter. Figure 15 shows a location map of the CSN sites in the State. Both the Buffalo and Whiteface Base sites have a one day in six sampling frequency, while the remainder of the sites have one in three day measurements. Albany switched to one day in six in February 2015.

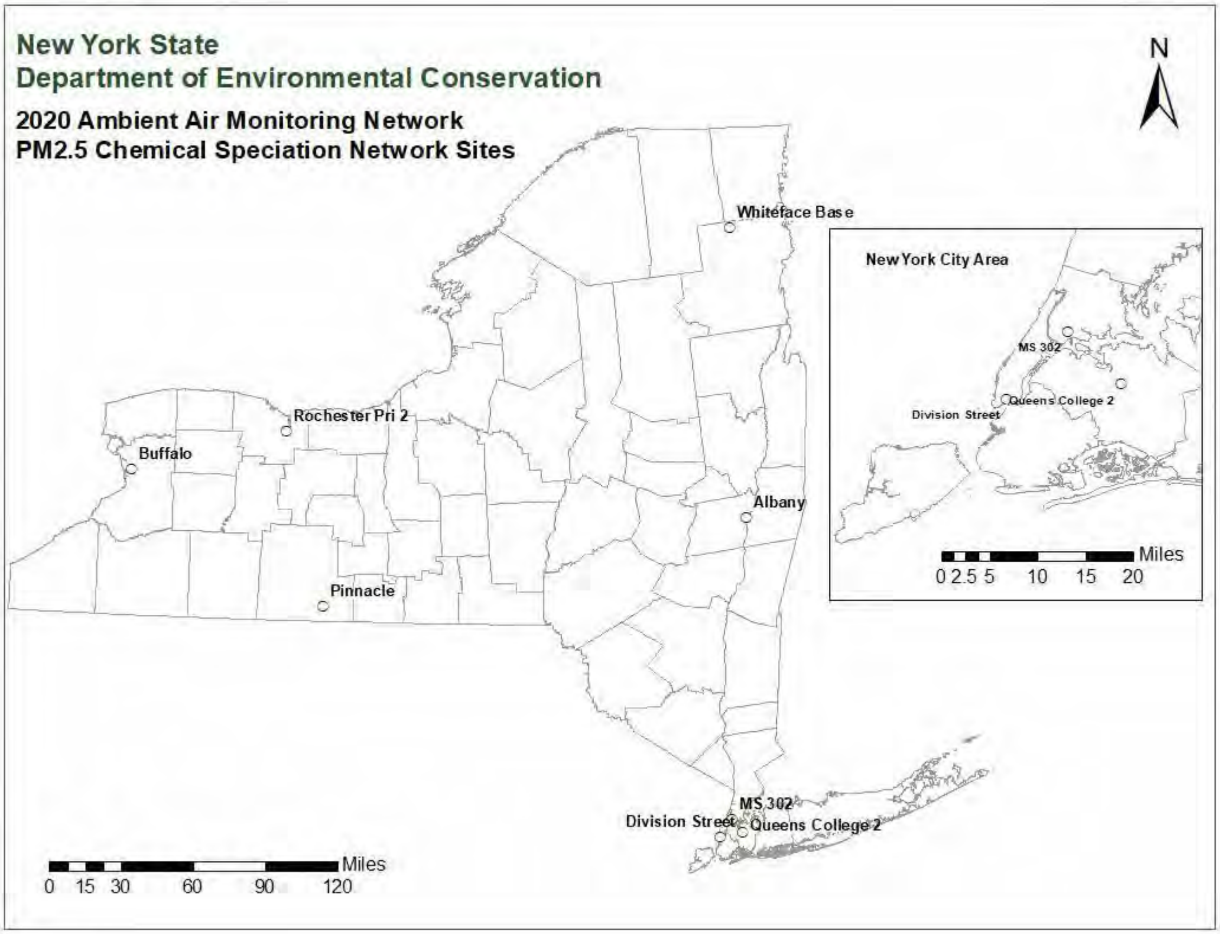


Figure 15. Site Location Map of $PM_{2.5}$ Chemical Speciation Monitoring Network

The $PM_{2.5}$ annual standard design value site in the NY Core Based Statistical Area (CBSA) was a site that was closed due to construction activity (PS 59). The building was substantially modified by the new construction and no longer met siting criteria. The site was replaced by Division St (36-061-0134) which has an FRM, a CSN and a continuous $PM_{2.5}$ instrument. The NY CBSA also has a CSN sampler in both the Bronx (IS52) and Queens (Queens College) which help determine the spatial gradient of components of $PM_{2.5}$ across the CBSA. The sites in Queens and the Bronx have suitable interior space and are hosting continuous speciation samplers as well as complementary gas species analyzers. This higher temporally resolved $PM_{2.5}$ speciation data adds tremendous value to the 24h integrated filter based CSN data. The NY CBSA 24-hr design value site is in New Jersey. This site does not have a CSN sampler which significantly complicates the interpretation of $PM_{2.5}$ speciation data.

In order to obtain higher temporal resolution data on two major components of $PM_{2.5}$, we operate two speciated carbon monitors (IS 52 (MS302) and Queens College) and three continuous sulfate instruments (Queens College, Whiteface Base and Pinnacle State Park). The following is a brief discussion of the trends and findings, demonstrating the informational value of $PM_{2.5}$ species data collection efforts.

$PM_{2.5}$ mass

A summary of annual $PM_{2.5}$ mass covering an 18 year period of measurements across New York State are shown below. Concentrations are highest in the large urban centers of NYC and Buffalo followed by Albany and Rochester and lowest at the rural sites of Pinnacle State Park and Whiteface Base. A significant downward trend is observed throughout amounting to a 30-40% decrease in annual $PM_{2.5}$ mass across the state since 2000. In NYC a substantial improvement in air quality has occurred since 2000 when $PM_{2.5}$ mass exceeded the annual standard of 15 µg/m^3 to the present which shows $PM_{2.5}$ mass below the current standard of 12 µg/m^3.

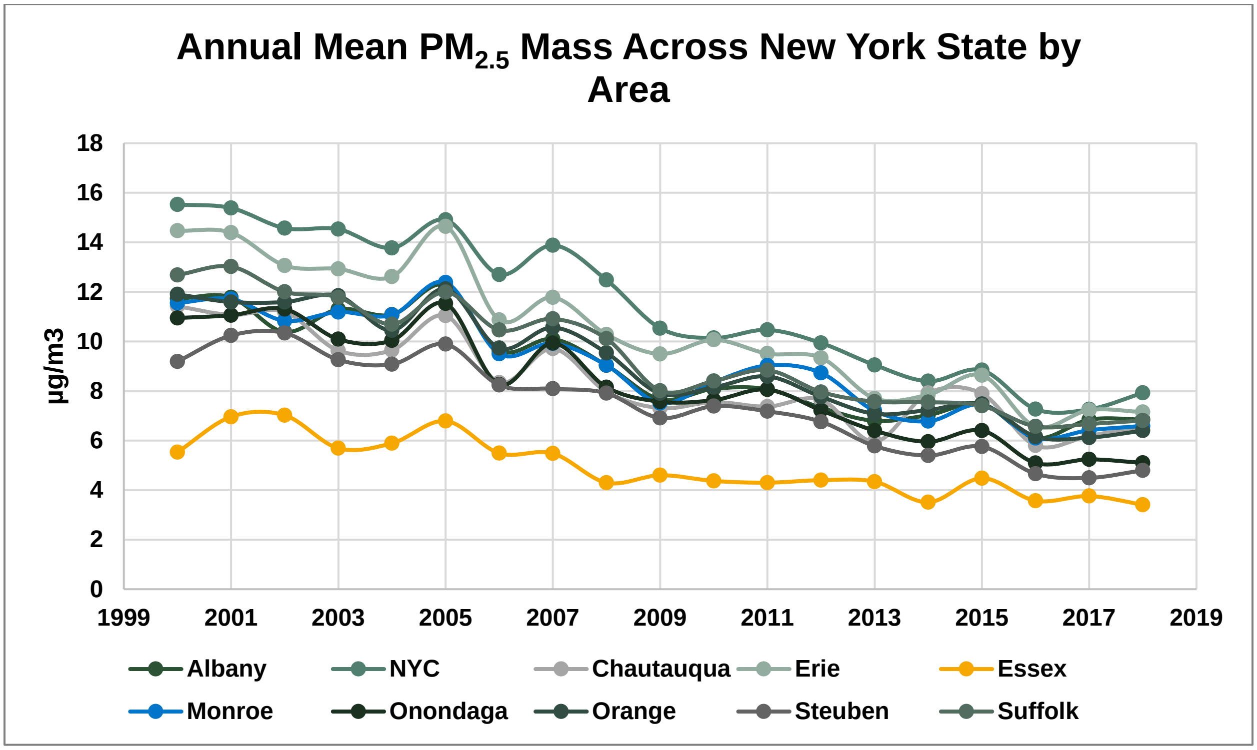


Figure 13 Annual Mean PM2.5 Mass Across New York State*

*NYC = Mean of Measurements across the 5 boroughs, Manhattan, Bronx, Queens, Brooklyn, and Staten Island.

Major ion species

The corresponding annual measurements of major ion species from our CSN network also shows a downward trend. Unlike $PM_{2.5}$ mass which varies across the state, particle SO_4 is relatively similar throughout with the exception of Whiteface Base which is lower in concentration by 2 µg/m^3. The similarity in SO_4 reflects its regional nature with the major source being SO_2 from coal burning Electric Power Generation Facilities which lie to the south and west of the state. As Whiteface Base lies in the northern part of the state it frequently is impacted by air from a different direction (with lower pollutant concentrations) than the other sites. Downward trends of SO_4 are observed at all sites amounting to a 50-60% reduction since 2001. Concentration appear to have levelled off in recent years. Particle NO_3 data appear as three distinct groups with highest concentrations at urban locations and lowest at rural sites including Pinnacle State Park and Whiteface Base. Across urban sites, NO_3 is highest at Manhattan and Rochester is the lowest. Nitrate is higher in urban areas because it arises from nitrogen oxides (NO_x) whose major source is from traffic emissions. A downward trend is clearly observed at the urban sites which have higher concentrations. The decrease amounts to a 40-60% reduction since 2001. Although the decrease at rural locations appears to be lower, the percentage drop is similar. NH_4 data is also clustered with highest concentrations in urban locations and Pinnacle State Park is intermediate between the urban sites and the remote Whiteface Base site. NH_4 also shows a downward trend (50-60% reduction) most of which occurs after 2007. Particle NH_4 is usually combined with SO_4 and NO_3.

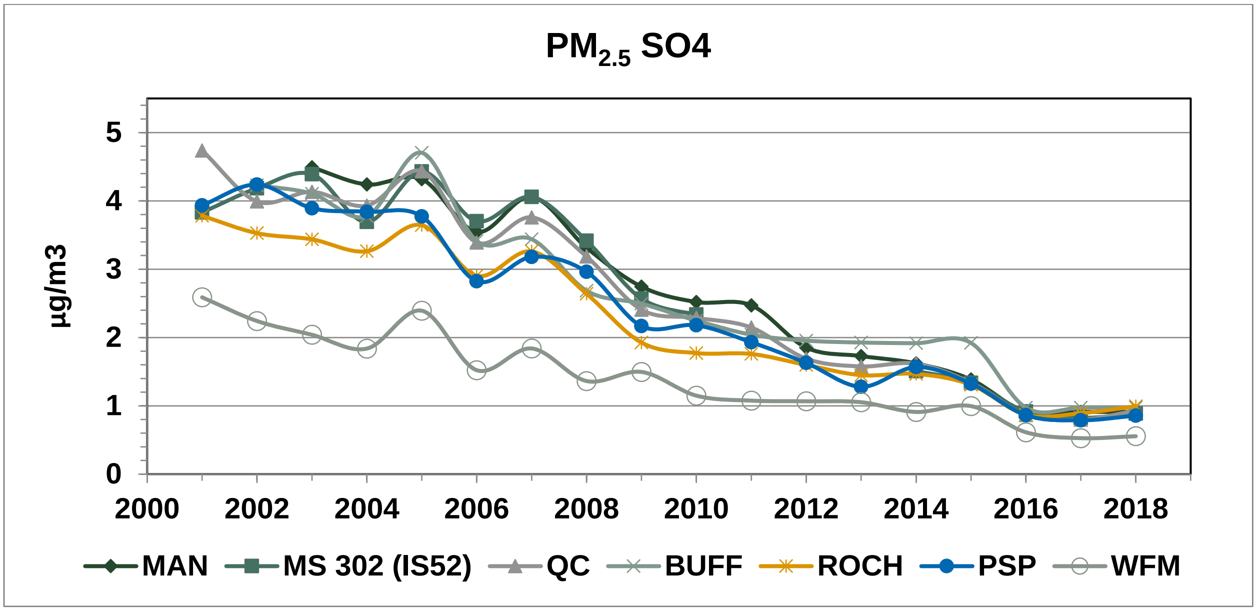


Figure 14 Annual Mean concentrations of SO_4 $PM_{2.5}$ Particles

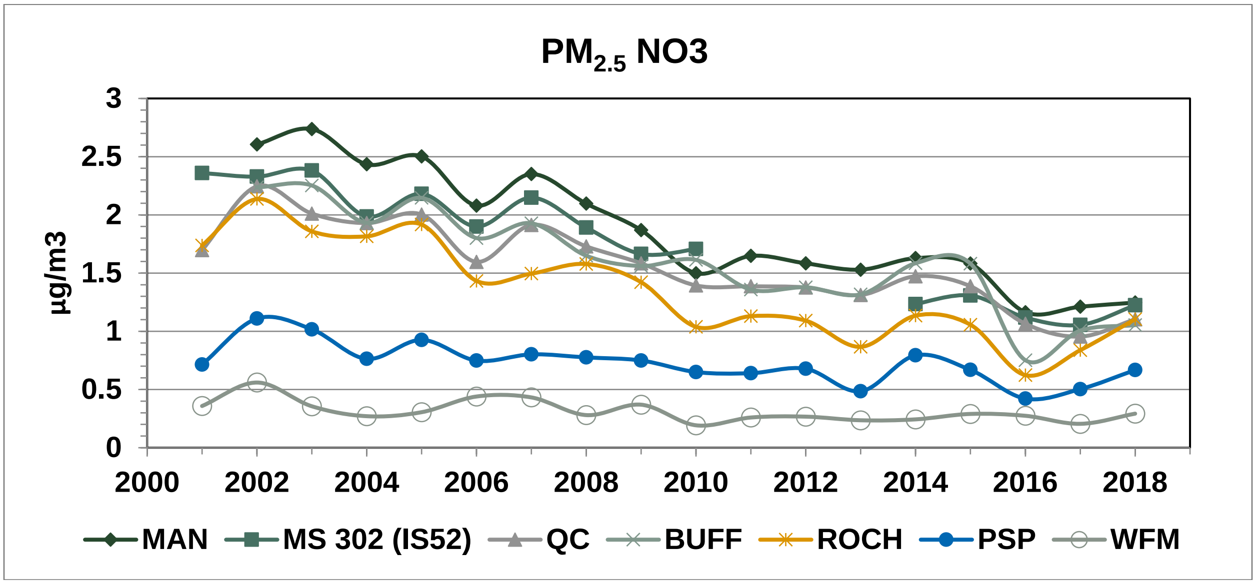


Figure 15 Annual Mean concentrations of NO3 PM2.5 Particles

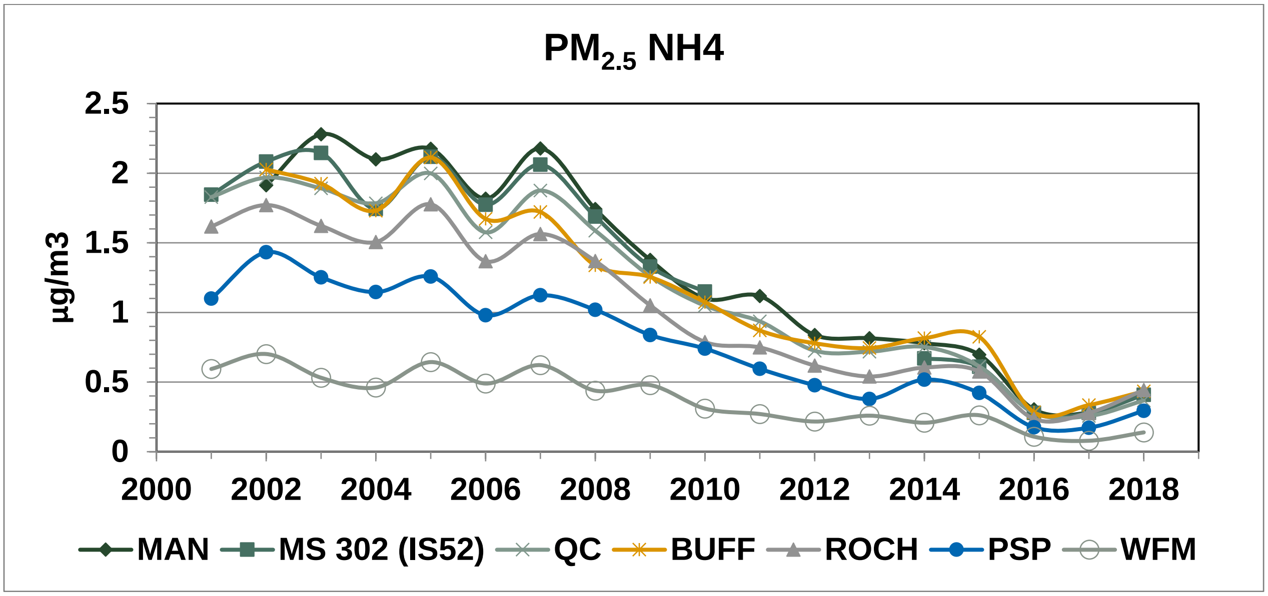


Figure 16 Annual Mean concentrations of NH4 in PM2.5 Particles

Carbonaceous particles

The annual trends for carbon containing particles, elemental carbon (EC) and organic carbon (OC), are quite different. EC is essentially black carbon which is formed by direct emissions from fossil fuel combustion. This includes vehicles, particularly heavy duty diesels and also oil combustion boilers used for space and water heating. A large number of oil boilers in New York City use residual oils which have high emissions. Annual EC data show a large site to site variability with nearly an order of magnitude variation from the highest concentrations in NYC to the lowest at Whiteface Base. Concentrations in descending order are highest in the boroughs of Manhattan and the Bronx followed by Queens, then Buffalo and Rochester with the lowest concentrations at the rural locations. EC started to decrease around 2007-2008 with 2014 data approximately 30-35% lower than 2007-2008. The decrease coincides with the introduction of cleaner highway diesel fuel (lower S content). In addition, in recent years residual oil number 6 in NYC has been replaced with distillate oil number 2 and natural gas which have lower emissions. Rochester data was unusual in 2011-2012 due to an atypical coloration of the sample filters which interfered with the determination of EC for those years. There was a smaller impact on OC.

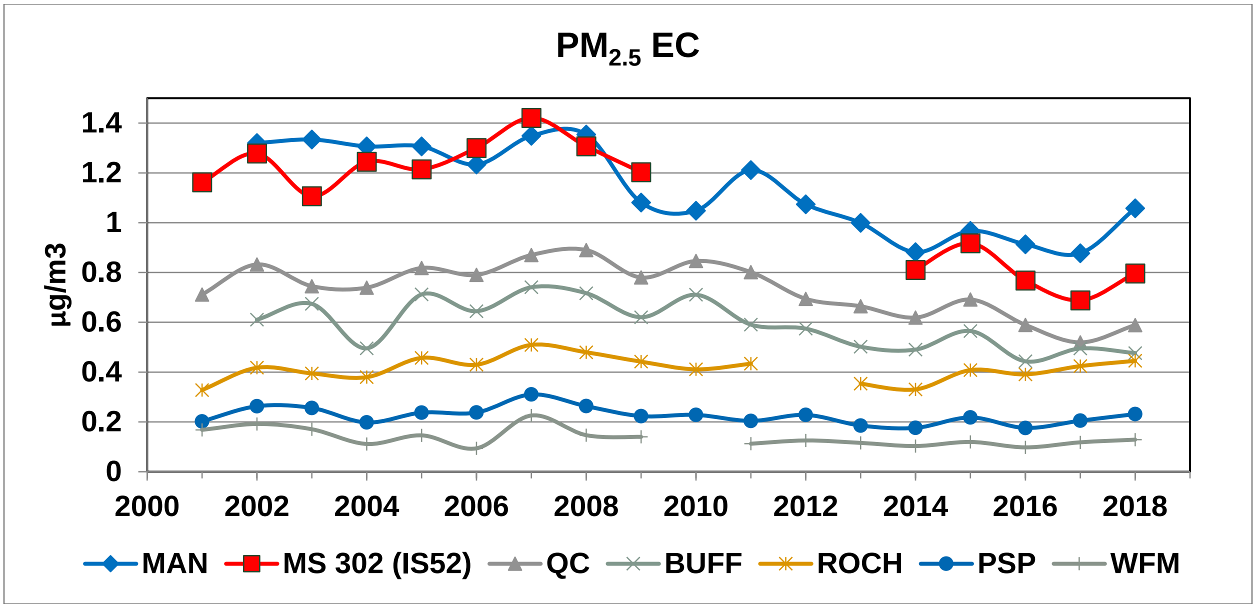


Figure 17 Annual EC Concentrations at Sites in NY*

*Man = Manhattan, Canal St/Division St. IS52 = Intermediate School 52, South Bronx. QC = Queens College. BUFF = Buffalo. Roch = Rochester. PSP = Pinnacle State Park. WFM = Whiteface Mountain Base.

Concentrations of organic carbon (OC) are also higher at urban sites, but with less of an urban-rural contrast compared to EC. OC is highest at Manhattan and is a factor of 3-4 times higher than Whiteface Base which is the lowest. Among the urban sites, OC at Manhattan is the highest with Bronx, Queens and Buffalo 1-1.5 µg/m^3 lower and Rochester 0.5 µg/m^3 lower still. OC has a primary source from direct emissions and a secondary source from atmospheric processing of volatile organics. Therefore, concentrations can be similar in urban and rural locations (Rochester and Pinnacle State Park for example). Unlike the major ions, there is no consistent trend in OC across the sites. At NYC and Buffalo, there is no apparent trend in OC whereas at Rochester OC shows an increase up to 2008 and remains uniform afterwards. At the rural sites, concentrations show a small increasing trend, but it is not significant within the 95% confidence intervals.

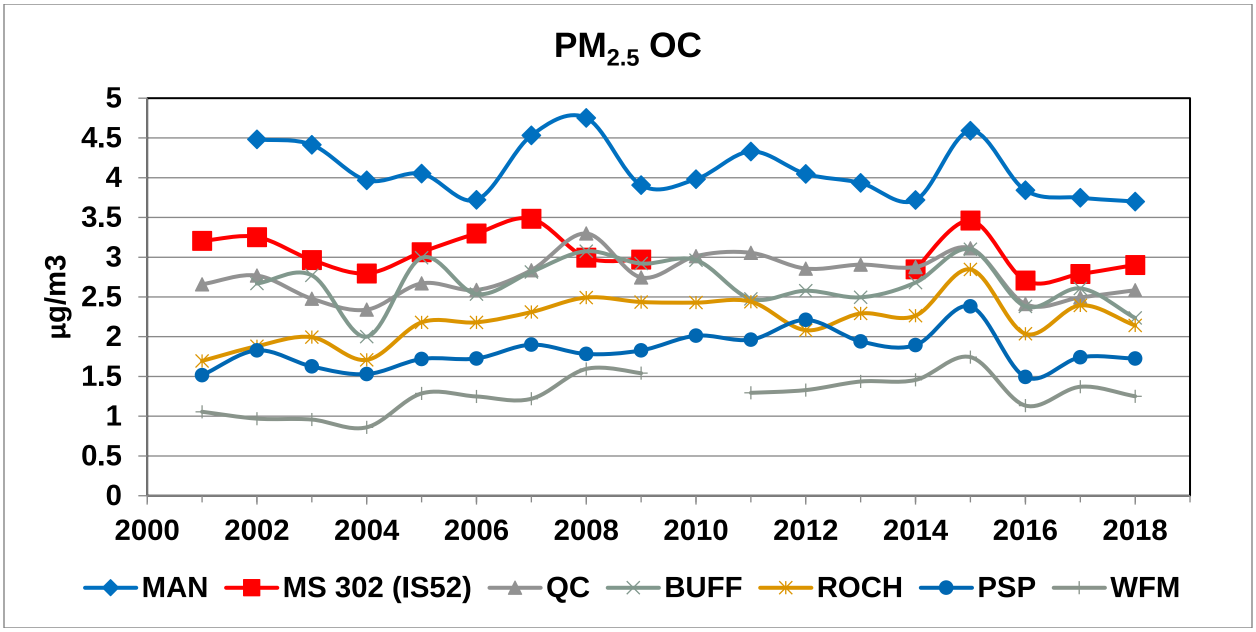


Figure 18 Annual OC Concentrations at Sites in New York State*

*Man = Manhattan, Canal St/Division St. IS52 = Intermediate School 52, South Bronx. QC = Queens College. BUFF = Buffalo. Roch = Rochester. PSP = Pinnacle State Park. WFM = Whiteface Mountain Base.

Trace element nickel (Ni)

The annual trend for trace element Ni is shown below. Ni only shows elevated concentrations in NYC with concentrations at or below the detection limit at all other sites. The higher than average Whiteface Base 2011 Ni is due to 2 unusual days in 2011 with Ni spikes of 25 and 42 ng/m^3. Iron (Fe) and chromium (Cr) were also elevated on those dates. The filter samples may have been contaminated with stainless steel fragments from the sampling inlet or filter backing screens. NYC annual Ni ranged from 12-20 ng/m^3 in 2001-2004 but a steady decline was observed since. By 2014, annual Ni concentrations were approximately 3 ng/m^3 amounting to a factor of 4-7 reduction. One of the major sources of Ni is residential heating oil particularly residual oil number 6, used for space and water heating in NYC[1]. A strong seasonal gradient is observed with winter Ni a factor of 2 higher than summer, reflecting the enhanced oil consumption during colder months as shown in Figure 21. NYC required the phase out of number 6 residual oil by July 1, 2015, which has led to the large reductions in Ni.

[1]Lippmann M., 2009. Semi-continuous speciation analysis for ambient air particulate matter: An urgent need for health effects studies. *J. Expo. Sci. Environ. Epidemiol*., 19, 235-247.

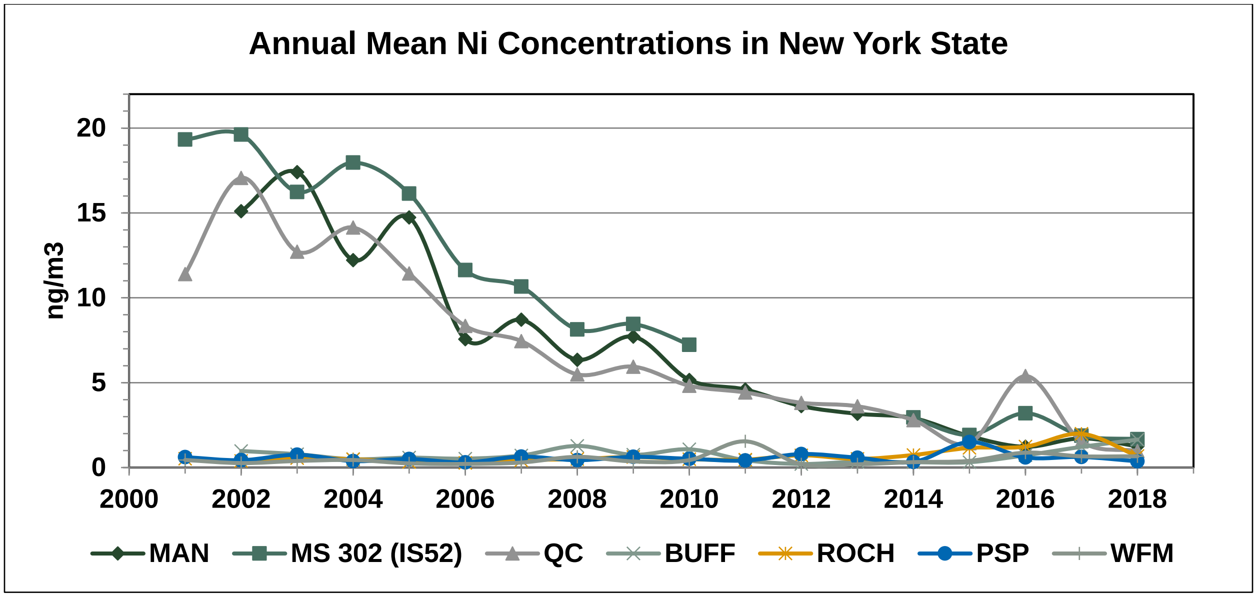


Figure 19 Annual Mean Ni Concentrations in New York State*

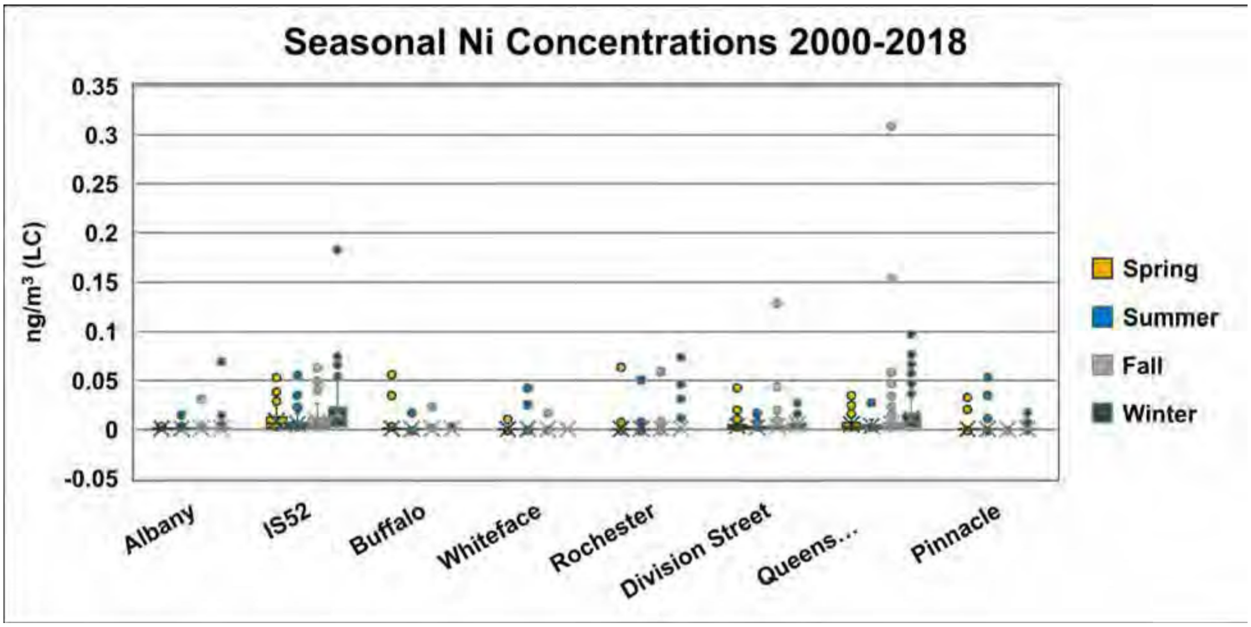


Figure 20 Mean Seasonal Ni Concentrations During 2000-2018 at NYSDEC Sites

Impact of PM reductions on species contribution to total $PM_{2.5}$

The impact of the pollutant reductions is shown in the species composition pie chart in Figure 22 below. This shows annual speciation data from Queens, NY for the combined years 2002-2003 versus 2012-2013. A multiplier of 1.6 was used to convert organic carbon to organic mass[2]. Metals represent the sum of soil components (coarse metal oxides) and remaining trace elements. These percentages are relative to total mass on the speciation sampler. The sum of major species is within 5% of 100%. Notice that in 2002-2003 the combined contribution of particle SO_4, NO_3 and NH_4 ions represented approximately 60% of the total mass versus 30% for organic mass. By 2012-2013 a substantial change has occurred with the major ions representing 40% compared to 45-50% for organic mass. Thus, in recent years as the total $PM_{2.5}$ mass has decreased the carbonaceous fraction (OM and EC) has become the dominant component representing 50-60% of the total $PM_{2.5}$ mass.

The speciation data shows the major contributors to $PM_{2.5}$ and can help to identify likely sources. This information is very important in understanding $PM_{2.5}$ exceedances and to identify pollution control strategies that have been effective in lowering $PM_{2.5}$ levels. Further improvements in air quality may come from targeting carbonaceous emissions as this is currently the dominant PM component. A sufficiently long term data record is critical in determining if control strategies are

[2]Bae, M.S., Demerjian, K.L., Schwab, J.J., 2006. Seasonal estimation of the organic mass to organic carbon in $PM_{2.5}$ at rural and urban locations in New York State. Atmos. Environ., 40, 7467-7479.

effective in lowering PM levels because other factors such as meteorology also impact ambient pollutant concentrations.

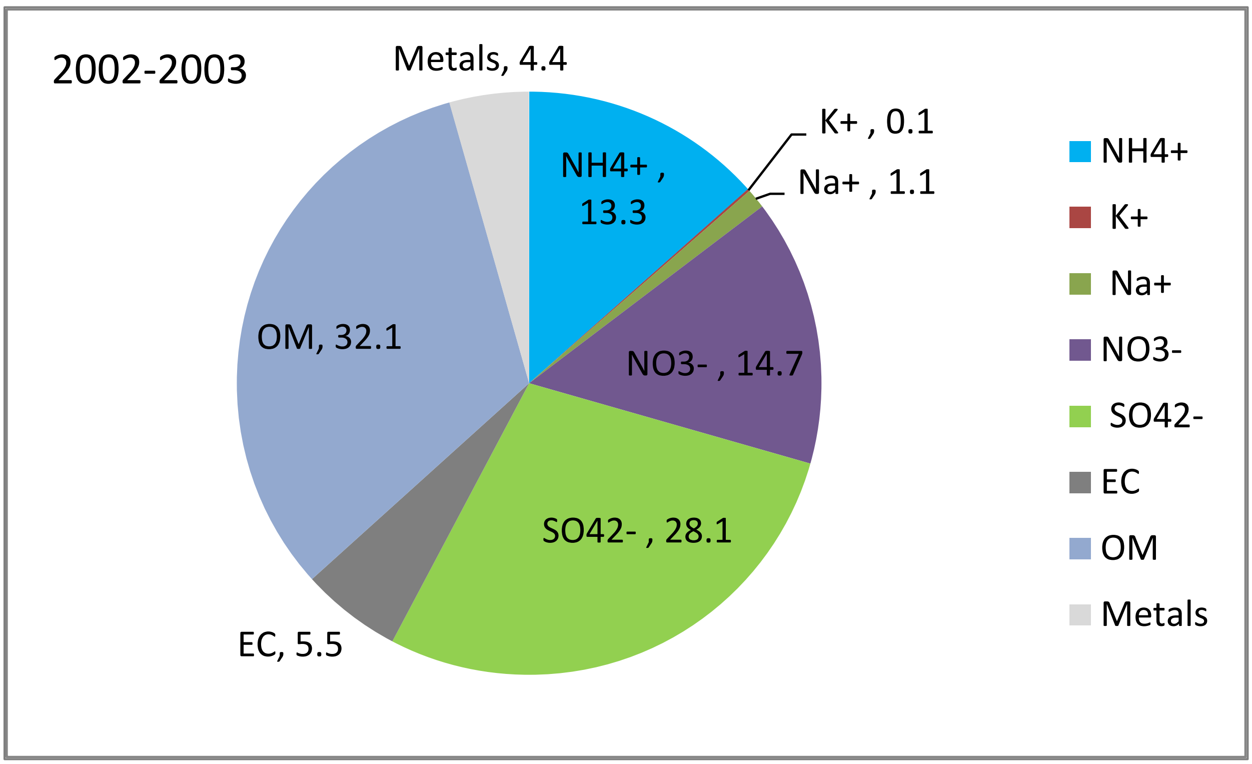


Figure 21 Species Percentage Contribution to the Total PM2.5 Mass from the Speciation Sampler in Queens, NY in 2002-3003

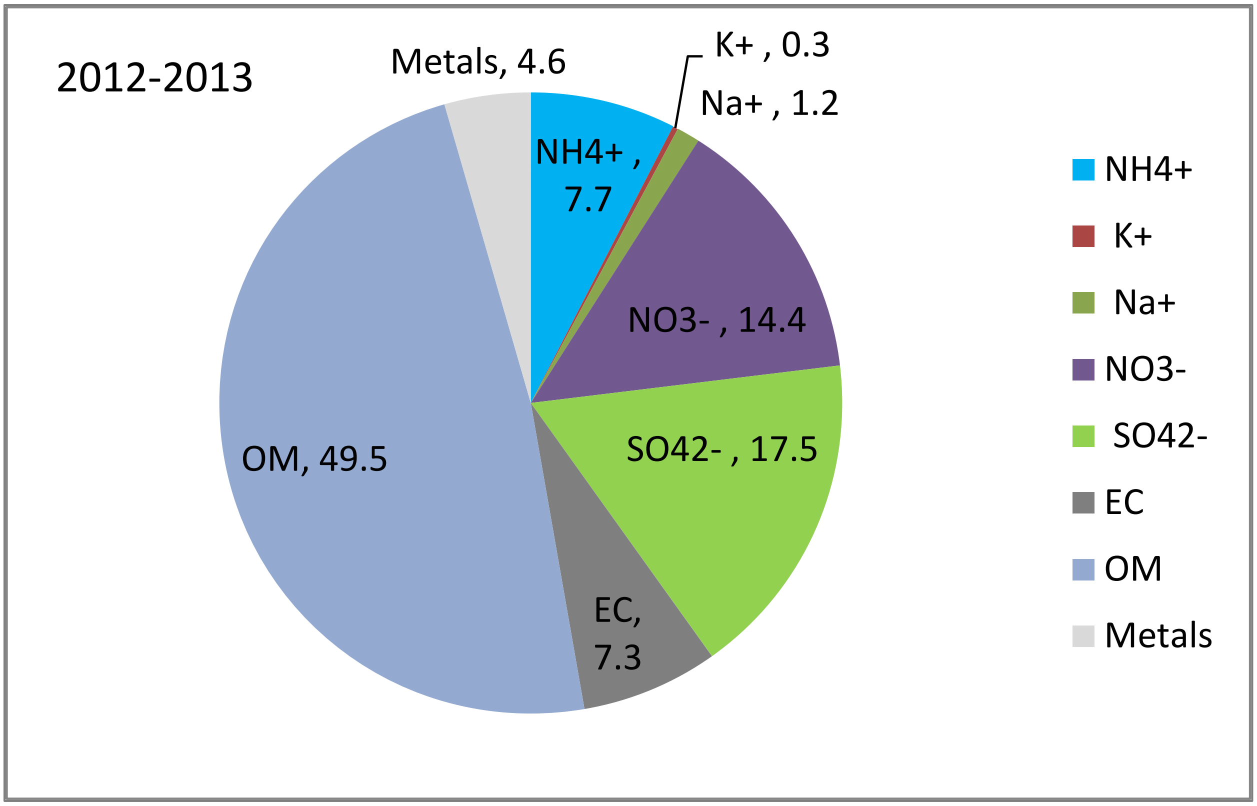


Figure 22 Species Percentage Contribution to the Total PM2.5 Mass from the Speciation Sampler in Queens, NY in 2012-2013

Higher time resolution data in the New York Metropolitan area such as hourly measurements of elemental carbon and organic carbon as well as aerosol sulfate and nitrate are more useful for understanding individual plume events and local source impacts. For example, the day of week pattern in elemental carbon at the South Bronx shows statistically higher concentrations during weekdays compared to weekends, Figure 23. This pattern is also reflected in NO_x indicating a significant mobile source contribution from nearby roadways. The weekday/weekend difference in elemental carbon and NO_x is most significant in summer months (top panel) and least noticeable in winter (bottom panel). There are additional EC emissions during cold months from space heating sources (oil furnaces for example) which are not likely to exhibit a day of week pattern.

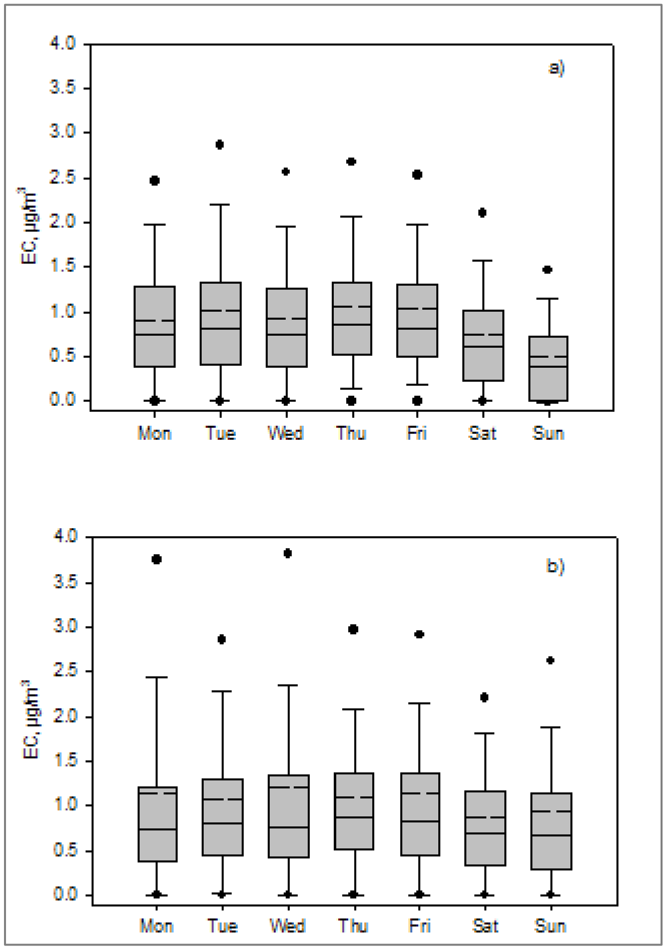


Figure 23 Day of the Week Pattern for Elemental Carbon during summer (top) and winter (bottom) in the South Bronx, NYC

The diurnal pattern for elemental carbon is similar to that of NO_x with a peak in the early morning indicative of fresh emissions into a relatively shallow boundary layer from local mobile sources during the commute period (Figure 24). Concentrations decrease in the late morning as the boundary layer height increases and pollutants are diluted and dispersed. Concentrations rise again in the late evening because the boundary layer height decreases (concentrating pollutants) and additional emissions from space heating sources during winter months. Organic carbon sometimes shows a similar pattern in winter (top panel) because of a significant primary source contribution most likely from traffic. The organic carbon diurnal pattern is different in summer months (bottom panel) because secondary organic aerosol production is enhanced during the day as the primary component decreases resulting in a relatively flat diurnal profile. Hourly measurements indicate that secondary organic aerosol accounts for approximately 40-50% of the total organic carbon during winter and up to 63-73% of during summer months.

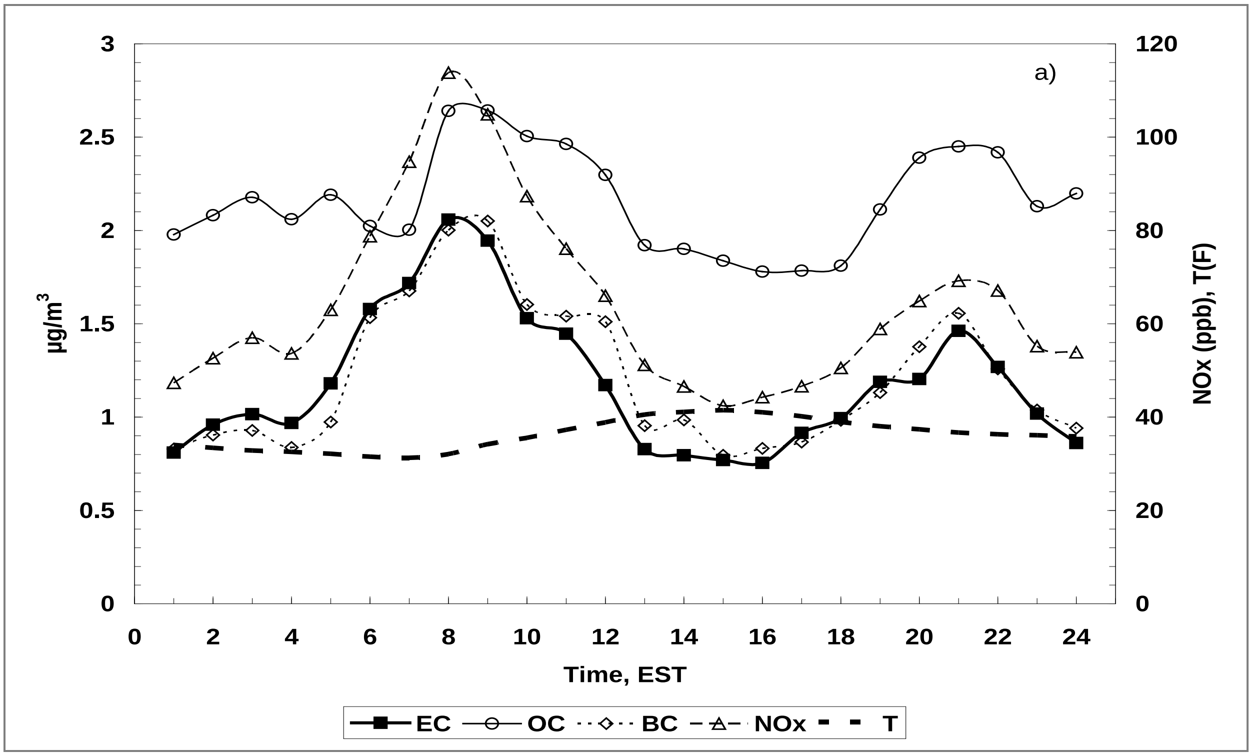


Figure 24 Diurnal Pattern for Various Parameters during winter measured in the South Bronx, NYC

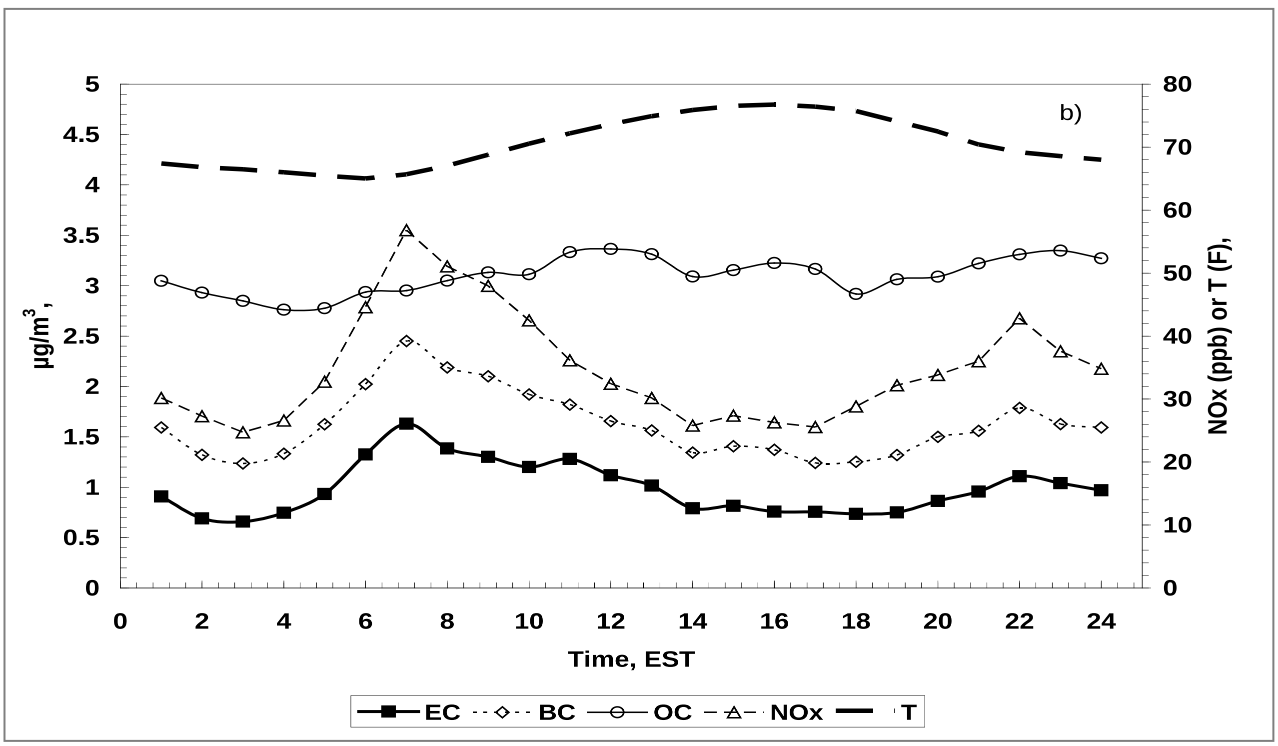


Figure 25 Diurnal Pattern for Various Parameters during summer measured in the South Bronx, NYC

Ultrafine Particulate Monitoring

The NYSDEC first began ultrafine particulate monitoring with the deployment of a TSI Model 3031 Ultrafine Particle Monitor (UPM) at Queens College in June of 2009. This instrument provides continuous measurements of size distribution and particle number concentrations of fine particles below 1 micron, in the range from to 20 to 500 nanometers. The Queens College NCore site was selected for the UPM so as to complement a suite of parameters already being measured there. Concurrently a demo UPM unit on loan for one year from the manufacturer was installed at the Eisenhower Park location in Nassau County, which is expected to have a significant impact from mobile sources. Preliminary data suggest that the ultrafine particles are to a large extent regional in nature and less impacted by local mobile sources. The particle counts and size distributions for the two sites are similar, and also track the $PM_{2.5}$ profile in some cases. It is possible that the mobile signal is damped out due to the siting of the monitor, as the inlet probe height may not be optimal and there may be interference from nearby trees. In addition, a resource recovery facility located about ¼ mile west of the site, as well as other local sources (wood-fired pizza ovens, etc.) may influence the measurements. Alternate explanations may be that mobile ultrafine emissions are predominantly smaller than the 20 nanometer cut-off point or affect the measurements only on a short time scale. Data on particle size distribution and concentration will provide valuable information for the understanding of $PM_{2.5}$ formation mechanisms, as well as source apportionment determination.

There has been significant and growing interest in mobile sources and ultrafine particles. The EPA has implemented a near road monitoring program for NO_2, $PM_{2.5}$ and CO and has included additional pollutants of interest for these locations which includes ultrafines. The recent establishment of initial regulations intended to address ultrafine particle emissions from mobile sources (LEV-3 in California, Euro V-VII in the EU) is an early indicator of more extensive regulation of ultrafine particle emissions from mobile sources expected in the future, and suggests the potential emergence of regulations for ambient ultrafine particles as well.
In our Air Pollution Microscopy laboratory, three particle characterization techniques (Laser Scanning Confocal Microscopy, Scanning Electron Microscopy, and Atomic Force Microscopy) are used to investigate the morphology of real world ultrafine particles, such as those from mobile source emissions and other industrial sources. As an example, the changes in ultrafine particle morphology resulting from the use of two strategies for reducing diesel emissions, i.e., exhaust after-treatment and the use of alternative diesel fuels were studied. These activities complement the ambient monitoring data to further the understanding of the formation, distribution and transport of ultrafine particulate.

$PM_{2.5}$ Air Quality Improvements

A 10-county downstate area had been designated nonattainment for both the 1997 annual and 2006 24-hr $PM_{2.5}$ NAAQS, consisting of Bronx, Kings, New York, Orange, Queens, Richmond, Rockland, Westchester, Nassau, and Suffolk Counties. On June 27, 2013, DEC submitted a request for these nonattainment areas to be redesignated to attainment as a result of monitored data demonstrating they attained the NAAQS; EPA approved this request effective April 18, 2014. The entirety of the state remains in attainment of these standards, as well as the more stringent annual standard of 12 µg/m^3 finalized by EPA in 2012, based on the most recent monitoring data. Implementation of policies and control strategies including new regulations contributes to the decreasing trend in the observed $PM_{2.5}$ levels. Reduction of sulfur in fuel has greatly impacted $PM_{2.5}$ emissions in the state. In 2007, sulfur in on-road diesel fuel was lowered to 15 ppm from about 3000 ppm. Beginning in 2010, sulfur levels in most non-road diesel fuel was reduced to 15 ppm, with locomotive and marine diesel fuel to follow suit in 2012. In 2011, NYC Department of Environmental Protection amended rules for new boilers and burners to use only one of the cleanest fuels, and also to phase out the use of No. 6 oil completely by 2015. Between 2007 and 2017, emissions of SO_2 and NO_x--two of the primary precursors to particulate formation--declined by 85 percent and 44 percent, respectively, partly as a result of revisions to state regulations.

Oxides of Nitrogen (NO_x)

The annual NAAQS for NO_2 is set at 53 ppb. The EPA revised the NAAQS to include an hourly standard of 100 ppb in 2010. Throughout the history of NO_2 monitoring, the annual standard has not been exceeded. The historical trend for the 1-hr standard is shown in Figure 25.

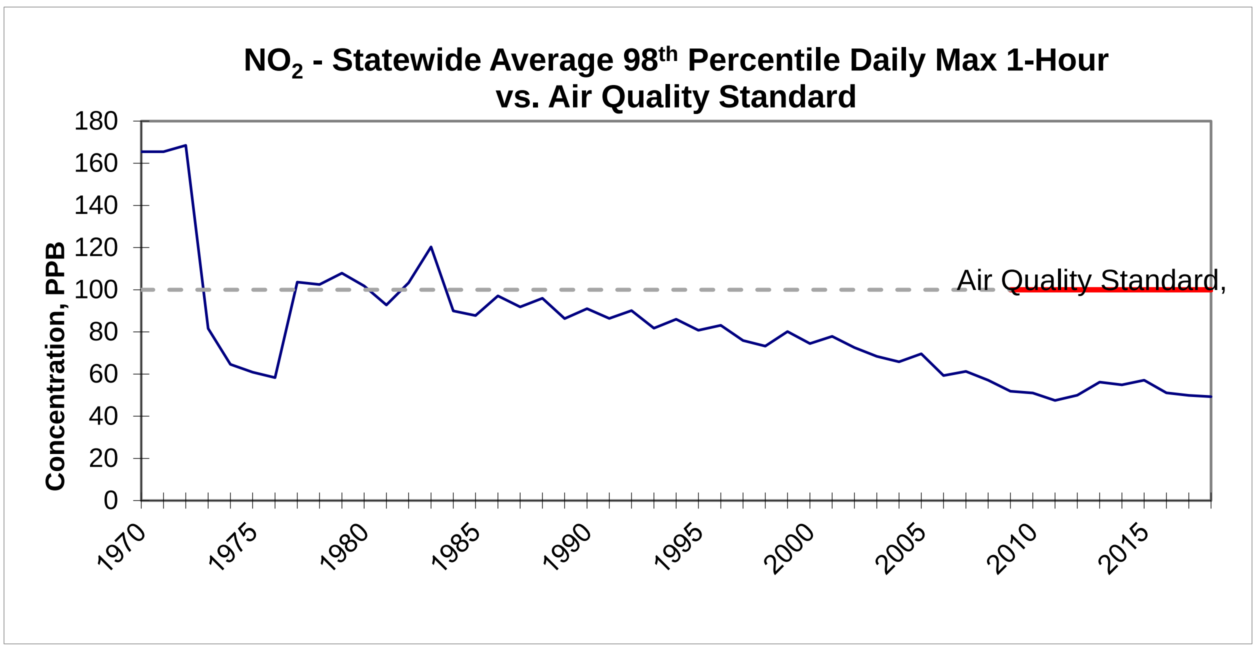


Figure 26 Statewide Trend for NO2 98th Percentile Maximum 1-Hr Concentration

At present, there are nine NO_2 monitors in the network, a location map is shown in Figure 26. Table 14 lists each site, county and MSA it serves. In addition, a NO_y monitor is being operated at each of the three NCore sites at Queens College, Rochester, and Pinnacle State Park.

Table 13 Site Location Listing of NO_2/NO_y Monitors

Site	County	MSA
NY Botanical Garden[a]	Bronx	New York-White Plains
IS 52	Bronx	New York-White Plains
Queens College[a,b]	Queens	New York-White Plains
Queens College Near-Road	Queens	New York-White Plains
Pinnacle State Park[b]	Steuben	Corning
Rochester[b]	Monroe	Rochester
Rochester Near-Road	Monroe	Rochester
Buffalo	Erie	Buffalo-Niagara Falls
Buffalo Near-Road	Erie	Buffalo-Niagara Falls

[a] PAMS site
[b] NCore site, NO_y

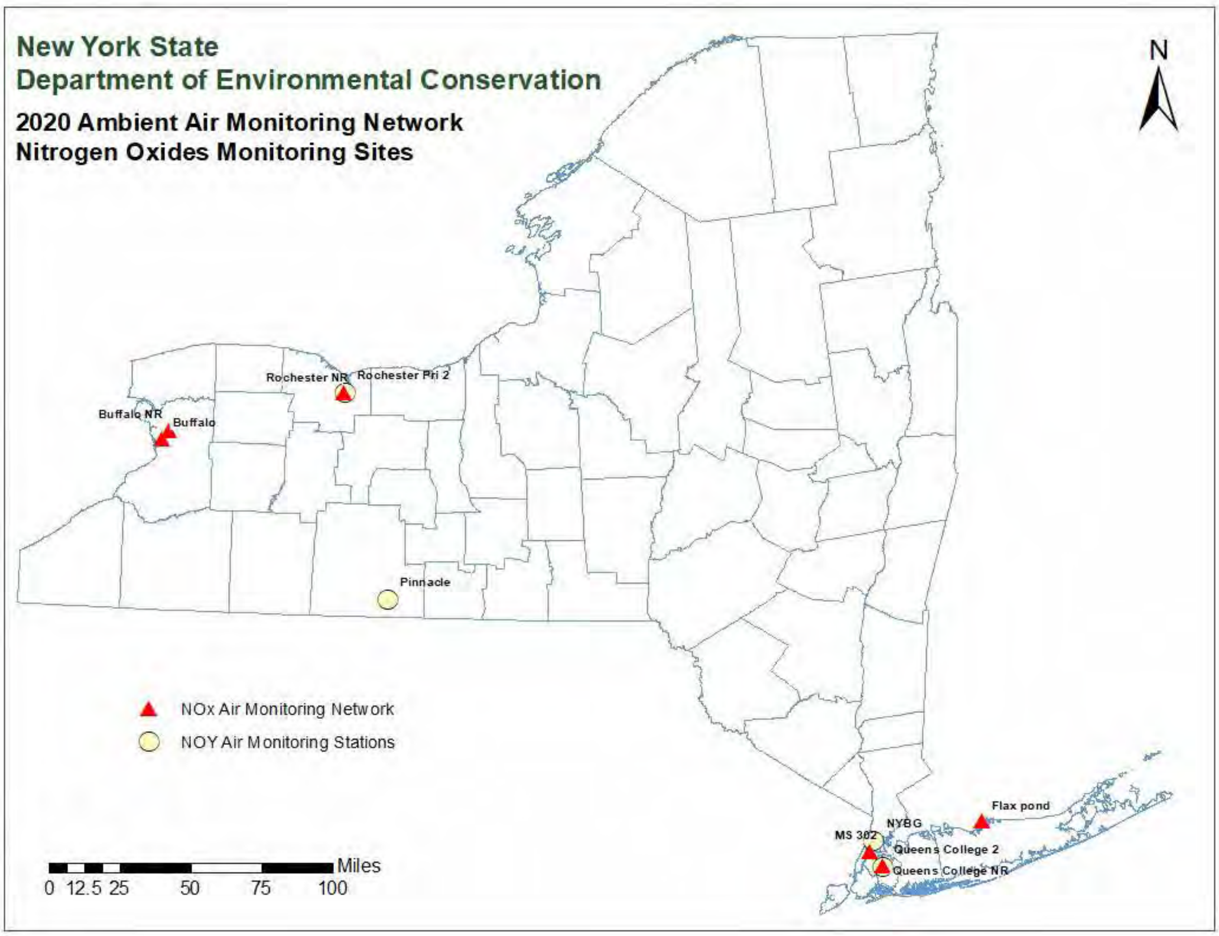


Figure 27 Site Location Map of Nitrogen Oxides Monitoring Network

Carbon Monoxide (CO)

There are no minimum requirements for the number of CO monitoring sites. Continued operation of existing SLAMS CO sites using FRM or FEM is required until discontinuation is approved by the EPA Regional Administrator. Monitoring at near-road sites is required in CBSAs over 2.5 million by January 1, 2015 and in the CBSAs over 1 million by January 1, 2017. Currently, a CO monitor is being operated at the Buffalo, Rochester, and Queens near-road sites.

A historic trend of the statewide CO average 8-hr levels is presented in Figure 27 below. The 8-hr and 1-hr NAAQS for CO are 9 and 35 ppm, respectively.

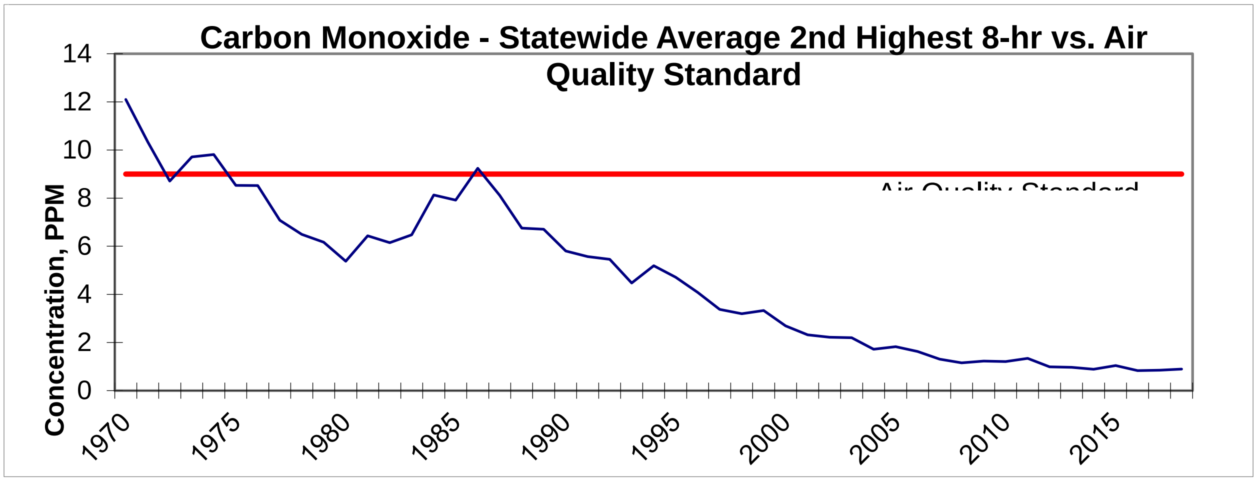


Figure 28 Statewide Average Trend for 2nd Maximum 8-hr Annual Values

CO is a product of motor vehicle exhaust, which contributes about 60 percent of all CO emissions nationwide. High concentrations of CO generally occur in areas with heavy traffic congestion. In cities, as much as 95 percent of all CO emissions may emanate from automobile exhaust. Other sources of CO emissions include industrial processes such as carbon black manufacturing, non-transportation fuel combustion, and natural sources such as wildfires. Woodstoves, cooking, cigarette smoke, and space heating are sources of CO in indoor environments. Peak CO concentrations typically occur during the colder months of the year when CO automotive emissions are greater and nighttime inversion conditions are more frequent.

At present, there are ten CO monitors in the network, a location map is shown in Figure 28. Table 15 lists each site, county and MSA it serves. With some site closures and additions the total number of monitors has remained the same since 2010.

Table 14 Site Location Listing of CO Monitors

Site	County	MSA
NY Botanical Garden	Bronx	New York-White Plains
Queens College	Queens	New York-White Plains
City College of NY	New York	New York-White Plains
Loudonville	Albany	Albany-Schenectady-Troy
Pinnacle State Park	Steuben	Corning
Rochester	Monroe	Rochester
Rochester Near-Road	Monroe	Rochester
Buffalo	Erie	Buffalo-Niagara Falls
Buffalo Near-Road	Erie	Buffalo-Niagara Falls

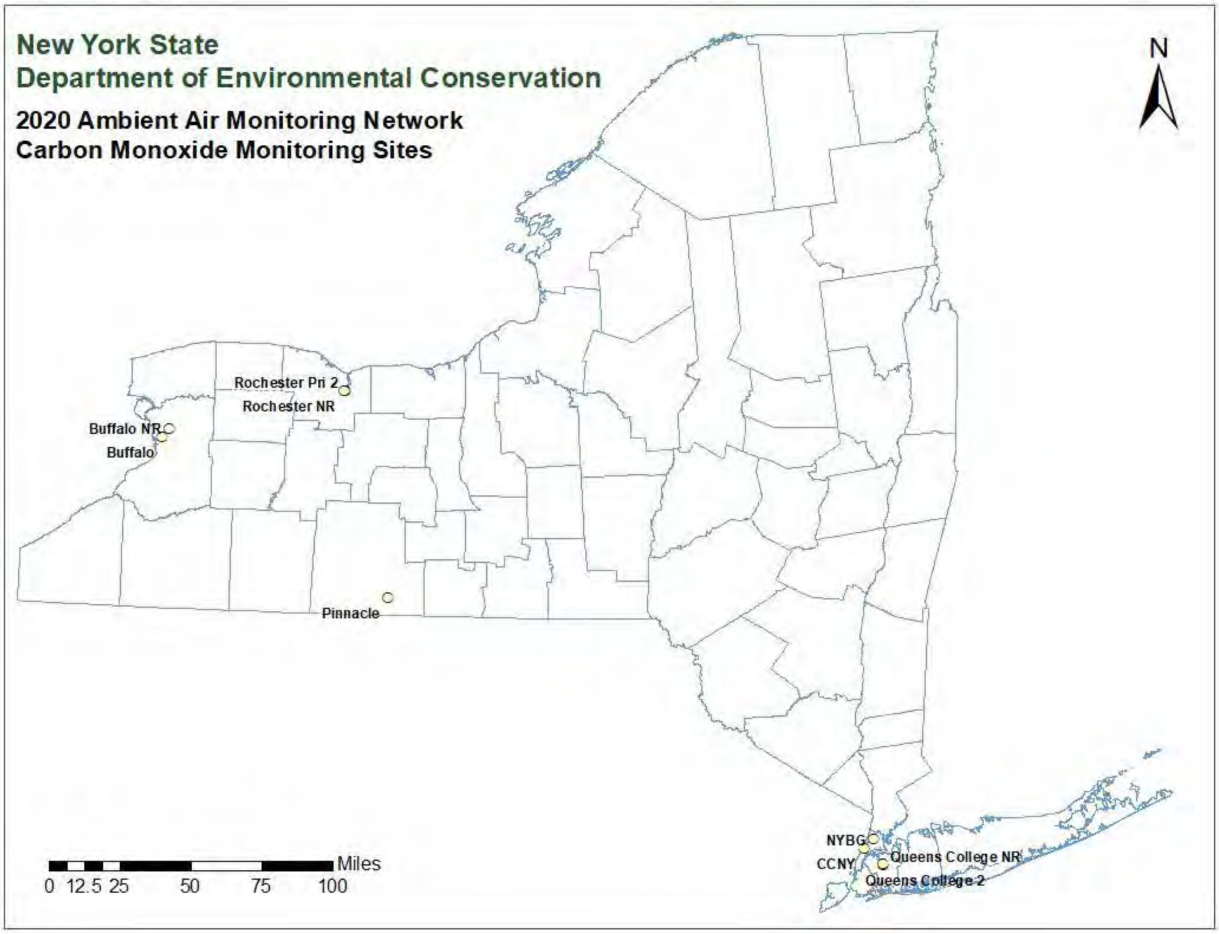


Figure 29 Site Location Map of CO Monitoring Network

Sulfur Dioxide (SO_2)

There are no minimum requirements for the number of SO_2 monitoring sites. Continued operation of existing SLAMS SO_2 sites using FRM or FEM is required until discontinuation is approved by the EPA Regional Administrator. Where SLAMS SO_2 monitoring is ongoing, at least one of the SLAMS SO_2 sites must be a maximum concentration site for that specific area.

A historic trend of the statewide SO_2 99th percentile daily 1-hr max is presented in Figure 29 below. The 1-hr, and 3-hr NAAQS for SO_2 are 100, and 500 ppb, respectively.

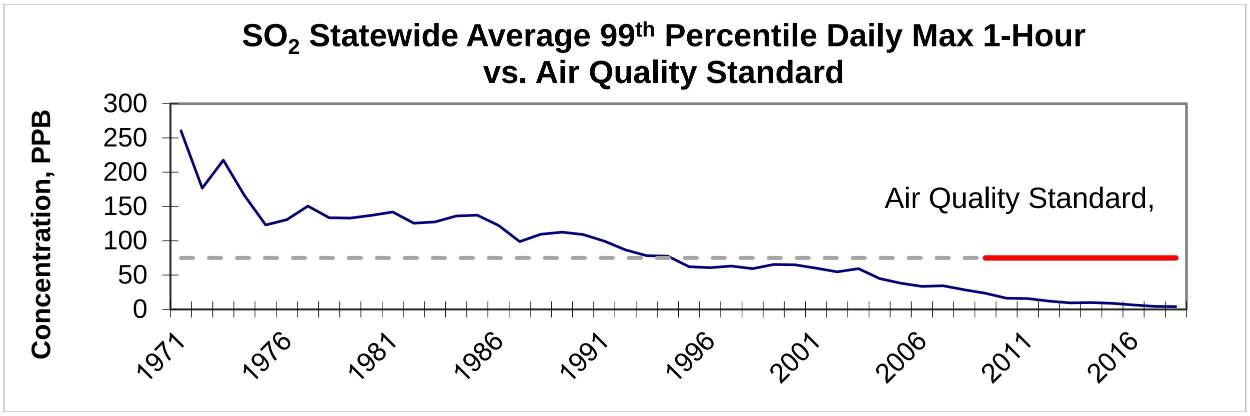


Figure 29. Statewide Trend for SO_2 99th Percentile Daily 1-Hr Max

Sulfur dioxide is produced during the burning of sulfur-containing fuels such as coal and oil, during metal smelting, and by other industrial processes. It belongs to a family of gases called sulfur oxides (SO_x). Major sources include power plants, industrial boilers, petroleum refineries, smelters, iron and steel mills. Generally, the highest concentrations of sulfur dioxide are found near large fuel combustion sources.

At present, there are 18 SO_2 monitors in the network. Table 16 lists each site, county and MSA it serves. A location map of the network is shown in Figure 30. Table 15 doesn't include site-specific monitors to determine compliance with the 2010 SO2 NAAQS, with designations to be made by EPA by 12/31/20. Two monitors were installed near Alcoa to inform the designation for St. Lawrence County. One monitor was installed in Tompkins County and one monitor was installed in Seneca County near Cayuga Generating Station.

Table 15 Site Location Listing of SO2 Monitors

Site	County	MSA
Eisenhower Park	Nassau	Nassau-Suffolk
Holtsville	Suffolk	Nassau-Suffolk
NYBG Pfizer Lab	Bronx	New York-White Plains
IS 52	Bronx	New York-White Plains
Queens College	Queens	New York-White Plains
Millbrook	Dutchess	New York-White Plains
Mt. Ninham	Putnam	New York-White Plains
Loudonville	Albany	Albany-Schenectady-Troy
Whiteface Base	Essex	Essex County
Piseco Lake	Hamilton	Hamilton County
Paul Smiths College	Franklin	Malone
Nick's Lake	Herkimer	Utica-Rome
East Syracuse	Onondaga	Syracuse
Pinnacle State Park	Steuben	Corning
Rochester	Monroe	Rochester
Buffalo	Erie	Buffalo-Niagara Falls
Tonawanda II	Erie	Buffalo-Niagara Falls
Dunkirk	Chautauqua	Jamestown-Dunkirk-Fredonia

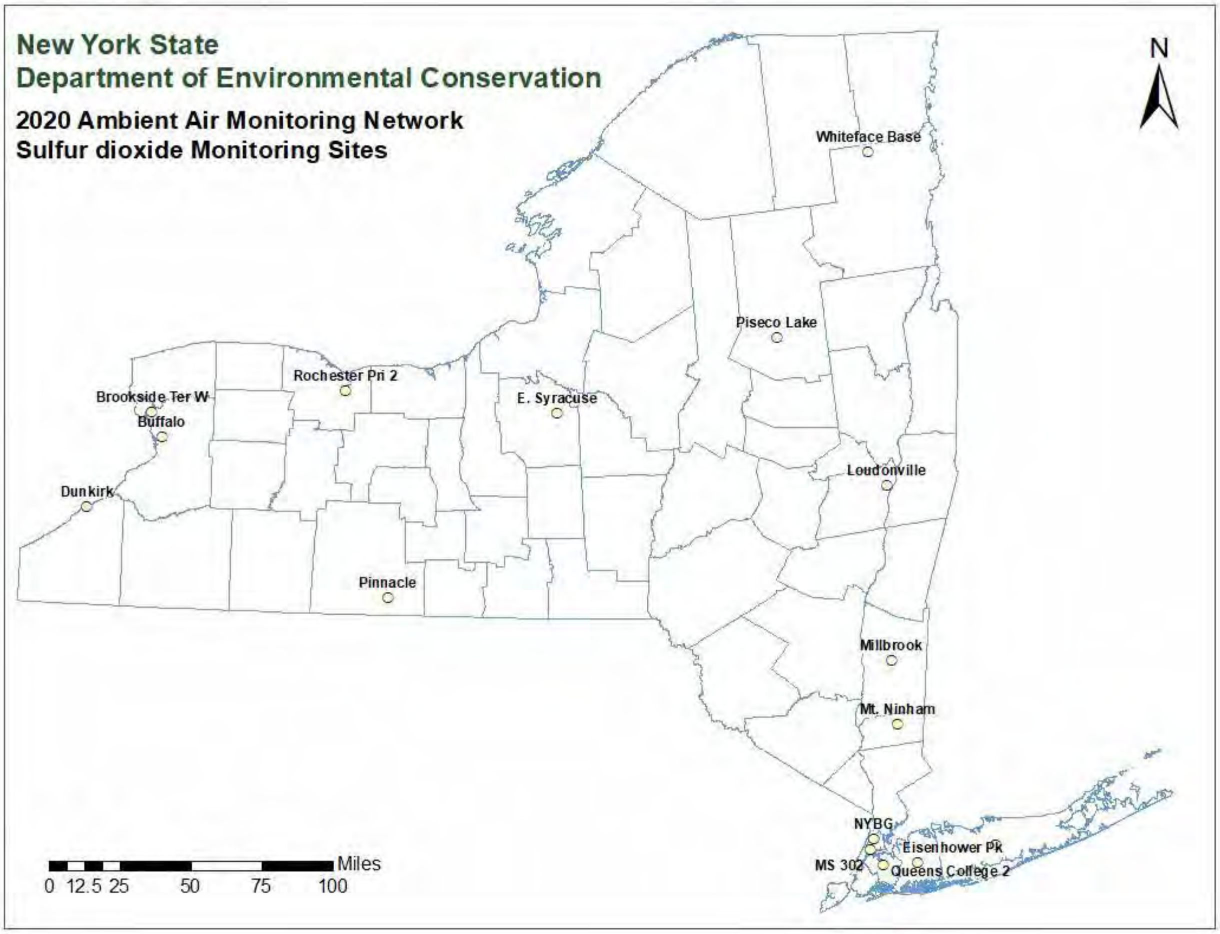


Figure 30 Site Location Map of SO2 Monitoring Network

Lead (Pb)

The major sources of lead emissions have historically been from fuels in motor vehicles (such as cars and trucks) and industrial sources. Emissions from on-road vehicles decreased 99% between 1970 and 1995 due primarily to the use of unleaded gasoline. Use of leaded gasoline in highway vehicles was prohibited on December 31, 1995. The major sources of lead emissions to the air today are ore and metals processing and leaded aviation gasoline (lead is no longer used in motor vehicle fuel).

In November 2008, the EPA revised the NAAQS for lead from the previous quarterly average of 1.5µg/m^3 to the more protective 3-month rolling average of 0.15µg/m^3.This NAAQS was upheld upon review in 2016. As part of the lead monitoring requirements, monitoring agencies are required to monitor ambient air near lead sources which are expected to or have been shown to have a potential to contribute to a 3-month average lead concentration in ambient air in excess of the level of the NAAQS. At a minimum, monitoring agencies must monitor near lead sources that emit 1.0 ton per year (tpy) or more. Monitoring is also required in each CBSA with a population equal to or greater than 500,000 people as determined by the latest available census figures. Revisions to the monitoring requirements pertaining to where State and local monitoring agencies would be required to conduct lead monitoring were finalized and became effective

January 26, 2011. The new regulations replaced the population oriented monitoring requirement with a requirement to add Pb monitors to the urban NCore monitors. The EPA also lowered the emission threshold from 1.0 tpy to 0.50 tpy for industrial sources of lead (e.g., lead smelters and foundries). However, the emission threshold for airports was maintained at 1.0 tpy. Brookhaven and Republic airports in Suffolk County, New York were selected as part of a 15 airports study nationwide to assess potential lead emissions. A 12-month monitoring study at Brookhaven Airport concluded in October, 2012 while the Republic Airport monitoring began in October. Both sites exhibited lead concentrations significantly below the NAAQS, and the EPA approved the discontinuation of monitoring.

Particulate lead samples are collected on glass fiber filters using a standard TSP high volume sampler which are subsequently analyzed by a state contract laboratory using atomic absorption spectroscopy. Under the new rule, the EPA is allowing Pb-PM_{10} in lieu of Pb-TSP where the maximum 3-month arithmetic mean Pb concentration is expected to be less than 0.10µg/m^3 (i.e., two thirds of the NAAQS) and where sources are not expected to emit ultra-coarse Pb. The population oriented Pb monitors at the NCore or NATTS sites are located away from known sources of Pb and will utilize Pb-PM_{10} samplers.

An annual trend plot of the statewide lead levels is presented in Figure 31 below. The quarterly average standard of 1.5µg/m^3, which was replaced in 2008 by the more stringent 3-month rolling average of 0.15µg/m^3, is shown on the graph for historic reference.

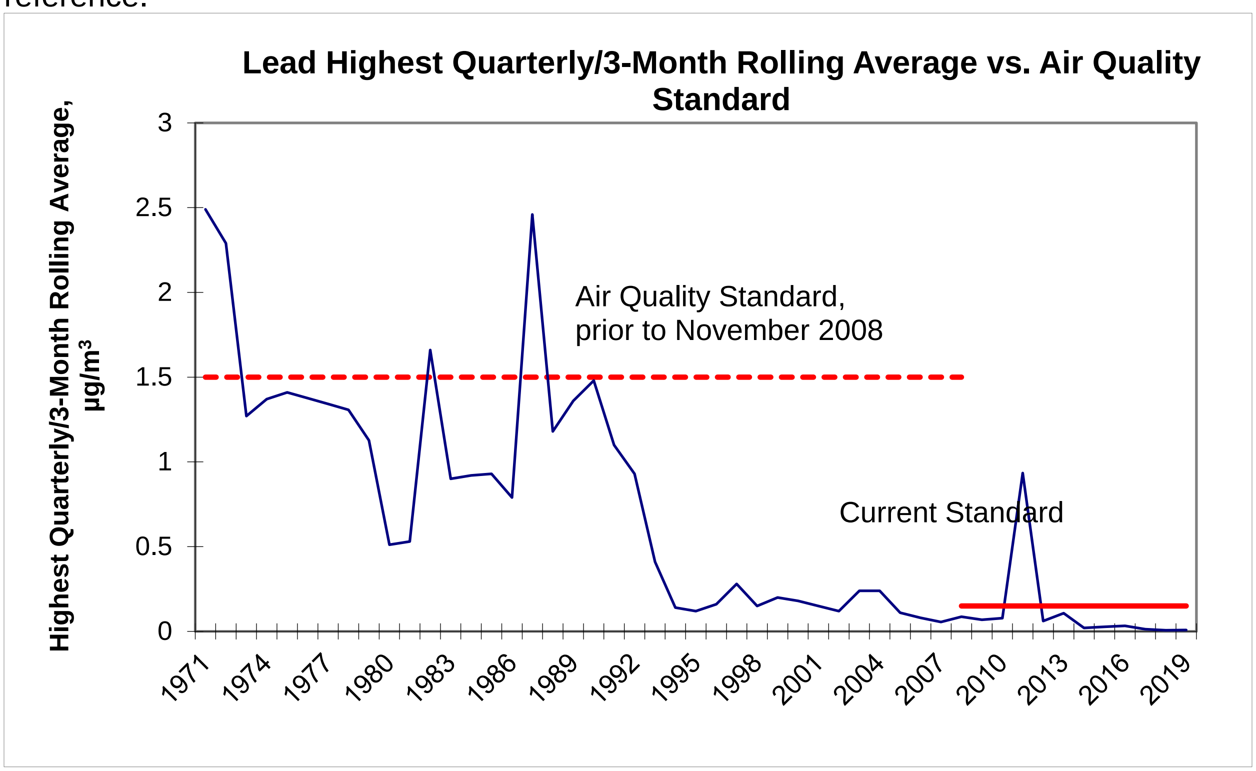


Figure 31 Statewide Annual Trend for Lead Maximum Quarterly Averages

At present, This site is the only routine lead monitoring sites in upstate New York, located in the vicinity of RSR Corporation and established as high priority SLAMS lead source-oriented monitoring site. This site on Ballard Road are upwind of RSR. In August 2011, an additional low volume PM10 sampler was put in place for daily mass and lead analysis at the Wakefern site when measurements from the prior winter showed unusually high values for a couple of sample dates. The PM10 mass data collected at this site was low and mass determination was discontinued in November 2012. Monitoring at the Scotchtown site downwind of RSR was discontinued at the end of 2015. In October 2016, the facility in Wallkill installed new emission control technologies that has led to reduced emissions of lead into the environment. As a result, the NYSDEC is closed the PbTSP site at Ballard Road and to move the co-located sampler to the Wakefern Food site at the end of 2017. The Ballard Road site was chosen for closure due to existing difficulties with the sites electrical systems, and because the site has historically shown lower values that the Wakefern Food site. Additionally, the NYSDEC transitioned the monitoring method at Wakefern food from high volume TSP sampling to low volume TSP sampling. The new monitoring method shall remain for so long as there are no changes to the emissions from the source, and the new method does not detect levels exceeding half the NAAQS. In addition there are two urban CBSA monitors (low volume PM_{10}) at the NATTS sites in the Bronx and Rochester.

Table 16 3-Month Rolling Average Lead Concentrations for TSP Lead

2019 TSP Lead 3-Month Rolling Average, ng/m^3	
Month	**Month**
January	0.0039
February	0.0046
March	0.0059
April	0.0057
May	0.0059
June	0.0059
July	0.0055
August	0.0052
September	0.0049
October	0.0074
November	0.0079
December	0.0072
Maximum	**0.0079**

Table 4.5 2019 3-Month Rolling Average PM_{10} Lead Concentrations for Urban Sites

2019 PM_{10} Lead 3 Month Rolling Average, ng/m^3		
January	0.0015	0.0009
February	0.0022	0.0010
March	0.0022	0.0011
April	0.0022	0.0011
May	0.0016	0.0012
June	0.0017	0.0011
July	0.0017	0.0013
August	0.0022	0.0016
September	0.0023	0.0017
October	0.0021	0.0017
November	0.0023	0.0013
December	0.0027	0.0014
Maximum	**0.0027**	**0.0017**

Photochemical Assessment Monitoring Stations (PAMS) Network

The PAMS network is designed to enable the characterization of precursor emission sources within the area, transport of O_3 and its precursors, and the photochemical processes related to O_3 nonattainment. NYSDEC operated two Type 2 monitors in the Bronx and Queens. The site in Queens was closed due to construction at Queensborough Community College. Type 2 sites were established to monitor the magnitude and type of precursor emissions in the area where maximum precursor emissions are expected to impact and are suited for the monitoring of urban air toxic pollutants. The PAMS program was re-engineered by EPA and as a result of the redesign, the PAMS sites in New York were expected to be installed at urban NCore sites. NYSDEC received waivers to move the Queens PAMS site to the existing location in the Bronx. The other PAMS site was supposed to be installed in Rochester which is attaining the Ozone NAAQS. Instead, NYSDEC has moved the site to Flax Pond which is just North of Stony Brook on Long island to help determine why ozone levels are higher on the edges of Long island Sound. This area has the highest Ozone design Values in the region. The relevant parameters sampled at each site are listed in Tables 17 and 18.

Table 17 PAMS Parameters Monitored at Flax Pond

Parameter	EPA Sampling Method	Analysis Method	Schedule
Ozone	API T400 Method 087	Ultraviolet Photometric	Continuous
Oxides of Nitrogen (NO, NO_2, NO_x)	TEI 42C Method 074	Chemiluminescence	Continuous
NOy	API 200EU Method 082	Chemiluminescence	Continuous
VOCs	Canister Method 150	GC/MS	1 day in 6

PAMS precursor	Method 128	GC/FID	Continuous
Carbonyl	DNPH Cartridge Method 202	HPLC Ultraviolet Absorption	1 day in 6
Temperature	Method 040	---	Continuous
Barometric Pressure	Method 011	---	Continuous
Relative Humidity	Method 011	---	Continuous

Table 18 PAMS Parameters Monitored at New York Botanical Garden/Pfizer Lab

Parameter	EPA Sampling Method	Analysis Method	Schedule
Ozone	API T400 Method 087	Ultraviolet Photometric	Continuous
Oxides of Nitrogen (NO, NO_2, NO_x)	TEI 42C Method 074	Chemiluminescence	Continuous
PAMS precursor	Method 128	GC/FID	Continuous
VOCs	Canister Method 150	GC/MS	1 day in 6
Carbonyl	DNPH Cartridge Method 202	HPLC - Ultraviolet Absorption	1 day in 6
Relative Humidity	Method 011	---	Continuous
Temperature	Method 040	---	Continuous

The PAMS target compounds include 55 C_2-C_{12} hydrocarbons and 3 carbonyls. For the New York metro area, it appears that ozone exceedances are often VOC limited. Although VOCs as a class are subject to control and reduction, particularly in nonattainment areas, specific compounds of high reactivity are not individually targeted. Controls and regulations are mainly aimed at toxic organic compounds rather than ozone precursors.

The continuous GC data verification is extremely labor intensive as typical concentrations for the majority of the targeted compounds are barely above background levels. The analyst has to manually adjust each peak baseline for quantification. The PAMS data are used by modelers within the Division for SIP development. The EPA is currently concluding the re-engineering of the PAMS program. The program objectives, network design, and measurement technologies have been reassessed.

The NYSDEC does not conduct any upper air meteorological measurements at the PAMS sites. The NYS Mesonet (http://www.nysmesonet.org) does operate five sites with upper air monitoring in the NYC and Long Island regions. Modelers use data from the closest installations for distinguishing stagnation events vs. transport.

NCore Monitoring Network

The NCore multipollutant sites measure multiple pollutants in order to provide support to integrated air quality management data needs. NCore sites generally include both neighborhood and urban scale measurements, in a selection of metropolitan areas and a limited number of more rural locations. These sites are required to measure O_3, CO, SO_2, and total reactive nitrogen (NO_y) (using high-sensitivity methods, where appropriate); $PM_{2.5}$ (with both a FRM and a continuous monitor); $PM_{2.5}$ chemical speciation; $PM_{10\text{-}2.5}$ (with a continuous FEM); and meteorological parameters including temperature, wind speed, wind direction, and relative humidity. The three sites in the state are at Queens College, Rochester, and Pinnacle State Park. A complete listing of parameters measured is provided in Tables 19 through 21.

Table 19 NCore Multi-parameter Site at Queens College

Parameter	Sampling Method	Analysis Method	Schedule
Ozone	TEI 49C Method 047	Ultraviolet Photometric	Continuous
Low Level SO_2	TEI 43i TLE Method 560	Pulsed Fluorescence	Continuous
Oxides of Nitrogen (NO, NO_2, NO_x)	TEI 42C Method 074	Chemiluminescence	Continuous
NO_y	API 200EU Method 082	Chemiluminescence	Continuous
Low Level CO	API 300EU Method 593	Non Dispersive Infrared	Continuous
$PM_{2.5}$	R&P Partisol 2025 Method 118	Gravimetric	Daily
$PM_{2.5}$ Speciation Ions and Elements	MetOne SASS Method 811	IC, XRF	1 day in 3
$PM_{2.5}$, PMcoarse, PM_{10}	Thermo Scientific 1405 DF FDMS Method 790	TEOM 30°C Gravimetric	Continuous
PM_{10}	R&P Partisol 2025 Method 127	Gravimetric	Daily
Carbon	URG 3000 Method 838	IMPROVE TOR	1 day in 3
	Sunset Laboratory Method 5040	Thermal Optical	Semi-continuous
Sulfate	TEI 5020i	Pulsed Fluorescence	Semi-continuous
Toxics	Canister Method 150	GC/MS	1 day in 6
Carbonyl	DNPH Cartridge Method 202	HPLC - Ultraviolet Absorption	1 day in 6
Wind Speed/direction	Method 020	---	Continuous
Temperature	Method 040	---	Continuous
Barometric Pressure	Method 011	---	Continuous
Relative Humidity	Method 011	---	Continuous

Table 20 NCore Multi-parameter Site at Pinnacle State Park

Parameter	Sampling Method	Analysis Method	Schedule
Ozone	TEI 49C Method 047	Ultraviolet Photometric	Continuous
Low Level SO_2	TEI 43i TLE Method 560	Pulsed Fluorescence	Continuous
Low Level CO	API 300EU Method 593	Non Dispersive Infrared	Continuous
NO_y	API 200EU Method 699	Chemiluminescence	Continuous
$PM_{2.5}$	Low volume FRM R&P 2025 Method 118	Gravimetric	1 day in 3
$PM_{2.5}$, PMcoarse, PM_{10}	TEI 1405 DF Method 790	TEOM 30ºC Gravimetric	Continuous
$PM_{2.5}$ Speciation Ions and Elements	Met One SASS Method 811	IC, XRF RTI Laboratory	1 day in 3
$PM_{2.5}$ Speciation Carbon	URG 3000 Method 838	IMPROVE TOR	1 day in 3
Sulfate	TEI 5020i	Pulsed Fluorescence	Semi-continuous
Toxics	Canister Method 150	GC/MS	1 in 6
Wind Speed/direction	Method 020	---	Continuous
Temperature	Method 040	---	Continuous
Barometric Pressure	Method 011	---	Continuous
Relative Humidity	Method 011	---	Continuous

Table 21 NCore Multi-parameter/NATTS Site at Rochester

Parameter	Sampling Method	Analysis Method	Schedule
Ozone	TEI 49C Method 047	Ultraviolet Photometric	Continuous
Sulfur Dioxide	TEI 43C Method 560	Pulsed Fluorescence	Continuous
Low Level CO	API 300EU Method 593	Non Dispersive Infrared	Continuous
NO_y	API 200EU Method 699	Chemiluminescence	Continuous
$PM_{2.5}$	Low volume FRM R&P 2025 Method 118	Gravimetric	1 in 6
$PM_{2.5}$, PMcoarse, PM_{10}	TEI 1405 DF Method 790	TEOM 30ºC Gravimetric	Continuous
PM_{10}	R&P Partisol 2025 Method 127	Gravimetric	1 in 6
PM_{10} - Metals	Method 907	ICPMS	1 in 6
$PM_{2.5}$ Speciation	Met One Super SASS Method 851	RTI Laboratory	1 in 3
$PM_{2.5}$ Speciation Carbon	URG 3000 Method 838	IMPROVE TOR	1 in 3
Black Carbon	Magee Scientific Aethalometer Method 866	Optical Absorption	Continuous
Mercury Elemental Reactive Gas Mercury Particle Bound Mercury	Tekran 2537B Tekran 1130 Tekran 1135	In situ cold vapor atomic fluorescence	5 minute avg 2 hr avg every 3 hr
Toxics	Canister Method 150	GC/MS	1 in 6
Carbonyl	DNPH Cartridge Method 202	HPLC - Ultraviolet Absorption	1 in 6
Polycyclic Aromatic Hydrocarbons (PAH)	Tisch TE 5007 Method 118	GC/MS EPA/ERG Lab	1 in 6
Mercury Wet Deposition	NCON Model 00-125-2 automatic sampler	Frontier Geosciences: cold vapor atomic fluorescence	Weekly
Wind Speed/direction	Climatronics Sonic Method 020		Continuous
Relative Humidity	Teledyne RH200 Method 011		Continuous
Temperature	Teledyne RH200 Method 040		Continuous
Barometric Pressure	Teledyne BP300 Method 011		Continuous
Precipitation	NAOH IV		Continuous
Acid Deposition	NCON Bucket Style Collector Model 00-120-2	Central Analytical Laboratory at the Illinois Water Survey: IC, ICP-OES, FIA	Weekly

National Air Toxics Trends Stations (NATTS) Network

The two New York NATTS sites, Rochester and IS 52 in the Bronx, are part of a 27-site national network of air toxics monitoring stations. The primary purpose of the NATTS network is tracking trends in ambient air toxics levels to facilitate measuring progress toward emission and risk reduction goals. The monitoring network is intended, over a six-year period, to be able to detect a 15% difference (trend) between two successive 3-year annual mean concentrations within acceptable levels of decision error. Parameters monitored for the Rochester and Bronx sites are given Tables 21 and 22, respectively.

Table 22 IS 52 NATTS Site

Parameter	Sampling Method	Analysis Method	Schedule
Ozone	TEI 49C Method 047	Ultraviolet Photometric	Continuous
Oxides of Nitrogen	TEI 42C Method 074	Chemiluminescence	Continuous
$PM_{2.5}$, PM_{10}, PMcoarse	Thermo Scientific 1405 DF FDMS	TEOM 30ºC Gravimetric	Continuous
$PM_{2.5}$	Low volume FRM R&P 2025 Method 118	Gravimetric	Daily 1 day in 3
$PM_{2.5}$ Speciation Ions and Elements	Met One SASS Method 811	IC,XRF	1 day in 3
$PM_{2.5}$ Speciation Carbon	URG 3000 Method 838	IMPROVE TOR	1 day in 3
PM_{10}	Low volume FRM R&P 2025 Method 127	Gravimetric	1 day in 6[a]
PM_{10} - Metals	Method 907	ICPMS	1 day in 6[a]
Sulfate	Thermo Scientific 5020i Sulfate Particulate	Pulsed Florescence	Continuous
Black Carbon	Magee Scientific Aethalometer Method 866	Optical Absorption	Continuous
Elemental Carbon/ Organic Carbon	Sunset Laboratory Method 5040	Thermal Optical	Semi-Continuous
Polycyclic Aromatic Hydrocarbons-PAH	Tisch TE 5007 Method 118	GC/MS EPA/ERG Lab	1 day in 6
Toxics	Canister Method 150	GC/MS	1 day in 6 [a]
Carbonyl	DNPH tube Method 202	HPLC - Ultraviolet Absorption	1 day in 6
Wind Speed/direction	Climatronics Method 020	Sonic	Continuous

[a] Collocated unit

Prior to the establishment of the NATTS network, the NYSDEC began a statewide toxics monitoring network back in 1990. Currently we monitor toxics (TO-15) at 13 sites and carbonyls at ten sites. Sample analysis is conducted by in-house laboratory staff.

Table 23 Site Location Listing of Toxics Monitors

Site	County	MSA	Toxics	Carbonyls
NYBG Pfizer Lab	Bronx	New York-White Plains	ü	ü
IS 52[a]	Bronx	New York-White Plains	ü	ü
PS 274	Kings	New York-White Plains	ü	
Queens College	Queens	New York-White Plains	ü	ü
Fresh Kills West	Richmond	New York-White Plains	ü	ü
Albany South[b]	Albany	Albany-Troy-Schenectady	ü	ü
Whiteface Base	Essex	Essex County	ü	ü
Rochester[a]	Monroe	Rochester	ü	ü
Rochester Near-Road	Monroe	Rochester		ü
Buffalo	Erie	Buffalo-Niagara Falls	ü	
Buffalo Near-Road	Erie	Buffalo-Niagara Falls		ü
Tonawanda II				ü
Grand Island Blvd[b]	Erie	Buffalo-Niagara Falls	ü	ü

[a]NATTS site; [b]Special Purpose Monitor

Figure 32 shows the site location map of the toxics monitoring network.

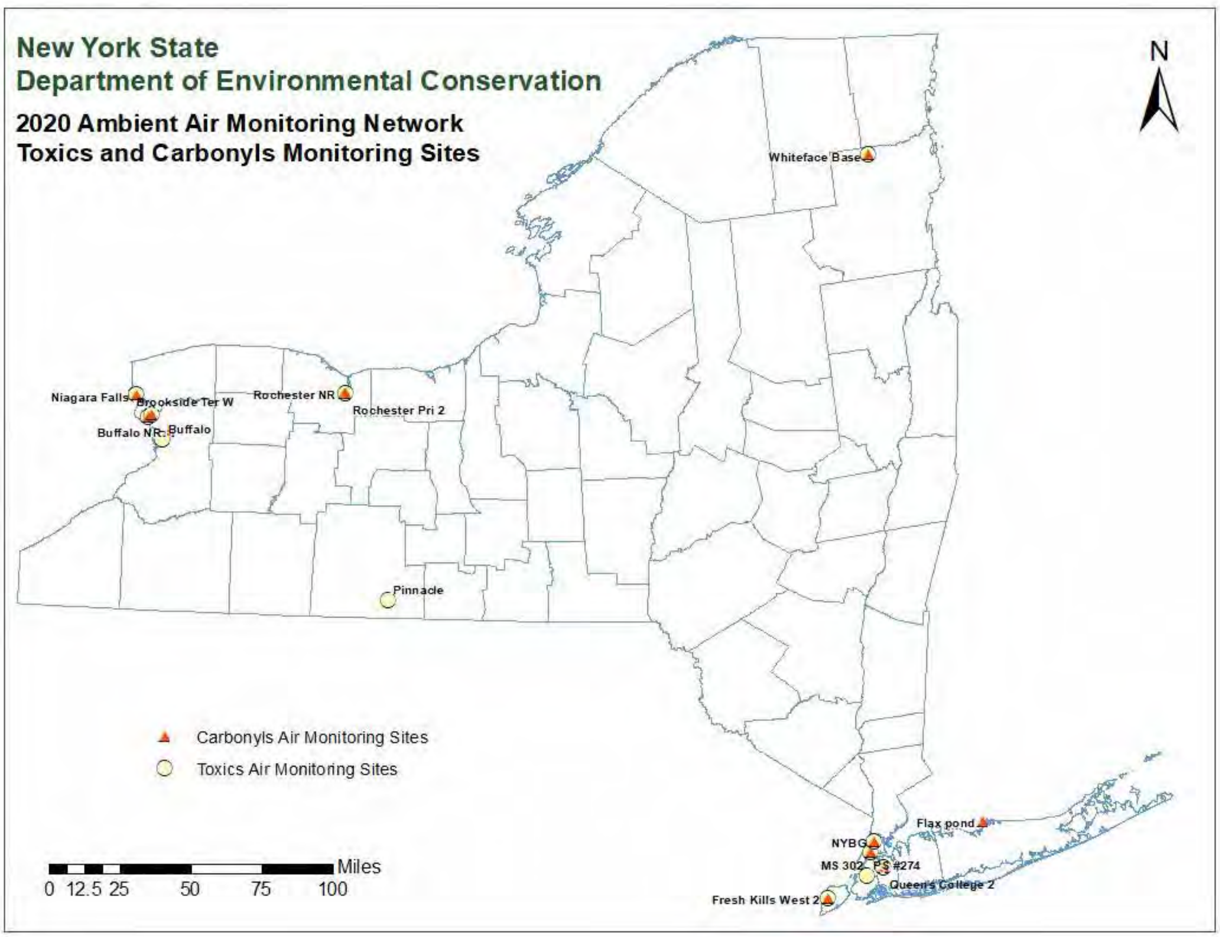


Figure 32 Site Location Map of Toxics Network

In the five years since the last network assessment, BAQS has experienced workforce reduction due to staff separations. It took until this past year to bring bureau staffing levels up to the 2010 fill level. In the intervening years, five toxics monitoring sites were closed, while four new ones were added. The Department intends to expand the toxics network to better characterize population exposure as resources become available.

The following charts (Figures 33 and 34) illustrate the statewide annual averages for benzene and 1,3-butadiene. Figures 35 and 36 show trends for the carbonyls, formaldehyde and acetaldehyde.

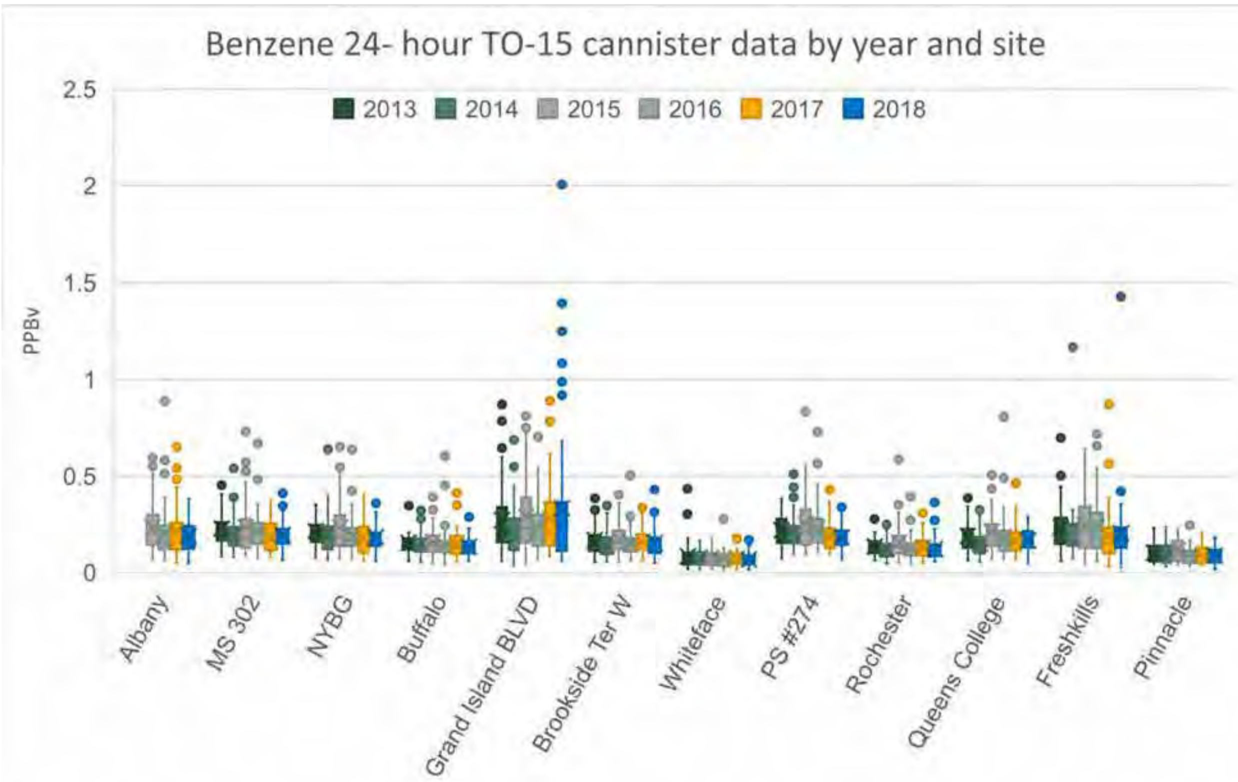


Figure 33 Benzene data for Toxics Network Sites

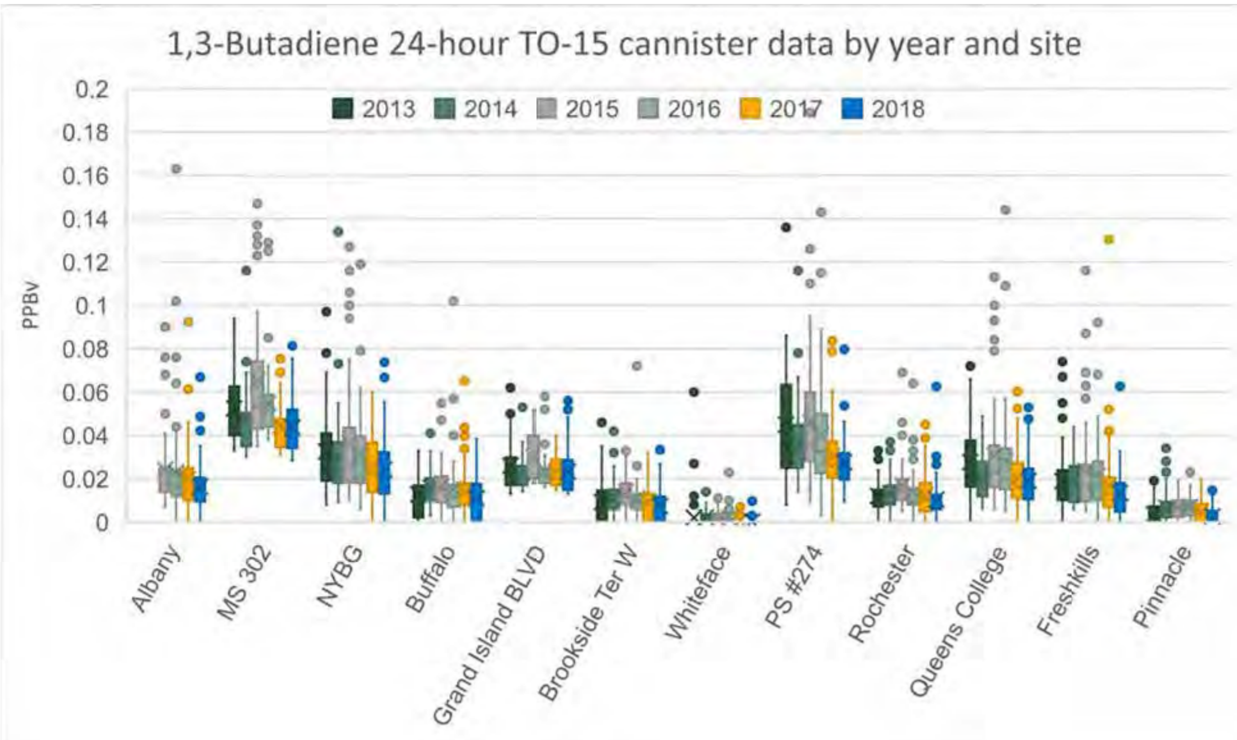


Figure 34 1,3-Butadiene data for Toxics Network Sites

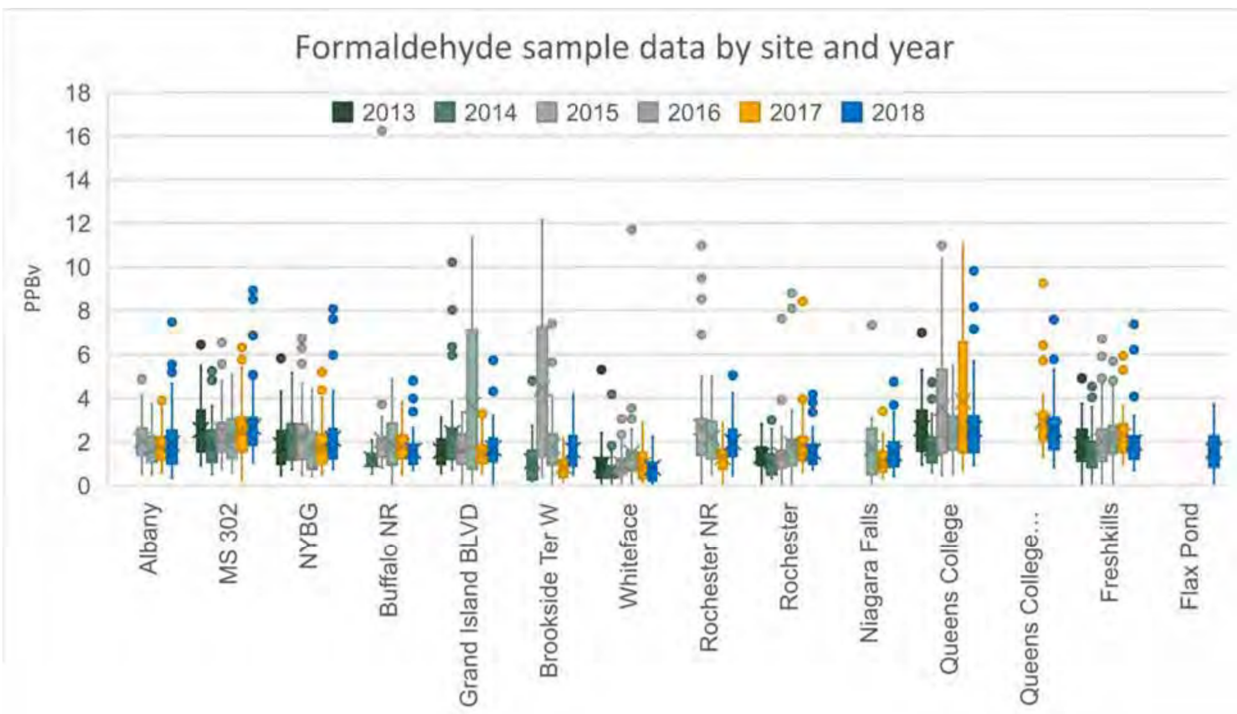


Figure 35 Formaldehyde data for Toxics Network Sites

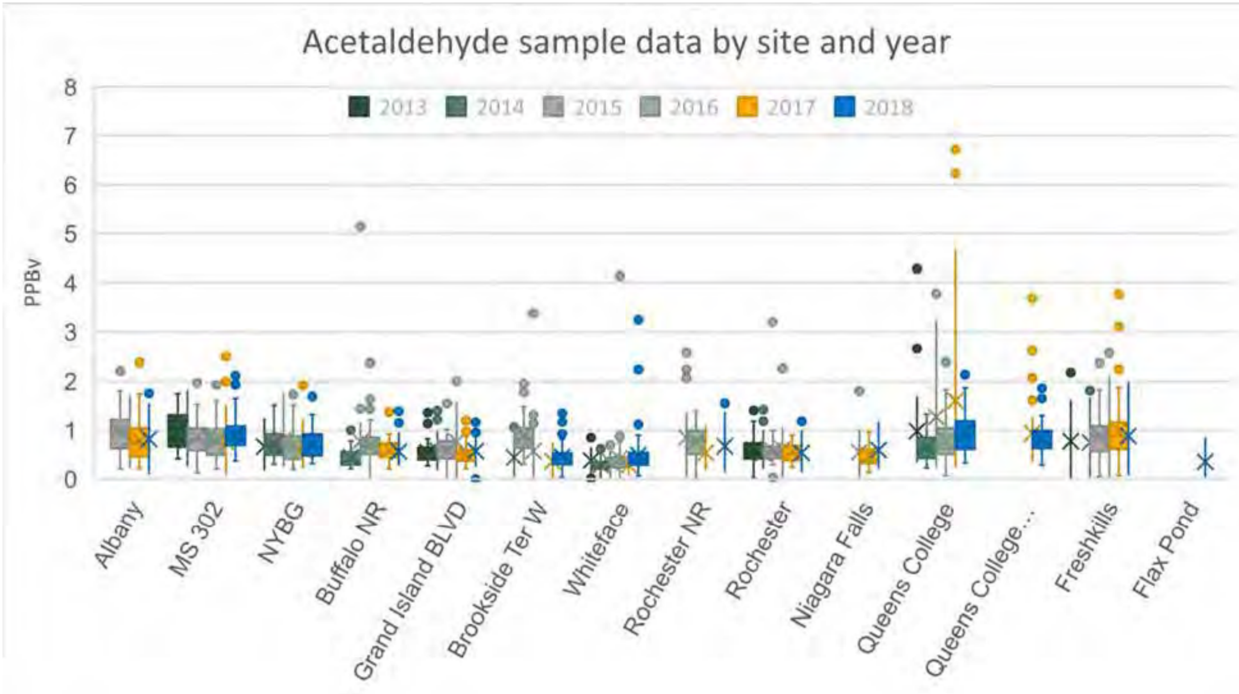


Figure 36 Acetaldehyde data for Toxics Network Sites

Acid Deposition Network

New York monitors and tests for acid deposition through the New York State Acid Deposition Monitoring Network, which was designed in 1985 to carry out requirements of the State Acid Deposition Control Act (SADCA). Measurements of acid deposition and related quantities are used to assess the effectiveness of sulfur control policy and other strategies aimed at reducing the effects of acid rain. Federal and State programs were implemented in recent years to further control emissions contributing to acid deposition. These include the NO_x and SO_x Budget Trading Programs, and the Cross-State Air Pollution Rule. As a result, sulfate deposition has decreased by more than 60% statewide since the monitoring program began and the concentrations of acidic pollutants continue to decline.

At the end of 2012, the Department discontinued the existing acid rain monitoring program and transitioned 7 monitoring locations to the National Acid Deposition Program (NADP). The transition to the NADP program will result in savings to the Department, provide better and more useful data for use in regulation development and will allow for the comparison of data from New York with other acid sensitive regions across the country. Additionally, because the NADP program provides a uniform operational framework, the data from existing NADP sites within New York and in neighboring states can be utilized in the analysis of deposition in New York.

The NADP program uses IC, ICP and FIA to determine the concentrations of free acidity (H^+ as pH), conductance, calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^+), potassium (K^+), sulfate (SO_4^{2-}), nitrate (NO_3^-), chloride (Cl^-), and ammonium (NH_4^+). The data and reports from this program from the 7 NYSDEC sites as well as other sites in New York and in the United States can be obtained from: http://nadp.sws.uiuc.edu/data/

The NYSDEC monitoring locations that were converted to the NADP in January 2013 are:

NY06 Bronx
NY28 Piseco Lake
NY43 Rochester (Established 2013)
NY59 Wanakena
NY92 Amherst (Established 2013)
NY93 Paul Smith's College

The other NADP sites currently operating in New York but sponsored by other organizations are:

NY01 Alfred
NY08 Aurora Research Farm
NY10 Chautauqua
NY20 Huntington Wildlife
NY22 Akwesasne Mohawk-Fort Covington

NY52 Bennett Bridge
NY67 Ithaca (NADP/AirMoN)
NY68 Biscuit Brook
NY96 Cedar Beach, Southold
NY98 Whiteface Base (Previously operated by NYSDEC)
NY99 West Point

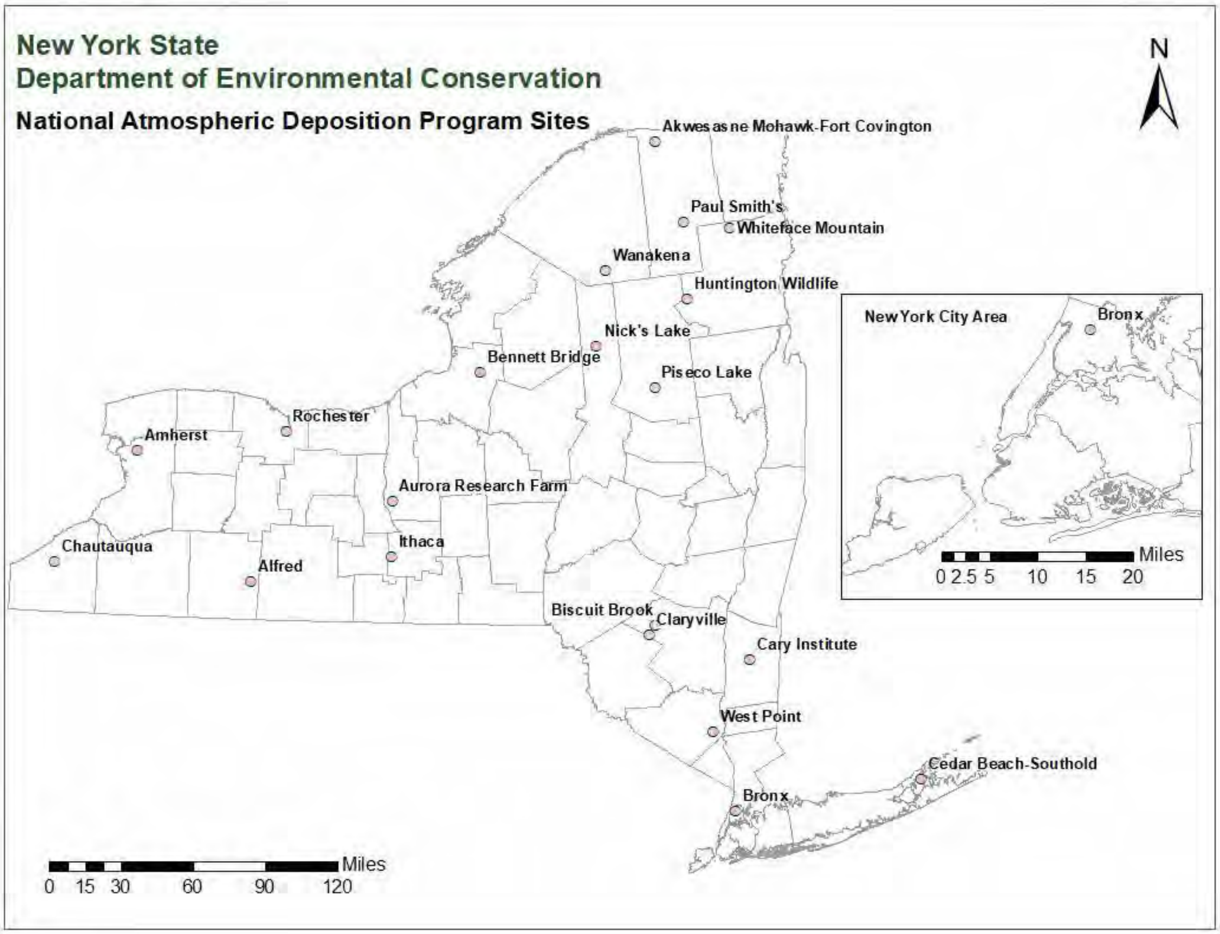


Figure 37 Site Location Map of Acid Deposition Network

Special Purpose Monitors

NYSDEC occasionally conducts short-term special ambient monitoring studies when the need arises. These include research-oriented projects, sometimes grant supported, as well as studies necessitated by citizen concerns

Tonawanda Community Air Quality Study

Although the original study funded by EPA concluded in 2008, NYSDEC has continued sampling at two of the four study sites. The Tonawanda Coke Corporation completely shut down their operation in October 2018. The Grand Island Blvd. industrial site and the met only site in Tonawanda were discontinued at the end of 2019. The Tonawanda II site at Brookside Terrace will remain in operation for at least another year.

South Albany Neighborhood Air Quality Monitoring

In response to community concerns, in 2015, NYSDEC added an air toxics monitor near the existing long-term PM monitoring site in the south Albany neighborhood at 274 S. Pearl St., Albany, NY. Samples are collected on a one in six-day schedule for the analysis of VOCs and carbonyls. The data will be useful in assessing if industrial activities in the Port area significantly impact the neighborhood air quality when compared to cities of similar size with normal urban emissions.

As part of the ongoing effort to assist those who live, work and play in the South End Neighborhood, the NYSDEC worked with local community groups to design and implement an intensive neighborhood-monitoring plan for a community air quality study. In summer 2017, staff began operation of the monitoring equipment. The monitoring portion of the study is continued through October 2018. The study utilized both fixed monitoring sites and portable instruments to evaluate the impacts of nearby roadways and commercial processes. Updated information about the Albany South End Study can be found on the study webpage: http://www.dec.ny.gov/chemical/108978.html

The NYSDEC discontinued monitoring in the shelter at Ezra Prentice Homes on S. Pearl St. at the end of 2019.

Miscellaneous Projects

Monitoring staff provide technical support and maintenance for several portable field instruments. The advanced leak detection and repair (LDAR) equipment purchased by the EPA for the Department has proven to be extremely valuable during recent field deployments at petroleum storage facilities and compressor stations. In addition to the FLIR camera, staff maintain and calibrate a H_2S real-time instrument, as well as train Regional staff in their proper field use. Also, wood smoke monitoring kits that measure black carbon, $PM_{2.5}$ and wind speed/direction are available for Regional field deployment. Laboratory staff prepare and ship evacuated canisters fitted with orifice flow devices to the Regions as needed for whole air grab sampling. These samples are returned to our laboratory facility for VOC analysis. It is anticipated that staff will be involved with “citizen science” projects.

Health-Related and Scientific Research

NYSDEC air staff routinely provide support to health related and other scientific research endeavors that take place. Some examples are listed below.

Rochester PM Center

The NYSDEC collaborates with researchers from the University of Rochester Medical Center and Clarkson University who have been awarded a second PM health research grant from EPA. Their work focuses on the pathways and effects from PM pollution on the cardiovascular system. The NYSDEC provides data and support for a fine particle classifying instrument at a monitoring location near the University of Rochester. A second instrument provided by Clarkson University was also installed at IS 52.

Integrated Assessment of the Effects of NH_3, PM, SO_2, and VOC Emissions on O_3 and $PM_{2.5}$ Concentrations and Trends in New York State

This project is a collaboration with scientists from EPRI, SUNYA, ARA Inc., Envair and Syracuse University. The project includes data collection for 15 months of 5-minute intervals of nitrogen species including NO_y, NO_x, PAN, AN, HNO_3, NO_3^- and NH_4^+ at an urban monitoring site in Queens, NY and at a rural site in the Southern Tier of New York. The data will be used to investigate how specific anthropogenic sources contribute to air quality impacts. Additionally, the project data and ancillary data will be used to determine the significance of in-state vs out-of-state emissions for nitrogen and carbonaceous aerosols.

Measurement of Ambient Ammonia to Identify its Spatial and Temporal Distribution, Source Types, and its Role in Secondary Particle Formation

This project is a collaboration with scientists from Clarkson University, ARA Inc. and SUNY Albany. The project includes data collection for 15 months of ammonia by denuder difference and by passive diffusion at four locations in NY State. The locations are Queens, Rochester, the Southern Tier and Potsdam. The high frequency measurements of NH_3 from four locations will provide information necessary to determine the significance of NH_3 on particle production across the state.

Multi-Ethnic Study of Atherosclerosis (MESA)

The University of Washington has continued air quality monitoring in New York City as part of the Multi-Ethnic Study of Atherosclerosis (MESA) air study. This monitoring is part of the MESA (Multi-Ethnic Study of Atherosclerosis) medical research study. Data are being used to evaluate the performance of the low-cost monitors used in the study and will be used to construct air pollution exposure models for several pollutants in all six of the MESA cities. The monitoring is being conducted concurrently with MESA participant clinical visits, so the exposure models can be used to determine associations between air pollution and the participants' cardiovascular health, particularly heart failure and atrial fibrillation.

Monitoring was originally conducted at IS 52 and CCNY between 2005 and 2009. Monitoring restarted in March 2017, adding additional DEC monitoring locations. This additional monitoring was conducted at five NYS DEC monitoring stations in New York City: IS 52, NYBG, CCNY, Division Street and PS 19 and continued until early 2019.

External Data Users

There are a multitude of organizations and individuals that use the data that are produced by our monitoring networks. They include other regulatory government agencies, health researchers, academics, citizen groups, consulting firms and other private citizens. For example, the American Lung Association uses our data and its own methodology to grade the air quality of states each year. Community groups also use the air quality data to alert their citizens of the potential “bad air” days. More notable uses are listed below:

- Environmental Public Health Tracking Program (EPHT) - CDC with state and local Health Depts. EPHT is the ongoing collection, integration, analysis, and interpretation of data about the following factors: 1) Environmental hazards; 2) Exposure to environmental hazards; and 3)Health effects potentially related to exposure to environmental hazards
- AIRNow
- DOH Asthma Study
- NESCAUM LISTOS

NESCAUM Long Island Sound Tropospheric Ozone Study (LISTOS)

Beginning in 2018, a group of State, Federal and Academic researchers will begin to examine ozone precursor and ozone formation from the I-95 corridor through NYC, Long Island, Long Island Sound and on to Connecticut and Rhode Island. The work is being designed to complement the PAMS network and in fact will be incorporated into the Enhanced Monitoring Plan for NY, CT and NJ. Additional information about LISTOS is available on NESCAUM’s website: http://www.nescaum.org/documents/listos

New and Proposed Rules

As mandated by the Clean Air Act, the EPA must periodically review the scientific bases (or criteria) for the various NAAQS by assessing newly available scientific information on a given criteria air pollutant. In addition to revising the NAAQS when deemed appropriate, regulations are also promulgated for the implementation of these standards, which specify monitoring requirements. Often litigations lead to the reconsideration of the adopted rules. There are a number of recently adopted and proposed rules which will significantly affect the existing monitoring networks.

Secondary Standards for NOx/SOx

The EPA considered setting a secondary standard for NO_x and SO_x that would specifically target the impact of acidic deposition on wilderness areas. The EPA ultimately decided that there was not enough information at this time to tie specific water quality thresholds with ambient air concentrations. In the July 2011 final rule for NO_x and SO_x, the EPA stated that they would set up a monitoring program in sensitive areas to collect information to link water quality impacts to ambient air quality measurements.

The NYSDEC is participating in this pilot monitoring program in the Adirondacks. Additional monitoring equipment has been installed at several sites to determine the concentrations of gasses and particles including ammonia. These data will be used in the future to inform the next review of the NO_x/SO_x standard. Although ambient NO_2 levels are not expected to contravene the NAAQS, monitoring is necessary due to NO_2 being an ozone precursor, and the need to track the effectiveness of emission reduction programs. EPA is again reviewing the available scientific evidence to determine the necessity of secondary NOx and SOx standards, and expects to release planning documents related to its NAAQS review in 2020.

Quality Assurance

In addition to the QA/QC procedures implicit in the daily operation of each network component, independent and regularly scheduled audits are performed by personnel from the Ambient Monitoring Section of the Bureau of Quality Assurance. They also carry out the Performance Evaluation Program (PEP) for the FRM $PM_{2.5}$ network, and Through The Probe (TTP) audits for all gaseous pollutants. All QA requirements specified in the monitoring rules of 40 CFR Parts 53 and 58 are adhered to.

Technology

We continue to evaluate new equipment and instrumentation as they become available on the market. The Queens College site is often used as a platform for manufacturers to test/certify their instruments for designation. We often provide support for collocated sampling for instruments under development.

Data Acquisition

NYSDEC recently deployed ten digital data acquisition systems in field for continuous instruments. These systems have added functions and capabilities including:

- i/o for RS 232 or Ethernet connection
- minute data storage eliminating the need for strip chart/recorder (cost saving)
- remotely operate and perform diagnostics of equipment
- connect to new generation instruments that no longer provide analog output

Ultrafine Measurements

On February 11-13, 2015, the EPA held a workshop in Research Triangle Park, NC that brought together international experts on emissions, air quality, exposures, and health impacts of ultrafine particles (UFP) to present and discuss the latest research and policy issues related to UFP. The workshop consisted of platform presentations on UFP relevant science such as emissions and health control issues, health effects and evidence, and policy considerations.

The NYSDEC first began ultrafine particulate monitoring with the deployment of a TSI Model 3031 Ultrafine Particle Monitor (UPM) at Queens College in June of 2009. This instrument provides continuous measurements of size distribution and particle number concentrations of fine particles below 1 micron, in the range from 20 to 500 nanometers.

The NYSDEC how UFP instrumentation at the Rochester Near Road, Pinnacle State Park, Albany County Health Department,

Next-gen Laboratory and Field Equipment

The Department is in the process of updating laboratory and field instruments for toxics monitoring. In addition to replacing the legacy GCMS system, the workhorse for canister sample analysis for the last decade, the BAQS laboratory facility will be acquiring a state-of-the-art research and development instrument system that will facilitate future monitoring advancements. This system will provide the capability to analyze non-routine samples captured in sorbent tubes or Tedlar bags. Also, an ion mobility spectrometer will be procured to complement other portable field instruments such as the FLIR camera and the H_2S monitor.

Personnel and Training

In the past ten years the monitoring program experienced a 15% staff reduction due to staff separations. Graying of the current staff could potentially lead to another 10% reduction as they become eligible for retirement and elect to do so. A considerable amount of technical expertise and skills will be lost if there is no succession plan to retain this knowledge. It is therefore our highest priority to address this issue.

New York has one of the most robust and advanced air monitoring programs in the nation. In order to maintain this high level of effort and play a major role in the implementation and development of cutting edge measurement technology, it is important for program management to recruit young professionals into the organization to replace outgoing staff. EPA Region 2 has been very supportive of New York’s program by providing grant monies for equipment purchase and network upgrade necessary to implement new monitoring requirements. However, recent awards have not included funding for personal services. It will be of tremendous help if grant monies are earmarked for the hiring of new personnel in the future.

Anticipated Changes in the Next 18 Months

Special Purpose Monitors

Proposed Changes and Additions at Existing Sites

As part of the requirements specified in the revised Monitoring Regulations Parts 53 and 58, a network assessment was performed to determine “if the network meets the monitoring objectives defined in appendix D to this part, whether new sites are needed, whether existing sites are no longer needed and can be terminated, and whether new technologies are appropriate for incorporation into the ambient air monitoring network.” As a result of this exercise, NYSDEC is proposing the following modifications to the existing network

Complete PAMS Site Installation

The NYSDEC is planning to complete the installation of a PAMS monitoring station on the North Shore of Long Island just north of Stony Brook. The location is in the Flax Pond Marine Laboratory. This facility is in the Village of Oldfield in Setauket, NY.

Flax Pond Marine Laboratory

Location
N 40.961015
W 73.139130

In 2019, installation work continued and some data were collected to support 1-hr VOC and 8-hr Carbonyl and Ozone measurements. The building is currently under renovation which should have been completed in time for the 2020 monitoring season. Due to delays associated with Cobid-19, the site will not re-open in time for the 2020 PAMS season. The PAMS monitoring season is from June 1st through August. The site will also support additional equipment that are integral to the Long Island Sound Tropospheric Ozone Study (LISTOS). The Enhanced Monitoring Plan (EMP) for PAMS has more information regarding the LISTOS program.

Reduction of Urban SO2 and CO Monitors

The NYSDEC will discontinue SO2 monitoring at Brookside Terrace and at Holtsville and CO monitoring at Loudonville. The SO2 and CO data are low and concentration gradients between sites have decreased.

Reduction of Source Oriented Pb Monitoring

The NYSDEC is no longer required to monitor for Pb around the Pb recycling facility in Wallkill, NY because the facility's emissions are well below the minimum required under 40 CFR Part 50 October 18, 2016. Monitoring is currently occurring on a 1-in-3 day schedule at this location. In 2021, monitoring will continue at a reduced frequency of 1-in-6 day.

Change in PM-2.5 FRM and FEM Monitoring Locations

The NYSDEC has been using a combination of non-FEM continuous PM-2.5 instruments and filter-based FRMs to meet the various needs for PM-2.5 data reporting. Many of the new continuous instruments are now designated as FEMs. In order to ensure the accuracy of continuous FEM instruments, it is recommended that these instruments be collocated with filter based FRMs that operate on a periodic 1 in 3 or 1 in 6 day schedule. To facilitate on-going data integrity, the NYSDEC is planning to close some sites with stand-alone FRMs or non-FEM continuous instruments and move those instruments to sites where the instruments can be collocated.

Close Morrisania and move continuous instrument to Pfizer.
Close JHS 126 and move FRM to PS 274
Close Maspeth – No longer necessary since Queens College and Queens Near Road are nearby
Close IS143 since site close to CCNY
Reduce Port Richmond FRM sampling frequency to 1 in 6 day

Appendicies

The following appendicies were constructed using the EPA NetAssess2020 toll

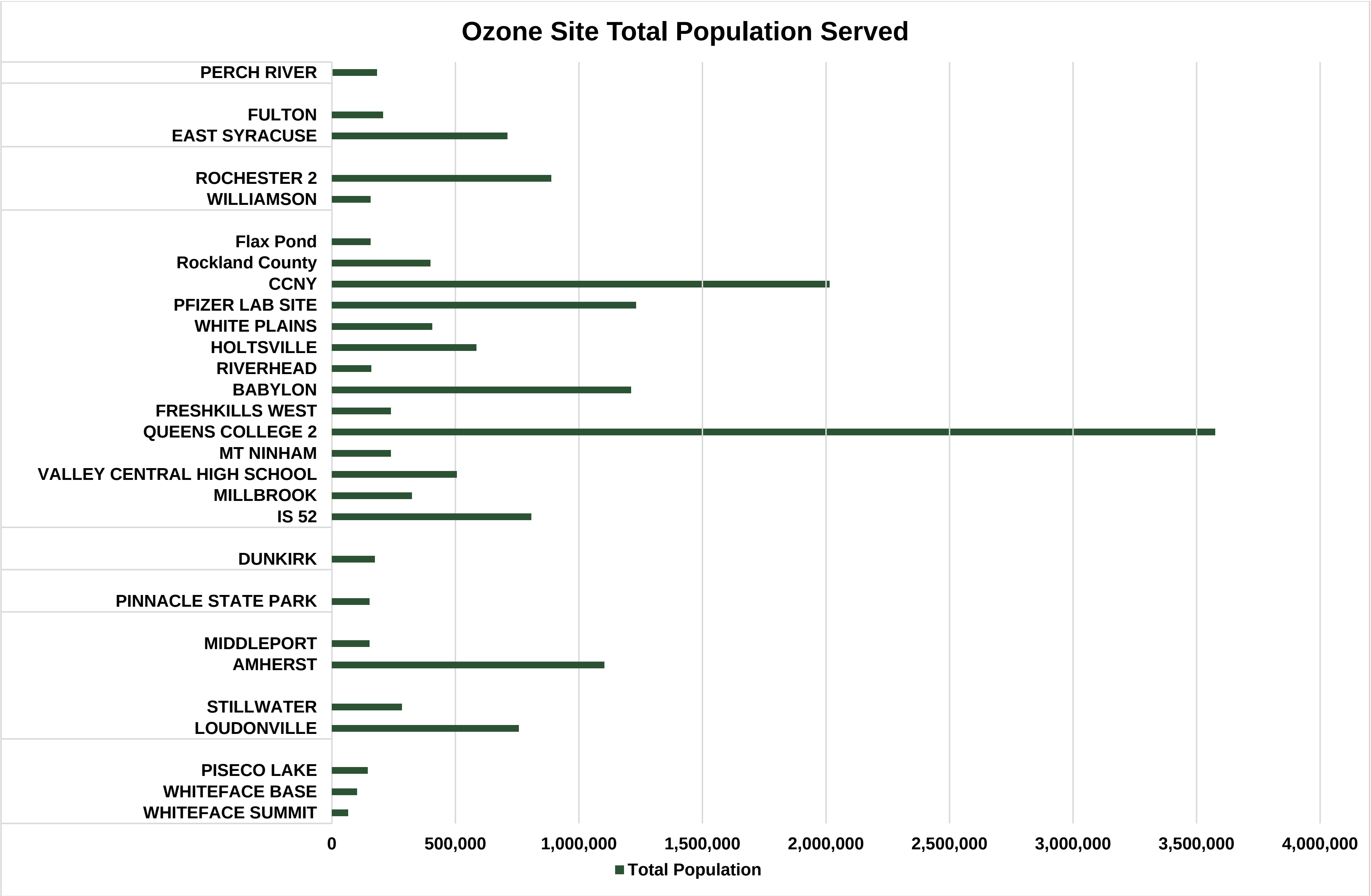
The NetAssess2020 app was developed by EPA's Office of Air Quality Planning and Standards. (OAQPS). It is an update of the NetAssess app developed by LADCO for the 2015 5-year Ambient Air Monitoring Network Assessments.

Credits

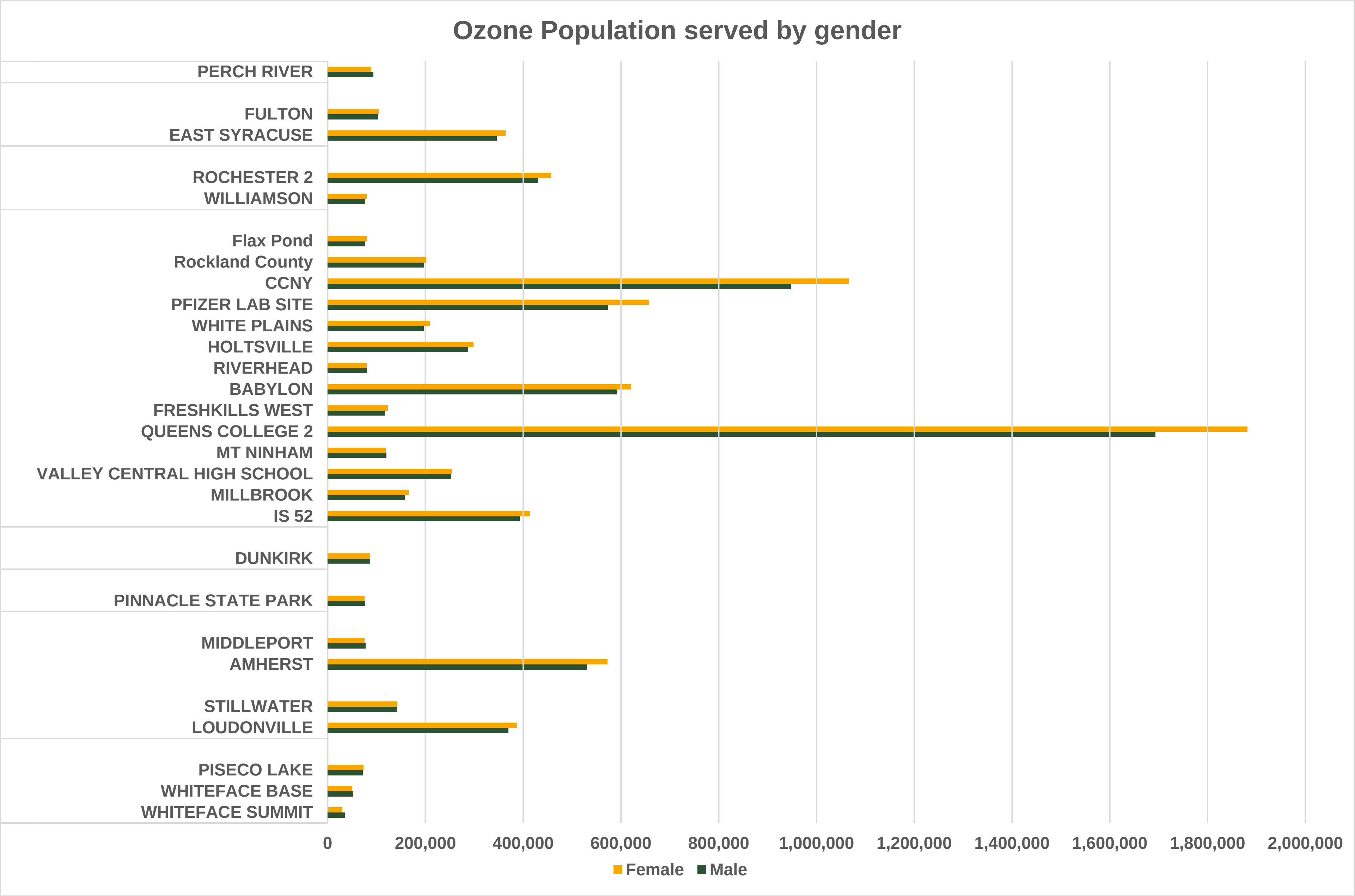
- **Ben Wells** - 2020 Network Assessment Tools
- **Eric Bailey** - 2015 Network Assessment Tools
- **Nathan Byers** - 2015 Network Assessment Tools
- **Cassie McMahon** - 2015 Network Assessment Tools
- **Donna Kenski** - 2015 Network Assessment Tools
- **Mike Rizzo** - 2010 Network Assessment Tools

Software

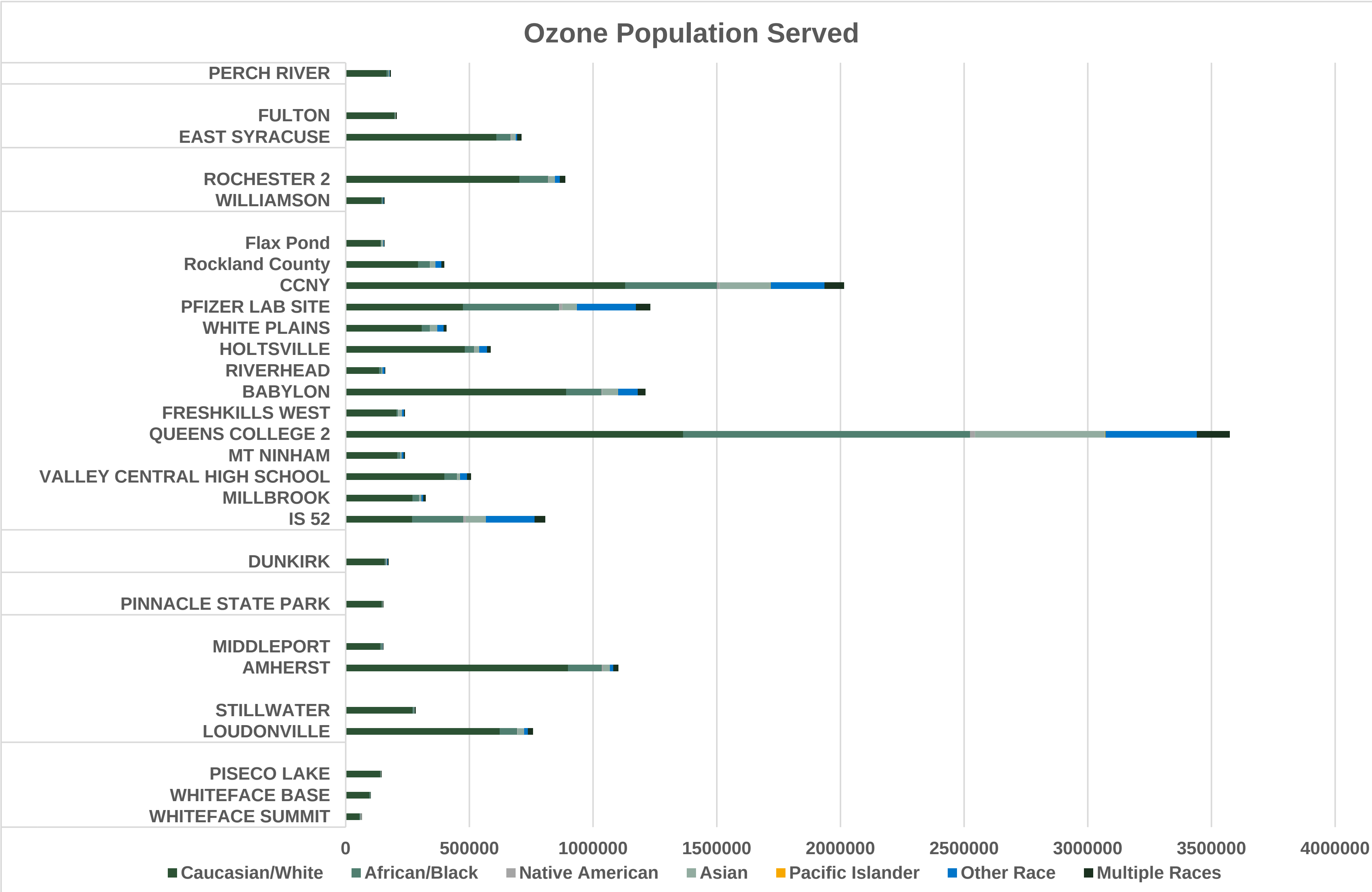
The NetAssess2020 app was created using the R shiny software package, with custom HTML, CSS, and javascript. The javascript library leaflet and many of its plugins were used to make the maps. The source code and data for the NetAssess2020 App is available on GitHub.



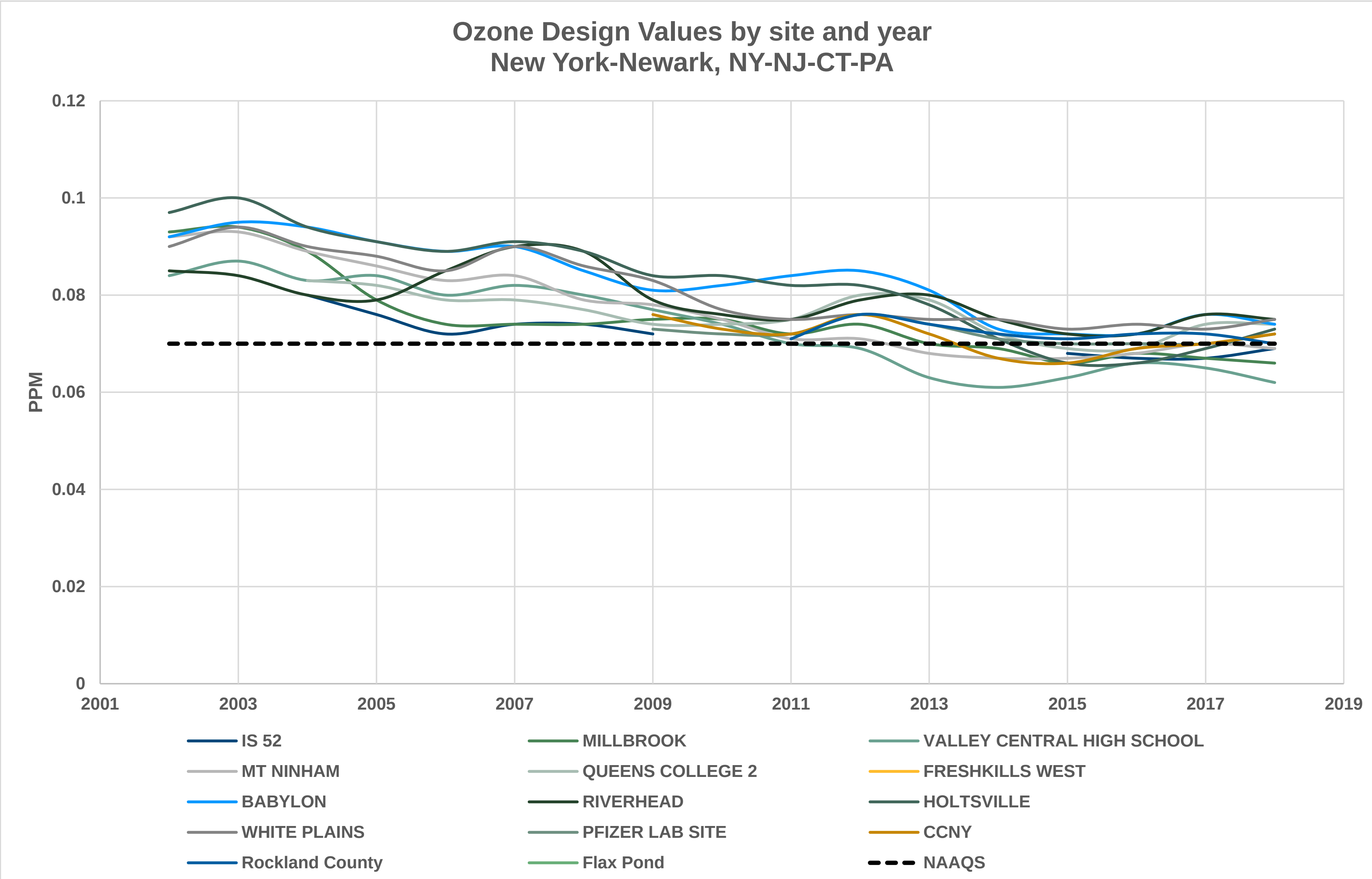
Ozone Site Total Population Served
PERCH RIVER
FULTON
EAST SYRACUSE
ROCHESTER 2
WILLIAMSON
Flax Pond
Rockland County
CCNY
PFIZER LAB SITE
WHITE PLAINS
HOLTSVILLE
RIVERHEAD
BABYLON
FRESHKILLS WEST
QUEENS COLLEGE 2
MT NINHAM
VALLEY CENTRAL HIGH SCHOOL
MILLBROOK
IS 52
DUNKIRK
PINNACLE STATE PARK
MIDDLEPORT
AMHERST
STILLWATER
LOUDONVILLE
PISECO LAKE
WHITEFACE BASE
WHITEFACE SUMMIT
0
500,000
1,000,000
1,500,000
2,000,000
2,500,000
3,000,000
3,500,000
4,000,000
Total Population

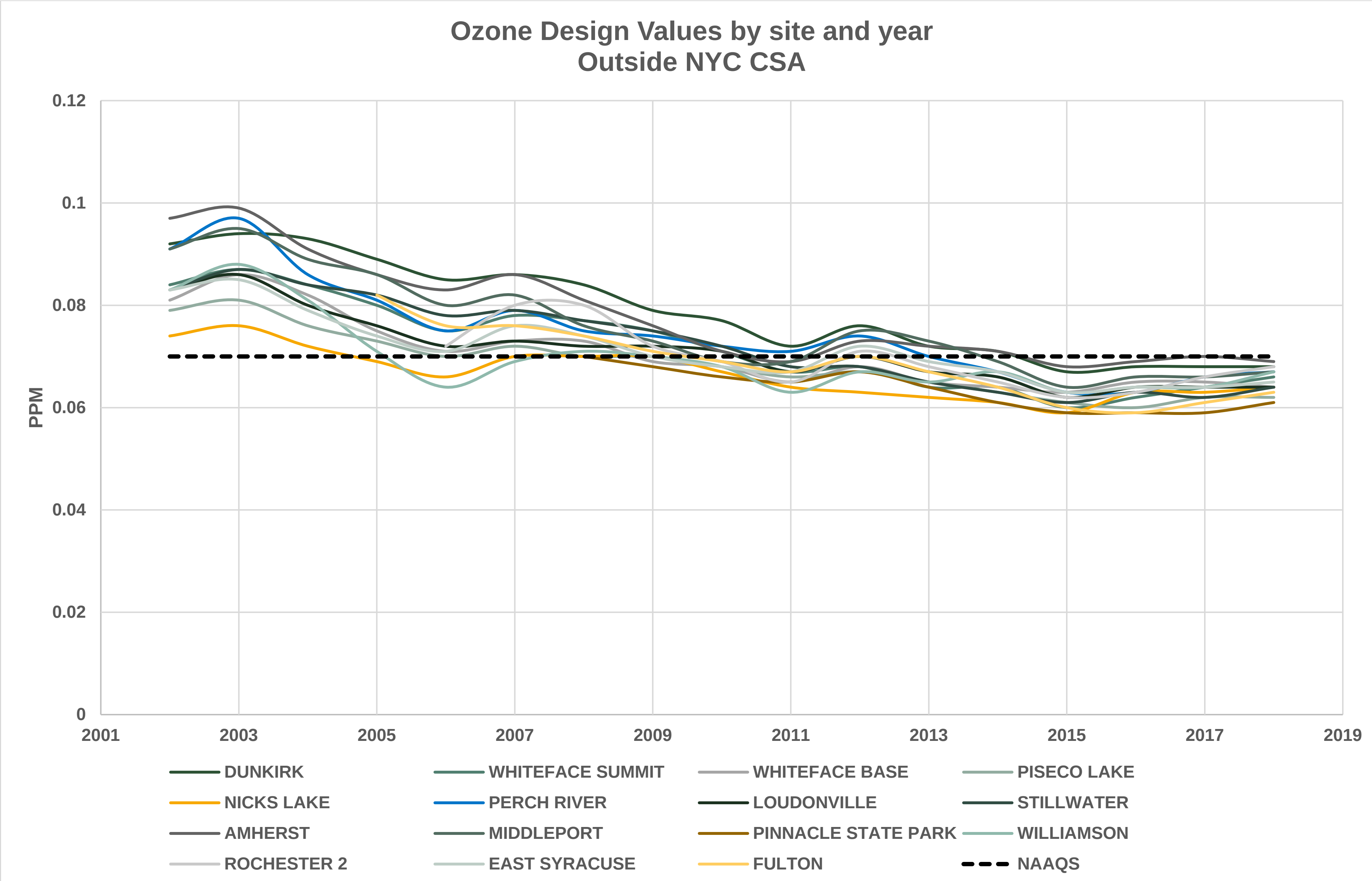


Ozone Population served by gender
PERCH RIVER
FULTON
EAST SYRACUSE
ROCHESTER 2
WILLIAMSON
Flax Pond
Rockland County
CCNY
PFIZER LAB SITE
WHITE PLAINS
HOLTSVILLE
RIVERHEAD
BABYLON
FRESHKILLS WEST
QUEENS COLLEGE 2
MT NINHAM
VALLEY CENTRAL HIGH SCHOOL
MILLBROOK
IS 52
DUNKIRK
PINNACLE STATE PARK
MIDDLEPORT
AMHERST
STILLWATER
LOUDONVILLE
PISECO LAKE
WHITEFACE BASE
WHITEFACE SUMMIT
0
200,000
400,000
600,000
800,000
1,000,000
1,200,000
1,400,000
1,600,000
1,800,000
2,000,000
Female
Male



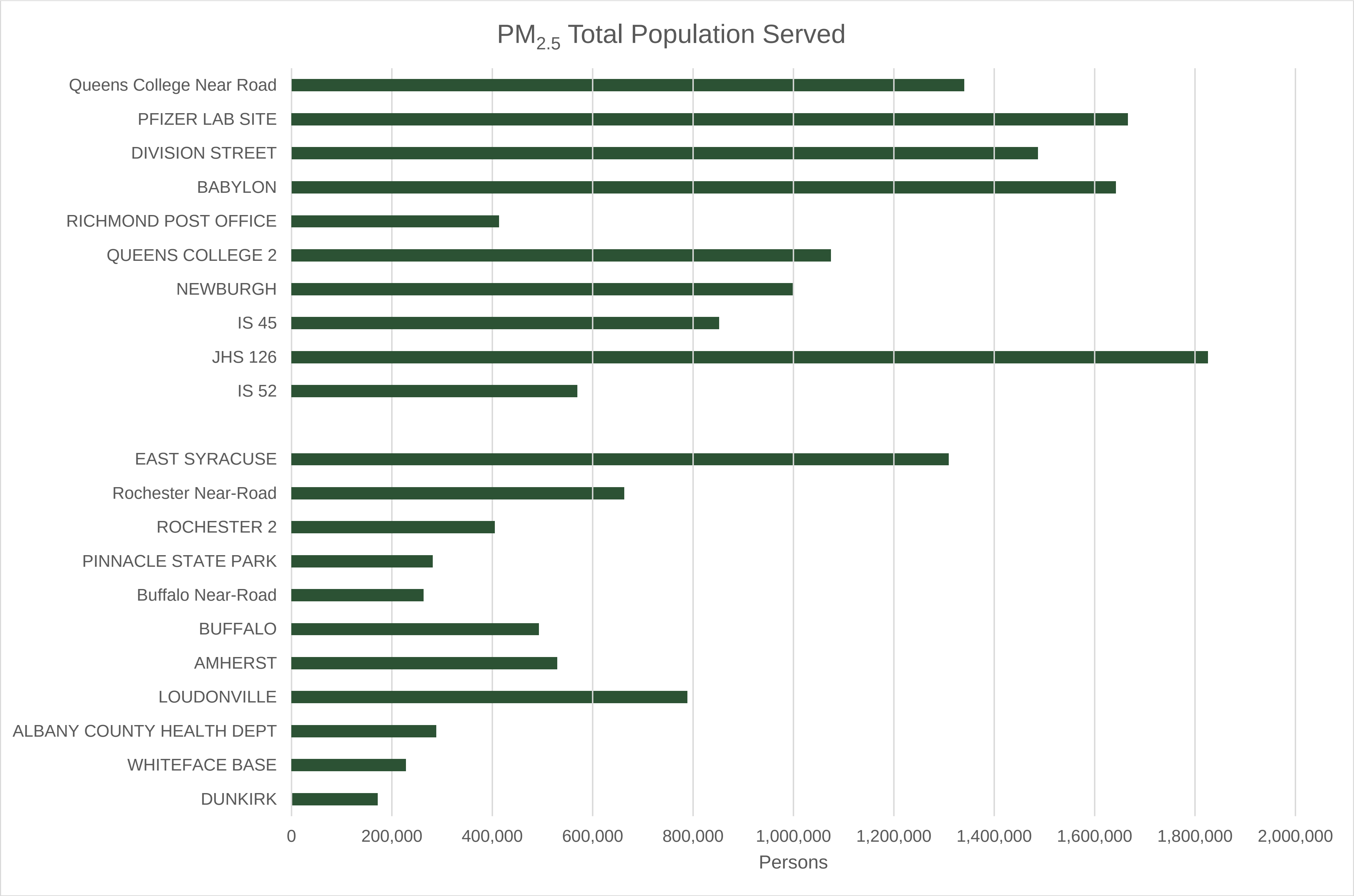
Ozone Population Served
PERCH RIVER
FULTON
EAST SYRACUSE
ROCHESTER 2
WILLIAMSON
Flax Pond
Rockland County
CCNY
PFIZER LAB SITE
WHITE PLAINS
HOLTSVILLE
RIVERHEAD
BABYLON
FRESHKILLS WEST
QUEENS COLLEGE 2
MT NINHAM
VALLEY CENTRAL HIGH SCHOOL
MILLBROOK
IS 52
DUNKIRK
PINNACLE STATE PARK
MIDDLEPORT
AMHERST
STILLWATER
LOUDONVILLE
PISECO LAKE
WHITEFACE BASE
WHITEFACE SUMMIT
0
500000
1000000
1500000
2000000
2500000
3000000
3500000
4000000
Caucasian/White
African/Black
Native American
Asian
Pacific Islander
Other Race
Multiple Races

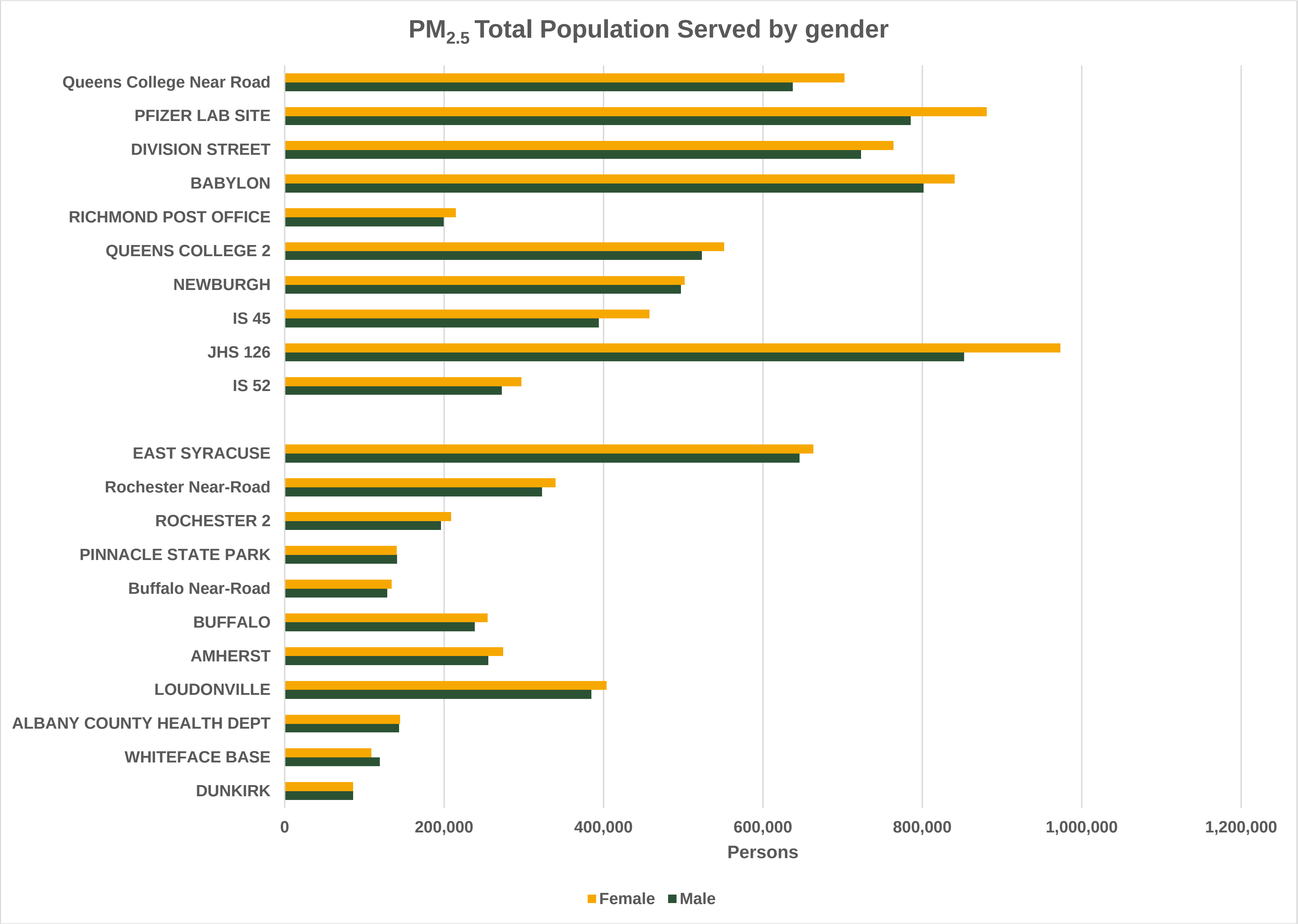

Ozone Design Values by site and year
New York-Newark, NY-NJ-CT-PA
PPM
0.12
0.1
0.08
0.06
0.04
0.02
0
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
IS 52
MILLBROOK
VALLEY CENTRAL HIGH SCHOOL
MT NINHAM
QUEENS COLLEGE 2
FRESHKILLS WEST
BABYLON
RIVERHEAD
HOLTSVILLE
WHITE PLAINS
PFIZER LAB SITE
CCNY
Rockland County
Flax Pond
NAAQS


Ozone Design Values by site and year
Outside NYC CSA
PPM
0.12
0.1
0.08
0.06
0.04
0.02
0
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
DUNKIRK
WHITEFACE SUMMIT
WHITEFACE BASE
PISECO LAKE
NICKS LAKE
PERCH RIVER
LOUDONVILLE
STILLWATER
AMHERST
MIDDLEPORT
PINNACLE STATE PARK
WILLIAMSON
ROCHESTER 2
EAST SYRACUSE
FULTON
NAAQS

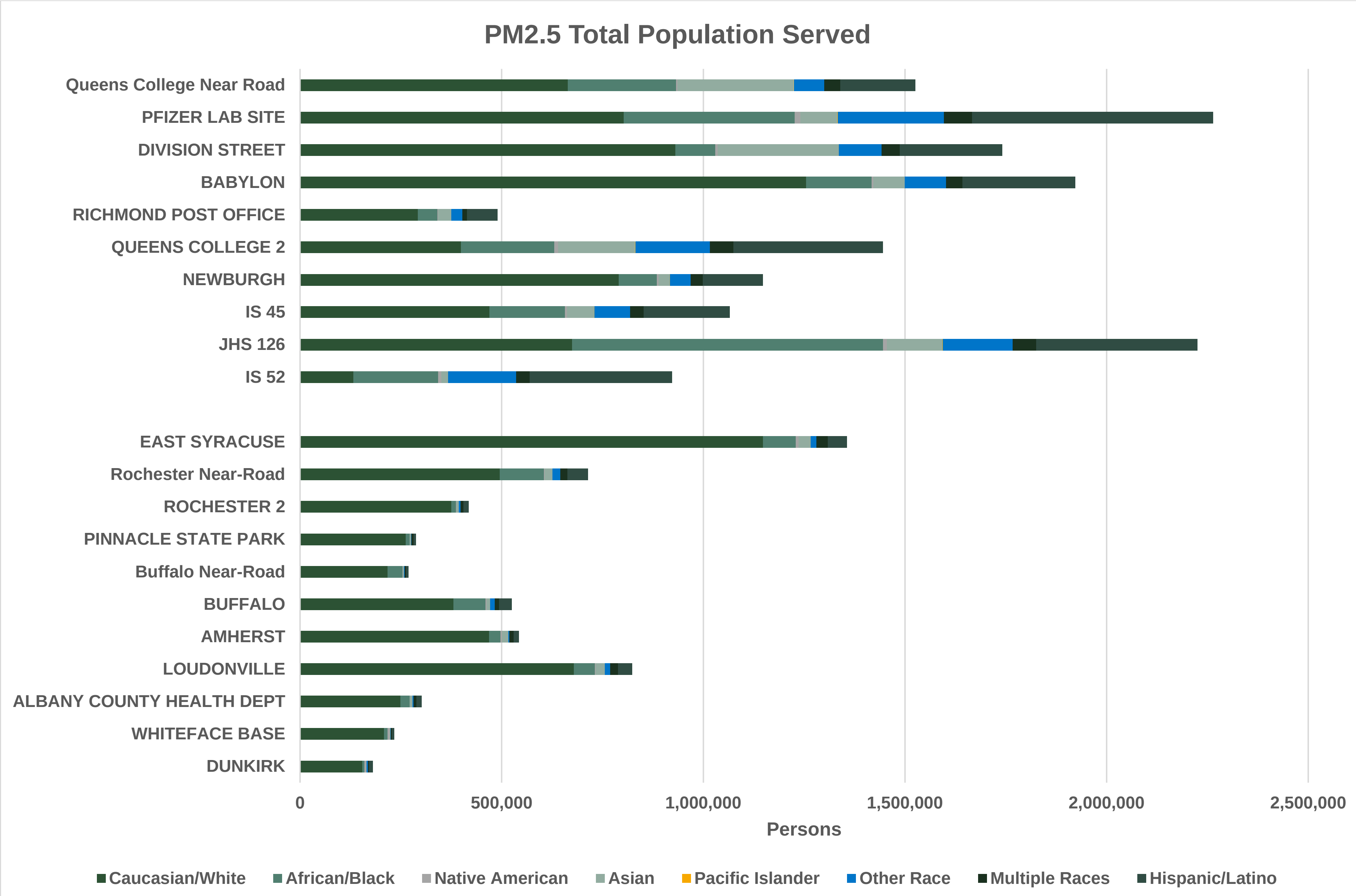
Ozone Bias

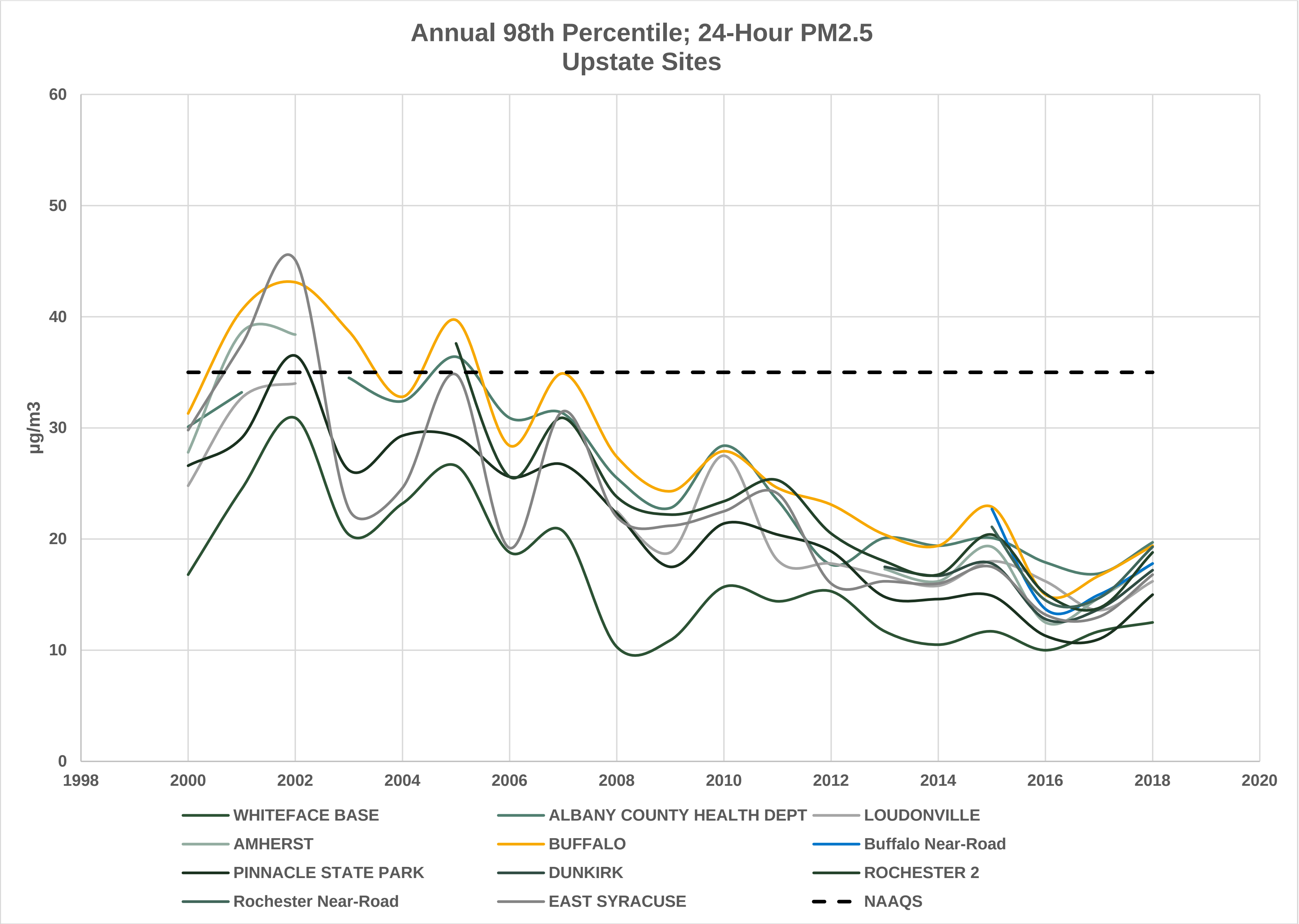
AQS Site ID	Neighbors Included	Daily Obs Count	Mean Removal Bias	Removal Bias Standard Deviation	Min Removal Bias	Max Removal Bias	Mean Relative Bias	Min Relative Bias	Max Relative Bias
Loudonville	6	1074	0.001	0.0041	-0.023	0.02	5%	-39%	241%
IS 52	3	1073	0.001	0.0022	-0.007	0.016	7%	-41%	533%
NYBG	6	1085	-0.001	0.002	-0.012	0.008	-3%	-57%	36%
Dunkirk	4	1036	-0.002	0.0036	-0.02	0.02	-4%	-29%	68%
Millbrook	6	1039	0.002	0.0044	-0.01	0.037	11%	-19%	1903%
AMHERST	6	1013	-0.001	0.0037	-0.019	0.022	0%	-50%	84%
WF SUMMIT	5	907	-0.004	0.0067	-0.046	0.013	-10%	-99%	48%
WF Base	5	1039	0.003	0.0065	-0.014	0.046	12%	-38%	1647%
PISECO LAKE	7	1017	-0.002	0.0033	-0.016	0.016	-5%	-55%	88%
NICKS LAKE	5	899	0.001	0.0043	-0.034	0.022	6%	-47%	156%
PERCH RIVER	10	800	0.000	0.0046	-0.026	0.022	4%	-36%	198%
ROCHESTER	4	1030	0.001	0.0034	-0.015	0.019	5%	-36%	132%
CCNY	5	1052	0.000	0.0026	-0.019	0.011	2%	-73%	203%
MIDDLEPORT	5	783	0.001	0.0034	-0.019	0.015	3%	-36%	133%
EAST SYRACUSE	6	1057	0.000	0.0036	-0.015	0.015	1%	-36%	124%
VALLEY CENTRAL	9	1070	0.002	0.004	-0.014	0.031	6%	-34%	564%
FULTON	4	976	0.001	0.0028	-0.008	0.012	2%	-24%	87%
MT NINHAM	6	1032	0.000	0.0039	-0.013	0.021	0%	-40%	59%
QUEENS COLLEGE	7	1035	-0.002	0.0035	-0.019	0.018	-7%	-76%	80%
FRESHKILLS W	4	169	0.000	0.0035	-0.011	0.009	2%	-34%	84%
Rockland County	5	1088	0.000	0.003	-0.027	0.015	0%	-30%	69%
360910004	5	1060	0.000	0.0029	-0.011	0.015	2%	-27%	104%
Pinnacle	8	1000	0.001	0.0044	-0.015	0.029	6%	-30%	175%
BABYLON	6	1035	0.000	0.0035	-0.016	0.022	2%	-47%	145%
RIVERHEAD	8	728	-0.001	0.0037	-0.024	0.016	-3%	-61%	33%
HOLTSVILLE	5	1034	0.000	0.0037	-0.021	0.022	0%	-55%	300%
FLAX	5	193	0.000	0.0041	-0.018	0.02	-1%	-69%	50%
WILLIAMSON	6	844	-0.001	0.0029	-0.011	0.018	-2%	-35%	84%
WHITE PLAINS	5	1088	-0.001	0.0028	-0.013	0.012	-1%	-42%	55%


PM2.5 Total Population Served
Queens College Near Road
PFIZER LAB SITE
DIVISION STREET
BABYLON
RICHMOND POST OFFICE
QUEENS COLLEGE 2
NEWBURGH
IS 45
JHS 126
IS 52
EAST SYRACUSE
Rochester Near-Road
ROCHESTER 2
PINNACLE STATE PARK
Buffalo Near-Road
BUFFALO
AMHERST
LOUDONVILLE
ALBANY COUNTY HEALTH DEPT
WHITEFACE BASE
DUNKIRK
0
200,000
400,000
600,000
800,000
1,000,000
1,200,000
1,400,000
1,600,000
1,800,000
2,000,000
Persons

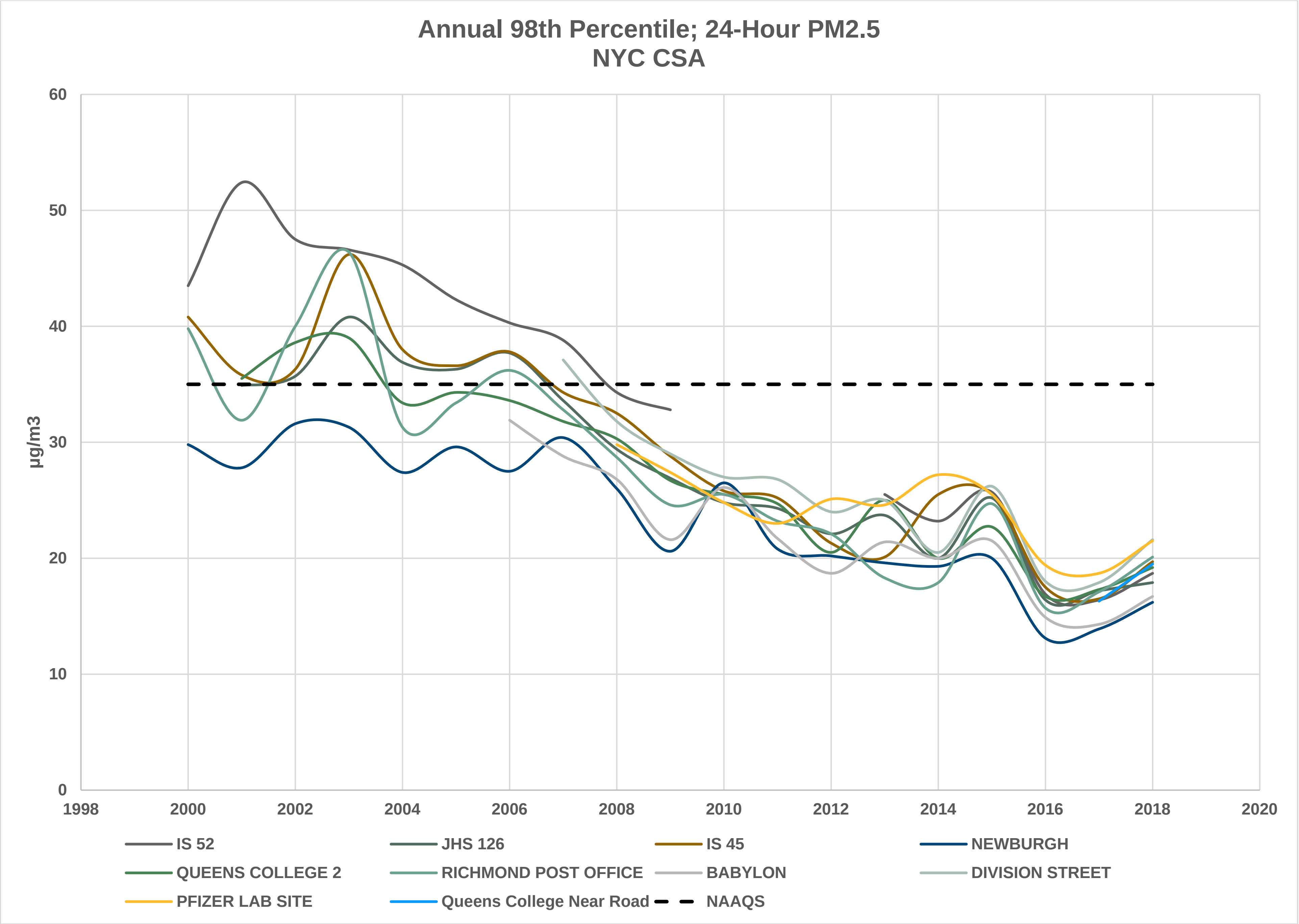


PM2.5 Total Population Served by gender
Queens College Near Road
PFIZER LAB SITE
DIVISION STREET
BABYLON
RICHMOND POST OFFICE
QUEENS COLLEGE 2
NEWBURGH
IS 45
JHS 126
IS 52
EAST SYRACUSE
Rochester Near-Road
ROCHESTER 2
PINNACLE STATE PARK
Buffalo Near-Road
BUFFALO
AMHERST
LOUDONVILLE
ALBANY COUNTY HEALTH DEPT
WHITEFACE BASE
DUNKIRK
0
200,000
400,000
600,000
800,000
1,000,000
1,200,000
Persons
Female
Male

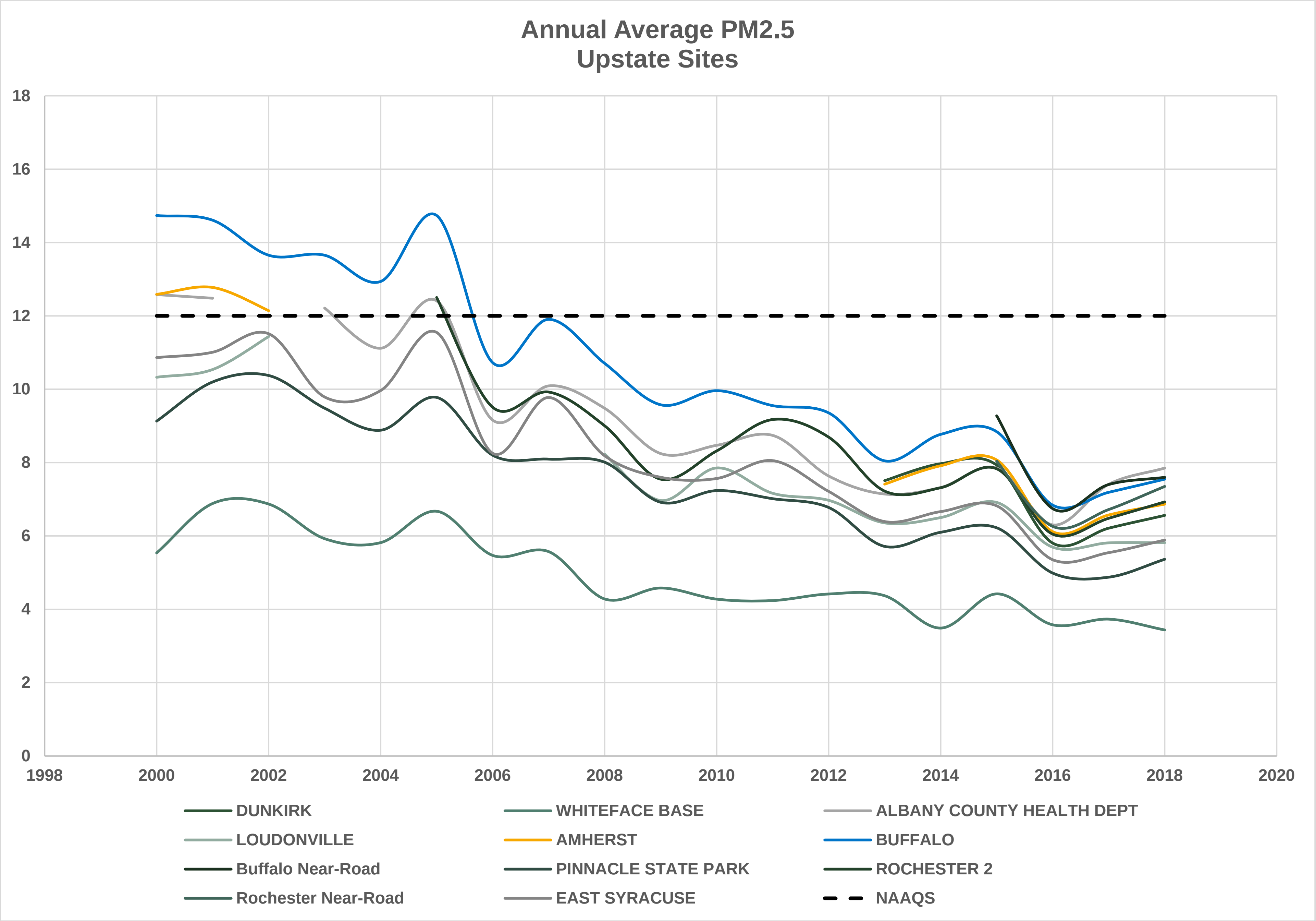

PM2.5 Total Population Served
Queens College Near Road
PFIZER LAB SITE
DIVISION STREET
BABYLON
RICHMOND POST OFFICE
QUEENS COLLEGE 2
NEWBURGH
IS 45
JHS 126
IS 52
EAST SYRACUSE
Rochester Near-Road
ROCHESTER 2
PINNACLE STATE PARK
Buffalo Near-Road
BUFFALO
AMHERST
LOUDONVILLE
ALBANY COUNTY HEALTH DEPT
WHITEFACE BASE
DUNKIRK
0
500,000
1,000,000
1,500,000
2,000,000
2,500,000
Persons
Caucasian/White
African/Black
Native American
Asian
Pacific Islander
Other Race
Multiple Races
Hispanic/Latino

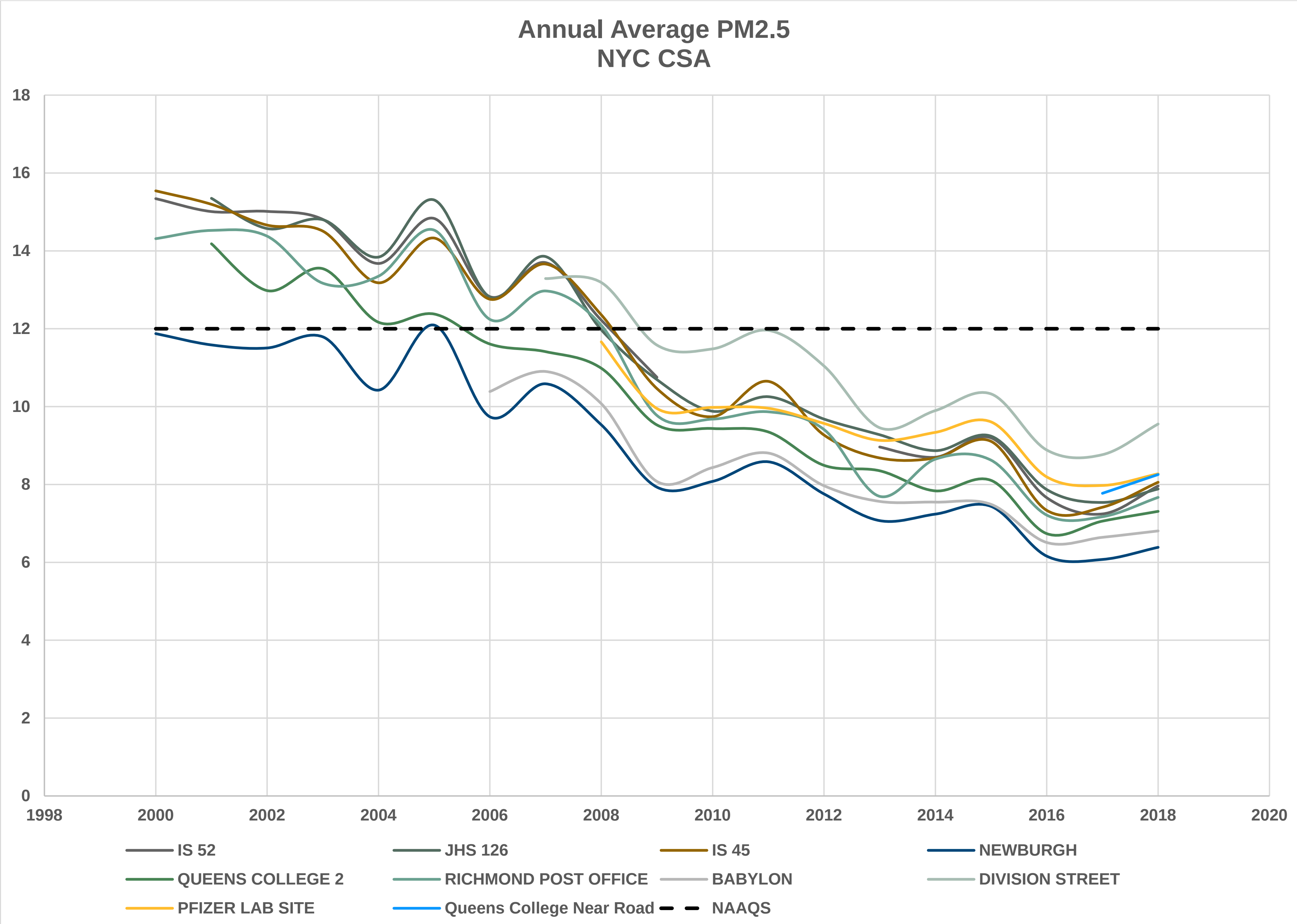


Annual 98th Percentile; 24-Hour PM2.5
Upstate Sites
µg/m3
60
50
40
30
20
10
0
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
WHITEFACE BASE
ALBANY COUNTY HEALTH DEPT
LOUDONVILLE
AMHERST
BUFFALO
Buffalo Near-Road
PINNACLE STATE PARK
DUNKIRK
ROCHESTER 2
Rochester Near-Road
EAST SYRACUSE
NAAQS



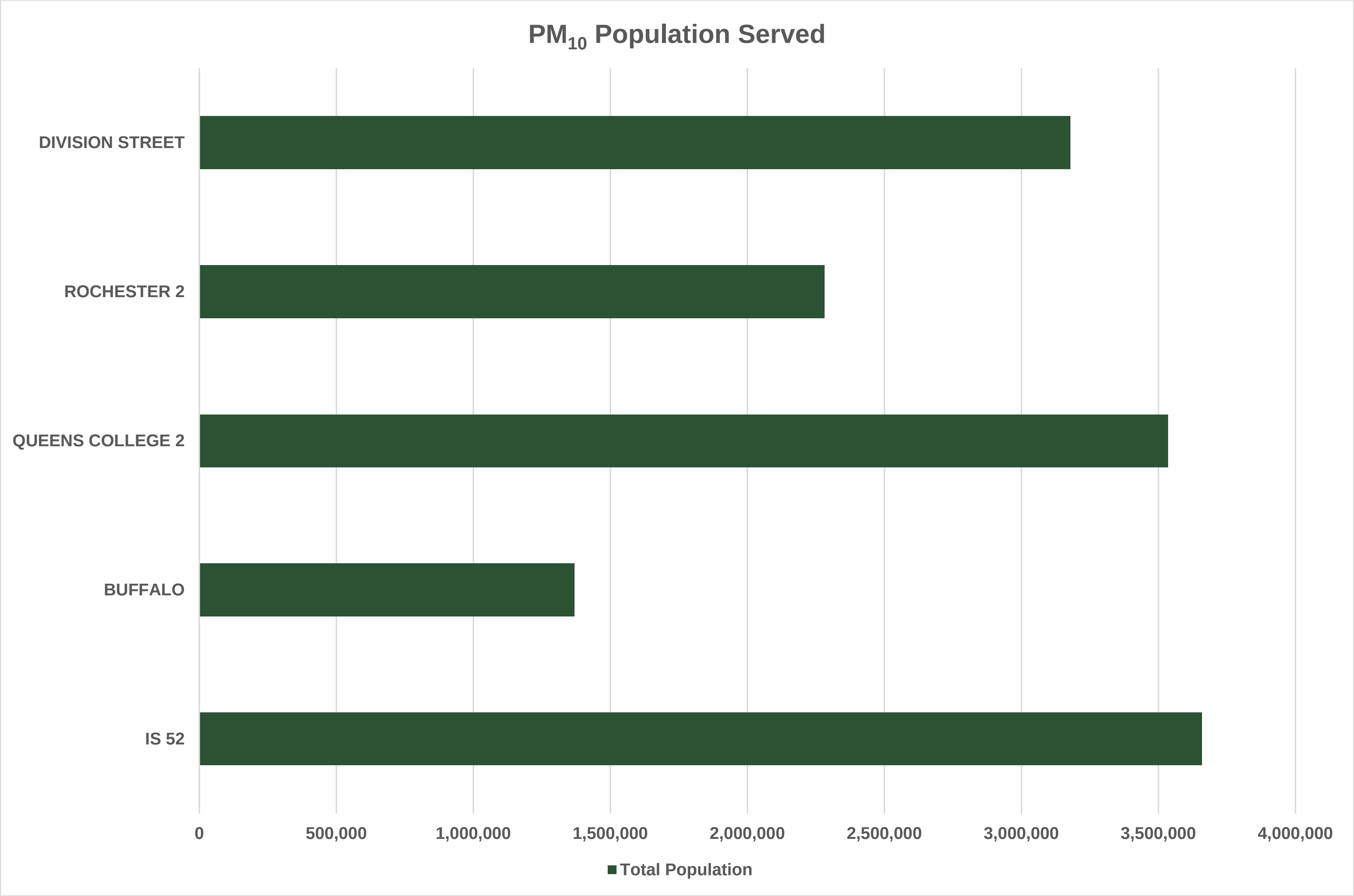
Annual 98th Percentile; 24-Hour PM2.5
NYC CSA
µg/m3
0
10
20
30
40
50
60
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
IS 52
JHS 126
IS 45
NEWBURGH
QUEENS COLLEGE 2
RICHMOND POST OFFICE
BABYLON
DIVISION STREET
PFIZER LAB SITE
Queens College Near Road
NAAQS


Annual Average PM2.5
Upstate Sites
18
16
14
12
10
8
6
4
2
0
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
DUNKIRK
WHITEFACE BASE
ALBANY COUNTY HEALTH DEPT
LOUDONVILLE
AMHERST
BUFFALO
Buffalo Near-Road
PINNACLE STATE PARK
ROCHESTER 2
Rochester Near-Road
EAST SYRACUSE
NAAQS

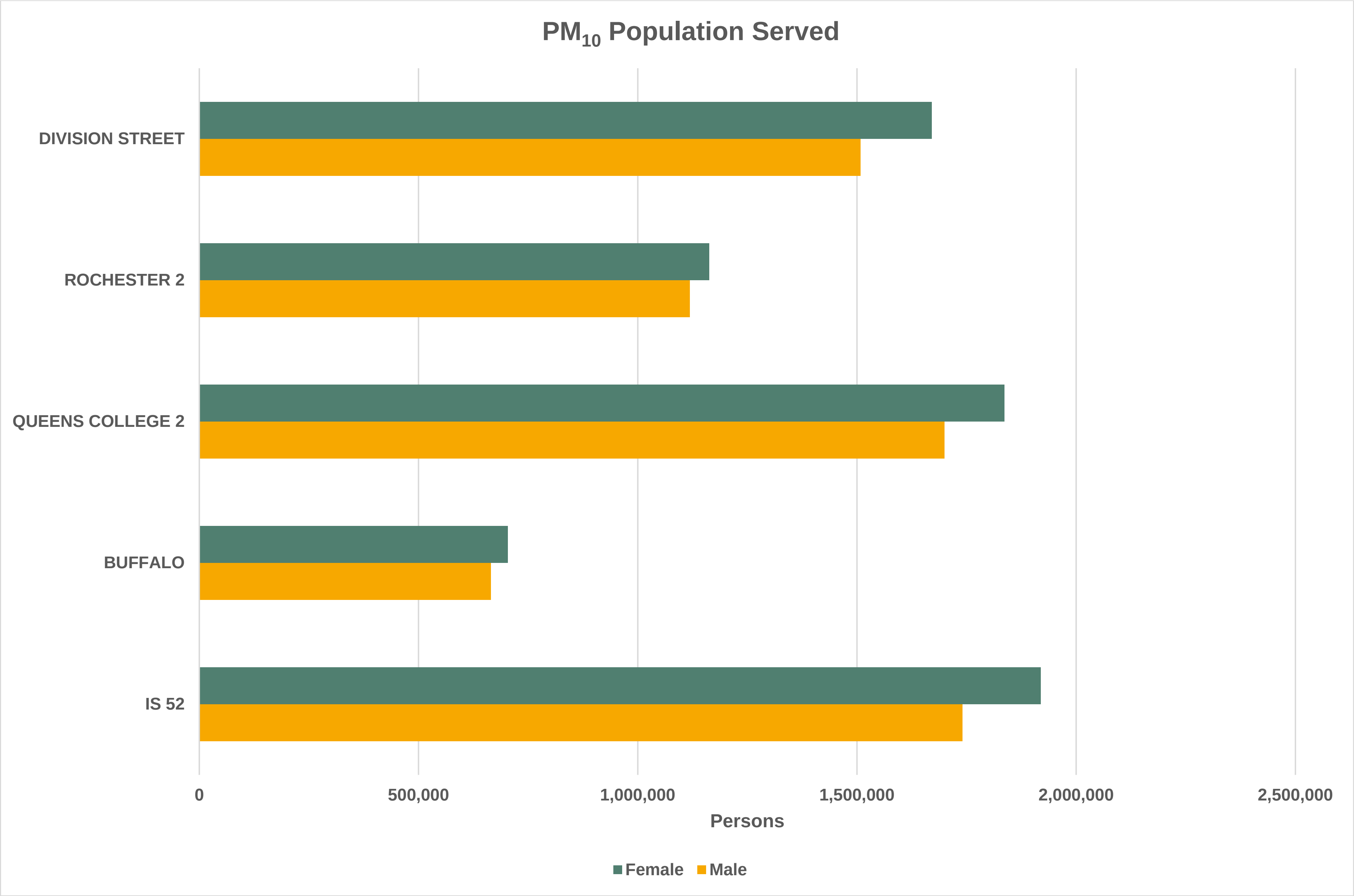

Annual Average PM2.5
NYC CSA
18
16
14
12
10
8
6
4
2
0
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
IS 52
JHS 126
IS 45
NEWBURGH
QUEENS COLLEGE 2
RICHMOND POST OFFICE
BABYLON
DIVISION STREET
PFIZER LAB SITE
Queens College Near Road
NAAQS

PM2.5 Removal Bias

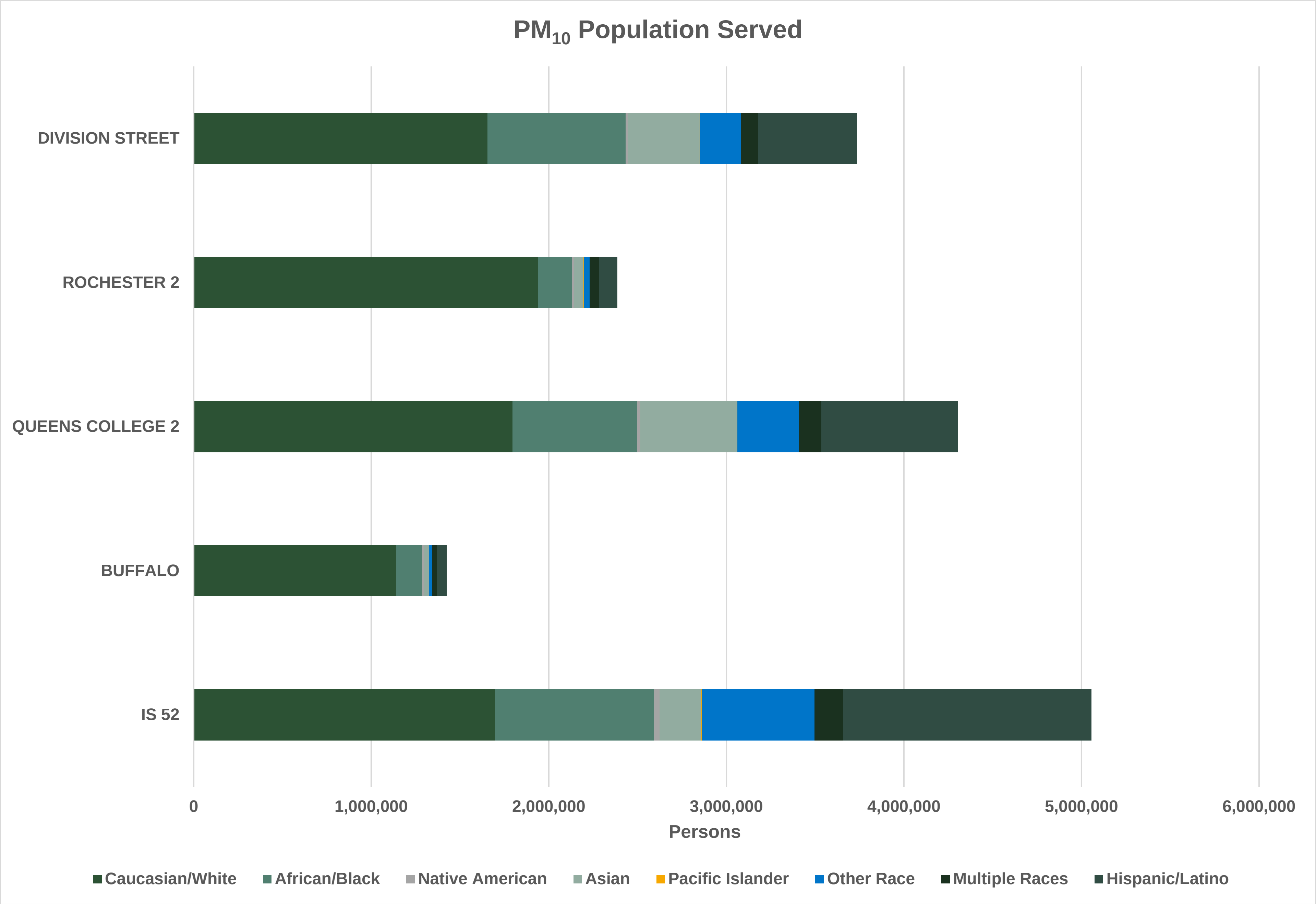
AQS Site ID	Neighbors Included	Daily Obs Count	Mean Removal Bias	Removal Bias Standard Deviation	Min Removal Bias	Max Removal Bias	Mean Relative Bias	Min Relative Bias	Max Relative Bias
ACHD	6	740	-1.79	1.85	-15.5	3	-23%	-91%	68%
Loudonville	6	357	1.45	1.48	-3	9.1	30%	-41%	196%
IS 52	6	873	1.73	2.12	-15.7	10.4	53%	-67%	1673%
NYBG	7	366	0.24	1.58	-7.3	5.7	6%	-45%	161%
Dunkirk	7	350	1.15	1.85	-15.5	7.2	27%	-63%	212%
AMHERST	6	345	0.63	1.3	-7	11.5	12%	-67%	80%
BUFFALO	5	353	-0.05	1.16	-8.2	9.6	1%	-60%	73%
BUFFALO NR	4	348	-0.35	1.04	-7.6	5	-4%	-83%	149%
WF Base	7	174	2.56	2.13	-1.9	11.7	113%	-22%	837%
JHS126	6	360	0.7	1.3	-4.1	10.2	13%	-57%	168%
ROCHESTER NR	5	348	0.01	1.39	-14.4	5	2%	-100%	103%
ROCHESTER	5	1012	-0.88	2.07	-11.4	14.4	-8%	-100%	379%
JHS45	6	357	0.28	1.06	-6.7	4.1	5%	-55%	62%
Division	5	349	-0.7	1.39	-8.7	8.7	-7%	-62%	135%
EAST SYRACUSE	6	1044	0.7	1.75	-6.6	9.1	37%	-84%	4106%
Newburgh	9	353	1.12	1.55	-5	10.5	23%	-49%	184%
QUEENS COLLEGE	5	1085	-0.45	1.95	-9.9	16.8	-5%	-100%	363%
Queens College NR	4	205	-0.93	0.91	-4.1	2.5	-13%	-58%	21%
Port Richmond	7	328	2.32	1.52	-1.6	10.7	40%	-37%	260%
Pinnacle	8	981	2.47	2.35	-22	10.8	95%	-71%	3651%
BABYLON	9	338	1.03	1.69	-12.4	7.8	21%	-61%	290%

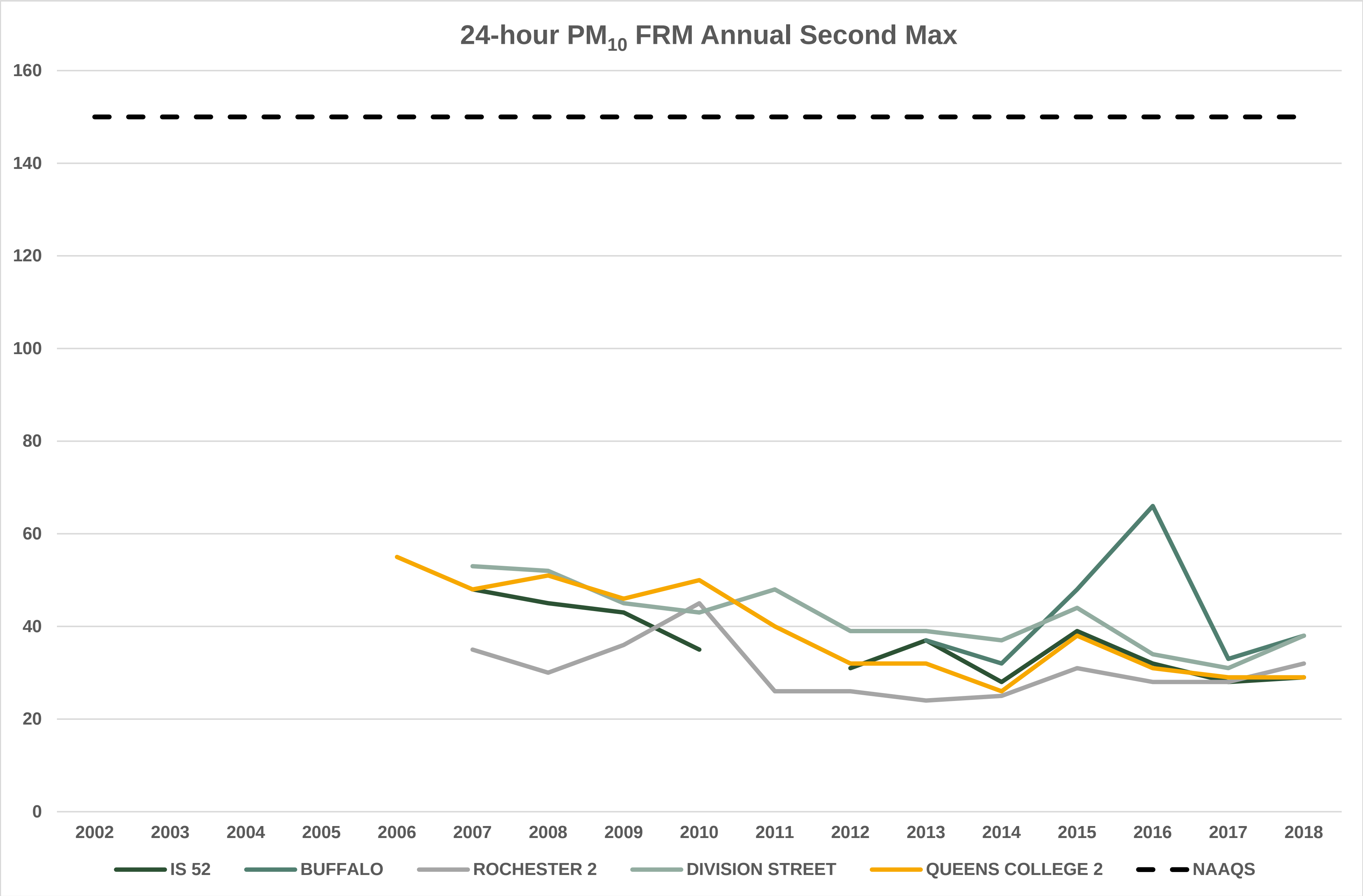


PM10 Population Served
DIVISION STREET
ROCHESTER 2
QUEENS COLLEGE 2
BUFFALO
IS 52
0
500,000
1,000,000
1,500,000
2,000,000
2,500,000
3,000,000
3,500,000
4,000,000
Total Population

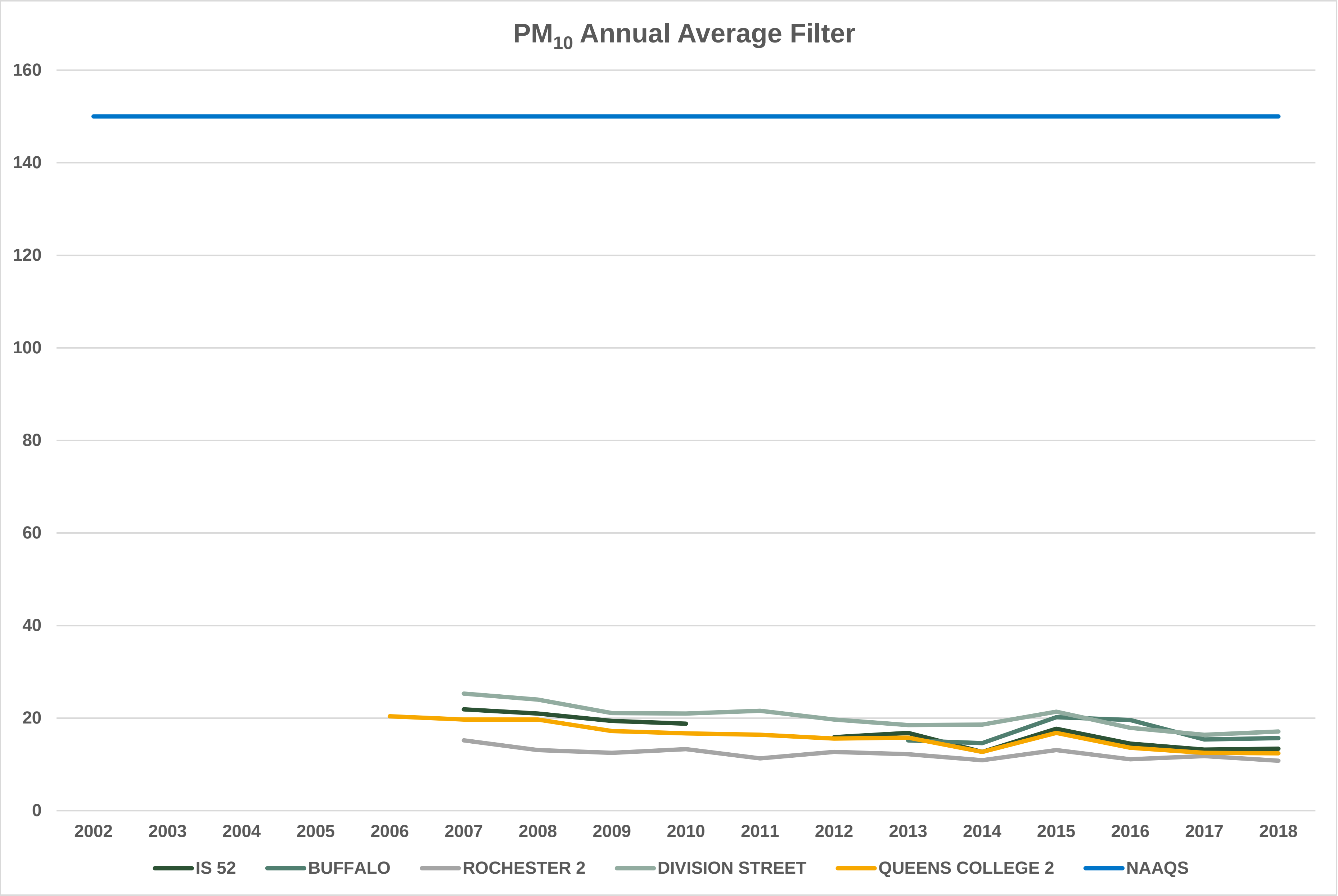


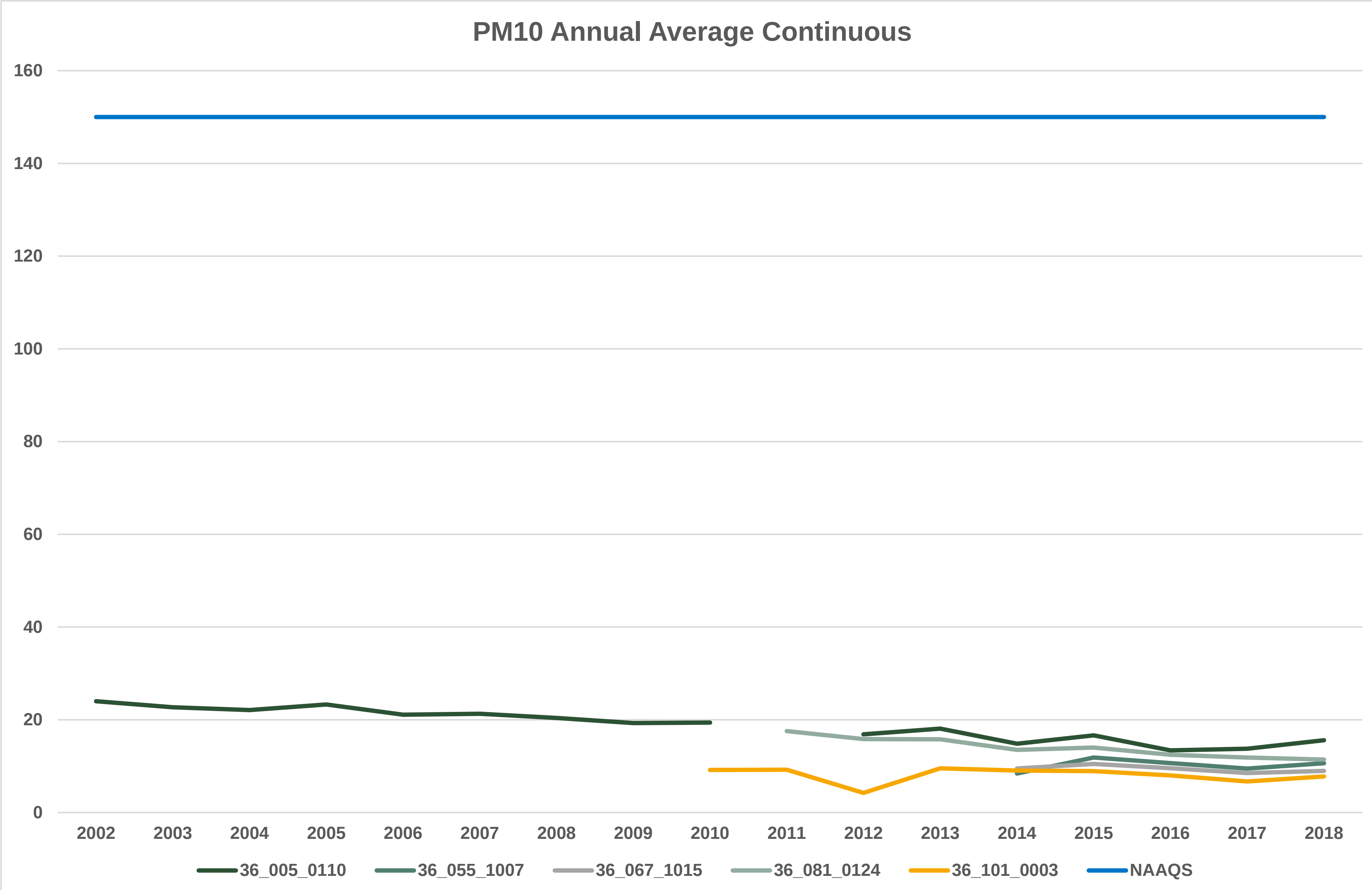
PM10 Population Served
DIVISION STREET
ROCHESTER 2
QUEENS COLLEGE 2
BUFFALO
IS 52
0
500,000
1,000,000
1,500,000
2,000,000
2,500,000
Persons
Female
Male

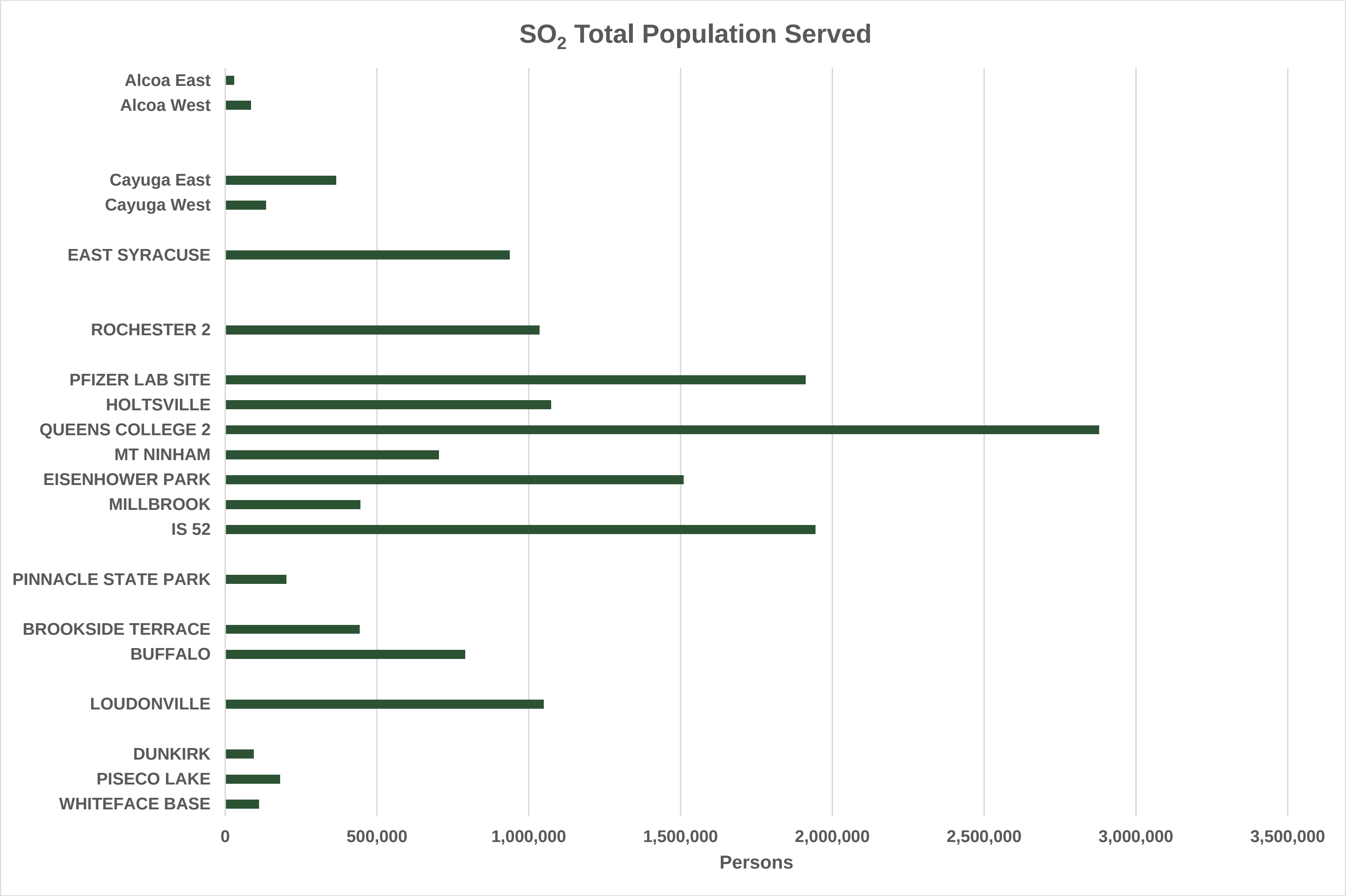

PM10 Population Served
DIVISION STREET
ROCHESTER 2
QUEENS COLLEGE 2
BUFFALO
IS 52
0
1,000,000
2,000,000
3,000,000
4,000,000
5,000,000
6,000,000
Persons
Caucasian/White
African/Black
Native American
Asian
Pacific Islander
Other Race
Multiple Races
Hispanic/Latino



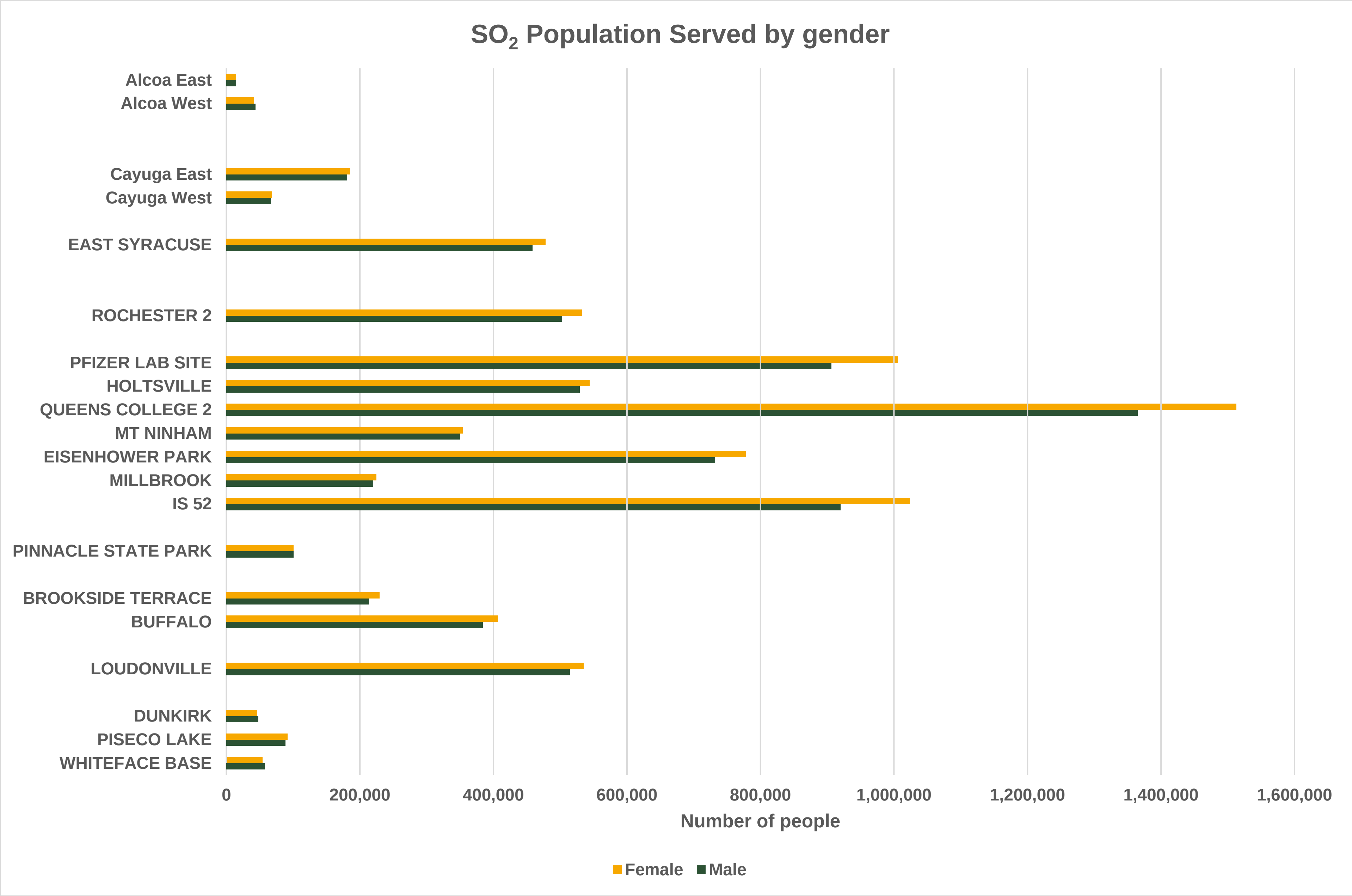
24-hour PM_{10} FRM Annual Second Max
160
140
120
100
80
60
40
20
0
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
IS 52
BUFFALO
ROCHESTER 2
DIVISION STREET
QUEENS COLLEGE 2
NAAQS

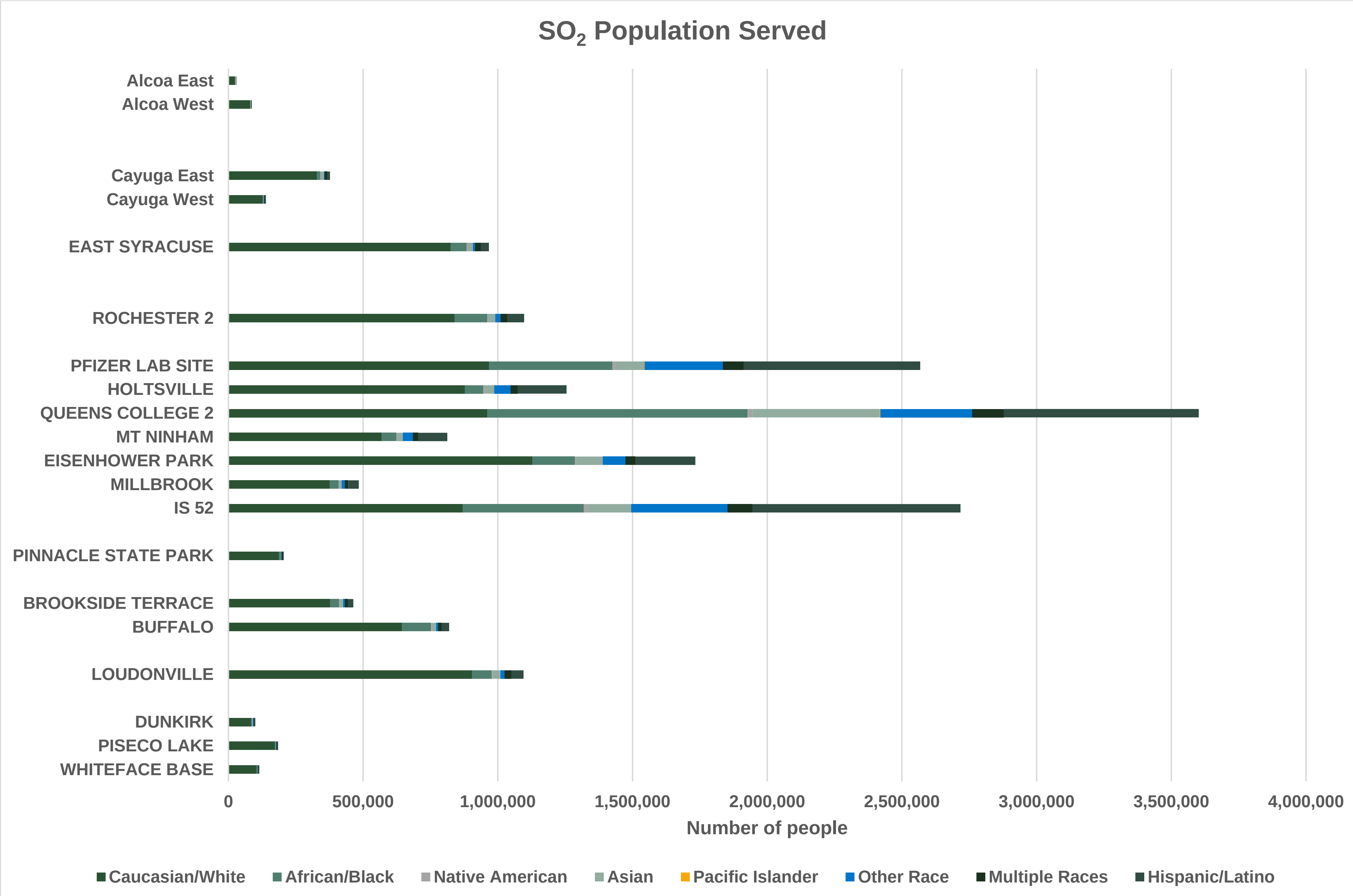

PM10 Annual Average Filter
160
140
120
100
80
60
40
20
0
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
IS 52
BUFFALO
ROCHESTER 2
DIVISION STREET
QUEENS COLLEGE 2
NAAQS


PM10 Annual Average Continuous
160
140
120
100
80
60
40
20
0
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
36_005_0110
36_055_1007
36_067_1015
36_081_0124
36_101_0003
NAAQS

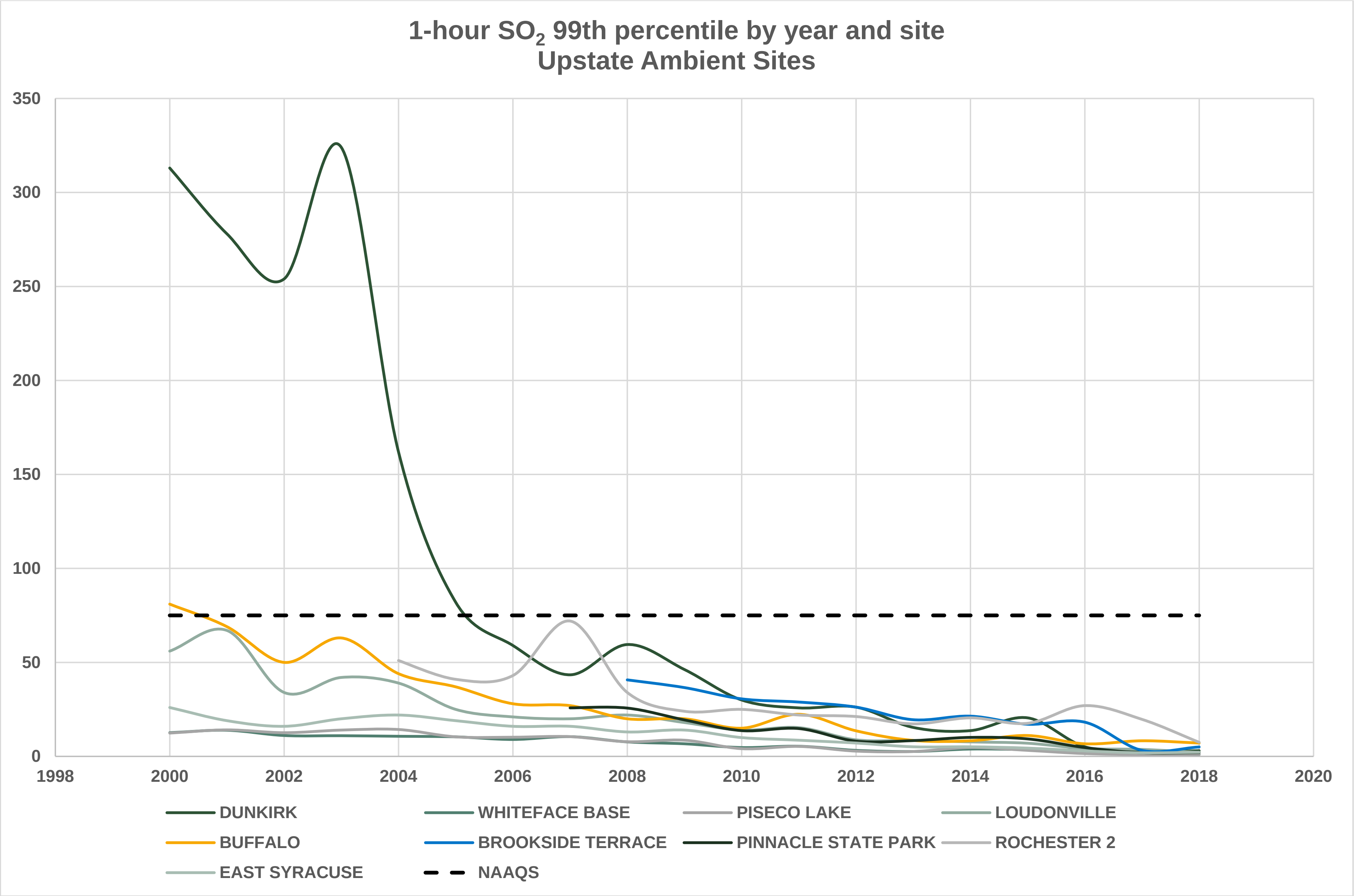


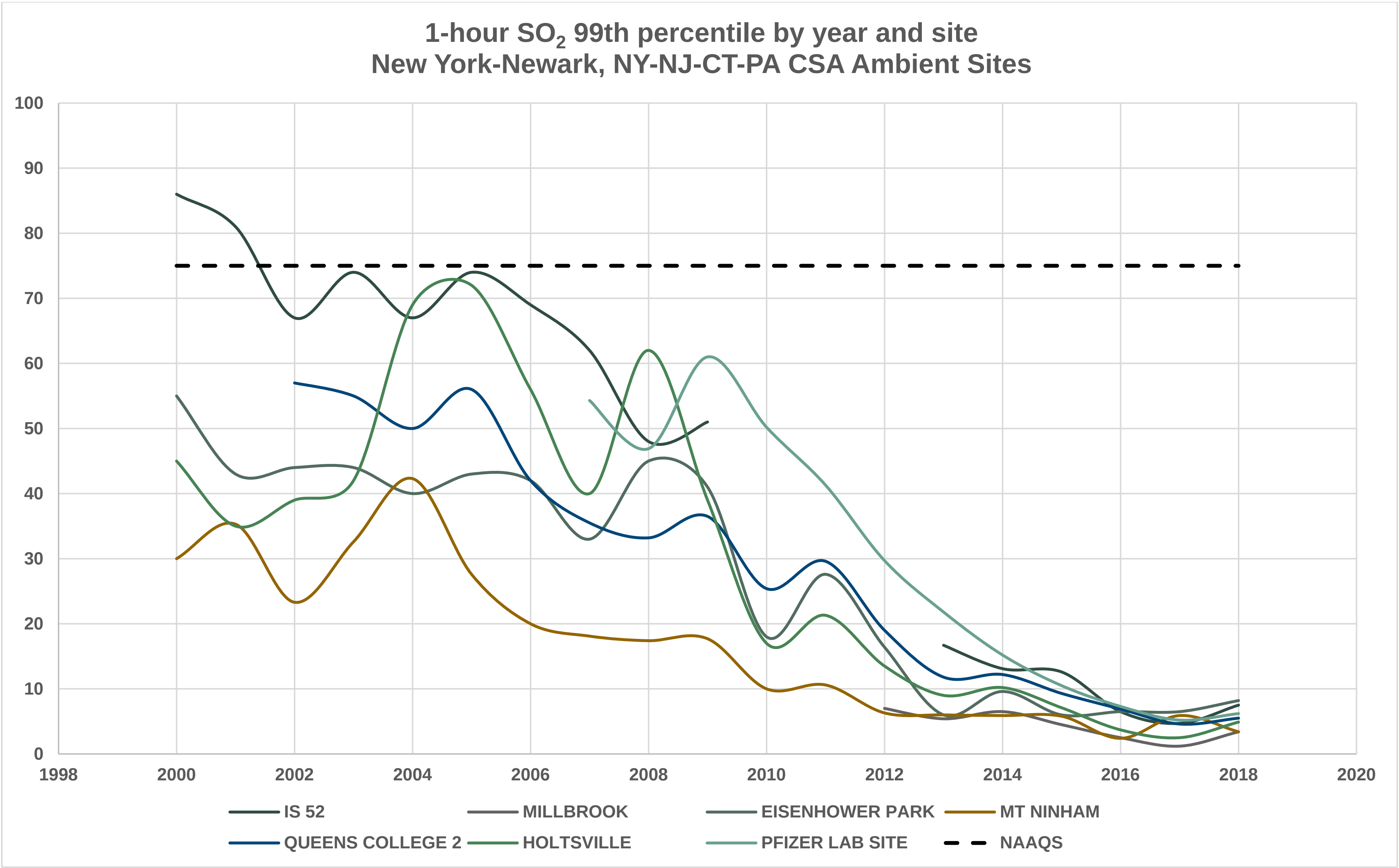
SO2 Total Population Served
Alcoa East
Alcoa West
Cayuga East
Cayuga West
EAST SYRACUSE
ROCHESTER 2
PFIZER LAB SITE
HOLTSVILLE
QUEENS COLLEGE 2
MT NINHAM
EISENHOWER PARK
MILLBROOK
IS 52
PINNACLE STATE PARK
BROOKSIDE TERRACE
BUFFALO
LOUDONVILLE
DUNKIRK
PISECO LAKE
WHITEFACE BASE
0
500,000
1,000,000
1,500,000
2,000,000
2,500,000
3,000,000
3,500,000
Persons

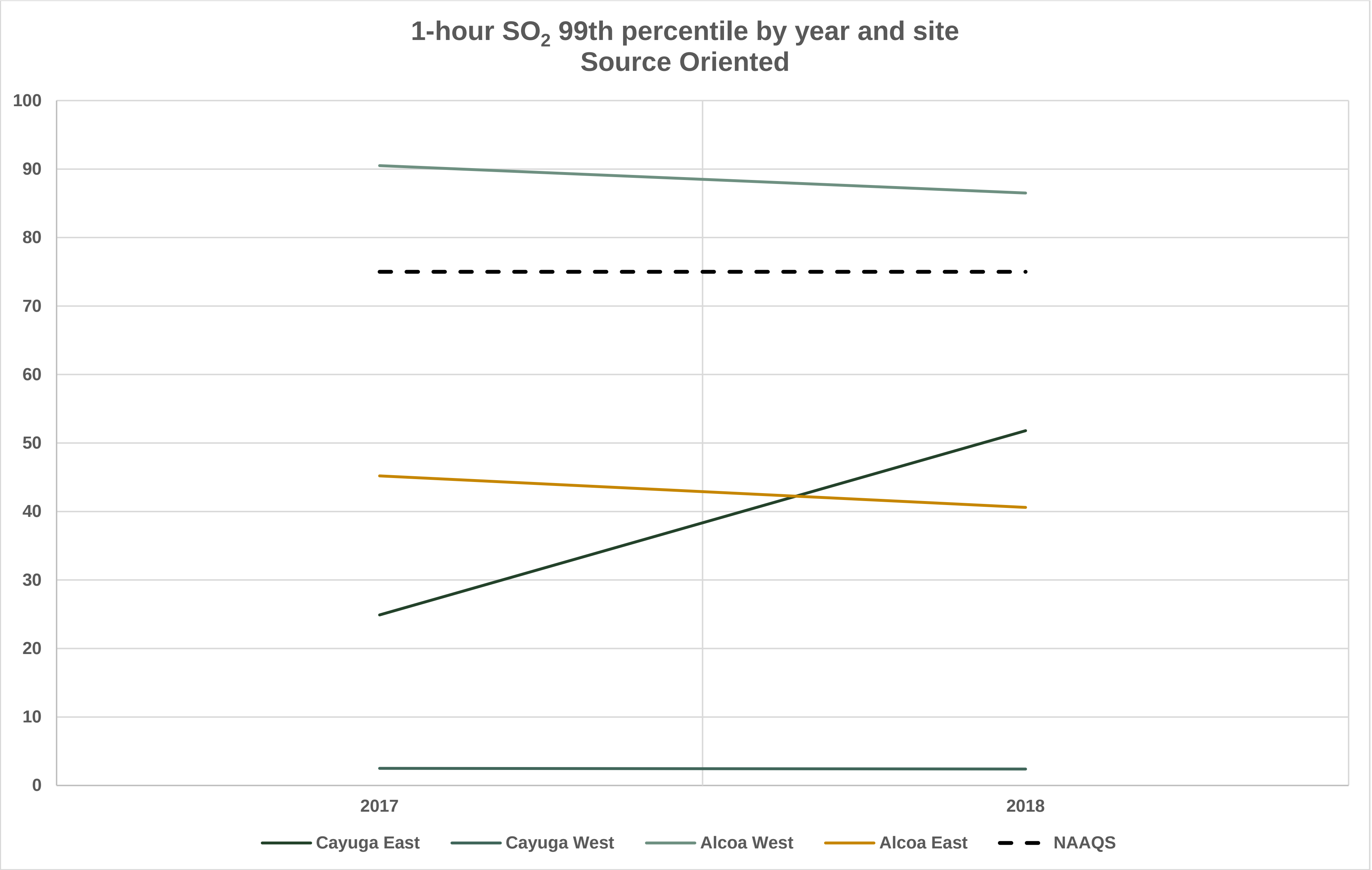

SO2 Population Served by gender
Alcoa East
Alcoa West
Cayuga East
Cayuga West
EAST SYRACUSE
ROCHESTER 2
PFIZER LAB SITE
HOLTSVILLE
QUEENS COLLEGE 2
MT NINHAM
EISENHOWER PARK
MILLBROOK
IS 52
PINNACLE STATE PARK
BROOKSIDE TERRACE
BUFFALO
LOUDONVILLE
DUNKIRK
PISECO LAKE
WHITEFACE BASE
0
200,000
400,000
600,000
800,000
1,000,000
1,200,000
1,400,000
1,600,000
Number of people
Female
Male



SO2 Population Served
Alcoa East
Alcoa West
Cayuga East
Cayuga West
EAST SYRACUSE
ROCHESTER 2
PFIZER LAB SITE
HOLTSVILLE
QUEENS COLLEGE 2
MT NINHAM
EISENHOWER PARK
MILLBROOK
IS 52
PINNACLE STATE PARK
BROOKSIDE TERRACE
BUFFALO
LOUDONVILLE
DUNKIRK
PISECO LAKE
WHITEFACE BASE
0
500,000
1,000,000
1,500,000
2,000,000
2,500,000
3,000,000
3,500,000
4,000,000
Number of people
Caucasian/White
African/Black
Native American
Asian
Pacific Islander
Other Race
Multiple Races
Hispanic/Latino

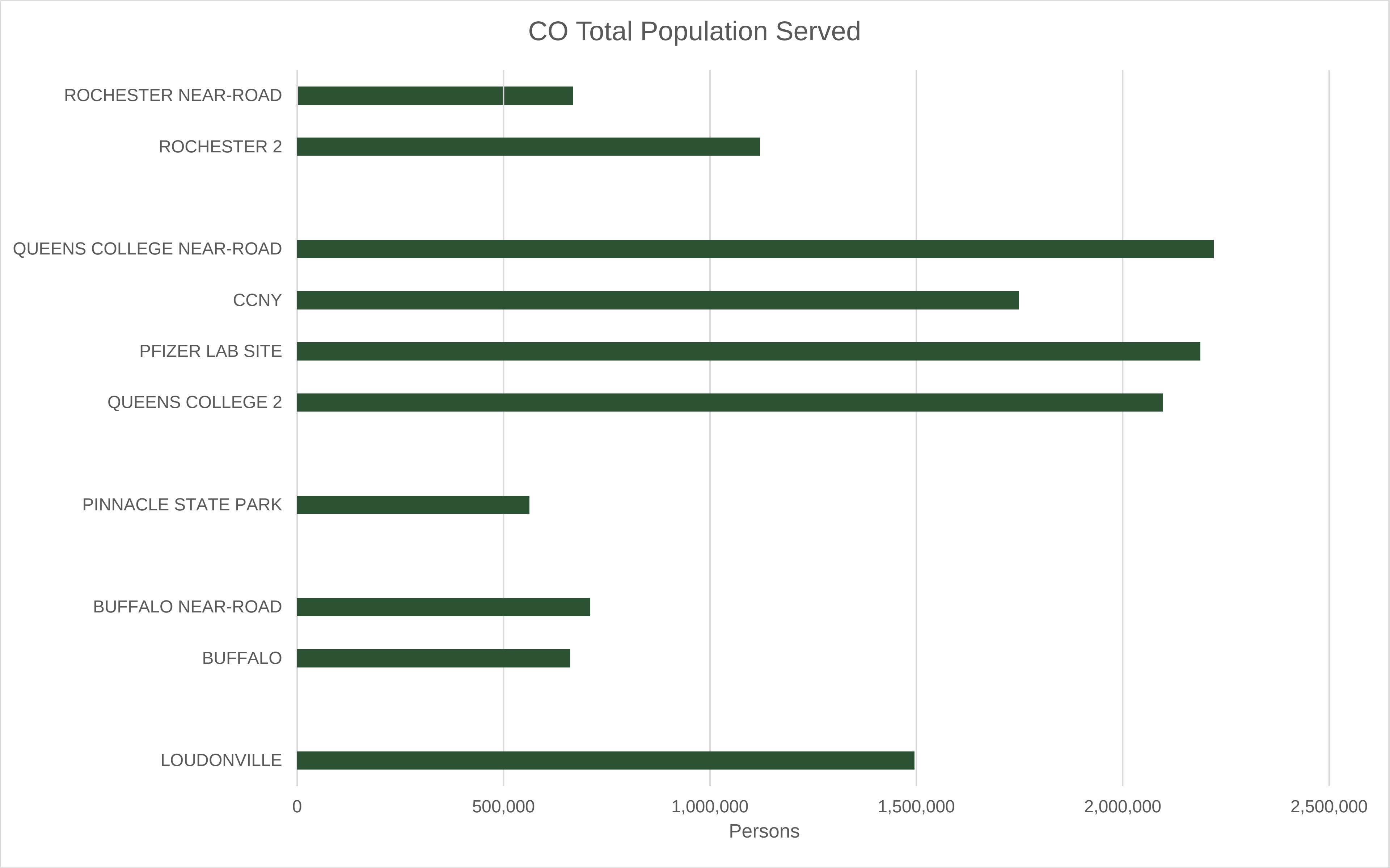

1-hour SO_2 99th percentile by year and site
Upstate Ambient Sites
350
300
250
200
150
100
50
0
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
DUNKIRK
WHITEFACE BASE
PISECO LAKE
LOUDONVILLE
BUFFALO
BROOKSIDE TERRACE
PINNACLE STATE PARK
ROCHESTER 2
EAST SYRACUSE
NAAQS

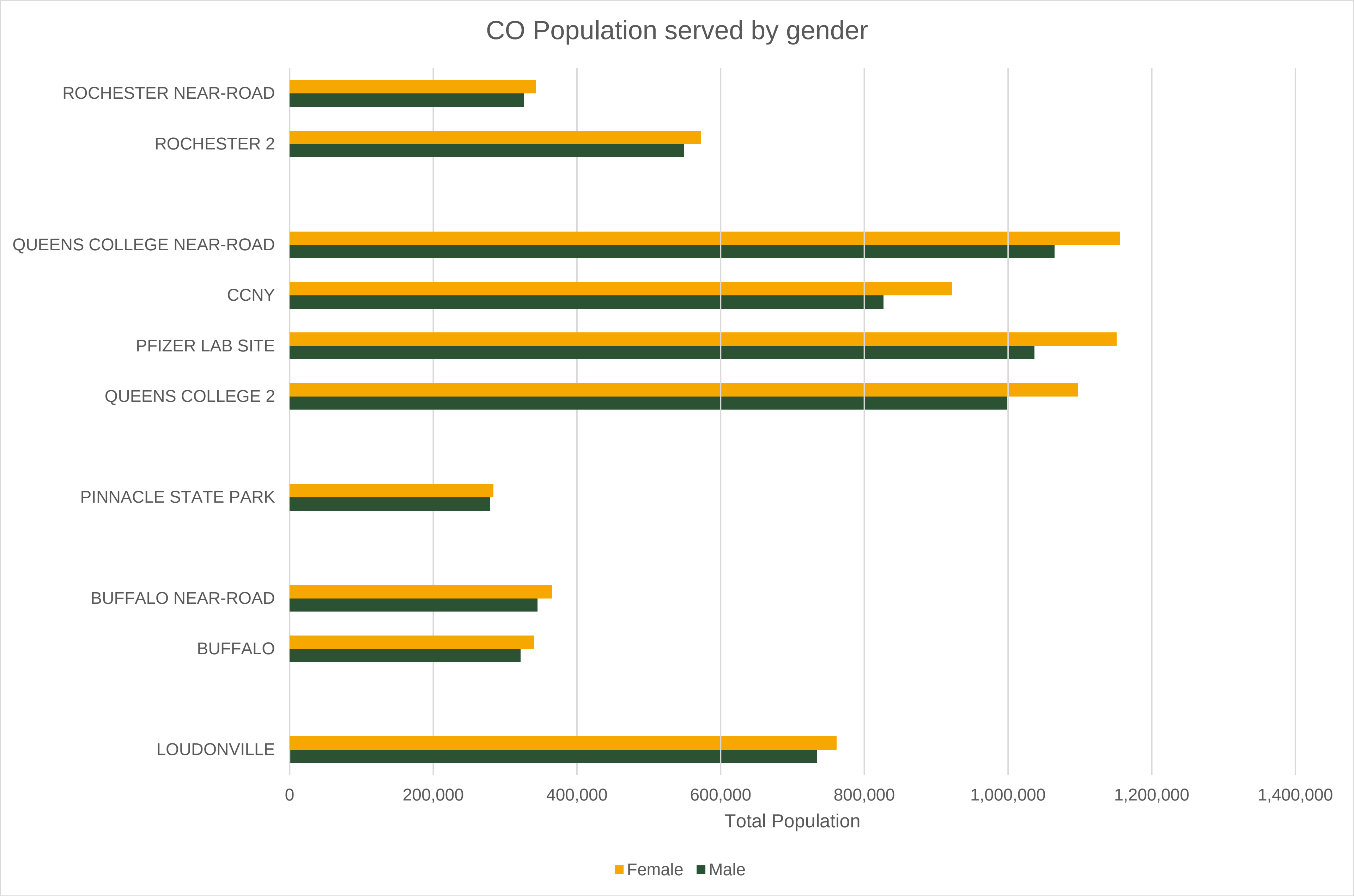

1-hour SO_2 99th percentile by year and site
New York-Newark, NY-NJ-CT-PA CSA Ambient Sites
100
90
80
70
60
50
40
30
20
10
0
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
IS 52
MILLBROOK
EISENHOWER PARK
MT NINHAM
QUEENS COLLEGE 2
HOLTSVILLE
PFIZER LAB SITE
NAAQS

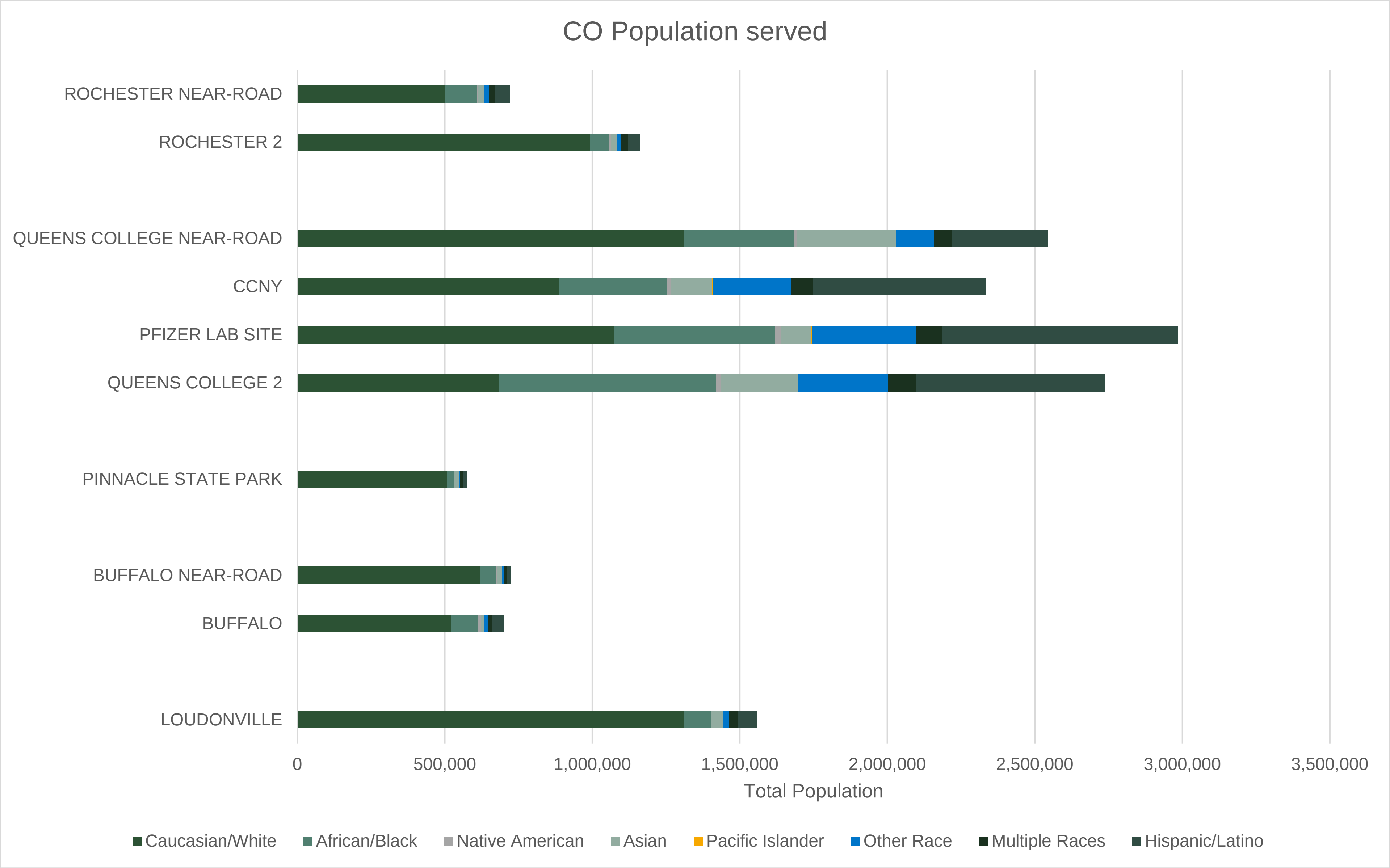

1-hour SO_2 99th percentile by year and site
Source Oriented
100
90
80
70
60
50
40
30
20
10
0
2017
2018
Cayuga East
Cayuga West
Alcoa West
Alcoa East
NAAQS

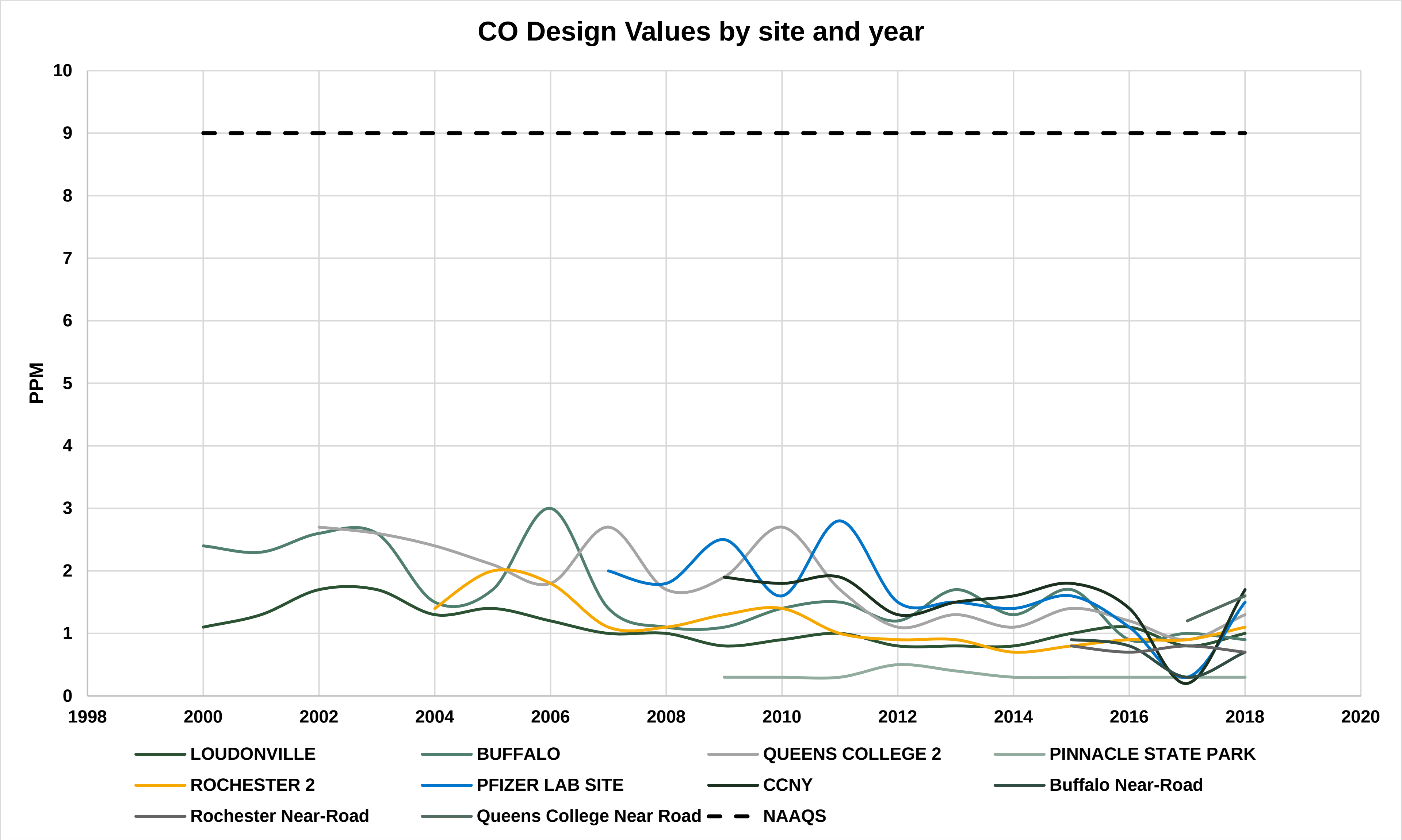
SO_2 Removal Bias

Local Site Name	Neighbors Included	Daily Obs Count	Mean Removal Bias	Removal Bias Standard Deviation	Min Removal Bias	Max Removal Bias	Mean Relative Bias	Min Relative Bias	Max Relative Bias
LOUDONVILLE	7	1078	-0.1	0.7	-9	8	16%	-96%	658%
IS 52	3	1087	0.1	0.7	-9	4	41%	-100%	1051%
PFIZER LAB SITE	6	1094	-0.3	0.7	-5	6	-6%	-94%	381%
DUNKIRK	6	1074	2.1	2.7	-9	33	580%	-91%	10930%
MILLBROOK	5	1082	0	1.2	-35	6	34%	-100%	1256%
BUFFALO	5	1043	-0.4	2.9	-46	43	36%	-100%	2008%
BROOKSIDE TERRACE	5	1080	0.4	2.9	-48	42	134%	-99%	6475%
WHITEFACE BASE	5	1045	0.4	0.9	-3	13	156%	-96%	6345%
PAUL SMITHS	5	1065	1.7	3	-11	32	699%	-100%	10251%
PISECO LAKE	7	1050	0.2	0.2	-1	2	138%	-66%	1005%
NICKS LAKE	4	909	0.6	1.6	-3	16	302%	-88%	8006%
ROCHESTER 2	7	1061	-0.9	4.1	-36	15	134%	-99%	5900%
EISENHOWER PARK	6	1092	0.5	1.3	-16	5	164%	-99%	2029%
EAST SYRACUSE	6	1083	1	2.7	-3	35	235%	-96%	9044%
MT NINHAM	7	1053	0.3	0.7	-8	15	116%	-89%	1482%
QUEENS COLLEGE 2	6	1088	-0.2	0.9	-5	5	30%	-90%	1198%
PINNACLE STATE PARK	6	1048	1.2	1.6	-5	17	501%	-77%	11409%
HOLTSVILLE	5	1024	0.3	0.7	-5	5	156%	-95%	5379%
Alcoa West	8	705	-8.5	29.5	-99	76	966%	-100%	17572%
Alcoa East	6	717	8.1	29.3	-76	99	1007%	-99%	24341%
Cayuga West	4	713	1.1	6.2	-13	74	296%	-100%	18450%
Cayuga East	4	714	-1.1	6.3	-76	13	19%	-100%	2717%


CO Total Population Served
ROCHESTER NEAR-ROAD
ROCHESTER 2
QUEENS COLLEGE NEAR-ROAD
CCNY
PFIZER LAB SITE
QUEENS COLLEGE 2
PINNACLE STATE PARK
BUFFALO NEAR-ROAD
BUFFALO
LOUDONVILLE
0
500,000
1,000,000
1,500,000
2,000,000
2,500,000
Persons


CO Population served by gender
ROCHESTER NEAR-ROAD
ROCHESTER 2
QUEENS COLLEGE NEAR-ROAD
CCNY
PFIZER LAB SITE
QUEENS COLLEGE 2
PINNACLE STATE PARK
BUFFALO NEAR-ROAD
BUFFALO
LOUDONVILLE
0
200,000
400,000
600,000
800,000
1,000,000
1,200,000
1,400,000
Total Population
Female
Male

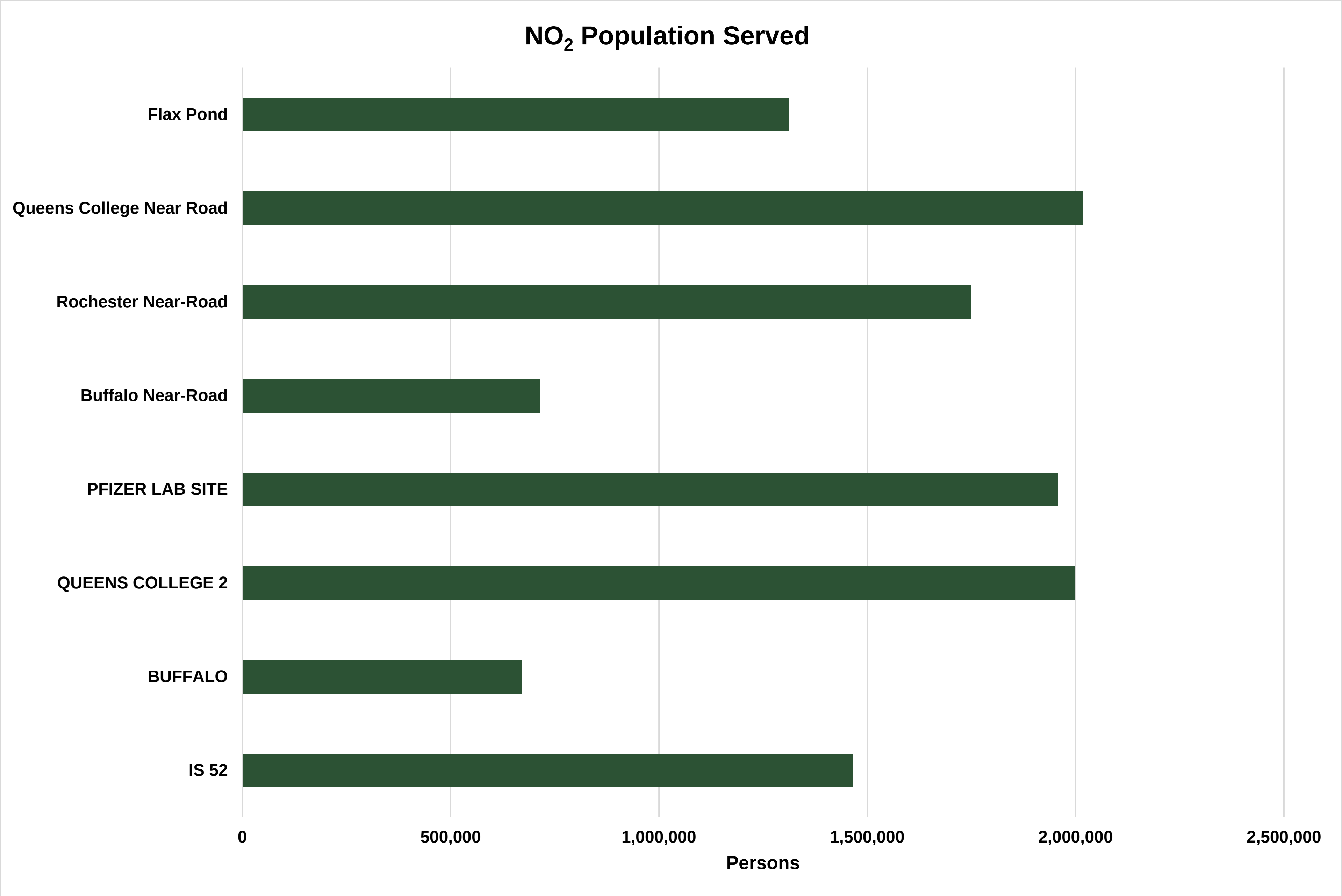

CO Population served
ROCHESTER NEAR-ROAD
ROCHESTER 2
QUEENS COLLEGE NEAR-ROAD
CCNY
PFIZER LAB SITE
QUEENS COLLEGE 2
PINNACLE STATE PARK
BUFFALO NEAR-ROAD
BUFFALO
LOUDONVILLE
0
500,000
1,000,000
1,500,000
2,000,000
2,500,000
3,000,000
3,500,000
Total Population
Caucasian/White
African/Black
Native American
Asian
Pacific Islander
Other Race
Multiple Races
Hispanic/Latino

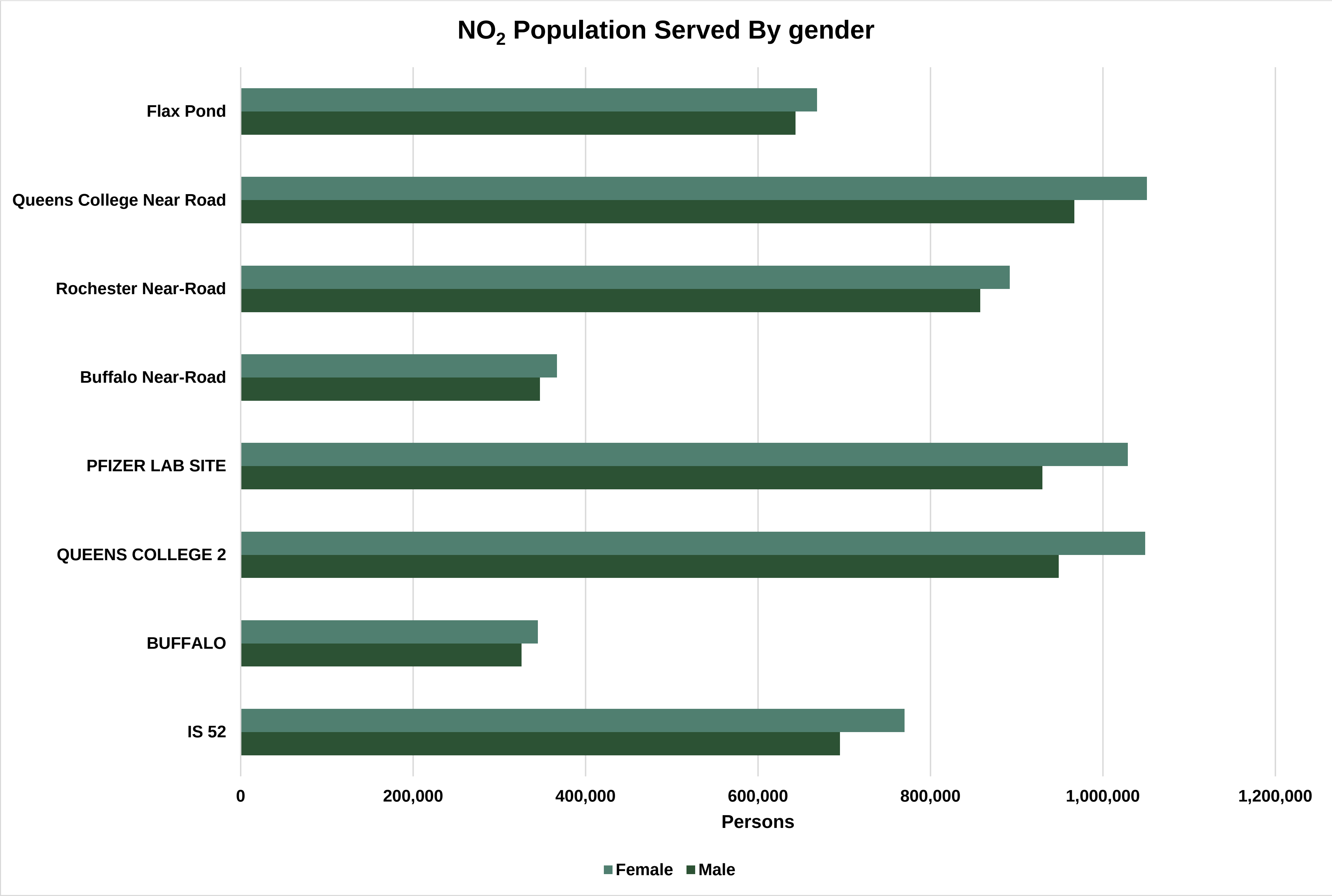


CO Design Values by site and year
PPM
0
1
2
3
4
5
6
7
8
9
10
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
LOUDONVILLE
BUFFALO
QUEENS COLLEGE 2
PINNACLE STATE PARK
ROCHESTER 2
PFIZER LAB SITE
CCNY
Buffalo Near-Road
Rochester Near-Road
Queens College Near Road
NAAQS

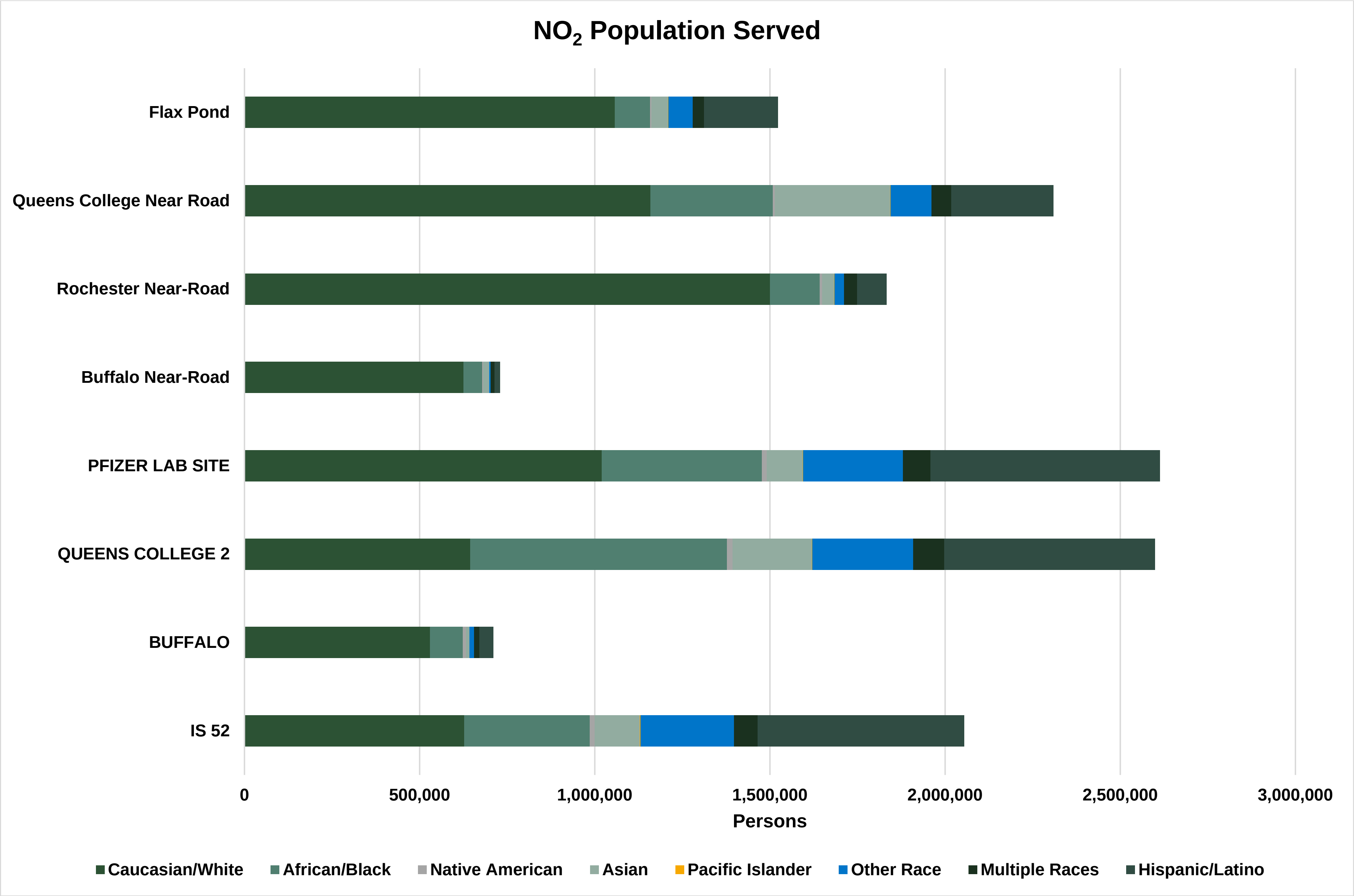
CO Removal Bias

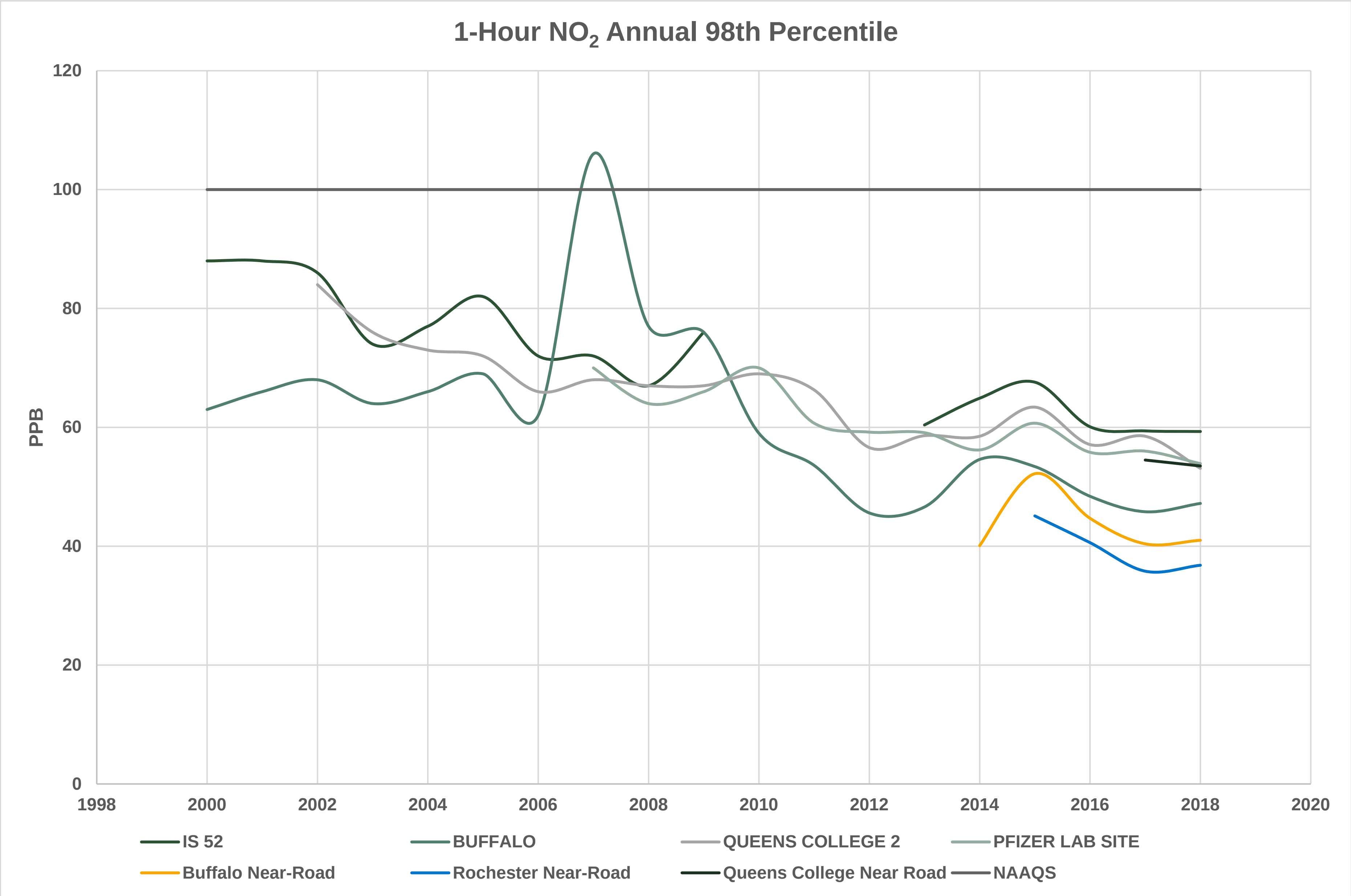
AQS Site ID	Neighbors Included	Daily Obs Count	Mean Removal Bias	Removal Bias Standard Deviation	Min Removal Bias	Max Removal Bias	Mean Relative Bias	Min Relative Bias	Max Relative Bias
Loudonville	7	1079	0	0.12	-0.6	0.4	17%	-74%	273%
NYBG	6	1092	0.02	0.18	-0.5	0.6	-18%	-70%	131%
BUFFALO	4	1064	-0.17	0.21	-1	0.3	-37%	-100%	200%
BUFFALO NR	8	1047	0.17	0.21	-0.3	1	24%	-99%	199%
ROCHESTER NR	5	1060	-0.03	0.09	-0.5	0.5	-8%	-93%	100%
ROCHESTER	5	1036	0.02	0.08	-0.5	0.3	13%	-53%	150%
CCNY	4	1059	0.12	0.18	-0.9	1.1	14%	-62%	369%
QUEENS COLLEGE	9	1019	0.06	0.14	-0.7	0.5	27%	-92%	278%
Queens College NR	4	582	-0.12	0.1	-0.7	0.2	-27%	-97%	50%
Pinnacle	7	1016	0.1	0.09	-0.1	0.6	69%	-66%	525%


NO2 Population Served
Flax Pond
Queens College Near Road
Rochester Near-Road
Buffalo Near-Road
PFIZER LAB SITE
QUEENS COLLEGE 2
BUFFALO
IS 52
0
500,000
1,000,000
1,500,000
2,000,000
2,500,000
Persons



NO2 Population Served By gender
Flax Pond
Queens College Near Road
Rochester Near-Road
Buffalo Near-Road
PFIZER LAB SITE
QUEENS COLLEGE 2
BUFFALO
IS 52
0
200,000
400,000
600,000
800,000
1,000,000
1,200,000
Persons
Female
Male


NO2 Population Served
Flax Pond
Queens College Near Road
Rochester Near-Road
Buffalo Near-Road
PFIZER LAB SITE
QUEENS COLLEGE 2
BUFFALO
IS 52
0
500,000
1,000,000
1,500,000
2,000,000
2,500,000
3,000,000
Persons
Caucasian/White
African/Black
Native American
Asian
Pacific Islander
Other Race
Multiple Races
Hispanic/Latino


1-Hour NO2 Annual 98th Percentile
PPB
0
20
40
60
80
100
120
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
IS 52
BUFFALO
QUEENS COLLEGE 2
PFIZER LAB SITE
Buffalo Near-Road
Rochester Near-Road
Queens College Near Road
NAAQS

NO_2 Removal Bias

AQS Site ID	Neighbors Included	Daily Obs Count	Mean Removal Bias	Removal Bias Standard Deviation	Min Removal Bias	Max Removal Bias	Mean Relative Bias	Min Relative Bias	Max Relative Bias
IS 52	5	1041	-1.6	5.3	-29	27	-3%	-52%	96%
NYBG	4	1063	3.4	6.1	-23	50	19%	-53%	173%
BUFFALO	5	1044	-1.3	7.1	-36	24	4%	-88%	389%
BUFFALO NR	4	992	0.3	6.8	-25	23	6%	-80%	462%
ROCHESTER NR	7	1037	-1	6	-29	23	-1%	-90%	229%
QUEENS COLLEGE	7	1053	1.3	5.5	-24	21	12%	-49%	164%
Queens College NR	5	609	-1.7	5.1	-31	10	-7%	-62%	33%