STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
OFFICE OF AIR RESOURCES

Rhode Island 2015 Annual Monitoring Network Plan

And

Five-Year Network Assessment

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Contents

Regulatory Background

Section 58.10(a) of Title 40 of the Code of Federal Regulations (40 CFR 58.10(a)) requires states to submit a monitoring network plan to the United States Environmental Protection Agency (EPA) in July of each year. The plan must provide a description of the state's current monitoring network, demonstrate that the network conforms to EPA requirements, and discuss any plans to remove or move a monitoring station in the 18 months following the plan submittal. The plan must be posted for public comment 30 days prior to submittal to the EPA.

In addition, Section 40 CFR 58.10(d) requires each state to prepare an assessment of its monitoring network once every five years. The second 5-year assessment must be submitted to EPA by July 1, 2015. In its 5-year assessment, the state must determine whether its existing network meets required monitoring objectives, whether new sites are needed, whether any existing sites are no longer needed, and whether new technologies are available that should be incorporated into the network. The assessment must also consider "the ability of existing and proposed sites to support air quality characterization for areas with relatively high populations of susceptible individuals, (e.g. children with asthma)" and must identify shifts in the distribution of the population within the state which may necessitate changing the location of population-oriented monitoring sites.

This document will serve as both Rhode Island's 2015 annual Monitoring Network Plan and Rhode Island's 5- Year Network Assessment.

Rhode Island Monitoring Network

The Rhode Island Department of Environmental Management (RI DEM), in conjunction with the Rhode Island Department of Health (RI DOH), operates a network of air monitoring stations that measure ambient concentrations of pollutants for which the EPA has established a National Ambient Air Quality Standard (NAAQS). Those pollutants, which are known as criteria pollutants, include ozone (O_3), particulate matter smaller than 10 microns (PM_{10}), particulate matter smaller than 2.5 microns ($PM_{2.5}$), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO) and lead. The criteria pollutant monitoring sites are part of the EPA's State or Local Air Monitoring Stations network (SLAMS).

In addition, RI DEM and RI DOH monitor ambient levels of toxic air pollutants and of ozone precursors, which are substances that react in the atmosphere to form ground-level ozone. The State operates one monitoring site that is part of the National Air Toxics Trends Sites (NATTS) network, two that are part of the Photochemical Assessment Monitoring Stations (PAMS) network, one that is part of the $PM_{2.5}$ Speciation Trends Network (STN) and one that is part of the network of core multipollutant monitoring stations (NCore).

Table 1 summarizes the NAAQS and Table 2 lists the locations of the eight Rhode Island air monitoring stations that are currently operating, along with the parameters monitored and monitoring methods used at each of the sites. The locations of those sites are shown in Figures 1-4.

All of these sites have been approved by EPA Region 1 as meeting applicable siting criteria, as specified in Subpart B of 40 CFR Part 58. All criteria pollutants are monitored, as required in the CFR, using Federal Reference Methods (FRMs) or Federal Equivalent Methods (FEMs) and monitors are operated according to the procedures specified in Quality Assurance Project Plans (QAPPs) that have been approved by EPA.[1] All sites are located in the Providence-New Bedford-Fall River, RI-MA Metropolitan Statistical Area (MSA), which includes municipalities in all five counties in Rhode Island as well as Bristol County in Massachusetts.

Table 1 National Ambient Air Quality Standards (NAAQS)

POLLUTANT	AVERAGING TIME	PRIMARY STANDARD	SECONDARY STANDARD
Sulfur Dioxide (SO_2)	3-Hour[A]	None	0.5 ppm (1300 $\mu g/m^3$)
	1-Hour[B]	0.075 ppm (75 ppb)	None
Carbon Monoxide (CO)	8-Hour[A]	9 ppm	None
	1-Hour[A]	35 ppm	None
Ozone (O_3)	8-Hour[C]	0.075 ppm (75 ppb)	Same as Primary Standard
Nitrogen Dioxide (NO_2)	Annual Arithmetic Mean	0.053 ppm (53 ppb)	Same as Primary Standard
	1-Hour[D]	100 ppb	None
Particulate Matter $\leq$ 10 micrometers (PM_{10})	24-Hour[E]	150 $\mu g/m^3$	Same as Primary Standard
Particulate Matter $\leq$ 2.5 micrometers ($PM_{2.5}$)	Annual Arithmetic Mean[F]	12.0 $\mu g/m^3$	15.0 $\mu g/m^3$
	24-Hour[G]	35 $\mu g/m^3$	Same as Primary Standard
Lead (Pb)	Rolling 3-Month Average[H]	0.15 $\mu g/m^3$	Same as Primary Standard

Primary standards protect against adverse health effects. **Secondary standards** protect against welfare effects such as damage to crops, vegetation, and buildings.

[A]Not to be exceeded more than once a year.

[1] RI DEM and RI DOH, "QAPP for Criteria Pollutants Including Particulates and NCore Parameters, Revision 10.0," approved by EPA December 5, 2012 and "QAPP: Air Toxics and PAMS Monitoring Programs, Revision 4.1," approved by EPA December 5, 2012.

[B] A rule revoking the annual and 24-hour SO_2 NAAQS and promulgating a new 1-hour SO_2 NAAQS was signed on June 2, 2010. To attain the 1-hour NAAQS, the 3-year average of the 99th percentile of the daily maximum 1-hour average SO_2 level at each monitor must not exceed 75 ppb.

[C] The ozone NAAQS is violated when the average of the 4th highest daily eight-hour concentration measured in 3 consecutive years exceeds 0.075 ppm (75 ppb). The 0.075 ppm NAAQS became effective in May 2008.

[D] To attain the 1-hour NO_2 NAAQS, effective January 22, 2010, the 3-year average of the 98th percentile of the daily maximum 1-hour average NO_2 concentration at each monitor must not exceed 100 ppb.

[E] To attain the PM_{10} standard, the 24-hour concentration at each site must not exceed 150 µg/m³ more than once per year, on average over 3 years.

[F] The primary annual average $PM_{2.5}$ NAAQS was revised on December 10, 2012. The secondary NAAQS was not changed. To attain the $PM_{2.5}$ annual standard, the 3-year average of the weighted annual means of the 24-hour concentrations must not exceed the NAAQS value.

[G] To attain the $PM_{2.5}$ 24-hour standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-based monitor must not exceed 35 µg/m^3.

[H]On October 15, 2008, the Pb NAAQS was changed to 0.15 µg/m^3 as a rolling 3-month average, not to be exceeded in a 3-year period.

µg/m³ = micrograms per cubic meter
mg/m³ = milligrams per cubic meter
ppb = parts per billion
ppm = parts per million

Table 2: Monitoring Sites

Site	AQS ID	Latitude Longitude	Parameter Measured	Method Of Sampling	EPA Method Designation
Vernon Trailer Vernon Street Pawtucket	440070026	41.874675 -71.379953	$PM_{2.5}$	Lo Vol	Reference
			PM_{10}	Hi Vol	Reference
			VOC	Canisters, GC/FID/MS	Reference
Johnson & Wales 111 Dorrance Street Providence	440070027	41.822686 -71.411089	PM_{10}	Hi Vol	Reference
Brown University 10 Prospect Street Providence	440070012	41.825556 -71.405278	Oxides of Nitrogen	Chemiluminescence (low range)	Reference
			Nitrogen Dioxide		
			Sulfur dioxide	Pulsed Fluorescence (low range)	Equivalent
USEPA Laboratory 27 Tarzwell Drive Narragansett	440090007	41.4950779 -71.4236587	Ozone	U.V. Photometric	Equivalent
			$PM_{2.5}$	Beta Attenuation/Cont	Equivalent
			Wind Speed	Anemometer	N/A
			Wind Direction	Wind Vane	N/A
			Temperature	Spot Reading	N/A
Francis School 64 Bourne Avenue E. Providence	440071010	41.840920 -71.36094	Oxides of Nitrogen	Chemiluminescence (low range)	Reference
			Nitrogen Dioxide		
			NO/NO_y	Chemiluminescence (low range)	Reference
			Carbon Monoxide	Gas Filter Correlation (low range)	Equivalent
			Sulfur dioxide	Pulsed Fluorescence (low range)	Equivalent
			Ozone	U.V. Photometric	Equivalent
			$PM_{2.5}$	Lo Vol	Reference
			$PM_{2.5}$	Beta Attenuation/Cont	Equivalent
			Speciated $PM_{2.5}$	Speciation Monitor	N/A
			Coarse PM ($PM_{10-2.5}$)	Lo Vols (PM_{10} & $PM_{2.5}$)	Reference
			Black Carbon	Aethalometer	N/A
			Lead	Lo Vol PM_{10}, XRF	Equivalent
			VOC	Canisters, GC/FID/MS	Reference
			Carbonyls	HPLC Cartridges	Reference
			Wind Speed	Anemometer	N/A
			Wind Direction	Wind Vane	N/A
			Barometric Pressure	Barometer	N/A
			Temperature	Spot Reading	N/A
			Relative Humidity	Plastic Film	N/A
			Solar Radiation	Pyranometric	N/A
			UV Radiation	UV Photometric	N/A
			Precipitation	Bucket/Continuous	N/A

Site	AQS ID	Latitude Longitude	Parameter Measured	Method Of Sampling	EPA Method Designation
Urban League 212 Prairie Avenue Providence	440070022	41.807949 -71.415103	$PM_{2.5}$	Lo Vol	Reference
			$PM_{2.5}$	Beta Attenuation/Cont	Equivalent
			PM_{10}	Lo Vol	N/A
			PM_{10}/Metals	Hi Vol	Reference
			Chromium VI (discontinued 6/14)	TSP/Ion chromatograph	N/A
			VOC	Canisters, GC/FID/MS	Reference
			Carbonyls	HPLC Cartridges	Reference
			Black Carbon	Aethalometer	N/A
			Semi-volatiles	PUF/XAD, GC/MS	N/A
			Wind Speed	Anemometer	N/A
			Wind Direction	Wind Vane	N/A
			Temperature	Spot Reading	N/A
			Relative Humidity	Plastic Film	N/A
Alton Jones Campus Victory Highway West Greenwich	440030002	41.615600 -71.719900	Ozone	U.V. Photometric	Equivalent
			Nitrogen Dioxide	Chemiluminescence	Reference
			Oxides Of Nitrogen	Chemiluminescence	Reference
			VOC	Canisters, GC/FID/MS	Reference
			PM_{10}	Hi Vol	Reference
			$PM_{2.5}$	Lo Vol	Reference
			$PM_{2.5}$	Beta Attenuation/Cont	Equivalent
			Wind Speed	Anemometer	N/A
			Wind Direction	Wind Vane	N/A
			Barometric Pressure	Barometer	N/A
			Temperature	Spot Reading	N/A
			Relative Humidity	Plastic Film	N/A
			Solar Radiation	Pyranometric	N/A
Near-Road Site Hayes and Park Sts. Providence	440070030	41.829495 -71.417457	Oxides of Nitrogen	Chemiluminescence (low range)	Reference
			Nitrogen Dioxide		
			Carbon Monoxide	Gas Filter Correlation (low range)	Equivalent
			$PM_{2.5}$	Beta Attenuation/Cont	Equivalent
			Black Carbon	Aethalometer	N/A

Population Distribution and Sensitive Populations

As discussed above, 40 CFR 58.10(d) specifies that 5-year assessments must include an evaluation of whether changes in the distribution of population within the state warrant changes in the location of population-oriented monitoring sites. As shown in Figure 5, the population distribution in Rhode Island counties has remained relatively constant over the period 1990 – 2014 and in the period since the last 5-year assessment. Rhode Island's population continues to be heavily concentrated in Providence County, which accounts for approximately 60% of the State's residents.

As shown in Figure 6, the populations of Rhode Island's cities have remained stable since the last Network Assessment; the City of Newport saw a decrease of 3.5% in that period, while the populations of all of the other Rhode Island cities changed by less than 1% between 2010 and 2014.[2] Note also that 28% of the population of the State and 47% of the population of Providence County reside in the three cities where RI DEM's monitoring activities are most focused: Providence, East Providence and Pawtucket. Therefore, since there have been no major population shifts and the monitoring network is focused in the most populated area of the State, a change in the location of population-oriented monitoring sites is not warranted.

As discussed above, the CFR also requires 5-year assessments to evaluate whether the state's monitoring network adequately characterizes air quality in areas with high populations of susceptible people, such as children with asthma. As shown in Figure 7, the rate of emergency room visits for childhood asthma is considerably higher in Rhode Island's core cities; Providence, Pawtucket, Central Falls and Woonsocket; (15.9 per thousand children) than in the State as a whole (9.5 per thousand children). The rate of pediatric asthma hospitalizations was also elevated in the core cities, as compared to the State average (2.7 versus 1.9 hospitalizations per thousand children).[3]

In addition, as shown in Figure 7, the core cities have demographic characteristics that have been linked to increased risk of pediatric asthma, including:

- Race - 14.3% of the children in the core cities are Black/African American, as compared to 6.4% statewide;
- Ethnicity – 42.0% of children in the core cities identify as Hispanic/Latino, as compared to 20.5% statewide;[4]
- Education – Mothers of 23.8% of babies in the core cities have not finished high school; statewide, that number is 14.0%;[5] and
- Poverty – 38.4% of children in the core cities live below the poverty line, as compared to 19.5% statewide.[6]

Three of the core cities; Providence, Pawtucket and Central Falls; are contiguous. Those cities comprise 2.7% of the State's land area and 25% of the State's population. As shown in Figure 8, the rates of pediatric asthma emergency room visits and hospitalizations in those cities are elevated and

[2] United States Department of Commerce, US Census, American Fact Finder. http://quickfacts.census.gov/qfd/states/44000lk.html

[3] Rhode Island KIDS COUNT, 2015 Rhode Island KIDS COUNT Factbook", Table 24 – "Asthma Emergency Department Visits for Children Underage Age 18, Rhode Island, 2009-2013. Data from the Rhode Island Department of Health, Center for Health Data and Analysis, Hospital Discharge Database.

[4] Ibid, Table 5 – "Child Population, by Race and Ethnicity, Rhode Island, 2010", data from 2010 US Census.

[5] Ibid, Table 4 – "Births by Education Levels of Mother, Rhode Island, 2009-2013", data from Rhode Island Department of Health, Center for Health Data and Analysis, Hospital Discharge Database.

[6] Ibid, Table 10 – "Children Living Below the Federal Poverty Threshold, Rhode Island, 2000 and 2009-2013. Data from US Census 2000 and Population Reference Bureaus analysis of 2009-2013 American Community Survey data.

the demographic profile of children in those cities is consistent with an increased asthma risk. Therefore, it is appropriate that much of the State's monitoring network is concentrated in that area.

Air monitoring currently is not conducted in the fourth. noncontiguous core city, Woonsocket, which is approximately eleven miles northwest of the Providence-Pawtucket-Central Falls area. As shown in Figure 8, Woonsocket's pediatric asthma emergency department visit rate is considerably higher than that of the State as a whole (14.2 versus 9.5 per thousand children) and the percentage of children living in poverty in that City (42.8%) is the highest in the State. An analysis of whether the existing monitoring network in Rhode Island and nearby states adequately characterizes exposures in the Providence-Pawtucket-Central Falls and Woonsocket areas is included in the following pollutant-specific discussions.

Network Evaluation

Following is a discussion, by pollutant, of:

- The current monitoring network,
- The NAAQS and a comparison of recent measurements with the NAAQS,
- Trends in pollutant levels measured,
- Whether that network meets EPA's monitoring criteria,
- Whether new sites are needed,
- Whether any existing sites are no longer needed,
- Whether new monitoring technologies are available that should be adopted;
- Whether the current network adequately characterizes air quality in the core cities, and
- Plans for modification of the network in the next 18 months.

Ozone (O_3)

Rhode Island's current ozone monitoring sites are listed in Table 3:

Table 3 Rhode Island Ozone Monitoring Sites

SITE	MEASUREMENT SCALE	MONITORING OBJECTIVE
Alton Jones Campus Victory Highway West Greenwich	Regional (PAMS Type I)	Upwind background Population exposure
USEPA Laboratory 27 Tarzwell Drive Narragansett	Regional	Population exposure
Francis School 64 Bourne Avenue E. Providence	Neighborhood (PAMS Type II, NCore)	Maximum precursor emissions impact Population exposure

The NAAQS for ozone is 75 ppb. A site is in violation of that NAAQS when the average of the 4th highest daily eight-hour ozone concentrations measured in each of 3 consecutive years (the design value) at that site exceeds 75 ppb.

As shown in Table 4 and Figure 9, the ozone design values for all of the Rhode Island sites have decreased substantially over time. Design values were higher in 2012 and 2013 than an in the two previous years, but dropped again in 2014, largely due to the small number of high temperature days during the summer of 2014. On April 30, 2012, the EPA designated Rhode Island as unclassifiable/attainment for the 75 ppb NAAQS, based on the State's design values for the 2009-2011 period. However, the design values for Narragansett for 2010-2012 and 2011-2013 and for E. Providence for 2011-2013 exceeded the 75 ppb NAAQS. For the most recent three year period, the design values for all three Rhode Island sites are again below the NAAQS.

Table 4 Ozone Design Values (ppb)

	W. Greenwich	Narragansett	E. Providence
2001 - 2003	95	95	93
2002 - 2004	87	90	84
2003 - 2005	84	89	82
2004 - 2006	83	85	81
2005 - 2007	86	84	84
2006 - 2008	80	81	82
2007 -2009	77	77	77
2008 - 2010	71	76	72
2009 –2011	73	73	71
2010 - 2012	74	78	75
2011 - 2013	74	78	76
2012 - 2014	70	74	73

Despite the trend toward improved air quality, ozone concentrations in the State continue to reach unhealthy levels (levels above 75 ppb) on some summer days. During the 2011- 2014 period, 8-hour average ozone levels were above 75 ppb at one or more of the Rhode Island monitoring sites on 18 days. Note also that, on November 25, 2014, the EPA proposed to revise the NAAQS for ozone to 65 – 70 ppb and requested comments on a NAAQS of 60 ppb (FR 79:75234). That regulation will be finalized by October 1, 2015. In the 2011- 2014 period, ozone levels in Rhode Island were above 70 ppb on 30 days, above 65 ppb on 42 days and above 60 ppb on 77 days.

Table D-2 of 40 CFR 58, Appendix D requires MSAs which have populations between 350,000 and 4 million and which measure ozone design values in excess of 85% of the NAAQS at one or more sites to operate a minimum of two ozone monitoring sites. Rhode Island is in that category; the 2013 estimated population of the Providence-New Bedford-Fall River, RI-MA MSA, which includes all

of Rhode Island, was 1,609,367[7] and the State's ozone design values at all sites are more than 85% of the 75 ppb NAAQS (63.75 ppb). Since Rhode Island operates three ozone sites, the State exceeds the minimum requirement.

40 CFR 58, Appendix D 4.1(b) states that at least one monitor in each MSA must be designed to record the maximum ozone concentration in the MSA. Since none of the three Rhode Island ozone monitors are near significant air pollution sources that may cause localized reductions in ambient ozone levels, those monitors represent maximum ozone concentrations in the areas of the State in which they are located. Note that, due to the size of the State and the time required for ozone formation to occur, maximum ozone impacts associated with Providence metropolitan area emissions likely occur in downwind states. The PAMS network, which is discussed in further detail below, is designed to address that issue.

40 CFR 58, Appendix D 4.1(b) also specifies that the network design must consider such factors as geographic size, population density, complexity of terrain and meteorology, ozone monitoring programs in adjacent states and air pollution transport from neighboring areas. Rhode Island is a small state (48 miles north-south and 37 miles east-west at its maximum) with minimal complex terrain and meteorology. The East Providence monitor is representative of the densely populated Providence metropolitan area. Impacts from transport of air pollutants emitted in upwind states are measured at the West Greenwich (inland) and Narragansett (coastal) monitors. The Rhode Island network complements the networks in Massachusetts and Connecticut, as shown in Figure 10. Therefore, the Rhode Island ozone monitoring network is consistent with these requirements.

40 CFR 58, Appendix D 4.1(c) states that ozone sites should be representative of neighborhood, urban or regional spatial scales, since the time and space associated with ozone formation minimizes the importance of monitoring for small spatial variability. Rhode Island is in compliance with this requirement because two of the State's sites (West Greenwich and Narragansett) are regional scale representative, while the third site, East Providence, is neighborhood scale representative.

On July 16, 2009, the EPA proposed revisions to its ambient ozone monitoring network design regulations.[8] Those regulations, as proposed, would require additional ozone monitors in rural areas that are not part of MSAs. It is not likely that that requirement, if promulgated, would apply to Rhode Island, since all portions of the State, including areas that are commonly considered rural, are part of the Providence-New Bedford-Fall River, RI-MA MSA. If that rule is promulgated, RI DEM will evaluate the amended requirements and determine whether action is required.

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[7] US Census Bureau, "Annual Estimates of the Resident Population: April 1, 2010 to July 1, 2014 - United States -- Metropolitan and Micropolitan Statistical Area; and for Puerto Rico
2014 Population Estimates."
http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk

[8] EPA, "Ambient Ozone Monitoring Regulations: Revisions to Network Design Requirements," Proposed Rule, Federal Register 74 (135):34525, July 16, 2009. http://frwebgate1.access.gpo.gov/cgi-bin/PDFgate.cgi?WAISdocID=166547143810+6+2+0&WAISaction=retrieve

As discussed above, children living in the Providence-Pawtucket-Central Falls area are at an increased asthma risk. Although no ozone monitors are currently operated in those cities, the concentrations measured at the East Providence site (44-007-1010), which is less than one mile from the Providence border, are representative of maximum ozone concentrations in the Providence metropolitan area. That site is purposely located immediately downwind of, rather than within, the area with the highest density of emissions sources, because freshly emitted nitrogen oxides react with atmospheric ozone, resulting in ozone levels in urbanized locations that are generally somewhat lower than in surrounding areas.

RI DEM has evidence that this "nitrogen scavenging" phenomenon occurs in the Providence area. For four years (1994 – 1997), ozone monitors were operated concurrently at a site in Providence (Brown University) and at the current East Providence location. On the 74 days that both sites were operational and the Providence monitor recorded a maximum 8-hour average ozone concentration of 60 ppb or higher, the measurements at the two sites correlated well ($r^2 = 0.76$). The maximum daily 8-hour ozone concentrations were the same or higher at the East Providence site than those at the Providence site on 89% (66 out of 74) of those days.

Since emissions of ozone precursors and resulting ozone levels have decreased in the past several years, the quantitative relationships between the Providence and East Providence levels may have changed somewhat since 1994 – 1997. However, due to the proximity of the East Providence monitor to Providence and the fact that Providence continues to be the most urban and industrialized area in the State, there is no reason to believe that the ozone concentrations measured in East Providence would not continue to represent (or somewhat over-represent) the concentrations in the Providence-Pawtucket-Central Falls area.

As discussed above, Woonsocket also has a high concentration of children at risk from asthma. As shown in Figure 10, Woonsocket is located midway between the ozone sites in East Providence, RI (44-007-1010) to the southeast and Uxbridge, MA (25-027-0024) to the northwest. Since, as shown in Table 5, the ozone measurements at those monitors correlate well with each other and with the ozone levels measured by monitors in W. Greenwich, RI, which is south southwest of Woonsocket, and Pomfret, CT (09-015-9991), to the west southwest, and there is no unusual topography in the Woonsocket area, the existing monitoring network adequately characterizes ozone levels in the Woonsocket area.

Table 5 – Comparison of Ozone Levels at Monitors near Woonsocket[9]

	Uxbridge, MA 25-027-0024		W. Greenwich, RI 44-003-0002		Pomfret, CT 09-015-9991	
	Correlation	Relative Error	Correlation	Relative Error	Correlation	Relative Error
E Providence, RI 44-007-1010	0.876	0.116	0.909	0.0897	0.919	0.102
Uxbridge, MA 25-027-0024			0.887	0.115	0.932	0.0819
W Greenwich, RI 44-003-0002					0.927	0.0818

RI DEM does not intend to add or remove any ozone monitoring sites from the network in the next 18 months. As discussed above, the current Rhode Island monitoring network fulfills the ozone monitoring requirements in 40 CFR 58, Appendix D, as discussed above, so no new sites are needed. RI DEM used the NetAssess Ambient Air Monitoring Network Assessment Tool[9], to determine whether any of the existing sites are redundant. The results of those evaluations indicated that both the W. Greenwich or E. Providence sites have a negative removal bias; therefore, if either of those sites were removed, estimated ozone concentrations at those locations, based on measured results at neighboring sites, would tend to be lower than the actual measured values at those sites. Therefore, it would not be appropriate to discontinue those sites.

According to the assessment tool, removal of the Narragansett site would be neutral –estimated values for that site, based on the results at neighboring sites, would, on average, be essentially equivalent to the measured values, an indication that that site may not be essential. However, since the Narragansett site is used to predict and characterize coastal exposures and is sometimes affected by meteorological conditions that do not affect inland areas, Rhode Island has no plans to remove that site from the network.

In the December 2014 revised ozone NAAQS proposal discussed above, the EPA proposed to lengthen the required ozone monitoring seasons in 33 states, including Rhode Island. If that requirement is promulgated as proposed, Rhode Island's required ozone monitoring season will change from April through September to March through September. In anticipation of such a change, RI DEM has been operating the ozone monitors at the Narragansett and East Greenwich sites from March through October since 2011. Beginning in 2011, ozone has been measured year round at the East Providence site, consistent with NCore requirements.

[9] Correlations, relative error and removal bias were calculated using NetAssess Ambient Air Monitoring Network Assessment Tool, v0.6b. https://ebailey78.shinyapps.io/NetAssessApp/

In the proposed NAAQS, the EPA proposed changes to the PAMS monitoring requirements in 40 CFR Part 58. Those proposals and their impact on the Rhode Island monitoring network are discussed in the "Ozone Precursor and Air Toxics" section of this document. EPA also proposed to establish a new, additional Federal Reference Method (FRM) for ozone based on nitric oxide-chemiluminescence (NO-CL). Rhode Island does not anticipate needing additional or replacement ozone monitors in the near future, but will consider the new technology before purchasing new equipment when needed.

Carbon Monoxide (CO)

The current CO monitoring network is as shown in Table 6:

Table 6 Carbon Monoxide Monitoring Network

SITE	MEASUREMENT SCALE	MONITORING OBJECTIVE
Francis School 64 Bourne Avenue E. Providence	Neighborhood	Maximum precursor emissions impact Population exposure
Near-Road Site Hayes and Park Sts. Providence	Microscale	Maximum emissions Near-road (began operation in April 2014)

The NAAQS for CO are:

- 35 ppm as a 1 hour average, not to be exceeded more than once per year (design value is the highest annual 2nd maximum 1-hour concentration) and
- 9 ppm as an 8 hour average, not to be exceeded more than once per year (design value is the highest annual 2nd maximum non-overlapping 8-hour concentration)

The highest CO design values recorded at the East Providence site in the last five years are:

- 2.3 ppm – 1 hour average, 7% of NAAQS,
- 1.6 ppm – 8-hour average, 18 % of NAAQS

The 2014 CO design values for Rhode Island are:

- 1.6 ppm – 1 hour average, 5% of NAAQS
- 1.2 ppm – 8 hour average, 13% of NAAQS

The CO NAAQS has not been exceeded in Rhode Island since 1984. Since 2001, all CO levels recorded in Rhode Island have been in the "Good" category of the EPA's Air Quality Index (AQI).

As shown in Figure 11, ambient CO levels in Rhode Island have decreased since the year 2000, although there has been no clear trend in recent years.

On August 21, 2011, EPA issued a decision retaining the CO NAAQS at the current levels.[10] The decision requires the operation of CO monitors at sites established to comply with the near-road monitoring requirements specified in the 2010 NO_2 NAAQS. Near-road sites are required in all urban areas which, like the Providence-New Bedford-Fall River, RI-MA MSA, have a population of 1,000,000 or more. Near-road CO monitoring is not required until January 1, 2017; however, Rhode Island began operating a low-range CO monitor at a site adjacent to Interstate Route 95 that meets the above near-road specifications in April 2014.

Since the CO monitor at the Rhode Island Near-Road site did not begin operating until April 2014, 2014 design values for that site are not available. In the first year of its operation, maximum daily one-hour concentrations measured at that site were, on average, approximately three times higher than those at the E. Providence site (see Figure 12), but still significantly lower than the CO NAAQS.

EPA's regulations do not specify a minimum number of CO monitors that must be operated in a state, except that CO monitoring is required at Type 2 PAMS sites (40 CFR 58, Appendix D, Table D-6), at NCore sites (40 CFR 58, Appendix D 3(b)) and, as discussed above, at near-road sites. Since the East Providence site is both a Type 2 PAMS site and the State's NCore site, carbon monoxide monitoring is conducted at that site using a low range monitor, consistent with NCore requirements.

Although carbon monoxide is not a pollutant that is generally associated with asthma, RI DEM evaluated whether the current monitoring network adequately characterizes levels of that pollutant in the core cities, where many sensitive individuals reside. Carbon monoxide levels tend to be highest in urban canyon areas and in locations close to major roadways. The Near Road site adequately characterizes worst case impacts from major roadways because it is located five meters downwind of the section of I-95 with the highest vehicle and diesel traffic counts and congestion in the State.

Carbon monoxide monitoring was conducted for more than 30 years at a site in downtown Providence which was considered a maximum impact urban canyon site. Over the course of that period, carbon monoxide levels decreased dramatically; the 8-hour average carbon monoxide design value at that site was 16.8 ppm in 1975 and had dropped to 2.5 ppm in 2006.

During the last eight years of the operation of the downtown site (1999 – 2006), the current East Providence carbon monoxide monitor was also operational. During those eight years, the 8-hour carbon monoxide design value at the downtown Providence site was between 0.1 and 2.3 ppm

[10] US EPA, "Review of National Ambient Air Quality Standards of Carbon Monoxide: Final Rule," Federal Register 76 (169):54294, August 31, 2011. http://www.gpo.gov/fdsys/pkg/FR-2011-08-31/pdf/2011-21359.pdf

(average of 1.1 ppm) higher than at the East Providence site. Since the 2014 8-hour carbon monoxide design value for the East Providence monitor was 1.2 ppm, as compared to the 8-hour NAAQS of 9 ppm, it is very unlikely that levels in the Providence area would endanger sensitive populations by exceeding the NAAQS.

Given the above considerations, RI DEM does not plan any changes in the State's carbon monoxide monitoring network in the next 18 months. Note that, since low-range CO monitors are now in use at both the East Providence and Near Road sites, RI DEM does not plan to further update the technology used for measuring that pollutant at this time.

Sulfur Dioxide (SO_2)

The current SO_2 monitoring network is as shown in Table 7:

Table 7 Sulfur Dioxide Monitoring Network

SITE	MEASUREMENT SCALE	MONITORING OBJECTIVE
Brown University 10 Prospect Street Providence	Neighborhood	Population exposure
Francis School 64 Bourne Avenue E. Providence	Neighborhood	NCore

The NAAQS for SO_2[11] are:

- 75 ppb, 1-hour average (primary standard effective June 2, 2010). The design value is the average of the 99th percentile maximum daily hour measured in 3 consecutive years

- 0.5 ppm (500 ppb) - 3 hour average (secondary standard), not to be exceeded more than once per year

The highest SO_2 design values recorded in the last five years in Rhode Island are:

- 25 ppb - 1 hour average, 33% of primary NAAQS (Brown monitor)
- 24 ppb - 3-hour average, 5% of secondary NAAQS (Brown and E. Providence monitors)

The highest 2014 SO_2 design values are:

[11] An EPA rule amending the SO_2 NAAQS was signed on June 2, 2010. The rule revokes the previous annual and 24-hour NAAQS and sets a new one-hour average NAAQS at 0.075 ppm (75 ppb). Revisions of monitoring networks consistent with the requirements in the rule must be in place by January 1, 2013.

- 14 ppb – 1 hour average, 19% of primary NAAQS (E. Providence monitor)
- 11 ppb- 3 hour average, 2% of secondary NAAQS (E. Providence monitor)

The SO_2 NAAQS has never been exceeded in the State. One-hour design values for SO_2 have been below 75 ppb, the one-hour NAAQS promulgated in 2010, since 1994. All measurements have been in the "Good" range of the AQI since 2007. As shown in Figure 13, one-hour average SO_2 design levels in Rhode Island have declined over the past decade. Levels measured at the East Providence monitor tend to be slightly higher than those in Providence, probably due to the influence of emissions from the Brayton Point coal-fired power plant in Fall River.

EPA's 2006 amended monitoring regulation requires SO_2 monitoring only at NCore sites. However, the 2010 SO_2 NAAQS rule requires at least one SO_2 monitor in the Providence-New Bedford-Fall River RI, MA MSA. That SO_2 monitor must be sited to meet one or more of the following objectives: (1) characterizing concentrations around emissions sources, (2) measuring the highest concentrations in an area, (3) determining population exposure, (4) establishing general background levels and (5) evaluating regional transport.

Rhode Island operates a SO_2 monitor at Brown University in Providence and, to meet NCore requirements, began operating a low-range SO_2 monitor at the East Providence site in January 2011.The Brown University SO_2 monitor was updated to a low-range unit in January 2013. RI DEM believes that the Brown University and East Providence monitors appropriately characterize population exposure in the major urban areas in Rhode Island.

The State of Massachusetts also operates a SO_2 monitor in the Providence-New Bedford-Fall River RI-MA MSA. Since that monitor is located in Fall River, MA, approximately two miles southeast of the Brayton Point coal-fired power plant, the SO_2 levels recorded at that site have historically been substantially higher than those at the Rhode Island sites; however, SO_2 levels recorded at that site dropped in 2014, probably due to the decreased operation of the power plant. The 2014 one-hour design value for SO_2 at the Fall River monitor was 47 ppb, 63% of the NAAQS and more than three times the highest Rhode Island design value. According to EPA's Emissions Inventory System (EIS), in 2011 the Brayton Point facility emitted 18,648 tons of SO_2, more than 50 times more than the highest emitting Rhode Island source, Central Landfill (352 tons). Therefore, the Fall River monitor is more appropriate than a Rhode Island location for characterizing maximum concentrations in the MSA. RI DEM will reevaluate the placement of the maximum concentration monitor subsequent to the closure of the Brayton Point plant, which is scheduled for the summer of 2017.

The Brown University monitor is located in Providence, the area with an elevated concentration of children at risk from asthma. RI DEM also operated a SO_2 monitor in downtown Providence until 2007. During each of the last six years of monitoring at that site, the 24-hour design values and annual average sulfur dioxide concentrations at the Brown University site correlated well with and

were higher than those at the downtown site. Therefore, the SO_2 levels measured at the Brown University site are appropriate for characterizing SO_2 exposures to Providence residents.

The EPA proposed the "Data Requirements Rule for the 1-Hour Sulfur Dioxide Primary National Ambient Air Quality Standard" on April 1, 2014. RI DEM will assess the monitoring requirements in that rule when the rule is finalized to determine whether any changes to the Rhode Island air monitoring network are needed to comply with those requirements.

Given the above considerations, RI DEM does not plan any changes in the State's sulfur dioxide monitoring network in the next 18 months. Note that, since low-range SO_2 monitors are now in use at both the East Providence and Brown University sites, RI DEM does not plan to further update the technology used for measuring that pollutant at this time.

Nitrogen Dioxide (NO_2)

The current NO_2 monitoring network is shown in Table 8a:

Table 8a Nitrogen Dioxide Monitoring Network

SITE	MEASUREMENT SCALE	MONITORING OBJECTIVE	SCHEDULE
Brown University 10 Prospect Street Providence	Neighborhood	Population exposure	Continuous Year round
Francis School 64 Bourne Avenue E. Providence	Neighborhood (PAMS)	Population exposure	Continuous Year round
Alton Jones Campus Victory Highway West Greenwich	Regional (PAMS)	Population exposure Upwind background	Continuous Ozone season
Near-Road Site Hayes and Park Sts. Providence	Microscale	Maximum emissions Near-road	Continuous Year round Beginning April 2014

In January 2013, NO_2 monitors at all sites were replaced with low-range units.

The NO_2 NAAQS are:

- 100 ppb - 1 hour average (effective January 22, 2010). The design value is the average of the 98^{th} percentile maximum daily hour measured in 3 consecutive years.

- 0.053 ppm (53 ppb) - annual average

The highest NO_2 design values recorded in the last five years are:

- 44 ppb - 1 hour average, 44% of NAAQS
- 11 ppb - annual average, 21% of NAAQS

Design values for 2014 are:

- 42 ppb - 1 hour average, 42% of NAAQS
- 10 ppb annual average, 20% of NAAQS

The NO_2 NAAQS have never been exceeded in Rhode Island. Since there was no short-term NAAQS for NO_2 until the standard was amended in 2010, this pollutant was not used in the Air Quality Index (AQI) before that date. The amended NAAQS for NO_2, which was published on February 9, 2010[12], established AQI concentration ranges for that pollutant; a maximum hourly level of 54 -100 ppb corresponds to a "Moderate" AQI. In the 5 year period of 2010 – 2014, there were a total of 4 days when NO_2 levels recorded in Rhode Island were in the Moderate range. No levels in the Unhealthy for Sensitive Populations or more serious AQI categories were recorded in that period. As shown in Figure 14, NO_2 levels have decreased in the past 15 years but did not change significantly between 2012 and 2014.

The 2010 amended NO_2 NAAQS requires Rhode Island to operate two NO_2 monitoring sites, one at "a location of expected highest NO_2 concentrations representing the neighborhood or larger spatial scales" and a second monitor at a near-road location where maximum microscale-representative concentrations are expected, Rhode Island intends to use the current NO_2/NO_x site at Brown University in Providence to fulfill the requirement for a neighborhood scale site. NO_2/NO_x monitoring has been conducted at that site, which has been approved as neighborhood scale representative, since 1994; therefore, the data collected at that site can be used to track trends in NO_2/NO_x concentrations over time. Moreover, the site is in the area of the State with the highest emitting NO_2/NO_x sources and the highest density of NO_2/NO_x emissions. NO_2 concentrations measured at the Brown University site are substantially lower than the NAAQS for that pollutant, including the 1-hour average standard.

As discussed above, after an evaluation of meteorology, traffic and diesel traffic counts and congestion and other factors, a Rhode Island Near-Road site was established on the east side of the Interstate Route 95 near downtown Providence. Monitoring for NO_2/NO_x, as well as CO, $PM_{2.5}$ and black carbon, began at that site in April 2014. It should be noted that the Rhode Island Department of Transportation is currently engaged in a large scale highway

[12] USEPA, "Primary National Ambient Air Quality Standards for Nitrogen Dioxide: Final Rule," FR 75(26):6474, 9 February 2010.
http://www.epa.gov/ttn/naaqs/standards/nox/fr/20100209.pdf

reconstruction/bridge repair project on the southbound side of I-95, just southwest of the monitoring site, and emissions from construction equipment and activities may have a measureable impact on monitored levels at the near-road site. In addition, construction is due to shift to the northbound lanes in the future, at which time the monitoring site will need to be relocated. Currently, northbound construction is scheduled to begin in the spring of 2017.

Since the NO_2 monitor at the Rhode Island Near-Road site did not begin operating until April 2014, 2014 design values for that site are not available. However, in the first year of its operation, maximum daily one-hour concentrations measured at that site were, on average, approximately twice as high as those at Brown and three times higher than those at the E. Providence site. As shown in Figure 15, these differences were especially pronounced in the warmer months, when NO_2 levels at the other sites tend to be low. As shown in Figure 16, the discrepancy between levels of nitric oxide (NO) at the Near-Road and other sites were more dramatic (Near-Road daily levels on average were 15 times those at Brown and nearly 40 times those at East Providence). This is expected because NO is associated with fresh emissions from combustion sources, including vehicles. Note that the NO_2 levels measured at the Near-Road site were below the one-hour NO_2 NAAQS, but, during the colder months, were frequently in the Moderate AQI range (54-100 ppb).

To fulfill PAMS requirements, NO_2/NO_x is also monitored at the East Providence and West Greenwich sites during the ozone season. To determine how NO_2/NO_x levels at the East Providence site compare to those measured at the Brown University site, Rhode Island has operated the East Providence NO_2/NO_x monitor continuously since March 2012. In the first two year that the East Providence monitor operated year-round, one hour and annual average concentrations were considerably lower at that site than at the Brown site, as shown in Table 8b.

Table 8b 2013 Nitrogen Dioxide Levels at Brown and East Providence Sites (ppb)

Site	Year	98th Percentile One-Hour	Annual Average
Brown Univ., Providence	2013	43.1	10.42
	2014	43.9	10.47
Francis School,, E Providence	2013	38.2	7.50
	2014	37.2	7.29

Therefore, it does not appear likely that operation of the East Providence monitor year-round would affect Rhode Island's NO_2 design values. However, NO_2 levels were higher at the East Providence site than at the Brown University sites on some days. On February 10, 2013, the maximum one-hour concentration at the East Providence site, 55.0 ppb, was in the Moderate AQI range, while the maximum at the Brown University site, 48.7 ppb, was in the Good category. Year-round operation of the East Providence monitor will be continued at least until the end of the 2016 ozone season.

The Brown University NO_2 monitor is located in Providence, a city with a high concentration of children at risk from asthma. As discussed above, NO_2 concentrations measured at that site are substantially lower than the NAAQS for that pollutant, including the newly promulgated 1-hour average standard. NO_2 concentrations at the State's Near-Road site, which is immediately adjacent to the busiest section of I-95 near downtown Providence, also do not exceed the NAAQS, although levels in the Moderate range of the AQI were frequently recorded in the colder months during the first year of that monitor's operation. The EPA's "Air Quality Guide for Nitrogen Dioxide"[13] states that, when NO_2 concentrations are in the Moderate range, "Individuals who are unusually sensitive to nitrogen dioxide should consider limiting prolonged outdoor exertion." RI DEM is now evaluating how to use data from the Near-Road site in its health messaging, particularly in messaging aimed at sensitive individuals. Since the Near-Road site is a maximum impact site for this pollutant, it is likely that the current measurements over-estimate NO_2 exposures to sensitive individuals in Rhode Island.

Given the above considerations, RI DEM does not plan any changes in the State's nitrogen dioxide monitoring network in the next 18 months. Since low-range NO_2 monitors are currently in use at the East Providence, Brown University and Near-Road sites, RI DEM does not plan to further update the technology used for measuring that pollutant at this time. A low-range monitor that measures NO and NO_y (total reactive nitrogen oxides) has also been operated at the East Providence site since January 2011, consistent with the NCore requirements.

Particulate Matter

Particles smaller than 10 microns (PM_{10})

The current PM_{10} monitoring network is as shown in Table 9 and Figure 2:

Table 9 PM_{10} Monitoring Network

SITE	MEASUREMENT SCALE	MONITORING OBJECTIVE	SCHEDULE
Vernon Trailer Vernon Street Pawtucket	Middle	Population exposure	24-hour 1 in 6 day
Johnson & Wales 111 Dorrance Street Providence	Neighborhood	Population exposure	24-hour 1 in 6 day
Urban League 212 Prairie Avenue Providence	Neighborhood (NATTS)	Population exposure Highest concentration	24-hour 1 in 6 day
Alton Jones Campus	Regional	Upwind background	24-hour

[13] http://www.epa.gov/airnow/no2.pdf

Victory Highway West Greenwich			1 in 6 day
Francis School 64 Bourne Avenue E. Providence	Neighborhood (NCore)	Population exposure (Lead and $PM_{10-2.5}$)	24-hour 1 in 6 day

The PM_{10} NAAQS is:

- 150 µg/m^3 – 24-hour average, not to be exceeded more than once per year on average over 3 years (design value is 4th high value in a 3-year period)

The highest PM_{10} value recorded in Rhode Island in the last five years is:

- 70 µg/m^3 – 24-hour average, 46% of NAAQS, recorded at Vernon St. in 2013

The highest design value for PM_{10} recorded at a Rhode Island site for the 2012 – 2014 period is:

- 55 µg/m^3 – 24-hour average, 37% of NAAQS, recorded at Vernon St. (note that 2012 data were incomplete for that site due to road construction)

The PM_{10} NAAQS has never been exceeded in Rhode Island. Since PM_{10} is measured using a filter-based method, results are not immediately available and cannot be used for Air Quality Index calculations. Trends in PM_{10} design values are shown in Figure 17. Levels tend to be highest at the Vernon Street site, which is adjacent to I-95, and higher at the two Providence sites than at the rural West Greenwich site. PM_{10} levels appear to have slightly decreased over the past decade but increased in at the Vernon Street site during the past year, primarily due to elevated PM_{10} levels recorded at that site in January 2013 and January – February 2014. Note that the Vernon Street site was not operated for much of the first two quarters of calendar year 2012, due to heavy construction in the immediate area of that site. Monitoring at that site resumed in July 2012.

Since late 2011, PM_{10} has also been measured at the East Providence NCore site every sixth day using a lo-vol sampler. Those PM_{10} measurements are used, in conjunction with $PM_{2.5}$ measurements at that site, for calculating $PM_{10-2.5}$ levels. The lo-vol PM_{10} filters are also used for lead measurements.

Table D-4 in 40 CFR 58, Appendix D 4.6(a) requires areas like the Providence-New Bedford-Fall River MSA, which has a population greater than 1,000,000 and measured PM_{10} concentrations below 80% of the NAAQS, to operate a minimum of 2- 4 PM_{10} monitoring sites. Since Rhode Island is currently operating five sites and is not measuring levels close to the NAAQS at any of the sites, one or more sites could be discontinued without violating the minimum criteria.

As discussed above, PM_{10} measurements at the East Providence site are used for calculating $PM_{10-2.5}$ levels and, since this measurement is required at NCore sites, PM_{10} sampling cannot be discontinued at that site. Similarly, PM_{10} samples collected at the Urban League site in Providence are analyzed for metals to fulfill NATTS requirements, so PM_{10} sampling at that location cannot be discontinued. The rural Alton Jones, West Greenwich site provides useful information about background concentrations of PM_{10} in Rhode Island. The Vernon St., Pawtucket site, which is adjacent to I-95, tends to record the highest PM_{10} concentrations in the State. Therefore, the Johnson & Wales Library in downtown Providence is the only site that is being considered for possible discontinuation at this time.

The Johnson & Wales site is approximately one mile from the Urban League location. In the 11 years that the Johnson & Wales site has been operational, the PM_{10} design values at that site have been, on average, 2.8 $\mu g/m^3$ higher than those at the Urban League site and 8.9 $\mu g/m^3$ lower than those at the Vernon Street, Pawtucket site. The PM_{10} levels at the Johnson & Wales site in the last five years correlate well with those at the Urban League ($r^2 = 0.81$). Since operation of the Johnson & Wales site is currently not resource-intensive and the concentrations measured at that location tend to be slightly higher than those at Urban League, RI DEM plans to continue to operate this site for the present. If the continued operation of this site becomes problematic, RI DEM will seek EPA approval to discontinue monitoring at Johnson & Wales.

Otherwise, RI DEM has no plans to modify the State's PM_{10} network in the next 18 months. Since four of the five PM_{10} monitors currently operating in the State are located in the Providence metropolitan area and one of those monitors is near a major roadway, the current PM_{10} measurements adequately characterize exposure of the sensitive populations in urban areas to that pollutant. There are no immediate plans to use new technology for measuring PM_{10} in Rhode Island.

Fine Particulate Matter (Particulate Matter smaller than 2.5 microns, or $PM_{2.5}$) and Coarse Particulate Matter (Particulate Matter between 2.5 and 10 microns or $PM_{10-2.5}$)

The Federal Reference Method/Federal Equivalent Method (FRM/FEM) $PM_{2.5}$ monitoring network is shown in Table 10 and in Figure 3:

Table 10 $PM_{2.5}$ Monitoring Network

SITE	MEASUREMENT SCALE	MONITORING OBJECTIVE	SCHEDULE
Vernon Trailer Vernon Street Pawtucket	Middle	Population exposure	24-hour, 1 in 3 day
Urban League 212 Prairie Avenue Providence	Neighborhood	Population exposure Highest concentration	24-hour, daily 1 in 6 day co-located sampler Continuous FEM
Francis School 64 Bourne Avenue E. Providence	Urban	Population exposure Highest concentration	24-hour, daily Continuous FEM
Alton Jones Campus Victory Highway West Greenwich	Regional	Population exposure General/Background Regional Transport	Continuous FEM 1 in 6 day co-located sampler
USEPA Laboratory 27 Tarzwell Drive Narragansett	Regional	Population exposure	Continuous FEM
Near Road Site Hayes and Park Sts. Providence	Microscale	Near-road	Continuous FEM (began operation April 2014)

Currently, the filter-based FRM $PM_{2.5}$ units are designated as the primary samplers at the Vernon, Urban League and East Providence sites and FEM continuous $PM_{2.5}$ monitors are operated as the primary samplers at the West Greenwich, Narragansett and, as of April 2014, the Near-Road site in Providence. Continuous $PM_{2.5}$ FEM monitors are operated at the Urban League site and the East Providence NCore site as secondary monitors; data recorded by those monitors are used as substitute measurements on days when valid data from the primary samplers at those locations are not available.

Co-located filter-based FRM samplers are operated every 6^{th} day at the West Greenwich and Urban League sites for quality assurance purposes. The EPA uses statistics calculated from the West Greenwich FRM and FEM data to determine the comparability of FEM and FRM data collected at sites throughout the State. As discussed below, RI DEM is requesting that EPA redesignate the FEM monitor as the primary $PM_{2.5}$ monitor at the East Providence site and that, in the future, that site be used to evaluate FEM-FRM comparability in the State. Rhode Island

would continue to operate the West Greenwich FRM monitor for informational purposes, but that monitor would not be designated as a co-located monitor.

The $PM_{2.5}$ NAAQS are:

- 35 µg/m^3 – 24-hour average (design value is the 3-year average of the 98th percentile 24-hour concentration)
- 12 µg/m^3- annual average (design value is calculated by averaging the daily concentrations from each quarter, averaging these quarterly averages to obtain an annual average, and then averaging the annual averages for three consecutive years)[14]

The highest $PM_{2.5}$ design values recorded in Rhode Island in the last 5 years are:

- 24 µg/m^3 – 24-hour average, 69% of NAAQS, recorded at Vernon St. (2008- 2010 period)
- 9.9 µg/m^3 – annual average, 83% of current NAAQS, recorded at Vernon St. (2010 – 2012 period[15])

The highest $PM_{2.5}$ design values for 2014 are:

- 21 µg/m^3 – 24-hour average, 61% of NAAQS, recorded at Vernon St
- 9.1 µg/m^3 – annual average, 76% of NAAQS, recorded at Vernon St

Trends in 24-hour and annual average $PM_{2.5}$ design values are shown in Figures 18 and 19, respectively. Annual average levels have been consistently highest at the Vernon Street, Pawtucket site, which is adjacent to I-95, and higher at the East Providence and the two Providence sites than at the rural West Greenwich site. $PM_{2.5}$ levels have decreased over the past decade; that decrease continued in 2014. Note that the FEM monitor at the Narragansett site began operating in 2013, so a design value for that site will not be available until the end of 2015; however, as shown in Figure 20, annual and 24-hour concentrations measured at that site in 2013 and 2014 were lower than those at the West Greenwich site.

Although none of the monitors violate the NAAQS, $PM_{2.5}$ levels at one or more sites in the State were at or above 35 µg/m^3 and, therefore, the air quality was unhealthy, on four days in the past five years (2009 – 2014), including one day in 2014. The December 2012 revised NAAQS for particulate matter, cited above, established the range of the Moderate category for the $PM_{2.5}$ AQI as >12 – 35 µg/m^3, as a 24-hour average; in 2014, there were 45 days with 24-hour average $PM_{2.5}$

[14] In December 2012, EPA revised the PM NAAQS, reducing the annual average $PM_{2.5}$ NAAQS from 15 to 12 µg/m^3. The rule left the PM_{10} NAAQS and the 24-hour average $PM_{2.5}$ NAAQS and the secondary annual average $PM_{2.5}$ NAAQS unchanged.

[15] Note that the Vernon St. monitor did not operate for several months in 2012, so the design values for that site were calculated using incomplete data for 2012.

concentrations in the Moderate range at one or more of the sites (not including the Near-road site, which is discussed below).

40 CFR 58, Appendix D 4.7.1(a), Table D specifies that urban areas which, like the Providence-New Bedford-Fall River RI-MA MSA, have a population greater than 1,000,000 and $PM_{2.5}$ design values for the most recent 3-year period at all sites that are below 85% of the NAAQS, must operate a minimum of two $PM_{2.5}$ monitoring sites. Rhode Island, with six $PM_{2.5}$ sites, exceeds that minimum requirement.

40 CFR 58, Appendix D 4.7.1(b) requires $PM_{2.5}$ monitoring stations that represent community-wide air quality and are generally neighborhood or urban scale representative, although population oriented micro-middle scale sites may be approved if they represent community air quality. The Rhode Island network fulfills this requirement because, as shown in Table 10, the Francis School in East Providence is urban scale representative and the Urban League site in Providence is neighborhood scale representative. Due to its proximity to Interstate Route 95, the Vernon Street, Pawtucket, site is designated as middle scale representative; however, the EPA approved that site as a community oriented site because a number of nearby residences are similarly close to the highway.

40 CFR 58, Appendix D 4.7.3 requires states to operate at least one site that measures regional background $PM_{2.5}$ levels and at least one site to monitor regional transport of $PM_{2.5}$. The Alton Jones, West Greenwich site, which is regional scale representative, fulfills those requirements. In addition, the Narragansett site, which has operated as a FEM since 2013, provides information about coastal transport and background concentrations; that site is also regional scale representative.

The 2012 revised NAAQS for particulate matter amended 40 CFR 58, Appendix D 4.7.1(b) to require states to establish a near-roadway $PM_{2.5}$ monitoring site in each MSA with a population of 2.5 million or more by January 1, 2015 and in remaining urban areas which, like the Providence-New Bedford-Fall River MSA, have a population of 1 million or more, by January 1, 2017. Rhode Island began operating a FEM continuous $PM_{2.5}$ monitor at its Near-Road site adjacent to I-95 in Providence in April 2014. As shown in Figures 21a and b, daily 24-hour average $PM_{2.5}$ concentration measured at the Near-Road site are, on average, approximately 50% (2.6 $\mu g/m^3$) higher than those at the E. Providence and Urban League sites and 27% (1.8 $\mu g/m^3$) higher than those at the Vernon St. site. A discussed above, the Vernon St. site is also located adjacent to I-95, but average highway traffic counts near the Vernon St. monitor are 63% of those in the section of the highway adjacent next to the Near-Road site.

40 CFR 58, Appendix D 4.7.2 requires states to operate continuous $PM_{2.5}$ monitors at a number of sites equal to at least one-half of the minimum number of FRM/FEM sites, which would be one site for Rhode Island. As discussed above, RI DEM currently operates continuous $PM_{2.5}$ monitors at five of its six $PM_{2.5}$ sites.

Although Rhode Island operates more $PM_{2.5}$ sites than required, each site was established to

fulfill a specific information need or EPA requirement. The West Greenwich site fulfills EPA's requirements for measurement of background and regional transport concentrations of $PM_{2.5}$. The Vernon Street, Pawtucket site is the population-oriented site with the highest annual and 24-hour average $PM_{2.5}$ levels. The Near-Road site is required by the NAAQS, the East Providence monitor is required because it is located at an NCore site, and the Urban League and Narragansett monitors supply information about air quality in urban and coastal areas of the State, respectively.

According to the NetAssess Tool, removal of the W. Greenwich, Narragansett or E. Providence $PM_{2.5}$ monitors would result in an overestimation of concentrations at those sites and removal of the Vernon Street monitor would result in an underestimation of concentrations at that location. The Tool calculates a neutral removal bias for the Urban League site, an indication that the concentrations measured at that site are similar to those that would be predicted from measurements at surrounding sites. RI DEM plans to continue operating both the FRM and FEM monitors at that site at this time. However, in the future, RI DEM may request approval to discontinue or reduce the frequency of the FRM sampling at that site. In particular, such a request may be necessitated if the Urban League building becomes unavailable for use as a monitoring site and the monitors are moved to a nearby location with space and/or weight limitations. If FRM measurements are discontinued at that site, the co-located FRM monitor will be move to another FRM site.

The State's $PM_{2.5}$ monitoring network is heavily concentrated in the Providence area, a section of the State with elevated rates of childhood asthma. Daily concentrations measured at the Urban League, Providence and Francis School, E. Providence, sites, are similar, as shown in Figure 22. The $PM_{2.5}$ concentrations measured at that site are representative of ambient air quality in the Providence area at locations that are not adjacent to a source, such as a major roadway. The concentrations measured at the Near-Road site represent worst-case highway impacts and those at Vernon St. represent highway impacts in the vicinity of a roadway with a somewhat lower traffic count. Those stations, together, provide sufficient data to characterize ambient exposures in the Providence metropolitan area.

As discussed above, although none of the Rhode Island monitors violate the NAAQS, $PM_{2.5}$ levels above the level of that standard are occasionally recorded and levels in the Moderate AQI range are common in the State. Levels in the Moderate range are particularly frequent at the Near-Road site; in the first year of that monitor's operation (April 2014 – March 2015), $PM_{2.5}$ levels in the Moderate range were recorded by the Near-Road monitor on 44 days when levels measured at the other sites were in the Good range. Due to the worst-case location of the Near-Road monitor, the levels measured by that monitor do not reflect population exposures. RI DEM is evaluating how best to use the Near-Road data in its air quality messaging to protect sensitive individuals.

No $PM_{2.5}$ monitors are located in the Woonsocket area, another Rhode Island core city area with elevated childhood asthma rates. However, Woonsocket is located midway between the

Providence area sites and a $PM_{2.5}$ monitoring site in Worcester, MA (25-027-0023). As shown in Figure 23, 24-hour and annual average concentrations measured at the Worcester site are similar to those at the Providence area sites and, like those in Rhode Island, are well below the $PM_{2.5}$ NAAQS. Since the Woonsocket area does not have unusual topography or nearby highways with traffic counts that approach those at the Near-Road site in Providence, there is no reason to believe that the Providence area and Worcester, MA sites would not adequately characterize $PM_{2.5}$ exposures in the Woonsocket area.

As discussed above, the results of FRM samples collected at the West Greenwich site every sixth day are compared with the data collected by the FEM monitor, which is designated as the primary $PM_{2.5}$ monitor at that site, to evaluate the comparability of FRM and FEM measurements in Rhode Island. The statistic used to evaluate comparability is the coefficient of variance (CV). The CV calculated from the W. Greenwich data does not meet EPA's acceptability criterion of 10%. Several factors contribute to this issue, including:

- $PM_{2.5}$ levels at the W. Greenwich site, which is in a rural area, tend to be very low. At low concentrations, small discrepancies between compared values can yield high CVs.
- The W. Greenwich FRM sampler is run only once every sixth days, yielding a relatively small number of comparison values. Therefore, a substantial discrepancy on any one day can cause an elevated CV for a quarter or year.
- As shown in Figure 24, the FEM at W. Greenwich tends to record measurements that are slightly lower than those recorded by the FRM.

RI DEM is requesting that EPA redesignate the FEM at the E. Providence site as the primary $PM_{2.5}$ monitor at that site and use the FEM and FRM data from that site to evaluate FEM-FRM comparability at Rhode Island sites. The advantages of using the East Providence, rather than the West Greenwich site for this purpose include:

- $PM_{2.5}$ levels at the East. Providence site, although still substantially below the NAAQS, tend to be higher than those at the West Greenwich site. For the period 2012 through the first quarter of 2015, 11% of the FRM measurements at the W. Greenwich site were 10 $\mu g/m^3$ or above, while 22% of the FRM measurements at the E. Providence site were in that range.
- Since the East Providence FRM runs every day, it generates six times as much comparison data as are generated at W. Greenwich.
- As shown in Figure 25, the E. Providence FEM and FRM measurements tend to be better correlated and to have less bias than is observed at the W. Greenwich site.

RI DEM acknowledges that this change will not by itself solve the FEM-FRM comparability issue in Rhode Island. A preliminary analysis of the East Providence data shows that the CVs for that site, although better than those for the W. Greenwich site, do not always meet the EPA 10% criterion. FRMs and FEMs operate according to different principles and, although FEM technology has evolved over time to produce data that are increasingly FRM-like, it is unlikely

that FEMs and FRMs will ever produce exactly the same measurements under all conditions. Since FEM and FRM data are used interchangeably and the health studies used to derive the NAAQS are largely based on FRM exposure data, RI DEM believes that producing FRM-like FEM data is very important and will continue to operate the W. Greenwich monitor and to work to improve data FRM-FEM comparability at all of the FEM sites. Such efforts include ongoing discussions with other states and the EPA concerning calibration protocols and consideration of new FEM technology as it becomes available.

40 CFR 58 Appendix D 4.8.1(a) specifies that monitoring for coarse particulate matter ($PM_{10-2.5}$) is required only at NCore sites. To fulfill that requirement, $PM_{10-2.5}$ monitoring has been conducted at the East Providence site NCore site since January 1, 2011, as discussed in the NCore section of this document. That parameter was measured using a Partisol-Plus 2025D Sequential Dichotomous Air Sampler in 2011, but, due to co-location issues, Rhode Island replaced that unit in 2012 with paired Partisol-Plus Model 2025 Sequential Samplers, one measuring $PM_{2.5}$ and the other PM_{10}.
.
RI DEM does not have immediate plans to purchase additional $PM_{2.5}$ monitoring equipment, but will evaluate the FRM-FEM comparability of available equipment before purchasing future replacement FEM monitors. As mentioned previously, the long-term future of the Urban League building is unknown at this time and RI DEM is working to identify alternative nearby locations for the site if the Urban League building becomes unavailable. RI DEM will request approval from the EPA of an alternative location if that move becomes necessary. If indicated due to resource or logistical constraints, RI DEM may request a reduction in the frequency of or discontinuation of FRM sampling at the Urban League site or its replacement site. If FRM sampling is discontinued at that site, the co-located FRM sampler will be moved to another FRM site. In addition, operation of the Near-Road site will be disrupted at some future date, due to the progression of construction activity in the area. RI DEM will notify EPA when it receives notice of that disruption to discuss future plans for near-road monitoring in the State. No other changes to the $PM_{2.5}$ network are anticipated in the next 18 months.

Speciation Monitoring

40 CFR 58 Appendix D 4.7.4 requires states to conduct chemical special speciation of $PM_{2.5}$ at sites that have been designated as part of the $PM_{2.5}$ Speciation Trends Network (STN). The STN is designed to characterize metal, ion and carbon constituents of $PM_{2.5}$. RI DEM began operating $PM_{2.5}$ speciation monitors at the Urban League and East Providence sites as a part of that network on a one in six-day schedule in June 2002. Operation of the East Providence speciation equipment was discontinued in May 2004 and, at that time, the monitoring frequency at the Urban League speciation site was increased to one in three days. In November 2008, the speciation equipment at the Urban League was replaced by a SASS speciation unit and, in March 2009, a URG carbon sampler began operation at that location as part of the speciation program. To conform to NCore requirements, the speciation equipment, including the carbon sampler, was moved to the East Providence NCore site in January 2011 and is now being operated there on a

one-in-three day schedule. PM Speciation filters are analyzed by an EPA contractor. Note that the EPA eliminated mass measurements of speciation samples in October 2014.

Lead (Pb)

On November 12, 2008, the EPA promulgated an amended NAAQS for lead (FR 73:66964). The revised NAAQS is an order of magnitude more stringent than the previous standard. To determine compliance with the new standard, the rule required two types of lead monitoring, which are codified in Appendix D of 40 CFR part 58.16: source- specific monitoring in the vicinity of lead sources that emit 0.5 or more tons of lead per year and area-wide lead monitoring at urban NCore sites. Rhode Island has no sources emitting 0.5 tons or more of lead per year and, therefore, was not required to operate any source-specific monitors. To fulfill the requirement for area-wide monitoring, RI DEM and RI DOH began collecting lo-vol PM-10 samples to be analyzed for lead at the East Providence NCore site in June 2011.

The current lead (Pb) monitoring network is as shown in Table 10:

Table 11 Lead Monitoring Network

SITE	MEASUREMENT SCALE	MONITORING OBJECTIVE
Francis School 64 Bourne Avenue E. Providence	Neighborhood	Population exposure (area-wide) (NCore)

The NAAQS for Pb is 0.15 $\mu g/m^3$, as a rolling three month average, measured in total suspended particulate matter (TSP) . The highest 24-hour average concentration measured in Rhode Island since NAAQS Pb monitoring began in the State in June 2011 is 0.016 $\mu g/m^3$ (11% of the NAAQS) and the highest 3-month average during that period is 0.007 $\mu g/m^3$ (5% of the NAAQS).

Rhode Island measures Pb in PM_{10}, not in TSP. In the lead NAAQS rule, EPA allows states to use Pb- PM_{10} monitoring, without a scaling factor, as a surrogate for Pb-TSP NAAQS monitoring at area-wide monitoring sites, as long as the 3-month average Pb- PM_{10} concentrations at those sites remain below 0.10 $\mu g/m^3$. Note that the highest 3-month average PM_{10} concentration that has been measured at the East Providence site is approximately 7% of that trigger level.

Rhode Island's lead filters are currently analyzed by the State of Maine using EPA-approved XRF methodology. As specified in the lead NAAQS rule, sampling is conducted on a one-in-six day schedule. The monitor is located in the Providence metropolitan area and, since there are no significant lead-emitting sources in the State, there is no reason to believe that those monitoring

results are not representative of ambient air exposures of Rhode Island residents, including sensitive individuals

In the September 11, 2014 Federal Register, the EPA is proposed to delete the requirement to monitor for nonsource Pb at NCore sites from Appendix D of 40 CFR part 58.16[16] and to allow monitoring agencies to request permission to discontinue nonsource monitoring following the collection of at least 3 years of data at urban NCore sites. Since ambient lead monitoring has been conducted in the State for more than 3 years and the lead levels have been consistently considerably lower than the NAAQS since the inception of monitoring, RI DEM plans to request permission to discontinue monitoring for that pollutant when that rule becomes final.

[16] "Revisions to Ambient Monitoring Quality Assurance and Other Requirements: Proposed Rule," 79FR 54395, 9/11/14. http://www.gpo.gov/fdsys/pkg/FR-2014-09-11/pdf/2014-19758.pdf

Ozone Precursor and Air Toxics Measurements

Photochemical Assessment Monitoring Stations (PAMS)

The Clean Air Act Amendments of 1990 (CAAA) required serious, severe and extreme ozone nonattainment areas to establish enhanced monitoring networks to measure ozone and ozone precursors. In response to that mandate, the US EPA promulgated rules in 1993 that required the establishment of a network of Photochemical Assessment Monitoring Stations (PAMS) to measure ozone, NO_x, volatile organic compounds (VOCs), carbonyls, and meteorological parameters in serious and above nonattainment areas. This network was designed to provide comprehensive data on trends in ambient concentrations of ozone and ozone precursors and to evaluate the spatial and diurnal variability of those pollutants in order to track the formation and transport of ozone across large areas and to evaluate the effectiveness of strategies implemented to reduce levels of that pollutant.

The EPA rule identifies four types of PAMS sites:

- Type 1 sites, located on the upwind side of the nonattainment area and used to characterize background and transported concentrations of ozone, NO_x and VOC;

- Type 2 sites, sited to measure the maximum impact of VOC and NO_x emitted in the area;

- Type 3 sites, sited to measure maximum ozone concentrations occurring downwind of the area, and

- Type 4 sites, sited to measure the concentration of ozone, NO_x and VOC exiting the area.

Two PAMS sites, including a Type 2 site, are currently required in each serious and above nonattainment area. Note that Rhode Island was a serious nonattainment area for the one-hour average ozone NAAQS, the ozone standard that was in effect at the time the enhanced monitoring requirements were promulgated. The Alton Jones monitoring site in West Greenwich was designated as the State's Type 1 PAMS site and the East Providence site as a Type 2 PAMS site. In addition, the Massachusetts Department of Environmental Protection (MA DEP) operates a site at the Blue Hills Observatory in Milton, Massachusetts (Site ID 25-021-3003) that has served as the Type 1 (upwind) site for the Boston area and as the Type 3 (downwind) site for the Providence area.

The following PAMS pollutants are monitored in the Rhode Island network:

- 24-hour speciated VOC samples are collected every sixth day year round at the Type 1 and Type 2 sites and eight 3-hour VOC samples are collected daily during June, July and August at the Type 2 site. Eight 3-hour samples also were collected every third day during June, July and August through 2012 at the Type 3 station in Milton, MA. RI DEM plans to purchase a continuous gas chromatograph within the next 18 months and to use that instrument to generate one-hour average VOC measurements during the ozone season at the Type 2 site in East. Providence. When that instrumentation is established, collection of 3-hour VOC samples at that site will be discontinued.

- 24-hour carbonyl samples are collected every sixth day year round at the East Providence Type 2 site. Eight 3-hour carbonyl samples per day were collected every third day during June, July and August through 2011 at that site. Note that 3-hour carbonyl samples currently are required only in nonattainment areas classified as serious or above for the 8-hour ozone standard. Since Rhode Island has never had a nonattainment classification higher than "moderate" for that NAAQS, this requirement does not apply to the State.

- In 2014, NO_x was measured continuously March through October at the Type 1 site in West Greenwich and year round at the Type 2 site in E. Providence the MA DEP Type 3 site in Milton, MA.

- Rhode Island has measured reactive nitrogen oxides (NO_y) at the Type 2 site since January 2011 to fulfill NCore requirements. EPA regulations require NO_y measurements at one Type 3 or Type 1 PAMS site during the ozone season. Rhode Island currently monitors NO_x, but not NO_y, at its Type 1 site. Similarly, NO_x, rather than NO_y, is monitored at the Type 3 site in Milton, MA, although MA DEP has measured NO_y at that site in the past. Rhode Island does not have any immediate plans to install NO_y equipment at the Type 1 site.

- CO is measured year round at the Type 2 site. In 2010, the conventional CO monitor at that site was replaced with a low-range (ppb) CO monitor, in fulfillment of both NCore and PAMS network requirements.

- Ozone is measured March through October at the West Greenwich and Narragansett sites and, since 2011, has been measured year-round at the Type 2 site in East Providence to fulfill NCore requirements Ozone has also been measured year-round at the Milton, MA site since February 2013.

- Surface meteorological parameters are measured at all three Rhode Island sites and at the Milton, MA site year-round.

- Rhode Island uses the upper air data collected at the Brookhaven, New York meteorological site to fulfill the PAMS requirements for those measurements

As discussed above, the EPA proposed an amended NAAQS for ozone in the December 17, 2014 Federal Register (79 FR75233). That document included several proposed changes to PAMS requirements, including:

- EPA is proposing to require PAMS measurements at existing NCore sites in ozone nonattainment areas (either based on the 2008 ozone NAAQS or the 2015 ozone NAAQS, which is due to be finalized by October 1, 2015) in lieu of the current PAMS network design requirements. Note that, since the current Rhode Island Type 2 PAMS site is also the State's NCore site, this requirement, if promulgated, would not necessitate a relocation of that site. Rhode Island is designated as attainment/unclassifiable for the 2008 NAAQS but will likely be a nonattainment area for the 2015 NAAQS if the promulgated standard is in the proposed range of 65 – 70 ppb.

- Current PAMS requirements allow options for measuring speciated VOCs, including: 1) hourly measurements using a continuous gas chromatograph (GC), 2) eight 3-hour samples daily using canisters, or 3) one morning and one afternoon sample with a 3-hour or less averaging time daily using canisters plus continuous total non-methane hydrocarbon measurements. Rhode Island's PAMS program employs the second option, collection of eight 3-hour canisters daily during the PAMS season. EPA is proposing to require all PAMS sites to measure hourly speciated VOCs using a continuous GC in order to obtain more complete and consistent nationwide speciated VOC data. As discussed above, RI DEM intends to purchase and employ a continuous GC at the East Providence PAMS site within the next 18 months.

- In 2006, the EPA revised its PAMS specifications to require carbonyl sampling only in areas classified as serious or above nonattainment for the 1997 8-hour ozone NAAQS. Since Rhode Island was designated as a moderate nonattainment area for that standard, 3-hour carbonyl sampling was discontinued in the State in 2011. In view of increased evidence of the importance of carbonyls, particularly formaldehyde, in ozone formation, the 2014 revised ozone NAAQS proposal requires measurement of the carbonyls formaldehyde, acetaldehyde, and acetone at all required PAMS sites. Rhode Island has a functional carbonyl monitoring/analytical program that measures the above carbonyls, but sample collection is currently limited to one 24-hour carbonyl sample every sixth day year-round at the State's Type 2 PAMS and NATTS sites. RI DEM will develop a plan to implement any additional carbonyl monitoring requirements in the revised ozone NAAQS when that rule is finalized.

- EPA's proposal would require measurement of NO_2 using either a direct reading NO_2 analyzer or a photolytic-converter NO_X analyzer. Rhode Island installed a FRM low-range NO_2/NO_x analyzer at the East Providence site in 2013 and operates that analyzer year-round. EPA's preferences for a particular NO_2/NO_x monitoring technology will be considered when replacement of that equipment is necessary.

· EPA is proposing to require monitoring of the following meteorological parameters at PAMS sites: wind direction, wind speed, temperature, humidity, atmospheric pressure, precipitation, solar radiation, and UV radiation. Those parameters are measured at the E. Providence site, so no additional meteorological monitoring is required at that site.

As discussed above, Rhode Island plans to purchase and employ a continuous GC for measuring one-hour average speciated VOCs at the East Providence PAMS site in the next 18 months. When the revised ozone NAAQS is finalized, RI DEM will develop a plan for implementing additional applicable PAMS requirements in that rule, including a possible expansion of the carbonyl monitoring program.

Air Toxics

Rhode Island operates one National Air Toxics Trends Stations (NATTS) site. The primary purposes of the NATTS network are to track trends in ambient air toxics levels, to characterize exposures, and to measure progress toward emission and risk reduction goals.

The Rhode Island NATTS site is located on the roof of the Urban League building in an urban residential neighborhood on the south side of Providence, approximately ½ mile west of I-95. This site was chosen as the State's NATTS site because it is not dominated by local sources and because levels of air toxics at this site appear to be representative of those in urban areas in the State. Note that, since the long-term future of the Urban League building is unknown at this time, RI DEM is working to identify nearby locations to which the NATTS site could be moved if necessary. RI DEM will request the EPA's approval of an alternative location if such a move is needed.

In keeping with EPA requirements, the following pollutants, at a minimum, are measured at the Rhode Island NATTS site:

Volatile Organic Compounds (VOC)

§ Acrolein
§ Perchloroethylene (tetrachloroethylene)
§ Benzene
§ Carbon tetrachloride
§ Chloroform
§ Trichloroethylene
§ 1,3-butadiene
§ Vinyl Chloride

Carbonyls

- Formaldehyde
- Acetaldehyde

Metals

- Nickel compounds (PM_{10})
- Arsenic compounds (PM_{10})
- Cadmium compounds (PM_{10})
- Manganese compounds (PM_{10})
- Beryllium (PM_{10})
- Lead (PM_{10})
- Hexavalent chromium (TSP) – Discontinued as of the end of June 2013.

Semi-Volatile Organic Compounds (SVOC)

- Benzo(a)pyrene
- Napthalene

VOC, carbonyls and PM_{10} metal samples are analyzed by RI DOH. SVOC samples are analyzed by an EPA contractor. Note that, due to the redirection of EPA resources, monitoring for hexavalent chromium in Rhode Island was discontinued at the end of June 2013. Sampling at the NATTS site is conducted for all of the above parameters for 24-hour periods every sixth day. 24-hour VOC samples are also collected every sixth day at the PAMS sites in West Greenwich and East Providence and at the Vernon Street, Pawtucket site, which is adjacent to I-95 in Pawtucket. 24-hour carbonyl samples are collected at the East Providence site on the same schedule.

As shown in Figure 26, benzene levels are decreasing with time at all of the Rhode Island sites, although the difference between measurements at the sites has remained, with the highest benzene levels at the Vernon Street highway-impacted site, followed by Urban League, East Providence and West Greenwich, in that order. Trends for the carbonyls formaldehyde and acetaldehyde are less clear, as shown in Figure 27. Note that, formaldehyde is formed by atmospheric photochemical reactions, so, as with ozone, formaldehyde concentrations tend to be highest on hot sunny days. Therefore, weather patterns influence annual concentrations of that pollutant.

In addition, RI DEM /RI DOH operates aethalometers, which measure black carbon, an indicator of diesel exhaust, at the Urban League NATTS site and the East Providence Type 2 PAMS/NCore site and, as of April 2014, at the Near-Road site in Providence.

If the Urban League building becomes unavailable, RI DEM will request EPA's approval to move the NATTS site to a nearby alternate location. RI DEM is not planning any other changes to the air toxics monitoring programs in the next 18 months.

National Core (NCore) Multi-pollutant Monitoring Stations Network

As required in an October 17, 2006 Federal Register notice (FR 71:61236), Rhode Island began operating a site that is part of EPA's network of core multipollutant monitoring (NCore) stations in January 2011. This network is designed to address the following monitoring objectives:

- timely reporting of data to the public through AIRNow, air quality forecasting, and other public reporting mechanisms
- supporting development of emission strategies through air quality model evaluation and other observational methods
- accessing accountability of emission strategy progress through tracking long-term trends of criteria and non-criteria pollutants and their precursors
- supporting long-term health assessments that contribute to ongoing reviews of the NAAQS
- establishing nonattainment/attainment areas by comparison with the NAAQS
- supporting multiple disciplines of scientific research, including; public health, atmospheric and ecological.

The Rhode Island Type 2 PAMS site in East Providence is also the State's NCore site. Ozone, low-range NO_2/NO_x, reactive oxides of nitrogen (NO_y), low-range CO, low range SO_2, $PM_{2.5}$ (FRM, continuous and speciated), coarse PM ($PM_{10-2.5}$), VOCs, carbonyls, black carbon, lead in lo-vol PM_{10}, and meteorological parameters are monitored at that site. $PM_{10-2.5}$ is measured as the difference between lo-vol PM_{10} and lo-vol $PM_{2.5}$ concentrations. Note that the conventional NO_2/NO_x monitor at this site was replaced by a low-range NO_2/NO_x monitor in January 2013 and that monitor is being operated year-round, at least until the end of the 2016 ozone season.

As discussed above, RI DEM plans to request permission to discontinue lead monitoring if EPA's proposed changes in Appendix D of 40 CFR part 58.16[17] are promulgated. Rhode Island has no other plans to change NCore monitoring in the next 18 months.

[17] "Revisions to Ambient Monitoring Quality Assurance and Other Requirements: Proposed Rule," 79FR 54395, 9/11/14. http://www.gpo.gov/fdsys/pkg/FR-2014-09-11/pdf/2014-19758.pdf

Summary of Proposed Changes in the Rhode Island Monitoring Network

In summary, RI DEM plans to modify the current monitoring network as follows:

- If the Urban League building becomes unavailable, RI DEM will request approval to move the $PM_{2.5}$ and NATTS monitoring activities at that site to a nearby building.

- If indicated by resource or logistical limitations, RI DEM may request the reduction of frequency or discontinuation of FRM $PM_{2.5}$ sampling at the Urban League site or its replacement location. FEM $PM_{2.5}$ monitoring will be maintained at that location and the co-located FRM sampler currently operated at Urban League will be moved to another FRM site.

- When necessitated by the progression of highway construction activity to the north side of I-95, RI DEM will discontinue monitoring at the Near-Road site and will ask EPA's approval of future Near-Road monitoring plans for Rhode Island. Work on the north side of the highway is currently scheduled to begin in spring of 2017.

- If the operation of the Johnson and Wales PM_{10} monitor becomes problematic, RI DEM will request EPA's approval to discontinue monitoring at that site.

- RI DEM is requesting that the $PM_{2.5}$ monitor designations at the E. Providence site be changed to designate the FEM $PM_{2.5}$ monitor as the primary $PM_{2.5}$ sampler and the FRM $PM_{2.5}$ sampler as a co-located sampler. Rhode Island will continue to operate the FRM monitor at the W. Greenwich site for informational purposes but that monitor would no longer be designated as a co-located monitor.

- If EPA's modified lead monitoring requirements are promulgated as proposed, RI DEM plans to request permission to discontinue NAAQS lead monitoring at the E. Providence site.

- RI DEM plans to purchase a continuous GC and employ that instrument at the E. Providence site for measuring one-hour speciated VOCs.

- RI DEM will evaluate the revised PAMS requirements in the final 2015 ozone NAAQS when that rule is promulgated and develop a plan for implementing those requirements, including the possible expansion of carbonyl monitoring.

RI DEM understands that all network modifications that involve discontinuation or moving of any sites are subject to EPA approval, even if the remaining network meets EPA's minimum requirements.

Figure 1
Air Quality Monitoring Network
Continous Gas Monitors
Site Locations

Figure 2
PM-10 Air Pollution Monitoring Network
Site Locations

Figure 3
PM-2.5 Air Pollution Monitoring Network
Site Locations

Figure 4
Air Toxics Monitoring Network
Site Locations

Figure 5 Rhode Island Population by County (1990- 2014)

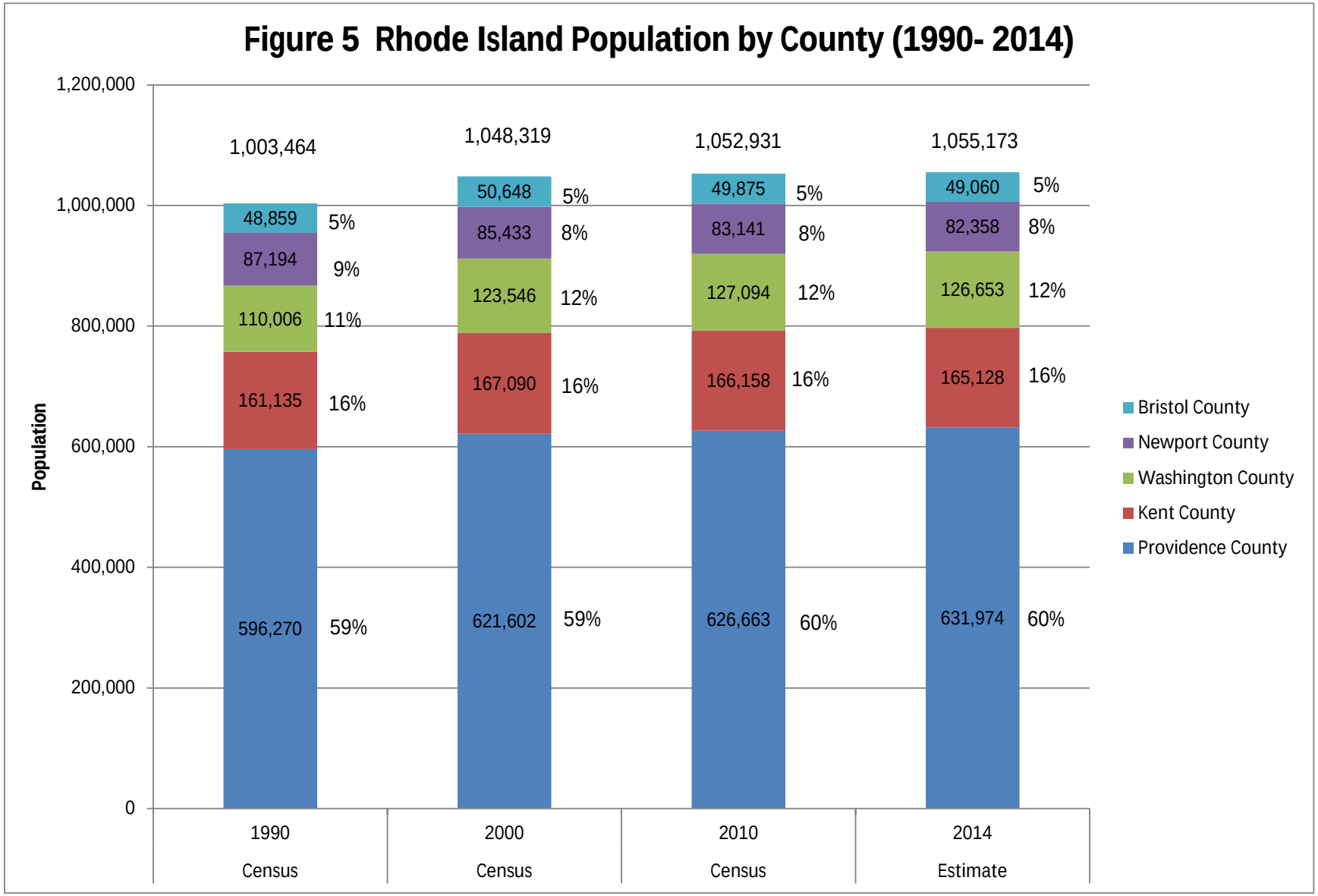


Figure 6 Population in Rhode Island Cities, 2010 and 2014

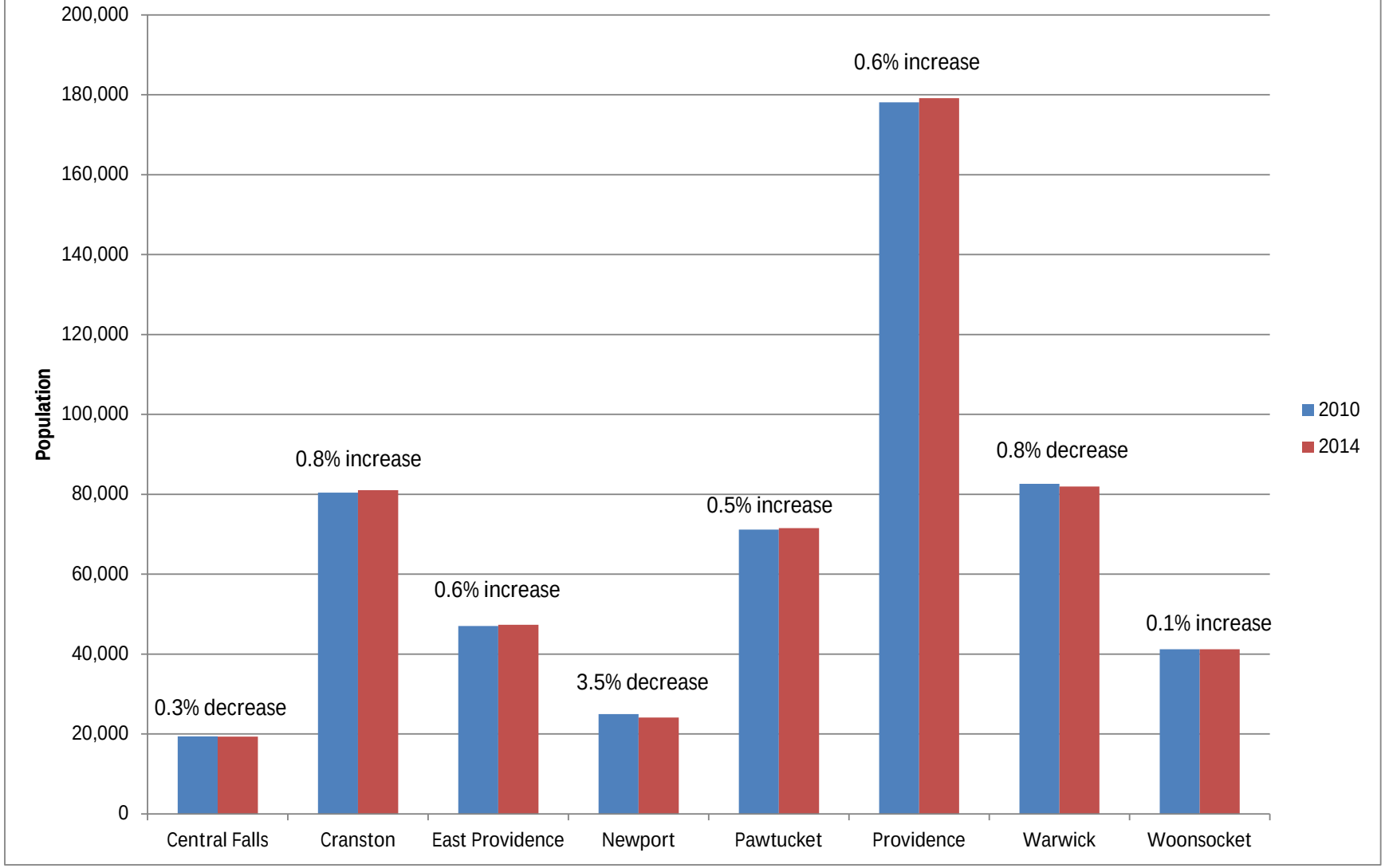
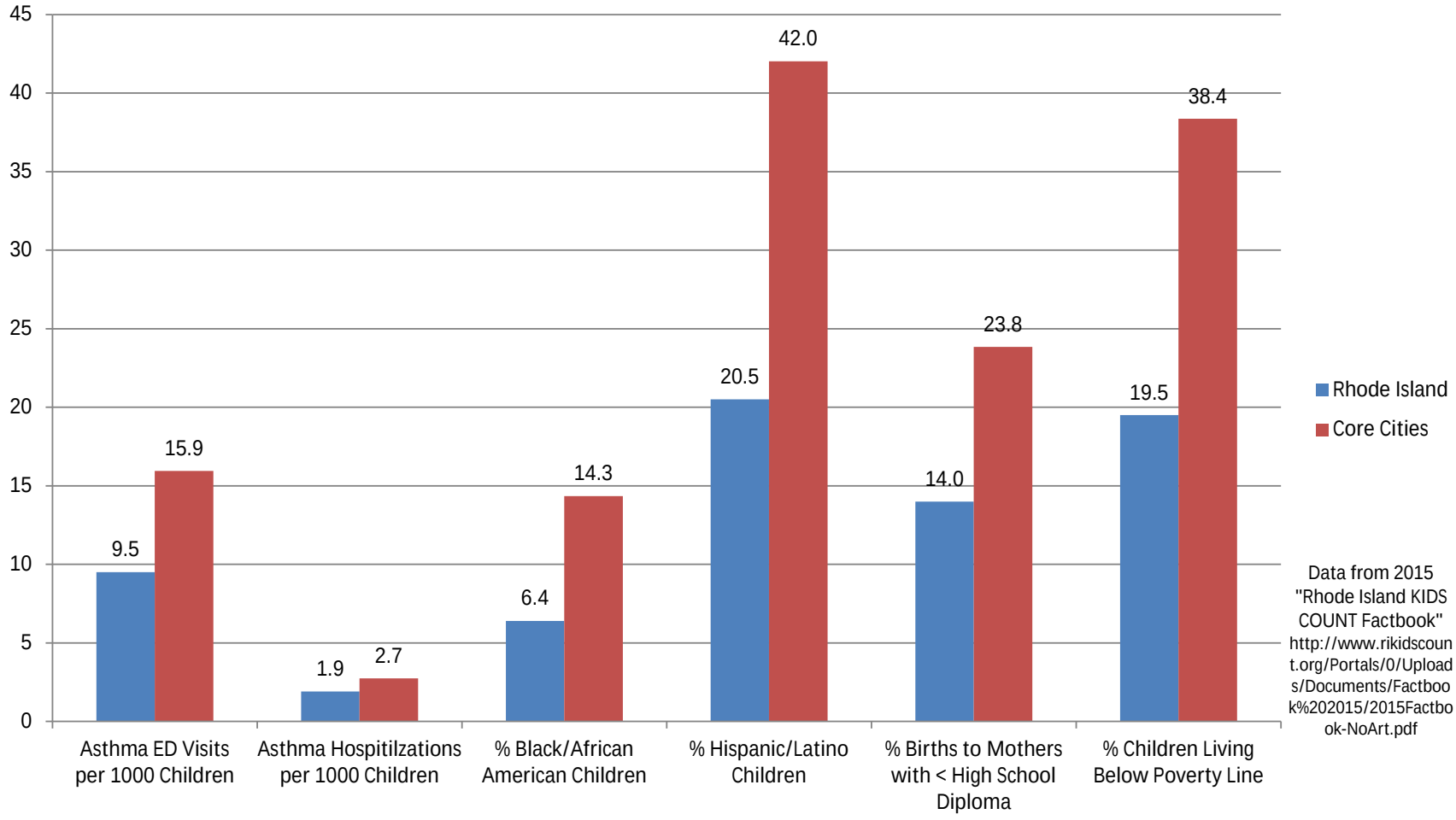
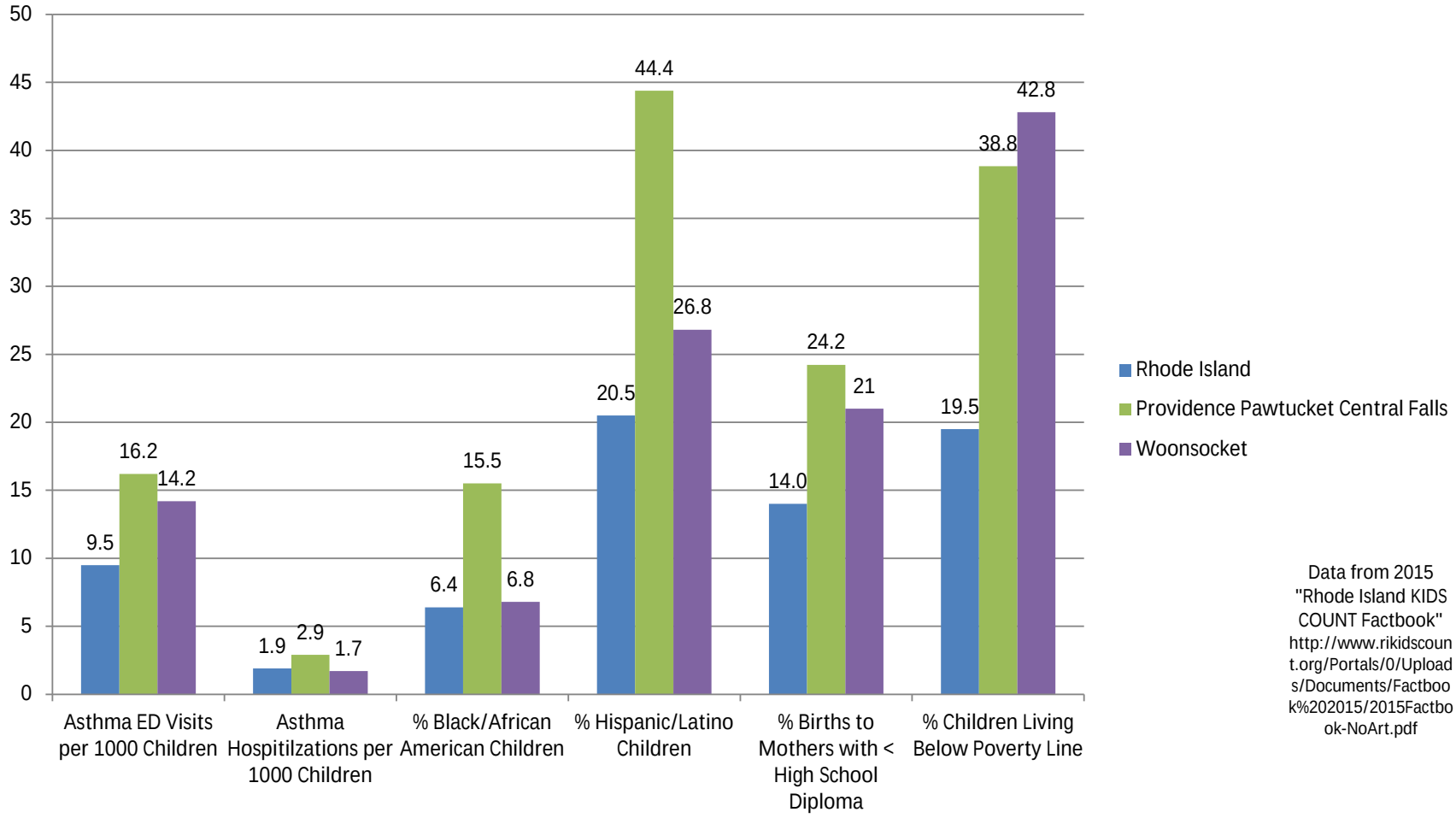


Figure 7 Asthma Rates and Demographics for Rhode Island Children - Statewide and in the Core Cities (Providence, Pawtucket, Central Falls and Woonsocket)



Data from 2015 "Rhode Island KIDS COUNT Factbook" http://www.rikidscount.org/Portals/0/Uploads/Documents/Factbook%202015/2015Factbook-NoArt.pdf

Figure 8 Asthma Rates and Demographics for Rhode Island Children - Comparison of Woonsocket with the State and the Other Core Cities (Providence, Pawtucket and Central Falls)



Data from 2015 "Rhode Island KIDS COUNT Factbook" http://www.rikidscount.org/Portals/0/Uploads/Documents/Factbook%202015/2015Factbook-NoArt.pdf

Figure 9 Trends in Rhode Island Ozone Concentrations
NAAQS = 75 ppb (8-hour average)

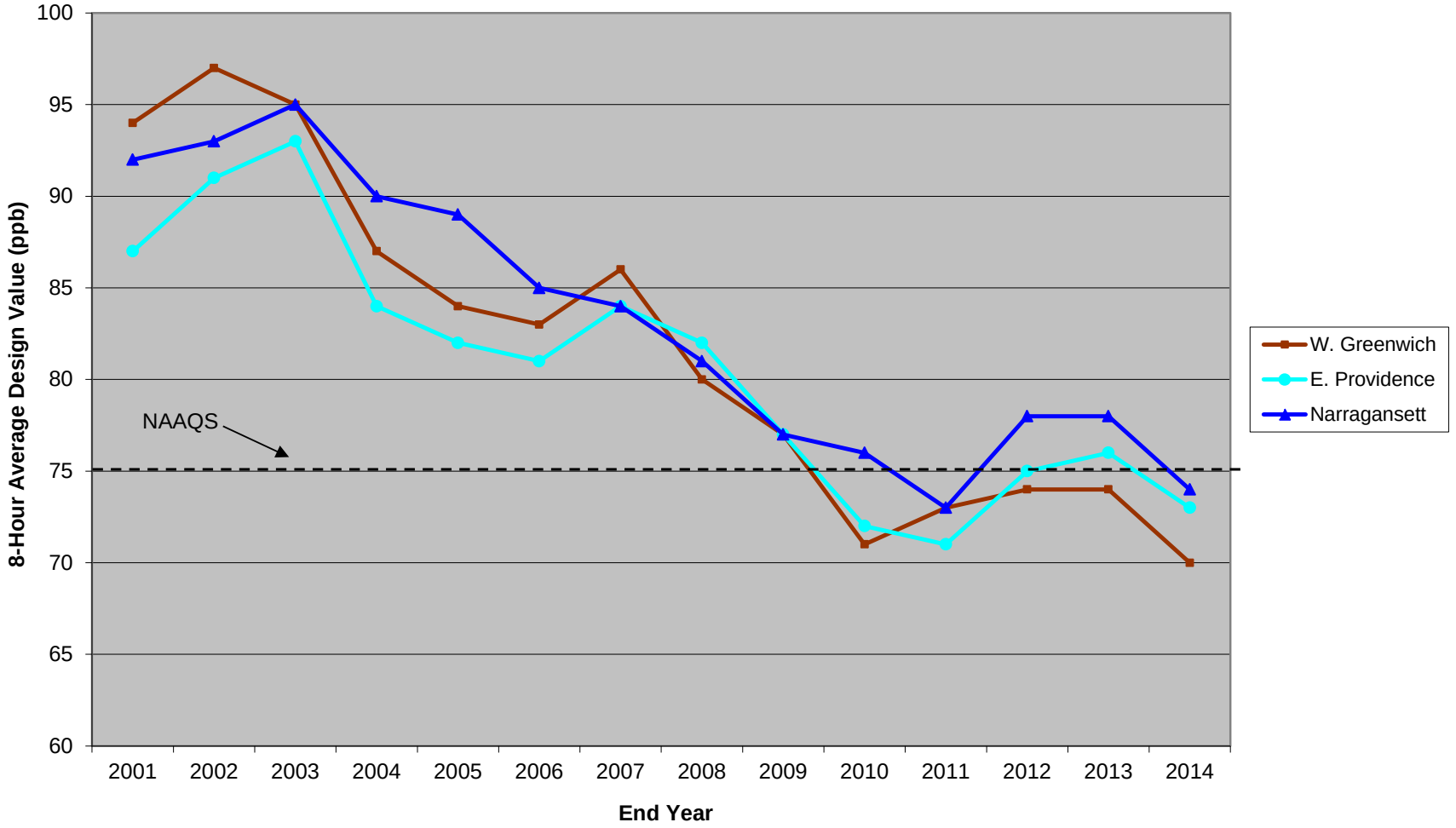


Figure 10 Locations of Ozone Monitors in Rhode Island and Nearby Massachusetts and Connecticut

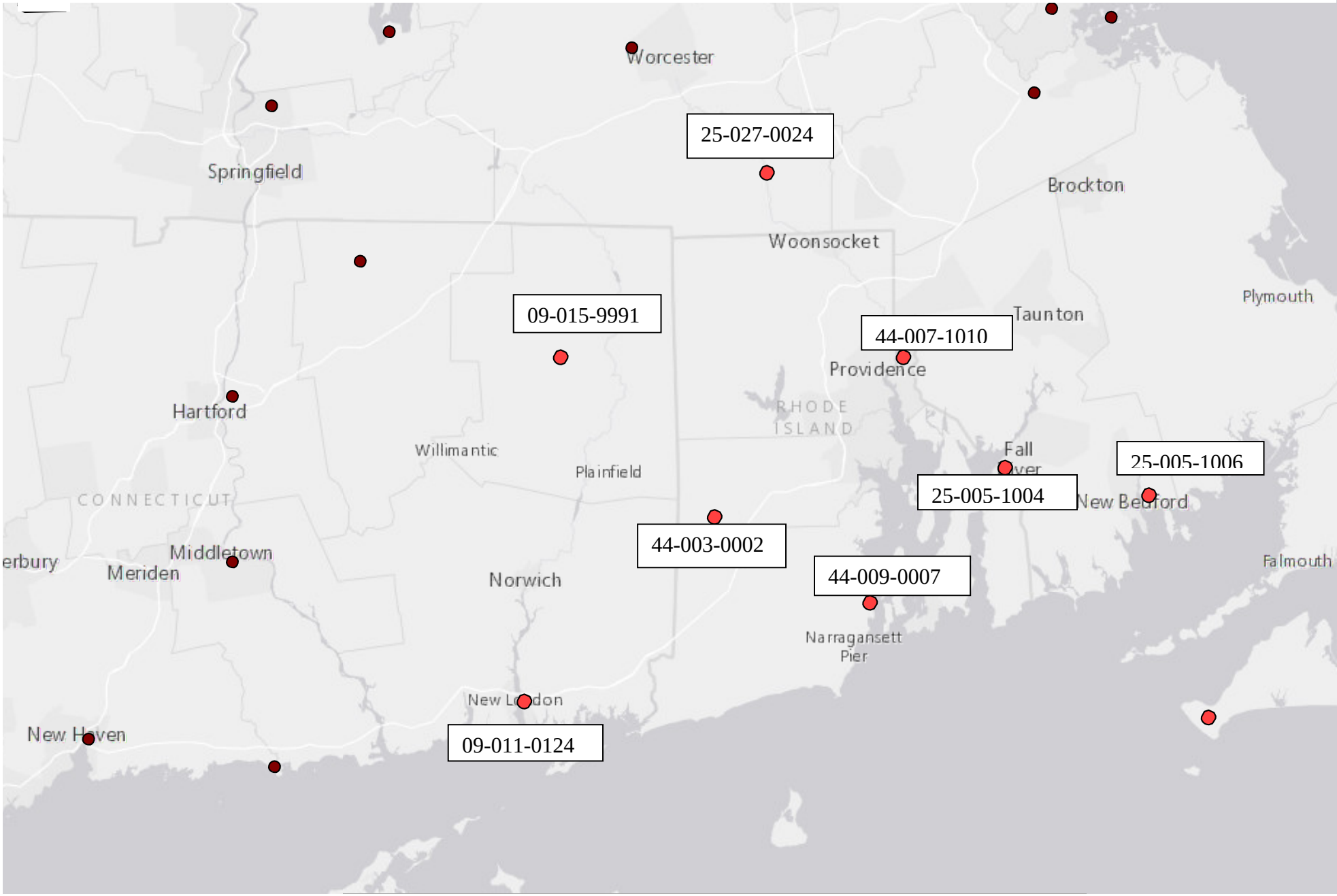


Figure 11 Trends in Carbon Monoxide (CO) Levels (8-Hour Average)
8-Hour Average NAAQS is 9 ppm

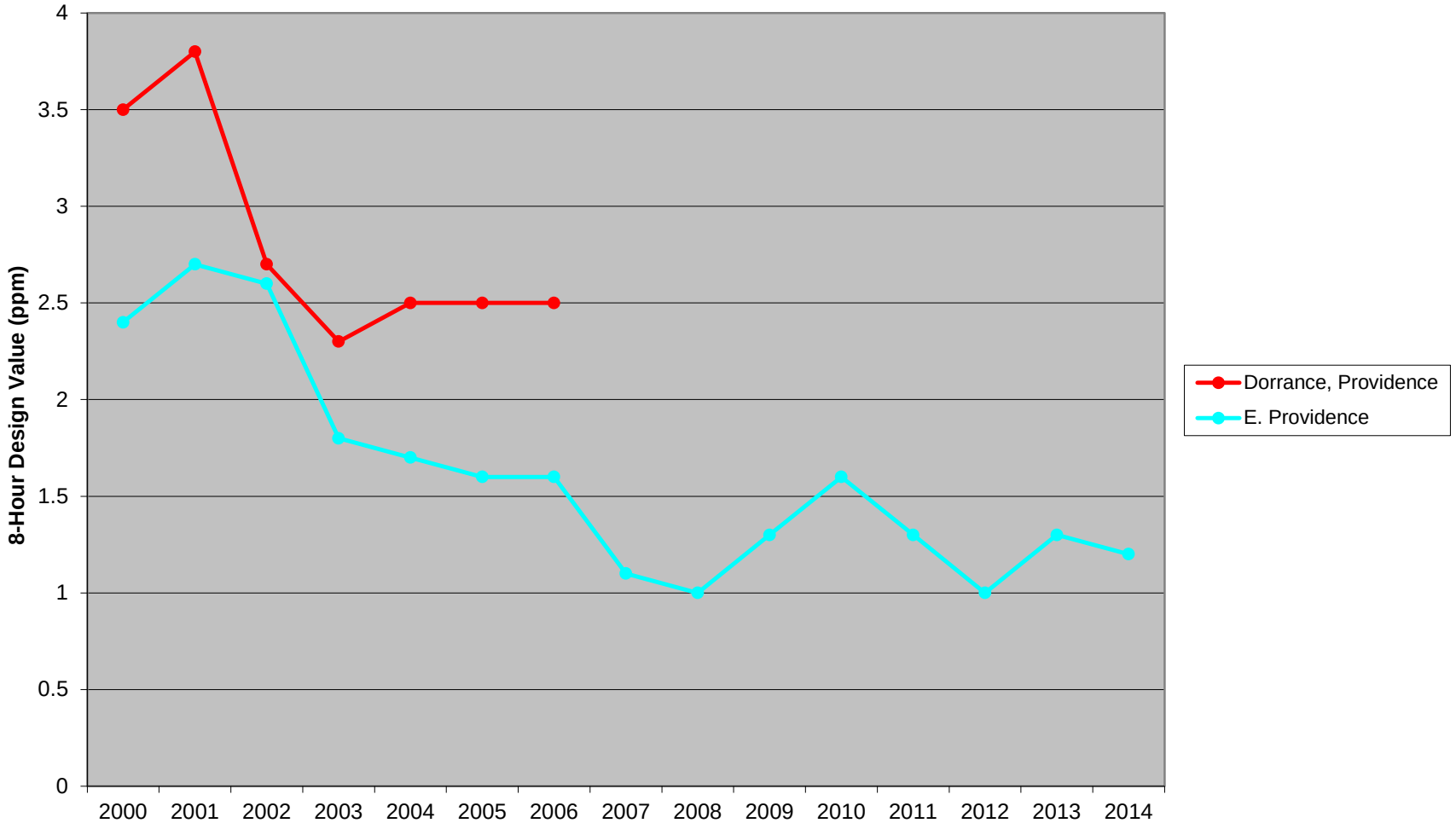


Figure 12 Comparison of Maximum Daily One-Hour Carbon Monoxide Concentrations at Near Road and E. Providence sites

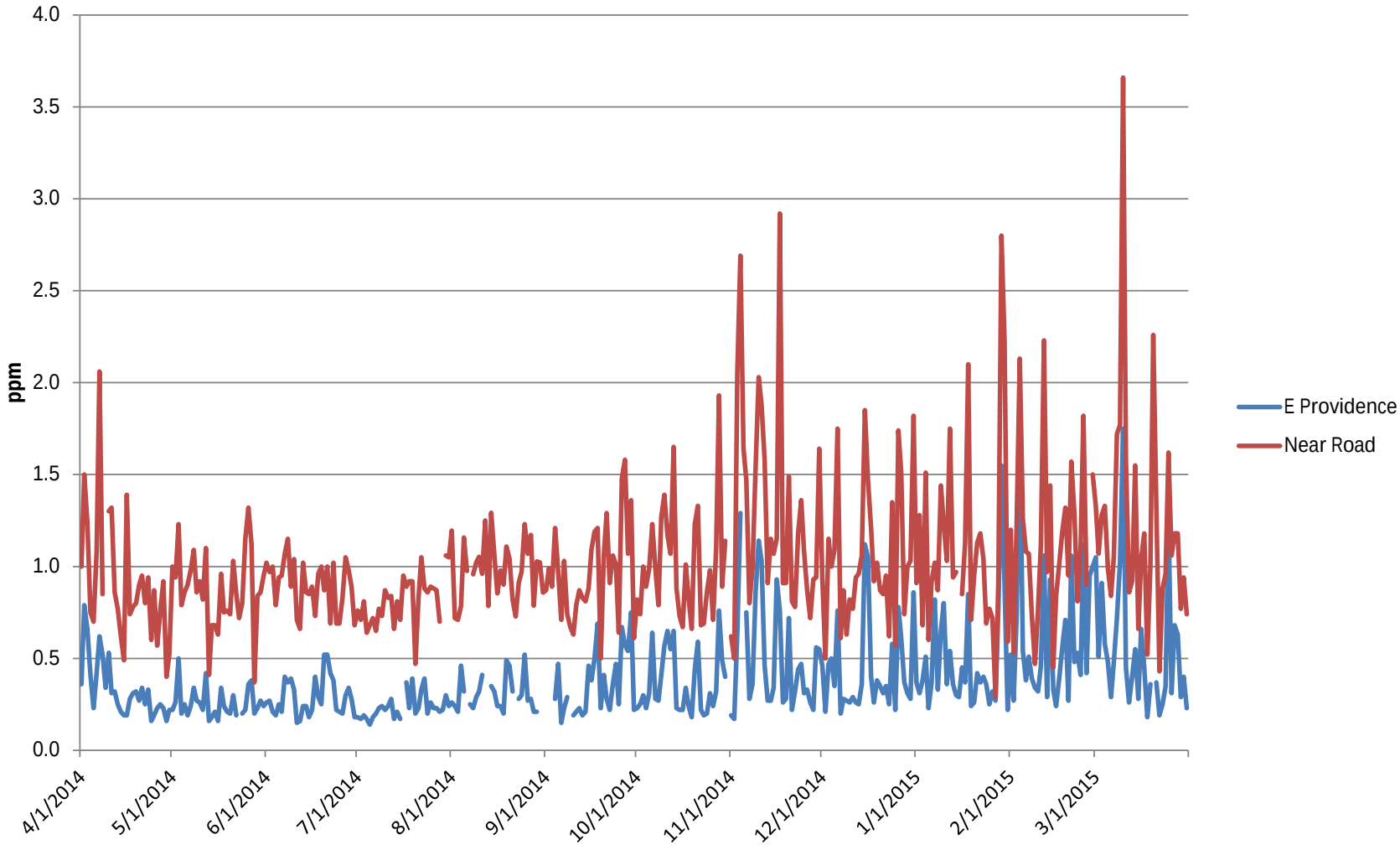


Figure 13 Trends in Sulfur Dioxide Levels (1-Hour Average)
Current 1-Hour NAAQS = 75 ppb

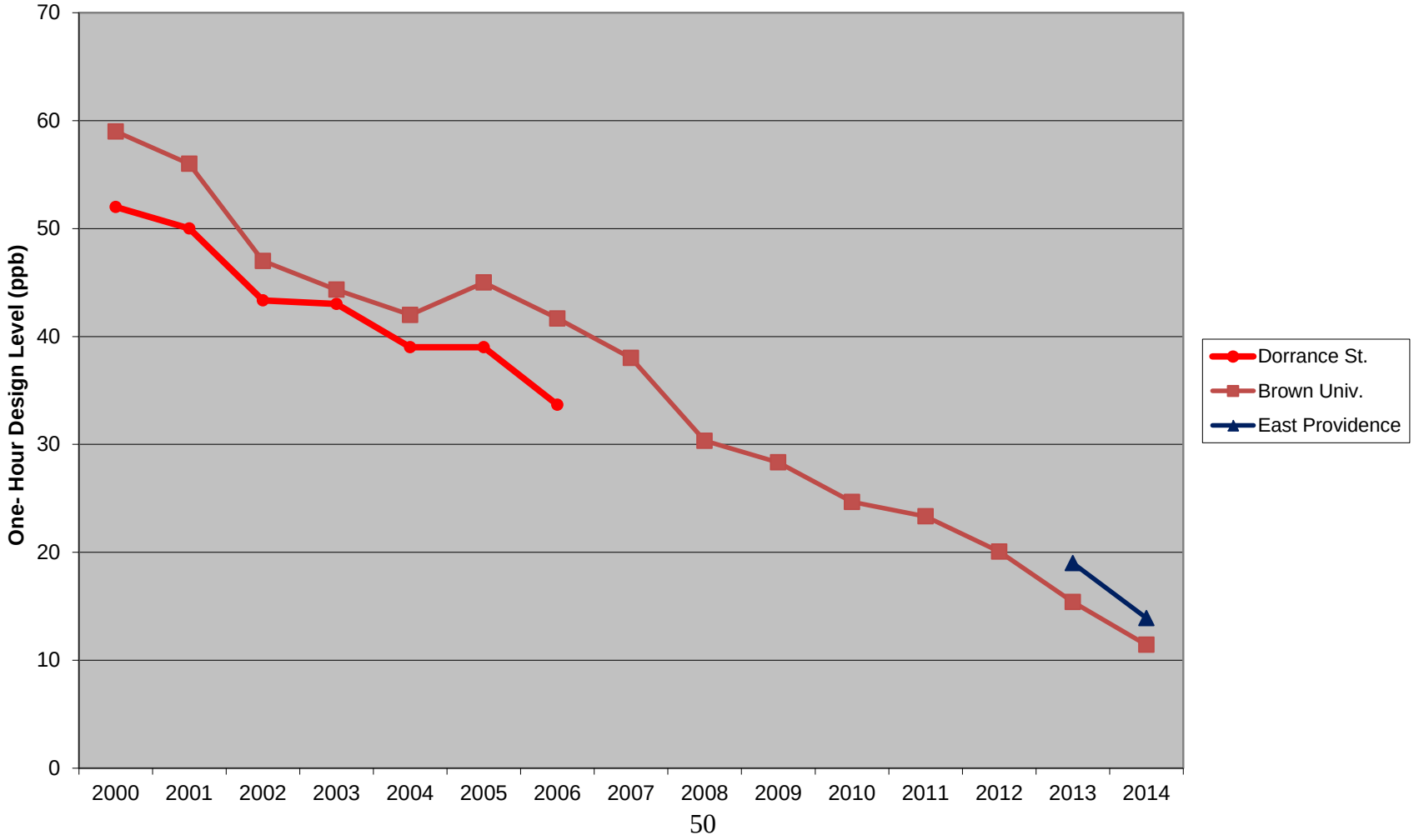


Figure 14 Trends in Nitrogen Dioxide Levels
Current NAAQS: 100 ppb (1 hr) and 53 ppb (annual mean)

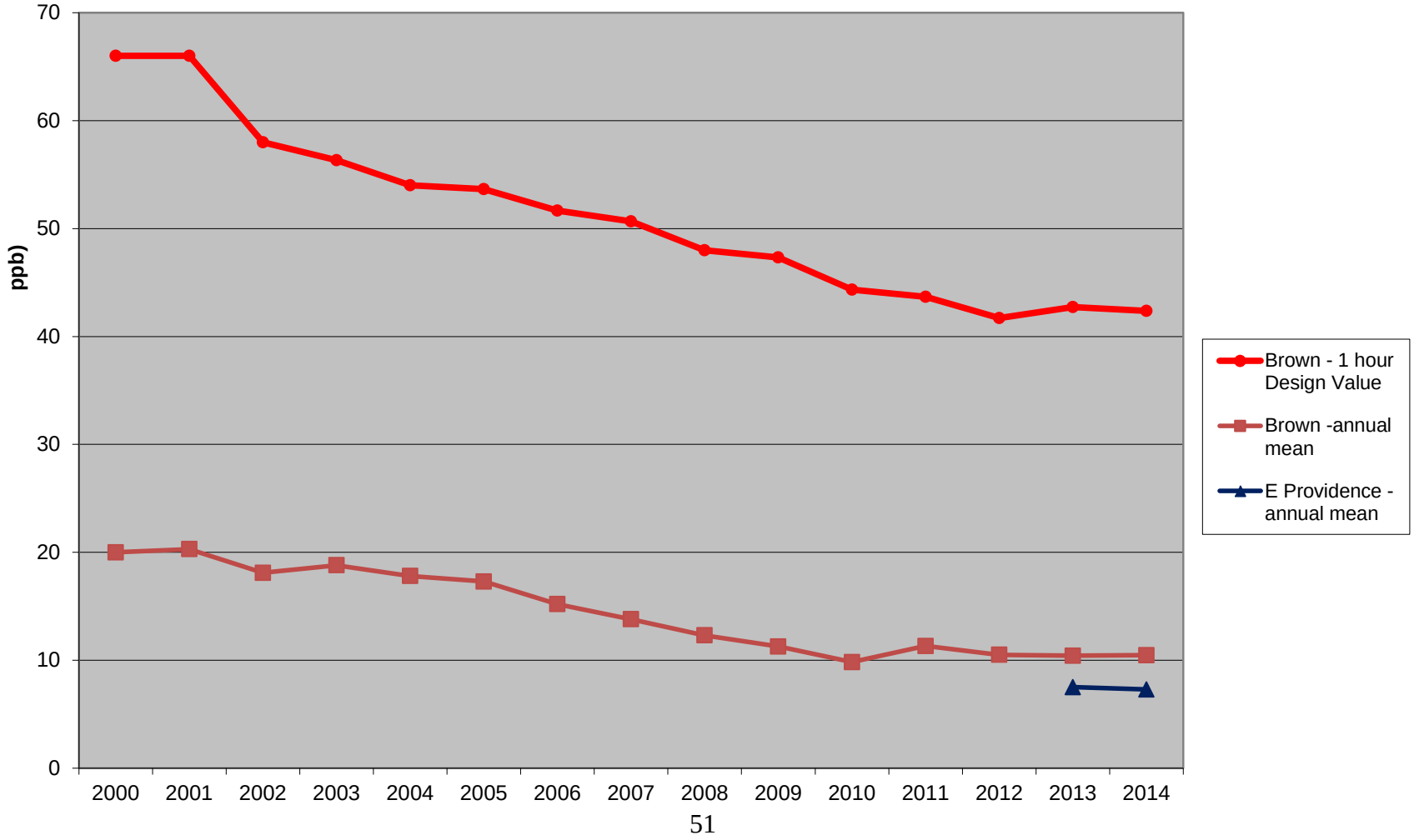


Figure 15 Comparison of Maximum Daily One-Hour Nitrogen Dioxide (NO_2) Concentrations at Near Road, Brown and E. Providence Sites

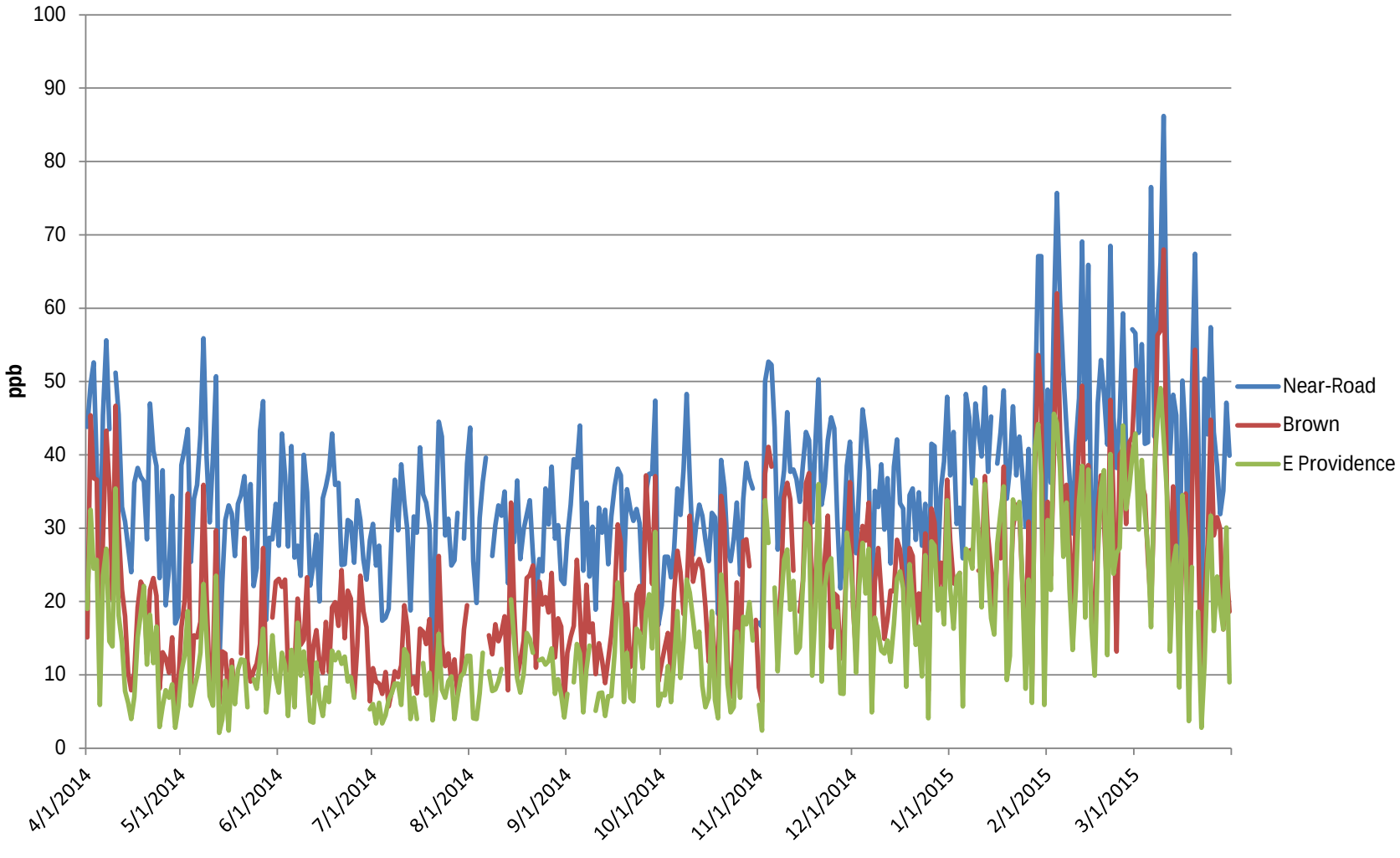


Figure 16 Comparison of Maximum Daily One-Hour Nitric Oxide (NO) Concentrations at Near Road, Brown and E. Providence Sites

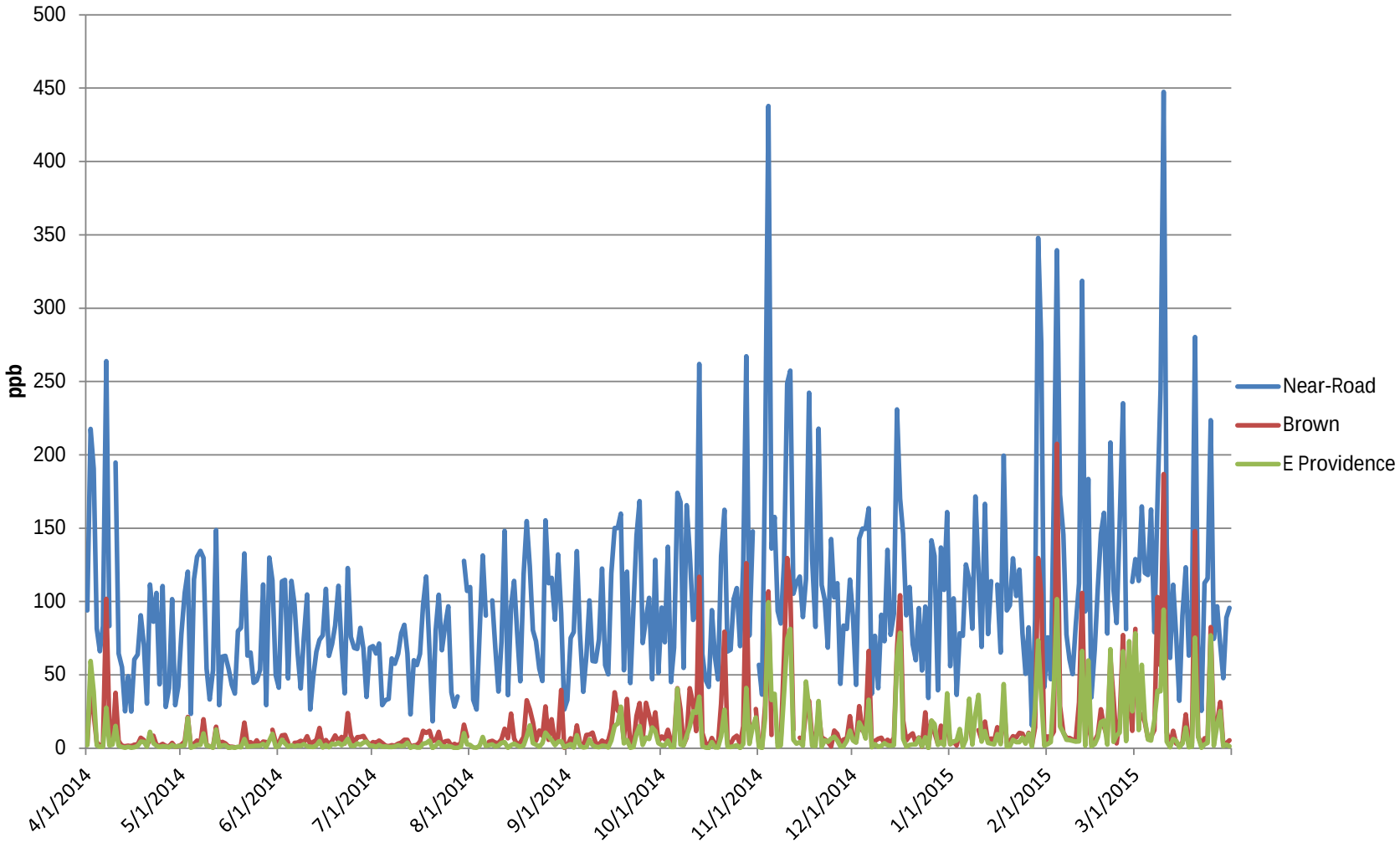


Figure 17 Trends in 24-Hour Average PM-10 Levels
NAAQS = 150 ug/m3

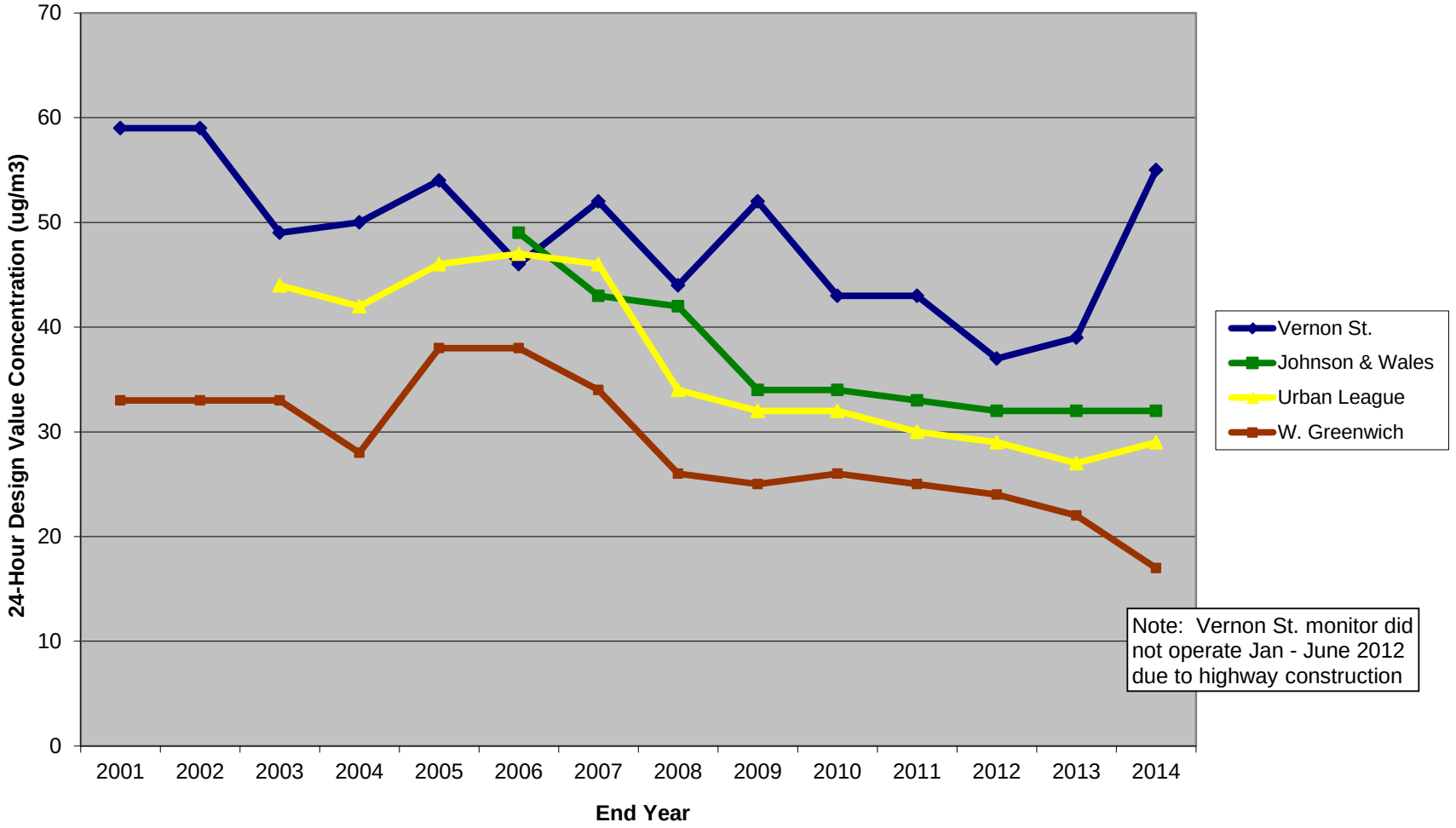


Figure 18 Trends in 24-Hour Average PM-2.5 Levels
NAAQS = 35 ug/m3

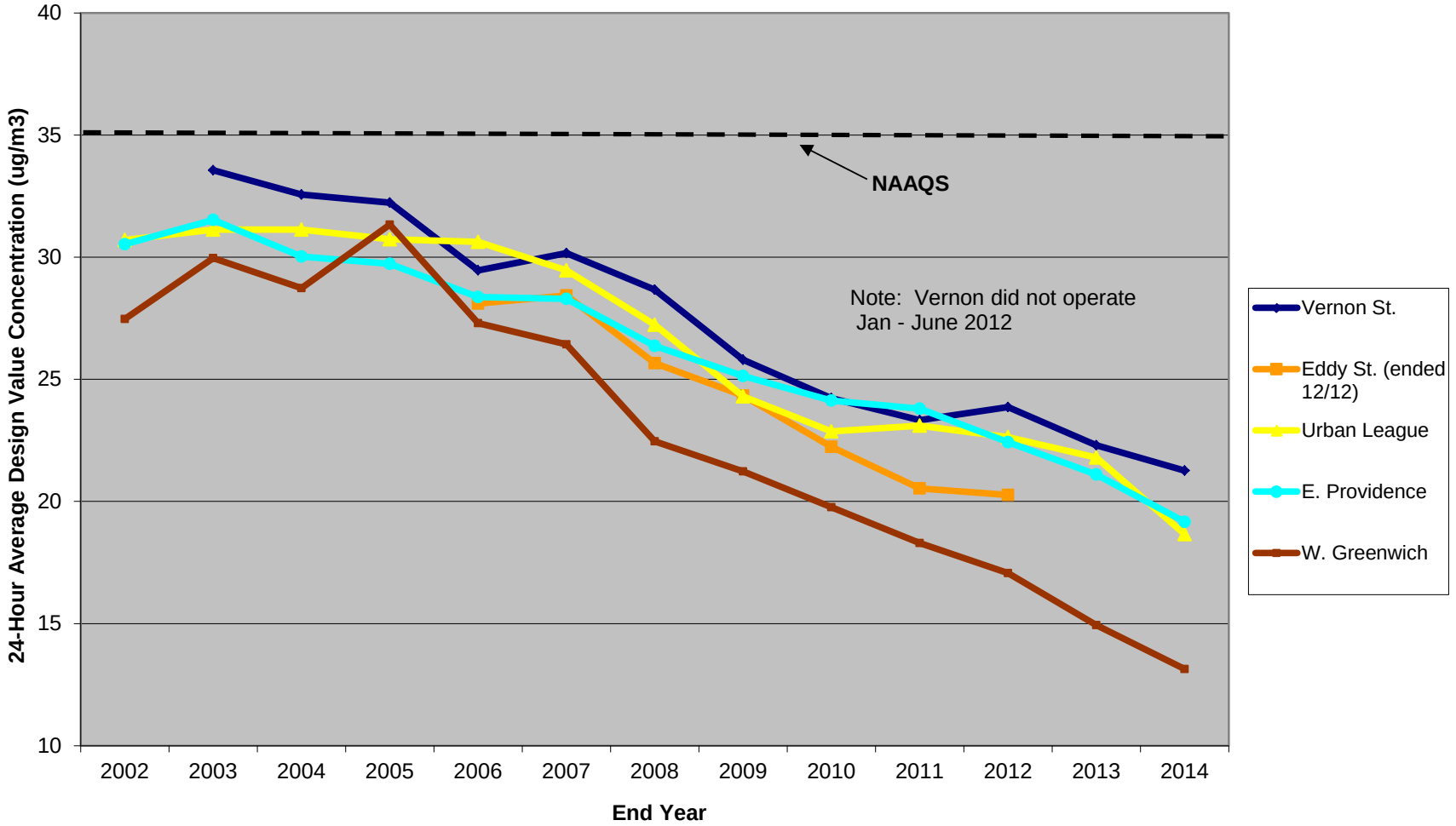


Figure 19 Trends in Annual Average PM-2.5 Levels
NAAQS = 12 ug/m3

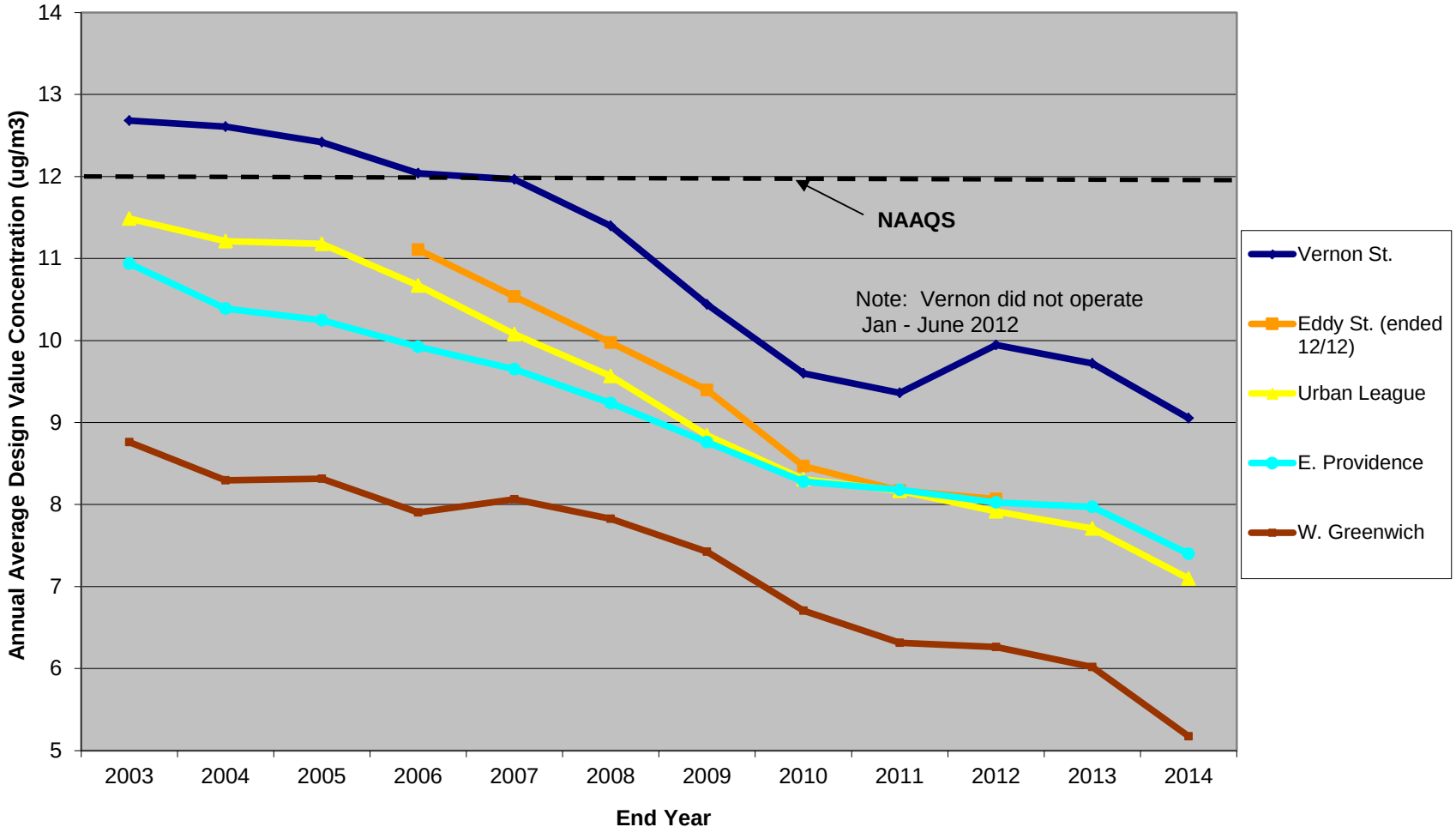


Figure 20 PM2.5 Concentrations in 2013 and 2104 at Rhode Island Sites

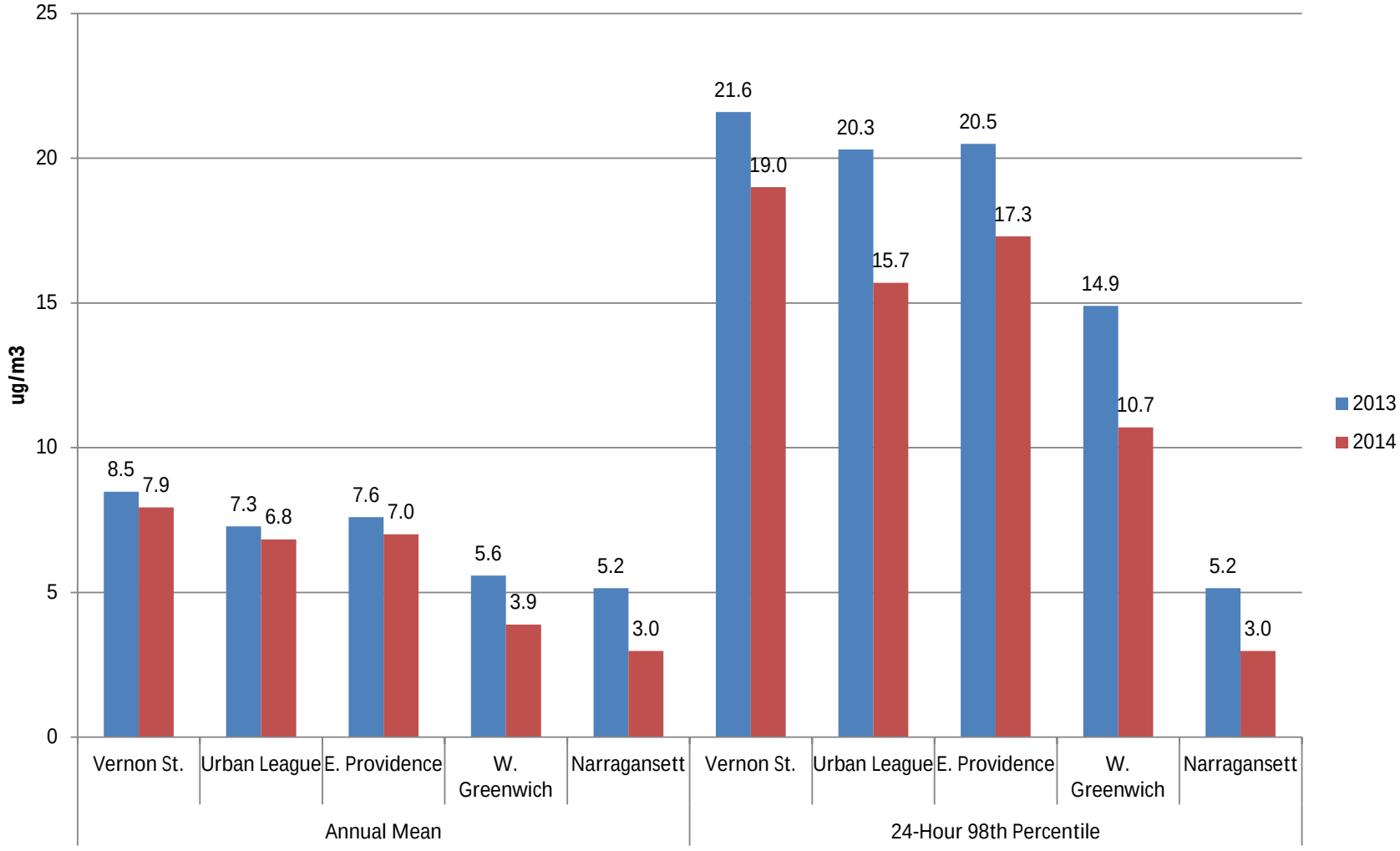


Figure 21a Comparison of Daily PM2.5 Concentrations at Near-Road, Urban League and E. Providence Sites

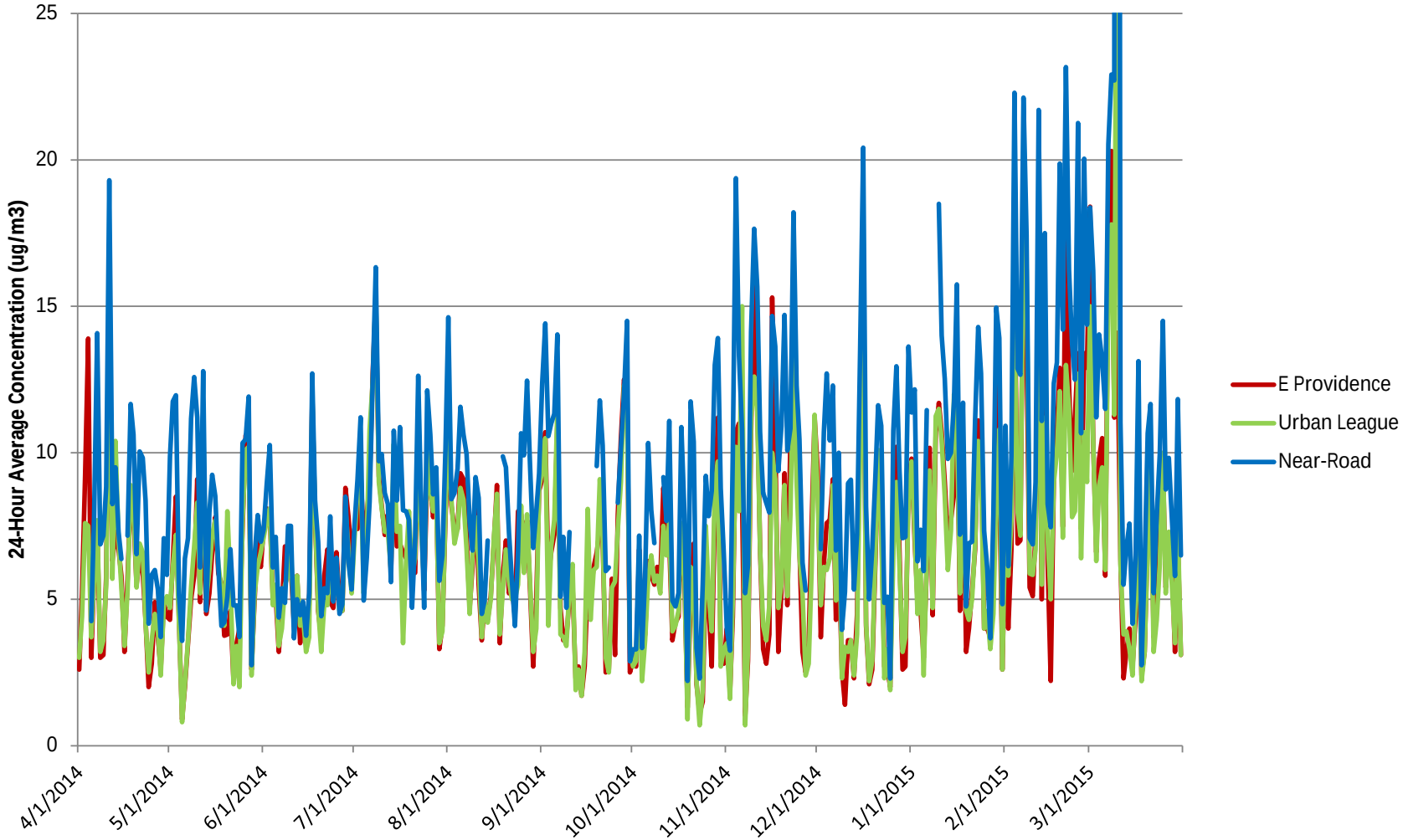


Figure 21b PM2.5 Concentrations at Rhode Island Sites Adjacent to I-95 - Near-Road Site in Providence and Vernon St., Pawtucket

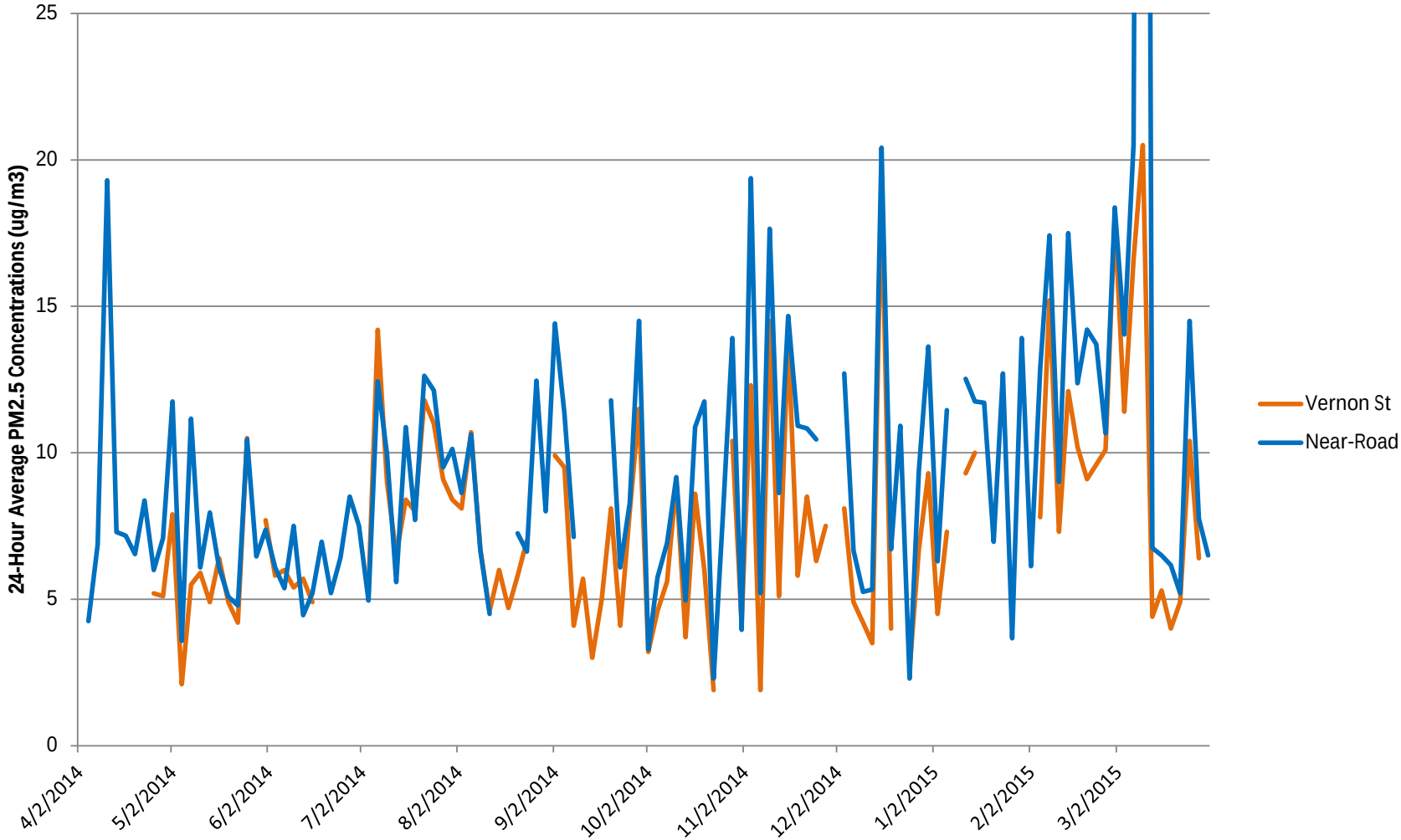


Figure 22 Correlation Between Urban League and East Providence PM2.5 (2012-2014)

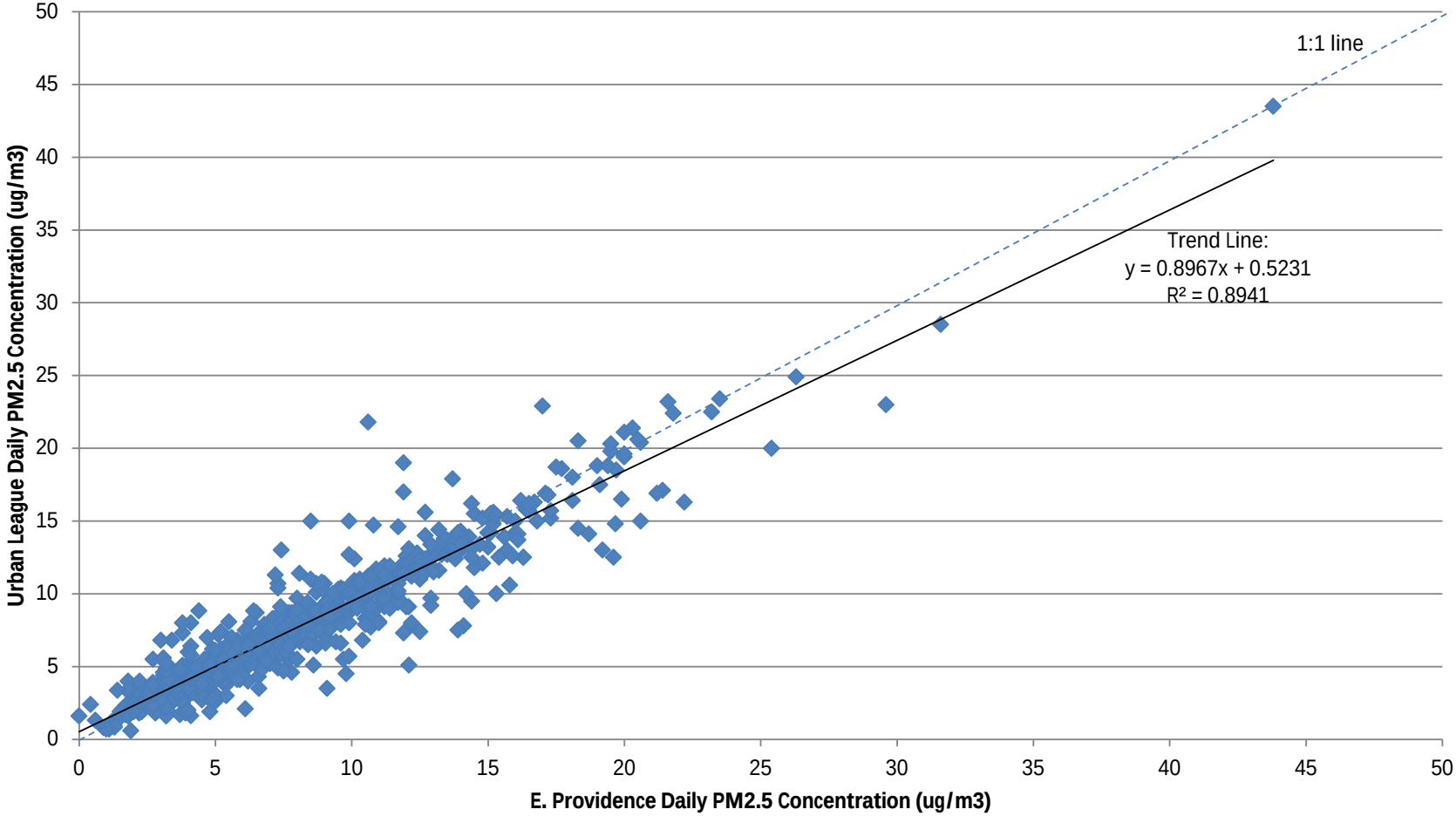
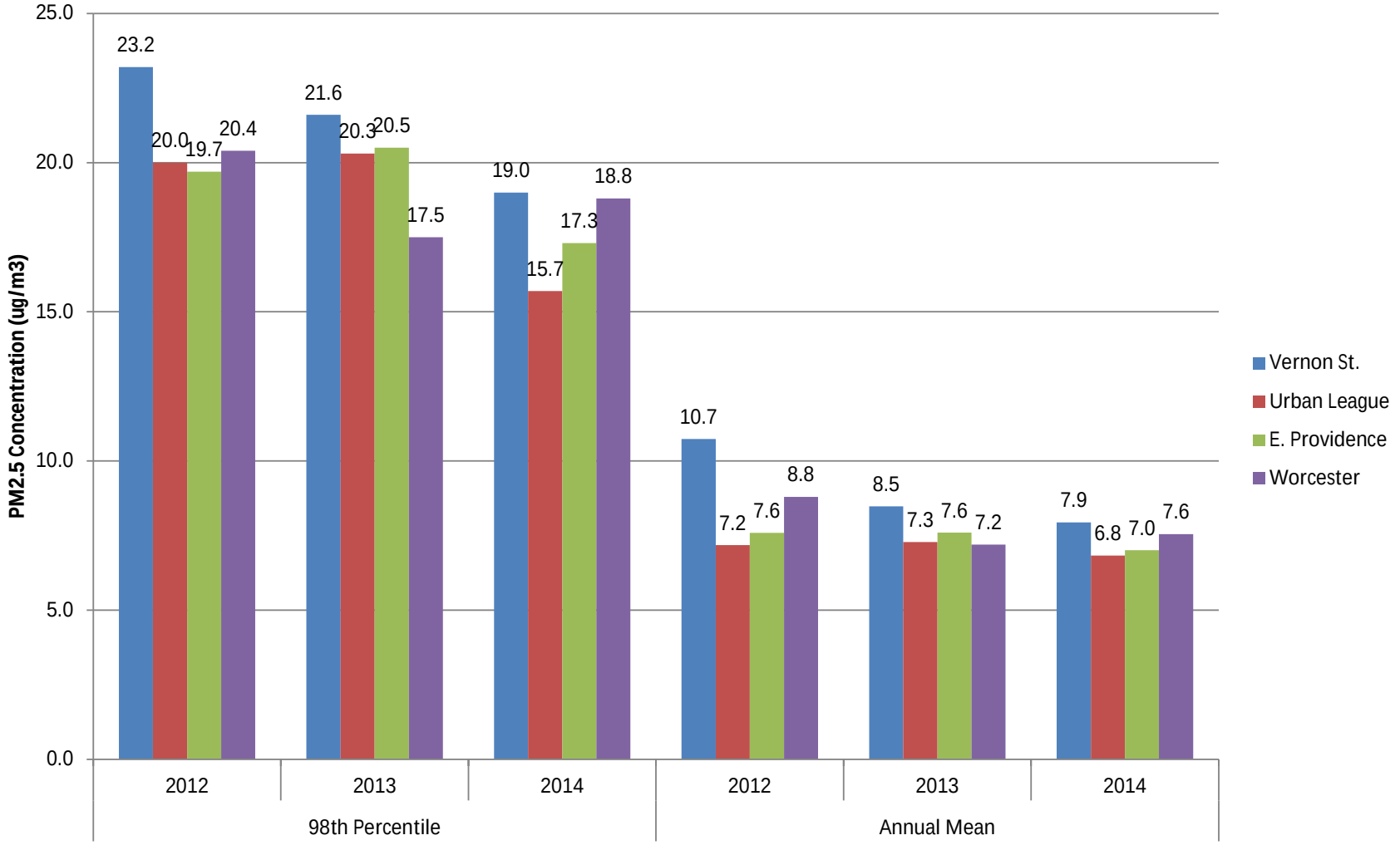


Figure 23 24-Hour and Annual Average PM2.5 Concentrations at Providence Area and Worcester, MA Sites



Data are from EPA's AQS database. Vernon St. 2012 data are incomplete. 2012-2013 concentrations for Worcester, MA are every third day FRM data and 2014 concentrations at that site are daily FEM data.

Figure 24 W Greenwich PM2.5 FEM-FRM Comparison (2012-1st Q 2015)

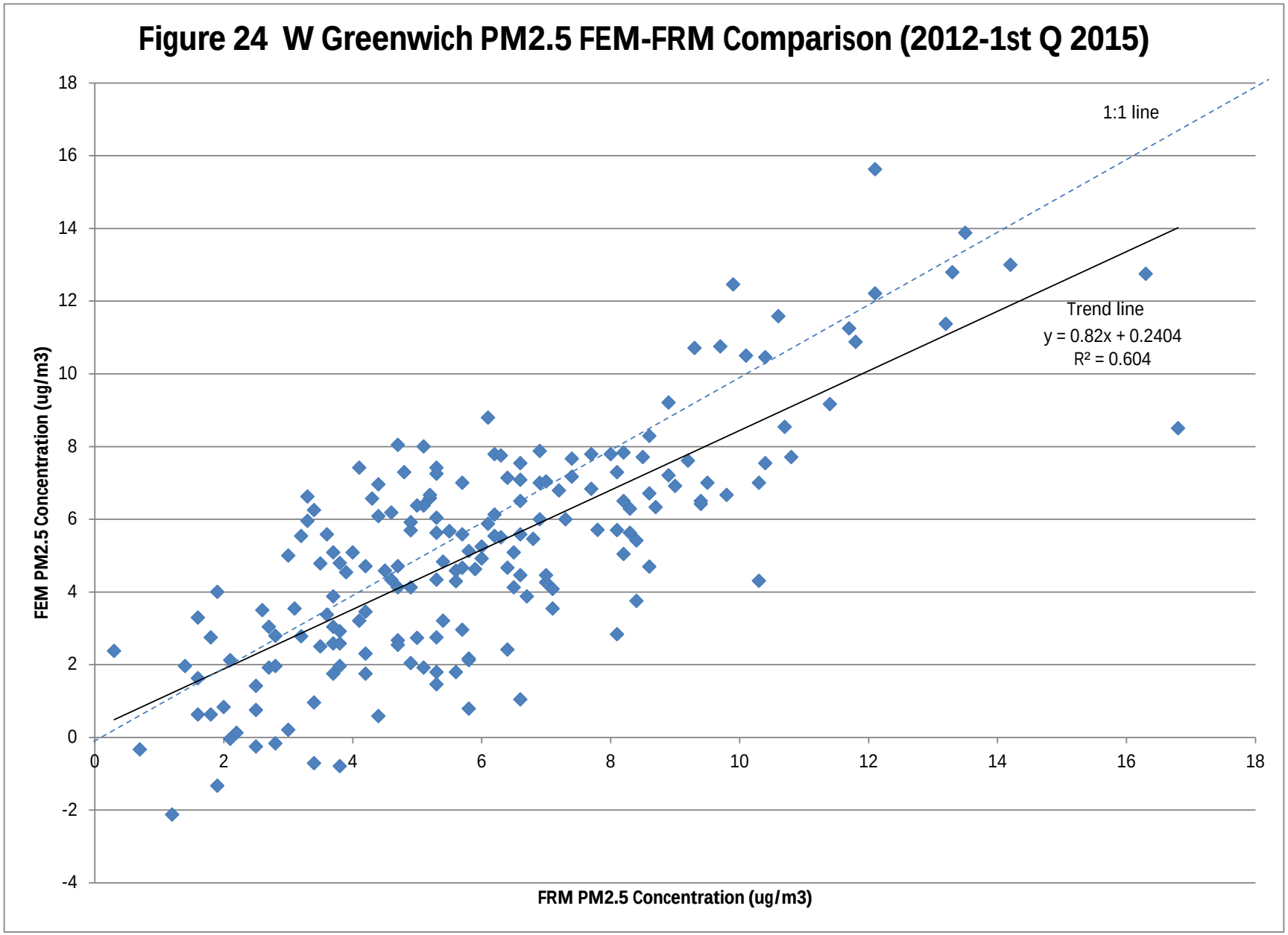


Figure 25 E. Providence PM2.5 FEM-FRM Comparison (2012-1st Q 2015)

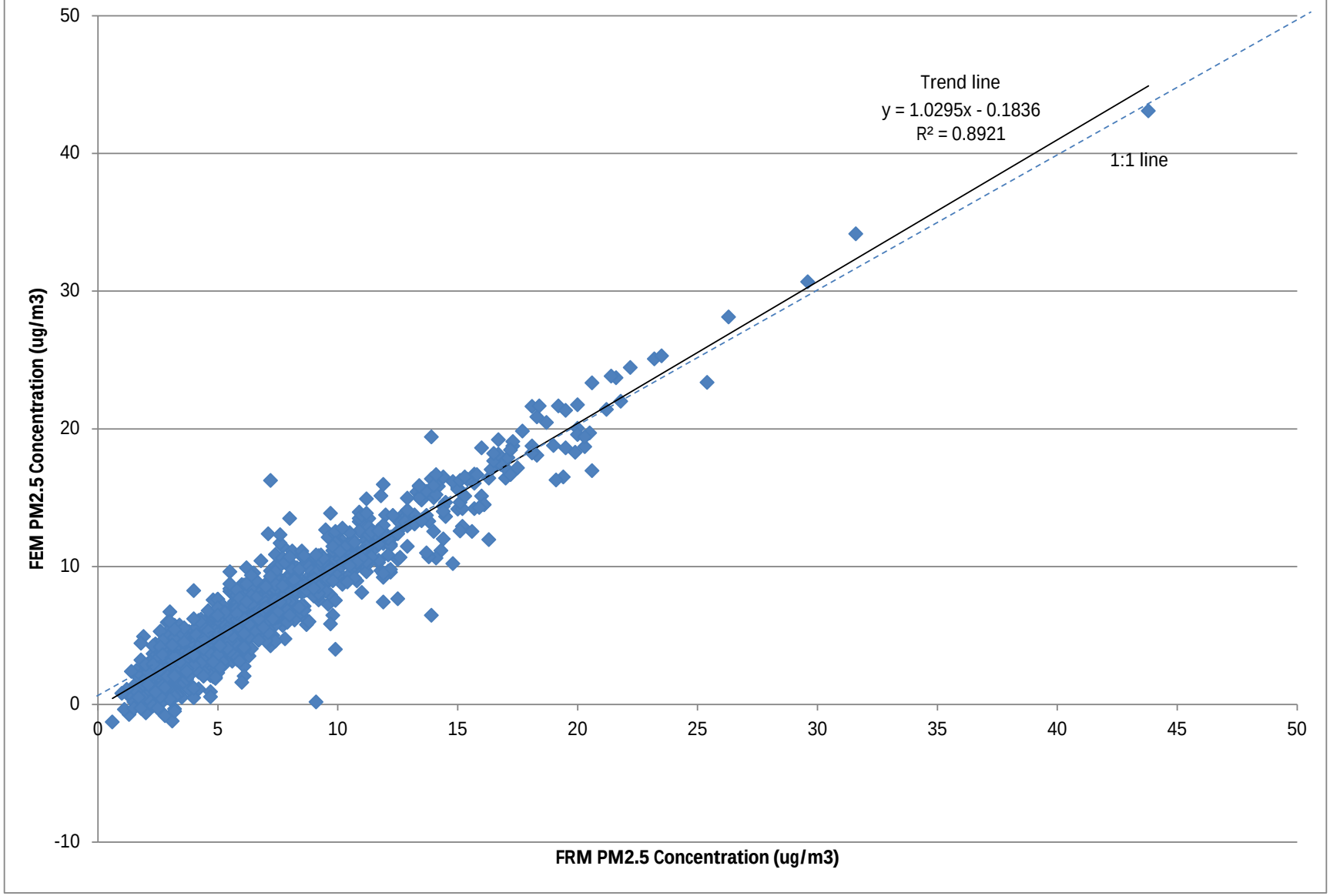


Figure 26 Benzene Trends at Rhode Island Sites

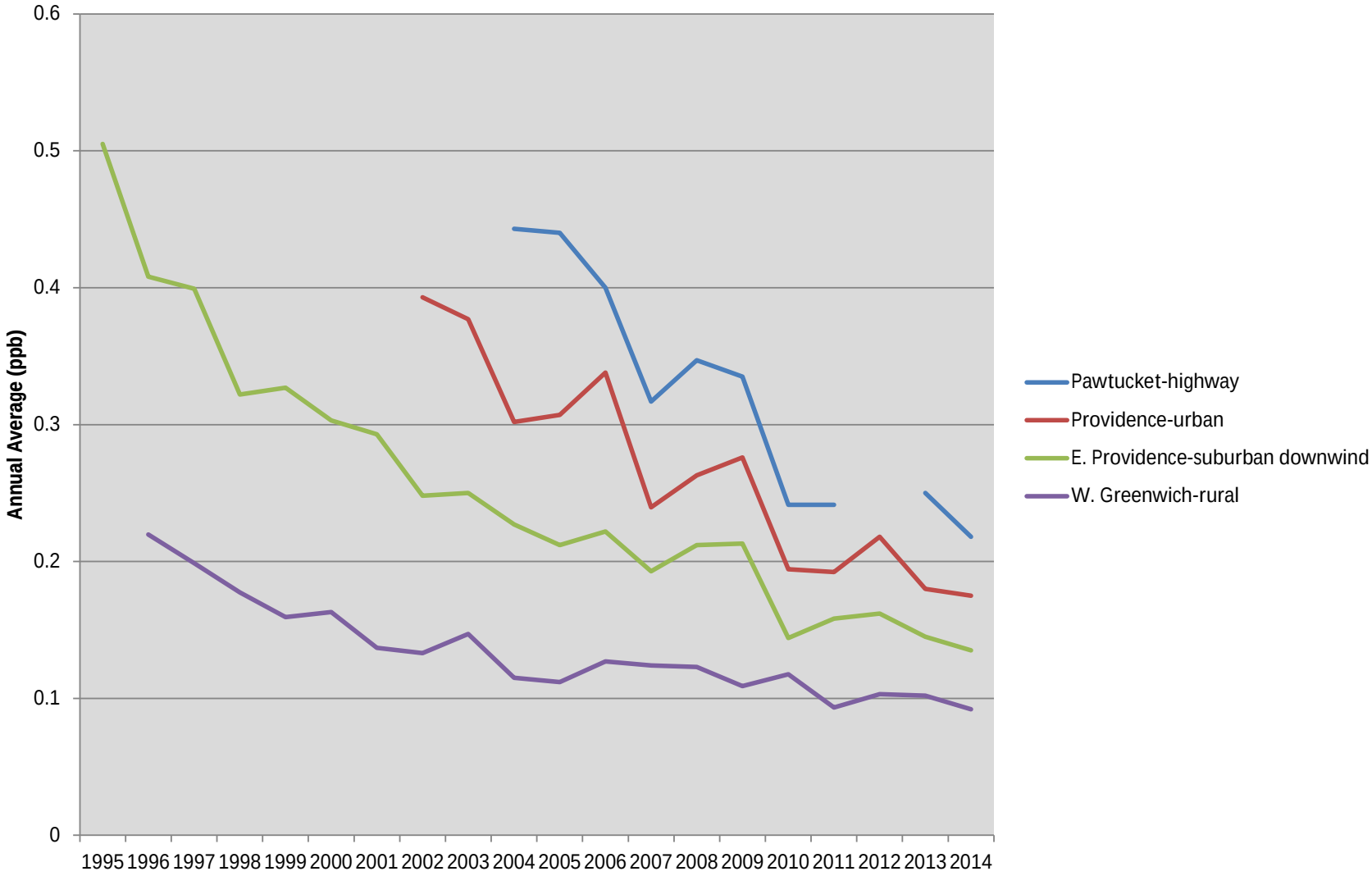


Figure 27 Carbonyl Trends at Rhode Island Sites