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

Rhode Island 2010 Annual Monitoring Network Plan

And

Five-Year Network Assessment

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Regulatory Background

Section 58.10(a) of Title 40 of the Code of Federal Regulations (40 CFR 58.10(a)) requires each state to submit a monitoring network plan to the United States Environmental Protection Agency (EPA) by July 1st 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 for 30 days before 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 first 5-year assessment must be submitted to EPA by July 1, 2010. 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 2010 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 HEALTH), operates a network of air monitoring stations that measure ambient concentrations of pollutants for which a National Ambient Air Quality Standard (NAAQS) has been established. 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) and carbon monoxide (CO). Lead is also a criteria pollutant, but is not currently monitored as such in Rhode Island because ambient lead levels have been substantially below the NAAQS since the use of leaded gasoline in on-road vehicles was prohibited. As discussed below, EPA significantly strengthened the lead NAAQS in November 2008 and, to determine compliance with the new standard, Rhode Island will resume NAAQS lead monitoring by January 1, 2011. The criteria pollutant monitoring sites are part of the EPA's State or Local Air Monitoring Stations network (SLAMS).

In addition, RI DEM/RI HEALTH monitors ambient levels of toxic air pollutants and 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 and one that is part of the $PM_{2.5}$ Speciation Trends Network (STN).

Table 1 summarizes the NAAQS and Table 2 lists the locations of the eight air monitoring stations currently operating in the State, 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 I 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-Fall River-Warwick, RI-MA Metropolitan Statistical Area (MSA), which encompasses all of Rhode Island as well as Bristol County in Massachusetts.

Beginning January 1, 2011, Rhode Island must operate a monitoring site that is part of the network of core multipollutant monitoring (NCore) stations; particulate matter ($PM_{2.5}$, speciated $PM_{2.5}$, continuous $PM_{2.5}$ and the coarse fraction of PM_{10} ($PM_{10-2.5}$)), O_3, SO_2, CO, nitrogen oxides (nitrogen oxide (NO) and total reactive nitrogen (NO_y)), lead, and basic meteorological parameters must be monitored at those sites. In October 2009, the EPA approved the East Providence monitoring site, which is the State's Type 2 (maximum precursor) PAMS site, as the State's NCore site location.

As mentioned above, Rhode Island does not currently conduct NAAQS sampling for lead, since ambient lead levels in the State have been considerably lower than the NAAQS since the removal of lead from gasoline. However, to determine compliance with EPA's more stringent 2008 lead NAAQS, states must conduct two types of monitoring – source-specific monitoring beginning in January 2010 and monitoring at NCore sites beginning in January 2011. As discussed below, there are no sources in the State with lead emissions that are high enough to trigger the source-specific monitoring requirements, so NAAQS lead monitoring will be limited to the NCore site.

[1] RI DEM and RI HEALTH, "QAPP for Criteria Pollutants Including Particulates, Revision 9.4," approved by EPA December 11, 2006 and "QAPP: Air Toxics and PAMS Monitoring Programs, Revision 3.1," approved by EPA September 27, 2006.

Table 1 National Ambient Air Quality Standards (NAAQS)

POLLUTANT	AVERAGING TIME	PRIMARY STANDARD	SECONADARY STANDARD
Sulfur Dioxide (SO2)	Annual Arithmetic Mean	0.03 ppm (80 μg/m³)	None
	24-Hour[A]	0.14 ppm (365 μg/m³)	None
	3-Hour[A]	None	0.5 ppm (1300 μg/m³)
	1-Hour[B]	0.075 ppm (75 ppb)	None
Carbon Monoxide (CO)	8-Hour[A]	9 ppm (10 mg/m³)	None
	1-Hour[A]	35 ppm (40 mg/m³)	None
Ozone (O_3)	8-Hour[C]	0.075 ppm (157 μg/m³)	Same as Primary Standard
Nitrogen Dioxide (NO_2)	Annual Arithmetic Mean	0.053 ppm (53 ppb, 100 μg/m³)	Same as Primary Standard
	1-Hour[D]	100 ppb	None
Particulate Matter ≤ 10 micrometers (PM_{10})	24-Hour[E]	150 μg/m³	Same as Primary Standard
Particulate Matter ≤ 2.5 micrometers ($PM_{2.5}$)	Annual Arithmetic Mean[F]	15.0 μg/m³	Same as Primary Standard
	24-Hour[G]	35 μg/m³	Same as Primary Standard
Lead (Pb)	Rolling 3-Month Average[H]	0.15 μg/m³[F]	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 be exceeded more than once a year.

[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 (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] 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 15 $\mu g/m^3$.

[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 $\mu g/m^3$.

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

$\mu g/m^3$ = micrograms per cubic meter
mg/m^3 = 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
Hallmark Building 695 Eddy Street Providence	440070028	41.80933 -71.40743	$PM_{2.5}$	Lo Vol	Reference
Brown University 10 Prospect Street Providence	440070012	41.825556 -71.405278	Oxides of Nitrogen	Chemiluminescence	Reference
			Nitrogen Dioxide	Chemiluminescence	Reference
			Sulfur Dioxide	Simulated Fluorescence	Equivalent
USEPA Laboratory 27 Tarzwell Drive Narragansett	440090007	41.4950779 -71.4236587	Ozone	U.V. Photometric	Reference
			$PM_{2.5}$	Beta Attenuation/Cont	N/A
			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	Reference
			Nitrogen Dioxide	Chemiluminescence	Reference
			VOC	Canisters, GC/FID/MS	Reference
			Carbon Monoxide 1/11-Low-range CO	Gas Filter Correlation	Equivalent
			Ozone	U.V. Photometric	Reference
			$PM_{2.5}$	Lo Vol	Reference
			Carbonyls	HPLC Cartridges	Reference
			Black Carbon	Aethalometer	N/A
			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
			1/11 - $PM_{2.5}$	Beta Attenuation/Cont	Equivalent
			1/11-Speciated $PM_{2.5}$	Speciation Monitor	N/A
			$PM_{10-2.5}$	Dichotomous Lo Vol	Equivalent
			1/11–Low-range NO/NO_y	Chemiluminescence	Reference
			1/11 – Low range Sulfur dioxide	Pulsed Fluorescence	Equivalent

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	N/A
			Speciated $PM_{2.5}$ (discontinued in 2010)	Speciation Monitor	N/A
			PM_{10}	Lo Vol	N/A
			PM_{10}/Metals	Hi Vol	Reference
			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	Reference
			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	N/A
			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

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, Washington County's population growth rate between1990 and 2008, a 15% increase, was higher than the rate in the other counties, but this resulted in only a slight increase in the percentage of Rhode Island's population that lives in that county. Rhode Island's population is still heavily concentrated in Providence County, which accounts for approximately 60% of the State's residents. The percentage of the State's total population in each of the five counties remained stable over the 1990- 2008 period, as shown in Table 3:

Table 3 County Population Count and Percent of Total State Population (1990 – 2008)

County	1990 Census[2]	2000 Census	2008 Estimate[3]
Bristol	48,859 (5%)	50,648 (5%)	49,838 (5%)
Kent	161,135 (16%)	167,090 (16%)	168,058 (16%)
Newport	87,194 (8%)	85,433 (8%)	80478 (8%)
Providence	596,270 (59%)	621,602 (59%)	626,150 (60%)
Washington	110,006 (11%)	123,546 (12%)	126,264 (12%)
Total Rhode Island	**1,003,464**	**1,048,319**	**1,050,788**

As shown in Figure 6, the City of Providence's population grew faster than that in the other major Rhode Island cities in the 1990 – 2008 period (7% growth), but the overall population distribution remained relatively stable during that period. Therefore, a change in the location of population-oriented monitoring sites is not warranted. Note also that 28% of the population of the State and 47% of the population of Providence County reside in the three cities where monitoring activities are most focused: Providence, East Providence and Pawtucket.

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. Rhode Island's Asthma State Plan[4] identifies the following groups or Rhode Island residents as being of increased risk for childhood asthma:

- Children from low income households;
- Hispanic and black children;
- Children that are Medicaid recipients; and
- Children residing in core urban cities, particularly Providence.

The asthma plan further states that the asthma hospitalization rates for children living in Providence are twice as high as those for children in the State as a whole and that Providence has the highest percentage of minority residents in the State (non-Hispanic whites comprise 45.8% of the population in Providence, but are 78.8%[5] of the population of the State as a whole). Moreover, the plan states

[2] Rhode Island Statewide Planning, "Population of Rhode Island by State, County and City and Town, 1990 and 2000, data from the US Census. http://www.planning.state.ri.us/census/pdf%20files/miscpdf/popcity.pdf

[3] Rhode Island Dept. of Labor and Training, "Rhode Island City and Town Resident Estimates." http://www.dlt.ri.gov/lmi/census/pop/townest.htm

[4] Rhode Island Asthma Control Coalition and, Rhode Island Department of Health, Asthma Control Program, Reducing the Burden of Asthma in Rhode Island: Asthma State Plan 2009-2014, 2009. http://www.health.ri.gov/publications/plans/AsthmaStatePlan2009-2014.pdf

[5] US Census Bureau, "State and County Quick Facts." http://quickfacts.census.gov/qfd/states/44000.html . Note, the Rhode Island statistic quoted here is for 2009, while the Providence statistic is for 2000.

that Providence has "a poverty rate that is among the ten highest for US cities with populations over 100,000 (>30%)."

Since Providence is a high risk area for childhood asthma, the analysis presented below will discuss whether the monitoring network adequately characterizes air quality in the Providence area to fulfill the requirement that the 5-year assessment must consider areas with "high populations of susceptible individuals (e.g. children with asthma)."

Network Evaluation

Following is a discussion, by pollutant, of:

- the current monitoring network,
- the NAAQS and a comparison of recent measurements as with the NAAQS,
- 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 Providence, and
- plans for modification of the network in the next 18 months.

Ozone (O_3)

The current ozone monitoring network is shown in Table 4:

Table 4 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)	Maximum precursor emissions impact Population exposure

The NAAQS for ozone is 75 ppb. A monitor is in violation of that NAAQS when the average of the 4th highest daily eight-hour concentration measured in 3 consecutive years (the design value) exceeds 75 ppb. Note that, in January 2010, the EPA proposed to reduce the ozone NAAQS to a value in the range of 60 –70 ppb.

Ozone design values at the three Rhode Island sites have decreased in recent years, but still exceed the NAAQS, 75 ppb, as shown in Table 5

Table 5 Ozone Design Values (ppb)

	W. Greenwich	Narragansett	E. Providence
2000 - 2002	97	93	91
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

Table D-2 in 40 CFR 58, Appendix D requires Metropolitan Statistical Areas (MSAs) with populations between 350,000 and 4 million which have one or more sites with ozone design values in excess of 85% of the NAAQS to operate a minimum of two ozone monitoring sites. Rhode Island is in that category; the 2009 estimated population of the Providence-Fall River-Warwick, RI-MA MSA, which includes all of Rhode Island, was 1,600,642[6] and the State's ozone design values at all sites are greater than the NAAQS. Since Rhode Island operates three ozone sites, the State exceeds this 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. The three Rhode Island ozone monitors are sited to represent maximum typical ozone concentrations in the areas of the State in which they are located, in that none are located close to sources of pollutants that may cause localized reductions in ozone concentrations. Note that, due to the small 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 Rhode Island PAMS Type 3 site, which is located in Milton, Massachusetts, addresses 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 and complexity of terrain and meteorology, ozone monitoring programs in adjacent states and air pollution transport from neighboring areas. Rhode Island is a very 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

[6] US Census Bureau, "Annual Estimates of the Population of Metropolitan and Micropolitan Statistical areas: April 1, 2000 – July 1, 2009."
http://www.census.gov/popest/metro/tables/2009/CBSA-EST2009-01.xls

populated Providence metropolitan area and transported air pollutants are measured at the West Greenwich (inland) and Narragansett (coastal) monitors. The Rhode Island network is designed to complement the ozone monitoring networks in Massachusetts and Connecticut. Therefore, the above factors do not indicate a need to change the network.

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 requirements.[7] Those requirements, as proposed, would require additional ozone monitors in rural areas that are not part of MSAs. It is not clear how this requirement will apply to Rhode Island, since all portions of the State, including areas that are commonly considered rural, are part of the Providence-Fall River-Warwick, RI-MA MSA. When that rule is finalized, RI DEM will evaluate the amended requirements and determine what actions are required.

The July 2009 Federal Register Notice discussed above also proposed to increase the length of time that ozone monitoring is required each year in several states, including Massachusetts and Connecticut. EPA did not propose a change in Rhode Island's ozone current monitoring season, April – September, but may do so in the final rule. Even if the rule is promulgated as proposed, Rhode Island will likely extend the State's ozone monitoring season to be consistent with that in neighboring states. Note also that, as will be discussed further below, year- round ozone monitoring will be conducted at the East Providence site beginning in 2011, consistent with NCore requirements.

As discussed above, RI HEALTH has identified Providence as the area of the State with the highest concentration of children at risk from asthma. Although no ozone monitors are currently operated in Providence, the East Providence site is less than one mile from the Providence border. Since emissions of pollutants such as nitrogen oxides can cause localized reductions in ozone levels, ozone concentrations are frequently somewhat higher in surrounding areas than in very urbanized locations. .

RI DEM has evidence that this is the case for the Providence area. For four years (1994 – 1997), monitors were operated concurrently at a site in Providence (Brown University) and at the current East Providence location. During that period, there were 74 days when both sites were operational and when the Providence monitor recorded maximum 8-hour average ozone concentrations of 60

[7] 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

ppb or higher. The measurements at the two sites on those days correlated well ($r^2 = 0.76$) and levels 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.

Emissions of ozone precursors and resulting ozone levels have decreased in the past several years, so 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 Providence.

Since the current Rhode Island monitoring network fulfills the ozone monitoring requirements in 40 CFR 58, Appendix D, as discussed above, no new sites are needed. RI DEM used EPA's Correlation Matrix and Removal Bias tools to determine whether any of the existing sites are redundant. The results of those evaluations indicated that the ozone levels measured at the East Providence site correlate well with and are similar to those measured in West Greenwich and that removal of the East Providence monitor would not significantly change the determination of whether the State is in attainment of the ozone NAAQS. However, since the East Providence site is the State's NCore site and Type 2 PAMS site and since it is the site most representative of exposures in the Providence metropolitan area, the most populous and sensitive area of the State, that site cannot be removed from the network.

Therefore, RI DEM does not intend to add or remove any ozone monitoring sites in the next 18 months. Rhode Island operates FRM ozone monitors at all sites and has no plans to replace that equipment with newer technology at this time. As mentioned above, the ozone monitor at the East Providence site will be operated year- round beginning in January 2011 and the operating season for the other two monitors will be reevaluated after EPA's proposed rules are finalized.

Carbon Monoxide (CO)

The current carbon monoxide 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

The NAAQS for carbon monoxide 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 carbon monoxide design values recorded in Rhode Island in the last five years are:

- 7.9 ppm – 1 hour average, 23 % of NAAQS, recorded at downtown Providence site[8]
- 2.5 ppm – 8-hour average, 28 % of NAAQS, recorded at downtown Providence site

The 2009 carbon monoxide design values for Rhode Island are:

- 2.7 ppm – 1 hour average, 7.7 % of NAAQS
- 1.3 ppm – 8 hour average, 14 % of NAAQS

The carbon monoxide NAAQS has not been exceeded in Rhode Island since1984. All measurements of this pollutant recorded in Rhode Island since 2001 have been in the range that is classified in EPA's Air Quality Index (AQI) as "Good" air quality.

According to 40 CFR 58, Appendix D 4.2(a), EPA has no minimum requirements for the number of carbon monoxide monitors that must be operated in a state. Carbon monoxide monitoring is required at Type 2 PAMS sites (40 CFR 58, Appendix D, Table D-6) and, beginning on January 1, 2011, at NCore sites (40 CFR 58, Appendix D 3(b)). Since the East Providence site is a Type 2 PAMS site and will become the State's NCore site, carbon monoxide monitoring will continue at that site.

The carbon monoxide monitor that is currently operating at the East Providence site will be replaced with a monitor that detects low ppb levels of that pollutant by January 2011, consistent with NCore requirements. This is appropriate because more than 75% of the hourly carbon monoxide measurements in 2009 were below the current instrument's Minimum Detection Level of 0.5 ppm.

Carbon monoxide monitoring at a site in downtown Providence was discontinued in 2007, after more than 30 years of monitoring at that site. Since carbon monoxide is often highest in downtown "urban canyon" areas, that site tended to record higher levels of carbon monoxide than those at other sites and, as such, was used to track maintenance of compliance with the carbon monoxide NAAQS in the State. When the downtown site was discontinued, EPA required RI DEM to revise its State Implementation Plan (SIP) to provide an alternative

[8] Note – Monitoring at Providence site (76 Dorrance Street in downtown Providence) was discontinued on June 28, 2007.

mechanism for tracking continued attainment of the carbon monoxide NAAQS in the State through September 2011. To comply with that requirement, RI DEM submitted the "Providence Carbon Monoxide Limited Maintenance Plan"[9] as a SIP revision to the EPA on September 22, 2008.

In that SIP revision, RI DEM committed to reestablishing a carbon monoxide monitoring site meeting EPA specifications in downtown Providence within six months if any of the following conditions occur before the end of September 2011:

- The East Providence 8-hour carbon monoxide design value increases to 5 ppm;
- Total carbon monoxide emissions for 2008 for Providence County from all anthropogenic source types exceed 190,883 tons per year or
- Average motor vehicle carbon monoxide emissions measured by the State's remote sensing program in any year between 2008 and 2011 exceed 0.39%.

The 2009 8-hour design value for the East Providence carbon monoxide monitor was 1.3 ppm, 26% of the trigger value cited above for reestablishing a monitor in Providence. 2008 emissions data are currently being compiled. Average motor vehicle carbon monoxide emissions were 0.14% in 2008, the most recent year that data are available for this parameter; that value is 36% of the above trigger value. Therefore, resumption of carbon monoxide monitoring in downtown Providence is not indicated at this time.

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 Providence area, where many sensitive individuals reside. The State's carbon monoxide monitor is located in Providence County, but is not at a location of maximum impact for that pollutant, since levels may be higher in urban canyon areas and in locations close to major roadways. As discussed above, carbon monoxide monitoring was conducted for more than 30 years at a site in downtown Providence which was considered a maximum impact 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 (average of 1.1 ppm) higher than at the East Providence site. Since the 2009 8-hour carbon monoxide design value for the East Providence monitor was 1.3 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.

[9] RI DEM, "Providence Carbon Monoxide Limited Maintenance Plan," September 2008, http://www.dem.ri.gov/programs/benviron/air/pdf/provcomp.pdf

Given the above considerations, RI DEM does not plan any changes in the State's carbon monoxide monitoring network in the next 18 months, with the exception of the deployment of a low-range monitor at the East Providence site by January 1, 2011.

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

The NAAQS for sulfur dioxide[10] are:

- 0.5 ppm - 3 hour average, not to be exceeded more than once per year (design value is the 2nd maximum 3-hour average concentration)
- 0.14 ppm - 24-hour average, not to be exceeded more than once per year (design value is 2nd maximum 24-hour average concentration)
- 0.03 ppm - annual average

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

- 0.048 ppm - 3 hour average, 10% of NAAQS, recorded at Brown University site
- 0.024 ppm - 24-hour average, 17% of NAAQS, recorded at Brown University site
- 0.0070 ppm - annual average, 23% of NAAQS, recorded at Brown University site

The 2009 sulfur dioxide design values are:

- 0.026 ppm - 3 hour average , 5% of NAAQS
- 0.013 ppm - 24-hour average, 9% of NAAQS
- 0.0022 ppm - annual average, 7% of NAAQS

The sulfur dioxide NAAQS has never been exceeded in the State and all measurements have been in the "Good" range of the AQI since 2001.

[10] An EPA rule amending the SO_2 NAAQS was signed on June 2, 2010. The rule revokes the annual and 24-hour NAAQS specified above and sets a new one-hour average NAAQS at 0.075 ppm. Revisions of monitoring networks consistent with the requirements in the rule must be in place by January 1, 2013. RI DEM will present its plan to comply with those requirements in future Annual Network Plans.

40 CFR 58, Appendix D 4.4(a) specifies that there are currently no minimum requirements for the number of sulfur dioxide monitors that must be operated in a state. However, RI DEM has continued to operate the sulfur dioxide monitor at Brown University in Providence in order to track trends in concentrations of that pollutant. That monitor has been operational since 1994. To fulfill NCORE requirements, a low-range sulfur dioxide monitor will be in operation at the East Providence site by January 1, 2011. RI DEM plans to continue to monitor for sulfur dioxide at the Brown University monitor for at least one year after the NCore monitor begins operation in order to compare levels of that pollutant measured at the two sites. After that relationship is established, RI DEM may file a request with EPA to discontinue operation of the Brown University SO_2 monitor.

The Brown University monitor is located in the City of Providence, the city with the greatest 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 tracked well with and were higher than those at the downtown site. Therefore, it appears that the SO_2 levels measured at the Brown University site are appropriate for characterizing SO_2 exposures to Providence residents.

Other than the initiation of operation of a low-range SO_2 monitor at the NCore site, no modifications to the current sulfur dioxide network are planned at this time. RI DEM may file a request with EPA to remove the Brown University monitor after one year of operation of the NCore monitor if it is determined that the NCore monitor makes the Brown site redundant.

Nitrogen Dioxide (NO_2)

The current nitrogen dioxide monitoring network is shown in Table 8:

Table 8 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 June-August
Alton Jones Campus Victory Highway West Greenwich	Regional (PAMS)	Population exposure Upwind background	Continuous June-August

The nitrogen dioxide NAAQS are:

- 100 ppb - 1 hour average (effective January 22, 2010). The design value is the average of the 98th percentile maximum daily hour measured in 3 consecutive years. The 98th percentile value corresponds approximately to the 8th highest daily maximum.

- 0.053 ppm (53 ppb) - annual average

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

- 60 ppb - 1 hour average, 60% of NAAQS
- 0.0178 ppm - annual average, 34% of NAAQS

Design values for 2009 are:

- 46 ppb - 1 hour average, 46% of NAAQS
- 0.0113 ppm annual average, 21% of NAAQS

The nitrogen dioxide NAAQS has never been exceeded in Rhode Island. Since there was no short-term NAAQS for nitrogen dioxide before January 2010, until this year, this pollutant was not used for the Air Quality Index (AQI). The amended nitrogen dioxide NAAQS rule, which was published on February 9, 2010[11], sets the range for a "Moderate" AQI at hourly levels of 54- 100 ppb. For the 5 year period 2005 – 2009, there were a total of 18 days when levels recorded in Rhode Island were in that range. No levels in the "Unhealthy for Sensitive Populations" or more serious AQI categories were recorded.

40 CFR 58, Appendix D 4.3(a) specifies that there are no minimum requirements for the number of nitrogen dioxide monitors that must be operated in a state. However, RI DEM has continued to operate the monitor that measures NO_2 and NO_x (NO_2 plus NO) at Brown University in Providence, in order to track trends in concentrations of those pollutants. NO_2/NO_x monitoring has been conducted at the Brown University site since 1994. In addition, monitors measuring NO_2 and NO_x are operated at the State's two PAMS sites (W. Greenwich and E. Providence) during June, July and August, in order to track the movement of ozone precursors during the peak ozone season. As discussed in the PAMS section below, the period of operation of those monitors will be extended to include the entire ozone season beginning in May 2010.

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 in a near-road location where maximum microscale-representative concentrations are expected. The State may also work with the EPA to identify an

[11] USEPA, "Primary National Ambient Air Quality Standards for Nitrogen Dioxide: Final Rule," FR 75(26):6474, 9 February 2010.

additional NO_2 site in an area of susceptible and/or vulnerable populations. Plans for these sites must be submitted to EPA by July 1, 2012 and the sites must be operational by January 1, 2013.

There are no immediate plans to use new technology for measuring NO_2 at Rhode Island sites for determining compliance with the NAAQS. As discussed in the NCore section of this document, a low-range monitor that measures NO and NO_y (total reactive nitrogen oxides) will be operational at the East Providence site by January 2011, consistent with the NCore requirements. The above cited NO_2 NAAQS rule states that "NO/NO_y measurements will produce conservative estimates for NO_2 that can be used to ensure tracking continued compliance with the NO_2 NAAQS.".

The currently operating NO_2 monitor, the Brown University monitor, is located in Providence, the Rhode Island city with the greatest concentration of children at risk from asthma. NO_2 concentrations measured at that site are substantially lower than the NAAQS for that pollutant, including the newly promulgated 1-hour average standard. However, as discussed above, RI DEM must evaluate its NO_2 network by July 2012 to identify monitoring locations that reflect maximum area-wide and near-roadway NO_2 concentrations. The current site may or may not meet the specifications for the area-wide monitoring site in the regulation and, if it does not, the monitor will be relocated. In addition, the July 2012 plan may request that EPA authorize monitoring at an additional monitor to measure exposures of particularly susceptible or vulnerable populations. All new monitoring sites, once approved by the EPA, will be operational by January 1, 2013

Particulate Matter:

Particles smaller than 10 microns (PM_{10})

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

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 Victory Highway West Greenwich	Regional	Upwind background	24-hour 1 in 6 day

The PM_{10} NAAQS is:

- 150 $\mu g/m^3$ - 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

- 62 $\mu g/m^3$ – 24-hour average, 41% of NAAQS, recorded at Vernon St. in 2009

The highest 2009 PM_{10} design value is:

- 52 $\mu g/m^3$ – 24-hour average, 35% of NAAQS, recorded at Vernon St.

The PM_{10} NAAQS has never been exceeded in Rhode Island and, since PM_{10} is measured using a filter-based method, results are not immediately available and are not used for Air Quality Index calculations.

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

PM_{10} samples are collected at the Urban League site in Providence because that site is part of the NATTS network and are analyzed for several toxic metals. Therefore, PM_{10} sampling at that location cannot be discontinued. The 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, if a site were to be discontinued, it would be the site at the Johnson & Wales Library in downtown Providence.

The Johnson & Wales site is approximately one mile from the Urban League location. In the six years that the Johnson & Wales site has been operational, the annual arithmetic mean PM_{10} levels at that site have been, on average, 1.8 $\mu g/m^3$ higher than those at the Urban League site and 2.8 $\mu g/m^3$ lower than at the Vernon Street, Pawtucket site. The EPA Correlation Matrix tool shows that PM_{10} levels at the Johnson & Wales site correlate well with those at the Urban League ($r^2 = 0.83$), with a minimal difference in the magnitude of concentrations (average relative difference 0.15 on a scale of 0 to 1). The Removal Bias tool shows an insignificant bias associated with removing the Johnson & Wales site from the network.

Since operation of the Johnson & Wales site is currently not resource-intensive, 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.

There are no immediate plans to use new technology for measuring PM_{10} in Rhode Island. Note that PM_{10} was measured with both hi-vol and lo-vol samplers at the Urban League site from January 1, 2007 through September 30, 2009 and those data are being used to evaluate the comparability of the two methods.

Since three of the four 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 that area to that pollutant.

Fine Particulate Matter (Particulate Matter smaller than 2.5 microns, or $PM_{2.5}$)

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

Table 10 $PM_{2.5}$ FRM/FEM Monitoring Network

SITE	MEASUREMENT SCALE	MONITORING OBJECTIVE	SCHEDULE
Vernon Trailer Vernon Street Pawtucket	Middle	Population exposure	24-hour 1 in 3 day
Hallmark Building 695 Eddy Street Providence	Urban	Population exposure	24-hour 1 in 3 day
Urban League 212 Prairie Avenue Providence	Neighborhood	Population exposure Highest concentration	24-hour daily
Francis School 64 Bourne Avenue E. Providence	Urban	Population exposure Highest concentration	24-hour daily
Alton Jones Campus Victory Highway West Greenwich	Regional	Population exposure General/Background Regional Transport	Continuous

Filter-based FRM $PM_{2.5}$ units are operated at the first four sites listed above and a FEM continuous $PM_{2.5}$ monitor is used at the West Greenwich site. Continuous $PM_{2.5}$ monitors are also operated at the Urban League site and at the US EPA Laboratory in Narragansett, but are not used to determine compliance with the NAAQS.

The $PM_{2.5}$ NAAQS are:

- 35 $\mu g/m^3$ - 24-hour average (design value is the 3-year average of the 98th percentile 24-hour concentration)
- 15 $\mu g/m^3$- 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)

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

- 32.4 $\mu g/m^3$ - 24-hour average, 93% of NAAQS, recorded at West Greenwich site
- 12.4 $\mu g/m^3$ - annual average, 82% of NAAQS, recorded at Vernon St.

The highest $PM_{2.5}$ design values for 2009 are:

- 25.8 $\mu g/m^3$ - 24-hour average, 74% of NAAQS, recorded at Vernon St.
- 10.4 $\mu g/m^3$ - annual average, 69% of NAAQS, recorded at Vernon St.

As stated above, a monitor is in violation of the 24-hour average $PM_{2.5}$ standard if the average of the 98th percentile 24-hour readings at that site in three consecutive years (the design value) is 35 $\mu g/m^3$ or higher. Although none of the monitors meet that criterion and thus none of the monitors are classified as nonattainment for the NAAQS, $PM_{2.5}$ levels at one or more sites in the State were at or above 35 $\mu g/m^3$ and, therefore, the air quality was unhealthy, on a total of eleven days in the past five years (2005 – 2009). Many members of the scientific community believe that the $PM_{2.5}$ NAAQS should be more stringent than it currently is, e.g. 30 $\mu g/m^3$, to be protective of public health. In the 2005-2009 period there were 33 days with concentrations at or above that concentration at one or more Rhode Island sites.

Table D-5 in 40 CFR 58, Appendix D 4.7.1(a) specifies that a MSA like the Providence MSA, which has 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 five $PM_{2.5}$ sites, exceeds that minimum requirement.

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

40 CFR 58, Appendix D 4.7.3 requires states to operate at least one site to measure 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, has been approved as fulfilling both of those requirements.

Although most of the current $PM_{2.5}$ FRM/FEM sites are concentrated in the Providence metropolitan area, RI DEM previously operated FRM sites in Chepachet, which is in northwest Rhode Island and in Narragansett, on the southeastern coast, for a three year period (2000 – 2002). The concentrations measured at those sites correlated well with those at the other sites and tended to be midway between those measured at the Alton Jones, West Greenwich background site and those at the more urban sites. Based on that observation, EPA approved the discontinuation of those sites at the end of 2002 and RI DEM believes that the current network adequately characterizes $PM_{2.5}$ concentrations throughout the State

As discussed above, RI HEALTH has identified Providence as the area of the State with the highest rates of childhood asthma. RI DEM operates two $PM_{2.5}$ monitoring sites (Eddy Street and Urban League) in an inner city Providence neighborhood and a third site (Vernon Street) at a location that is intended to be representative of urban neighborhoods that are adjacent to highways. Therefore, the current network adequately characterizes exposure to $PM_{2.5}$ for sensitive populations in the Providence area.

Since Rhode Island is operating more $PM_{2.5}$ FEM/FRM monitoring sites than the minimum number required, RI DEM conducted an analysis to determine whether any of those sites could be discontinued. The West Greenwich site cannot be removed from the network because it fulfills EPA's requirements for a regional background/transport site. As shown in Figures 7 and 8, the annual and 24-hour $PM_{2.5}$ design values for the Vernon Street site tend to be higher than at the other sites, so that site cannot be removed from the network. The East Providence site also cannot be removed because $PM_{2.5}$ monitoring is required at NCore sites.

Therefore, the only two sites that could potentially be removed are the Urban League and the Eddy Street sites, which are approximately 0.4 miles apart from each other in the south side of Providence. The $PM_{2.5}$ measurements at both of these sites for the period 2005-2009 correlate well with concurrent values at the other two urban sites, Vernon Street and East Providence ($r^2 \geq 85\%$) and the average relative differences in the concentrations at both the Urban League and the Eddy Street site and those at the Vernon Street and East Providence sites, calculated using the equation in the EPA Cormat Tool[12], were very low (≤ 0.04 on a scale of 0 to approximately 1.0).

[12] As documented in: Rizzo, M., EPA OAQPS/AQAD/AQAG, "Network Assessment Analyses and Tools Documentation," March 1, 2010. http://www.epa.gov/ttn/amtic/netassess/documentation/draft_Network_Assessment_tools_documentation.doc

As shown in Figure 8, 24-hour average $PM_{2.5}$ design values at the Eddy Street site tend to be similar to those at the East Providence sites. 24-hour design values tend to be slightly higher at the Urban League site and highest at the Vernon Street site. However, the 24-hour design values for all four of the urban sites are quite similar; for the most recent 3-year period, 2007-2009 the 24-hour design values ranged from 24.3 to 25.8 $\mu g/m^3$ at the four sites. Note that these values may be somewhat influenced by differences in sampling frequencies, since the Eddy Street and Vernon Street sites are on a one-in-three day schedule and the Urban League and East Providence sites operate daily. Figure 7 shows that the annual average $PM_{2.5}$ design values for the urban sites, which line up consistently as follows, in order of highest to lowest level: Vernon Street, Eddy Street, Urban League and East Providence.

Since $PM_{2.5}$ concentrations at both the Urban League and Eddy Street sites tend to be lower than at Vernon Street, the removal of those sites would not be likely to result in an underestimation of $PM_{2.5}$ concentrations in the Providence metropolitan area. However, maintenance of at least one of those sites is important to provide information about typical $PM_{2.5}$ concentrations in urban Rhode Island neighborhoods that are not immediately adjacent to a highway.

RI DEM is not proposing to eliminate either of these sites at this time. $PM_{2.5}$ has been measured at the Urban League site since the inception of that monitoring program in 1997, and so measurements at that site provide useful long-term trends data. In addition, RI DEM measures a number of other parameters at that location, including PM_{10}, PM_{10} metals, continuous $PM_{2.5}$, black carbon, volatile organic compounds, semi-volatile compounds and carbonyls, so that site provides a comprehensive picture of exposures of potential public health concern in the urban area of the State. The Eddy Street site, which has been operational since 2004, is located in an area that is in flux due to nearby highway reconstruction. RI DEM plans to continue $PM_{2.5}$ monitoring at that site at least until the new highway pattern is completed, at which time the usefulness of continued operation of the site will be reevaluated. .

40 CFR 58, Appendix D 4.7.2 requires states to operate, at a minimum, the number of continuous $PM_{2.5}$ monitors equal to half of the number of $PM_{2.5}$ FRM sites required in Table D-5. At least one continuous monitor in each MSA must either be a FEM monitor or be co-located with a FRM monitor. Since Table D-5 requires Rhode Island to operate two $PM_{2.5}$ FRM/FEM sites, the State must operate at least one continuous $PM_{2.5}$ monitor. As discussed above, Rhode Island is currently operating three continuous $PM_{2.5}$ monitors, one of which (West Greenwich) is a FEM instrument and one of which (Urban League) is co-located with a FRM. Therefore, RI DEM is more than fulfilling the Appendix D requirements for continuous monitors. Note that, to fulfill NCore requirements, a continuous FEM $PM_{2.5}$ will be operational at the East Providence site by January 1, 2011.

Although the number of continuous $PM_{2.5}$ monitoring sites operating in the State exceeds minimum requirements, RI DEM has no plans to discontinue monitoring at any of those sites. These monitors provide essential timely data needed for predicting the AQI, issuing health alerts and tracking daily concentrations. Concentrations recorded by the Narragansett monitor are

representative of coastal conditions, the W. Greenwich monitor represents the inland southern and central part of the State and the Urban League monitor represents conditions in the Providence metropolitan area.

RI DEM is in the process of replacing its continuous $PM_{2.5}$ equipment with FEM units. By January 1, 2011, all four of the continuous monitors will be FEM units. As discussed above, a continuous FEM unit has been operating at the W. Greenwich site since December 2008 as the primary method of determining compliance with the $PM_{2.5}$ NAAQS at that site. 40 CFR 58 Appendix A 3.2.5.2(b) states that, if a state is operating a FEM unit at only one site, that monitor must be co-located with a FRM monitor for quality assurance purposes. 40 CFR 58 Appendix A 3.2.5.7 specifies that co-located monitors at SLAMS sites must be operated on a 12-day schedule. To evaluate comparability of the FEM and FRM methods, RI DEM is operating a FRM unit at the Alton Jones site, co-located with the FEM. The FRM is operated on a 6-day schedule, which exceeds the minimum quality assurance co-location requirements in Appendix A.

The installation of FEM continuous units at the E. Providence and Urban League sites, co-located with FRM monitors, will allow RI DEM to compare the FEM and FRM data at those sites as well. Since the continuous units provide real-time data that are invaluable for forecasting, tracking and providing information to the public about $PM_{2.5}$ levels, RI DEM anticipates a gradual conversion of many of its filter-based FRM sites to continuous FEM monitors.

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). RI DEM currently collects $PM_{2.5}$ speciation samples on a one-in-three day schedule at the Urban League site, which is part of the STN network. To fulfill NCore requirements, $PM_{2.5}$ speciation monitors will be moved to the East Providence site by January 2011 and that site will become Rhode Island's STN site.

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. Beginning in January 2007, Rhode Island monitored for $PM_{10-2.5}$ on a one-in-six day at the Urban League site by co-locating a lo-vol PM_{10} unit with the $PM_{2.5}$ FRM unit at that site. $PM_{10-2.5}$ was calculated by subtracting $PM_{2.5}$ mass measurements from the concurrent PM_{10} lo-vol measurements. The PM_{10} lo-vol unit was removed at the end of September 2009 because the equipment was needed to meet $PM_{2.5}$ FRM co-location requirements. During the period that the monitor operated, the $PM_{10-2.5}$ fraction accounted for, on average, 44% of the total PM_{10} mass.

To fulfill NCore requirements, $PM_{10-2.5}$ monitoring will be conducted at the East Providence site beginning on or before January 1, 2011, as discussed below in the NCore section of this document. That parameter will be measured using a Partisol Plus 2025D Sequential Dichotomous Air Sampler that was recently purchased by RI DEM and which will allow for the measurement of this parameter using a single instrument.

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RI DEM does not intend to add or remove any $PM_{2.5}$ monitoring sites in the next 18 months. As discussed above, Rhode Island will begin operating a continuous $PM_{2.5}$ monitor and a $PM_{10-2.5}$ monitor at the East Providence site and will move the $PM_{2.5}$ speciation equipment from Urban League to the East Providence site by January 2011 to be consistent with NCore requirements

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, NO_x and VOC species and to evaluate the spatial and diurnal variability of those pollutants. Those data are used 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.

40 CFR 58, Appendix D 5.1 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.

40 CFR 58, Appendix D 5.3 requires two PAMS sites, including a Type 2 site, in each serious and above nonattainment area. Since Rhode Island was a serious nonattainment area for the one-hour average ozone NAAQS that was in effect at the time the enhanced monitoring requirements were promulgated, a PAMS network was established in the State. The Alton Jones monitoring site in W. 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 that currently serves both as the Type 3 (downwind) site for the Providence area and the Type 1 (upwind) site for the Boston area.

40 CFR 58 Appendix D 5.2 establishes the PAMS monitoring period as, at a minimum, the months of June, July and August, when ozone concentrations are expected to be highest. Table D-6 of Appendix D to 40 CFR 58 requires the following types of monitoring at PAMS sites:

- *Speciated VOC monitoring during the PAMS season at two sites per area, one of which is a Type 2, during the PAMS season using one of the following schedules/methods:*

    - *Hourly automated gas chromatograph readings;*
    - *Eight 3-hour canisters per day;*
    - *One morning and one afternoon canister with a 3-hour or less averaging time plus continuous total non-methane organic compound (TNMOC) measurements*.

  Rhode Island has chosen the second option, and, as such, collects eight 3-hour VOC samples per day at the East Providence (Type 2) station. Eight 3-hour samples are collected every third day during the PAMS season at the Type 3 station in Milton, MA. Eight 3-hour VOC samples per day are also collected at the Type 1 site in W. Greenwich during a limited number of ozone episodes in the summer months.

- *Eight 3-hour carbonyl samples per day during the PAMS season at the Type 2 site in areas classified as serious or above for the 8-hour ozone standard*. Since Rhode Island has never had a classification higher than "moderate" for that NAAQS, this requirement does not currently apply to the State. However, Rhode Island presently collects eight 3-hour samples every third day at the Type 2 site during the PAMS season. RI DEM will reevaluate that schedule in the future.

- *NO_x, hourly, at Type 2 sites during the ozone season*. Rhode Island currently measures NO_x only during the PAMS season at both the Type 1 and Type 2 site. Since the PAMS season (June-August) is shorter than the ozone season (currently April –September), Rhode Island will increase the time period that NO_x is monitored at the Type 1 and Type 2 sites, effective June 2010, to be consistent with the CFR requirements. NO_x is also measured by MA DEP at the Milton, MA site, the Type 3 site for Rhode Island, during the ozone season.

- *Reactive nitrogen oxides (NO_y) at one site per area (a Type 3 or Type 1 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. Note that a NO_y monitor will be operational at the East Providence site by January 1, 2011 to fulfill NCore requirements but, since the E. Providence site is a Type 2 PAMS site, measuring NO_y at that site will not fulfill the current PAMS NO_y requirements. .

- *Carbon monoxide (ppb level) at the Type 2 site during the ozone season*. Rhode Island currently measures CO year round at the Type 2 station. The current CO monitor at that site will be replaced by a low-range (ppb) monitor by January 1, 2011, to fulfill NCore requirements, and will continue to be operated year-round.

- *Ozone at all PAMS sites during the ozone season*. Ozone is measured during the ozone season at all three sites. By January 1, 2011, ozone will be measured year-round at the Type 2 site, to fulfill NCore requirements.

- *Surface meteorology parameters at all PAMS sites during the ozone season*. Surface meteorological parameters are measured at all three sites year-round.

- *Upper air meteorology at one representative location within the PAMS area*. Rhode Island uses the upper air data collected at the Brookhaven, New York meteorological site to fulfill the PAMS requirements

Note that the PAMS program is now under review to determine whether changes in site locations, pollutants monitored, or monitoring methods are necessary to obtain the most appropriate data for assessing ozone formation and transport of ozone and precursors. RI DEM does not anticipate that this review will recommend a change in the Rhode Island PAMS site locations, but changes in monitoring methods, parameters measured, or monitoring schedules may be indicated as a result of those recommendations.

Air Toxics

RI DEM conducted a year long air toxics monitoring study measuring VOCs, carbonyls and metals at five sites in the Providence metropolitan area beginning in May 2001 as part of an EPA pilot project aimed at informing the design of a national air toxics monitoring network. In 2002, one of the pilot sites, the Urban League site in Providence, became a part of the new National Air Toxics Trends Stations (NATTS) network, which now includes 27 sites nationwide[13]. 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 at the Urban League building in an urban residential area in South Providence approximately ½ mile west of I-95. The Urban League building houses a variety of community services, including a health clinic and day care center. This site was chosen as the State's NATTS site because it is not dominated by local sources and because the results of the pilot study indicated that levels of air toxics at this site appear to be representative of urban levels in the State

The requirements for NATTS sites are specified in an EPA Technical Assistance Document (TAD).[14] The TAD requires monitoring of meteorological variables, including wind direction,

[13] USEPA, "National Air Toxics Trends Stations (NATTS) Network," last updated December 22, 2009. http://www.epa.gov/ttn/amtic/files/ambient/airtox/nattsite.pdf

[14] Eastern Research Group for the USEPA, OAQPS, "Technical Assistance Document for the National Air Toxics Trends and Assessment Program," February 28, 2007.

wind speed, temperature, relative humidity, precipitation, barometric pressure, and solar radiation. In Rhode Island, wind speed, wind direction, temperature and relative humidity are measured at the NATTS site. Barometric pressure, precipitation and solar radiation are measured at the State's Type 2 PAMS site in East Providence, approximately 3.3 miles northeast of the NATTS site.

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

Volatile Organic Compounds (VOC)

- Acrolein
- Perchloroethylene (tetrachloroethylene)
- Benzene
- Carbon tetrachloride
- Chloroform
- Trichloroethylene
- 1,3-butadiene
- 1,2-dichloropropane
- Dichloromethane
- 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)

Semi-Volatile Organic Compounds (SVOC)

- Benzo(a)pyrene
- Napthalene

VOC, carbonyls and PM_{10} metal samples are analyzed by RI HEALTH. Hexavalent chromium and SVOC samples are analyzed by an EPA contractor. Consistent with the TAD guidance, the

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http://www.epa.gov/ttn/amtic/airtox.html

following sampling/analytical methods are used for measuring the pollutants at the NATTS site:

- TO-15 for VOC;
- TO-11A for all carbonyls;
- IO 3.5 for PM10 metals;
- Modified CARB Method 039 for TSP hexavalent chromium; and
- TO-13A/ASTM D 6209 for SVOCs.

Minimum Detection Levels for those analyses are consistent with EPA guidance. Sampling is conducted at the NATTS site 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 W. Greenwich and E. Providence and at the Vernon Street, Pawtucket site, which is adjacent to I-95 in Pawtucket. 24-hour carbonyl samples are collected at the E. Providence site on the same schedule.

In addition, RI DEM/ RI HEALTH operate aethalometers, which measure black carbon, an indicator of diesel exhaust, at the Urban League NATTS site and the E. Providence Type 2 PAMS site.

RI DEM is not planning any changes to the ozone precursor or air toxics monitoring sites in the next 18 months

Lead (Pb)

On November 12, 2008, the EPA promulgated an amended NAAQS for lead (FR 73:66964); the new NAAQS, which is an order of magnitude more stringent than the previous value, included additional monitoring requirements for that pollutant. The regulation required two types of lead monitoring: source- specific monitoring in the vicinity of each lead source that emits 1.0 or more tons of lead per year, to begin by January 1, 2010 (40 CFR 58 Appendix D 4.5(a)) and one population- based monitor in each Core Based Statistical Area (CBSA) with a population of 500,000 or more beginning in January 1, 2011 (40 CFR 58 Appendix D 4.5(b)). Since the Providence MSA has a population in excess of 500,000, Rhode Island would be required to operate one population-based monitor under the terms of that rule. The State has no sources emitting one ton or more of lead per year and so would not be required to operate any source-specific monitors. To fulfill the requirement for a population-based monitor, RI DEM planned to measure lead at the Urban League NATTS site.

However, on December 23, 2009, the EPA proposed a revision of its lead monitoring requirements (74 FR 69050). The modified requirements, which are expected to be promulgated in mid-2010, reduce the trigger for source-specific monitoring requirements from 1.0 to 0.5 tons per year and replace the requirement for population-based monitoring with a specification that lead monitoring must be conducted at all NCore sites.

The change in the source-specific monitoring trigger does not change Rhode Island's status, because there are no sources that emit 0.5 tons or more of lead in the State. This was determined using the following sources:

- A file compiled by the EPA and posted on EPA's CHIEF website that lists lead emissions from point sources; those data were extracted from the 2002 National Emissions Inventory (NEI) and the 2005 Toxics Release Inventory (TRI).[15] The three largest lead emitters in Rhode Island identified in that file are:
    - Narragansett Bay Commission Sewage Sludge Incinerator[16] 97 pounds
    - Woonsocket Waste Water Treatment Facility 26 pounds
    - Teknor Apex 17 pounds;
- The Rhode Island stationary source emissions inventory database for 2005. The three largest lead emitters identified from that database are three sewage sludge incinerators:
    - Narragansett Bay Commission Sewage Sludge Incinerator[6] 79 pounds
    - Cranston Water Pollution Control Facility 43 pounds
    - Woonsocket Waste Water Treatment Facility 24 pounds
- A review of Rhode Island emissions inventory forms for eleven stationary sources identified by EPA Region 1 as possible lead emitters based on those companies' NAICS or SIC codes. None of these sources were determined to be significant lead emitters; and
- Lead emissions data associated with general aviation activity at Rhode Island airports, as estimated by EPA's Office of Transportation and Air Quality (OTAQ).[17] OTAQ estimated 2002 Rhode Island airport emissions as follows:
    - TF Green Airport 474 pounds
    - North Central State Airport 337 pounds
    - Newport State Airport 71 pounds
    - Quonset State Airport 60 pounds
    - Block Island State Airport 51 pounds
    - Westerly State Airport 19 pounds

Those data were derived for calendar year 2002; since the number of operations of general aviation and air taxi aircraft, the aircraft that use lead-containing aviation gasoline, has decreased since 2002, current lead emissions are likely to be even lower. Specifically, the number of annual

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[15] Available on the EPA CHIEF website at: http://www.epa.gov/ttn/chief/net/2005inventory.html

[16] No longer operational

[17] EPA OTAQ, Lead Emissions from the Use of Leaded Aviation Gasoline in the Unite States: Technical Support Document, October 2008, available on the CHIEF website at http://www.epa.gov/ttn/chief/net/tsd_avgas_pb_inventory_2002.pdf

general aviation and air taxi operations decreased between 2002 and 2008 from 81,205 to 46,927 at TF Green and from 31,487 to 4,715 at North Central.[18]

Therefore, no source-specific lead monitors are required for Rhode Island under the existing or the proposed amended requirements. The amendments also would not change the requirement that one non-source-specific monitor be operated in the State to determine compliance with the new lead NAAQS. However, if the amendments are finalized as proposed, Rhode Island will be required to site that monitor at the E. Providence NCore site, rather than at the Urban League site, as originally planned. In keeping with this requirement, Rhode Island plans to begin operating a FRM lead monitor at the E. Providence site by January 1, 2011.

The indicator associated with the new lead NAAQS is, as with the previous NAAQS, lead in Total Suspended Particulate Matter (Pb-TSP). However, 40 CFR 58, Appendix C 2.10.1.1 stipulates that: "Pb-PM_{10} samplers can be approved for use at the non-source-oriented sites required under paragraph 4.5(b) of Appendix D to part 58 if there is no existing monitoring data indicating that the maximum arithmetic 3-month mean Pb concentration (either Pb-TSP or Pb-PM_{10}) at the site was equal to or greater than 0.10 micrograms per cubic meter during the previous 3 years.

Rhode Island does not currently monitor lead in ambient air using approved FRM or FEM methodology. However, the State does measure lead, as well as several other metals, at the Urban League site using methodology approved for the NATTS program; collection with a hi-vol PM_{10} monitor and analysis with an ICP/MS. Figure 9 shows the 3-month rolling average levels of lead in PM_{10} measured at that site during the most recent 3-year period (2007 – 2009). The highest 3-month average measured during that period, 0.0047 $\mu g/m^3$, is 3% of the NAAQS and less than 5% of the level that would trigger the need to conduct TSP monitoring.

Therefore, RI DEM plans to measure lead at the E. Providence NCore site using a lo-vol PM_{10} monitor. RI HEALTH has been developing methodology to analyze the lo-vol filters using a ICP/MS detector but, since that methodology has not yet been approved as a FEM, Rhode Island will out-source the analysis to another state that has XRF capability until the ICP/MS method is approved. As specified in the lead NAAQS rule, sampling will be conducted on a one-in-six day schedule.

[18] Federal Aviation Administration, Terminal Area Forecast. http://aspm.faa.gov/main/taf.asp

National Core (NCore) Multi-pollutant Monitoring Stations Network

On October 17, 2006, the EPA published a Federal Register notice (FR 71:61236) revising the ambient air monitoring requirements in 40 CFR parts 53 and 58. The revised rule requires the establishment of a network of core multipollutant monitoring (NCore) stations. At these stations, states will monitor for a number of pollutants; for several of the pollutants, low-range monitors will be employed to enable the quantification of lower pollutant concentrations than those currently measured. The NCore Network will replace the current National Air Monitoring Station (NAMS) networks and must be operational by January 1, 2011.

The NCore Network addresses the following monitoring objectives:

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

As required, RI DEM submitted a plan to EPA in July 2009 detailing its intentions to establish a NCore site at the State's Type 2 PAMS site in E. Providence. Ozone, NO_2/NO_x, CO, $PM_{2.5}$ (FRM), VOCs, carbonyls, black carbon and meteorological parameters are currently monitored at that site. The required NCore parameters and monitoring schedules are listed in Table 11 below. All equipment will be operational by January 1, 2011.

In keeping with the NCore specifications, the current CO monitor will be replaced by a low-range instrument. The SO_2 monitor that will be operated at that site is also a low-range instrument. In the 2009 plan, RI DEM requested a waiver to the requirement that NO_y be measured at the site and asked to substitute a low-range NO_x monitor for the NO_y equipment. Although the plan provided a number of examples of co-located NO_x and NO_y monitors at Type 2 PAMS sites in other states which produced very similar data, in November 2009 the EPA denied all such waiver requests. Therefore, Rhode Island has purchased NO_y monitoring equipment which will be operating at the E. Providence site by January 1, 2011.

In addition, Rhode Island has purchased a dichotomous PM sampler, which measures the coarse fraction of PM_{10} ($PM_{10-2.5}$) and a continuous $PM_{2.5}$ FRM Beta Attenuation Monitor; that equipment will also be operational at the site by January 1, 2011. With the exception of the request for a waiver of NO_y monitoring requirements, the Rhode Island NCore plan was approved by the EPA on October 30, 2009.[19]

Rhode Island's status for installing and operating NCore equipment at the East Providence is summarized in the Table 11:

Table 11 NCore Parameters, Equipment, Schedule and Status

Parameter	Equipment Type	Operating Schedule	Current Status
$PM_{2.5}$ FRM Mass	$PM_{2.5}$ FRM (Lo-Vol)	Daily (Minimum Requirement 1 in 3 day)	Operating at Site
$PM_{2.5}$ Speciation	SASS with URG Carbon Channel	1 in 3 Day	Operating at another site (Urban League) Will be moved to NCore site by 1/1/11
$PM_{10-2.5}$ FRM Mass	Partisol Plus 2025D Sequential Dichotomous Air Sampler	1 in 3 Day	At the site, will be fully operational by 1/1/11
Continuous $PM_{2.5}$ Mass	Beta Attenuation Monitor (FEM)	Continuous (1 hour reporting interval)	On order
Ozone	FRM	Continuous (1 hour reporting interval)	Operating, will operate year-round beginning in 2011
Carbon monoxide	Low Range CO Monitor	Continuous (1 hour reporting interval)	On order, fully operational at site by 1/1/11

[19] Letter from Robert C. Judge, Air Monitoring Coordinator, EPA-New England to Barbara Morin, RI DEM, dated April 1, 2010.

Parameter	Equipment Type	Operating Schedule	Current Status
Nitrogen oxides	Low Range NO/NO_y Monitor	Continuous (1 hour reporting interval)	Purchased, fully operational at site by 1/1/11
Sulfur dioxide	Low Range SO_2 Monitor	Continuous (1 hour reporting interval)	On order, fully operational at site by 1/1/11
Surface meteorology	Wind speed, wind direction, temperature, relative humidity, precipitation and solar radiation monitors	Continuous (1 hour reporting interval)	Operating

Note that monitoring for VOCs, carbonyls, NO_2/NO_x and black carbon will also continue at the East Providence site.

Summary of Proposed Changes in the Rhode Island Monitoring Network

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

- The East Providence ozone monitor will be operated year-round beginning in 2011. Rhode Island may increase the monitoring period for the other two ozone monitors when EPA finalizes the rule amendments that address that issue.

- In keeping with NCore requirements, Rhode Island will begin monitoring for $PM_{10-2.5}$, continuous $PM_{2.5}$ mass, low-range SO_2 and low-range NO/NO_y at the E. Providence site by January 1, 2011. The CO monitor at that site will be replaced by a low-level CO monitor and the $PM_{2.5}$ speciation monitor will be moved to that site by the same date.

- In keeping with the lead NAAQS monitoring requirements, Rhode Island will begin monitoring for lead in PM_{10}, using FRM or FEM methodology, at the E. Providence NCore site by January 1, 2011.

- By January 1, 2011, all of the continuous $PM_{2.5}$ monitors operating in the State will be FEM units.

- If operation of the PM_{10} monitoring at Johnson & Wales in Providence becomes problematic, RI DEM may ask EPA to be allowed to discontinue that site.

- Monitoring of NO_x at the Type 1 and Type 2 PAMS sites (W. Greenwich and E. Providence) will be extended to include the entire ozone season (April – September), beginning in June 2010.

- As funds become available, RI DEM will begin to convert its $PM_{2.5}$ FRM network to equivalent continuous instruments.

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 (2010)
Continuous Monitors
Site Locations

Figure 2
PM-10 Air Pollution Monitoring Network
(2010)
Site Locations

Figure 3
PM-2.5 Air Pollution Monitoring Network
(2010)
Site Locations

Figure 4
Air Toxics Monitoring Network (2010)
Site Locations

Figure 5 Rhode Island Population Trends by County (1990 - 2008)

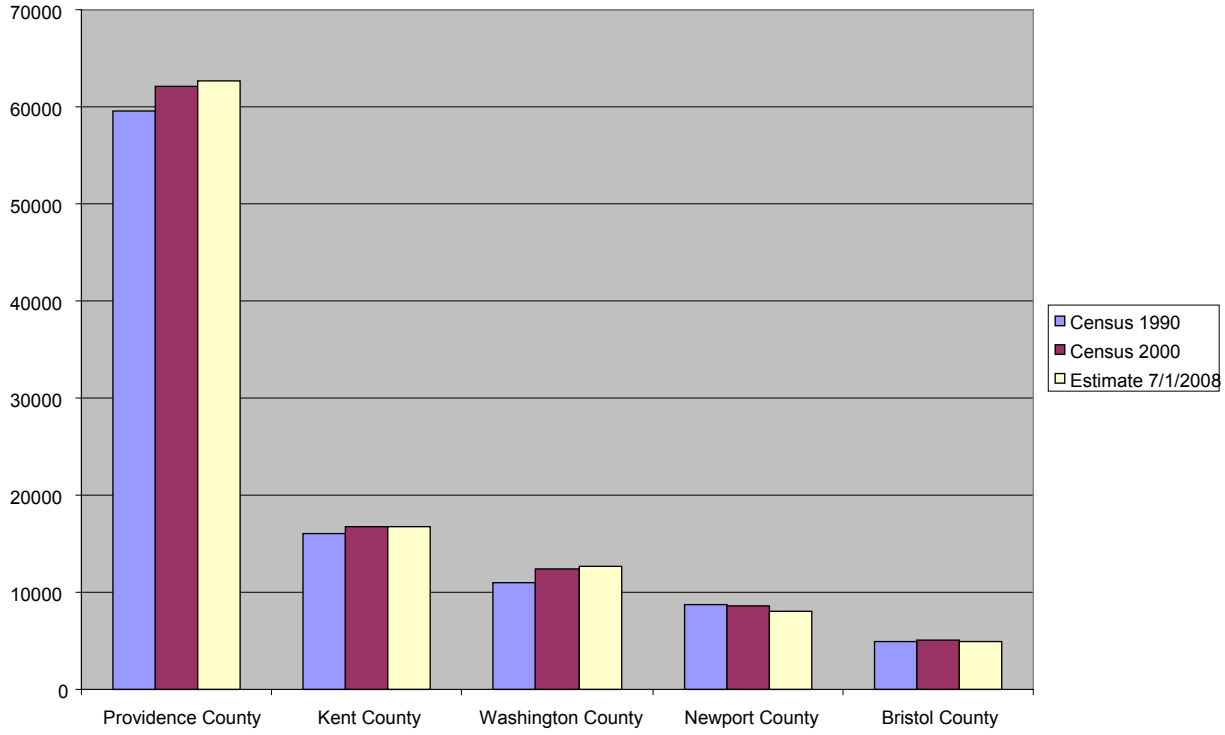

Figure 6 Population Trends in Rhode Island's Largest Cities (1990 - 2008)

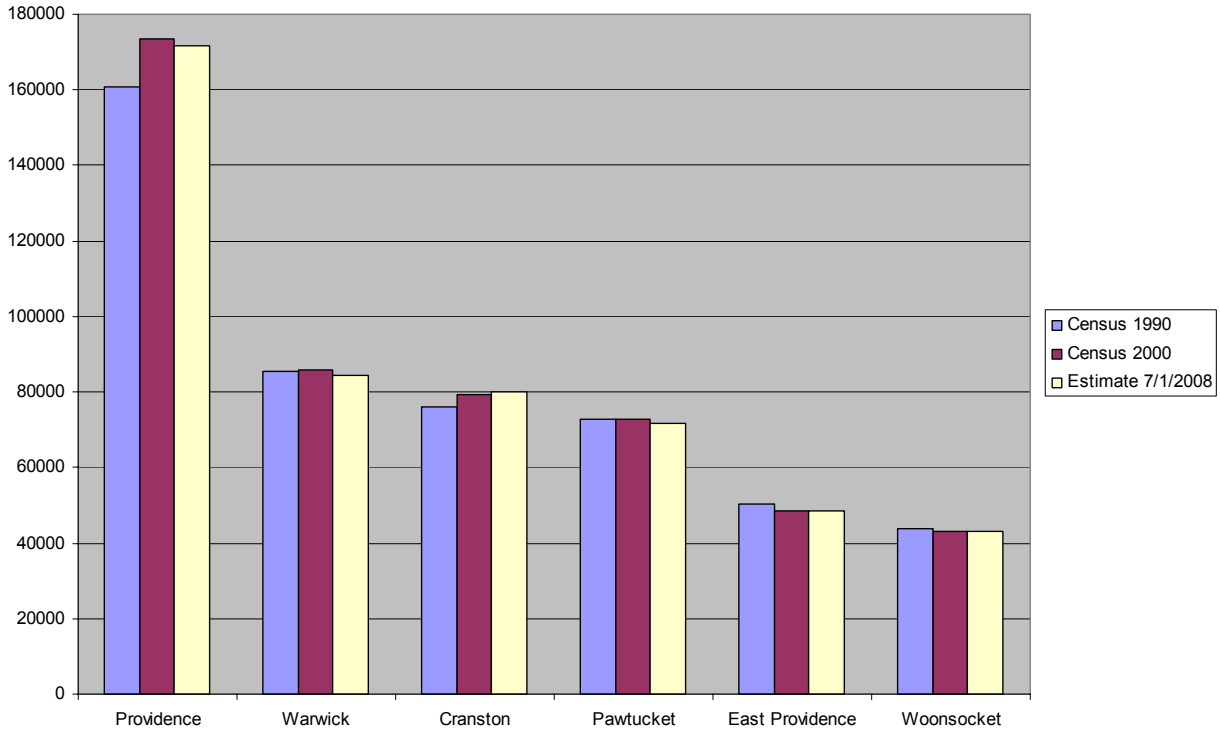

Figure 7 PM2.5 Annual Average Design Value

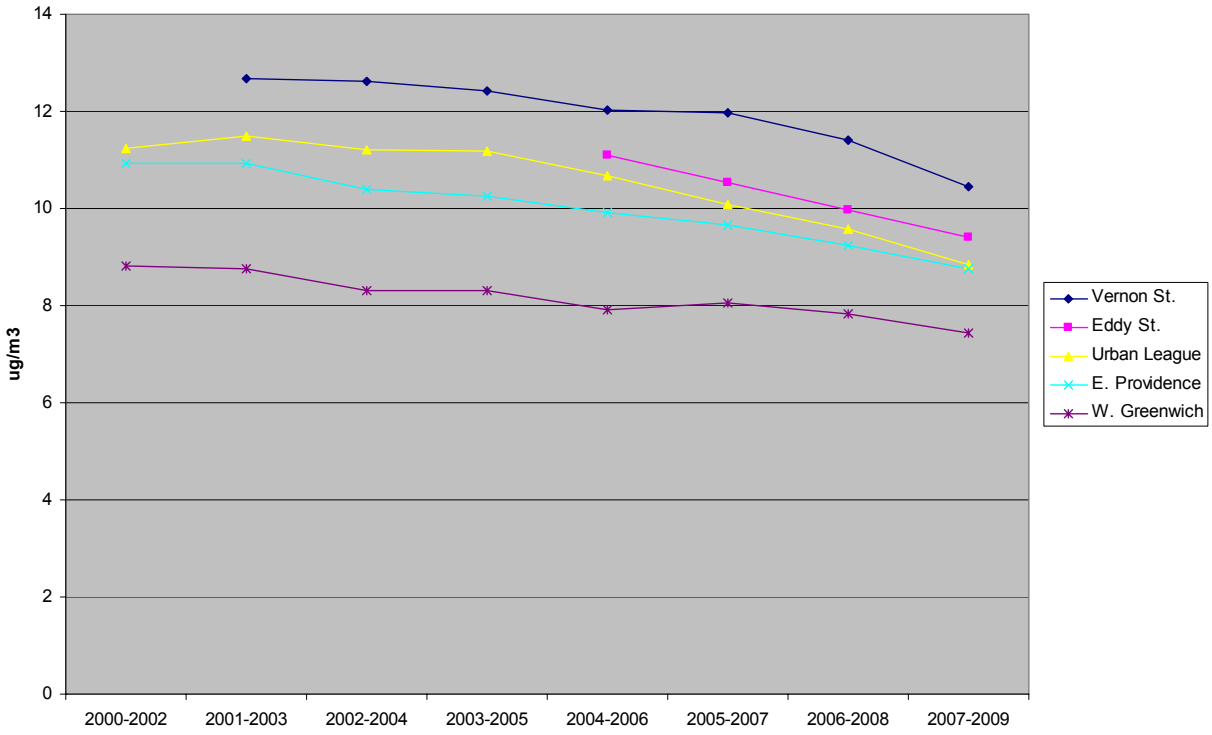

Figure 8 24-hour PM2.5 Design Values

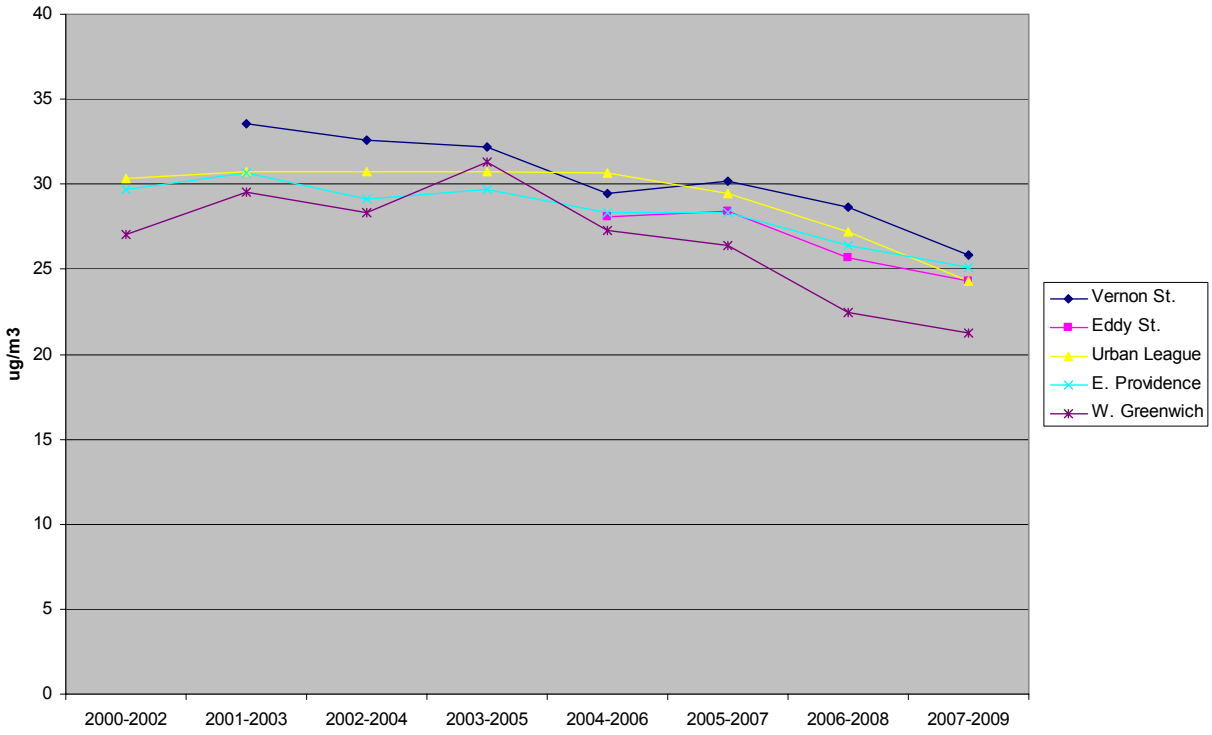

Figure 9 Rolling 3-Month Average - Lead in Hi-Vol PM10 - Urban League Site