2015
Five Year Network Assessment of the Philadelphia Air Quality Surveillance System

City of Philadelphia
Department of Public Health
Air Management Services

July 1, 2015

EXECUTIVE SUMMARY

Starting July 1, 2010, and every five years thereafter, 40 CFR Part 58.10(d) requires the City of Philadelphia's Department of Public Health, Air Management Services (AMS) to submit to the United States Environmental Protection Agency (EPA) an assessment of the air quality surveillance system (Assessment). This Assessment focuses primarily on Ozone and Particulate Matter of less than 2.5 microns ($PM_{2.5}$) using network assessment tools provided by the Lake Michigan Air Directors Consortium (LADCO). This Assessment also covers the other criteria pollutants of Carbon Monoxide (CO), Sulfur Dioxide (SO_2), Nitrogen Dioxide (NO_2), Lead (Pb), and Particulate Matter of less than 10 microns (PM_{10}), in addition to air monitoring equipment needs and costs for the next five years.

This Assessment supplements the Air Monitoring Network Plan (Plan) submitted on July 1, 2015. The Assessment and Plan provide a comprehensive review of the Philadelphia air monitoring network and the relative value of each monitor and station. In general, the Assessment determined that the AMS network still meets the monitoring objectives. The results of this Assesment are as follows:

- $PM_{2.5}$: The commitment to EPA requires five $PM_{2.5}$ monitoring sites. AMS has transitioned to continuous/FEM monitors as the primary monitor at all locations with the exception of LAB (AQS ID 421010004).

- Ozone: AMS currently operates 3 ozone monitors.

- Other Pollutants: The trends for CO, SO_2, NO_2, Pb, and PM_{10} show large declines over the past 10 years and are well below the corresponding NAAQS. AMS operates two near-road NO_2 monitors.

- Monitoring Equipment: There is a need to replace many of the current air monitoring devices within the next five years. Many of the indirect air monitoring equipment will approach or exceed the expected life span and may require replacement. The cost of replacement for many of the analysis machines is significant when compared to the cost of individual monitors.

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INTRODUCTION / REGULATORY REQUIREMENT

Philadelphia has an air monitoring network of twelve air monitoring stations that house instruments that measure ambient levels of gaseous, solid and liquid aerosol pollutants. It is operated by the City of Philadelphia, Department of Public Health, Air Management Services (AMS), the local air pollution control agency for the City of Philadelphia. This network is part of a broader network of air monitoring agencies in Pennsylvania, New Jersey, Delaware and Maryland that make up the Philadelphia-Wilmington-Atlantic City, PA-NJ-DE-MD Metropolitan Statistical Area (MSA).

The United States Environmental Protection Agency (EPA) created regulations on how the air monitoring network is to be set up. These regulations can be found in Title 40 - Protection of Environment in the Code of Federal Regulations (CFR) Part 58 – Ambient Air Quality Surveillance, located online at: http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?sid=5bedef69a2b6781c32e6aa76b2f98429&c=ecfr&tpl=/ecfrbrowse/Title40/40cfrv6_02.tpl.

Beginning July 1, 2007, and each year thereafter, AMS has submitted to EPA Region III, an Air Monitoring Network Plan (Plan) which assures that the network stations continue to meet the criteria established by federal regulations.

Per 40 CFR Part 58.10(d), AMS shall perform and submit to EPA Region III an assessment of the air quality surveillance system every 5 years to determine, at a minimum, if the network meets the monitoring objectives defined in 40 CFR Part 58 appendix D, whether new sites are needed, whether existing sites are no longer needed and can be terminated, and whether new technologies are appropriate for incorporation into the ambient air monitoring network. The network assessment must 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 for any sites that are being proposed for discontinuance, the effect on data users other than the agency itself, such as nearby States and Tribes or health effects studies. AMS must submit a copy of this 5-year assessment (Assessment), along with a revised Plan, to EPA Region III. The first Assessment was submitted July 1, 2010.

This Assessment, in combination with the Plan, provides a comprehensive review of the Philadelphia air monitoring network and the relative value of each monitor and station with consideration of data users such as nearby States or health effect studies, using tools provided by EPA. It covers the National Ambient Air Quality Standards (NAAQS), Air Toxics, and meteorological monitoring networks and associated technology for which AMS has responsibility, with an emphasis on those NAAQS associated with high human health risk. This Assessment helps to optimize the network to achieve, with limited resources, the best possible scientific value and protection of public and environmental health and welfare, focusing on pollutants that are new or persistent challenges, addressing multiple, interrelated air quality issues, and deemphasizing pollutants that are steadily becoming less problematic and better understood.

NETWORK ASSESSMENT TOOLS

The R-based network assessment tools developed by Michael Rizzo from EPA's Office of Air Quality Planning and Standards (OAQPS) for the 2010 Assessment were updated and enhanced by a subset of the Lake Michigan Air Directors Consortium (LADCO) workgroup for the 2015 Assessment. The updated tools are now web-based and available to all state and local agencies at http://ladco.github.io/NetAssessApp/index.html.

Data for the web-based network assessment tools (Tools) were based on 2011 – 2013 data. Active site and monitor records were taken from EPA's Air Quality System (AQS) as of April 2014 including daily maximum 8 hour ozone, daily maximum 24 hour PM2.5 data, and design value trends for all criteria pollutants.

The Tools aid in the network assessment to answer two questions:

- Which sites are redundant and could possibly be either removed or relocated?
- Where is more information needed to better characterize air quality and could, therefore, use a new site?

The Tools are used as a weight of evidence in deciding whether or not to keep a site or possibly establish a new site. These Tools include the area served, correlation matrix, exceedance probabilities, and removal bias.

The area served tool uses a spatial analysis technique known as Voronoi or Thiessen polygons to show the area represented by a monitoring site. The shape and size of each polygon is dependent on the proximity of the nearest neighbors to a particular site. All points within a polygon are closer to the monitor in that polygon than to any other monitor. Once the polygons are calculated, data from the 2010 decennial census are used to find the census tract centroids within each polygon. The population represented by the polygon is calculated by summing the populations of these census tracts.

The correlation matrix tool calculates and displays the correlation, relative difference, and distance between pairs of sites. The purpose of this tool is to provide a means of determining possible redundant sites that could be removed. Possible redundant sites would exhibit fairly high correlations consistently across all of their pairings and would have low average relative difference despite the distance. Usually, it is expected that correlation between sites will decrease as distance increases. However, for a regional air pollutant such as ozone, sites in the same air shed can have very similar concentrations and be highly correlated. More unique sites would exhibit the opposite characteristics. They would not be very well correlated with other sites and their relative difference would be higher than other site to site pairs.

The correlation matrix tool generates a graphical display that summarizes the correlation, relative difference and distance between pairs of monitoring sites. Within the graphical display, the shape of the ellipses represents the Pearson squared correlation between sites. Circles represent zero correlation and straight diagonal lines represent a perfect correlation. The correlation between two sites quantitatively describes the degree of relatedness between the measurements made at two sites. That relatedness could be caused by various influences including a common source affecting both sites to pollutant transport caused meteorology. The correlation, however, may indicate whether a pair of sites is related, but it does not indicate if one site consistently measures pollutant concentrations at levels substantially higher or lower than the other. For this purpose, the color of the ellipses represents the average relative difference between sites.

The correlation matrix tool uses daily summary pollutant concentration data for ozone and fine particles collected between January 1, 2011 and December 31, 2013. Data was retrieved using EPA's AQS AMP 435 daily summary report. For ozone, the correlation matrix tool calculates a Pearson correlation (r) for all valid 8-hour average ozone concentration pairs (DURATION CODE=W, DAILY CRITERIA IND=Y). In the AMP 435 Report, the daily maximum 8-hour ozone concentration is stored in the field labeled "MAX VALUE". Individual monitoring sites are identified using the AQS Site ID, which is a combination of the state code, county code, and site ID fields (XX-XXX-XXXX). If a site has more than one monitor collecting ozone data, the daily maximum 8-hour ozone concentration is the average of all valid results for that site on that date. For PM2.5, the correlation matrix tool calculates Pearson Correlations (r) for all valid 24-hour fine particle concentration pairs stored under AQS parameter codes 88101 (PM2.5 Local Conditions - FRM/FEM/ARM) or 88502 (Acceptable PM2.5 AQI & Speciation Mass). The correlation matrix tool allows users to calculate correlations between all monitors reporting data under parameter code 88101 or 88502. The tool does not allow users to calculate correlations across these parameter codes. For parameter code 88101, within the settings menu of the Tool, users can select whether correlations should be calculated using data from FRM monitors only, FEM monitors only, or all available data stored under parameter code 88101 (FRM and FEM data). Individual monitoring sites are identified using the AQS Site ID, which is a combination of the state code, county code, and site ID fields (XX-XXX-XXXX). If a site has more than one monitor collecting PM2.5 data, the daily average PM2.5 concentration is the average of all valid results for that site on that date.

The exceedance probabilities tool consists of maps for spatial comparisons. One objective of the network assessment is to determine if new sites are needed. In order to make that decision, it is helpful to have some estimation of the extreme pollution levels in areas where no monitors currently exist. The Tool provides ozone and PM2.5 maps of the contiguous US that can be used to make spatial comparisons regarding the probability of daily values exceeding a certain threshold.

The surface probability maps do not show the probability of violating the National Ambient Air Quality Standards (NAAQS). They provide information about the spatial distribution of the highest daily values for a pollutant (not, for example, the probability of the 4th highest daily 8-hour ozone maximum exceeding a threshold).

These maps are intended to be used as a spatial comparison and not for probability estimates for a single geographic point or area. The probability estimates alone should not be used to justify a new monitor. The maps should be used in conjunction with existing monitoring data. If a monitor has historically measured high values, then the probability map gives an indication of areas where you would expect to observe similar extreme values. This information, along with demographic and emissions data, could be used in a weight of evidence approach for proposing new monitor locations.

The surface probability maps were created by using EPA/CDC downscaler data. Downscaler data are daily estimates of ground level ozone and PM2.5 for every census tract in the continental US. These are statistical estimates from “fusing” photochemical modeling data and ambient monitoring data using Bayesian space-time methods. For more details on how the data were generated, see the meta data document on the EPA website. Daily downscaler estimates for 8-hour maximum ozone and 24-hour mean PM2.5 for the years 2007 and 2008 were obtained from the EPA website. Years 2009-2011 were obtained from the CDC’s Environmental Public Health Tracking Program
Removal Bias

The removal bias tool is meant to aid in determining redundant sites. The bias estimation uses the nearest neighbors to each site to estimate the concentration at the location of the site if the site had never existed. This is done using the Voronoi Neighborhood Averaging algorithm with inverse distance squared weighting. The squared distance allows for higher weighting on concentrations at sites located closer to the site being examined. The bias was calculated for each day at each site by taking the difference between the predicted value from the interpolation and the measured concentration. A positive average bias would mean that if the site being examined was removed, the neighboring sites would indicate that the estimated concentration would be larger than the measured concentration. Likewise, a negative average bias would suggest that the estimated concentration at the location of the site is smaller than the actual measured concentration.

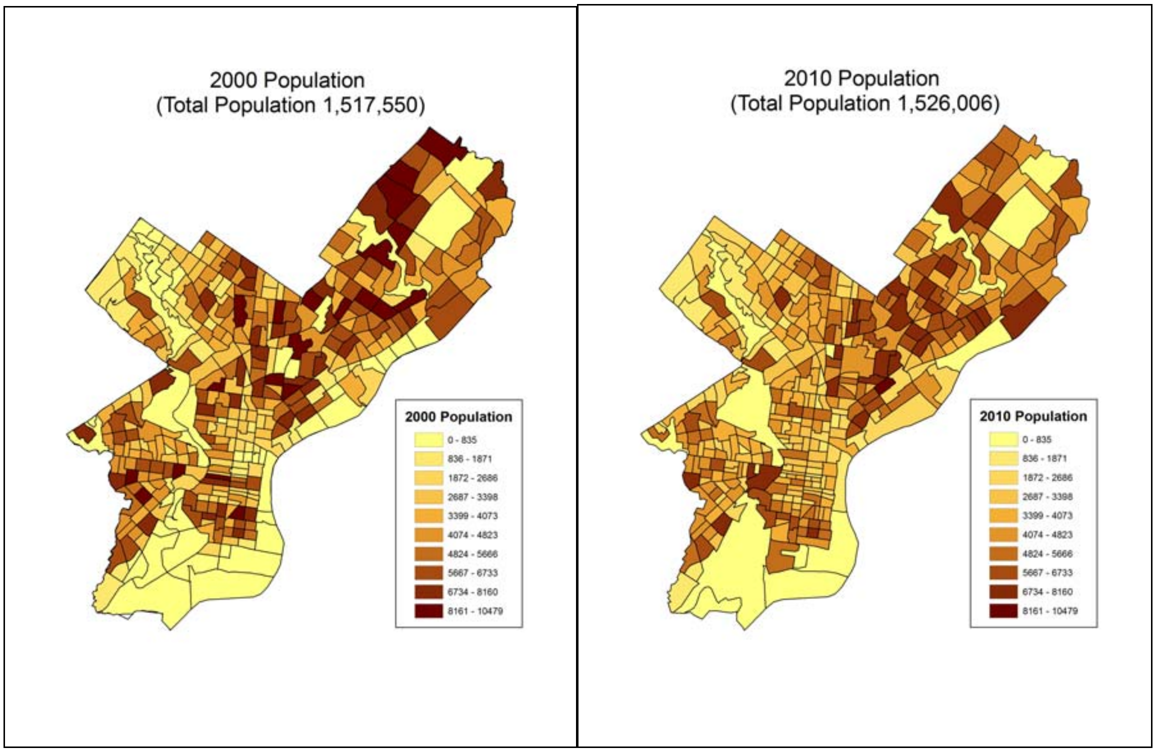
PURPOSE/GOALS OF ASSESSMENT

The goals of the air monitoring network are to protect the health and quality of life for the citizens of Philadelphia from the adverse effects of air contaminants. To achieve this goal, air monitors are placed in areas of high concentrations or high populations. Based on 2010 census data, Philadelphia ranked as the 5th largest city in United States with a population of 1,526,006 people. Figure 1 shows the population by census tracts in 2000 and 2010.

Currently, Philadelphia County is in attainment for all NAAQS except for Ozone. The Philadelphia-Wilmington-Atlantic City, PA-NJ-MD-DE 8-hour Ozone nonattainment area consists of eighteen counties in Pennsylvania (Bucks, Montgomery, Chester, Delaware, and Philadelphia), New Jersey (Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester, Mercer, Ocean, and Salem), Maryland (Cecil), and Delaware (Kent, New Castle, and Sussex). As of July 1, 2015, this area is classified as marginal nonattainment for the 2008 8-hour Ozone standard. The NEA monitor is one of the highest design value monitors in the region.

This Assessment focuses mainly on Ozone and $PM_{2.5}$. The other criteria pollutants are briefly discussed.

Figure 1 – 2000 and 2010 Population for Philadelphia County



NETWORK ASSESSMENT

$PM_{2.5}$

Monitoring Introduction

AMS currently monitors $PM_{2.5}$ (FRM, continuous, or speciated) at six monitoring sites[1]. The focus of this discussion pertains to $PM_{2.5}$ monitors designated as the primary monitor at each location. Table 1 and Figure 2 show the $PM_{2.5}$ monitoring network in and around Philadelphia County. Tables 2 and 3 show trends for the annual and 24-hour averages for $PM_{2.5}$[2].

[1] The count assumes that CHS is shut down, MON is operating, and does not include EPA's Village Green monitor (VGR; see 2015-2016 Air Monitoring Network Plan for more information)
[2] $PM_{2.5}$ data from EPA's AQS (AMP480 report) downloaded 4/13/2015.

Table 1 – $PM_{2.5}$ Monitoring Sites

AMS Site	AQS Site ID	$PM_{2.5}$ Monitor	Comment
LAB	421010004	FRM	
CHS	421010047	Continuous	Discontinued 7/1/2015
NEW	421010048	Continuous; Speciated	
RIT	421010055	Continuous; Speciated	
FAB	421010057	Continuous	
TOR	421010075	Continuous	
MON	421010076	Continuous	To begin 7/1/2015

Figure 2 – $PM_{2.5}$ Monitoring Sites in and around Philadelphia County

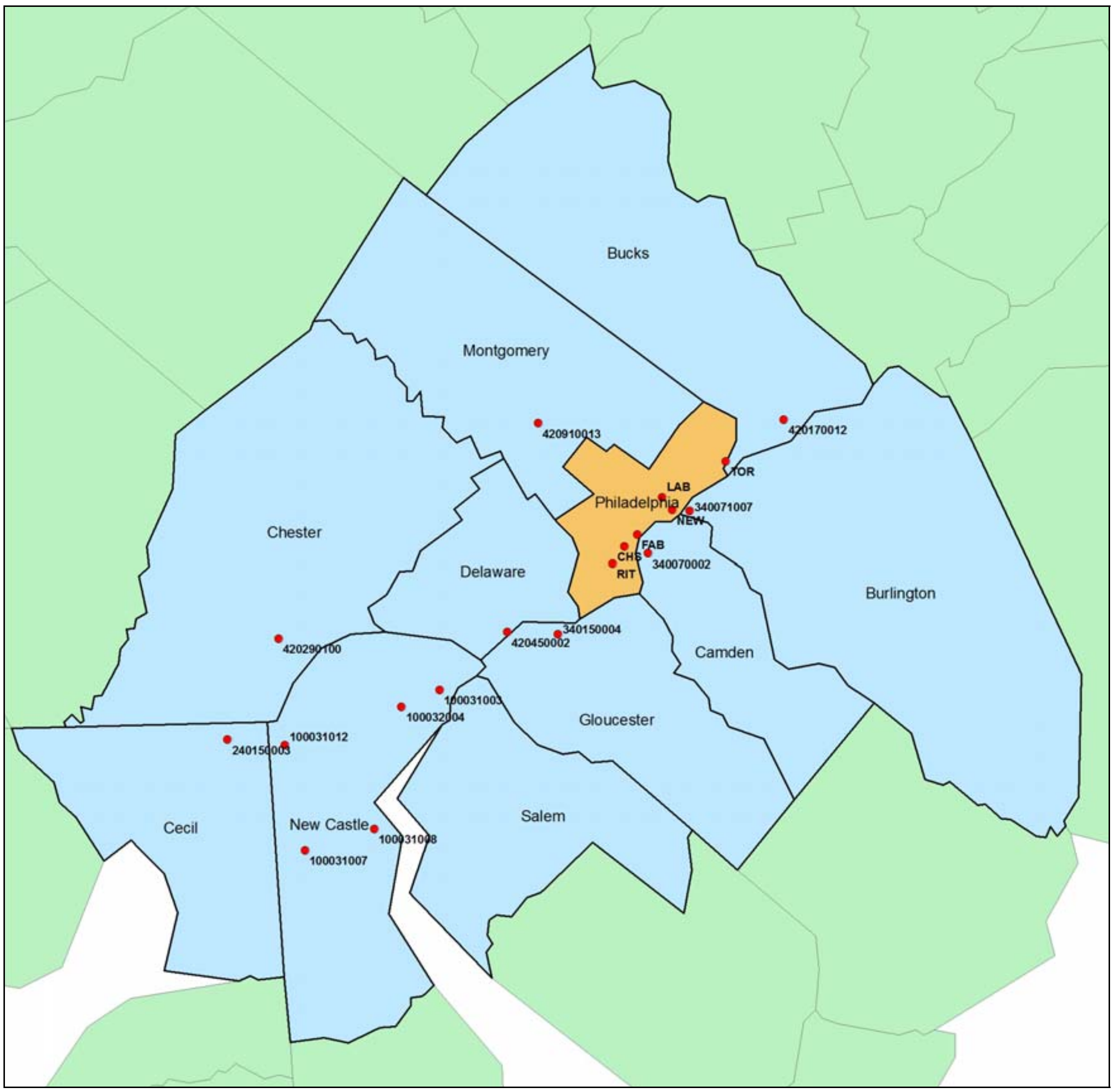


Table 2 – $PM_{2.5}$ Annual Arithmetic Mean (μg/m^3)

YEAR	LAB	CHS	NEW	RIT	FAB	TOR
2005	14.2	15.1				
2006	13.6	15.5				
2007	13.7	14.3			12.0	
2008	13.0	13.5		13.5	13.3	
2009	10.8	11.1		11.3	11.1	
2010	10.7	11.0		11.3	10.9	
2011	8.9	11.4		11.4	11.4	
2012	9.7	10.2		10.3	10.1	
2013	9.2	9.6	10.9	11.5	10.5	
2014	9.8	11.1	11.0	12.7	11.9	11.8

Table 3 – $PM_{2.5}$ 24 Hour (98th Percentile) (μg/m^3)

YEAR	LAB	CHS	NEW	RIT	FAB	TOR
2005	35.9	39.4				
2006	38.6	48				
2007	35.4	39.7			33.1	
2008	34.5	37.6		34.5	32.8	
2009	25.9	37.4		28.6	28.3	
2010	27.6	31.6		28.9	27.9	
2011	23.7	32.1		30.6	30.5	
2012	21.1	24.2		24.8	23.3	
2013	35.1	28.4	35.3	29.8	25.5	
2014	28.2	25.5	28.4	30.8	31.7	27.3

Correlation Matrix Tool

Tables 4 – 8 and Figure 3 show the correlation matrix for all monitoring sites in Philadelphia except for TOR. The following discussion excludes NEW due to the limited number of pairs (n).

In general, the correlations and average relative differences for the Philadelphia monitors had two noticeable trends. LAB, CHS, and RIT were moderately correlated (correlations less than 0.9) with neighboring and Philadelphia monitors. The relative differences were consistent amongst these three monitors. FAB had higher correlations (greater than 0.9) with neighboring and Philadelphia monitors although the relative differences were similar to those of LAB, CHS, and RIT.

Figure 3 – $PM_{2.5}$ FRM/FEM Daily Correlation Matrix, All Sites

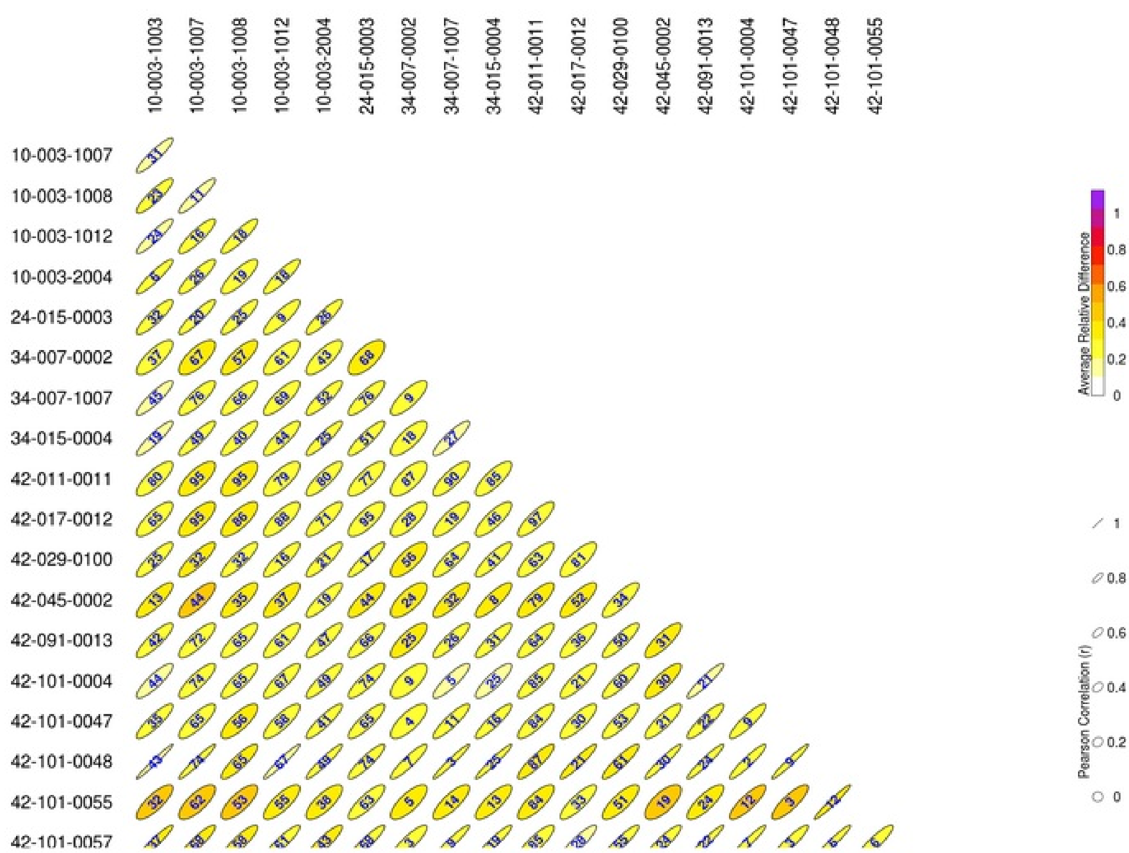


Table 4 – $PM_{2.5}$ Correlation Matrix for LAB

Site 1	Site 2	Correlation	n	Rel. Diff	Distance (km)
LAB	10-003-1003	0.870	173	0.197	44
LAB	10-003-1007	0.843	154	0.266	74
LAB	10-003-1008	0.850	195	0.263	65
LAB	10-003-1012	0.857	163	0.225	67
LAB	10-003-2004	0.885	323	0.23	49
LAB	24-015-0003	0.861	309	0.278	74
LAB	34-007-0002	0.699	104	0.281	9
LAB	34-007-1007	0.876	184	0.152	5
LAB	34-015-0004	0.855	188	0.196	25
LAB	42-011-0011	0.858	324	0.273	85
LAB	42-017-0012	0.848	325	0.253	21
LAB	42-029-0100	0.872	300	0.226	60
LAB	42-045-0002	0.839	310	0.302	30
LAB	42-091-0013	0.932	325	0.173	21
LAB	CHS	0.892	305	0.229	9
LAB	NEW	0.935	68	0.285	2
LAB	RIT	0.848	185	0.433	12
LAB	FAB	0.961	169	0.269	7

Table 5 – $PM_{2.5}$ Correlation Matrix for CHS

Site 1	Site 2	Correlation	n	Rel. Diff	Distance (km)
CHS	10-003-1003	0.879	323	0.24	35
CHS	10-003-1007	0.828	308	0.3	65
CHS	10-003-1008	0.791	198	0.367	56
CHS	10-003-1012	0.834	305	0.242	58
CHS	10-003-2004	0.9	985	0.21	41
CHS	24-015-0003	0.86	939	0.252	65
CHS	34-007-0002	0.757	180	0.275	4
CHS	34-007-1007	0.891	329	0.21	11
CHS	34-015-0004	0.9	334	0.206	16
CHS	42-011-0011	0.846	988	0.253	84
CHS	42-017-0012	0.831	991	0.266	30
CHS	42-029-0100	0.856	896	0.26	53
CHS	42-045-0002	0.862	894	0.297	21
CHS	42-091-0013	0.89	989	0.251	22
CHS	LAB	0.892	305	0.229	9
CHS	NEW	0.968	73	0.226	9
CHS	RIT	0.841	221	0.41	3
CHS	FAB	0.92	171	0.287	3

Table 6 – $PM_{2.5}$ Correlation Matrix for NEW

Site 1	Site 2	Correlation	n	Rel. Diff	Distance (km)
NEW	10-003-1003	0.982	26	0.197	43
NEW	10-003-1007	0.964	24	0.24	74
NEW	10-003-1008	0.872	75	0.37	65
NEW	10-003-1012	0.967	26	0.137	67
NEW	10-003-2004	0.949	74	0.231	49
NEW	24-015-0003	0.899	71	0.29	74
NEW	34-007-0002	0.91	24	0.239	7
NEW	34-007-1007	0.97	22	0.216	3
NEW	34-015-0004	0.967	25	0.227	25
NEW	42-011-0011	0.89	75	0.326	87
NEW	42-017-0012	0.939	75	0.309	21
NEW	42-029-0100	0.907	69	0.321	61
NEW	42-045-0002	0.955	69	0.218	30
NEW	42-091-0013	0.951	75	0.246	24
NEW	LAB	0.935	68	0.285	2
NEW	CHS	0.968	73	0.226	9
NEW	RIT	0.972	62	0.304	12
NEW	FAB	0.962	71	0.244	6

Table 7 – $PM_{2.5}$ Correlation Matrix for RIT

Site 1	Site 2	Correlation	n	Rel. Diff	Distance (km)
RIT	10-003-1003	0.806	73	0.433	32
RIT	10-003-1007	0.754	65	0.464	62
RIT	10-003-1008	0.766	195	0.44	53
RIT	10-003-1012	0.794	70	0.384	55
RIT	10-003-2004	0.77	231	0.384	38
RIT	24-015-0003	0.843	223	0.281	63
RIT	34-007-0002	0.763	71	0.331	5
RIT	34-007-1007	0.808	74	0.387	14
RIT	34-015-0004	0.807	77	0.385	13
RIT	42-011-0011	0.797	236	0.303	84
RIT	42-017-0012	0.851	236	0.274	33
RIT	42-029-0100	0.805	224	0.368	51
RIT	42-045-0002	0.701	214	0.441	19
RIT	42-091-0013	0.813	236	0.388	24
RIT	LAB	0.848	185	0.433	12
RIT	CHS	0.841	221	0.41	3
RIT	NEW	0.972	62	0.304	12
RIT	FAB	0.901	159	0.256	6

Table 8 – $PM_{2.5}$ Correlation Matrix for FAB

Site 1	Site 2	Correlation	n	Rel. Diff	Distance (km)
FAB	10-003-1003	0.949	56	0.309	37
FAB	10-003-1007	0.907	47	0.336	68
FAB	10-003-1008	0.88	177	0.334	58
FAB	10-003-1012	0.911	52	0.252	61
FAB	10-003-2004	0.894	174	0.303	43
FAB	24-015-0003	0.921	170	0.213	68
FAB	34-007-0002	0.872	54	0.231	3
FAB	34-007-1007	0.95	55	0.238	9
FAB	34-015-0004	0.941	58	0.241	19
FAB	42-011-0011	0.855	177	0.201	85
FAB	42-017-0012	0.896	177	0.177	28
FAB	42-029-0100	0.918	171	0.251	55
FAB	42-045-0002	0.905	166	0.268	24
FAB	42-091-0013	0.964	177	0.253	22
FAB	LAB	0.961	169	0.269	7
FAB	CHS	0.92	171	0.287	3
FAB	NEW	0.962	71	0.244	6
FAB	RIT	0.901	159	0.256	6

Area Served Tool

Figure 4 shows the results for the six $PM_{2.5}$ monitoring sites in Philadelphia. The population statistics are shown in Table 9.

Figure 4 – $PM_{2.5}$ FRM Area Served

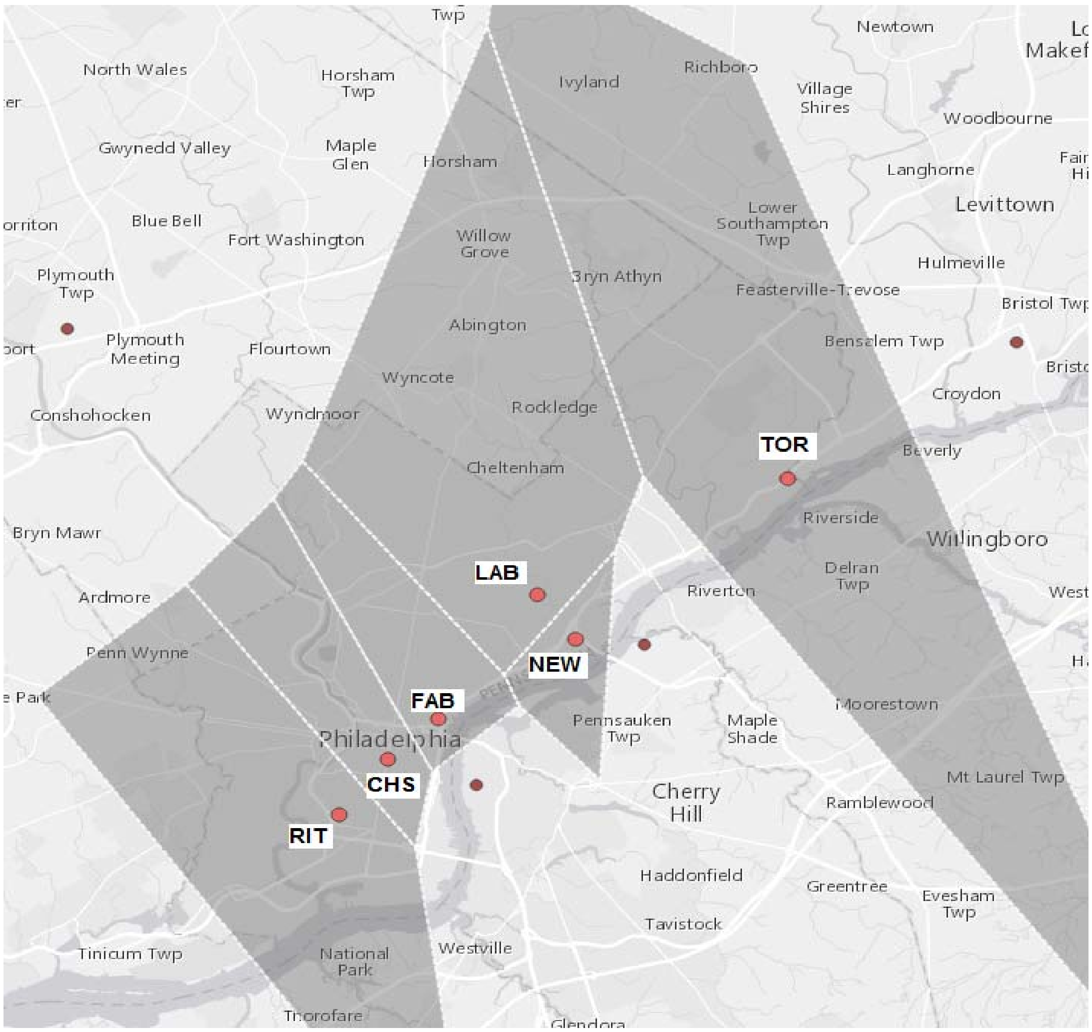


Table 9 – $PM_{2.5}$ FRM Area Served Population Statistics (Voronoi Polygon)

SITE	TOTAL POPULATION (2010)	TOTAL AGE 65 AND UP	TOTAL MINORITY	TRACT AREA (km^2)	POPULATION DENSITY (per km^2)
LAB	621,469	74,682	380,166	72	8,632
CHS	249,891	31,458	106,411	19	13,152
NEW	53,347	4,757	27,688	8	6,668
RIT	475,667	56,825	315,464	65	7,318
FAB	201,119	21,157	134,859	17	11,831
TOR	395,416	68,794	71,117	146	2,708

Exceedance Probabilities Tool

Surface probability maps for the entire United States and Philadelphia area are shown in Figures 5 and 6. The maps do not show the probability of exceeding the NAAQS but instead provide information about the spatial distribution of the highest daily values for $PM_{2.5}$ and are intended for to be used for spatial comparison.

Figure 5 – Daily $PM_{2.5}$ Surface Probability Map for Entire United States

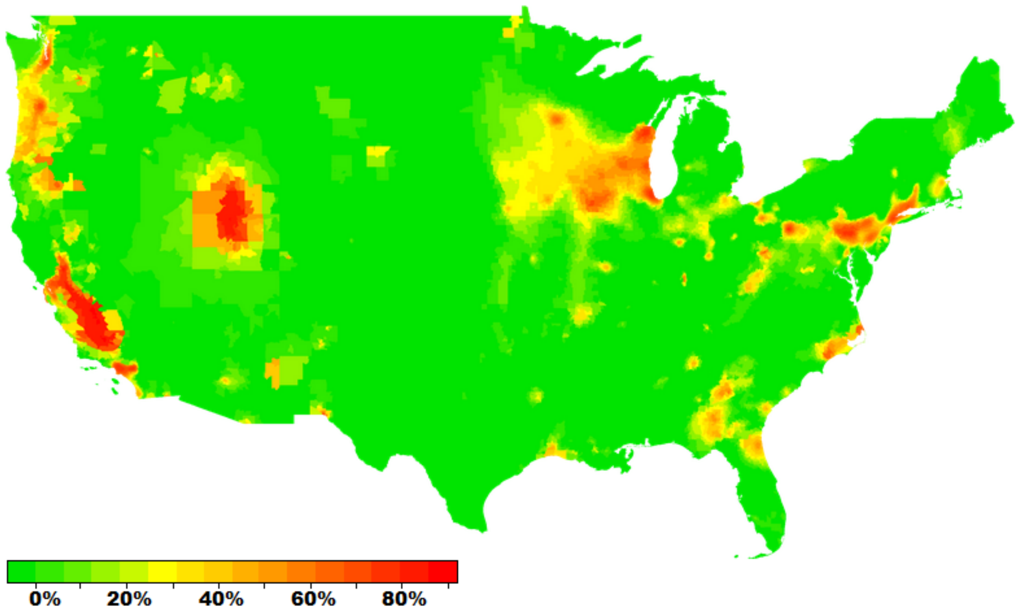
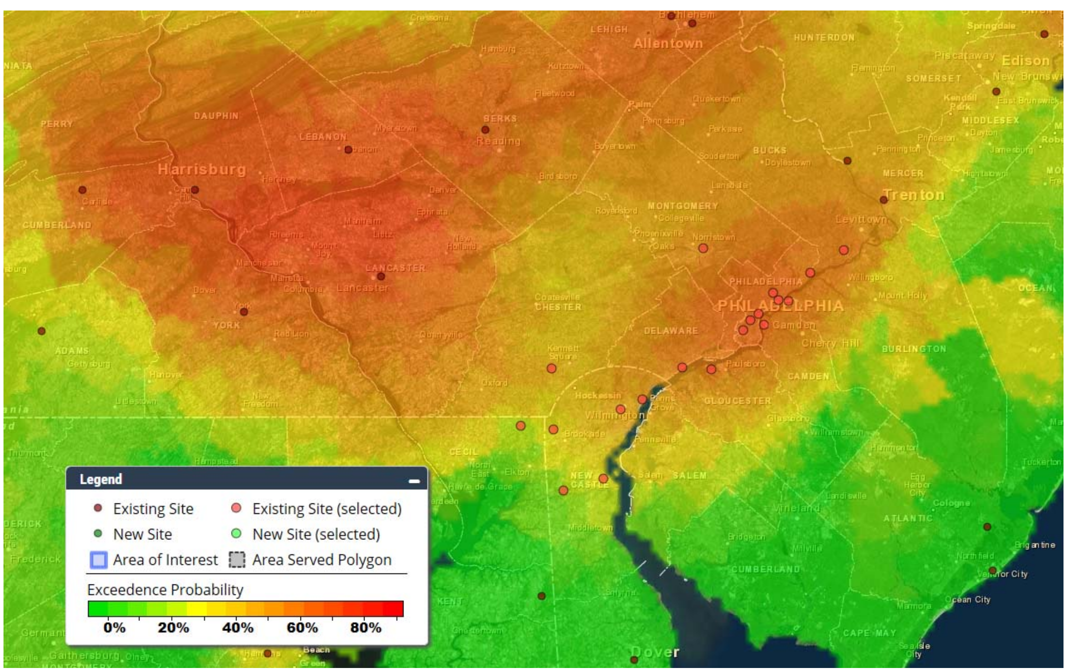


Figure 6 – Daily $PM_{2.5}$ Surface Probability Map of Philadelphia Area



Removal Bias Tool

The results from the removal bias tool are shown in Figure 7 and Table 10. LAB, NEW, RIT, and FAB had either a positive or negative mean removal bias. CHS had a very neutral removal bias indicating it may be a redundant site.

Figure 7 – Removal Bias Map for Philadelphia

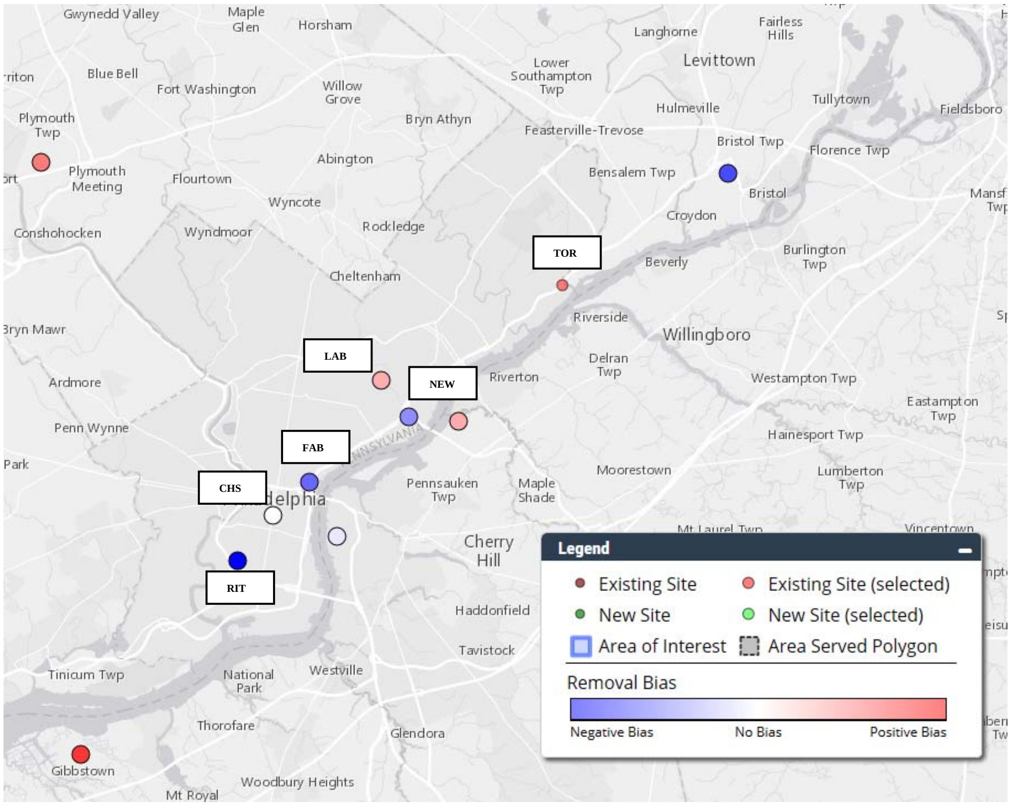


Table 10 – Removal Bias Summary for Philadelphia

SITE ID	MEAN REMOVAL BIAS (µg/m³)	MIN REMOVAL BIAS (µg/m³)	MAX REMOVAL BIAS (µg/m³)	REMOVAL BIAS STANDARD DEVIATION	NEIGHBORS INCLUDED	MEAN RELATIVE REMOVAL BIAS (%)	MIN RELATIVE REMOVAL BIAS (%)	MAX RELATIVE REMOVAL BIAS (%)
LAB	0.895	-7.35	18	2.446	6	39	-78	8975
CHS	0.0573	-15.9	18.8	3.111	4	8	-85	602
NEW	-1.2225	-6.29	7.42	2.506	4	7	-51	835
RIT	-2.7334	-11	5.88	3.366	5	-19	-78	240
FAB	-1.6299	-9.37	7.57	2.474	5	-12	-76	124

Future Plans: 2015 – 2019

On January 15, 2013, EPA finalized a rule (78 FR 3086) which lowered the annual $PM_{2.5}$ standard to 12.0 $\mu g/m^3$ while retaining the 2006 24-hour standard of 35 $\mu g/m^3$. Philadelphia County was classified as unclassifiable/attainment for the new annual standard (80 FR 18535).

On April 12, 2015, EPA published the final rule (80 FR 22112) determining that the Pennsylvania portion of the Philadelphia-Wilmington, PA-NJ-DE Nonattainment Area (Philadelphia Area) attained the 1997 annual and 2006 24-hour fine $PM_{2.5}$ NAAQS.

AMS' commitment to EPA requires five $PM_{2.5}$ monitoring sites. As of July 1, 2015, AMS has six operating FEM/FRM $PM_{2.5}$ monitors. As mentioned in the Plan, $PM_{2.5}$ at CHS has shut down as of July 1, 2015. Over the next five years, AMS plans to:

- Reduce $PM_{2.5}$ at the LAB
- Reduce $PM_{2.5}$ at one of the near-road monitoring sites
- Establish a port monitoring site to measure $PM_{2.5}$
- Further optimize the network pending cost

Additionally ultrafine particulate monitoring and black carbon monitoring started as of July 1, 2015 at the near-road site MON to learn more about these subtypes of atmospheric particles.

OZONE

Monitoring Introduction

AMS currently monitors Ozone at three monitoring sites: LAB, NEA, and NEW. Trends for the 4^{th} maximum 8-hour values and design values are shown in Tables 11 and 12. Figure 8 shows the Ozone monitoring sites in and around Philadelphia County for 2011 – 2013.

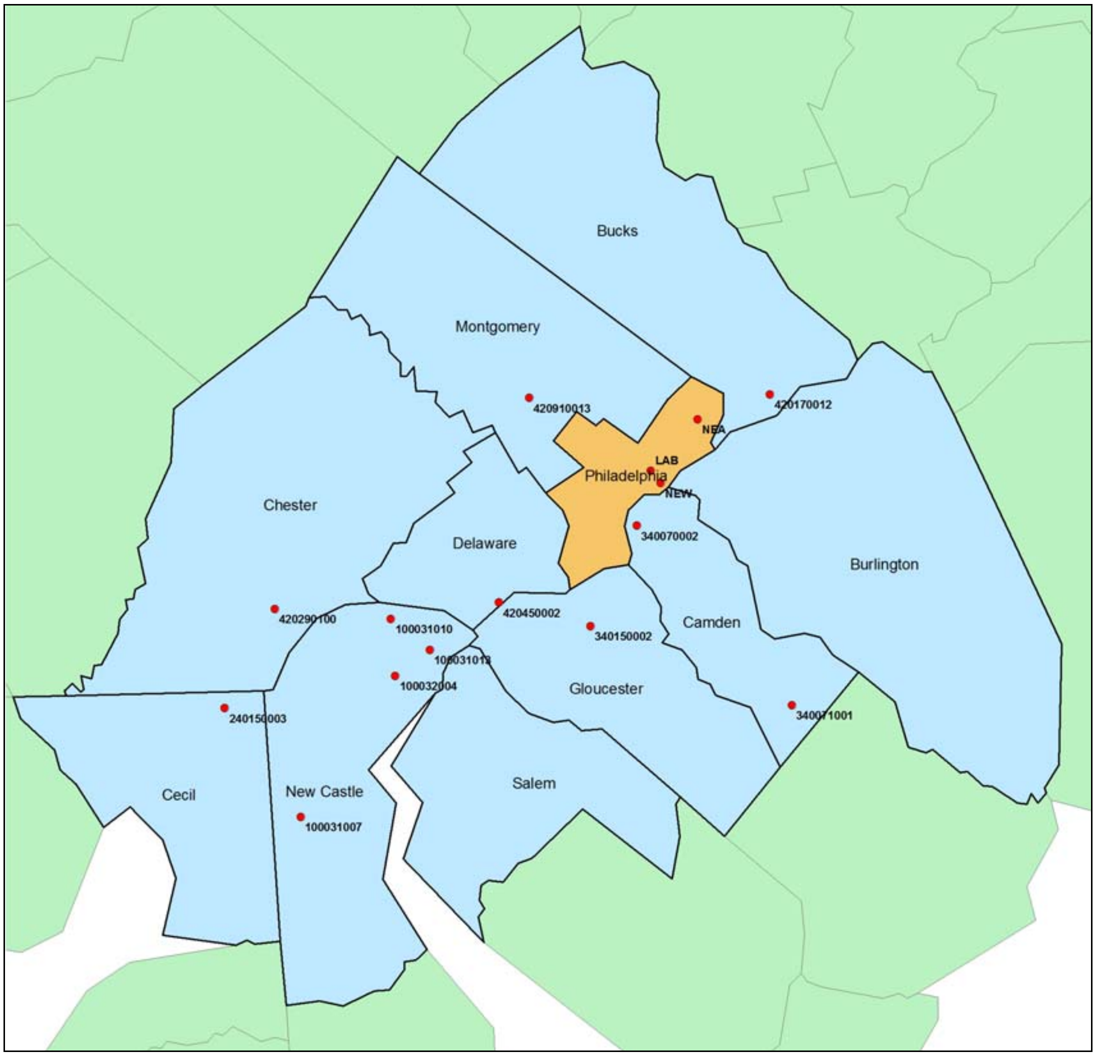
Table 11 – Ozone 4th Highest 8-Hour Values (ppm)

Year	LAB	NEA	NEW
1990		0.101	
1991		0.112	
1992		0.087	
1993	0.086	0.097	
1994	0.080	0.092	
1995	0.091	0.113	
1996	0.087	0.092	
1997	0.067	0.101	
1998	0.077	0.093	
1999	0.073	0.060	
2000	0.067	0.089	
2001	0.074	0.097	
2002	0.082	0.110	
2003	0.069	0.086	
2004	0.054	0.091	
2005	0.066	0.094	
2006	0.066	0.085	
2007	0.073	0.095	
2008	0.062	0.087	
2009	0.059	0.072	
2010	0.077	0.088	
2011	0.070	0.089	
2012	0.065	0.085	
2013	0.047	0.068	0.036
2014	0.058	0.072	0.068

Table 12 – Ozone 8-Hour Design Values (ppm)

Year	LAB	NEA	NEW
1990 - 1992		0.100	
1991 - 1993		0.099	
1992 - 1994		0.092	
1993 - 1995	0.086	0.101	
1994 - 1996	0.086	0.099	
1995 - 1997	0.082	0.102	
1996 - 1998	0.077	0.095	
1997 - 1999	0.072	0.085	
1998 - 2000	0.072	0.081	
1999 - 2001	0.071	0.082	
2000 - 2002	0.074	0.099	
2001 - 2003	0.075	0.098	
2002 - 2004	0.068	0.096	
2003 - 2005	0.063	0.090	
2004 - 2006	0.062	0.090	
2005 - 2007	0.068	0.091	
2006 - 2008	0.067	0.089	
2007 - 2009	0.064	0.084	
2008 - 2010	0.066	0.082	
2009 - 2011	0.068	0.083	
2010 - 2012	0.070	0.087	
2011 - 2013	0.060	0.080	
2012 - 2014	0.056	0.075	

Figure 8 – Ozone Monitoring Sites in and around Philadelphia County



Correlation Matrix Tool

Tables 13, 14, 15, and Figure 9 show the correlation matrix for all monitoring sites. Table 14 shows that NEA is highly correlated with neighboring monitors with a low average relative difference (except for LAB). The NEA site is the highest ozone site in Philadelphia and one of the highest ozone sites in the region. Table 13 shows that LAB is highly correlated with neighboring monitors as well, but with a larger average relative difference than NEA. Table 15 shows the correlations for NEW but due to the limited sample size (n), no additional analysis is provided.

Table 13 – Ozone Correlation Matrix for LAB

Site 1	Site 2	Correlation	n	Rel. Diff	Distance (km)
LAB	10-003-1007	0.891	988	0.315	74
LAB	10-003-1010	0.915	720	0.387	45
LAB	10-003-1013	0.924	1005	0.331	43
LAB	10-003-2004	0.892	979	0.293	49
LAB	24-015-0003	0.869	616	0.39	74
LAB	34-007-0002	0.924	605	0.364	9
LAB	34-007-1001	0.856	765	0.386	41
LAB	34-015-0002	0.896	786	0.363	25
LAB	42-011-0011	0.869	1003	0.36	85
LAB	42-017-0012	0.917	1004	0.334	21
LAB	42-029-0100	0.892	984	0.412	60
LAB	42-045-0002	0.918	1001	0.345	30
LAB	42-091-0013	0.92	1000	0.323	21
LAB	NEA	0.937	1071	0.37	11
LAB	NEW	0.744	72	0.265	2

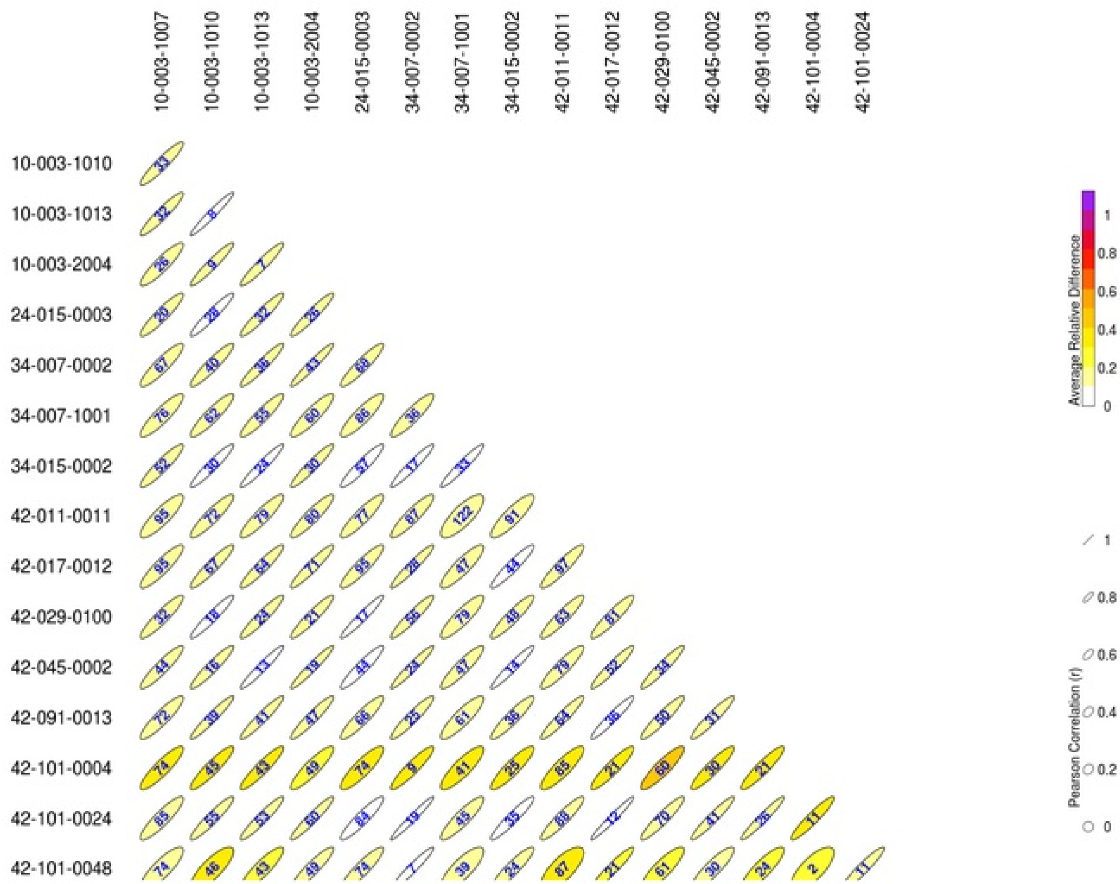
Table 14 – Ozone Correlation Matrix for NEA

Site 1	Site 2	Correlation	n	Rel. Diff	Distance (km)
NEA	10-003-1007	0.895	986	0.169	85
NEA	10-003-1010	0.936	722	0.129	55
NEA	10-003-1013	0.943	1004	0.126	53
NEA	10-003-2004	0.949	978	0.158	60
NEA	24-015-0003	0.922	612	0.0996	84
NEA	34-007-0002	0.975	599	0.0977	19
NEA	34-007-1001	0.894	761	0.122	45
NEA	34-015-0002	0.941	782	0.0943	35
NEA	42-011-0011	0.922	1002	0.132	88
NEA	42-017-0012	0.975	1004	0.0891	12
NEA	42-029-0100	0.93	983	0.125	70
NEA	42-045-0002	0.952	1000	0.111	41
NEA	42-091-0013	0.96	1000	0.11	26
NEA	LAB	0.937	1071	0.37	11
NEA	NEW	0.944	72	0.163	11

Table 15 – Ozone Correlation Matrix for NEW

Site 1	Site 2	Correlation	n	Rel. Diff	Distance (km)
NEW	10-003-1007	0.841	41	0.128	74
NEW	10-003-1010	0.805	72	0.361	46
NEW	10-003-1013	0.882	56	0.225	43
NEW	10-003-2004	0.917	68	0.171	49
NEW	24-015-0003	0.907	13	0.154	74
NEW	34-007-0002	0.962	71	0.1	7
NEW	34-007-1001	0.805	37	0.196	39
NEW	34-015-0002	0.914	38	0.157	24
NEW	42-011-0011	0.741	72	0.309	87
NEW	42-017-0012	0.945	67	0.206	21
NEW	42-029-0100	0.86	69	0.294	61
NEW	42-045-0002	0.886	67	0.195	30
NEW	42-091-0013	0.863	71	0.217	24
NEW	LAB	0.744	72	0.265	2
NEW	NEA	0.944	72	0.163	11

Figure 9 – Ozone Correlation Matrix



Area Served Tool

Figure 10 shows the results for the three Ozone monitoring sites in Philadelphia. The population statistics are shown in Table 16.

Figure 10 – Ozone Area Served

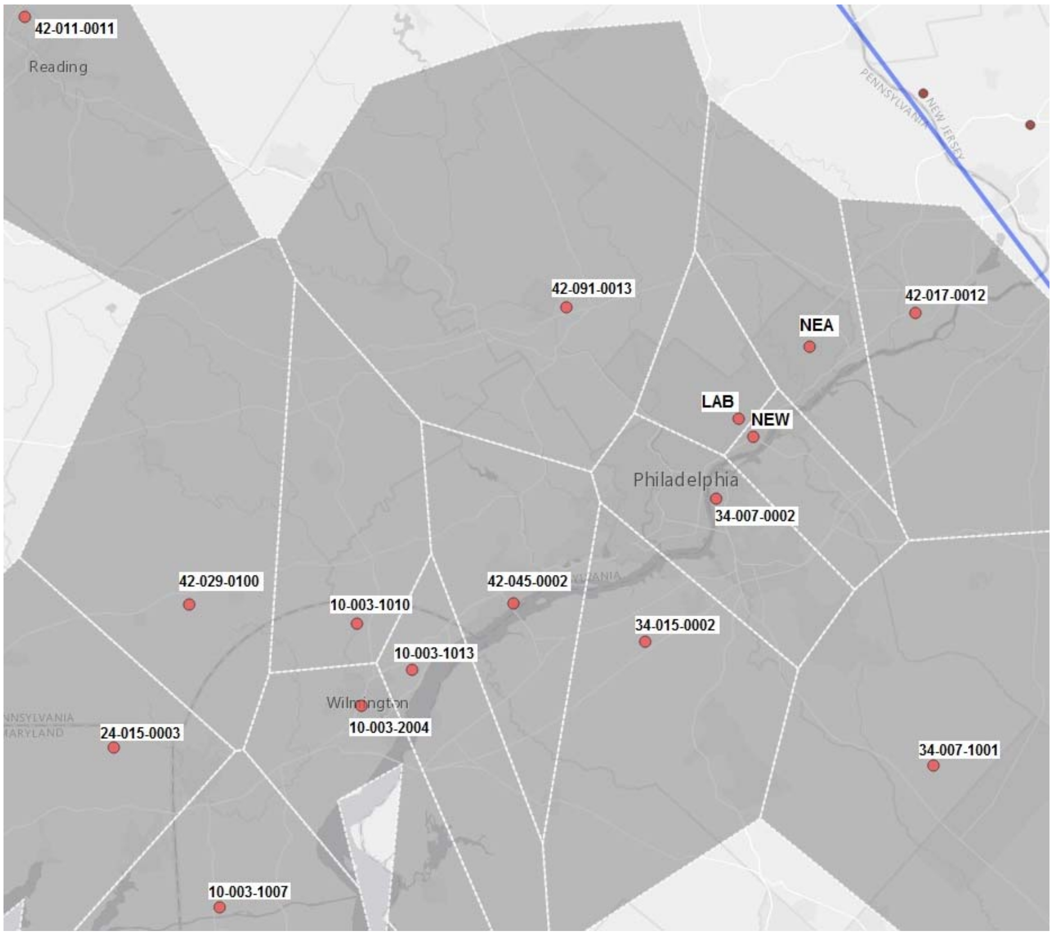


Table 16 – Ozone Area Served Population Statistics (Voronoi Polygon)

SITE	TOTAL POPULATION (2010)	TOTAL AGE 65 AND UP	TOTAL MINORITY	TRACT AREA (km^2)	POPULATION DENSITY (per km^2)
LAB	685,953	76,703	457,907	63	10,888
NEA	494,303	84,232	85,914	157	3,148
NEW	236,681	32,263	72,506	68	3,481

Exceedance Probabilities Tool

Surface probability maps for the entire United States and Philadelphia area are shown in Figures 11 and 16 for various ozone standard thresholds (75, 70, 65 ppb). As a reminder, the maps do not show the probability of exceeding the NAAQS but instead provide information about the spatial distribution of the 8-hour average ozone values and are intended for to be used for spatial comparison.

Figure 11 – Ozone 8-Hour (75 ppb) Surface Probability Map for Entire US

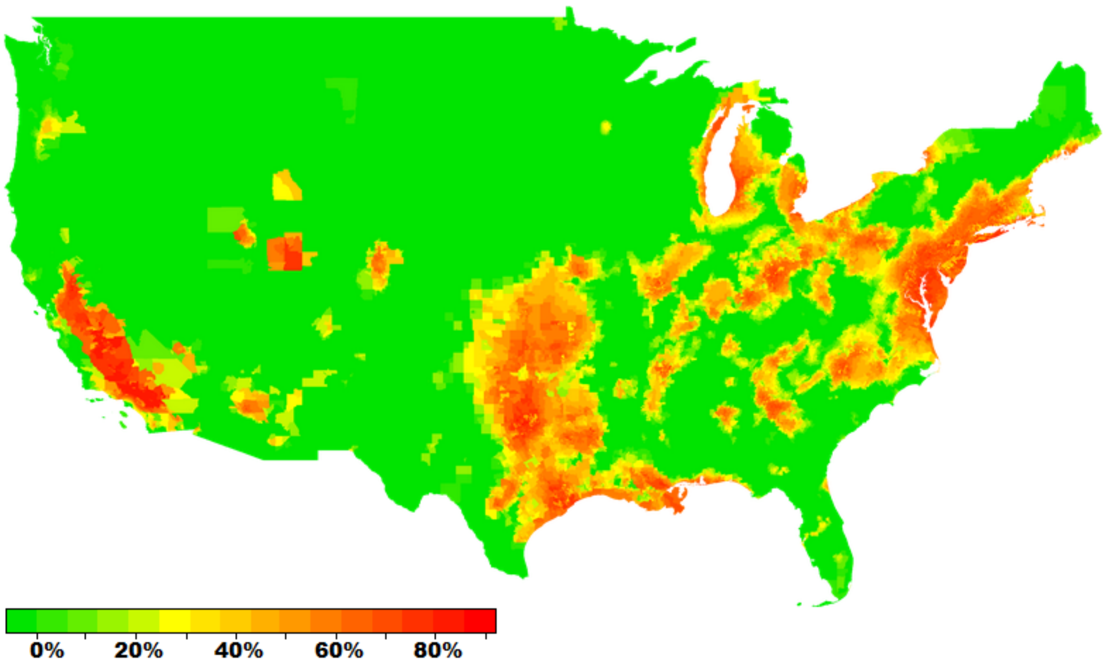


Figure 12 – Ozone 8-Hour (75ppb) Surface Probability Map for Philadelphia Area

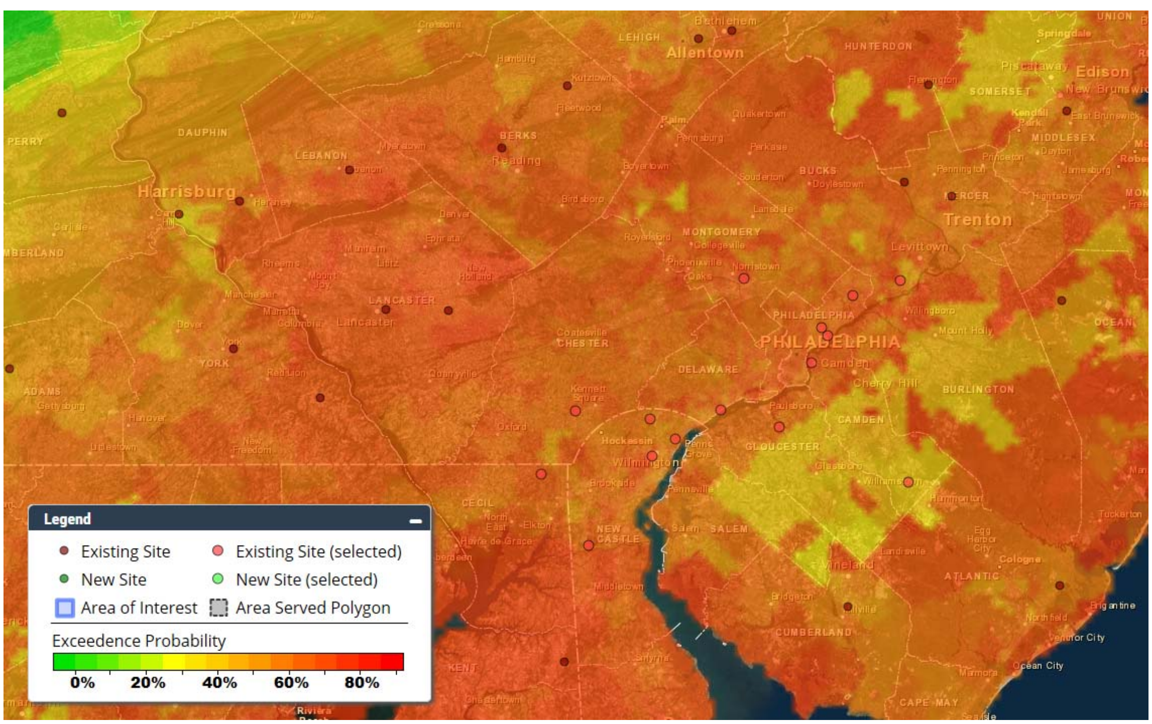


Figure 13 – Ozone 8-Hour (70 ppb) Surface Probability Map for Entire US

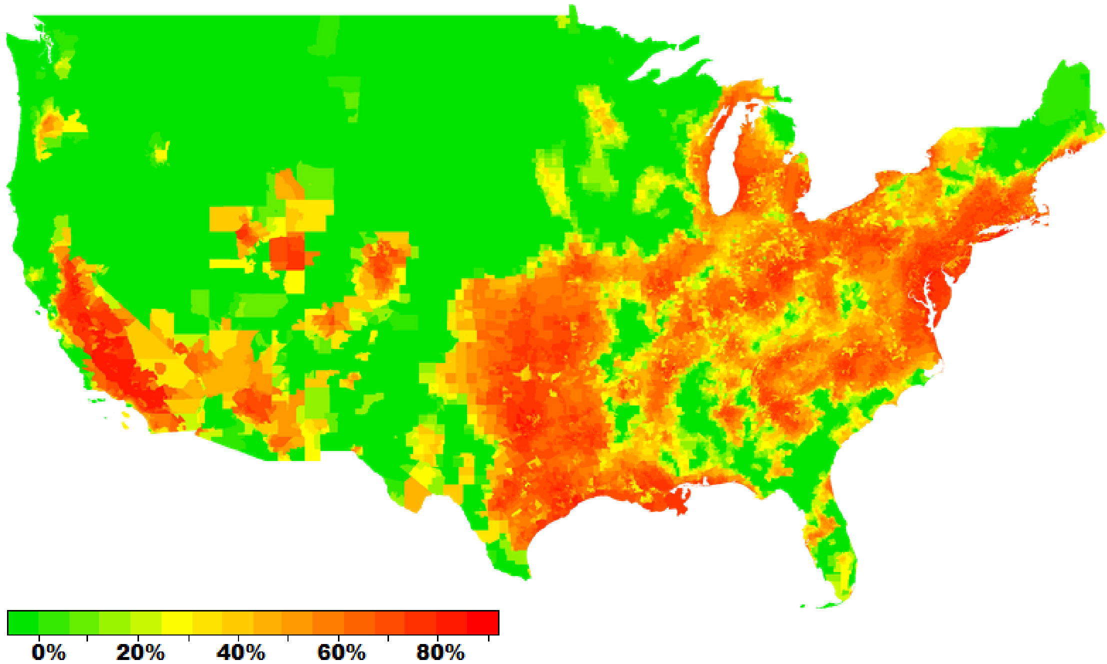


Figure 14 – Ozone 8-Hour (70 ppb) Surface Probability Map for Philadelphia Area

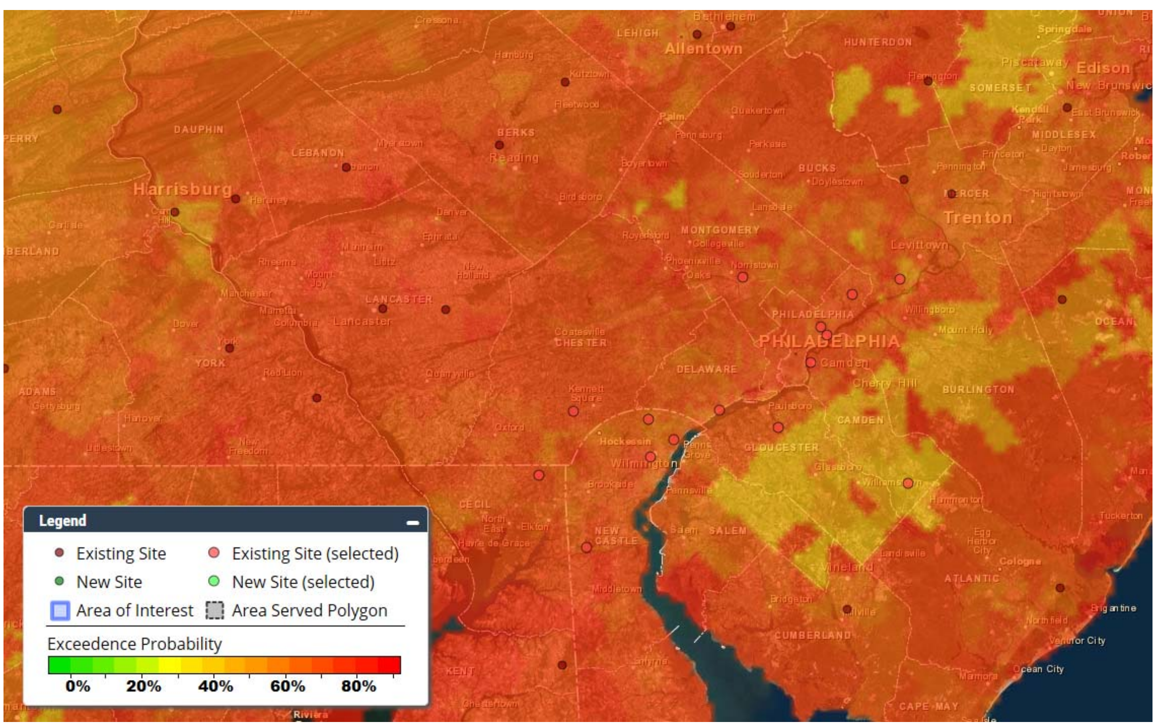


Figure 15 – Ozone 8-Hour (65 ppb) Surface Probability Map for Entire US

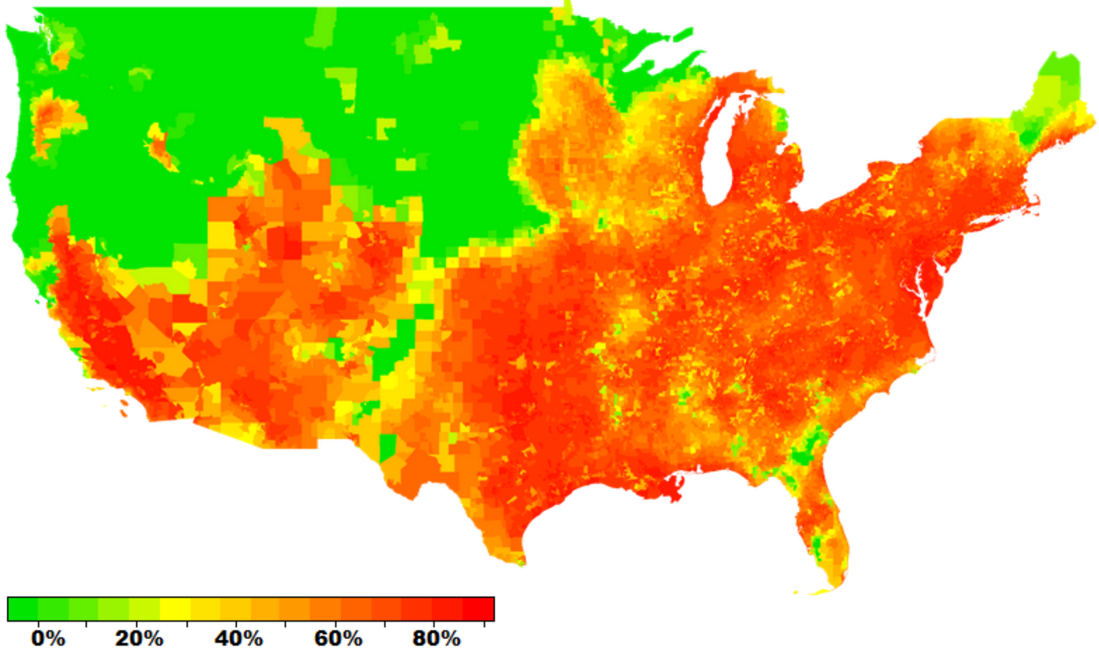
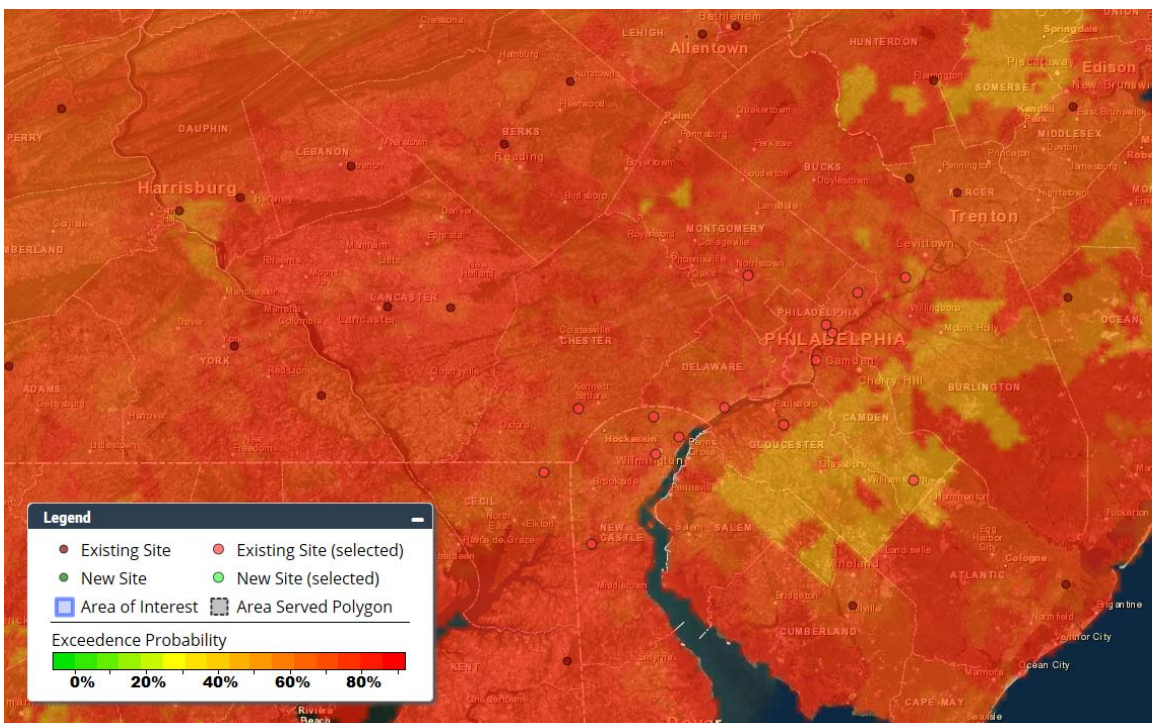


Figure 16 – Ozone 8-hour (65 ppb) Surface Probability Map for Philadelphia Area



Removal Bias Tool

Figure 17 and Table 17 show the removal bias for the three ozone monitors in Philadelphia.

Figure 17 – Removal Bias Map for Philadelphia

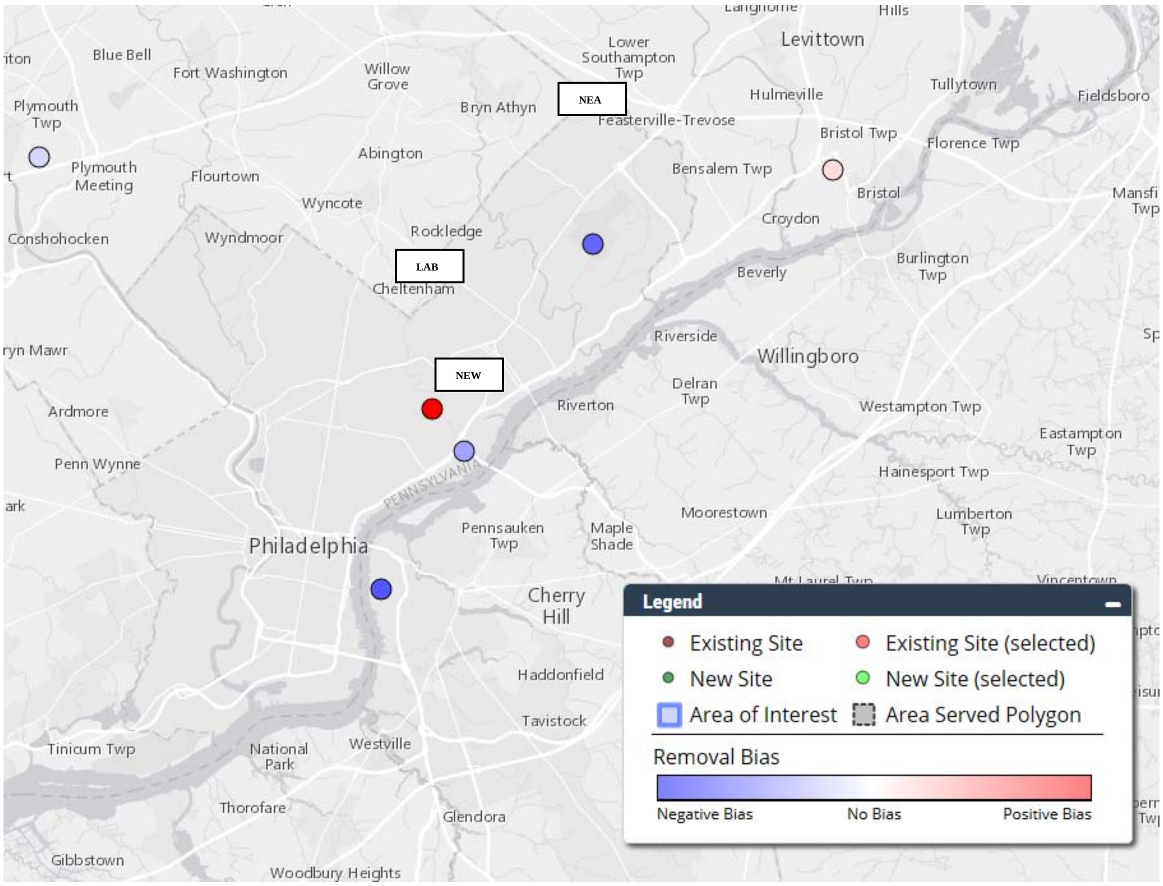


Table 17 – Removal Bias Summary for Philadelphia

SITE ID	MEAN REMOVAL BIAS (ppm)	MIN REMOVAL BIAS (ppm)	MAX REMOVAL BIAS (ppm)	REMOVAL BIAS STANDARD DEVIATION	NEIGHBORS INCLUDED	MEAN RELATIVE REMOVAL BIAS (%)	MIN RELATIVE REMOVAL BIAS (%)	MAX RELATIVE REMOVAL BIAS (%)
LAB	0.0108	-0.00258	0.0352	0.0059	4	46	-17	351
NEA	-0.0065	-0.0212	0.00368	0.0037	5	-16	-53	46
NEW	-0.0039	-0.0157	0.00333	0.0050	5	-14	-60	26

Future Plans: 2010 – 2015

On March 12, 2008 EPA announced revisions to the 8-hour NAAQS for ozone to a level of 0.075 parts per million (ppm) (73 FR 16436).

On March 26, 2012, EPA determined that the Philadelphia Area attained the 1997 8-hour ozone standard (77 FR 17341).

On November 25, 2014, EPA proposed to strengthen the NAAQS for ozone by setting the primary and secondary standards within a range of 65 to 70 ppb. EPA plans to issue a final decision by October 2015.

On January 22, 2015, EPA issued a memo to help states develop state implementation plans to address cross-state transport of air pollution for the 2008 ozone standard. The memo includes results of EPA's preliminary air quality modeling providing average and maximum design values (DV) for 2018. Based on EPA's modeling, NEA has a projected maximum DV of 78.0 ppm for 2018.[3]

Over the next five years, AMS plans to (pending any additional requirements from a new standard):

- Continue to measure at NEA as it is one of the highest ozone values in the Philadelphia area
- Possibly add ozone to TOR and compare to NEA
- Continue to measure at the Ncore site NEW
- Continue to measure at the LAB because it is a PAMS site

OTHER POLLUTANTS

Discussion and Future Plans

Table 18 shows the maximum NAAQS summary for CO, NO_2, SO_2, PM_{10}, and Pb from 2009 – 2014[4]. The maximum values for these criteria pollutants are well below the NAAQS. Monitoring locations and requirements are documented in the Plan.

Table 18 – Maximum NAAQS Summary for CO, NO_2, SO_2, PM_{10}

Year	CO 2nd Max 1-hr	CO 2nd Max 8-hr	NO2 98th Percentile 1-hr	SO2 99th Percentile 1-hr	SO2 2nd Max 24-hr	PM10 2nd Max 24-hr	Pb 3 month avg
2014	1.8	1.4	60	15	7	60	0.02
2013	2.3	1.7	52	15	6	61	0.04
2012	2.3	1.5	56	14	6	44	0.05
2011	2.5	1.7	76	15	8	73	0.02
2010	3	1.8	62	25	18	91	0.03
2009	3.3	2	56	37	14	47	0.03
Standard	**35 ppm**	**9 ppm**	**100 ppb**	**75 ppb**	**140 ppb**	**150 ug/m3**	**0.15 ug/m3**

[3] See section "January 2015 – Memo and Information Sharing" at http://www.epa.gov/airtransport/ozonetransportNAAQS.html.
[4] Air Quality Statistics Report from www.epa.gov/airdata, downloaded 3/4/15. Lead data from AQS AMP 480 report, downloaded 5/11/15.

MONITORING EQUIPMENT ASSESSMENT

An important and often overlooked component of a network assessment is the evaluation of the condition and cost of all monitoring equipment as well as any indirect equipment needed to support the air monitoring network.

Tables 19 – 23 inventory the type, condition, and cost for all air monitoring and indirect equipment. These tables show that in the next five years, many of the indirect air monitoring equipment will approach or exceed expected life span and may require replacement. The cost of replacement for many of the analysis machines is significant when compared to the cost of individual monitors. The tables also show a need to replace many of the current air monitoring devices within the next five years.

Table 19 – Air Monitoring Equipment Inventory

Site: 421010004 (LAB)							
Instrument	Vendor	Year Purchased	Age (yrs.)	Avg. Life Span	Estimated Cost	Condition	Replacement Recommended
FRM - PM 2.5 - C	Thermo	Sep-98	16	5	$29,000	5. Well Performing Equipment	NO
FRM - PM 2.5 - D	Thermo	Sep-98	16	5	$29,000	5. Well Performing Equipment	NO
NOx	T-API	Sep-11	4	7	$13,000	5. Well Performing Equipment	NO
NOy	T-API	Apr-07	8	7	$16,000	5. Well Performing Equipment	NO
CO	T-API	Oct-05	10	7	$12,500	5. Well Performing Equipment	NO
Ozone	T-API	Oct-05	10	7	$13,000	5. Well Performing Equipment	NO
Carbonyl	ATEC	Jul-13	2	7	$17,000	5. Well Performing Equipment	NO
Canister Sampler	TISCH	Jul-08	6	7	$12,000	5. Well Performing Equipment	NO

Site: 421010014 (ROX)							
Instrument	Vendor	Year Purchased	Age (yrs.)	Avg. Life Span	Estimated Cost	Condition	Replacement Recommended
TSP	TISCH	Feb-87	26	15	$4,000	5. Well Performing Equipment	NO
Carbonyl	REMSI	Mar-09	6	5	$17,000	7. Poorly Performing Equipment	YES
Canister Sampler	TISCH	Jul-08	7	5	$12,000	5. Well Performing Equipment	NO

Site: 421010024 (NEA)							
Instrument	Vendor	Year Purchased	Age (yrs.)	Avg. Life Span	Estimated Cost	Condition	Replacement Recommended
MET System	Vaisala	Jan-15	1	10	$3,000	5. Well Performing Equipment	NO
Ozone	T-API	Jan-15	1	7	$13,000	5. Well Performing Equipment	NO

Site: 421010047 (CHS)							
Instrument	Vendor	Year Purchased	Age (yrs.)	Avg. Life Span	Estimated Cost	Condition	Replacement Recommended
Continuous PM 2.5	Met One	Jul-10	5	5	$23,000	5. Well Performing Equipment	NO

TSP	TISCH	Apr-87	27	5	$4,000	5. Well Performing Equipment	NO
NOx	T-API	Oct-05	10	5	$13,000	5. Well Performing Equipment	NO
Carbonyl	REMSI	Feb-03	12	7	$17,000	7. Poorly Performing Equipment	YES
Canister Sampler	TISCH	Jul-08	7	5	$12,000	5. Well Performing Equipment	NO

Site: 421010048 (NEW)

Instrument	Vendor	Year Purchased	Age (yrs.)	Avg. Life Span	Estimated Cost	Condition	Replacement Recommended
FRM - PM 2.5	Thermo	Jun-09	6	5	$29,000	5. Well Performing Equipment	NO
FRM - PM 10	Thermo	Jun-09	6	5	$29,000	5. Well Performing Equipment	NO
Continuous PM 2.5	Met One	Nov-07	8	5	$22,000	5. Well Performing Equipment	NO
Spec. PM 2.5 (2 ch.)	Met One	Nov-09	6	5	$13,500	5. Well Performing Equipment	NO
Spec. PM 2.5 (1 ch.)	URG	Nov-09	6	5	$22,000	7. Poorly Performing Equipment	NO
NOy	T-API	Feb-08	7	5	$16,000	7. Poorly Performing Equipment	YES
CO	T-API	Feb-08	7	5	$13,000	5. Well Performing Equipment	NO
SO_2	T-API	Feb-08	7	5	$13,000	5. Well Performing Equipment	NO
Ozone	T-API	Feb-08	7	5	$13,000	5. Well Performing Equipment	NO
Continuous PM 10	Met One	Jul-11	4	5	$22,000	5. Well Performing Equipment	NO
MET System	Vaisala	Jan-15	1	10	$3,000	5. Well Performing Equipment	NO

Site: 421010055 (RIT)

Instrument	Vendor	Year Purchased	Age (yrs.)	Avg. Life Span	Estimated Cost	Condition	Replacement Recommended
Spec. PM 2.5 (2 ch.)	Met One	Oct-00	14	5	$13,500	5. Well Performing Equipment	NO
Spec. PM 2.5 (1 ch.)	URG	Nov-06	8	5	$22,000	5. Well Performing Equipment	YES
Continuous PM 2.5	Met One	Nov-13	2	5	$23,000	5. Well Performing Equipment	NO
TSP	TISCH	Feb-12	23	15	$4,000	5. Well Performing Equipment	NO
SO_2	T-API	Oct-14	1	7	$13,000	5. Well Performing Equipment	NO
Carbonyl	ATEC	Dec-12	3	7	$17,000	5. Well Performing Equipment	NO
MET System	Vaisala	Jan-15	1	10	$3,000	5. Well Performing Equipment	NO

Canister Sampler	TISCH	Jul-08	6	5	$12,000	5. Well Performing Equipment	NO

Site: 421010057 (FAB)

Instrument	Vendor	Year Purchased	Age (yrs.)	Avg. Life Span	Estimated Cost	Condition	Replacement Recommended
Continuous PM 2.5	Met One	Nov-07	8	5	$22,000	5. Well Performing Equipment	NO

Site: 421010063 (SWA)

Instrument	Vendor	Year Purchased	Age (yrs.)	Avg. Life Span	Estimated Cost	Condition	Replacement Recommended
Carbonyl	ATEC	Dec-12	3	7	$17,000	5. Well Performing Equipment	NO
TSP	TISCH	Feb-87	28	15	$4,000	5. Well Performing Equipment	NO
Canister Sampler	TISCH	Jul-08	7	5	$12,000	5. Well Performing Equipment	NO

Site: 421010075 (TOR)

Instrument	Vendor	Year Purchased	Age (yrs.)	Avg. Life Span	Estimated Cost	Condition	Replacement Recommended
Continuous PM 2.5	Met One	Nov-13	2	5	$22,000	5. Well Performing Equipment	NO
CO	T-API	Oct-13	2	7	$12,500	5. Well Performing Equipment	NO
MET System	Vaisala	Jan-14	1	10	$3,000	5. Well Performing Equipment	NO
NOx	T-API	Sep-13	2	7	$13,000	5. Well Performing Equipment	NO

Table 20 – Carbonyl (TO-11) Analysis Equipment

Instrument	Vendor	Year Purchased	Age (yrs.)	Avg. Life Span	Estimated Cost	Condition	Replacement Recommended
HPLC-E, Alliance 2695 Sep Module w/sample and column heater, and 2487 dual uv/vis det	Waters Corp.	2003	12	10	$75,000	Well performing equipment (due for replacement by new model of same type)	YES
HPLC-F, Alliance 2695 Sep Module w/sample and column heater, and 2487 dual uv/vis det	Waters Corp.	2003	12	10	$75,000	Well performing equipment (due for replacement by new model of same type)	YES
HPLC-G, Alliance 2695 Sep Module w/sample and column heater, and 2487 dual uv/vis det	Waters Corp.	2003	12	10	$75,000	Well performing equipment (due for replacement by new model of same type)	YES
Millipore Direct-Q 3uv Reverse osmosis water purifications system w/30L Storage tank.	Millipore	2006	10	10	$10,000	Well performing equipment (due for replacement by new model of same type)	YES

Table 21 – PAMS and TO-15 Analysis Equipment

Instrument	**Vendor**	**Year Purchased**	**Age (yrs.)**	**Avg. Life Span**	**Estimated Cost**	**Condition**	**Replacement Recommended**
GCMS	Alilent	2003	8	10	$120,000	Well Performing Equipment (obsolete software - Win XP - equipment no longer supported after 2017).	YES
GC-FID	Alilent	2001	9	10	$50,000	Well Performing Equipment (obsolete software - Win XP - equipment no longer supported after 2017).	YES
Prec Concentrator	Entech	2003	7	10	$40,000	Well Performing Equipment (obsolete software - Win XP - equipment no longer supported after 2017).	YES
Prec Concentrator	Entech	2015	0	10	$40,000	Well performing equipment	NO
Entech Auto Sampler	Entech	2003	13	10	$11,000	Adequately performing equipment (recently updated interface (cable). No upgraded needed as of 2015.	NO

Table 22 – Calibration Equipment

Instrument	Vendor	Year Purchased	Age (yrs.)	Avg. Life Span	Estimated Cost	Condition	Replacement Recommended
Gaseous Calibrator-LAB	Sabio	2001	14	10	$16,000	Replacement API 700 in hand	NO
Gaseous Calibrator-CHS	Sabio	2001	14	10	$16,000	Station will be shut down in 2015	NO
Calibrator 700 - RIT	Teledyne API	2014	1	10	$16,000	Well Performing Equipment	NO
Calibrator 700 - NEW	Teledyne API	2011	4	10	$16,000	Well Performing Equipment	NO
Calibrator 700 - TOR	Teledyne API	2014	1	10	$16,000	Well Performing Equipment	NO
Calibrator 700 - MON	Teledyne API	2015	0	10	$16,000	Well Performing Equipment	NO
Teledyne API 703 - LAB	Teledyne API	2007	8	10	$9,000	Calibrator 700 will be used.	NO
Teledyne API 703 - NEA	Teledyne API	2007	8	10	$9,000	No spare unit on hand. Spare unit needed.	YES
Zero Air Supply- LAB	TEI	1993	17	10	$6,000	Replacement API 701 in hand	NO
Zero Air Supply - CHS	TEI	1993	17	10	$6,000	Station will be shut down in 2015	NO
Zero Air Supply 701 - RIT	Teledyne API	2014	1	10	$9,000	Well Performing Equipment	NO
Zero Air Supply- NEW	Teledyne API	2011	4	10	$9,000	Well Performing Equipment	NO
Zero Air Supply- TOR	Teledyne API	2014	1	10	$9,000	Well Performing Equipment	NO
Zero Air Supply- MON	Teledyne API	2015	0	10	$9,000	Well Performing Equipment	NO
Zero Air Supply- NEA	TEI	1993	17	10	$6,000	Calibrator could do without ZAS	NO
Gaseous Calibrator	CSI	1988	25	15	$16,000	Equipment not working/ Replaced by API 700	NO
Gaseous Calibrator	CSI	1988	25	15	$16,000	Poorly performing equipment	YES
Portable Zero Air Generator	Perma Pure				$6,000	New Equipment needed	YES
Calibrator, Definer 220	Mesa Lab	2010	5	10	$2,000	Well Performing Equipment	NO
Calibrator, Definer 220	Mesa Lab	2010	5	10	$2,000	Well Performing Equipment	NO
Calibrator, Definer 220	Mesa Lab	2010	5	10	$2,000	Well Performing Equipment	NO
Calibrator, Definer 220	Mesa Lab	2010	5	10	$2,000	Well Performing Equipment	NO
Calibrator, Definer 220	Mesa Lab	2010	5	10	$2,000	Well Performing Equipment	NO
Calibrator, Definer 220	Mesa Lab	2010	5	10	$2,000	Well Performing Equipment	NO
Calibrator, Definer 220	Mesa Lab	2010	5	10	$2,000	Well Performing Equipment	NO
Flow Calibrator - Deltacal	Mesa Lab	2001	14	15	$3,000	Poorly performing equipment	YES
Flow Calibrator - Deltacal	Mesa Lab	2001	14	15	$3,000	Poorly performing equipment	YES

Table 23 – General Chemistry Equipment

Instrument	Vendor	Year Purchased	Age (yrs.)	Avg. Life Span	Estimated Cost	Condition	Replacement Recommended
Epsilon 3[x]	Panalytical	2014	1	10	$60,000	New -Well performing equipment	NO
AG204 Balance S/N 1114150791	Mettler Toledo	May-95	20	10	$6,000	Well performing equipment.	NO
Titrator	Metrohm	May-95	20	10	$12,000	Well performing equipment. May need replacement at any time.	YES
Laboratory Oven	Thelco	Jun-96	19	15	$4,000	Well performing equipment	NO
AB104S Balance S/N 1120291235	Mettler Toledo	Oct-01	16	10	$6,000	Well performing equipment	NO
AG205DR Balance S/N 1126021226	Mettler Toledo	May-05	10	10	$9,000	Well performing equipment	NO
AE100 Balance S/N L72602 CP#452170	Mettler Toledo	Sep-91	24	10	$6,000	Well performing equipment	NO
Filter Weighing Chamber For AE100	Mettler Toledo	Sep-91	24	10	$3,000	Well performing equipment	NO
Atomic Absorption Spectrophotometer Analyst 300 (used for Lead & metals analysis)	Perkin Elmer	May-99	16	10	$160,000	Not Used - insufficient detection limit for current metals analysis application.	YES
Laboratory Oven	CMS	Jan-84	31	20	$4,000	Well performing equipment	NO
Laboratory Hood C/P# 400161	Hemco Corp.	Mar-94	21	26	$1,500	Well performing equipment	NO
Conductance Meter CP# 400161	YSI	Before 1984	>26	15	$2500	Poorly Performing Equipment	YES
Zymate XP Robot CP# 506447	Calipher	Feb-99	16	10	$55,000	Adequately performing equipment. Obsolete equipment and software.	YES
MX5 Balance S/N 1122281049	Mettler Toledo	Oct-02	13	10	$12,000	Well performing equipment	NO
MT5 Balance S/N 11155500943	Mettler Toledo	Feb-97	18	10	$12,000	Well performing equipment	NO
7890 Chromatograph SN CN11081101 1CN1080001	Agilent	Feb-11	4	15	$60,000	Well performing equipment	NO