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Annual Data Summary Report for the Chemical Speciation of $PM_{2.5}$ Filter Samples Project

January 1 through December 31, 2014

Prepared for:
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Executive Summary

Introduction

The U.S. Environmental Protection Agency (EPA) established a $PM_{2.5}$ Chemical Speciation Network (CSN) in 1999, and monitoring operations began in February, 2000. The CSN includes the Speciation Trends Network (STN), a core set of 52 speciation trends analysis sites, as well as a variable number of other sites. RTI has been supporting EPA with the chemical speciation analysis of the $PM_{2.5}$ filter samples since the inception of the CSN program.

On this continuing program, RTI supports EPA/OAQPS by shipping ready-to-use filter packs loaded into cartridges and coated denuders to all the field sites and by conducting gravimetric analysis of Teflon filters and chemical analyses of Teflon, Nylon and Quartz-fiber filters used in the samplers after sample collection. Beginning October 1, 2014, gravimetric analysis of Teflon Filters was discontinued for the entire network except for six sites. RTI is also responsible for scheduling shipments of filters to the monitoring sites and for data reporting. RTI staff perform an extensive array of quality assurance/quality control (QA/QC) activities to ensure that the data provided to EPA and the States are of the highest quality. Laboratory QA activities and results in terms of accuracy, precision, completeness and sensitivity are summarized in this report, along with any corrective actions taken between January 1 and December 31, 2014.

Data Quality Overview

Analytical data completeness typically exceeded 95%, and laboratory accuracy and precision were within limits as demonstrated by routine QC samples, laboratory audits, and instrument intercomparison. The RTI International laboratories analyzed performance evaluation (PE) audit materials provided by EPA during early 2014. RTI reported results of PE samples as part of a multi-lab study conducted by EPA's Montgomery Laboratory in early 2014. These PE samples encompassed all the major analyses being performed under the CSN contract. The PE report showed that the RTI team's results (RTI and DRI laboratories) compared well with results from the other speciation laboratories and the EPA reference laboratory. There was no Technical Systems Audit (TSA) of RTI performed by EPA in 2014. The last TSA was conducted by EPA in July 2012. The 2012 TSA complimented all RTI laboratories for good compliance with the Standard Operating Procedures (SOPs), good record-keeping and quality-control practices and for the excellent agreement in results between the RTI analyses and the EPA results. The TSA reported no deficiencies. The TSA of the DRI OC/EC laboratory was performed in October 2013 with the report finalized in March 2014. The TSA found that the lab followed good QC and record keeping procedures.

Laboratory Performance

Section 3.0 of this report provides the details of accuracy, precision, and other measures of laboratory performance. The laboratories consistently met their QC goals of routine analyses, which are detailed in Sections 3.1 (Gravimetry Laboratory), 3.2 (Ion Analysis), 3.3 (Organic and Elemental Carbon (OC/EC) by IMPROVE_A), and 3.4 (X-ray Fluorescence).

Data quality for gravimetric mass results was found to be satisfactory during 2014. Issues included problems with the weighing chamber environmental controls. These issues were dealt with aggressively to minimize downtime, as described in Section 3.1. No filters were weighed during periods of chamber issues.

No data quality issues were reported by the Ion Analyses Lab (Section 3.2) and by the DRI OC/EC lab during 2014 (Sections 3.3). Interlaboratory performance comparison results were satisfactory. New URG 3000N software have now been deployed throughout the entire CSN network to sample quartz filters for OC/EC. DRI analyzes all filters from the 3000N samplers using the IMPROVE_A protocol.

The XRF laboratories operated by RTI and subcontractor Chester LabNet (CLN) generally met the prescribed QC criteria for analysis (Sections 3.4.1 and 3.4.2). The RTI and CLN laboratories participate in an intercomparison (round-robin) program described in Section 3.4.1.3. Interlaboratory performance comparison results performed by EPA's National Air and Radiation Environmental Laboratory showed excellent agreement. The issue related to high chromium background in Teflon filters that was identified in 2013 affected one batch in 2014. Lot-specific background correction was performed as discussed in the 2013 annual data summary report. A total of 934 filters from one Teflon Filter Lot (Lot # 137102) reported as part of Batch 169 was affected in 2014. All affected chromium data were flagged. Corrective actions have been implemented to verify filter specifications.

No significant quality issues were reported by the denuder refurbishment laboratory (Section 3.5). Operations in RTI's Sample Handling and Archiving Laboratory (SHAL) proceeded satisfactorily during 2014 (Section 3.6). One corrective action was implemented in the SHAL to rectify an incorrect assignment of field sampler channels during the data entry process. Those sampling events with incorrect channel assignments appeared to have no sample volume and were therefore invalidated in the database, impacting a total of 26 events between the sampling dates of June 24, 2013 and July 7, 2014. Corrective actions were implemented to automate filter channel assignment. All data for the 26 events were corrected and reposted to AQS.

No significant data quality issues were reported by the data processing and data validation functions during 2014 (Sections 4.0 and 5.0).

Data continues to be reviewed and posted to a secure Web site on a monthly basis for review. Finalized data are posted to the EPA Air Quality System (AQS) database approximately 60 days after initial posting (Section 4.0). A number of data users with total number of communications exceeding 1000, contacted SHAL, data processing, and QA personnel with questions about specific data items, or to request explanations about apparent discrepancies. RTI attempts to answer such questions promptly, and works closely with the agencies to determine the most appropriate data flags for particular situations.

Estimation of MDLs and Uncertainties

Method Detection Limits (MDLs) for all laboratory methods are provided in Appendix A. Uncertainties are estimated based on laboratory QC data, augmented by a 5% concentration-proportional term to account for field handling and sample volume uncertainties. Results from collocated samplers (Section 5.3) indicate that this uncertainty model is reasonable for most chemical species.

Quality Issues

There was one Corrective Action Request (CAR) issued during 2014. There were some issues that have not been assigned CARs because there was no specific action that RTI could take, or because they required input and cooperation from others outside RTI. These issues are summarized in the following table.

CAR Number	Lab	Description	Response	Effect on Data
006	SHAL	Incorrect data entry of sampler channel resulted in an apparent missing volume causing data to be voided	Corrective action has been implemented to automate sampler channel assignment based on scheduled events. Affected data were reprocessed with corrected channel assignments and posted to AQS.	Data for 26 events were initially invalidated due to apparent missing field information caused by incorrect channel assignment. All affected data were reprocessed, and posted to AQS after QA review.
None	SHAL	Late-arriving Coolers	Delivery Order Project Officer (DOPO) and others are notified whenever coolers are received late from the field.	Data are flagged as missing.

1.0 Introduction

1.1 Program Overview

In 1997, the U.S. Environmental Protection Agency (EPA) promulgated the new National Ambient Air Quality Standards (NAAQS) for particulate matter (PM). The regulations (given in 40 CFR Parts 50, 53, and 58) apply to the mass concentrations (µg/m^3 of air) of particles with aerodynamic diameters less than 10 micrometers (the PM_{10} standard) and less than 2.5 micrometers (the $PM_{2.5}$ standard).

In response to the 1997 $PM_{2.5}$ NAAQS, a federal reference method (FRM) network of approximately 900 sites that measures gravimetric mass and a Chemical Speciation Network (CSN) was established to monitor levels of $PM_{2.5}$ in the U.S. The CSN consists of approximately 180 sampling sites as of the date of this report, which includes six collocated sites. The mass measurement data from the FRM network is used for identifying areas that meet or do not meet the NAAQS criteria and supporting designation of an area as attainment or non-attainment. The $PM_{2.5}$ CSN, which is mostly supported by RTI International (RTI), includes the Speciation Trends Network (STN), a core set of 52 speciation trends monitoring sites located primarily in urban areas and a variable number of other sites operated by State, Local and Tribal air monitoring agencies.

This data summary report covers the quality assurance (QA) aspects of the collection and chemical analysis of samples from the CSN sites from January 1 through December 31, 2014. RTI is supporting the $PM_{2.5}$ CSN by shipping ready-to-use filter packs loaded into cartridges and coated denuders to the field sites and by conducting gravimetric and chemical analyses of the several types of filters used in the samplers. Beginning October 1, 2014, gravimetric analysis of Teflon Filters was discontinued for the entire network except for six sites. The details of the QA activities that are performed for the CSN are described in the RTI QA Project Plan (QAPP) for this project, along with the Standard Operating Procedures (SOPs).

1.2 Project/Task Description

The CSN laboratory contract involves four broad areas:

1. Supplying each site or State with sample collection media (loaded filter packs and coated denuders) and field data documentation forms. RTI ships the collection media to monitoring agencies on a schedule specified by the Delivery Order Project Officer (DOPO).

2. Receiving the samples from the field sites and analyzing the sample media for gravimetric mass and for an array of chemical constituents, including elements (by energy-dispersive x-ray fluorescence [EDXRF]), and soluble anions and cations (by ion chromatography). Desert Research Institute (DRI), a subcontractor to RTI, is performing analysis of carbonaceous material using the IMPROVE_A thermal-optical analysis method in both the reflectance and transmittance modes. Analysis of semi-volatile organic compounds,

optical density and examination of particles by electron or optical microscopy are included in RTI's contract with EPA/OAQPS, but have not been performed to date.

3. Assembling validated sets of data from the analyses, preparing data reports for EPA management and the State Agencies within 45 days of sampling, and entering data into the Air Quality System (AQS) data bank 60 days after initial data reports are first submitted to the DOPO and the State Agencies.

4. Establishing and applying a comprehensive QA/quality control (QC) system. RTI's Quality Management Plan (QMP), QAPP, and associated SOPs provide the documentation for RTI's quality system.

1.3 Major Laboratories and Operational Areas

This report addresses the operation of RTI's Sample Handling and Archiving Laboratory (SHAL) and QA/QC for the four major analytical areas active during the time period of January 1 through December 31, 2014. These analytical areas are: (1) gravimetric determination of particulate mass on Teflon® filters; (2) determination of 33 elements on Teflon® filters using X-ray fluorescence (XRF) spectrometry; (3) determination of nitrate, sulfate, sodium, ammonium, and potassium on nylon filters using ion chromatography; and (4) determination of organic carbon (OC), elemental carbon (EC), total carbon (TC), and individual peaks for OC, EC, and pyrolysis carbon on quartz filters using thermal optical reflectance (TOR) and transmittance (TOT) by the IMPROVE_A protocol. RTI laboratories conduct the gravimetric, ions, and XRF measurements. DRI performs the IMPROVE_A carbon analysis for the quartz filters. Denuder refurbishment, data processing, and QA and data validation are also major elements of this program performed by RTI, and are also included in this report.

2.0 Quality Issues and Corrective Actions

2.1 Data Quality

RTI staff perform an extensive array of QA/QC activities to ensure that the CSN data provided to EPA and the States are of the highest quality and so that they can support the needs of scientific research and regulatory compliance.

Data quality for the CSN has several dimensions, supporting a goal of usefulness to data users. There are several metrics that are considered in assuring and assessing the quality of the CSN data set:

- Accuracy. All analyses standardized to reference values that are traceable to the National Institute of Standards and Technology (NIST.)
- Precision. Measured both as laboratory and whole-system through regular QC replicates and results from samplers collocated at the same site.
- Completeness. Excellent completeness (>90%) is demonstrated overall. Some individual sites may have lower completeness, typically due to site maintenance, instrument downtime due to repairs and/or upgrades or shipping problems.
- Spatial coverage. Selection of sites for CSN is outside of RTI's control. The CSN sites are generally selected to evaluate population-based health effects and tend to be in populated areas. Because of this, the CSN has relatively little coverage of rural sites in the western United States, where IMPROVE sites predominate.
- Comparability. Intercomparison studies recently conducted by EPA have shown good agreement with programs such as the FRM network for mass, and IMPROVE results for mass and for most of the major chemical species.
- Representativeness. While primary site selection and field-sampling operations are out of RTI's control, the RTI laboratories follow appropriate extraction and sample preparation procedures to guard against non-representative sampling of the filters.
- Sensitivity/Detection. The ability to quantify major species, such as gravimetric mass, OC, sulfate, nitrate, ammonium, and iron, is adequate; however, many of the trace elements are routinely below limits of detection. Data users should carefully screen out species that are present in such low levels that their inclusion would only add noise to their analysis. Method Detection Limits (MDLs) are provided in **Appendix A** of this report.

In addition to the general data quality assessment criteria listed above, there are other, specific issues that affect CSN data usability. The following specific issues and characteristics of the data should be taken into account by data users:

- Lack of blank correction. From the beginning of the CSN program, blank corrections have not been applied (except for normal laboratory calibrations). The main concern is the artifact in OC measurement. The IMPROVE network includes blank correction for OC in its reported data. This is a fundamental difference between the data reported by CSN and IMPROVE.

- Intermittent media contamination issues. Equipment and media contamination issues arise from time to time and may cause the occasional outliers reported by the monitoring agencies, in which the CSN mass differs from the mass reported by a nearby FRM sampler. RTI makes an effort to flag data, retroactively if necessary, to invalidate or mark as suspicious any events reported by the monitoring agencies.
- Estimation of Uncertainty.
  - Comparability between CSN and other networks. RTI worked with XRF experts at the University of California at Davis (UC Davis) and EPA to define an acceptable method for determining XRF uncertainty. This work resulted in a White Paper that was delivered to EPA in 2006.[1] A peer-reviewed publication based on this work was published in the Journal of the Air and Waste Management Association in early 2010.[2]
  - Realism of total uncertainty estimates based on statistics from sites with side-by-side collocation of samplers.[3] Uncertainties calculated from collocation results agree with uncertainties reported to AQS within a factor of 2x for most species. See Section 5.3 and Table 5-5 for uncertainty statistics for 2014.

2.2 Summary of Data Completeness

Appendix B of this report includes the data completeness summary for the Reporting Batches delivered in 2014. Table B-1 provides the completeness for the "core" STN sites. Table B-2 summarizes completeness for the non-STN sites that are supported on the CSN contract with EPA. Data completeness network-wide typically exceeded 90% during 2014. During 2014, a number of sites were converted to sequential sampling resulting in sampler downtime. This may be part of the reason for higher occurrence of reduced data completeness seen in Appendix B. Completeness is defined as the number of valid measurement values divided by the potential number of values. Data records with AQS validity status codes ("suspicious" data) are included in the completeness figure, but data records with an AQS null value code are counted as missing data.

2.3 Corrective Actions

To ensure ongoing quality work, RTI reacts quickly and decisively to any unacceptable changes in data quality. These reactions are usually in the form of corrective actions. Most

[1] Gutknecht, W. F., J. B. Flanagan, and A. McWilliams, "Harmonization of Interlaboratory X-ray Fluorescence Measurement Uncertainties." RTI/0208858/TO2/04D, August 4, 2006.
[2] Gutknecht, W.F., J.B. Flanagan, A. McWilliams, R.K.M. Jayanty, et al. 2009. Harmonization of uncertainties of X-ray fluorescence data from $PM_{2.5}$ air filter analysis. *Journal of the Air and Waste Management Association*, February, 2010.
[3] Flanagan, J.B., Jayanty, R.K.M., Rickman, E.E., Jr., Peterson, M.R., 2006. PM2.5 Speciation Trends Network: Evaluation of whole-system uncertainties using data from sites with collocated samplers. J. Air & Waste Manage. Assoc. 56, 492-499.

corrective actions have been in response to very short-term problems, such that very few results were impacted negatively. The following subsections describe any significant corrective actions undertaken in each laboratory area during 2014.

2.3.1 Gravimetric Mass

There were no quality issues that affected data quality during the reporting period. See Section 3.1.1 for a summary of operational and maintenance issues that were addressed during 2014.

2.3.2 Ion Analysis

There were no significant issues that affected data quality in RTI's Ion Chromatography laboratory during the reporting period. See Section 3.2.1 for a summary of operational and maintenance issues that were addressed during 2014.

2.3.3 Elemental Analysis

There were no significant issues that affected data quality in RTI's XRF laboratory during the reporting period. See Section 3.4.1.1 for a summary of operational and maintenance issues that were addressed during 2014.

See Section 3.4.2.1 for a summary of quality issues and maintenance from Chester Labnet, which performs some of the elemental analysis by XRF for the CSN contract.

2.3.4 Organic Carbon/Elemental Carbon Analysis

All of the reportable CSN carbon analyses by the IMPROVE_A method are being performed by DRI, which is a subcontractor on the CSN contract. DRI reports that there were no quality issues requiring corrective actions during 2014; see Section 3.3.1 for a summary of operational issues.

2.3.5 Sample Handling and Archiving Laboratory (SHAL)

As discussed in Section 3.6.1, there was one quality issue in 2014 that required corrective action. This was related to an incorrect assignment of field sampler channels during the data entry process. While entering the field sampling data into the CSN database at RTI, the data entry person mistakenly entered channel 1 instead of channel 2 for some of the URG 3000N sequential sampling events. Those sampling events with incorrect channel assignments appeared to have no sample volume and were therefore automatically invalidated in the database with the AQS Null Value Code of "AM -Miscellaneous Void". A total of 26 events between the sampling dates of June 24, 2013 and July 7, 2014 were incorrectly invalidated. Corrective actions were taken to prevent future incorrect assignment of the field sampler channels in the database, which included automating channel selection based on scheduled events and adding an automated check during the monthly QA review. All data for the 26 events were corrected and reposted to AQS after a thorough QA review.

2.3.6 Data Processing

There were no quality issues or corrective actions taken during this reporting period. The uncertainties for the carbon values for the samples collected by URG 3000N have not yet been posted into AQS, pending direction from EPA about the method to be used for calculations. Blank-corrections and/or artifact corrections for the IMPROVE_A carbon measurements rely on the same set of calculations, and these have also not been posted, pending direction from EPA.

2.4 Other Quality Issues

One major data quality issue related to the manufacturer contamination of blank Teflon filters that was identified during 2013 also impacted one reporting batch in 2014. RTI's XRF laboratory identified high chromium values in Teflon field blank samples and in Teflon Lot Blanks during 2013. This issue did not originate from an RTI laboratory and was traced back to possible chromium contamination of filters by the filter manufacturer. The high background was detected prior to reporting of Batch 166 in 2013 and was addressed by performing appropriate extensive Lot-specific background correction. The chromium contamination was detected at an early stage and the manufacturer was notified promptly. In 2014, this impact was restricted to batch 169 consisting of 934 valid filters from one Teflon Filter Lot (Lot # 137102). An XRF analysis of unused filter lot blanks from all the affected Lots in 2013 and 2014 showed average chromium loadings ranging from 0.2 to 0.95 µg/filter, more than 10 to 40 times higher than the typical blank loading of 0.01 to 0.02 µg/filter, and more than 12 to 25 times higher than the typical network-average ambient chromium concentration of 0.016 to 0.034 µg/filter. All affected chromium data were flagged. Corrective actions have been implemented to verify filter specifications.

3.0 Laboratory Quality Control Summaries

3.1 Gravimetry Laboratory

The RTI Gravimetric Laboratory's two weigh chambers were used to tare 13,160 Teflon filters for the $PM_{2.5}$ speciation program between January 1 and December 31, 2014. During the same time period, the laboratory performed final (post-sampling) weighings of 12,901 Teflon filters for the program. The difference between the number of tared filters and the number of final filters is partly due to the inherent lag time between the initial and final weighing sessions. Determination of $PM_{2.5}$ mass is based on two separate weighings performed several weeks apart. The total also reflects a contingency buffer factored into the number of filters tared each week to ensure an adequate number of tared filters for sampling and extra filters for use in-house blanks contamination monitoring. Filter weighing totals given in this report are those recorded by the laboratory's database application. Beginning October 1, 2014, gravimetric analysis of Teflon Filters was discontinued for the entire network except for six sites.

3.1.1 Quality Issues and Corrective Actions

No significant filter quality issues were identified in the Gravimetry Laboratory in 2014. The laboratory continued to proactively monitor mass balance data and to perform routine filter inspections during conditioning and weighing. No pervasive problem with extraneous contaminating debris was identified in 2014 in the routine visual inspection in the chamber. Lot stability tests indicated that the eight Teflon filter lots used for the program in 2014 did not have issues with debris or outgassing.

The laboratory's environmental chambers experienced little downtime due to system failure in 2014. A drive actuator for the chilled water valve was replaced in Chamber 2. Chamber 1 had two fan motors and the chilled water valve actuator replaced. Chamber 1 was also affected by the damper for the dehumidifier being stuck open as well as the drain line for the dehumidifier being set to manual. RTI's Facilities and Maintenance HVAC team was able to complete most of this work within a timeframe that caused a single day of downtime or less. When one of the fan motors for Chamber 1 failed, it caused the heater to malfunction, which was replaced by Bahnson Environmental Specialties. There were no prolonged instances of chamber malfunction. When necessary, weighing was suspended pending repair and stabilization of the chamber environment.

During the course of 2014, the high bay that houses the chambers had minor problems with the building's chilled water supply. The chambers' temperature and humidity controls could not maintain the chamber set points when the building conditions became unstable after the boiler tripped. RTI's Facilities and Maintenance HVAC team quickly responded to fix these issues. RTI's Facilities and Maintenance coordinated with the Gravimetric Laboratory before performing any additional work on the high bay so as to have minimal effect on project work. In all cases, weighing was suspended pending repair and stabilization of the chamber environment. As an example, Figure 3-1 illustrates the environmental history stability of Chamber 2. This level of tracking was implemented in 2014 with an improved Vaisala HMT333 data logger. The figure shows 1-min temperature and relative humidity (RH) readings for the entire year. As seen, both temperature and RH were within specified limits except for periods of service, maintenance issues or planned special study as noted on the figure. No CSN filters were impacted during these periods.

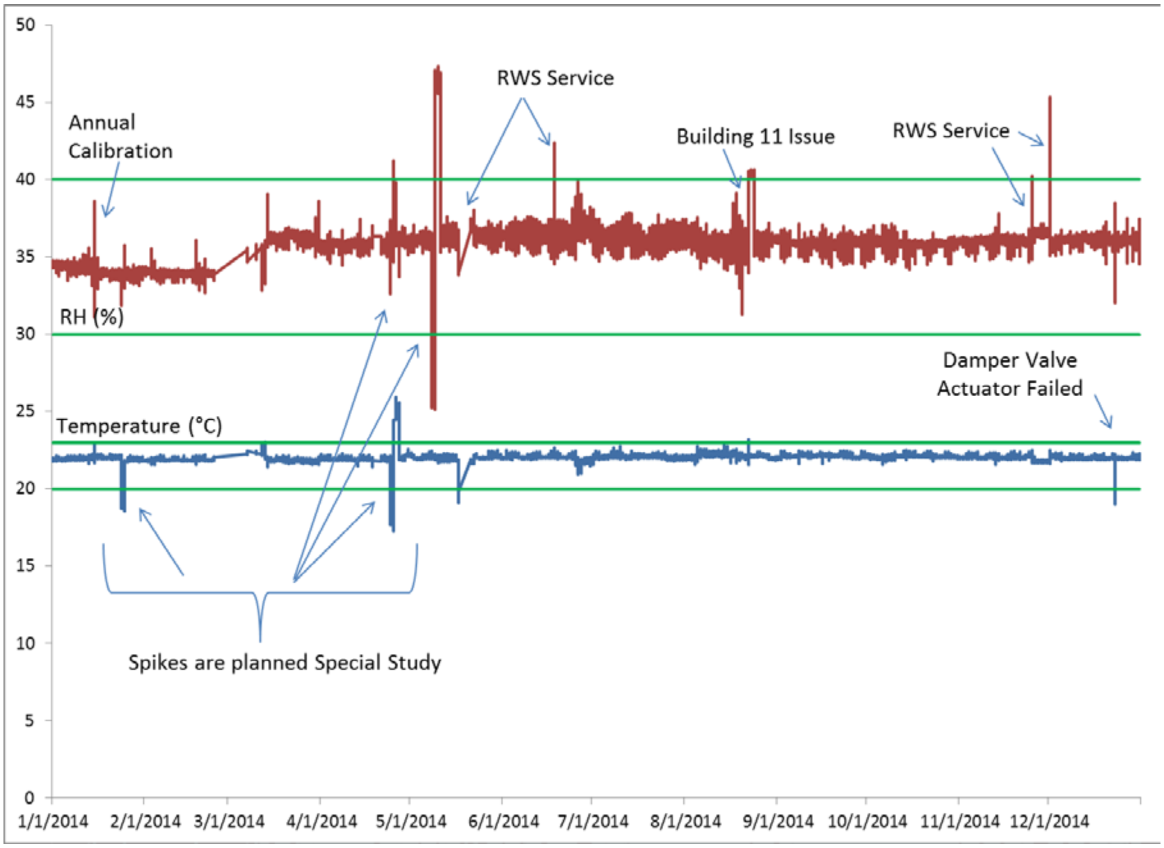


Figure 3-1. Gravimetric Laboratory Chamber 2 Environmental History during 2014

The gravimetric laboratory continues to monitor any instance of static electricity effects in the laboratory. The laboratory utilizes electrostatic discharge devices (ESD) to decrease the effect of static electricity on weigh sessions. The ESD devices employed by the Gravimetric Laboratory are grounding wrist straps, continuous wrist strap monitors, and anti-static laboratory coats. Balances with a glass weighing chamber also have a 1” Polonium strip attached to the top of the chamber. These devices are in addition to the MT U-shaped ionizers that have been used during weigh sessions for many years.

An MTL AH-225 Precision Weighing System was deployed in mid-2014. The robotic weighing system (RWS) provides greater precision and lower detection limits than are possible with manual weighing. The robotic autohandler is equipped with a highly sensitive Mettler Toledo microanalytical balance linked to a network computer for electronic data transmission to database or spreadsheet without hand entry of weighing data. The RWS and balance were thoroughly vetted prior to beginning to use it for the CSN. Therefore, no data was impacted by this change. Results from the RTI evaluation including RWS weighing, precision, and trace metals characterization of the MTL Precision Weighing System were presented at the National Air Quality Conference at the EPA RTP in February 2014[4].

Working mass standards were removed from use during the year when due for re-verification by Henry Troemner LLC or Heusser Neweigh. Troemner and Heusser Neweigh are independent commercial mass metrology laboratories offering weight calibration services. Both weight calibration laboratories and processes are ISO/IEC 17025 compliant. The laboratory maintains several sets of working mass standards and substituted verified standards when standards were removed from service. The laboratory's staggered (spring and fall) re-verification schedule ensures that verified weights are available when a working set is removed from routine use in the chambers. Verifications have already been scheduled for Spring 2015 and Fall 2015.

3.1.2 Description of QC Checks Applied

Internal QC checks applied in the Gravimetric Laboratory are described in **Table 3-1**, along with results achieved during this reporting period. In addition to routine QC checks, the RWS provides the capability of performing a balance repeatability test prior to each weigh session. A Balance Repeatability test is performed by using a single weight that is weighed multiple times in a row. The Mettler XP6 balance that is installed in the RWS uses an internal calibration weight that is applied to verify the balance performance prior to performing a weigh session. As seen in Figure 3-2, the balance repeatability in 2014 was on average 0.52 µg, with individual session tests ranging typically from 0.3 to 0.75 µg. Eight instances of 173 tests resulted in a repeatability above 0.8 µg, the suggested RWS upper limit. However, all of the data points were within the criteria specified in the QA Handbook, Volume II[5], which states that the accepted balance repeatability for ambient air filter weighing is 1.0 µg.

3.1.3 Summary of QC Results

Internal QC values generated by the laboratory usually met the criteria shown in **Tables 3-1 and 3-2**; however, a small number of outliers were noted. Sixteen of the outlier laboratory blank weighings for four individual laboratory blank filters fell outside the warning limit. These weighings occurred over the course of the entire year; therefore, it is not believed to be a systematic issue of debris on Teflon. In the case of outlier replicates, Gravimetric Laboratory analysts reweigh outliers to validate weights. Although the balance test weights used in the laboratory are working standards and may fall out of tolerance due to wear (scratches or nicks during handling) or environmental contamination, the weights were quite stable in 2014. The laboratory's primary standards are maintained by RTI's Quality Systems personnel and are used to audit the microbalances and verify the working mass standards annually.

[4] Presler-Jur, P., L.C. Greene, L. Michael, F. Weber, and O. Hammond. Intercomparison of Gravimetry Methods and Trace Metals Characterization. Poster presented at the National Air Quality Conference, Research Triangle Park, NC. February 2014.

[5] Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Ambient Air Quality Monitoring Program. Section PM2.5 Filter Based Local Conditions Validation Template. May 2013. http://www.epa.gov/ttnamti1/files/ambient/pm25/qa/QA-Handbook-Vol-II.pdf

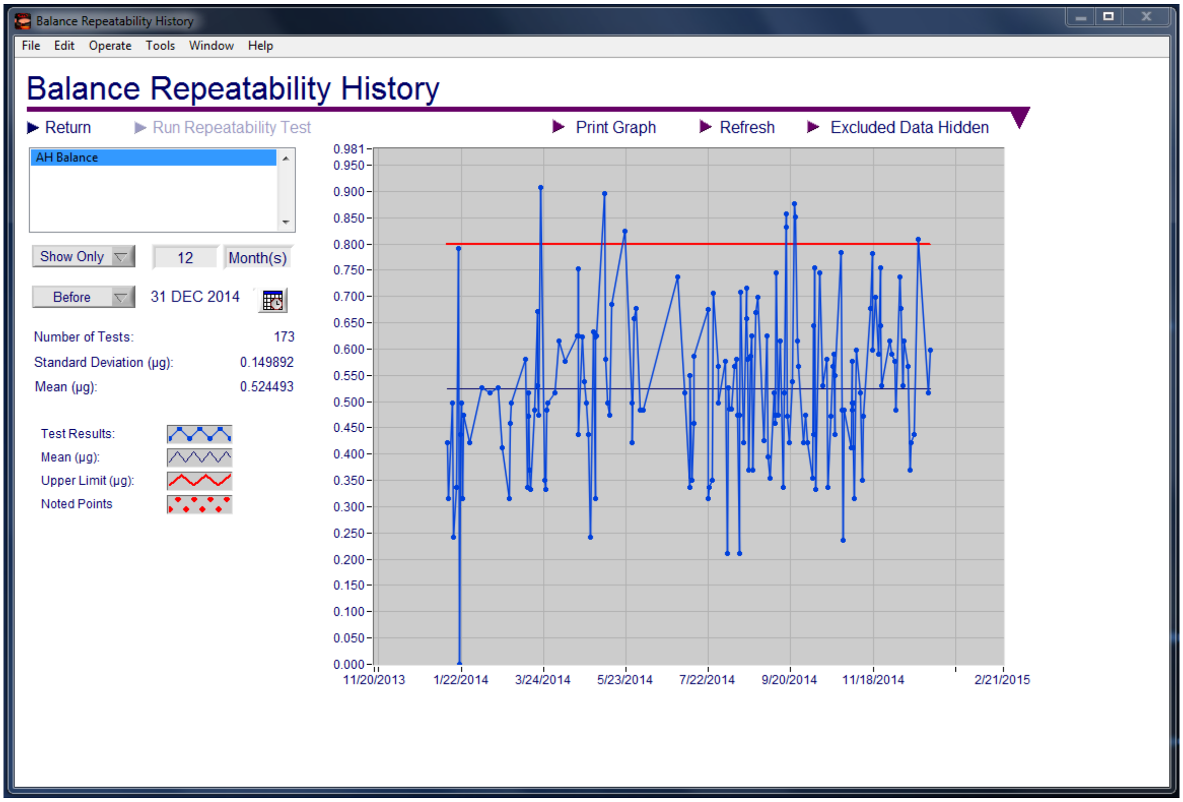


Figure 3-2. Gravimetric Laboratory RWS Balance Repeatability History during 2014

Table 3-1. Summary of QC Checks Applied and Results Achieved in the Gravimetric Laboratory

QC Check	Requirements	QC Checks Applied in RTI Laboratory	Average Value Determined by Lab	Comments
Working standard reference weights (mass reference standards)	Verified value ± 3 µg [Standard reference weights initially calibrated at purchase by Troemner. Verified by Troemner in 2014. Verified by the laboratory in conjunction with 2014internal balance audit performed by RTI Quality Systems Program.	Chamber 1 100-mg S/N 41145 05/24/2013 Verification: 99.9979 mg ± 0.0025 Laboratory Tolerance Interval: 99.996 – 100.002 mg	Average = 99.997 mg Std Dev = 0.0008 for 358 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		100-mg S/N 41144 10/3/2013 Verification: 99.9971 mg ± 0.0025 Laboratory Tolerance Interval: 99.994 – 100.000 mg	Average = 99.997 mg Std Dev = 0.0007 for 93 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		100-mg S/N 58097 05/24/2013 Verification: 99.9987 mg ± 0.00025 Laboratory Tolerance Interval: 99.996 – 100.002 mg	Average = 99.998 mg Std Dev = 0.0009 for 257 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		05/21/2014 Verification: 99.998 mg ± 0.00025 Laboratory Tolerance Interval: 99.996 – 100.002 mg	Average = 99.998 mg Std Dev = 0.0009 for 38 weighings	Laboratory average falls within tolerance interval. No weighing

QC Check	Requirements	QC Checks Applied in RTI Laboratory	Average Value Determined by Lab	Comments
				exceeded tolerance interval.
		100-mg S/N 83426 10/03/2013 Verification: 100.0046 mg ± 0.00025 Laboratory Tolerance Interval: 100.002 – 100.008 mg	Average = 100.004 mg Std Dev = 0.0010 for 76 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		200-mg S/N 41147 05/24/13 Verification: 200.0032 mg ± 0.00025 Laboratory Tolerance Interval: 200.000–200.006 mg	Average = 200.003 mg Std Dev = 0.0005 for 358 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		200-mg S/N 58099 05/24/2013 Verification: 200.0002 mg ± 0.0025 Laboratory Tolerance Interval: 199.997 – 200.003 mg	Mean = 200.000 mg Std Dev = 0.0009 for 257 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		05/21/2014 Verification: 200.002 mg ± 0.0025 Laboratory Tolerance Interval: 199.999 – 200.005 mg	Mean = 200.001 mg Std Dev = 0.0005 for 38 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		200-mg S/N 41148 10/03/2013 Verification: 199.9971 mg ± 0.0025 Laboratory Tolerance Interval: 199.994 – 200.000 mg	Average = 199.997 mg Std Dev = 0.00008 for 93 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		200-mg S/N 83429 10/03/2013 Verification: 200.0004 mg ± 0.0025 Laboratory Tolerance Interval: 199.998 – 200.003 mg	Average = 200.000 mg Std Dev = 0.0010 for 78 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		Chamber 2 100-mg S/N 58096 05/21/2014 Verification: 99.998 mg ± 0.0025 Laboratory Tolerance Interval: 99.995 –100.001 mg	Average = 99.997 mg Std Dev = 0.0010 for 86 weighings	Laboratory average falls within tolerance interval.
		100-mg S/N 83252 05/24/2013 Verification: 99.998 mg ± 0.0025 Laboratory Tolerance Interval: 99.995 – 100.001 mg	Mean = 99.996 mg Std Dev = 0.0007 for 442 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		100-mg S/N 83425 10/03/2013 Verification: 99.9987 mg ± 0.0025 Laboratory Tolerance Interval: 99.996 – 100.002 mg	Mean = 99.998 mg Std Dev = 0.0007 for 212 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		100-mg S/N 07012014100B	Mean = 99.967 mg	Laboratory average

QC Check	Requirements	QC Checks Applied in RTI Laboratory	Average Value Determined by Lab	Comments
		07/05/2014 Verification: 99.9692 mg ± 0.0001 Laboratory Tolerance Interval: 99.966 – 99.972 mg 07/05/2014 Verification (Verified Value): 99.961 mg ± 0.0001 Laboratory Tolerance Interval: 99.958 – 99.964 mg	Std Dev = 0.0008 for 762 weighings Mean = 99.961 mg Std Dev = 0.0011 for 378 weighings	falls within tolerance interval. Two individual weighings fell 1 µg below lower limit. Laboratory average falls within tolerance interval. One individual weighing fell 1 µg below lower limit, two individual weighings fell 2 µg above upper limit, and one individual weighing fell 3 µg above upper limit.
		200-mg S/N 41146 05/24/13 Verification: 200.0011 mg ± 0.0025 Laboratory Tolerance Interval: 199.998 – 200.004 mg 200-mg S/N 18659 10/03/2013 Verification: 199.9981 mg ± 0.0025 Laboratory Tolerance Interval: 199.995 – 200.001 mg 200-mg S/N 58098 05/21/2014 Verification: 199.9997 mg ± 0.0025 Laboratory Tolerance Interval: 199.995 – 200.001 mg 200-mg S/N 07012014200C 07/05/2014 Verification: 200.011 mg ± 0.0025 Laboratory Tolerance Interval: 200.008 – 200.014 mg	Mean = 199.999 mg Std Dev = 0.0007 for 442 weighings Mean = 199.998 mg Std Dev = 0.0008 for 212 weighings Mean = 199.998 mg Std Dev = 0.00011 for 86 weighings Mean = 200.011 mg Std Dev = 0.0011 for 936 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval. Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval. Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval. Laboratory average falls within tolerance interval. Nine individual weighings fell 1 - 7 µg above upper limit.
Balance calibrations	Auto (internal) calibration daily External calibration annually or as needed	Daily All balances inspected and externally calibrated by Mettler Toledo on August 22, 2014, using NIST-traceable weight	N/A N/A	 Next inspection and external calibration scheduled for August 2015

QC Check	Requirements	QC Checks Applied in RTI Laboratory	Average Value Determined by Lab	Comments
Balance audits	Annually	Audits of all balances performed by RTI Quality Systems Program personnel on November 14, 2014, using Class S-1 NIST-traceable weights	N/A	Audit included environmental evaluation, level test, scale-clarity test, zero-adjustment test, off-center (corner load) test, precision test, and accuracy test; all balances performed satisfactorily.
RH/T monitoring devices calibrations	Annually	Chamber temperature and humidity sensors, temperature and humidity controllers, and process alarm control board (mother board) calibrated by Bahnson Environmental Specialties on January 15, 2014 Chamber data loggers calibrated by Veriteq Data Logger Test and Calibration Services on July 4, 2014	N/A N/A	Chamber sensors, controllers, and process boards are calibrated on-site annually by Environmental Specialties Next calibration due July 2015
Laboratory (Filter) blanks	Initial weight ± 15 µg	22,180 total replicate weighings of 243 individual laboratory blanks	Average difference between final and initial weight = 1.1 µg Std Dev = 4.1 Min wt change = -19 µg Max wt change = 23 µg	16 total replicate weighings of 4 individual laboratory blank filters (0.08% of the replicate weighings; 1.66% of the individual laboratory blanks) exceeded the 15 µg criterion.
Replicates	Initial weight ± 15 µg	7,280 individual filters were weighed as pre-sampling (tared) replicates 3,263 individual filters were weighed as post-sampling replicates	Average difference = -0.08 µg Average difference = -0.28 µg	0 replicate weighings (0.0% of the weighings) exceeded the 15 µg criterion on the first pass. Outliers would be reweighed in order to confirm a mass value with two weights within 5 µg of each other. 1 replicate weighings (0.03% of the weighings) exceeded the 15 µg criterion. Filter was reweighed to confirm value with two weights within 5 µg of each other.

Table 3-2 details the results of the lot stability tests performed to ensure filters are conditioned at least as long as the stability test indicate. All lot stability tests are performed on 12 filters, with 2 filters randomly selected from each of 6 randomly selected boxes. The filters are weighed until a 24-hour weight change < ± 5 µg is demonstrated or for 5 consecutive days.

Table 3-2. Summary of Lot Stability QC Results for the Gravimetric Laboratory

Lot	Received	24 Hours (mg)	48 Hours (mg)	72 Hours (mg)	96 Hours (mg)	120 Hours (mg)	Comment
159978	11/27/2013	140.926	140.922	140.922	140.924	140.927	Weight changes fall within required range
		141.799	141.793	141.793	141.794	141.794	
		145.149	145.145	145.144	145.147	145.148	
		138.415	138.411	138.410	138.411	138.412	
		143.981	143.975	143.975	143.975	143.978	
		147.133	147.126	147.126	147.127	147.131	
		143.606	143.603	143.604	143.605	143.604	
		139.718	139.713	139.713	139.716	139.717	
		142.901	142.897	142.896	142.899	142.902	
		140.788	140.784	140.789	140.789	140.788	
		143.029	143.025	143.024	143.024	143.024	
		145.311	145.306	145.307	145.306	145.305	
160578	11/27/2013	144.561	144.558	144.558	144.560		Weight changes fall within required range
		145.766	145.763	145.762	145.765		
		144.792	144.790	144.790	144.793		
		150.004	150.003	150.003	150.001		
		142.017	142.016	142.015	142.016		
		141.726	141.723	141.721	141.724		
		142.887	142.889	142.889	142.890		
		142.561	142.558	142.558	142.557		
		144.493	144.493	144.491	144.495		
		144.113	144.112	144.110	144.114		
		143.278	143.276	143.277	143.276		
		146.393	146.391	146.387	146.387		
160754	11/27/2013	145.772	145.770	145.770	145.771		Weight changes fall within required range
		141.904	141.904	141.904	141.903		
		141.026	141.024	141.024	141.024		
		141.350	141.349	141.349	141.350		
		143.694	143.691	143.692	143.692		
		144.954	144.952	144.953	144.953		
		146.444	146.442	146.442	146.443		
		147.002	147.000	146.999	147.000		
		138.958	138.955	138.957	138.956		
		141.743	141.741	141.742	141.742		
		142.713	142.708	142.710	142.710		
		146.398	146.395	146.396	146.396		

Lot	Received	24 Hours (mg)	48 Hours (mg)	72 Hours (mg)	96 Hours (mg)	120 Hours (mg)	Comment
160767	12/5/2013	142.578	142.580	142.578	142.578	142.578	Weight changes fall within required range
		143.091	143.091	143.090	143.088	143.090	
		150.162	150.161	150.159	150.158	150.158	
		146.988	146.987	146.988	146.986	146.985	
		148.028	148.031	148.031	148.028	148.029	
		142.837	142.837	142.839	142.836	142.837	
		144.458	144.458	144.458	144.455	144.455	
		147.452	147.453	147.452	147.451	147.450	
		149.055	149.053	149.051	149.050	149.051	
		143.560	143.561	143.560	143.558	143.557	
		145.427	145.428	145.427	145.425	145.424	
		143.730	143.731	143.727	143.724	143.724	
161068	12/5/2013	140.349	140.349	140.345	140.345	140.346	Weight changes fall within required range
		147.287	147.288	147.286	147.283	147.287	
		141.113	141.113	141.110	141.106	141.109	
		142.135	142.137	142.132	142.130	142.133	
		146.936	146.937	146.934	146.933	146.939	
		142.117	142.119	142.116	142.116	142.119	
		141.418	141.419	141.417	141.415	141.421	
		141.641	141.640	141.637	141.636	141.639	
		142.489	142.489	142.484	142.481	142.486	
		145.201	145.201	145.199	145.197	145.201	
		144.834	144.833	144.833	144.832	144.838	
		135.462	135.464	135.460	135.456	135.462	
174783	2/5/2014	140.508	140.512	140.509	140.508	140.510	Weight changes fall within required range
		141.846	141.847	141.848	141.847	141.850	
		138.376	138.378	138.379	138.376	138.379	
		140.640	140.642	140.645	140.643	140.643	
		146.515	146.515	146.515	146.514	146.518	
		141.155	141.157	141.159	141.157	141.157	
		144.390	144.388	144.391	144.389	144.393	
		148.546	148.549	148.550	148.551	148.552	
		148.400	148.401	148.403	148.403	148.403	
		142.197	142.196	142.200	142.200	142.202	
		146.056	146.058	146.057	146.058	146.061	
		141.176	141.175	141.175	141.175	141.174	
186770	6/3/2014	140.073	140.073	140.073	140.072	140.073	Weight changes fall within required range
		134.714	134.714	134.713	134.714	134.715	
		137.108	137.108	137.109	137.109	137.109	
		136.219	136.222	136.222	136.223	136.222	
		137.304	137.303	137.305	137.304	137.307	
		136.575	136.575	136.574	136.575	136.575	
		137.748	137.748	137.748	137.748	137.747	
		136.572	136.574	136.574	136.574	136.573	
		135.989	135.989	135.989	135.990	135.990	
		137.779	137.777	137.777	137.778	137.778	
		136.375	136.375	136.374	136.375	136.373	

Lot	Received	24 Hours (mg)	48 Hours (mg)	72 Hours (mg)	96 Hours (mg)	120 Hours (mg)	Comment
		136.827	136.826	136.827	136.830	136.829	
203963	8/8/2014	136.288	136.289	136.288	136.291	136.287	Weight changes fall within required range
		131.424	131.421	131.419	131.424	131.419	
		135.628	135.626	135.625	135.629	135.627	
		135.397	135.391	135.391	135.399	135.392	
		133.187	133.187	133.187	133.187	133.188	
		132.754	132.754	132.748	132.748	132.746	
		132.581	132.587	132.580	132.586	132.584	
		135.000	135.001	134.999	134.999	134.999	
		131.607	131.604	131.609	131.611	131.608	
		135.105	135.105	135.107	135.107	135.110	
		132.056	132.047	132.047	132.047	132.047	
		135.538	135.536	135.535	135.536	135.538	

3.1.4 Determination of Uncertainties and Method Detection Limits

The Gravimetric Laboratory's MDL calculations are based on replicate weighings of a large number of filters from filter lot acceptance batches. Because determination of gravimetric mass requires two separate weighings, each of which contributes to the total uncertainty, a multiplicative factor of 1.414 is included to account for the fact that each filter must be weighed twice to generate the final net mass. MDLs reported to AQS are shown in Appendix A.

3.1.5 Audits, Performance Evaluations, Training, and Accreditations

Table 3-3 contains information regarding audits, performance evaluations (PEs), training, and accreditations for the Gravimetric Laboratory.

3.2 Ions Analysis Laboratory

The Ion Analysis Laboratory used nine ion chromatograph systems to analyze approximately 14,991 filter samples for cations (sodium, potassium, and ammonium) and anions (nitrate and sulfate), excluding duplicates and replicates. The analyses were performed for the CSN program during the period January 1 through December 31, 2014. During this period, more than 2,300 QC samples were analyzed for anions and more than 2,000 QC samples were analyzed for cations.

3.2.1 Quality Issues and Corrective Actions

There were no quality issues or corrective actions during the reporting period.

Table 3-3. Description of Audits, PEs, Training, and Accreditations

Type of Evaluation	Date	Administered By	Significant Findings/Comments
Internal Audit	January 23, 2014 November 7, 2014	RTI FRM Project QA Officer RTI CSN Project QA Manager	The auditor noted that the gravimetric chambers were clean and that the log books and records were up to date. The audit found the lab operations to be consistent with the SOP. The chambers and balances were all clean with proper calibration records. No major deficiencies were found. One minor recommendation was to consolidate the electronic documents onto one or two servers. Documentation is now maintained on two servers - one dedicated to CSN data, and the other server for general lab documents.
Proficiency Evaluation (PE)	May 30, 2014 (results finalized)	EPA National Air and Radiation Environmental Laboratory (NAREL)	EPA NAREL finalized the results of the experimental inter-comparison of speciation laboratories completed in the winter of 2013-2014. Analyses were performed on real-world samples collected in Montgomery, AL. RTI's Gravimetric Laboratory performance in the study was good, with the RTI laboratory agreeing with the EPA NAREL laboratory within 5 µg on exposed (sampled) filters.
Accreditation	Updated Scope of Accreditation Certificate issued July 1, 2013	National Environmental Laboratory Accreditation Program (NELAP)	RTI maintains accreditation in the National Environmental Laboratory Accreditation Program (NELAP) through the Louisiana Department of Environmental Quality (LDEQ) Louisiana Environmental Laboratory Accreditation Program (LELAP).
External Audit	N/A	National Environmental Laboratory Accreditation Program (NELAP)	The next NELAP external audit is scheduled for March 2015.

3.2.2 Description of QC Checks Applied

Ion chromatographic analyses were performed by personnel from RTI's Ion Analysis Laboratory. Nine Dionex ion chromatographic systems were used for performance of the CSN measurements and are summarized in **Table 3-4**. Distribution of samples among these nine instruments was determined by laboratory workload and instrument availability.

Table 3-4. Description of Ion Chromatographic Systems Used for Analysis of $PM_{2.5}$ Filter Samples

System No.	Dionex IC Model	Ions Measured
A4	DX-600	SO_4^{2-}, NO_3^-
A5	DX-600	SO_4^{2-}, NO_3^-
A6	ICS-2000	SO_4^{2-}, NO_3^-
A8	ICS-3000	SO_4^{2-}, NO_3^-
A9	ICS-3000	SO_4^{2-}, NO_3^-
C3	ICS-2000	Na^+, NH_4^+, K^+
C4	DX-600	Na^+, NH_4^+, K^+
C6	ICS-3000	Na^+, NH_4^+, K^+
C7	ICS-3000	Na^+, NH_4^+, K^+

QC checks for ion analyses are summarized in **Table 3-5**. For ion analyses, a daily multipoint calibration (7 points for cations; 8 points for anions) is performed over the range of 0.05 to 25.0 ppm for each ion (Na^+, NH_4^+, and K^+ for cation analyses; NO_3^- and SO_4^{2-} for anion analyses) followed by QC samples, including (1) an RTI-prepared QC sample containing concentrations of each ion in the mid- to high-range of the calibration standard concentrations; (2) an RTI-prepared QC sample containing concentrations of each ion at the lower end of the calibration standard concentrations; both of these solutions prepared from a commercially available NIST-traceable standard containing known concentrations of each ion. This standard is different from the commercial standards that are used to prepare calibration standards.

The regression parameters (a,b,c, and correlation coefficient, r) for the standard curve for each ion are compared with those obtained in the past. Typically, a correlation coefficient of 0.999 or better is obtained for each curve. If the correlation coefficient is < 0.999, the analyst carefully examines the individual chromatograms for the calibration standards and re-runs any standard that is judged to be out of line with respect to the other standards or to values (peak area and/or height) obtained in the past for the same standard. Possible causes for an invalid standard run include instrumental problems, such as incomplete sampling by the autosampler. If necessary, a complete recalibration is performed. When all individual calibrations have been judged acceptable, the results for the QC samples are carefully examined. If the observed value for any ion being measured differs by more than 10% from the known value, the problem is identified and corrected. Any field samples are then analyzed.

During an analysis run, a replicate sample, a QC sample, and a spiked sample are analyzed at the rate of at least one for every 20 field samples. Precision objectives for replicate analyses are ±5% for concentrations that equal or exceed 100 times the MDL, ±10% for concentrations at 10 times the MDL, and ±100% for concentrations at the MDL. MDLs for each instrument and analyte are listed in **Table 3-6**. The observed value for any ion being measured must be within 10% of the known value for the QC samples (**Table 3-7**), and ion recoveries for the spiked samples must be within 90 to 110% of the target value. If these acceptance criteria are not met for any QC or spiked sample, the problem is identified and corrected. All field samples analyzed since the last acceptable check sample are then re-analyzed.

Table 3-5. Ion Analysis of $PM_{2.5}$ Quality Control Checks

QC Check	Frequency	Requirements
Calibration Regression Parameters	Daily	r $\geq$0.999
Initial QC Checks: ▪ RTI prepared QC sample at mid- to high-range concentration ▪ RTI prepared QC sample at lower-end concentration	 Daily, immediately after calibration Daily, immediately after calibration	 Measured concentrations within 10% of known values Measured concentrations within 10% of known values
Periodic QC Checks: ▪ Replicate sample † ▪ QC sample ▪ Matrix spiked sample extract ▪ Duplicates ‡	 Every 20 samples Every 20 samples Every 20 samples At least one per day	 RPD** = 5% at 100x MDL* RPD = 10% at 10x MDL* RPD = 100% at MDL* Measured concentrations within 10% of known values Recoveries within 90 to 100% of target values No limit set. This data gathered for comparability studies.
▪ Reagent Blanks	One reagent blank per reagent used (DI H_2O and/or eluent sample set extracted)	No limit set. This data gathered for comparability studies.

* MDL = Minimum Detectable Limit
** RPD = Relative Percent Difference
†Replicates indicate a specific sample is run twice on the same instrument.
‡Duplicates indicate a specific sample is run on two different instruments.

Table 3-6. Minimum Detection Limit* for Each Instrument and Analyte

Instrument	Nitrate	Sulfate	Sodium	Ammonium	Potassium
A4	0.070	0.100	NA	NA	NA
A5	0.070	0.100	NA	NA	NA
A6	0.211	0.036	NA	NA	NA
A8	0.109	0.159	NA	NA	NA
A9	0.044	0.046	NA	NA	NA
C3	NA	NA	0.109	0.244	0.228
C4	NA	NA	0.290	0.160	0.134
C6	NA	NA	0.063	0.029	0.066
C7	NA	NA	0.105	0.007	0.019

* In µg/filter
NA – Not applicable

Table 3-7. Definitions and Specifications for QC Samples

Ion	Sample ID	Description/Specification
Anions	QC-CPI_LOW	0.6 ppm nitrate, 1.2 ppm sulfate
	QC-CPI_MED-HI	3.0 ppm nitrate, 6.0 ppm sulfate
	RTI-QC-HIGH	6.0 ppm nitrate, 12.0 ppm sulfate
	RTI-QC-MED	1.5 ppm nitrate, 3.0 ppm sulfate
Cations	GFS 0.4 PPM	0.4 ppm each sodium, ammonium, and potassium
	GFS 4.0 PPM	4.0 ppm each sodium, ammonium, and potassium
	RTI 2.0 PPM	2.0 ppm each sodium, ammonium, and potassium
	RTI 5.0 PPM	5.0 ppm each sodium, ammonium, and potassium

3.2.3 Summary of QC Results

QC checks performed included the following:

- Percent recovery for QC samples
- Relative percent difference (RPD) for replicates
- Spike recovery
- Reagent blank (elution solution and DI water).

Table 3-8 shows recoveries for all five analytes (nitrate, sulfate, sodium, ammonium, and potassium) with low, medium, and high QC for all of the instruments used for analysis.

Average recoveries for the QC samples ranged from 95.7 to 102.4% for the year. These recoveries are well within our acceptance range of 90 to 110%.

Table 3-9 shows percent recovery for all analyte spikes for the year. Average recoveries for the spikes ranged from 99.6 to 100.9%.

Table 3-10 presents filter blank (NQC BLANK) and reagent blank statistics for all analytes over the 12-month period. Ion loadings on cleaned nylon filters have to be less than 1 µg/filter to be accepted.

Table 3-8. Average Percent Recovery for QC Samples

Analyte	Sample ID	Count	Conc. µg/mL	Avg % Rec *	SD	Min Conc. µg/mL	Max Conc. µg/mL
Nitrate	QC-CPI_LOW	632	0.6	98.6%	1.9%	0.531	0.638
	QC-CPI_MED-HI	634	3.0	101.5%	1.5%	2.798	3.265
	QC-HIGH	328	6.0	102.4%	1.4%	5.952	6.552
	QC-MED	709	1.5	100.3%	1.5%	1.391	1.613
Sulfate	QC-CPI_LOW	632	1.2	98.0%	1.5%	1.126	1.282
	QC-CPI_MED-HI	634	6.0	100.3%	1.3%	5.517	6.428
	QC-HIGH	328	12.0	100.8%	1.4%	11.686	12.968
	QC-MED	709	3.0	99.8%	1.4%	2.880	3.197
Sodium	GFS 0.4 PPM	665	0.4	98.2%	2.3%	0.371	0.429
	GFS 4.0 PPM	653	4.0	100.2%	1.2%	3.856	4.191
	RTI 2.0 PPM	379	2.0	100.1%	1.4%	1.929	2.190
	RTI 5.0 PPM	344	5.0	100.9%	1.3%	4.894	5.238
Ammonium	GFS 0.4 PPM	665	0.4	99.3%	2.4%	0.371	0.443
	GFS 4.0 PPM	653	4.0	100.2%	1.3%	3.802	4.228
	RTI 2.0 PPM	379	2.0	99.7%	1.4%	1.922	2.171
	RTI 5.0 PPM	344	5.0	100.9%	1.3%	4.890	5.318
Potassium	GFS 0.4 PPM	665	0.4	95.7%	2.9%	0.358	0.425
	GFS 4.0 PPM	653	4.0	97.9%	1.2%	3.750	4.170
	RTI 2.0 PPM	379	2.0	98.2%	1.6%	1.871	2.136
	RTI 5.0 PPM	344	5.0	98.4%	1.5%	4.729	5.158

* Acceptance criteria for average percent recovery is ± 10%.

Table 3-9. Average Percent Recovery for Spikes

Analyte	Avg Recovery *	StDev	Count	Min	Max
Nitrate	100.7%	1.4%	630	93.3%	106.5%
Sulfate	100.9%	1.1%	630	96.5%	105.5%
Sodium	100.4%	1.5%	641	95.2%	107.6%
Ammonium	100.4%	1.6%	641	94.2%	109.2%
Potassium	99.6%	1.9%	641	90.5%	106.2%

* Acceptance criteria for average percent recovery is ± 10%

Table 3-10. Filter Blank (NQC) and Reagent Blank Values (ppm) for all Analytes

Analyte	Type	Count	Avg (ppm)	StDev (ppm)	Min (ppm)	Max (ppm)
Nitrate	Reagent	657	0.001	0.003	0.000	0.033
	NQC	331	0.009	0.012	0.000	0.040
Sulfate	Reagent	657	0.001	0.003	0.000	0.036
	NQC	331	0.001	0.004	0.000	0.036
Sodium	Reagent	665	0.001	0.004	0.000	0.038
	NQC	37	0.002	0.006	0.000	0.032
Ammonium	Reagent	665	0.000	0.001	0.000	0.032
	NQC	37	0.000	0.000	0.000	0.000
Potassium	Reagent	665	0.000	0.002	0.000	0.033
	NQC	37	0.000	0.000	0.000	0.000

* NQC is a blank filter extract analyzed to test the acceptability of the cleaned nylon filter batches. One nylon filter is tested from each bottle used for filter cleaning. If the ion loading for any ion is >1 μg/filter or 0.040 ppm, the filters from that bottle are rejected.

** Reagent is a 25-ml aliquot of deionized water that has been pipetted into an extraction tube and carried through the same extraction procedure as the filters.

3.2.4 Assessment of Between-instrument Comparability

Anion duplicates were analyzed on all anion instruments and cation duplicates were analyzed on all cation instruments. **Table 3-11** compares QC samples run on separate instruments on the same day. Each day, the anion instruments ran at least four QC samples. Similarly, the cation instruments ran at least four QC samples on each instrument each day. This Table shows that the difference between two instruments analyzing the same QC sample are typically within ±5% of the nominal concentration. The calculated average difference and standard deviation indicate a high level of between-instrument comparability.

Table 3-11. Between-instrument Comparability: IC Systems A6 vs. A8 and C3 vs. C6

Analyte	QC Type	Conc., ppm	Count	Average * Difference (ppm)	Standard Deviation of Diff. (ppm)	Minimum Diff. ppm)	Maximum Diff. (ppm)
Nitrate	QC-CPI_LOW	1.2	218	-0.005	0.010	-0.037	0.031
	QC-CPI_MED-HI	6.0	217	0.012	0.026	-0.109	0.127
	QC-HIGH	12.0	56	0.077	0.075	-0.098	0.547
	QA-MED	3.0	252	-0.011	0.016	-0.092	0.030
Sulfate	QC-CPI_LOW	1.2	218	-0.003	0.015	-0.068	0.063
	QC-CPI_MED-HI	6.0	217	0.066	0.052	-0.154	0.228
	QC-HIGH	12.0	56	0.109	0.141	-0.218	0.953
	QC-MED	3.0	252	0.005	0.029	-0.126	0.116
Sodium	GFS 0.4 PPM	0.4	190	0.006	0.006	-0.013	0.024
	GFS 4.0 PPM	4.0	182	-0.015	0.042	-0.179	0.215
	RTI 2.0 PPM	2.0	56	-0.002	0.013	-0.026	0.037
	RTI 5.0 PPM	5.0	49	-0.008	0.039	-0.091	0.137
Ammonium	GFS 0.4 PPM	0.4	190	-0.003	0.008	-0.024	0.022
	GFS 4.0 PPM	4.0	182	0.013	0.050	-0.103	0.249
	RTI 2.0 PPM	2.0	56	-0.010	0.023	-0.053	0.041
	RTI 5.0 PPM	5.0	49	0.047	0.069	-0.116	0.246
Potassium	GFS 0.4 PPM	0.4	190	0.016	0.009	-0.009	0.047
	GFS 4.0 PPM	4.0	182	-0.017	0.048	-0.158	0.290
	RTI 2.0 PPM	2.0	56	-0.004	0.015	-0.035	0.049
	RTI 5.0 PPM	5.0	49	-0.010	0.056	-0.130	0.181

* Differences are calculated as Concentration of A6 – Concentration of A8 for Anions and Concentration of C3 – Concentration of C6 for Cations.

3.2.5 Determination of Uncertainties and MDLs

Detection limits are determined by analyzing the lowest calibration standard 7 times and the detection limit, in µg/mL (or ppm), is calculated as 3 times the standard deviation of the 7 measurements. This detection limit is multiplied by 25mL, which is the extraction volume for each filter, to determine the detection limits in µg/filter. These calculations are performed for each instrument so that the detection limits are reported by instrument. Since most samples are not analyzed in replicate, analytical uncertainties must be estimated based on historical data and scientific judgment. A simple formula of the form $U = a \cdot C + b$ is used, where U is the uncertainty and C is the concentration. The coefficients “a” and “b” vary by instrument and by analyte. The “b” coefficient is essentially MDL/3. The value for “a” is assumed to be 0.05 (5%). MDLs for the CSN Program are summarized in Appendix A and represent the maximum MDL by species shown in Table 3-6.

3.2.6 Audits, Performance Evaluations, Training, and Accreditations

In February 2014, the IC laboratory participated in NAREL's inter-laboratory comparison study in which several laboratories analyzed replicate sets of single-blind filter samples for ions. Results from the proficiency testing study, which were summarized in the NAREL report dated May 30, 2014, indicated good performance by RTI's IC lab.

In November 2014, an internal audit of the IC laboratory was performed by the RTI QA Manager for the CSN project. The audit found the laboratory in compliance with the SOPs with good record-keeping practices. No major deficiencies were noted. Minor recommendations included adding temperature sensors to all refrigerators to monitor storage temperature, as well as exploring automated data backup options for the lab computers. It must be noted that data has always been backed up manually through the IC instrument software.

3.3 DRI Carbon Analysis Laboratory

The DRI Carbon Analysis Laboratory, as a subcontractor to RTI for EPA's Chemical Speciation Network (CSN), received and analyzed 16,644 quartz-fiber filters during the period January 1, 2014 through December 31, 2014 (sent to DRI twice per month in filter batches numbered 188 through 211). DRI performed 20,450 analyses on these quartz-fiber filter samples in the batches using the IMPROVE_A method (Chow et al. 2007) and reported the results of those analyses to RTI. Ten DRI Model 2001 Thermal/Optical Carbon Analyzers (designated as units # 6 – 13, 16, and 20) were used for the CSN IMPROVE_A analyses.

3.3.1 Quality Issues and Corrective Actions

No formal corrective action forms were submitted by DRI during 2014.

3.3.2 Description of QC Checks Applied

Samples received at the DRI Carbon Laboratory follow the chain-of-custody procedure specified in DRI SOP #2-111.4. Samples are analyzed following DRI SOP # 2-216r3, revised October 22, 2012. Quality control (QC) measures for the DRI carbon analysis are included in the SOP and summarized in **Table 3-12.** It specifies the frequency and standards required for the specified checks, along with the acceptance criteria and corrective actions.

Table 3-13 contains a list of quality-related data flags assigned to carbon analysis data and the number of filter analysis results assigned each flag by the DRI Carbon Laboratory during the reporting period. Out of 20,450 analyses, there were 1,742 runs flagged as invalid. In addition, 2,768 runs (including replicates and duplicates) were assigned blank or backup flags (i.e., backup filters, SHAL blanks, and 24-hour field blanks) based on information that RTI provided to DRI on January 24, 2015. Blanks are not identified in the data files that RTI sends to DRI at the time the filters are to be analyzed. A complete list of sample IDs for blank filters was provided to DRI in January 2015, after all the 2014 data had been processed and validated. There were 2,066 runs with replicate (or duplicate) flags. In many cases, there was more than one flag for a sample run. The flag category "v" will generally result in additional runs.

Table 3-12. DRI Carbon Analysis Quality Control Measures

Requirement	Calibration Standard and Range	Calibration Frequency[b]	Acceptance Criteria	Corrective Action
Laboratory Blank Check	NA[a]	Beginning of analysis day.	<0.2 µg C/cm^2.	Check instrument and filter lots.
Leak Check	NA	Beginning of analysis day.	Oven pressure drops less than 0.52 mm Hg/s.	Locate leaks and fix.
Laser Performance Check	NA	Beginning of analysis day.	Transmittance >700 mV; Reflectance >1500 mV	Check laser and filter holder position.
Calibration Peak Area Check	NIST 5% CH_4/He gas standard; 20 µg C (Carle valve injection loop, 1000 µl).	Every analysis.	Counts >20,000 and 95-105% of average calibration peak area of the day.	Void analysis result and repeat analysis with second filter punch.
Auto-Calibration Check	NIST 5% CH_4/He gas standard; 20 µg C (Carle valve injection loop, 1000 µl).	Beginning of analysis day.	95-105% recovery and calibration peak area 90-110% of weekly average.	Troubleshoot and correct system before analyzing samples.
Manual Injection Calibration	NIST 5% CH_4/He or NIST 5% CO_2/He gas standards; 20 µg C (Certified gas-tight syringe, 1000 µl).	End of analysis day.	95-105% recovery and calibration peak area 90-110% of weekly average.	Troubleshoot and correct system before analyzing samples.
Sucrose Calibration Check	10µL of 1800 ppm C sucrose standard; 18 µg C.	Thrice per week (began March, 2009).	95-105% recovery and calibration peak area 90-110% of weekly average.	Troubleshoot and correct system before analyzing samples.
System Blank Check	NA	Once per week	<0.2 µg C/cm^2.	Check instrument and filter lots.
Multiple Point Calibrations	1800 ppm C Potassium hydrogen phthalate (KHP) and sucrose; NIST 5% CH_4/He, and NIST 5% CO_2/He gas standards; 9-36 µg C for KHP and sucrose; 2-30 µg C for CH_4 and CO_2.	Every six months or after major instrument repair.	All slopes ±5% of average.	Troubleshoot instrument and repeat calibration until results are within stated tolerances.
Sample Replicates (on the same or a different analyzer)	NA	Every 10 analyses.	±10% when OC and TC ≥10 µg C/cm^2 ±20% when EC ≥ 10µg C/cm^2 or <±1 µg/cm^2 when OC and TC <10 µg C/cm^2 <±2 µg/cm^2 when EC <10µg C/cm^2	Investigate instrument and sample anomalies and rerun replicate when difference is > ±10%.
Temperature Calibrations	Tempilaq® G (Tempil, Inc., South Plainfield, NJ, USA); Three replicates each of 121, 184, 253, 510, 704, and 816 °C.	Every six months, or whenever the thermocouple is replaced.	Linear relationship between thermocouple and Tempilaq® G values with R^2 >0.99.	Troubleshoot instrument and repeat calibration until results are within stated tolerances.
Oxygen Level in Helium Atmosphere (using GC/MS)[c]	Certified gas-tight syringe; 0-100 ppmv.	Every six months, or whenever leak is detected.	Less than the certified amount of He cylinder.	Replace the He cylinder and/or O_2 scrubber.
Interlaboratory comparisons	NA	Once per year.	NA	Review and verify procedures.
External systems audits	NA	Once every two to three years.	NA	Take action to correct any deficiencies noted in audit report.

[a] NA: Not Applicable.

[b] Calibration performed by carbon analyst, except for interlaboratory comparisons and external systems audits, which are conducted by the U.S. Environmental Protection Agency (EPA) National Air and Radiation Environmental Laboratory (NAREL).

[c] Gas chromatography/mass spectrometer (Model 5975, Agilent Technology, Palo Alto, CA, USA).

Table 3-13. DRI Carbon Laboratory-Assigned Data Flags

Validation Flag Category	Validation Flag Subcategory	Description	No. of Sample Runs
n		Foreign substance on sample	2
s		Suspect analysis result	12
v		Void (invalid) analysis result	1742
	v2	Replicate analysis failed acceptable limit	136
	v3	Potential contamination	27
	v5	Analytical instrument error	1487
	v6	Analyst error	67
	v7	Software malfunction	25
		Total (n, s, v)	**1756**
r		Replicate analysis	
	r1	First replicate analysis on same analyzer (duplicate)	109
	r5	Replicate on different analyzer	1957
		Total (r)	**2066**
		No n, s, v, or r flag	**16628**
		Total no. of original sample runs (incl. blank and replicate flags)	**20450**

Only flags assigned in DRI Carbon Laboratory data reports to RTI are included in the table. RTI interprets the DRI Carbon Laboratory validation flags and assigns AQS null value codes or validity status codes when reporting the data to AQS.

3.3.3 Summary of QC Results

3.3.3.1 Blanks

Table 3-14 contains the number of instrument system blanks run during the reporting period and the average, standard deviation, maximum, minimum, and median measured blank values for the ten carbon aerosol analyzers used during the period. **Table 3-15** gives the laboratory blank statistics for each of the ten carbon analyzers used during the reporting period.

Laboratory blanks are run at the beginning of each analysis day for each operating analyzer. They may be rerun until the analyzer gives readings lower than 0.2 µg C/cm^2 of TC. However, they are also run to check instrument performance after repairs and adjustments. In addition, laboratory system blanks are assigned to the instrument and not to the project. The data in **Tables 3-14** and **3-15** include all laboratory and system blank data that were analyzed using the IMPROVE_A method for this and other projects. Blanks that did not meet the 0.2 µg C/cm^2 criteria were repeated until the system was clean. DRI uses the term “system blank” for a run that is made without a filter punch in the analyzer and “laboratory blank” for a run with a “clean” punch in the analyzer. DRI’s SOP distinguishes laboratory blanks from system blanks.

Tables 3-16 through **3-18** give the analysis results by analyzer for the 24-hour field blanks, backup filters, and SHAL blanks, respectively. These blank filters were identified based upon the list of blank filters IDs provided to DRI by RTI on January 24, 2015. In these tables, all records that were invalid (RTI Invalid Code = “1”) were removed. There were no trip blanks during 2014. SHAL blanks are pre-fired filters that have never been sent to the field, and are packaged and labeled by RTI to look like the other filters in a shipment. SHAL blanks are intended to diagnose the amount of carbon picked up during the filter storage, shipping, and handling processes at and between RTI and DRI. There is minimal instrument to instrument variation among the 24-hour field blanks or backup filters. Differences between means for each instrument were typically less than one standard deviation. Some differences between means may be due to the influence of high outliers. For SHAL and 24-hour field blanks, the number of filters with TC > 2.0 µg/cm^2 (excluding replicates and invalid records) was 0 and 107, respectively. For all types of blanks, it was found that nearly all the TC was in OC, with negligible quantities of EC.

Table 3-19 summarizes the results for each type of blank combined over all analyzers. Average TC concentration (excluding replicates and invalids) was 0.23 ± 0.22 µg/cm^2 for the 158 SHAL blanks, 1.1 ± 0.9 µg/cm^2 for the 1,445 24-hr field blanks, and 2.8 ± 1.5 µg/cm^2 for the 718 backup filters. As noted above, all records that were invalid were excluded prior to generating the data summary, primarily driven by a 24-hr field blank sample (filter ID# A9625416) that had an exceptionally high TC value of 32.19 µg/cm^2. That blank filter was invalidated by RTI during the monthly review as it was not representative of a field blank and showed high TC similar to the routine sample for that day, and did not appear to be swapped with the routine sample. It affected the maximum value for the field blank summary data that was unrealistic. Consequently, all invalids were excluded prior to calculating the statistics. Although the data summaries for OC/EC blanks in previous year reports did not exclude the invalid records, the blank statistics are not expected to affected significantly due to the negligible number of invalid records (and lack of extreme outliers), relative to the total number of samples.

3.3.3.2 Calibrations

Table 3-20 provides summary statistics for full multi-point calibrations by analyzer for the period during which the project samples were analyzed. The multipoint calibrations are performed semi-annually or whenever major repairs or changes are made to the instruments. Separate calibrations are performed using four different sources of carbon: methane (CH_4), carbon dioxide (CO_2), sucrose ($C_{12}H_{22}O_{11}$), and potassium hydrogen phthalate (KHP). The average of the regression slopes through zero is obtained and used for converting counts to µg C. The slope represents the response of the entire analyzer to generic carbon compounds and includes the efficiencies of the oxidation and methanator zones and sensitivity of the FID. The slope and correlation are for a least squares fit to all points in calibration curves using the four sources of carbon while the scatter is the standard deviation (root mean square of the variance) of the actual points from the fitted curve. Note that Analyzer 20 was only used for routine operation between May 21, 2014 and August 30, 2014, when it was again reassigned to experimental use.

Table 3-14. DRI Carbon Laboratory System Blank Statistics for Each Analyzer

Analyzer No.	No.*	Statistic*	IMPROVE_A Parameter (units are µg C/cm^2)													
			O1TC	O2TC	O3TC	O4TC	OPTRC	OPTTC	OCTRC	OCTTC	E1TC	E2TC	E3TC	ECTRC	ECTTC	TCTC
6	34	Mean	0.003	0.003	0.009	0.002	0.000	0.000	0.016	0.016	0.001	0.001	0.000	0.002	0.002	0.019
		StdDev	0.018	0.015	0.024	0.009	0.000	0.001	0.064	0.064	0.005	0.009	0.001	0.013	0.013	0.077
		Max	0.102	0.085	0.131	0.052	0.000	0.003	0.371	0.371	0.026	0.050	0.003	0.078	0.078	0.449
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
7	12	Mean	0.000	0.009	0.082	0.004	0.000	0.000	0.096	0.096	0.001	0.000	0.000	0.001	0.001	0.097
		StdDev	0.000	0.031	0.236	0.014	0.000	0.000	0.281	0.281	0.003	0.000	0.001	0.003	0.003	0.281
		Max	0.000	0.107	0.832	0.048	0.000	0.000	0.986	0.986	0.010	0.000	0.002	0.010	0.010	0.986
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.020	0.000	0.000	0.000	0.020	0.020	0.000	0.000	0.000	0.000	0.000	0.020
8	43	Mean	0.003	0.004	0.013	0.000	0.001	0.000	0.021	0.020	0.000	0.002	0.000	0.002	0.003	0.023
		StdDev	0.018	0.017	0.020	0.002	0.004	0.000	0.055	0.052	0.001	0.010	0.001	0.009	0.010	0.056
		Max	0.119	0.103	0.100	0.011	0.022	0.003	0.351	0.329	0.008	0.056	0.007	0.056	0.056	0.358
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.005	0.000	0.000	0.000	0.006	0.006	0.000	0.000	0.000	0.000	0.000	0.007
9	44	Mean	0.001	0.002	0.004	0.001	0.000	0.001	0.009	0.010	0.001	0.002	0.000	0.003	0.002	0.012
		StdDev	0.009	0.013	0.018	0.008	0.002	0.006	0.046	0.052	0.006	0.012	0.002	0.018	0.013	0.064
		Max	0.057	0.084	0.113	0.051	0.011	0.037	0.305	0.342	0.037	0.082	0.011	0.121	0.084	0.426
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	39	Mean	0.011	0.007	0.031	0.007	0.000	0.011	0.056	0.067	0.002	0.006	0.004	0.012	0.001	0.068
		StdDev	0.056	0.031	0.067	0.033	0.000	0.071	0.172	0.240	0.014	0.032	0.027	0.073	0.004	0.243
		Max	0.346	0.188	0.303	0.201	0.000	0.443	1.039	1.482	0.090	0.201	0.166	0.458	0.018	1.497
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.004	0.000	0.000	0.000	0.005	0.005	0.000	0.000	0.000	0.000	0.000	0.005
11	37	Mean	0.003	0.004	0.016	0.011	0.000	0.000	0.034	0.034	0.001	0.002	0.000	0.003	0.003	0.036
		StdDev	0.016	0.012	0.025	0.063	0.000	0.000	0.078	0.078	0.003	0.009	0.002	0.010	0.010	0.083
		Max	0.096	0.067	0.086	0.385	0.000	0.000	0.388	0.388	0.019	0.050	0.010	0.050	0.050	0.388
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	41	Mean	0.008	0.006	0.018	0.003	0.000	0.008	0.036	0.044	0.003	0.006	0.002	0.010	0.002	0.046
		StdDev	0.049	0.016	0.024	0.012	0.000	0.038	0.093	0.119	0.016	0.025	0.008	0.039	0.009	0.119
		Max	0.311	0.089	0.128	0.065	0.000	0.212	0.592	0.718	0.100	0.126	0.047	0.212	0.051	0.718
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.018	0.000	0.000	0.000	0.020	0.020	0.000	0.000	0.000	0.000	0.000	0.020
13	36	Mean	0.004	0.003	0.012	0.002	0.000	0.000	0.021	0.021	0.000	0.002	0.000	0.002	0.002	0.023
		StdDev	0.026	0.016	0.032	0.009	0.000	0.000	0.072	0.072	0.001	0.010	0.000	0.011	0.011	0.082
		Max	0.158	0.098	0.160	0.051	0.000	0.001	0.408	0.408	0.004	0.062	0.000	0.064	0.064	0.472
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.001	0.000
		Median	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16	17	Mean	0.004	0.010	0.015	0.012	0.000	0.000	0.040	0.041	0.003	0.012	0.016	0.031	0.030	0.071
		StdDev	0.009	0.022	0.020	0.037	0.000	0.001	0.067	0.067	0.012	0.048	0.059	0.119	0.117	0.170
		Max	0.028	0.073	0.065	0.148	0.000	0.005	0.199	0.204	0.049	0.197	0.244	0.490	0.485	0.689
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20	5	Mean	0.000	0.002	0.003	0.000	0.000	0.000	0.005	0.005	0.000	0.000	0.000	0.000	0.000	0.005
		StdDev	0.000	0.004	0.007	0.000	0.000	0.000	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.007
		Max	0.000	0.009	0.015	0.000	0.000	0.000	0.015	0.015	0.000	0.000	0.000	0.000	0.000	0.015
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
All	308	Mean	0.005	0.005	0.017	0.004	0.000	0.003	0.030	0.033	0.001	0.003	0.002	0.006	0.004	0.037
		StdDev	0.030	0.019	0.057	0.027	0.002	0.029	0.103	0.123	0.009	0.020	0.017	0.042	0.029	0.131
		Max	0.346	0.188	0.832	0.385	0.022	0.443	1.039	1.482	0.100	0.201	0.244	0.490	0.485	1.497
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.001	0.000
		Median	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.002

* Excludes replicates

Table 3-15. DRI Carbon Laboratory Lab Blank Statistics for Each Analyzer

Analyzer No.	No.*	Statistic*	IMPROVE_A Parameter (units are µg C/cm^2)													
			O1TC	O2TC	O3TC	O4TC	OPTRC	OPTTC	OCTRC	OCTTC	E1TC	E2TC	E3TC	ECTRC	ECTTC	TCTC
6	300	Mean	0.004	0.005	0.021	0.004	0.002	0.005	0.037	0.039	0.003	0.002	0.005	0.007	0.005	0.044
		StdDev	0.032	0.028	0.072	0.021	0.018	0.026	0.138	0.141	0.027	0.011	0.033	0.044	0.038	0.152
		Max	0.430	0.324	0.561	0.215	0.257	0.288	1.215	1.256	0.421	0.129	0.446	0.462	0.462	1.470
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.002	0.000	0.000	0.000	0.000	0.000	0.002
7	91	Mean	0.016	0.021	0.022	0.002	0.000	0.002	0.062	0.063	0.000	0.002	0.002	0.004	0.003	0.065
		StdDev	0.068	0.070	0.058	0.012	0.004	0.006	0.180	0.181	0.001	0.008	0.009	0.011	0.010	0.186
		Max	0.461	0.364	0.399	0.089	0.043	0.035	0.905	0.905	0.010	0.047	0.060	0.060	0.060	0.922
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	332	Mean	0.001	0.004	0.015	0.003	0.000	0.003	0.024	0.026	0.001	0.001	0.002	0.004	0.001	0.028
		StdDev	0.007	0.030	0.062	0.017	0.002	0.022	0.104	0.120	0.011	0.012	0.012	0.024	0.009	0.121
		Max	0.101	0.486	0.795	0.262	0.029	0.314	1.385	1.686	0.141	0.186	0.147	0.301	0.147	1.686
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	331	Mean	0.004	0.005	0.012	0.003	0.000	0.004	0.023	0.027	0.001	0.002	0.002	0.004	0.001	0.027
		StdDev	0.034	0.025	0.050	0.022	0.001	0.026	0.119	0.136	0.008	0.017	0.011	0.028	0.005	0.138
		Max	0.408	0.242	0.432	0.294	0.010	0.404	1.281	1.635	0.109	0.295	0.110	0.404	0.086	1.635
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	290	Mean	0.006	0.008	0.018	0.004	0.001	0.005	0.037	0.040	0.001	0.004	0.002	0.006	0.002	0.043
		StdDev	0.035	0.032	0.055	0.020	0.011	0.031	0.133	0.143	0.006	0.018	0.019	0.034	0.013	0.148
		Max	0.376	0.298	0.544	0.218	0.157	0.407	1.231	1.231	0.072	0.156	0.274	0.438	0.164	1.231
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
11	294	Mean	0.002	0.005	0.011	0.002	0.002	0.002	0.023	0.023	0.001	0.002	0.003	0.004	0.004	0.026
		StdDev	0.027	0.030	0.039	0.013	0.017	0.013	0.098	0.098	0.006	0.013	0.013	0.018	0.022	0.106
		Max	0.452	0.352	0.326	0.136	0.262	0.142	1.173	1.173	0.062	0.115	0.123	0.143	0.285	1.173
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.018	-0.018	0.000
		Median	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	329	Mean	0.006	0.006	0.019	0.004	0.000	0.004	0.036	0.040	0.002	0.002	0.002	0.006	0.003	0.042
		StdDev	0.036	0.026	0.075	0.025	0.006	0.020	0.141	0.152	0.014	0.011	0.012	0.029	0.022	0.153
		Max	0.521	0.263	0.721	0.366	0.101	0.199	1.430	1.503	0.161	0.121	0.130	0.370	0.362	1.503
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.004	0.000
		Median	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.002
13	300	Mean	0.001	0.003	0.012	0.001	0.000	0.002	0.017	0.019	0.001	0.001	0.003	0.005	0.003	0.022
		StdDev	0.009	0.017	0.041	0.010	0.000	0.017	0.068	0.073	0.009	0.007	0.021	0.028	0.018	0.078
		Max	0.090	0.223	0.524	0.135	0.006	0.265	0.882	0.918	0.149	0.065	0.240	0.299	0.214	0.967
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.001	0.000
		Median	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16	175	Mean	0.007	0.027	0.044	0.020	0.000	0.016	0.099	0.115	0.009	0.012	0.013	0.035	0.018	0.133
		StdDev	0.026	0.063	0.108	0.056	0.000	0.054	0.228	0.254	0.033	0.036	0.037	0.082	0.063	0.288
		Max	0.193	0.291	0.640	0.317	0.000	0.462	1.392	1.392	0.227	0.231	0.204	0.480	0.440	1.603
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.003	0.000
		Median	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.017	0.000	0.000	0.000	0.000	0.000	0.017
20	66	Mean	0.010	0.013	0.018	0.001	0.000	0.002	0.042	0.044	0.000	0.002	0.000	0.002	0.000	0.044
		StdDev	0.042	0.033	0.042	0.009	0.001	0.016	0.114	0.123	0.001	0.016	0.000	0.016	0.000	0.123
		Max	0.243	0.182	0.167	0.065	0.007	0.129	0.621	0.641	0.007	0.129	0.003	0.129	0.003	0.641
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
All	2508	Mean	0.004	0.007	0.018	0.004	0.001	0.004	0.034	0.038	0.002	0.003	0.003	0.007	0.004	0.042
		StdDev	0.031	0.034	0.063	0.024	0.010	0.026	0.132	0.143	0.015	0.016	0.020	0.036	0.026	0.152
		Max	0.521	0.486	0.795	0.366	0.262	0.462	1.430	1.686	0.421	0.295	0.446	0.480	0.462	1.686
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.018	-0.018	0.000
		Median	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

* Excludes replicates

Table 3-16. DRI Carbon Analysis Statistics for 24-Hour Field Blanks

Analyzer			IMPROVE_A Parameter (units are µg C/cm^2)													
No.	No.*	Statistic*	O1TC	O2TC	O3TC	O4TC	OPTRC	OPTTC	OCTRC	OCTTC	E1TC	E2TC	E3TC	ECTRC	ECTTC	TCTC
6	168	Mean	0.164	0.290	0.540	0.050	0.007	0.019	1.051	1.063	0.014	0.009	0.001	0.017	0.006	1.068
		StdDev	0.097	0.202	0.328	0.094	0.035	0.081	0.615	0.648	0.046	0.064	0.013	0.084	0.044	0.653
		Max	0.908	1.678	2.333	0.655	0.419	0.805	4.617	4.803	0.421	0.634	0.171	0.807	0.566	4.806
		Min	0.000	0.082	0.185	0.000	0.000	0.000	0.326	0.326	0.000	0.000	0.000	0.000	0.000	0.326
		Median	0.161	0.249	0.439	0.007	0.000	0.000	0.886	0.886	0.000	0.000	0.000	0.000	0.000	0.889
7	25	Mean	0.227	0.321	0.622	0.038	0.000	0.004	1.208	1.211	0.002	0.006	0.001	0.009	0.005	1.217
		StdDev	0.153	0.106	0.239	0.046	0.000	0.011	0.459	0.463	0.010	0.015	0.003	0.027	0.018	0.469
		Max	0.748	0.500	1.354	0.172	0.000	0.048	2.539	2.539	0.050	0.068	0.016	0.134	0.085	2.539
		Min	0.000	0.135	0.309	0.000	0.000	0.000	0.444	0.444	0.000	0.000	0.000	0.000	0.000	0.444
		Median	0.218	0.360	0.635	0.017	0.000	0.000	1.137	1.153	0.000	0.000	0.000	0.000	0.000	1.153
8	184	Mean	0.166	0.327	0.626	0.063	0.008	0.021	1.189	1.202	0.017	0.005	0.003	0.018	0.005	1.207
		StdDev	0.202	0.350	0.460	0.145	0.069	0.085	1.077	1.093	0.068	0.022	0.028	0.056	0.022	1.095
		Max	1.987	4.191	4.495	1.369	0.744	0.744	11.425	11.425	0.616	0.152	0.344	0.421	0.190	11.425
		Min	0.000	0.000	0.105	0.000	0.000	0.000	0.105	0.105	0.000	0.000	0.000	0.000	0.000	0.105
		Median	0.130	0.267	0.500	0.025	0.000	0.000	0.943	0.943	0.000	0.000	0.000	0.000	0.000	0.943
9	262	Mean	0.206	0.287	0.579	0.044	0.016	0.031	1.132	1.147	0.034	0.005	0.000	0.023	0.008	1.155
		StdDev	0.168	0.235	0.465	0.221	0.177	0.237	1.080	1.143	0.304	0.026	0.000	0.162	0.094	1.220
		Max	2.075	2.973	4.979	3.091	2.468	3.473	14.420	15.426	4.658	0.325	0.003	2.516	1.510	16.936
		Min	0.000	0.000	0.053	0.000	0.000	0.000	0.053	0.053	0.000	0.000	0.000	0.000	0.000	0.053
		Median	0.183	0.245	0.462	0.000	0.000	0.000	0.941	0.944	0.000	0.000	0.000	0.000	0.000	0.944
10	148	Mean	0.180	0.259	0.609	0.039	0.005	0.009	1.092	1.096	0.017	0.001	0.000	0.013	0.009	1.105
		StdDev	0.170	0.162	0.523	0.137	0.040	0.051	0.809	0.819	0.075	0.008	0.001	0.063	0.057	0.842
		Max	1.660	1.448	4.590	1.451	0.453	0.471	7.402	7.419	0.660	0.080	0.009	0.660	0.660	7.505
		Min	0.000	0.000	0.188	0.000	0.000	0.000	0.198	0.198	0.000	0.000	0.000	0.000	0.000	0.198
		Median	0.152	0.226	0.460	0.000	0.000	0.000	0.869	0.869	0.000	0.000	0.000	0.000	0.000	0.869
11	221	Mean	0.124	0.281	0.618	0.047	0.005	0.017	1.075	1.087	0.012	0.006	0.001	0.015	0.002	1.089
		StdDev	0.135	0.162	0.617	0.146	0.028	0.057	0.902	0.928	0.049	0.018	0.005	0.043	0.009	0.930
		Max	1.188	1.193	8.040	1.804	0.318	0.556	11.119	11.356	0.555	0.123	0.048	0.313	0.080	11.390
		Min	0.000	0.000	0.070	0.000	0.000	0.000	0.076	0.076	0.000	0.000	0.000	0.000	0.000	0.076
		Median	0.107	0.255	0.491	0.003	0.000	0.000	0.898	0.900	0.000	0.000	0.000	0.000	0.000	0.900
12	166	Mean	0.178	0.288	0.666	0.057	0.000	0.017	1.189	1.205	0.019	0.009	0.000	0.028	0.011	1.216
		StdDev	0.144	0.144	0.389	0.094	0.003	0.051	0.638	0.671	0.050	0.030	0.003	0.067	0.041	0.689
		Max	0.943	0.968	3.201	0.523	0.038	0.351	4.083	4.211	0.351	0.244	0.024	0.421	0.365	4.390
		Min	0.000	0.000	0.066	0.000	0.000	0.000	0.066	0.066	0.000	0.000	0.000	0.000	0.000	0.066
		Median	0.153	0.261	0.552	0.013	0.000	0.000	1.035	1.035	0.000	0.000	0.000	0.000	0.000	1.041
13	205	Mean	0.203	0.288	0.566	0.028	0.002	0.007	1.086	1.091	0.011	0.003	0.001	0.013	0.008	1.099
		StdDev	0.193	0.277	0.367	0.074	0.018	0.028	0.736	0.743	0.042	0.025	0.019	0.052	0.048	0.757
		Max	2.304	3.490	2.731	0.538	0.250	0.210	6.945	7.036	0.325	0.340	0.278	0.412	0.412	7.044
		Min	0.000	0.012	0.145	0.000	0.000	0.000	0.157	0.157	0.000	0.000	0.000	0.000	0.000	0.157
		Median	0.181	0.247	0.454	0.000	0.000	0.000	0.919	0.919	0.000	0.000	0.000	0.000	0.000	0.939
16	61	Mean	0.198	0.403	0.626	0.082	0.000	0.026	1.310	1.335	0.028	0.014	0.002	0.044	0.018	1.354
		StdDev	0.117	0.173	0.278	0.089	0.000	0.058	0.528	0.568	0.102	0.026	0.013	0.107	0.071	0.590
		Max	0.424	0.838	1.954	0.465	0.000	0.278	3.379	3.657	0.734	0.131	0.088	0.744	0.518	3.657
		Min	0.000	0.075	0.295	0.000	0.000	0.000	0.395	0.395	0.000	0.000	0.000	0.000	0.000	0.395
		Median	0.202	0.372	0.588	0.063	0.000	0.000	1.218	1.232	0.000	0.000	0.000	0.000	0.000	1.237
20	5	Mean	0.187	0.291	0.924	0.063	0.000	0.027	1.465	1.492	0.023	0.003	0.000	0.027	0.000	1.492
		StdDev	0.038	0.083	0.503	0.102	0.000	0.059	0.659	0.715	0.053	0.007	0.000	0.059	0.000	0.715
		Max	0.228	0.398	1.768	0.233	0.000	0.133	2.561	2.693	0.117	0.015	0.000	0.133	0.000	2.693
		Min	0.150	0.190	0.547	0.000	0.000	0.000	0.952	0.952	0.000	0.000	0.000	0.000	0.000	0.952
		Median	0.169	0.284	0.700	0.000	0.000	0.000	1.212	1.212	0.000	0.000	0.000	0.000	0.000	1.212
All	1445	Mean	0.177	0.291	0.598	0.047	0.006	0.017	1.127	1.130	0.018	0.006	0.001	0.019	0.007	1.138
		StdDev	0.164	0.228	0.455	0.141	0.083	0.115	0.858	0.888	0.140	0.031	0.014	0.090	0.055	0.914
		Max	2.304	4.191	8.040	3.091	2.468	3.473	14.420	15.426	4.658	0.634	0.344	2.516	1.510	16.936
		Min	0.000	0.000	0.053	0.000	0.000	0.000	0.053	0.053	0.000	0.000	0.000	0.000	0.000	0.053
		Median	0.158	0.252	0.478	0.000	0.000	0.000	0.946	0.942	0.000	0.000	0.000	0.000	0.000	0.943

* Excludes replicates and filters with RTI Invalid Code =1

Table 3-17. DRI Carbon Analysis Statistics for Backup Filters

Analyzer			IMPROVE_A Parameter (units are µg C/cm^2)													
No.	No.*	Statistic*	O1TC	O2TC	O3TC	O4TC	OPTRC	OPTTC	OCTRC	OCTTC	E1TC	E2TC	E3TC	ECTRC	ECTTC	TCTC
6	68	Mean	0.609	0.744	1.035	0.249	0.049	0.079	2.687	2.718	0.066	0.024	0.001	0.041	0.011	2.729
		StdDev	0.538	0.367	0.498	0.185	0.107	0.134	1.340	1.374	0.104	0.051	0.006	0.078	0.036	1.378
		Max	3.041	2.040	2.508	0.944	0.669	0.669	7.136	7.136	0.427	0.279	0.048	0.396	0.248	7.136
		Min	0.000	0.042	0.264	0.000	0.000	0.000	0.400	0.400	0.000	0.000	0.000	0.000	0.000	0.400
		Median	0.556	0.698	0.938	0.200	0.000	0.003	2.479	2.519	0.003	0.000	0.000	0.000	0.000	2.526
7	25	Mean	0.697	0.850	1.051	0.204	0.017	0.088	2.819	2.890	0.065	0.022	0.002	0.072	0.001	2.890
		StdDev	0.268	0.437	0.435	0.119	0.067	0.120	1.095	1.151	0.093	0.035	0.006	0.094	0.003	1.151
		Max	1.185	2.539	2.153	0.488	0.334	0.430	6.463	6.560	0.334	0.106	0.027	0.298	0.016	6.560
		Min	0.039	0.334	0.544	0.063	0.000	0.000	1.160	1.160	0.000	0.000	0.000	0.000	0.000	1.160
		Median	0.729	0.711	0.931	0.189	0.000	0.041	2.649	2.649	0.030	0.000	0.000	0.046	0.000	2.649
8	84	Mean	0.549	0.778	1.228	0.284	0.020	0.050	2.859	2.889	0.045	0.024	0.000	0.050	0.019	2.909
		StdDev	0.501	0.322	0.490	0.181	0.056	0.105	1.186	1.224	0.086	0.040	0.000	0.096	0.047	1.237
		Max	3.027	1.925	2.546	0.843	0.287	0.538	6.919	7.000	0.395	0.153	0.003	0.523	0.249	7.000
		Min	0.000	0.252	0.503	0.009	0.000	0.000	1.042	1.042	0.000	0.000	0.000	0.000	0.000	1.042
		Median	0.421	0.746	1.163	0.280	0.000	0.000	2.744	2.751	0.000	0.000	0.000	0.000	0.000	2.751
9	114	Mean	0.701	0.710	1.033	0.184	0.011	0.057	2.638	2.684	0.043	0.019	0.000	0.051	0.005	2.690
		StdDev	0.469	0.377	0.540	0.192	0.072	0.133	1.284	1.345	0.104	0.053	0.002	0.103	0.020	1.351
		Max	3.633	2.678	3.312	1.110	0.627	0.819	7.352	7.678	0.661	0.331	0.019	0.664	0.168	7.678
		Min	0.000	0.000	0.149	0.000	0.000	0.000	0.149	0.149	0.000	0.000	0.000	0.000	0.000	0.149
		Median	0.643	0.644	0.927	0.142	0.000	0.000	2.442	2.442	0.000	0.000	0.000	0.000	0.000	2.443
10	86	Mean	0.694	0.671	0.918	0.158	0.007	0.034	2.449	2.476	0.032	0.011	0.000	0.036	0.009	2.485
		StdDev	0.648	0.342	0.407	0.146	0.032	0.100	1.350	1.412	0.071	0.041	0.000	0.086	0.026	1.419
		Max	4.966	2.266	2.077	0.865	0.214	0.773	10.310	10.869	0.440	0.332	0.000	0.559	0.142	10.869
		Min	0.000	0.175	0.260	0.000	0.000	0.000	0.743	0.743	0.000	0.000	0.000	0.000	0.000	0.743
		Median	0.537	0.592	0.826	0.112	0.000	0.000	2.102	2.161	0.000	0.000	0.000	0.000	0.000	2.161
11	105	Mean	0.408	0.835	1.206	0.261	0.050	0.094	2.760	2.803	0.094	0.040	0.000	0.083	0.040	2.843
		StdDev	0.422	0.465	0.666	0.250	0.182	0.253	1.476	1.540	0.456	0.128	0.001	0.413	0.348	1.736
		Max	2.424	3.251	4.029	1.699	1.679	2.310	9.669	10.300	4.622	1.254	0.004	4.197	3.566	13.866
		Min	0.000	0.000	0.081	0.000	0.000	0.000	0.081	0.081	0.000	0.000	0.000	0.000	0.000	0.081
		Median	0.349	0.764	1.095	0.210	0.000	0.000	2.445	2.492	0.000	0.000	0.000	0.000	0.000	2.492
12	84	Mean	0.778	0.818	1.282	0.278	0.026	0.106	3.182	3.263	0.086	0.035	0.004	0.099	0.019	3.282
		StdDev	0.676	0.542	0.706	0.292	0.227	0.306	2.080	2.188	0.264	0.074	0.020	0.170	0.050	2.209
		Max	4.314	3.644	4.734	2.162	2.083	2.567	16.464	16.949	2.238	0.480	0.164	0.791	0.273	17.099
		Min	0.004	0.108	0.239	0.000	0.000	0.000	0.405	0.405	0.000	0.000	0.000	0.000	0.000	0.425
		Median	0.649	0.711	1.216	0.201	0.000	0.000	2.883	2.895	0.000	0.000	0.000	0.012	0.000	2.901
13	107	Mean	0.704	0.711	0.973	0.172	0.002	0.041	2.563	2.602	0.031	0.011	0.000	0.040	0.001	2.603
		StdDev	0.487	0.435	0.491	0.155	0.012	0.082	1.354	1.417	0.069	0.032	0.001	0.081	0.004	1.418
		Max	2.955	3.730	3.918	1.067	0.080	0.540	10.338	10.867	0.490	0.246	0.008	0.540	0.032	10.877
		Min	0.000	0.000	0.072	0.000	0.000	0.000	0.074	0.074	0.000	0.000	0.000	0.000	0.000	0.074
		Median	0.610	0.651	0.915	0.150	0.000	0.000	2.385	2.433	0.000	0.000	0.000	0.000	0.000	2.433
16	40	Mean	0.543	0.753	1.094	0.273	0.015	0.089	2.677	2.752	0.076	0.023	0.000	0.084	0.010	2.761
		StdDev	0.427	0.297	0.511	0.221	0.089	0.159	1.131	1.215	0.150	0.033	0.001	0.132	0.017	1.225
		Max	1.639	1.631	2.783	1.082	0.562	0.705	6.296	6.438	0.612	0.151	0.006	0.546	0.067	6.496
		Min	0.000	0.064	0.240	0.000	0.000	0.000	0.314	0.314	0.000	0.000	0.000	0.000	0.000	0.320
		Median	0.462	0.715	0.990	0.210	0.000	0.019	2.542	2.607	0.001	0.015	0.000	0.030	0.000	2.610
20	5	Mean	0.523	0.671	1.241	0.189	0.000	0.022	2.624	2.646	0.019	0.003	0.000	0.022	0.000	2.646
		StdDev	0.398	0.293	0.456	0.126	0.000	0.030	1.174	1.184	0.026	0.007	0.000	0.030	0.000	1.184
		Max	1.089	1.057	1.832	0.315	0.000	0.056	3.759	3.813	0.056	0.016	0.000	0.056	0.000	3.813
		Min	0.000	0.348	0.553	0.000	0.000	0.000	0.901	0.901	0.000	0.000	0.000	0.000	0.000	0.901
		Median	0.493	0.565	1.270	0.202	0.000	0.000	2.415	2.415	0.000	0.000	0.000	0.000	0.000	2.415
All	718	Mean	0.630	0.755	1.093	0.225	0.022	0.067	2.725	2.770	0.057	0.023	0.001	0.059	0.014	2.784
		StdDev	0.530	0.411	0.558	0.208	0.118	0.175	1.433	1.498	0.213	0.067	0.007	0.187	0.136	1.537
		Max	4.966	3.730	4.734	2.162	2.083	2.567	16.464	16.949	4.622	1.254	0.164	4.197	3.566	17.099
		Min	0.000	0.000	0.072	0.000	0.000	0.000	0.074	0.074	0.000	0.000	0.000	0.000	0.000	0.074
		Median	0.535	0.675	0.999	0.176	0.000	0.000	2.481	2.510	0.000	0.000	0.000	0.000	0.000	2.522

* Excludes replicates and filters with RTI Invalid Code =1

Table 3-18. DRI Carbon Analysis Statistics for SHAL Blanks

Analyzer			IMPROVE_A Parameter (units are µg C/cm^2)													
No.	No.*	Statistic*	O1TC	O2TC	O3TC	O4TC	OPTRC	OPTTC	OCTRC	OCTTC	E1TC	E2TC	E3TC	ECTRC	ECTTC	TCTC
6	22	Mean	0.043	0.022	0.191	0.007	0.004	0.004	0.266	0.266	0.004	0.000	0.000	0.000	0.000	0.266
		StdDev	0.043	0.022	0.212	0.029	0.017	0.017	0.272	0.272	0.017	0.000	0.000	0.000	0.000	0.272
		Max	0.127	0.072	1.092	0.136	0.077	0.077	1.397	1.397	0.077	0.000	0.000	0.000	0.000	1.397
		Min	0.000	0.000	0.067	0.000	0.000	0.000	0.085	0.085	0.000	0.000	0.000	0.000	0.000	0.085
		Median	0.033	0.015	0.131	0.000	0.000	0.000	0.200	0.200	0.000	0.000	0.000	0.000	0.000	0.200
7	2	Mean	0.054	0.047	0.218	0.000	0.000	0.000	0.319	0.319	0.000	0.000	0.000	0.000	0.000	0.319
		StdDev	0.076	0.024	0.156	0.000	0.000	0.000	0.256	0.256	0.000	0.000	0.000	0.000	0.000	0.256
		Max	0.108	0.064	0.328	0.000	0.000	0.000	0.500	0.500	0.000	0.000	0.000	0.000	0.000	0.500
		Min	0.000	0.030	0.107	0.000	0.000	0.000	0.137	0.137	0.000	0.000	0.000	0.000	0.000	0.137
		Median	0.054	0.047	0.218	0.000	0.000	0.000	0.319	0.319	0.000	0.000	0.000	0.000	0.000	0.319
8	20	Mean	0.028	0.030	0.165	0.005	0.002	0.017	0.231	0.246	0.017	0.000	0.000	0.015	0.000	0.247
		StdDev	0.046	0.035	0.195	0.023	0.010	0.064	0.234	0.292	0.064	0.002	0.000	0.063	0.002	0.291
		Max	0.149	0.101	0.915	0.105	0.046	0.281	1.109	1.390	0.281	0.009	0.000	0.281	0.009	1.390
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.010	0.115	0.000	0.000	0.000	0.200	0.200	0.000	0.000	0.000	0.000	0.000	0.200
9	24	Mean	0.034	0.017	0.142	0.005	0.000	0.003	0.198	0.201	0.003	0.000	0.001	0.004	0.001	0.202
		StdDev	0.048	0.024	0.185	0.021	0.000	0.015	0.229	0.243	0.015	0.000	0.005	0.015	0.005	0.243
		Max	0.174	0.067	0.954	0.102	0.000	0.072	1.182	1.254	0.072	0.000	0.026	0.072	0.026	1.254
		Min	0.000	0.000	0.006	0.000	0.000	0.000	0.006	0.006	0.000	0.000	0.000	0.000	0.000	0.006
		Median	0.000	0.000	0.101	0.000	0.000	0.000	0.145	0.145	0.000	0.000	0.000	0.000	0.000	0.145
10	21	Mean	0.012	0.007	0.133	0.000	0.000	0.000	0.151	0.151	0.000	0.000	0.000	0.000	0.000	0.152
		StdDev	0.023	0.017	0.111	0.000	0.000	0.000	0.124	0.124	0.001	0.000	0.000	0.001	0.001	0.125
		Max	0.064	0.064	0.405	0.000	0.000	0.000	0.451	0.451	0.006	0.000	0.000	0.006	0.006	0.451
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.101	0.000	0.000	0.000	0.127	0.127	0.000	0.000	0.000	0.000	0.000	0.127
11	21	Mean	0.020	0.018	0.168	0.001	0.000	0.000	0.206	0.207	0.000	0.002	0.000	0.002	0.002	0.208
		StdDev	0.030	0.031	0.136	0.003	0.000	0.001	0.162	0.162	0.000	0.008	0.001	0.008	0.008	0.164
		Max	0.086	0.102	0.511	0.014	0.000	0.005	0.563	0.563	0.000	0.036	0.005	0.036	0.036	0.563
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.143	0.000	0.000	0.000	0.176	0.176	0.000	0.000	0.000	0.000	0.000	0.176
12	14	Mean	0.039	0.023	0.177	0.012	0.000	0.001	0.250	0.251	0.000	0.002	0.000	0.002	0.001	0.252
		StdDev	0.052	0.038	0.139	0.044	0.000	0.004	0.202	0.202	0.000	0.005	0.000	0.005	0.003	0.204
		Max	0.181	0.117	0.439	0.166	0.000	0.015	0.758	0.758	0.000	0.015	0.000	0.015	0.011	0.769
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.006	0.000	0.000	0.000	0.000	0.000	0.006
		Median	0.019	0.002	0.148	0.000	0.000	0.000	0.210	0.218	0.000	0.000	0.000	0.000	0.000	0.218
13	23	Mean	0.061	0.015	0.134	0.000	0.000	0.000	0.211	0.211	0.000	0.000	0.000	0.000	0.000	0.211
		StdDev	0.050	0.024	0.116	0.001	0.000	0.000	0.144	0.144	0.000	0.000	0.002	0.002	0.002	0.145
		Max	0.198	0.080	0.555	0.003	0.000	0.000	0.630	0.630	0.000	0.002	0.009	0.009	0.009	0.630
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.000	0.000	0.000	0.000	0.000	0.004
		Median	0.073	0.000	0.107	0.000	0.000	0.000	0.155	0.155	0.000	0.000	0.000	0.000	0.000	0.155
16	7	Mean	0.062	0.095	0.226	0.013	0.000	0.003	0.396	0.399	0.000	0.006	0.000	0.006	0.003	0.402
		StdDev	0.067	0.059	0.155	0.015	0.000	0.008	0.262	0.261	0.000	0.010	0.001	0.011	0.009	0.264
		Max	0.185	0.181	0.503	0.042	0.000	0.021	0.775	0.775	0.000	0.021	0.003	0.023	0.023	0.775
		Min	0.003	0.000	0.065	0.000	0.000	0.000	0.123	0.123	0.000	0.000	0.000	0.000	0.000	0.123
		Median	0.036	0.087	0.224	0.012	0.000	0.000	0.332	0.353	0.000	0.000	0.000	0.000	0.000	0.353
20	4	Mean	0.016	0.025	0.255	0.000	0.000	0.000	0.295	0.295	0.000	0.000	0.000	0.000	0.000	0.295
		StdDev	0.031	0.018	0.089	0.000	0.000	0.000	0.099	0.099	0.000	0.000	0.000	0.000	0.000	0.099
		Max	0.063	0.042	0.333	0.000	0.000	0.000	0.365	0.365	0.000	0.000	0.000	0.000	0.000	0.365
		Min	0.000	0.000	0.129	0.000	0.000	0.000	0.153	0.153	0.000	0.000	0.000	0.000	0.000	0.153
		Median	0.000	0.029	0.278	0.000	0.000	0.000	0.331	0.331	0.000	0.000	0.000	0.000	0.000	0.331
All	158	Mean	0.035	0.022	0.163	0.004	0.001	0.003	0.226	0.228	0.003	0.001	0.000	0.003	0.001	0.229
		StdDev	0.046	0.033	0.159	0.021	0.007	0.024	0.204	0.216	0.024	0.004	0.002	0.023	0.004	0.216
		Max	0.198	0.181	1.092	0.166	0.077	0.281	1.397	1.397	0.281	0.036	0.026	0.281	0.036	1.397
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.009	0.003	0.128	0.000	0.000	0.000	0.178	0.178	0.000	0.000	0.000	0.000	0.000	0.178

* Excludes replicates

Table 3-19. DRI Carbon Analysis Annual Statistics for CSN Blank Categories

Type of Blank	No.*	Statistic*	IMPROVE_A Parameter (units are µg C/cm^2)													
			O1TC	O2TC	O3TC	O4TC	OPTRC	OPTTC	OCTRC	OCTTC	E1TC	E2TC	E3TC	ECTRC	ECTTC	TCTC
SHAL	158	Mean	0.035	0.022	0.163	0.004	0.001	0.003	0.226	0.228	0.003	0.001	0.000	0.003	0.001	0.229
		StdDev	0.046	0.033	0.159	0.021	0.007	0.024	0.204	0.216	0.024	0.004	0.002	0.023	0.004	0.216
		Max	0.198	0.181	1.092	0.166	0.077	0.281	1.397	1.397	0.281	0.036	0.026	0.281	0.036	1.397
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.009	0.003	0.128	0.000	0.000	0.000	0.178	0.178	0.000	0.000	0.000	0.000	0.000	0.178
		MDL	0.137	0.099	0.476	0.062	0.021	0.073	0.613	0.647	0.073	0.012	0.007	0.070	0.013	0.648
24-Hour Field	1445	Mean	0.177	0.291	0.598	0.047	0.006	0.017	1.127	1.130	0.018	0.006	0.001	0.019	0.007	1.138
		StdDev	0.164	0.228	0.455	0.141	0.083	0.115	0.858	0.888	0.140	0.031	0.014	0.090	0.055	0.914
		Max	2.304	4.191	8.040	3.091	2.468	3.473	14.420	15.426	4.658	0.634	0.344	2.516	1.510	16.936
		Min	0.000	0.000	0.053	0.000	0.000	0.000	0.053	0.053	0.000	0.000	0.000	0.000	0.000	0.053
		Median	0.158	0.252	0.478	0.000	0.000	0.000	0.946	0.942	0.000	0.000	0.000	0.000	0.000	0.943
		LQL	0.491	0.684	1.366	0.424	0.249	0.346	2.573	2.665	0.421	0.092	0.041	0.270	0.165	2.743
Backup	718	Mean	0.630	0.755	1.093	0.225	0.022	0.067	2.725	2.770	0.057	0.023	0.001	0.059	0.014	2.784
		StdDev	0.530	0.411	0.558	0.208	0.118	0.175	1.433	1.498	0.213	0.067	0.007	0.187	0.136	1.537
		Max	4.966	3.730	4.734	2.162	2.083	2.567	16.464	16.949	4.622	1.254	0.164	4.197	3.566	17.099
		Min	0.000	0.000	0.072	0.000	0.000	0.000	0.074	0.074	0.000	0.000	0.000	0.000	0.000	0.074
		Median	0.535	0.675	0.999	0.176	0.000	0.000	2.481	2.510	0.000	0.000	0.000	0.000	0.000	2.522
		LQL	1.590	1.234	1.673	0.624	0.355	0.524	4.299	4.495	0.638	0.200	0.022	0.561	0.408	4.612

* Excludes replicates and filters with RTI Invalid Code =1

Table 3-21 provides summary statistics for the multi-point temperature calibrations of each carbon analyzer. The temperature calibrations are performed every six months or after a major instrument repair. Criteria for an acceptable calibration are given in **Table 3-12**.

Table 3-22 provides a summary of the oxygen leak tests that are performed every six months or after major instrument repairs. The results are considered acceptable if the O_2 concentration is < 100 ppm. The O_2 contents were well below 100 ppm, in the range of 3-35 ppm. The scheduled February 2015 tests were not completed in time for this report.

Figure 3-3 shows the daily autocalibration response during the reporting period for each analyzer. Using the Carle valve, the methane standard is injected once in a He-only atmosphere, once in a He/O_2 atmosphere, and finally the normal calibration peak at the end. The three peaks should have similar peak areas if the catalysts are in good condition and the calibration factor holds. Thermogram peaks are compared and the calibration peak area is examined. Significant changes in calibration peak area counts are monitored and instruments are checked for performance against daily calibrations. Typical ranges fall between 20,000 and 32,000 counts. Sudden changes or atypical counts result in instrument maintenance. Details of instrument maintenance performed during the reporting period as a result of the autocalibration check are included in **Table 3-23**. In addition, metadata concerning QC measures and instrument maintenance are reported to RTI quarterly.

Table 3-20. DRI Multi-Point Calibration Statistics

Analyzer No.	Date	Slope	Correlation	Comment
6	12/30/13	21.66	0.9903	
	03/11/14	22.00	0.9891	
	04/02/14	21.82	0.9934	
	09/22/14	21.05	0.9931	
	01/27/15	22.08	0.9960	
7	09/23/13	20.54	0.9884	
	01/13/14	21.99	0.9888	
	01/27/14	18.84	0.8918	
	04/15/14	21.26	0.9938	
	07/23/14	20.88	0.9880	Removed from service Oct '14
8	12/18/13	22.26	0.9908	
	03/27/14	21.92	0.9936	
	08/07/14	22.02	0.9961	
	08/21/14	22.07	0.9809	
	08/27/14	21.91	0.9969	
9	12/17/13	20.55	0.9840	
	01/14/14	20.76	0.9844	
	06/13/14	20.50	0.9917	
	12/31/14	20.73	0.9975	
10	08/20/13	20.72	0.9910	
	02/20/14	22.84	0.9933	
	04/29/14	21.84	0.9906	
	05/07/14	21.57	0.9885	
	06/18/14	20.55	0.9882	
	11/03/14	21.49	0.9871	
	12/14/14	21.45	0.9815	
11	10/29/13	21.23	0.9940	
	03/18/14	22.04	0.9956	
	05/15/14	22.23	0.9890	
	06/24/14	21.03	0.9905	
	08/04/14	22.01	0.9973	
	12/01/14	23.11	0.9759	
	12/23/14	27.25	0.9906	
	01/26/15	27.24	0.9974	
	02/07/15	26.86	0.9977	
12	10/03/13	22.55	0.9575	
	02/13/14	22.54	0.9973	
	03/10/14	23.05	0.9852	
	04/10/14	22.61	0.9981	
	08/29/14	22.26	0.9879	
	01/26/15	22.44	0.9987	
13	12/14/13	21.86	0.9874	
	12/01/14	24.00	0.9968	
	01/26/15	23.01	0.9964	
16	12/03/13	22.55	0.9891	
	02/05/14	23.33	0.9976	
	02/20/14	23.05	0.9981	
	03/19/14	22.58	0.9953	
	03/28/14	22.21	0.9956	
	05/17/14	23.09	0.9969	
	06/05/14	22.86	0.9981	
	06/26/14	22.37	0.9958	
	08/25/14	21.50	0.9881	
20	05/17/14	20.54	0.9896	In service May '14 through Aug '14
	06/02/14	19.34	0.9951	
	07/22/14	20.86	0.9840	
	01/29/15	21.10	0.9985	

Table 3-21. DRI Multi-Point Temperature Calibration Statistics

Cal No.	Param.	Units	Analyzer No. 6	7*	8	9	10	11	12	13	16**	20***
1	Slope		1.0417	0.9856	1.0174	1.0371	1.0300	1.0261	1.0140	1.0378	1.0131	1.0280
	Intercept	° C	8.3546	14.4170	8.0488	10.3890	7.6965	5.3466	5.8484	8.0604	10.2880	1.8475
	r^2		0.9989	0.9999	0.9959	0.9983	0.9967	0.9976	0.9991	0.9967	0.9975	0.9988
	Date		Dec-13	Dec-13	Dec-13	Dec-13	Aug-13	Oct-13	Aug-13	Oct-13	Sep-13	May-14
2	Slope		1.0156	1.0322	1.0327	1.0484	1.0150	1.0184	1.0233	1.0255	1.0075	1.0301
	Intercept	° C	9.2678	12.8430	5.8247	0.4560	6.6299	9.1989	4.9594	10.3150	22.3830	3.4665
	r^2		0.9994	0.9991	0.9997	0.9972	0.9993	0.9993	0.9990	0.9985	0.9977	0.9978
	Date		Mar-14	Apr-14	Mar-14	Jun-14	Feb-14	Mar-14	Feb-14	Jan-14	Jan-14	Nov-14
3	Slope		1.0191	1.0193	1.0415	1.0078	1.0007	1.0307	1.0246	1.0193	1.0189	
	Intercept	° C	9.5004	13.6290	13.6290	14.9100	7.8063	-3.5475	6.3087	9.2460	2.9118	
	r^2		0.9973	0.9993	0.9993	0.9993	0.9990	0.9994	0.9995	0.9993	0.9993	
	Date		Sep-14	Jul-14	Aug-14	Dec-14	Jun-14	Jul-14	Aug-14	Jun-14	Jun-14	
4	Slope						1.0131	1.0120		1.0244		
	Intercept	° C					4.4679	8.3083		3.7206		
	r^2						0.9997	0.9987		0.9997		
	Date						Dec-14	Dec-14		Nov-14		

* Analyzer #7 taken out of regular service 10/21/14.

** Analyzer #16 taken out of regular service 11/5/14.

*** Analyzer #20 in regular service from 5/21/14 to 8/30/14.

Table 3-22. DRI Oxygen Test Statistics

Analyzer No.	Date Temp	(°C)	August 2013 140	August 2013 580	February 2014 140	February 2014 580	August 2014 140	August 2014 580
6	Mean O_2	(ppm)	7.7	7.2	14.2	15.1	23.7	24.5
	Std Dev	(ppm)	1.2	1.1	1.9	1.9	0.7	0.6
7	Mean O_2	(ppm)	6.9	6.4	13.2	10.4	10.3	10.7
	Std Dev	(ppm)	1.2	1.1	2.1	1.9	0.8	0.5
8	Mean O_2	(ppm)	18.4	16.3	18.1	14.9	9.3	9.1
	Std Dev	(ppm)	1.5	1.3	2.0	1.8	0.5	0.6
9	Mean O_2	(ppm)	12.7	9.4	10.8	11.2	13.1	13.0
	Std Dev	(ppm)	1.4	1.1	1.9	1.9	0.6	0.5
10	Mean O_2	(ppm)	2.9	3.0	12.4	12.5	18.0	18.4
	Std Dev	(ppm)	1.0	1.1	1.9	1.8	1.0	1.0
11	Mean O_2	(ppm)	14.0	13.3	20.7	20.4	11.0	10.3
	Std Dev	(ppm)	1.2	1.2	1.9	1.9	0.6	0.6
12	Mean O_2	(ppm)	33.9	32.8	12.0	12.1	15.0	16.0
	Std Dev	(ppm)	1.8	1.2	1.9	1.9	0.5	0.7
13	Mean O_2	(ppm)	10.7	12.6	9.7	10.0	28.0	23.5
	Std Dev	(ppm)	1.1	1.1	2.0	1.9	1.0	0.5
16	Mean O_2	(ppm)	8.6	7.4	10.3	11.4	14.1	13.9
	Std Dev	(ppm)	1.3	1.1	1.9	2.0	0.5	0.4
20	Mean O_2	(ppm)	Not in Service		Not in Service		9.7	9.2
	Std Dev	(ppm)	Mar '13- May '14		Mar '13- May '14		0.7	0.4

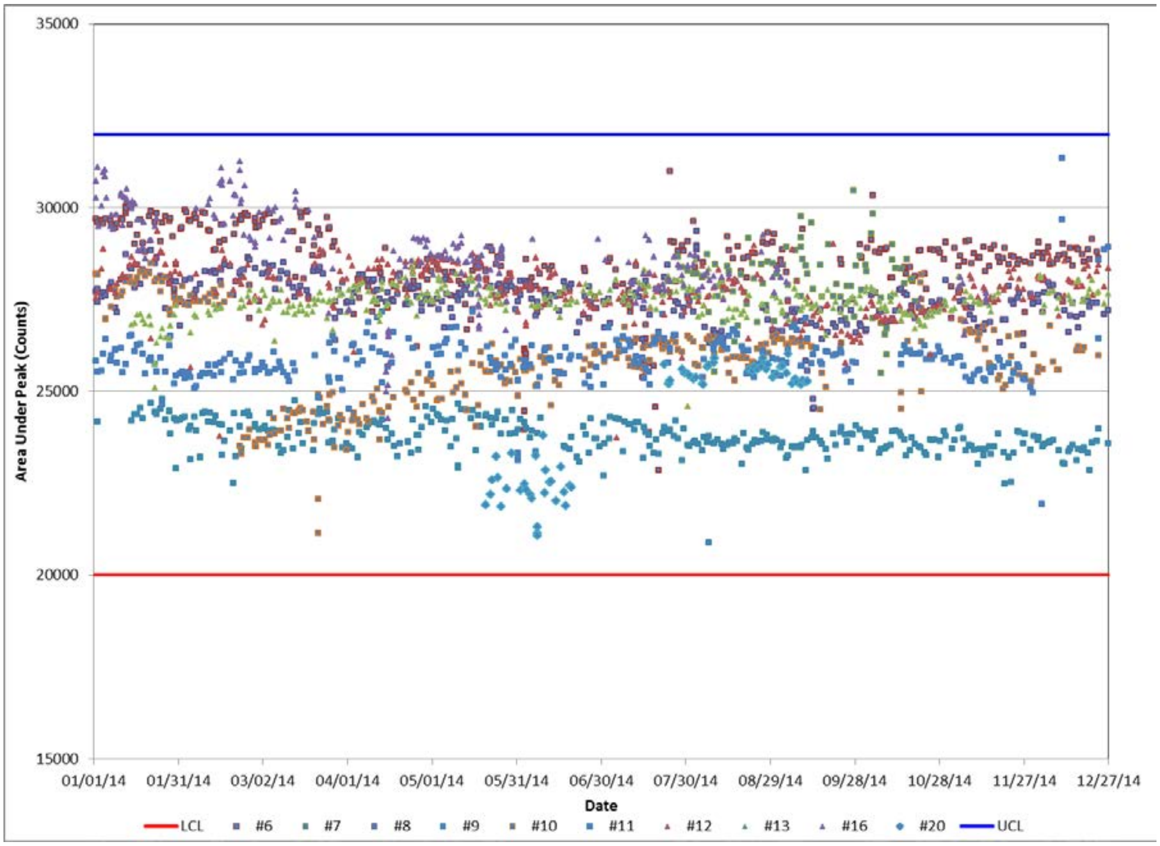


Figure 3-3. DRI Carbon Analyzer Daily AutoCalibration (cmdAutoCalibCheck) Response during 2014

3.3.3.3 Replicate and Duplicate Analyses

Replicate analysis results are from two or more punches from the same sample run on different analyzers. Duplicate analysis results are from two punches from the same sample run on the same analyzer. **Table 3-24** gives the criteria and summary statistics for replicate and duplicate IMPROVE_A carbon analyses run on all analyzers for the CSN filter samples during the reporting period. A replicate or duplicate analysis was selected randomly from every group of 10 samples. A total of 2,066 replicate or duplicate analyses were analyzed during the reporting period. Of the 2,066 replicates or duplicates, 37 contained f, g, h, i, or n analysis flags for filter damaged or ripped, filter deposit damaged, filter holder assembly problem, inhomogeneous sample deposit, or foreign substance on sample, respectively. These were not included in the replicate and duplicate statistical summary. Of the 2,029 remaining, 108 were duplicate analyses and 1,921 were replicate analyses.

Table 3-23. Summary of Instrument Maintenance Performed as a Result of Autocalibration Peak Response

Analyzer No.	Date	Resolution
6	04/07/14 07/24/14	Cal peak low – realigned Carle valve and replaced set screw Cal peak low – replaced methane rotameter
7	09/14/14	Cal peak low – repaired leak
8	---	
9	04/22/14	Cal peak low – repaired leak
10	05/06/14 09/19/14 09/25/14 10/01/14 10/06/14 10/14/14	Cal peak low – changed o-ring, balanced flows and realigned Carle valve Cal peak low – balanced flows Cal peak low – replaced 055 board for back valve control Cal peak low – replaced methanator and set and balanced flows Cal peak low – replaced electrometer Cal peak low – realigned Carle valve
11	12/04/14 12/10/14	Cal peak low – readjusted rotameter Cal peak low – changed methanator, reset flows and balanced flows
12	07/18/14 07/24/14 07/29/14	Cal peak low – repaired leak Cal peak low – repaired leak Cal peak low – repaired leak
13	03/24/14	Cal peak low - repaired leak
16	08/20/14 11/05/14	Cal peak low – unplugged and replugged valve Cal peak low – realigned Carle valve
20	06/26/14	Cal peak low – realigned Carle valve

3.3.4 Assessment of Duplicate and Replicate Analyses

Duplicate and replicate analysis results for TC, OC, and EC agree well, with higher relative percent differences (RPD) at loading levels below 10.0 µg C/cm^2. Replicate analyses results are more variable than duplicate analyses, but remain within acceptable limits. The small size (25 mm) of the filter used in the IMPROVE_A carbon analysis method does not permit more than three punches (each ~0.5 cm^2) to be taken from the filter. Samples not meeting replicate criteria (i.e., for TC, OC, or EC < 10 µg C/cm^2, TC, OC < ± 1.0 µg C/cm^2 and EC < ± 2.0 µg C/cm^2; and for TC, OC or EC ≥ 10 µg C/cm^2, TC or OC < 10% RPD and EC < 20% RPD) are re-analyzed or examined for inhomogeneities.

Table 3-24. DRI Replicate Analysis Criteria and Statistics

			Replicates				Duplicates				
Range	Criteria	Statistic	No.	TC	OC	EC	No.	TC	OC	EC	Units
All		Count	1921				108				
TC, OC, & EC < 10 µg C/cm²	TC, OC < ±1.0 µg C/cm²	Count		276	425	1598		28	36	101	
	EC < ±2.0 µg C/cm²	No. Fail		0	4	10		0	0	0	
		%Fail		0.0	0.9	0.6		0.0	0.0	0.0	%
		Mean		0.234	0.294	0.376		0.191	0.227	0.195	µg C/cm²
		StdDev		0.227	0.258	0.389		0.173	0.200	0.192	µg C/cm²
		Max		0.957	1.249	2.864		0.629	0.806	0.906	µg C/cm²
		Min		0.001	0.001	0.000		0.001	0.001	0.000	µg C/cm²
		Median		0.145	0.199	0.246		0.124	0.208	0.133	µg C/cm²
TC, OC, & EC ≥ 10 µg C/cm²	TC, OC %RPD < 10%	Count		1645	1496	323		80	72	7	
	EC %RPD < 20%	No. Fail		0	0	0		0	0	0	
		%Fail		0.0	0.0	0.0		0.0	0.0	0.0	%
		Mean		1.86	2.16	4.23		1.78	1.87	2.60	%RPD
		StdDev		1.26	1.52	3.04		1.08	1.23	1.73	%RPD
		Max		6.19	8.95	16.68		4.31	6.50	5.38	%RPD
		Min		0.00	0.01	0.08		0.06	0.00	0.81	%RPD
		Median		1.71	1.83	3.54		1.56	1.53	2.24	%RPD

The revised SOP states that the criteria for EC < 10 µg C/cm² is ± 2.0 µg C/cm² to achieve consistency with EC criteria of an RPD < 20% for EC ≥ 10 µg C/cm². Instrument performance is also verified to eliminate instrument issues as a source of replicate or duplicate variation. Higher percent errors in OC and TC may be due to inhomogeneous sample deposits and organic artifacts. Higher percent error in EC may be due to the low EC loadings on the samples.

3.3.5 Determination of MDLs and LQLs

Table 3-25 gives estimated minimum detection limits (MDLs) for IMPROVE_A parameters corresponding to filter batches analyzed in 2014. The MDLs in **Table 3-25** are determined as three times the standard deviation of DRI system and lab blanks and RTI SHAL blanks, although only the DRI lab blanks are also used to determine Carbon Laboratory MDLs. The DRI system and lab blanks are used to assess instrument performance as used in multiple projects. In addition, the MDLs reported here for system and lab blanks tend to be less than the MDLs reported in the current SOP and RTI data reports. DRI routinely uses a more conservative set of MDLs than those in the SOP to be more conservative in its assessments of data quality.

Table 3-25 also gives estimated lower quantifiable limits (LQLs) for the IMPROVE_A parameters. These LQLs are determined as three times the standard deviation of the 24-hour field blanks and backup filters based on blank identification information provided to DRI after the analyses were completed.

Table 3-25. Estimated MDLs and LQLs for IMPROVE_A Parameters for 2014

Type of Blank	No.*	Statistic*	IMPROVE_A Parameter (units are µg C/cm^2)													
			O1TC	O2TC	O3TC	O4TC	OPTRC	OPTTC	OCTRC	OCTTC	E1TC	E2TC	E3TC	ECTRC	ECTTC	TCTC
System	308	Mean	0.005	0.005	0.017	0.004	0.000	0.003	0.030	0.033	0.001	0.003	0.002	0.006	0.004	0.037
		StdDev	0.030	0.019	0.057	0.027	0.002	0.029	0.103	0.123	0.009	0.020	0.017	0.042	0.029	0.131
		Max	0.346	0.188	0.832	0.385	0.022	0.443	1.039	1.482	0.100	0.201	0.244	0.490	0.485	1.497
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.001	0.000
		Median	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.002
		MDL	0.090	0.056	0.171	0.082	0.005	0.087	0.310	0.368	0.026	0.060	0.052	0.125	0.088	0.394
Lab	2508	Mean	0.004	0.007	0.018	0.004	0.001	0.004	0.034	0.038	0.002	0.003	0.003	0.007	0.004	0.042
		StdDev	0.031	0.034	0.063	0.024	0.010	0.026	0.132	0.143	0.015	0.016	0.020	0.036	0.026	0.152
		Max	0.521	0.486	0.795	0.366	0.262	0.462	1.430	1.686	0.421	0.295	0.446	0.480	0.462	1.686
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.018	-0.018	0.000
		Median	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		MDL	0.092	0.102	0.189	0.071	0.029	0.078	0.396	0.429	0.046	0.048	0.061	0.109	0.077	0.455
SHAL	158	Mean	0.035	0.022	0.163	0.004	0.001	0.003	0.226	0.228	0.003	0.001	0.000	0.003	0.001	0.229
		StdDev	0.046	0.033	0.159	0.021	0.007	0.024	0.204	0.216	0.024	0.004	0.002	0.023	0.004	0.216
		Max	0.198	0.181	1.092	0.166	0.077	0.281	1.397	1.397	0.281	0.036	0.026	0.281	0.036	1.397
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.009	0.003	0.128	0.000	0.000	0.000	0.178	0.178	0.000	0.000	0.000	0.000	0.000	0.178
		MDL	0.137	0.099	0.476	0.062	0.021	0.073	0.613	0.647	0.073	0.012	0.007	0.070	0.013	0.648
24-Hour Field	1445	Mean	0.177	0.291	0.598	0.047	0.006	0.017	1.127	1.130	0.018	0.006	0.001	0.019	0.007	1.138
		StdDev	0.164	0.228	0.455	0.141	0.083	0.115	0.858	0.888	0.140	0.031	0.014	0.090	0.055	0.914
		Max	2.304	4.191	8.040	3.091	2.468	3.473	14.420	15.426	4.658	0.634	0.344	2.516	1.510	16.936
		Min	0.000	0.000	0.053	0.000	0.000	0.000	0.053	0.053	0.000	0.000	0.000	0.000	0.000	0.053
		Median	0.158	0.252	0.478	0.000	0.000	0.000	0.946	0.942	0.000	0.000	0.000	0.000	0.000	0.943
		LQL	0.491	0.684	1.366	0.424	0.249	0.346	2.573	2.665	0.421	0.092	0.041	0.270	0.165	2.743
Backup	718	Mean	0.630	0.755	1.093	0.225	0.022	0.067	2.725	2.770	0.057	0.023	0.001	0.059	0.014	2.784
		StdDev	0.530	0.411	0.558	0.208	0.118	0.175	1.433	1.498	0.213	0.067	0.007	0.187	0.136	1.537
		Max	4.966	3.730	4.734	2.162	2.083	2.567	16.464	16.949	4.622	1.254	0.164	4.197	3.566	17.099
		Min	0.000	0.000	0.072	0.000	0.000	0.000	0.074	0.074	0.000	0.000	0.000	0.000	0.000	0.074
		Median	0.535	0.675	0.999	0.176	0.000	0.000	2.481	2.510	0.000	0.000	0.000	0.000	0.000	2.522
		LQL	1.590	1.234	1.673	0.624	0.355	0.524	4.299	4.495	0.638	0.200	0.022	0.561	0.408	4.612

* Excludes replicates and filters with RTI Invalid Code =1

3.3.6 Audits, PEs, Training, and Accreditations

3.3.6.1 System Audits

EPA's National Air and Radiation Laboratory (NAREL) conducts periodic technical system audits (TSAs), performance evaluations (PEs), and inter-comparisons of $PM_{2.5}$ chemical speciation laboratories, including DRI. TSAs are conducted approximately once every three years and inter-comparisons/PEs approximately yearly. These audits, PEs, and inter-comparisons cover the analysis of mass by gravimetry, elements by x-ray fluorescence (XRF), ions by ion chromatography (IC), and carbon analysis by thermo-optical methods, including the (now phased out) STN thermo-optical transmittance (TOT) and thermo-optical reflectance methods of IMPROVE (also phased out) and IMPROVE_A. DRI has participated in these programs since 2005. The last TSA of DRI's EAF, including its Carbon Laboratory, was conducted on October 29, 2013, with a report issued March 6, 2014. The report found that "Good laboratory practices, good QC practices, and good record keeping are performed in the carbon analysis laboratory." NAREL TSA reports may be found at EPA's Ambient Monitoring Technical Information center (AMTIC) website at:

http://www.epa.gov/ttnamti1/pmspec.html

3.3.6.2 Performance Evaluations

Inter-laboratory comparisons and PEs, including DRI's Carbon Laboratory, have been conducted annually from 2005 through 2014. The 2013-2014 comparison report was issued May 30, 2014. The most recent and previous year's reports are available at EPA's Ambient Monitoring Technical Information center (AMTIC) website at:

http://www.epa.gov/ttnamti1/pmspec.html

3.3.6.3 Accreditations

There are no accreditation programs specifically for thermal/optical carbon analysis, but since 2008, DRI has been accredited annually by the Texas Commission on Environmental Quality (TCEQ) through the National Environmental Laboratory Accreditation Program (NELAP) for the gravitational analysis of TSP, PM_{10}, and $PM_{2.5}$.

3.3.7 References

Chow, J.C.; Watson, J.G.; Chen, L.W.; Chang, M.C..; Robinson, N.F..; Dana Trimble; Steven Kohl. (2007). The IMPROVE_A Temperature Protocol for Thermal/Optical Carbon Analysis: Maintaining Consistency with a Long-Term Database. *J. Air Waste Manage. Assoc.*, **57**:1014-1023.

Chow, J.C.; Watson, J.G.; Robles, J.; Wang, X.L.; Chen, L.-W.A.; Trimble, D.L.; Kohl, S.D.; Tropp, R.J.; Fung, K.K. (2011). Quality assurance and quality control for thermal/optical analysis of aerosol samples for organic and elemental carbon. *Anal. Bioanal. Chem.*, **401**(10):3141-3152. DOI 10.1007/s00216-011-5103-3.

3.4 X-ray Fluorescence Laboratories

The two XRF laboratories, RTI and CLN used 4 and 1 XRF instruments, respectively, to analyze over 14,800 filters for 33 elements during the period of January 1 through December 31, 2014.

3.4.1 RTI International XRF Laboratory

3.4.1.1 Quality Issues and Instrument Maintenance and Repairs

The following repairs and maintenance were performed for XRF 1:

- None

The following repairs and maintenance were performed for XRF 2:

- 07/29/14 – Replaced vacuum pump
- 10/09/14 – Replaced X-ray tube and 24V dc fan

The following repair and maintenance was performed for XRF 3:

- 12/04/14 – Preventive maintenance performed, checked voltages, resolution, and stability

The following repair and maintenance was performed for XRF 4:

- 07/08/14 – Replaced XRF control board
- 08/26/14 – Replaced X-ray tube and High Voltage Power Supply
- 12/04/14 – Preventive maintenance performed, checked voltages, resolution, and stability

3.4.1.2 Description of QC Checks Applied

QC activities for the analysis of elements by EDXRF for the RTI XRF Laboratory, their frequency of application and control limits, comments, and corrective actions are shown in **Table 3-26**.

Table 3-26. QC Procedures Performed in RTI XRF Elemental Analysis Laboratory

QC Check	QC Frequency	Control Limits	Comments/ Corrective Action
Calibration	as needed	—	—
Calibration verification[1]	monthly	90–110% average recovery	check calibration
Instrument precision[2]	analyzed with each tray of samples (10 tray autosampler)	within 5% CV	check calibration and reanalysis of tray
Energy calibration	daily	—	—
Sample replicate precision (Relative Percent Difference [RPD])	5%	+/- 50 RPD	Reanalysis

1 Using NIST SRM
2 Micromatter QC

3.4.1.3 Summary of QC Results

Precision was monitored by the reproducibility of the measurements of the multi-element Micromatter QC sample at a certified concentration of 5-10 µg/cm^2. Please note that this concentration refers to the loading of element or compound used in the standard and not necessarily each individual element. The QC sample has six selected elements and is analyzed with each tray of samples. Comparison of the element’s replicate values gives the measure of reproducibility or precision. The data used to monitor precision are presented in **Tables 3-27 through 3-30**. The percent coefficient of variation (%CV) for the average of all data for each of the six elements ranged between 0.22 and 0.49% for XRF 1, between 0.28 and 0.72% for XRF 2, between 0.27 and 0.67% for XRF 3, and between 0.41 and 1.32% for XRF 4, indicating excellent precision.

Table 3-27. Summary of RTI XRF 1 Laboratory QC Precision Data, μg/cm^2, 1/1/2014 through 12/31/2014

Element	n	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Si	683	4.95	5.10	5.00	0.0247	0.49	0.041
Ti	683	6.74	6.85	6.80	0.0198	0.29	-0.045
Fe	683	6.89	6.99	6.94	0.0192	0.28	0.084
Cd	683	5.47	5.61	5.55	0.0251	0.45	-0.004
Se	683	3.94	4.05	3.99	0.0194	0.49	-0.156
Pb	683	9.06	9.17	9.12	0.023	0.22	0.023

Table 3-28. Summary of RTI XRF 2 Laboratory QC Precision Data, μg/cm^2, 1/1/2014 through 12/31/2014

Element	N	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Si	377	5.16	5.29	5.24	0.0261	0.50	-0.431
Ti	377	8.47	8.69	8.64	0.0242	0.28	0.216
Fe	377	7.16	7.35	7.29	0.0388	0.53	-1.129
Cd	377	4.35	4.47	4.41	0.0273	0.62	0.155
Se	377	2.93	3.05	3.00	0.0215	0.72	-0.038
Pb	377	7.81	7.98	7.90	0.0345	0.44	-0.500

Table 3-29. Summary of RTI XRF 3 Laboratory QC Precision Data, μg/cm^2, 1/1/2014 through 12/31/2014

Element	n	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Si	622	4.66	4.79	4.73	0.0259	0.55	-0.055
Ti	622	5.49	5.60	5.55	0.0263	0.47	0.003
Fe	622	6.19	6.30	6.25	0.0237	0.38	0.159
Cd	622	5.57	5.80	5.75	0.0250	0.44	-0.021
Se	622	3.83	3.98	3.91	0.0262	0.67	-0.394
Pb	622	8.85	8.98	8.91	0.0242	0.27	-0.098

Table 3-30. Summary of RTI XRF 4 Laboratory QC Precision Data, μg/cm^2, 1/1/2014 through 12/31/2014

Element	n	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Si	193	4.48	4.69	4.59	0.0605	1.32	0.684
Ti	193	5.94	6.05	6.00	0.0247	0.41	-0.041
Fe	193	6.49	6.68	6.59	0.0517	0.79	0.395
Cd	193	5.45	5.64	5.55	0.0548	0.99	0.548
Se	193	3.76	3.86	3.81	0.0258	0.68	0.147
Pb	193	8.86	9.07	8.98	0.0602	0.67	0.377

n = number of observations
Min = minimum value observed
Max = maximum value observed
Std Dev = standard deviation
%CV = percent coefficient variation ((Std Dev/Average)*100)

Recovery or system accuracy was determined by the analysis of a NIST Standard Reference Material (SRM) filter. Recovery is calculated by comparisons of measured and expected values. **Tables 3-31 through 3-34** show recovery for 8 elements of the 33 elements normally measured. The average recovery values for all the elements ranged between 90 and 110% for XRF 1; between 90 and 110% for XRF 2; between 90 and 110% for XRF 3; and between 90 to 110% for XRF 4. Note that every month, 33 elements of the Micromatter calibration standards are analyzed as unknowns to verify calibration.

Table 3-31. Percent Recovery Determined from Analysis of NIST SRM 2783 for RTI XRF 1, 1/1/2014 through 12/31/2014

Element	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Al	91	101	95	0.0560	2.55	-5.362
K	91	102	95	0.0130	2.59	-1.220
Ca	90	103	98	0.0383	3.13	-4.530
Mn	91	106	98	0.0013	4.27	-0.030
Fe	93	101	96	0.0557	2.04	-6.497
Cu	91	108	99	0.0018	4.43	-0.206
Zn	95	110	104	0.0068	3.67	-0.303
Pb	93	110	103	0.0013	4.08	-0.004

Table 3-32. Percent Recovery Determined from Analysis of NIST SRM 2783 for RTI XRF 2, 1/1/2014 through 12/31/2014

Element	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Al	90	99	94	0.0564	2.58	0.620
K	90	104	97	0.0184	3.60	-1.403
Ca	90	99	93	0.0380	3.11	-1.814
Mn	91	110	102	0.0015	4.49	-0.058
Fe	91	99	95	0.0674	2.49	-1.803
Cu	91	105	97	0.0018	4.61	-0.101
Zn	98	110	104	0.0059	3.19	0.203
Pb	90	109	99	0.0015	4.87	-0.029

Table 3-33. Percent Recovery Determined from Analysis of NIST SRM 2783 for RTI XRF 3, 1/1/2014 through 12/31/2014

Element	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Al	90	106	97	0.0866	3.85	-0.166
K	90	103	94	0.0171	3.45	-0.995
Ca	90	102	93	0.0413	3.35	-0.067
Mn	93	109	101	0.0014	4.22	-0.093
Fe	90	99	94	0.0634	2.35	-0.112
Cu	90	104	98	0.0016	4.04	0.002
Zn	97	110	103	0.0072	3.91	-0.115
Pb	92	109	101	0.0014	4.28	0.027

Table 3-34. Percent Recovery Determined from Analysis of NIST SRM 2783 for RTI XRF 4, 1/1/2014 through 12/31/2014

Element	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Al	91	101	96	0.0608	2.73	-0.075
K	90	100	94	0.0160	3.21	-2.152
Ca	90	100	93	0.0370	3.00	-4.929
Mn	91	108	101	0.0016	4.86	-0.214
Fe	92	99	95	0.0499	1.84	-0.082
Cu	90	107	96	0.0016	4.10	0.011
Zn	96	110	103	0.0069	3.76	-0.478
Pb	91	109	99	0.0014	4.42	-0.111

Replicates were analyzed at a frequency of at least 5% of the number of filters analyzed in the RTI XRF Laboratory. Six elements were selected for comparison through regression analysis. **Table 3-35** shows the correlation coefficients and average RPDs for the replicate analysis. The correlation coefficients for XRF 1 range from 0.9979 to 0.9999, the correlation coefficients for XRF 2 range from 0.9997 to 0.9999, the correlation coefficients for XRF 3 range from 0.9983 to 0.9999, and the correlation coefficients for XRF 4 range from 0.9978 to 0.9999 indicating acceptable replication with all four instruments. Also, for the six elements, the average RPD was within ±2% on XRF 1 and XRF 2, within ±3% for XRF 3 and XRF 4.

Table 3-35. Summary of Replicate Results for XRF 1, XRF 2, XRF 3, and XRF 4

Element	n	Correlation Coefficient	Average RPD
XRF 1			
Si	387	0.9979	-1.65
S	387	0.9999	0.20
K	387	0.9999	-0.80
Ca	387	0.9997	-1.23
Fe	387	0.9999	-1.06
Zn	387	0.9998	2.04
XRF 2			
Si	230	0.9997	1.31
S	230	0.9999	0.17
K	230	0.9999	0.44
Ca	230	0.9999	-0.83
Fe	230	0.9999	0.09
Zn	230	0.9999	-0.60
XRF 3			
Si	351	0.9983	1.59
S	351	0.9997	-0.94
K	351	0.9999	-0.59
Ca	351	0.9996	-2.88
Fe	351	0.9999	-0.13
Zn	351	0.9996	-1.34
XRF 4			
Si	120	0.9978	-2.10
S	120	0.9998	0.06
K	120	0.9999	0.26
Ca	120	0.9995	2.60
Fe	120	0.9998	-0.02
Zn	120	0.9979	1.20

Assessment of Between-Instrument Comparability

Overview of Round-Robin Samples Run During 2014

In addition to passing internal QC samples as described in the sections above, the RTI laboratories and CLN participated in a "round-robin" filter program coordinated by the RTI XRF Laboratory. It should be emphasized that the round-robin program is only used to collect descriptive statistics about network performance; the results are not currently being used for QC purposes. The lag time between successive analyses and the potential for filter contamination and damage in transit make it impractical to use these filters for laboratory QC.

In the round-robin program, previously analyzed CSN filters are recycled through all the instruments in the two laboratories. **Table 3-36** summarizes the number of round-robin filters analyzed during 2014.

Table 3-36. Numbers of Round-Robin Filter Analyses Performed during 2014

Laboratory	Instrument	Filters Analyzed
CLN	Kevex 770	12
CLN	Kevex 772*	12
RTI	XRF 1	12
RTI	XRF 2	12
RTI	XRF 3	12
RTI	XRF 4	12

* - CLN 772 is not an approved instrument in the CSN PM2.5 Program, but CLN analyzed all 2014 round robin filters on the 772 and provided the data.

The majority of elements on the Round-Robin filters are present in quantities at or below the detection capabilities of the XRF instruments; therefore, it was necessary to restrict the statistical analysis of the round-robin results to 9 elements that were found in sufficient quantity on a majority of the filters. The statistics to follow in this section are restricted to only filters analyzed in 2014.

Assessment of Bias and Precision

The primary purpose of the round-robin program is to assess bias between instruments for the various elements. Inter-laboratory precision, a component of overall network error, can also be estimated based on these statistics.

One simple way to assess potential differences in performance of the different instruments is to perform linear regression in which the individual observations for each instrument are regressed against a reference value. **Tables 3-37 through 3-39** show linear regression results for which the data for the filters are regressed versus the median for the six instruments for each filter. The median value is used as the reference value, since the "true" value is unknown for these filters. Each instrument in the program reported zeros or low-level detections in some of the elements.

This was especially noticeable for Ni, Cu, and Pb, which affected the calculation for slope and correlation coefficient for these elements. Note that the calculated uncertainty of these results for each instrument was not taken into account when doing the regression (i.e., no weighting factors were used). In general, the analyses showed excellent correlation. Intercepts were typically near zero indicating no consistent bias. The slopes were typically within ±10% of unity, although occasional drifts were noticed for Si (RTI) and S and Ca (CLN). These results indicate general agreement of the instruments within 10% of the median value.

Table 3-37. Regression Results for 9 Elements RTI XRF Instruments XRF 1 and XRF 2

Element	RTI 1				RTI 2			
	n	Correlation Coefficient	Slope	Intercept	n	Correlation Coefficient	Slope	Intercept
Si	12	0.9958	1.0131	-0.0558	12	0.9951	1.0085	-0.0272
S	12	0.9998	0.9908	0.0591	12	0.9997	0.9746	0.1544
K	12	0.9998	0.9963	-0.0065	12	0.9995	1.0215	0.0029
Ca	12	0.9997	0.9902	-0.0172	12	0.9987	0.9894	-0.0729
Fe	12	0.9999	1.0033	0.0137	12	0.9999	0.9940	-0.0039
Ni	12	0.9982	1.0343	-0.0021	12	0.9986	0.9682	0.0005
Cu	12	0.9972	1.0086	-0.0136	12	0.9958	1.0158	-0.0014
Zn	12	0.9997	1.0036	-0.0039	12	0.9995	0.9849	0.0197
Pb	12	0.9877	0.9902	0.0059	12	0.9918	1.0346	-0.0064

Note: Units for intercept are µg/filter; correlation coefficient and slope are dimensionless.

Table 3-38. Regression Results for 9 Elements RTI XRF Instruments XRF 3 and XRF 4

Element	RTI 3				RTI 4			
	n	Correlation Coefficient	Slope	Intercept	N	Correlation Coefficient	Slope	Intercept
Si	12	0.9913	0.9450	0.0057	12	0.9763	1.2283	-0.1881
S	12	0.9994	0.9575	0.2029	12	0.9940	1.0282	-0.1953
K	12	0.9996	0.9682	0.0135	12	0.9988	0.9096	0.0547
Ca	12	0.9992	0.9725	-0.0582	12	0.9989	0.9999	0.0344
Fe	12	0.9999	0.9940	-0.0644	12	0.9999	0.9730	0.0629
Ni	12	0.9970	0.9914	-0.0006	12	0.9871	1.0053	0.0016
Cu	12	0.9979	0.9904	0.0039	12	0.9539	1.0546	0.0139
Zn	12	0.9983	0.9753	-0.0021	12	0.9977	0.9418	0.0024
Pb	12	0.9928	0.9863	-0.0118	12	0.9777	0.9728	-0.0015

Note: Units for intercept are µg/filter; correlation coefficient and slope are dimensionless.

**Table 3-39. Regression Results for 9 Elements
CLN XRF Instruments 770 and 772**

Element	770				772			
	n	Correlation Coefficient	Slope	Intercept	N	Correlation Coefficient	Slope	Intercept
Si	12	0.9958	0.9694	0.0129	12	0.9956	1.0953	-0.0239
S	12	0.9993	1.1457	-0.3587	12	0.9997	1.0180	0.0314
K	12	0.9985	1.0973	-0.0476	12	0.9998	1.0047	0.0095
Ca	12	0.9991	1.2211	0.0148	12	0.9993	1.2514	-0.0785
Fe	12	0.9996	1.0096	0.0039	12	0.9999	1.0283	-0.0167
Ni	12	0.9945	1.0881	0.0045	12	0.9910	0.9133	0.0022
Cu	12	0.9943	0.9684	0.0030	12	0.9918	1.0215	0.0043
Zn	12	0.9996	1.0438	-0.0189	12	0.9997	1.0610	-0.0069
Pb	12	0.9938	1.0516	-0.0019	12	0.9960	0.9612	0.0221

Note: Units for intercept are µg/filter; correlation coefficient and slope are dimensionless.

3.4.1.4 Determination of Uncertainties and MDLs

MDLs are determined periodically by obtaining data from the analysis of 10 laboratory blanks. The MDLs are calculated as three times the average counting uncertainty for each element. This is equivalent to a "3-sigma" MDL; data users should be careful to know what multiple has been used in establishing the MDL when comparing values reported by different environmental laboratories, since some laboratories may report 1-sigma, 2-sigma, or 2.5-sigma detection limits. The network-wide maximum of the calculated MDLs based on XRF uncertainty from XRF 1, XRF 2, XRF 3, and XRF 4 are presented in Appendix A.

Instrument counting uncertainties for each analytical result are automatically calculated by the Thermo WinTrace software, except when the concentration value is zero. The instrument software does not calculate uncertainty values when the peak counts, and hence the concentrations are zero (i.e., peak area ≤ background area). In such cases where the measured result is zero, an uncertainty calculation is performed during the import process into the RTI XRF database, using the following formula[6] (Watson, 2003):

$$\text{Counting uncertainty} = \text{slope} * A * \text{sqrt}(3 * \text{sqrt}(B * t) + B * t) / t$$

Where

A = scaling factor

B = background counts (cps) is incorporated during the importing of the data into the RTI XRF database

t = livetime

[6] Watson, Wayne, ThermoFisher Scientific (Previously Thermo NORAN), Personal Communication to Ms. Andrea McWilliams, June 20, 2003

Slope = element-specific instrument calibration slope

The instrument-reported (or calculated, when counts are zero) uncertainties are then combined with the attenuation uncertainty, calibration uncertainty and field-sampling and handling uncertainty to arrive at a total uncertainty. This is performed to harmonize the uncertainties between instruments and laboratories using consistent uncertainty estimation methods as reported in Gutknecht et al. (2006; 2010)[7,8,9]. For $PM_{2.5}$, the attenuation uncertainty is estimated using the homogeneous layer model for all elements. The calibration uncertainty is assumed to be 5%, and is consistent with the estimated uncertainty of the calibration standards. The field sampling and handling uncertainty accounts for the uncertainties in the flowrate, filter deposit area, and losses and/or contamination during shipping and handling steps. Based on analysis of prior data, the field sampling and handling uncertainty is assumed to be 5%. The total harmonized uncertainty is then calculated as:

Total Harmonized XRF Uncertainty

$$U_i = \sqrt{\delta^2_{i,\text{attenuation}} + \delta^2_{i,\text{calibration}} + \delta^2_{i,\text{field-sampling \& handling}} + \delta^2_{i,\text{instrument peak counts}}}$$

Where
U_i = total harmonized XRF Uncertainty for element i
δ_i = uncertainty for each component for element i

3.4.1.5 Audits, PEs, Training, and Accreditations

In January 2014, the XRF laboratory participated in NAREL's inter-laboratory comparison study in which multiple laboratories analyzed 47mm and 25mm Teflon filter samples for 33 elements. Results from the inter-laboratory study, which were summarized in the NAREL report dated May 30, 2014, indicated good performance by RTI's XRF lab.

In November 2014, an internal audit of the RTI XRF laboratory was performed by the RTI QA Manager for the CSN project. The audit found the laboratory to be in compliance with the SOPs with good record-keeping procedures. No major deficiencies were noted. Minor recommendations included adding temperature sensors to all refrigerators to monitor storage temperature and exploring automated data backup options for the lab computers. It must be noted

[7] Gutknecht, W. F., J. B. Flanagan, and A. McWilliams, "Harmonization of Interlaboratory X-ray Fluorescence Measurement Uncertainties." RTI/0208858/TO2/04D, August 4, 2006. Available online at http://epa.gov/ttn/amtic/files/ambient/pm25/spec/xrfdet.pdf

[8] Gutknecht, W.F., J.B. Flanagan, A. McWilliams, R.K.M. Jayanty, et al. 2010. Harmonization of Uncertainties of X-Ray Fluorescence Data from $PM_{2.5}$ Air Filter Analysis. *Journal of the Air and Waste Management Association*, 60, pp. 184-194.

[9] Watson, Wayne, ThermoFisher Scientific (Previously Thermo NORAN), Personal Communication to Ms. Andrea McWilliams, June 20, 2003

that the data were always backed up manually. External hard drives, added to each lab computer, now backup data automatically on a weekly basis.

3.4.2 Chester LabNet X-Ray Fluorescence Laboratory

During the period covered by this report, Chester operated one Kevex 770 XRF instrument analyzing 630 samples for 33 elements.

3.4.2.1 Quality Issues and Instrument Repair and Maintenance

The following repairs and maintenance were performed for XRF-770:

- 2/28/14 – Replaced vacuum pump
- 4/14/14 – Replaced X-ray tube chiller

3.4.2.2 Description of QC Checks Applied

QC activities for the analysis of elements by EDXRF for the Chester LabNet XRF laboratory, their frequency of application and control limits, comments and corrective actions are shown in **Table 3-40.**

Table 3-40. QC Procedures Performed in Support of XRF Elemental Analysis

QC Check	QC Frequency	Control Limits	Comments/Corrective Action
Calibration	As needed	± 5%	Calibration
Calibration verification[1]	Once per week	± 2 sigma	Recalibrate
Instrument precision[2]	Per 10 to 15 samples	± 10%	Re-analyze
Excitation condition check	Per 10 to 15 samples	± 10%	Re-analyze
Sample replicate precision	Per 10 samples	RPD < 2x uncertainty	Re-analyze if necessary

1 - Using NIST SRMs
2 – Micromatter QC

3.4.2.3 Summary of QC Results

Precision

Precision was monitored by the reproducibility of the multi-element Micromatter QC sample. The QC sample has six selected elements and is analyzed with each tray of samples.

The comparison of the element's values gives the measure of reproducibility or precision. The data used to monitor precision are presented in **Table 3-41**. The percent coefficient of variation (%CV) for the average of all data for each of the six elements ranged between 1.90 and 4.10%.

Table 3-41. Summary of Chester XRF 770 Laboratory QC Precision Data 1/1/2014 through 6/30/2014

Element	n	Min %	Max %	Average %	Std Dev	%CV	Slope (%/year)
Si	57	93.7	108.5	100.4	3.28	3.26	2.19
Ti	57	92.9	109.8	100.7	3.57	3.55	13.13
Fe	57	94.0	108.6	101.6	3.26	3.21	12.56
Cd	57	99.2	107.4	103.3	1.96	1.90	6.39
Se	57	92.3	109.7	101.6	4.16	4.10	13.57
Pb	57	91.2	108.9	101.7	3.98	3.91	14.13

Accuracy

Accuracy determinations are performed with three NIST thin film SRMs, four vapor deposited Micromatter standards, and one NIST particle size standard. Recovery is calculated by dividing the measured result by the expected value. **Table 3-42** recovery for 13 elements spanning the atomic mass range of the 33 elements normally measured. The min and max recovery values for all the elements ranged between 88.2% and 109.6%. Analysis of NIST Particle Standard SRM2783 yielded recoveries of 96.6% for Ca and 101.3% for Zn. Averages over the reporting period were within the recovery goal of twice the standard deviation; however individual measurements were sometimes outside this criterion. Corrective actions were taken whenever a recovery was outside specifications as follows:

- If one of the elements in **Table 3-42** fell outside of the 2-sigma limit, a single re-analysis of the standard was performed in that excitation condition. If re-analysis resulted in failure, then recalibration of that excitation condition was necessary.
- If recalibration demonstrated that the log of the inverse of the new calibration factor (log sensitivity) –vs- atomic number (Z) for the "failed element" did not conform to a smoothly varying curve defined by the log of the sensitivity factors –vs- atomic numbers for the remaining elements, then the calibration factor was "forced" to fit the curve, with the resulting calibration factor yielding "less than optimum" recovery values.

Table 3-42. Percent Recovery Determined from Analysis of NIST SRMs 1832, 1833, 2708 and 2783 for Chester XRF 770 -- 1/1/2014 through 6/30/2014

Element	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Al	100.3	106.9	103.4	1.73	1.68	-4.77
Si	97.0	102.9	99.6	1.64	1.64	-4.72
Si	88.2	94.3	92.3	1.23	1.33	1.54
S	93.7	101.1	97.0	1.85	1.91	-4.93
K	99.6	106.8	103.3	1.77	1.71	2.40
Ca	89.8	106.0	96.6	3.82	3.95	-0.50
Ti	91.7	98.3	95.1	1.59	1.68	-0.36
V	101.0	109.6	104.9	1.74	1.66	1.45
Mn	102.0	106.8	104.4	0.98	0.94	-3.60
Fe	90.5	94.8	93.5	0.92	0.99	1.73
Cu	91.0	107.8	103.2	2.88	2.79	-2.63
Zn	97.6	107.8	101.3	2.65	2.62	-0.04
Pb	89.8	102.0	97.4	2.18	2.23	1.56

Reproducibility

Replicate analysis of field samples are used to assess reproducibility of the analytical system. Replicates were analyzed at a frequency of 10% of the filters analyzed. Six elements were selected for comparison through regression analysis. **Table 3-43** shows the correlation coefficient and average RPDs for the replicate analysis. The correlation coefficients range from 0.9827 to 0.9993.

Table 3-43. Replicate Data for Chester XRF 770

Kevex 770			
Element	n	Correlation Coefficient	Average RPD
Al	30	.9827	3.26
Si	59	.9959	-1.48
S	60	.9976	-1.30
K	60	.9985	1.55
Ca	60	.9973	0.36
Fe	60	.9993	0.13
Zn	58	.9989	0.74

There are times when the distribution of a certain species across the filter is not uniform, and will not produce tight precision. This is important information for those who intend to use the data. It is Chester's position that re-analysis of particle deposits on filters received from the field represents the degree of confidence the client may expect more accurately than precision calculated from the uniformly distributed deposits from the Micromatter QC standard.

Failure of individual replicate analysis results to fall within the 2x uncertainty criteria can be due to multiple reasons requiring different corrective actions:

- The wrong sample was probably re-analyzed, which can be easily deduced and corrected by re-analyzing the correct sample.

- If one element in a sample lies outside the 2-sigma range, especially a volatile species such as Cl which can be an order of magnitude lower on subsequent analysis due to the low pressure atmosphere in the analysis chamber, no action is taken. However, if several elements in one excitation condition lie outside action levels, while other species in different excitation conditions demonstrate good precision, then the spectra for the excitation condition in question are examined for anomalies, and re-analysis of that excitation condition is performed.

3.4.2.4 Assessment of Between-instrument Comparability

For XRF, inter-instrument comparability is assessed by a round-robin filter exchange program coordinated by the RTI XRF laboratory. See Section 3.4.1.3 for comparative performance of both laboratories.

Since the inception of the $PM_{2.5}$ Speciation project, Chester has performed numerous comparisons between instruments via replicate analysis of a number of clients, but much of this data is proprietary and cannot be shared in this report.

3.4.2.5 Uncertainties and MDLs

The methods for determining uncertainties and MDLs are described in SOPs XR-002.02 and XR-006.01. MDLs were determined for the 770 instrument on December 26, 2005. The network-wide maximum of the MDLs for all the elements, that includes Chester's analysis are presented in Appendix A.

3.4.2.6 Audits, PEs, Training, and Accreditations

Chester LabNet has not received any audit visits from EPA on the CSN program since the beginning of the speciation project, and would welcome any PE samples or other oversight, which the EPA might deem appropriate.

3.5 Denuder Refurbishment Laboratory

The purpose of the laboratory is to clean and refurbish the coatings on acid-gas-removing denuders used in samplers within the CSN operated by EPA and various state, local, and tribal agencies, which utilize the RTI/EPA contract. The laboratory also prepares denuders for capture of either acidic or basic gases from the atmosphere and subsequent extraction and analysis to quantify the concentrations of these gases. The laboratory follows these SOPs, which are kept on file in the laboratory:

- Standard Operating Procedures for Coating [MetOne] Aluminum Honeycomb Denuders with Magnesium Oxide
- Standard Operating Procedure for Coating and Extracting Annular Denuders with Sodium Carbonate [IMPROVE]
- Standard Operating Procedure for Coating and Extracting Denuders for Capture of Ammonia and Its Measurement [specific for use with glass honeycomb denuder] [MetOne]
- Standard Operating Procedure for Coating and Extracting Compact Parallel-Plate Denuders for Capture of Ammonia [specific for use with the parallel plate denuder for the MetOne SASS sampler]

3.5.1 Quality Issues and Corrective Actions

Mr. Jim O'Rourke coordinates the Denuder Refurbishment Laboratory. He reviews the denuder refurbishment SOPs to ensure procedures are clearly stated and all processes are up to date. Personnel have been cross-trained to be able to process denuders. At present, there are two persons trained to refurbish and coat denuders. RTI is also capable of coating denuders in a glove cabinet so that exposure of denuders to ambient air is minimized and the denuders can later be extracted to quantify the mass of acidic (e.g., HNO_3) or basic (e.g., NH_3) gases collected.

For the 2014 calendar year, there were no quality issues reported.

3.5.2 Operational Discussion

3.5.2.1 Numbers of Denuder Serviced

Table 3-44 lists the denuders refurbished and the number of refurbishments completed in 2014.

Table 3-44. Denuder Refurbishments, January 1, 2014 through December 31, 2014

Denuder Type	Total Refurbished
Aluminum Honeycomb	766

3.5.2.2 Scheduling of Replacements

MetOne speciation sampler aluminum honeycomb denuders are coated with magnesium oxide. Because the MetOne denuders are part of the sampling module and six sets of modules are in circulation to each site, these denuders are refurbished at 18-month intervals. RTI is able to remove MgO from denuders using a dilute hydrochloric acid solution. As needed, RTI orders uncoated aluminum honeycomb denuder substrates from MetOne, cleans them with solvent and deionized water, and then coats them with magnesium oxide. The change-out occurs whenever the MetOne denuder assembly has been in use for 18 months.

3.5.3 Description of QC Checks Applied and Results

QC checks for coating weight are no longer done. Work in earlier years of the project(s) showed that coating weights on the same types of MgO-coated denuders were usually within 10% of one another and that the amount (number of moles) of MgO applied far exceeded the expected mass (number of moles) of acidic gases that would be drawn through the denuder during the cumulative sampling period. Now the newly-coated denuder surfaces are examined by holding the denuder up to a light and sighting along the interior to determine the coating is thoroughly applied and the annuli are not blocked.

3.6 Sample Handling and Archiving Laboratory

3.6.1 Quality Issues and Corrective Actions

There were two major quality issues in the SHAL during 2014.

The first issue was the failure of the walk-in cold room on May 13, 2014. Although repairs were made within 24 hours, packages inside the cold room reached a maximum temperature of 30^0C during the outage. All filters inside the cold room during the outage were assigned the data qualifying flag of "RTS – Refrigeration Lost Prior to Analysis". A total of 68 events from sampling dates of May 8, 2014 and May 11, 2014 were assigned the RTS data qualifying flag.

The second major quality issue concerned the incorrect assignment of field sampler channels during the data entry process. While entering the field sampling data into the CSN database at RTI, the data entry person mistakenly entered channel 1 instead of channel 2 for some of the URG 3000N sequential sampling events. Those sampling events with incorrect channel assignments appeared to have no sample volume and were therefore automatically invalidated in the database with the AQS Null Value Code of "AM -Miscellaneous Void". A total of 26 events between the sampling dates of June 24, 2013 and July 7, 2014 were incorrectly invalidated. Corrective actions were taken to prevent future incorrect assignment of the field sampler channels in the database, which included automating channel selection based on scheduled events and adding an automated check during the monthly QA review. All data for the 26 events were corrected and reposted to AQS after a thorough QA review.

3.6.2 Description of QC Checks Applied

The SHAL uses a customized database program written specifically for RTI's SHAL operation. This database has been refined over 14 years to incorporate many built-in QC checks. For example, RTI has assigned an inventory number to all filter modules in the network. The database will only accept allowable inventory numbers for filter modules. This avoids errors in data input for any filter module used for a sampling event. Another example is the unique number of the Teflon filters used by RTI. RTI purchases Teflon filters with a check sum digit in the numbering sequence. The database will only accept those filter numbers with the correct check sum. This prevents inadvertent entry of incorrect filter identification numbers.

- Bar-code readers are used to input identification numbers from modules, containers, and data forms to eliminate data transcription errors.
- A SHAL technician other than the one who prepared an outgoing shipment checks the package of outgoing filters. A checklist is used by the technician to verify that the package contents are correct before it is shipped from RTI. This check is performed on all outgoing shipments from the SHAL.
- Blank filters are taken from the SHAL refrigerator and sent unopened to the analytical laboratories for analysis. The results of the analysis of these QC filters are used to improve the overall quality of the program.
- The field site operators are provided contact information for the SHAL laboratory so they may communicate directly with personnel at RTI if any problems are discovered upon receipt of the filter modules. RTI personnel will attempt to resolve issues promptly. For example, a Field Data Form may be faxed or emailed from RTI to the site operator if necessary.

3.6.3 Summary of QC Results and Field Site Completeness

During calendar year 2014, the SHAL shipped out and received back more than 32,000 packages of filters. By employing the QC checks described in Section 3.6.2, the majority of the coolers shipped and received at RTI contained the correct filter modules and the required paperwork for completing the sampling event at the field site. This is a critical component of the network operation and support. The high number of correctly packaged shipments sent from RTI helped the field-sampling locations meet their completion goals. (See Appendix B). Data completeness at the sites was typically 90 to 100%, although there was a wide variation for some months at some sites. Most often, lower data completeness was due to factors beyond the control of RTI, such as inclement weather preventing state/local operators accessing the site for filter retrievals/changes, operational problems or activities at the sites such as malfunctioning samplers, sampler upgrades, lost power etc., and so forth.

3.6.4 Summary of Scheduling Problems

RTI prepares shipping schedules for the CSN and distributes these to all field sampling locations through the EPA DOPO's. The schedules indicate when each cooler will be sent from RTI, the scheduled sampling date for the filters, and the return ship date from the site back to RTI. The schedules are designed to allow RTI to send the sampling site clean filters, allowing time for field site operators to set up and retrieve filters from the samplers. A 48 hour window for sample retrieval by the site operator is built into the schedule. **Table 3-45** lists those sites with less than 95% of their filters run on the intended sampling date during 2014.

Table 3-45. Sites with Less than 95% of Filters Run on Intended Sampling Date

AQS Site Code	POC	Location	Events[1]	On Date	Percent
060658001	6	Riverside-Rubidoux (Collocated)	122	98	80
471570075	6	Shelby Farms	150	136	91
150030010	5	Kapolei	232	214	92

[1]For sites with both SASS and URG 3000 N, each sampler was counted separately.

3.6.5 Support Activities for Site Operators and Data Users

SHAL staff provided support to site operators and data users throughout 2014. A summary of email and phone communications with site operators and data users is presented in **Table 3-46**. In consultation with EPA, a list of frequently asked questions has been prepared (currently under review) that can be posted on the AMTIC website that site operators and data users can refer to for clarification on common issues/questions.

Table 3-46. Summary of SHAL Communications with Site Operators and Data Users

Description	Number of Communications
Site will send cooler late	137
Site needs schedule	33
RTI did not receive cooler	52
Change of operator/site information	113
Sampler problems/questions	195
Field Blank/Trip Blank ran as routine sample	0
Request change of ship date from RTI	31
Site is stopping	52
Miscellaneous QA Issues	389
Data questions/reporting	239
Site did not receive cooler	66
Other	230
Total	1,537

3.6.6 Audits, PEs, Training, and Accreditations

- In November 2014, an internal audit of the SHAL was performed by the RTI QA Manager for the CSN project. The audit found the SHAL operations to be consistent with the SOPs with good record-keeping procedures. No major deficiencies were noted.

- All new SHAL technicians must undergo a formal training process before they handle any filters. This process includes a Safety and Occupational Health Orientation, a review of the SOP and instruction by senior staff in filter handling. A record of this training is kept on file.
- SHAL staff periodically review the SOP and a record of this review is added to their training file.
- All SHAL staff are trained in the handling of the 25mm quartz filters used in the URG 3000N sampler and the proper installation and removal of the quartz filter using the URG 3000N cassette.
- Throughout the year, senior SHAL staff will periodically observe the SHAL technicians processing filter modules. A checklist has been prepared listing each step in the module processing task. The checklist is used during the observation of the technician. The SHAL supervisor keeps the completed checklists. Technicians are briefed following the review of any findings. A summary of the reviews for calendar year 2014 is shown in **Table 3-47**.

Table 3-47. Review of SHAL Technician Processing Filter Modules

Module Type	Number Observed	Findings	Findings Reviewed with Technician
MET ONE	97	5	5
URG 3000N	96	5	5

3.6.7 Chemical Speciation Site Changes 2014

A chronological listing of CSN field site changes during 2014 is listed below in Table 3-48. During 2014, a number of sites were converted from 1-in-3 day sampling to sequential sampling as shown in Table 3-48. This may be part of the reason for reduced data completeness seen in Appendix B.

Table 3-48. CSN Field Site Changes During 2014

Date	AQS Site ID	Site Name	State	Description
1/14/2014	061112002	Simi Valley	CA	Site stopped permanently. Last event was 1/14/14.
1/17/2014	170314201	Northbrook	IL	Stopped the URG 3000N sampler only. Restarted the URG 3000N sampler 2/4/14.
1/17/2014	500070012	Burlington	VT	Site stopped due to sampler repairs. Last event was 1/17/14. Restarted with 2/13/14 sample date.
1/23/2014	100032004	MLK	DE	Site restarted. Had been down since 11/18/13. First event = 1/23/14.
2/1/2014	360050110	IS 52	NY	Site started sampling after being down since 6/16/10. Site will sample on sequential schedule. First event = 2/1/14.
2/4/2014	170314201	Northbrook	IL	Restarting the URG 3000N sampler. Had been sampling with MET ONE only since 1/17/14. Both samplers started again on 2/4/14.
2/4/2014	410510080	Portland-SE Lafayette	OR	Site restarted. Had been down since 11/21/13. First sample date was 2/4/14.
2/13/2014	500070012	Burlington	VT	Site restarted. Had been down since 1/17/14. First sample date was 2/13/14.
2/28/2014	060730003	El Cajon	CA	Site stopped permanently. Samplers moved to a new location. Last event 2/28/14.
2/28/2014	540511002	Moundsville Armory	WV	Site stopped. Last sample date was 2/28/14.
3/30/2014	420692006	Scranton	PA	Site stopped permanently. Samplers moved to a new location. Last event 3/30/14.

Date	AQS Site ID	Site Name	State	Description
4/1/2014		Network Wide		Increased the number of icepacks in speciation packages from 6 to 8 for the warmer months.
4/5/2014	010732003	Wylam	AL	Started sequential sampling. First event = 4/5/14.
4/5/2014	100010003	Dover	DE	Site stopped due to sampler repairs. Last event was 4/5/14.
4/5/2014	250250042	Roxbury	MA	Started sequential sampling. First event = 4/5/14.
4/5/2014	300930005	Butte-Greeley School	MT	Site is changing from Alt 1/3 Schedule to 1/6 Schedule. First sample date on 1/6 schedule is 4/5/14.
4/5/2014	320310016	Reno	NV	Started sequential sampling. First event = 4/5/14.
4/5/2014	371190041	Garinger High School	NC	Started sequential sampling. First event = 4/5/14.
4/5/2014	530330080	Beacon Hill	WA	Started sequential sampling. First event = 4/5/14.
4/5/2014	540390011	WV Guthrie Ag Center	WV	Started sequential sampling. First event = 4/5/14.
4/5/2014	540391005	South Charleston Library	WV	Site stopped due to sampler repairs. Last event was 4/5/14.
4/17/2014	220150008	Shreveport Airport	LA	Changed sample frequency from 1/6 to 1/3 for two months. Changed back to 1/6 frequency beginning with 6/22/14 sample date.
4/29/2014	390990014	Head Start	OH	Site stopped. Last sample date was 4/29/14. Restarted with 6/16/14 sample date.
5/5/2014	540511002	Moundsville Armory	WV	Site restarted. Had been down since 2/28/14. First sample date was 5/5/14.

Date	AQS Site ID	Site Name	State	Description
5/11/2014	180970078	Indpls. Washington Park	IN	Site stopped. Last sample date was 5/11/14. Restarted with 6/10/14 sample date.
5/14/2014	500070012	Burlington	VT	Site stopped. Last sample date was 5/14/14. Restarted with 5/23/14 sample date.
5/23/2014	500070012	Burlington	VT	Site restarted. Had been down since 5/14/14. First sample date was 5/23/14.
6/7/2014	160010010	St Lukes Meridian (IMS)	ID	Started sequential sampling. First event = 6/7/14.
6/7/2014	240053001	Essex	MD	Started sequential sampling. First event = 6/7/14.
6/7/2014	360551007	Rochester Primary	NY	Started sequential sampling. First event = 6/7/14.
6/7/2014	481410044	Chamizal	TX	Started sequential sampling. First event = 6/7/14.
6/10/2014	180970078	Indpls. Washington Park	IN	Site restarted. Had been down since 5/11/14. Restarted with 6/10/14 sample date.
6/16/2014	390990014	Head Start	OH	Site restarted. Had been down since 4/29/14. First sample date was 6/16/14.
6/22/2014	220150008	Shreveport Airport	LA	Changed sample frequency back to 1/6. Site was temporarily on 1/3 frequency since 4/17/14.
6/28/2014	370350004	Hickory	NC	Site stopped permanently. Last sample date was 6/28/14.
7/10/2014	120111002	Univ. of Florida Ag School	FL	Site has stopped. The SASS sampler is down for repairs. Last sample date 7/10/14. Site restarted on 8/15/14.

Date	AQS Site ID	Site Name	State	Description
7/16/2014	420692006	Scranton	PA	Site restarted. Had been down since 3/30/14 due to site relocation. Site moved less than 1/3 mile. No change in AQS Site Code. First sample date was 7/16/14.
8/15/2014	120111002	Univ. of Florida Ag School	FL	Site had been down since 7/10/14. Restarted on 8/15/14.
7/10/2014	450790007	Parklane	SC	Site has stopped the URG 3000N. URG 3000N is down and replacement parts cannot be purchased until the new fiscal year. SASS will continue operation.
7/25/2014	220330009	Capitol-MetOne	LA	Started sequential sampling. First Event 7/25/14
7/25/2014	371830014	Millbrook	NC	Started sequential sampling. First Event 7/25/14
7/25/2014	360810124	Queens College	NY	Started sequential sampling. First Event 7/25/14
7/25/2014	391351001	National Trail High School	OH	Started sequential sampling. First Event 7/25/14
7/25/2014	471570075	Shelby Farms	TN	Started sequential sampling. First Event 7/25/14
8/15/2014	191630015	Jefferson Elementary	IA	Started sequential sampling. First Event 8/15/14
8/15/2014	060670006	Sacramento - Del Paso Manor	CA	Started sequential sampling. First Event 8/15/14
8/15/2014	440071010	East Providence	RE	Started sequential sampling. First Event 8/15/14
8/15/2014	270530963	Philips	MN	Started sequential sampling. First Event 8/15/14
8/15/2014	270031002	Blaine Anoka	MN	Started sequential sampling. First Event 8/15/14

Date	AQS Site ID	Site Name	State	Description
		County Airport		
8/6/2014	295100085	Blair Street	MO	Site has stopped the URG 3000N. URG 3000N is down. SASS will continue operation. Began sampling again with both samplers on 9/2/14.
9/2/2014	295100085	Blair Street	MO	Site had been down since 8/6/14. Restarted with 9/2/14 event.
9/20/2014	040139997	Phoenix Supersite	AZ	Started Sequential Sampling. First event 9/20/14
9/20/2014	060371103	North Los Angeles	CA	Started Sequential Sampling. First event 9/20/14
9/20/2014	170314201	Northbrook	IL	Started Sequential Sampling. First event 9/20/14
10/23/2014	300490004	Sieben Flats	MT	Started Sequential Sampling. First event 10/23/14
9/23/2014	060731018	El Cajon-Floyd Smith Drive Site	CA	Temporarily moved site from El Cajon to El Cajon-Floyd Smith Drive site. First sample date 9/23/14
10/23/2014	040191028	Children's Park	AZ	Started Sequential Sampling. First event 10/23/14
10/3/2014	540391005	South Charleston Library	WV	Site notified EPA they will stop speciation sampling permanently. Site had been down since 4/5/14.
8/12/2014	150030010	Kapolei	HI	Site stopped due to sampler repairs. Last event = 8/12/14.
8/30/2014	150030010	Kapolei	HI	Site restarted with the 8/30/14 event. Had been down since 8/12/14.
9/26/2014	391130032	Downtown Library	OH	Site stopped. Last event = 9/26/14. Samplers moved to Sinclair Community College (391130038). First sample date at new location = 10/2/14.

Date	AQS Site ID	Site Name	State	Description
10/2/2014	391130038	Sinclair Community College	OH	Samplers moved to this location from Downtown Library site (391130032). First event = 10/2/14.
10/2/2014	530110023	VANNEVAN	WA	Site stopped permanently. Last event = 10/2/14.
10/1/2014		Network Wide		Reduced the number of icepacks in speciation packages from 8 to 6 for the winter months as a cost saving measure. Only exceptions were for those sites on the Sequential Sampling Schedule and San Jose - Jackson St (CA), Children's Park (AZ) and Kapolei (HI).
10/1/2014		Network Wide		Gravimetric mass analysis was discontinued in the CSN. Exceptions were the following six locations that will continue gravimetric mass analysis: Athens, GA (130590001), Douglas, GA (130690002), Skyview, FL (121030026), WV Guthrie Ag Center, WV (540390011), Bonne Terre, MO (291860005) and Shreveport Airport, LA (220150008).
11/1/2014	450790007	Parklane	SC	Resumed sampling with the URG 3000N quartz filter on 1/1/14. Had only been sampling with MET ONE Teflon and nylon filters since 7/10/14.
11/13/2014	530330030	Seattle 10th Ave	WA	New site. Sampling started 11/13/14.
11/25/2014	420270100	State College	PA	Site stopped permanently. Last event = 11/25/14. Samplers moved to Chester (PA) site. First event at new location 12/1/14.
11/25/2014	421330008	York	PA	Site stopped permanently. Last event = 11/25/14. Samplers moved to Marcus Hook site. First event at new location 12/1/14.
12/1/2014	420450002	Chester (PA)	PA	Site started speciation sampling. First event was 12/1/14.

Date	AQS Site ID	Site Name	State	Description
12/1/2014	420450109	Marcus Hook	PA	Site started speciation sampling. First event was 12/1/14.
12/25/2014	180970078	Indpls. Washington Park	IN	Started Sequential Sampling. First event 12/25/14.
12/31/2014	180390008	Elkhart Prairie Street	IN	Site stopped permanently. Last event = 12/31/14.

4.0 Data Processing

4.1 Quality Issues and Corrective Actions

No significant quality issues arose during the period of this report that affected reportable data.

4.2 Operational Summary

Routine data-processing activities have remained largely unchanged since the beginning of the program. These include the following:

- Accepting data entered from field forms
- Accepting data from the laboratories
- Backing up and maintaining the database
- Generating data monthly for validation and review
- Posting review data monthly to the Web site for external review
- Incorporating data change requested by the States
- Uploading finalized data to AQS
- Responding to user inquiries and data requests, including support to EPA and RTI personnel.

4.3 Operational Changes and Improvements

RTI has started reporting flow audits results to AQS. These results are submitted to RTI's QA web site (https://airqa.rti.org) using preformatted spreadsheets. The uploaded spreadsheets are processed by RTI to produce batch records for upload (in RA record format).

4.4 Monthly Data Postings to Web Site

Each month, RTI posts data for samples received on or before the 15th of the previous month. **Table 4-1** shows monthly totals for postings, and **Table 4-2** shows totals for events. Sample dates may overlap between different batches due to different shipping schedules for the 1-in-3 and 1-in-6 sampling schedules. In addition, the latest date may include samples received late (i.e., after the previous report's cutoff date).

Table 4-1. Events Posted to Web Site

Report		Sampling Date				Blanks		Backup Filters[3]
Report	Date	Earliest	Latest	Total [1]	Routine	Field	24 Hour[2]	Routine
169	2/17/2014	11/30/2013	1/9/2014	1,634	1,259	14	187	174
170	3/14/2014	1/8/2014	2/11/2014	1,786	1,397	67	240	82
171	4/15/2014	1/29/2014	3/9/2014	1,146	1,073		73	
172	5/15/2014	3/6/2014	4/12/2014	1,597	1,342	81	93	81
173	6/13/2014	4/5/2014	5/11/2014	1,480	1,208	91	91	90
174	7/15/2014	5/8/2014	6/10/2014	1,350	1,269		81	
175	8/15/2014	6/4/2014	7/10/2014	1,550	1,217	81	171	81
176	9/15/2014	7/4/2014	8/12/2014	1,503	1,424		79	
177	10/15/2014	8/3/2014	9/8/2014	1,490	1,150		170	170
178	11/14/2014	9/8/2014	10/8/2014	1,248	1,169		79	
179	12/15/2014	9/17/2014	11/11/2014	1,800	1,373	173	173	81
180	1/15/2015	11/1/2014	12/7/2014	1,270	1,188		82	
			Total	17,854	15,069	507	1,519	759

1) Counts for Total Events include routine events, field blanks, 24-hour blanks and backup filters.
2) 24 Hour blanks are only used with the URG 3000N samplers. Only results for OC/EC analysis by the IMPROVE_A method are reported for these samples.
3) Backup filters are only used for URG 3000N samplers. Only results for OC/EC analysis by the IMPROVE_A method are reported.

Table 4-2. Records Posted to Web Site

Report		Sampling Date				Blanks		Backup Filters(3)
Batch	Date	Earliest	Latest	Total (1)	Routine	Field	24 Hour(2)	Routine
169	2/17/2014	11/30/2013	1/9/2014	138,952	130,936	1,092	4,488	2,436
170	3/14/2014	1/8/2014	2/11/2014	157,292	145,158	5,226	5,760	1,148
171	4/15/2014	1/29/2014	3/9/2014	113,344	111,592		1,752	
172	5/15/2014	3/6/2014	4/12/2014	149,252	139,568	6,318	2,232	1,134
173	6/13/2014	4/5/2014	5/11/2014	136,174	125,632	7,098	2,184	1,260
174	7/15/2014	5/8/2014	6/10/2014	133,920	131,976		1,944	
175	8/15/2014	6/4/2014	7/10/2014	138,124	126,568	6,318	4,104	1,134
176	9/15/2014	7/4/2014	8/12/2014	149,654	147,758		1,896	
177	10/15/2014	8/3/2014	9/8/2014	125,670	119,210		4,080	2,380
178	11/14/2014	9/8/2014	10/8/2014	122,884	120,988		1,896	
179	12/15/2014	9/17/2014	11/11/2014	159,892	141,279	13,327	4,152	1,134
180	1/15/2015	11/1/2014	12/7/2014	124,501	122,533		1,968	
			Total	1,649,659	1,563,198	39,379	36,456	10,626

1) Counts for Total Events include routine events, field blanks, 24-hour blanks, and backup filters.

2) 24 Hour blanks are only used with the URG 3000N samplers. Only results for OC/EC analysis by the IMPROVE_A method are reported for these samples.

3) Backup filters are only used for URG 3000N samplers. Only results for OC/EC analysis by the IMPROVE_A method are reported.

Postings to AQS

After data have been posted to the external Web site, the state/local monitoring agencies have 45 days to review data and send corrections to RTI. RTI then is required to post data to AQS within 15 days. RTI met all processing deadlines for this reporting year. **Table 4-3** contains totals of events posted to AQS. **Table 4-4** contains totals of records posted to AQS. Note that blanks involve fewer records per event, as temperature and barometric pressure for field blanks are not posted to AQS. Some data, such as results for the collocated shipping study, were reported to the sites, but were not reported to AQS.

4.5 Data User Support Activities

RTI had continuing data-user support throughout the year. Most responses may be categorized into four categories; data change requests, requests for old data, support requests for the Speciation Data Validation and Analysis Tool (SDVAT), and requests from data users.

4.5.1 Data Change Requests

Sites are asked to review their data and submit any changes to RTI within 45 days. RTI then processes these changes before posting the data to AQS. Sites report changes via e-mail. Many sites do not report unless they have changes, whereas others send a report back indicating there are no changes to be made. **Table 4-5** shows a count of the number of change requests per batch. Note that many requests represent multiple sites (often an entire state).

Table 4-3. Events Posted to AQS

Report Batch	Routine(1)	Blanks		Backup Filters(2)
		24 Hour(2)	Field	
167	1,404	85	82	81
168	1,132	83		
169	1,267	187	14	174
170	1,403	240	67	82
171	1,076	73		
172	1,348	93	81	81
173	1,213	91	91	90
174	1,274	81		
175	1,222	171	81	81
176	1,428	79		
177	1,157	170		170
178	1,171	79		
Total	15,095	1,432	416	759

(1) A sampling event is defined as a sample taken at a single AQS site ID and Parameter Occurrence Code (POC) on a single day. This would represent two physical samplers at sites that use URG 3000N samplers for carbon sampling

(2) URG 3000N samplers only

Table 4-4. Records Posted to AQS

Report Batch	Routine	Blanks		Backup Filters(1)
		24 Hour(1)	Field	
167	81,258	1,105	3,690	1,053
168	65,366	1,079		
169	73,022	2,431	630	2,262
170	80,961	3,120	3,015	1,066
171	62,234	949		
172	77,836	1,209	3,645	1,053
173	70,064	1,183	4,095	1,170
174	73,602	1,053		
175	70,586	2,223	3,645	1,053
176	82,423	1,027		
177	66,505	2,210		2,210
178	67,344	1,027		
Total	871,201	18,616	18,720	9,867

(1) URG 3000N only

Table 4-5. Change Requests per Report Batch(1)

	Report Batch											
	167	168	169	170	171	172	173	174	175	176	177	178
Change Requests[1]	5	7	4	7	2	5	5	4	6	4	1	2

1) Number of site data contact changes. Multiple data changes by one site contact are counted as one request

5.0 Quality Assurance and Data Validation

5.1 QA Activities

5.1.1 QAPP Updates

RTI's QAPP was revised in January 27, 2014 to reflect personnel changes.

5.1.2 SOP Updates

RTI's SOPs were updated in preparation for the procurement of the CSN contract in July 2008. All SOPs were finalized in 2009, after contract award. One SOP was added during 2012: EIS-401 on ICP/MS analysis for metals. DRI updated the *DRI Model 2001 Thermal/Optical Carbon Analysis (TOR/TOT) of Aerosol Filter Samples – Method IMPROVE_A* SOP in 2012. The current versions of all SOPs are listed in Section 7 of this report.

5.1.3 Internal Surveillance Activities

The QA Manager conducted an internal audit of all the RTI laboratories and activities related to the CSN. This included the SHAL, the RTI analytical laboratories (gravimetry, XRF, Ion Analysis and RTI OC/EC laboratories), and the data processing and data reporting activities. The internal audit found all laboratories and activities to be in compliance with the SOPs and maintained proper documentation of laboratory records. No major deficiencies were found. Minor recommendations for most laboratories included developing data backup plans.

In addition to the audit, the QA Manager follows up regularly with the laboratories on data issues as part of the monthly data review process, and sometimes requests raw data for verification. Outstanding quality issues were discussed at monthly project meetings, and any new changes required were implemented. Each laboratory performs its own internal surveillance and QC. For example, SHAL technicians crosscheck each other's outgoing packages (coolers) before they are shipped to the sites. In the chemical laboratories, the supervisor checks and approves data before it is released.

5.1.4 Data User Support Activities

The Project Manager, QA Manager, SHAL Supervisors, Data Processing Supervisor and other project personnel responded to a number of questions and requests for data during 2014. These originated from both network participants (state agency personnel and EPA), as well as data users who were not affiliated with the CSN program. See Sections 3.0 and 4.0 for additional information.

5.2 Data Validation and Review

5.2.1 Review of Monthly Data Reports to the CSN Web Site

Each month, RTI reviews data completed during the previous month. These reviews include the following activities:

- Verification of data attribution to the correct site, POC, and date
- Automated range checks (e.g., barometric pressure, temperature)
- Investigation and corrective actions when discrepancies are found
- Level 1 checks (e.g., reconstructed mass balance, anion/cation balance, and sulfur/sulfate balance)

The monitoring agencies are responsible for Level 2 and above data validation and to recommend data flagging and/or invalidation. To aid the monitoring agencies, beginning in 2013, after discussions with EPA, RTI began to invalidate certain events when sufficient evidence was available and notified the respective monitoring agencies of the events invalidated with a brief justification. No action was needed by the agency unless they disagreed with the invalidation.

Tables **5-1** through **5-3** summarize the data flags attached to the data posted to the Web site for review by the state and local agencies. These flags are assigned during the data review process, although some flags are assigned by field operators or by the laboratories. Examining trends in flag percentages is a useful tool in diagnosing potential problems; however, during 2014 the flag percentages were low and stable. Please note that during 2013, as a result of the chromium contamination issue, a new internal flag, “BFC – Blank Filter Contamination” was added to track contamination found in unused blank filters and was mapped to the AQS Validity Code of “4 – Possible Lab Contamination.” All data records affected by the high chromium background were flagged “BFC” and “4”. This is the reason for the percentages showing up for AQS Code of “4” in Table 5-1. It must be noted, however, that in this instance, the contamination issue did not originate at any RTI Laboratory, but was tracked to possible contamination during filter manufacture. Regular variations in the percentages of flags such as DST, temperature of receipt above 4°C, is explained by seasonal factors.

Table 5-1 lists the percentages of records that are flagged with Validity Status Codes defined in AIRS/AQS. Data records containing a validity status code should be used with caution because the reported concentration value may have been flagged as an outlier, or some unusual circumstance was reported by the field operator or by the laboratory. Table 5-2 lists the percentages of records containing Null Value Codes defined in AIRS/AQS. These data records have been invalidated due to more serious problems. Concentration values will not be included in AQS when a Null Value Code has been assigned to the record. Table 5-3 lists percentages of internal RTI informational flags. These flags are not defined in AIRS/AQS, but give more insight to the monitoring agencies during data review about the reasons why AIRS/AQS flags were set. As discussed in Section 3.6.1, the “RTS” flag is related to the short-term loss of refrigeration that was experienced by the walk-in cold room in the SHAL as a result of hot ambient temperatures. The cooler was restored within 24-hours. All samples that were in the cold room at that time received the RTS flag. The complete definitions of all flags are given in the report (.rtf) files that are posted on the external RTI QA Web Site for review by the state/local monitoring agencies.

Shipping containers received from the field sites are checked for internal temperature when they are opened for module disassembly. The temperature goal is 4°C, but some fraction

Table 5-1. Summary of Validity Status Codes by Delivery Batch Number (percent of data records reported)

Flag	Description	169	170	171	172	173	174	175	176	177	178	179	180
1	Critical Criteria Not Met												
2	Operational criteria not met							0.02%	0.06%				
3	Possible field contamination	0.04%											
4	Possible lab contamination	0.65%											
5	Outlier - cause unknown	2.97%	2.78%	2.87%	3.24%	4.63%	2.68%	3.90%	3.76%	3.20%	2.85%	0.60%	0.84%
IE	Demolition	0.38%	0.40%	0.09%		0.07%							
IF	Fire - Canadian								0.14%	0.11%			
IH	Fireworks				0.07%			0.81%					
II	High Pollen Count				0.21%	0.02%	0.02%						
IJ	High Winds				0.14%	0.15%							
IK	Infrequent Large Gatherings								0.07%				
IL	Other	0.05%	0.05%	0.09%	0.24%	0.06%	0.27%	0.37%	0.29%	0.14%	0.08%	0.03%	
IM	Prescribed Fire				0.07%						0.02%	0.06%	
IP	Structural Fire												0.08%
IT	Wildfire-U. S.						0.09%		0.87%		0.41%		
W	Flow Rate Average Out of Spec.	0.30%	0.06%	0.07%	0.02%		0.06%	0.26%	0.10%	0.10%	0.04%	0.03%	0.02%
X	Filter Temperature Difference Out of Spec.	0.79%	0.51%	0.73%	0.73%	0.45%	0.51%	0.57%	0.60%	0.73%	0.82%	0.83%	0.61%
Y	Elapsed Sample Time Out of Spec.		0.02%			0.07%				0.08%		0.02%	

Table 5-2. Summary of Null Value Codes by Delivery Batch Number (percent of data records reported)

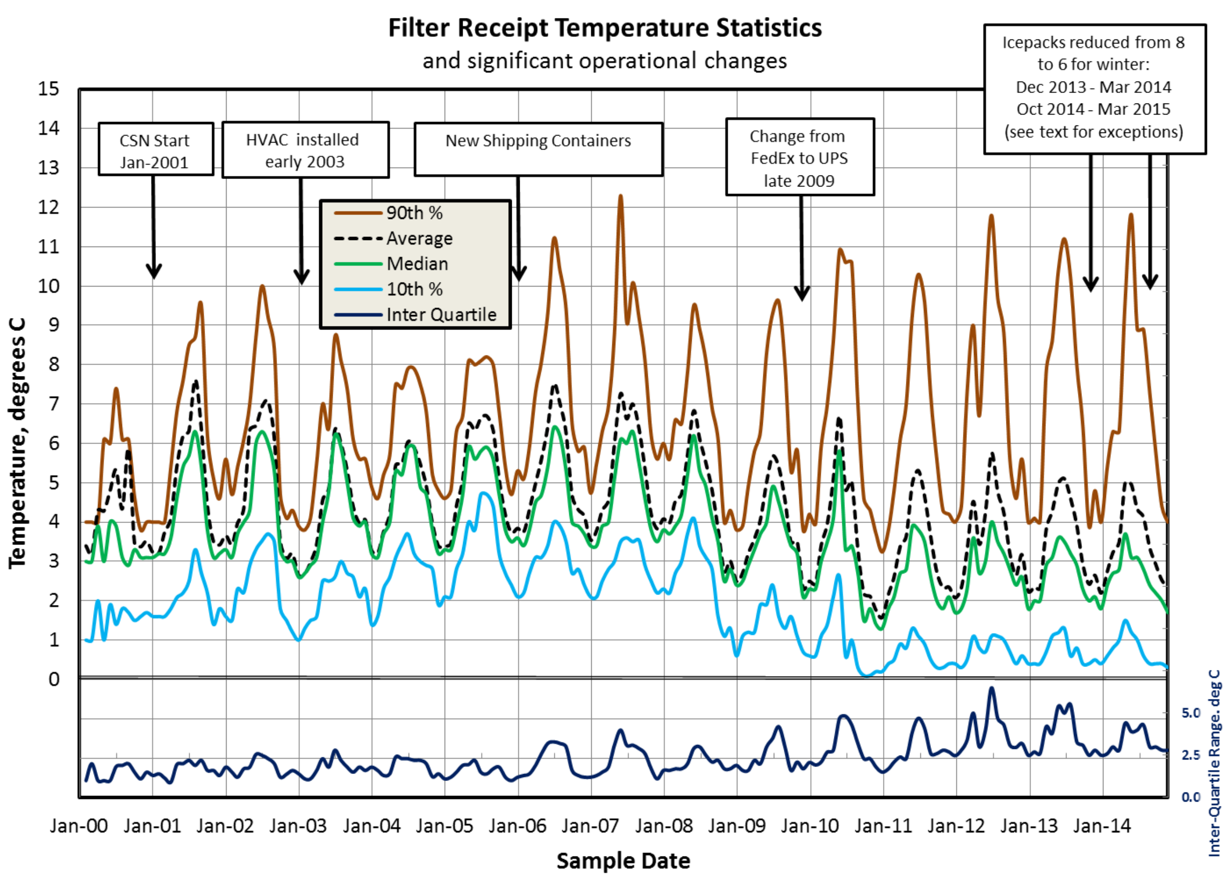
Flag	Description	169	170	171	172	173	174	175	176	177	178	179	180
AB	Technician Unavailable	0.48%	0.03%	0.11%	0.36%	0.34%	0.21%	0.35%	0.27%	0.26%	0.07%	0.08%	
AC	Construction/Repairs in Area				0.07%						0.25%	0.06%	
AD	Shelter Storm Damage												
AF	Scheduled but not Collected	2.67%	2.08%	1.05%	0.72%	1.29%	0.70%	1.01%	0.88%	1.62%	1.03%	1.04%	2.38%
AG	Sample Time out of Limits	0.91%	0.58%	0.42%	0.90%	0.72%	0.75%	0.81%	0.96%	0.37%	0.68%	0.54%	0.55%
AH	Sample Flow Rate out of Limits	1.14%	1.56%	1.38%	0.58%	0.22%	0.39%	0.97%	0.64%	0.73%	0.30%	0.41%	0.85%
AI	Insufficient Data (Can't Calculate)	0.13%	0.08%	0.04%	0.02%	0.02%	0.13%	0.08%	0.10%	0.08%	0.02%	0.01%	
AJ	Filter Damage	0.12%	0.06%	0.27%	0.23%	0.12%	0.09%	0.10%	0.10%	0.11%	0.14%	0.12%	
AK	Filter Leak				0.07%		0.04%						
AL	Voided by Operator	0.22%	0.14%	0.09%	0.02%	0.34%	0.17%	0.33%	0.19%	0.08%	0.31%	0.22%	0.10%
AM	Miscellaneous Void	0.16%		0.01%	0.05%	0.08%		0.15%	0.00%	0.00%	0.10%		0.02%
AN	Machine Malfunction	1.38%	1.44%	1.35%	1.24%	1.23%	1.00%	1.44%	0.91%	0.77%	0.51%	0.57%	0.30%
AO	Bad Weather	0.11%	0.16%	0.18%	0.20%				0.07%	0.08%	0.02%		0.12%
AP	Vandalism						0.23%						
AQ	Collection Error	0.50%	0.21%	0.28%	0.28%	0.22%	0.30%	0.06%	0.31%	0.26%	0.06%	0.05%	0.12%
AR	Lab Error	0.10%	0.19%	0.16%	0.07%	0.03%	0.09%	0.28%	0.31%	0.18%	0.02%	0.07%	0.17%
AS	Poor Quality Assurance Results		0.01%		0.02%	0.02%	0.05%		0.12%	0.02%	0.00%		
AU	Monitoring Waived	0.09%		0.09%	0.07%			0.31%	0.02%	0.08%	0.02%		0.02%
AV	Power Failure	0.66%	0.11%	0.22%	0.56%	0.26%	0.68%	1.01%	0.66%	0.28%	0.51%	0.23%	0.05%
BA	Maintenance/Routine Repairs		0.05%	0.07%	0.12%	0.32%	0.25%		0.14%	0.13%	0.03%	0.05%	
BB	Unable to Reach Site	0.07%		0.33%	0.07%	0.10%		0.07%			0.02%		0.08%
BE	Building/Site Repairs				0.14%								
BI	Lost or Damaged in Transit		0.06%										

Table 5-3. RTI-assigned Flags (not reported to AQS) by Delivery Batch Number (percent of data records reported)

Flag	Description	169	170	171	172	173	174	175	176	177	178	179	180
BFC	Blank Filter Contamination	0.65%											
DFM	Filter missing	0.02%	0.04%		0.02%		0.05%	0.02%	0.07%	0.02%		0.02%	
DST	Shipping temperature out of specifications	15.3%	10.7%	16.1%	25.6%	21.0%	36.9%	34.3%	32.8%	28.4%	12.0%	14.0%	10.7%
FC1	Channel 1 used instead of designated channel	0.02%											
FC2	Channel 2 used instead of designated channel				0.02%	0.02%	0.02%						
FC3	Channel 3 used instead of designated channel	1.25%	1.54%	1.56%	1.37%	1.64%	2.02%	2.03%	1.96%	2.13%	1.59%	1.76%	1.58%
FC4	Channel 4 used instead of designated channel	0.55%	0.61%	0.61%	0.56%	0.64%	0.82%	0.82%	0.78%	0.85%	0.65%	0.71%	0.65%
FC5	Channel 5 used instead of designated channel	0.98%	0.91%	0.94%	0.90%	1.07%	1.21%	0.94%	1.01%	0.82%	1.04%	0.95%	0.91%
FC6	Channel 6 used instead of designated channel	0.41%	0.38%	0.39%	0.38%	0.45%	0.49%	0.39%	0.42%	0.34%	0.44%	0.40%	0.39%
FC7	Channel 7 used instead of designated channel	0.08%	0.14%	0.14%	0.25%	0.20%	0.32%	0.31%	0.40%	0.30%	0.35%	0.46%	0.45%
FCE	Corrected - operator data entry error	1.17%	1.27%	1.53%	0.84%	0.99%	0.98%	2.97%	1.38%	2.87%	3.25%	3.28%	4.36%
FES	Field environmental data taken from other flow channel	0.21%	0.25%	0.16%	0.17%	0.12%	0.05%	0.11%	0.09%	0.07%	0.05%	0.01%	0.07%
FHT	Pickup Holding Time Exceeded	16.3%	17.8%	20.2%	11.5%	18.4%	18.9%	18.3%	13.8%	25.8%	23.3%	20.9%	16.9%
LFA	Filter inspection flags* - filter wet	0.02%	0.01%	0.20%	0.08%	0.05%	0.02%	0.02%					
LFH	Filter inspection flags* - Holes in filter			0.04%					0.06%	0.04%			
LFL	Filter inspection flags* -Loose Material					0.00%							
LFO	Filter inspection flags* -Other (wrinkling, warping, etc.)									0.00%	0.00%		
LFT	Filter inspection flags* - Tear		0.03%		0.11%			0.03%			0.08%	0.10%	
LLI	Analysis Invalid - Other												
QAC	Anion/Cation total charge ratio out of limits	0.24%	0.28%	0.26%	0.19%	0.24%	0.21%	0.35%	0.38%	0.25%	0.25%	0.36%	0.17%
QL1	Outlier based on Level 1 check (e.g., Sulfur/Sulfate Ratio outside limits)	0.18%	0.09%	0.07%	0.07%	0.09%	0.03%	0.07%	0.09%	0.14%	0.08%	0.06%	0.10%
QMB	Total mass balance outside limits	2.60%	2.43%	2.58%	3.01%	4.34%	2.44%	3.53%	3.34%	2.85%	2.55%	0.19%	0.58%
RTS	Refrigeration lost prior to analysis					3.95%	1.14%						

of the packages is always higher than this goal. **Figure 5-1** shows the average temperature, the 10th, 50th and 90th percentiles, and the interquartile range plotted monthly through the end of 2014. Significant events with the potential to affect package temperature are indicated on the chart, including the change from the original "picnic cooler" type shipping container to a lighter-weight custom designed package, and the change from FedEx to UPS as the carrier. Although some fraction of the containers is always above 4°C goal, particularly during summer, temperature percentiles have generally trended lower in recent years, indicating that shipping conditions are under good control. Any package that is received above 4°C generates a "DST" flag, which is included in the monthly report going to the monitoring agencies for their information. No flag corresponding to DST has been defined in AQS. Also, as described in the 2013 annual data summary report, all sites, except the Kapolei, HI, site and sites with sequential sampling, were switched to using 6 icepacks from 12/18/2013 to 3/31/2014. Likewise, the number of icepacks was reduced back to 6 beginning 10/1/2014, except for the following sites: San Jose - Jackson St (CA), Children's Park (AZ), Kapolei (HI) and sites with sequential sampling. As shown in Figure 5-1, the temperature distribution during these months is in general quite similar to the temperature distribution in previous years.

Figure 5-1. Filter Receipt Temperature Statistics.



5.2.2 Review of Monthly Data Packages to AQS

Approximately 60 days after initial posting on the RTI Web site, the data are uploaded to the AQS database. Prior to uploading, the data processing staff prepares a QC summary report, which is reviewed by the QA Manager. This summary and review includes the following main areas:

- Verification that changes requested by the state agencies have been implemented. This includes checking data flags that are different between original reporting (Web site posting) and final AQS reporting.

- Verification that record counts match exactly the number of records previously reported on the CSN Web site, with allowance for all records that were added and deleted during processing. Record counts may change as the result of such things as elimination of duplicate records, or re-reporting of previously reported that has been changed or corrected.

- Scanning for unusual values such as start times other than midnight.
- Scanning for formatting errors such as the following:
  - duplicate records
  - flags and other data in incorrect columns
  - previously delivered data (unless they are Modify records)
  - MDLs and uncertainties that do not agree between the original report and the AQS data file.

5.3 Analysis of Collocated Data

The CSN program operated six sites with collocated samplers during 2014, shown in **Table 5-4**. All six sites included collocated MetOne samplers for Teflon and nylon filters, plus the URG 3000N samplers for quartz on both the primary and collocated sampler. The primary samplers at these sites run on a 1-in-3 schedule, but the collocated (secondary) samplers typically only run on a 1-in-6 day schedule, which governs how much collocation data are available for analysis. The data from the sites with collocated samplers affords an opportunity to calculate

Table 5-4. Collocated Sites in the CSN During 2014.

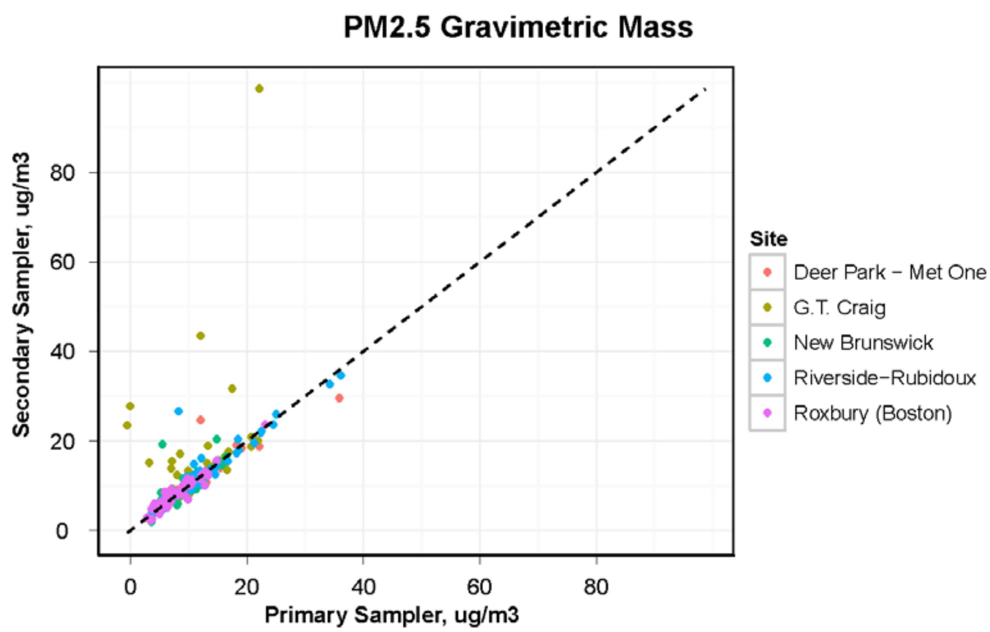
Location Name	State	AQS Code	Sampler Type
Bakersfield-California Ave*	California	060290014	MetOne SASS + URG 3000N
Deer Park	Texas	482011039	MetOne SASS + URG 3000N
G.T. Craig	Ohio	390350060	MetOne SASS + URG 3000N*
New Brunswick	New Jersey	340230006	MetOne SASS + URG 3000N
Riverside-Rubidoux	California	060658001	MetOne SASS + URG 3000N
Roxbury (Boston)	Massachusetts	250250042	MetOne SASS + URG 3000N

** The primary and the collocated samplers at the Bakersfield-California Ave site were out of service for all of 2014 and are therefore not included in Figure 5-2 statistics.*

total precision and compare the values with the uncertainty values that are currently being reported to AQS. Absolute accuracy cannot be assessed from this dataset because neither of the collocated samplers can be assumed to be more accurate than the other. Collocation data from the URG 3000N samplers may also be useful in evaluating the magnitude and uncertainty of the artifact in Organic Carbon measurement.

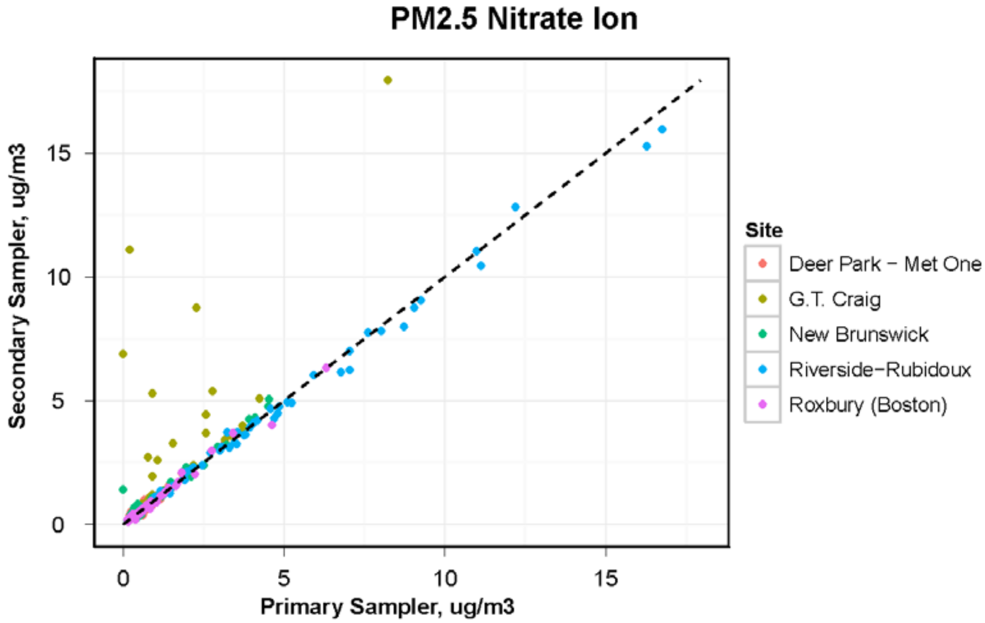
The figures that follow (**Figure 5-2**) show examples of the comparisons for $PM_{2.5}$ mass, nitrate, sulfate, sulfur and OC/EC (IMPROVE_A TOR and TOT methods). Also included in the figure are linear least-squares regression parameters (slope, intercept, R^2) by site for each of these species. These figures demonstrate good or excellent agreement for the major analytes; however, precision for the species sampled by the MetOne sampler at the G.T. Craig site are visibly poorer than those at the other four sites (i.e., excluding Bakersfield site) likely due to sampler issues. In addition, elemental carbon data at the G.T. Craig site showed larger variability than the other four sites.

Figure 5-2 Collocation Data for Selected Species During 2014.



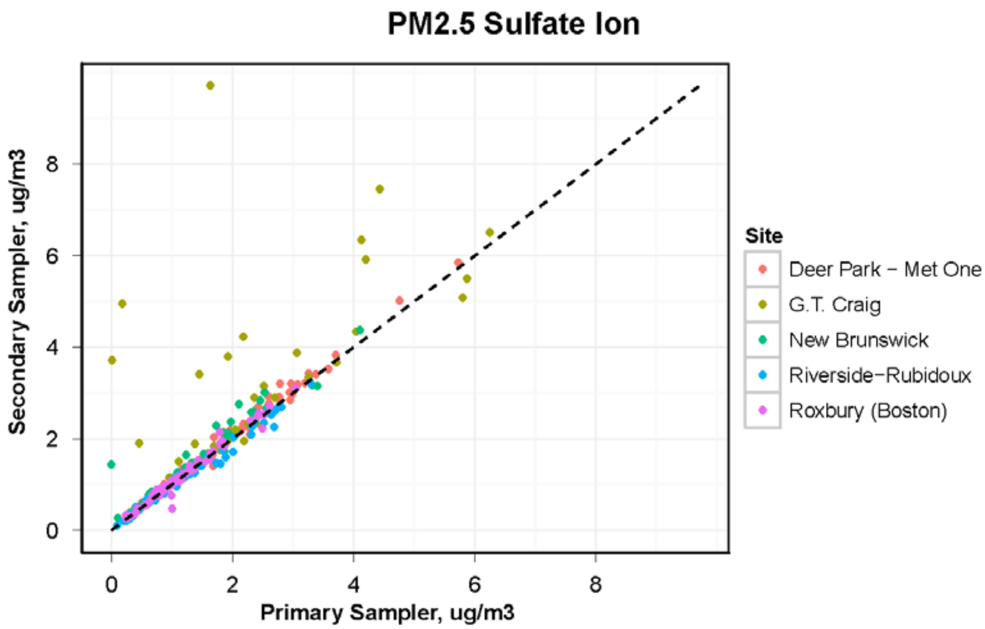
Site	Intercept	Slope	R2
Deer Park – Met One	1.50	0.84	0.82
G.T. Craig	4.40	1.10	0.15
New Brunswick	1.40	0.88	0.57
Riverside–Rubidoux	1.70	0.90	0.83
Roxbury (Boston)	0.29	0.96	0.91

Figure 5-2 (continued).



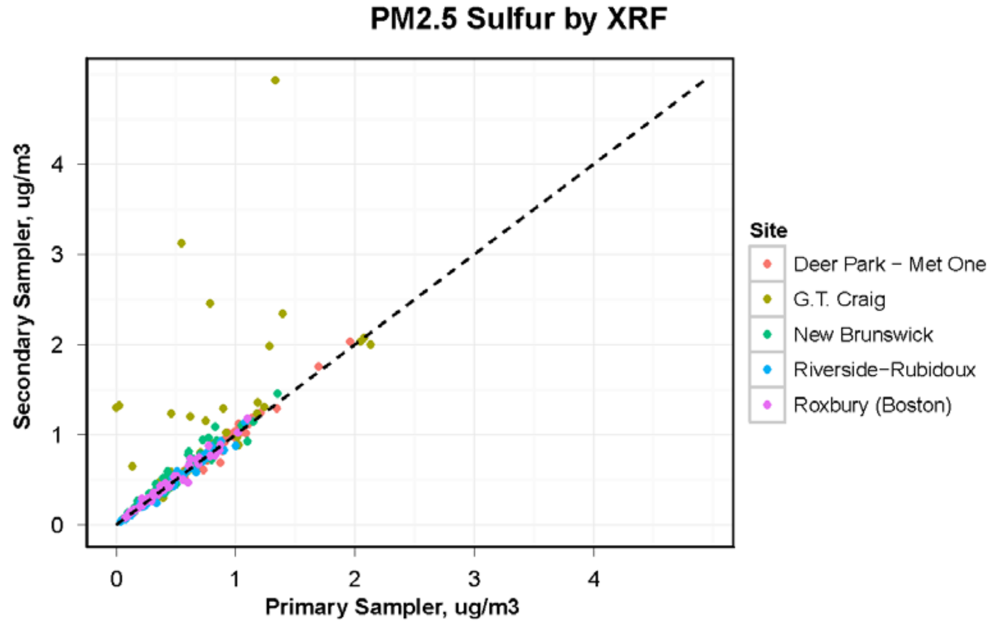
Site	Intercept	Slope	R2
Deer Park − Met One	0.0092	1.00	0.94
G.T. Craig	0.3400	1.60	0.49
New Brunswick	0.0520	1.00	0.97
Riverside−Rubidoux	0.0560	0.96	1.00
Roxbury (Boston)	−0.0066	0.98	0.99

Figure 5-2 (continued).



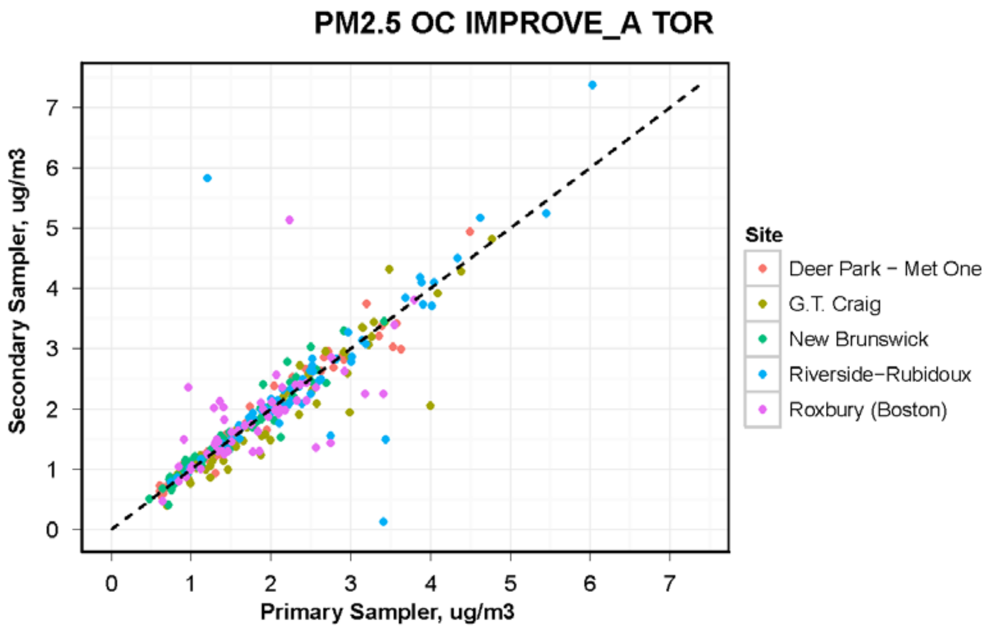
Site	Intercept	Slope	R2
Deer Park − Met One	0.0200	1.00	0.99
G.T. Craig	1.0000	0.85	0.39
New Brunswick	0.1300	0.99	0.92
Riverside−Rubidoux	0.0270	0.93	0.99
Roxbury (Boston)	−0.0055	1.00	0.97

Figure 5-2 (continued).



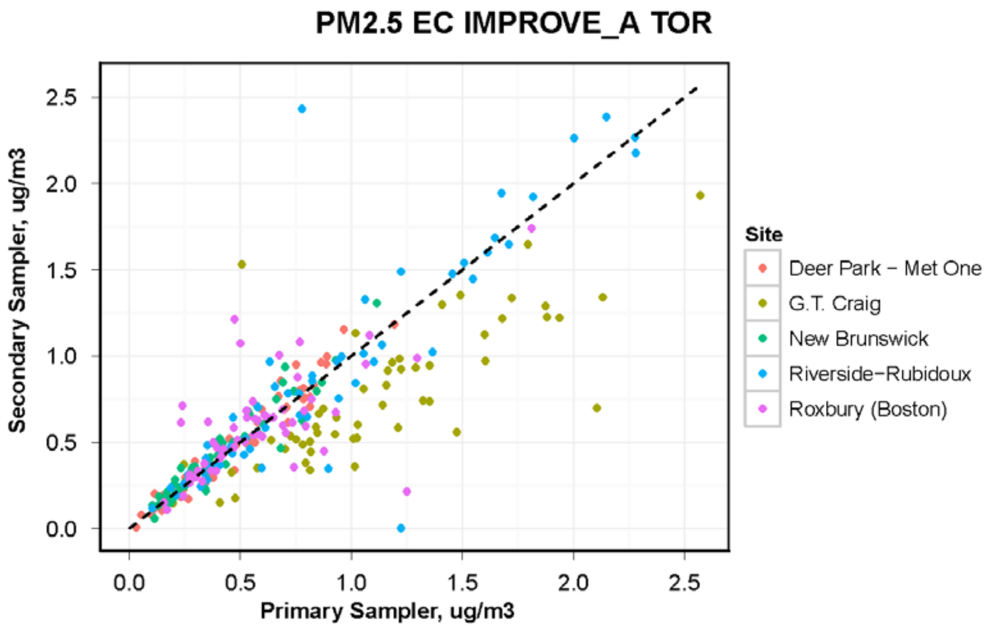
Site	Intercept	Slope	R2
Deer Park − Met One	−0.0120	1.00	0.98
G.T. Craig	0.3000	1.00	0.32
New Brunswick	0.0180	1.00	0.93
Riverside−Rubidoux	−0.0031	0.99	0.98
Roxbury (Boston)	0.0054	1.00	0.97

Figure 5-2 (continued).



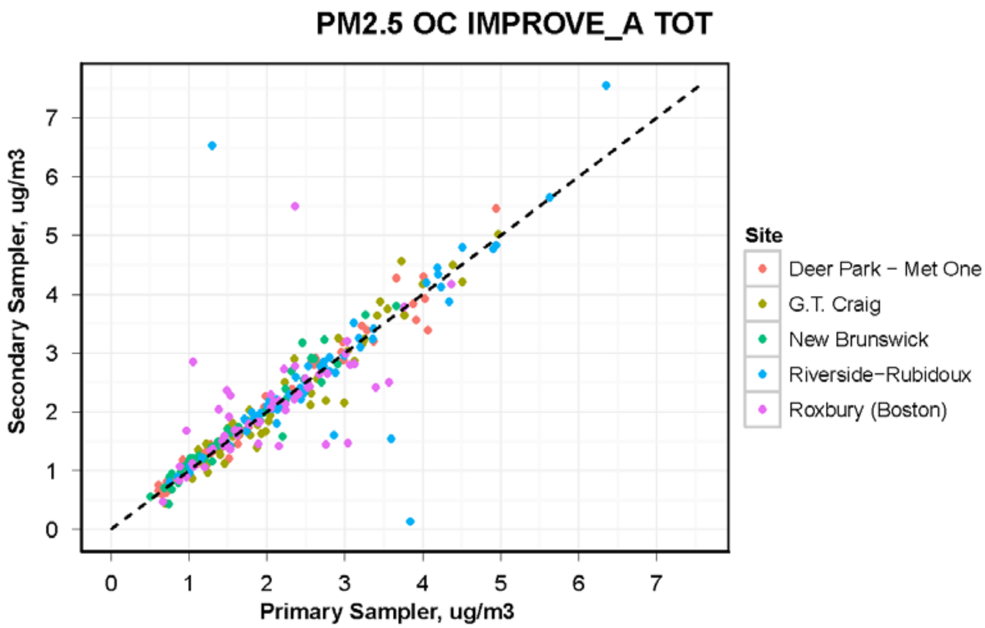
Site	Intercept	Slope	R2
Deer Park − Met One	0.0280	0.99	0.96
G.T. Craig	−0.0840	0.98	0.87
New Brunswick	0.0084	1.00	0.93
Riverside−Rubidoux	0.2200	0.91	0.59
Roxbury (Boston)	0.4900	0.74	0.49

Figure 5-2 (continued).



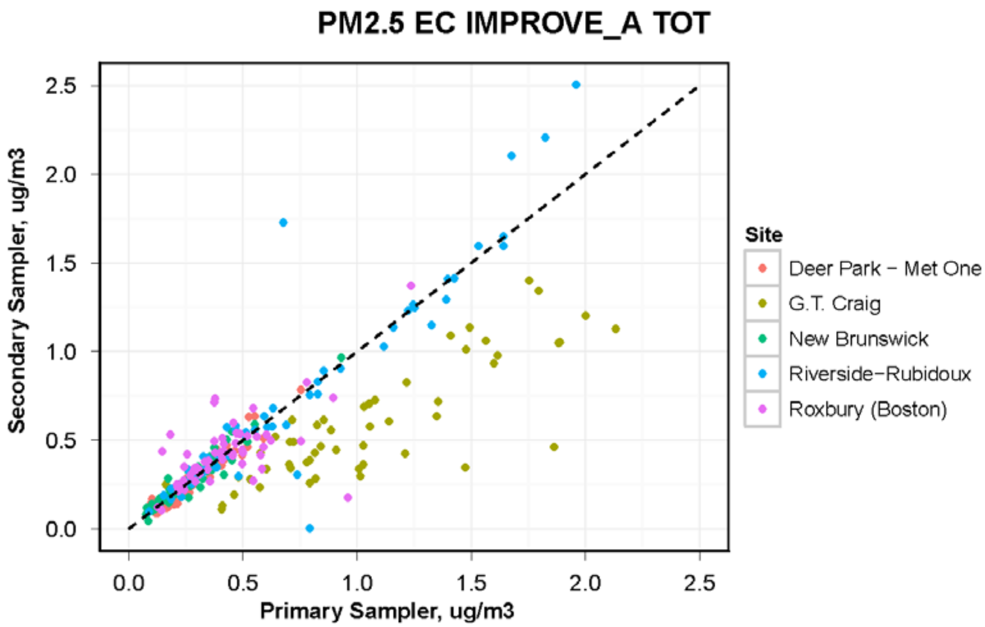
Site	Intercept	Slope	R2
Deer Park – Met One	−0.019	1.00	0.94
G.T. Craig	0.082	0.62	0.60
New Brunswick	0.004	1.10	0.90
Riverside–Rubidoux	0.016	0.99	0.77
Roxbury (Boston)	0.220	0.64	0.44

Figure 5-2 (continued).



Site	Intercept	Slope	R2
Deer Park − Met One	0.021	1.00	0.97
G.T. Craig	−0.100	1.00	0.94
New Brunswick	−0.027	1.10	0.94
Riverside−Rubidoux	0.330	0.88	0.56
Roxbury (Boston)	0.530	0.75	0.50

Figure 5-2 (continued).



Site	Intercept	Slope	R2
Deer Park − Met One	−0.0210	1.00	0.93
G.T. Craig	−0.0150	0.58	0.70
New Brunswick	0.0063	1.00	0.93
Riverside−Rubidoux	−0.0380	1.10	0.86
Roxbury (Boston)	0.1600	0.63	0.44

Table 5-5 provides an analysis of the collocated sampling data, and compares the precisions calculated from the collocation data vs. the uncertainties reported to AQS. Data from collocated samplers provide an estimate of the whole-system measurement precision. Comparison of the collocated precision to the reported uncertainties (also an estimate of the precision) is a way of reconciling these uncertainty/precision estimates. If both of the values compare reasonably, the uncertainty estimate is reflective of the whole-system measurement precision. If the differences are large, then it may indicate that either the uncertainties do not capture the real-world whole-system variability and/or issues with the collocated data set (or outliers). For the most part, reported uncertainties are in the same ballpark range as the collocated precision.

The first column indicates the name of the chemical analyte. Only species having 10 or more paired values meeting the selection criteria (see below) are included in the table. Note that the standard deviations under Sampler 1 and Sampler 2 are primarily determined by variability of the ambient concentrations, and that the relative contribution of experimental errors is small.

Table 5-5. Precision of Collocated Samplers, 2014

Analyte	Sampler 1		Sampler 2		Avg Rel Diff (ARD)(2)	Avg Rel AQS Unc (AvAQS)(3)	Ratio(4) AvAQS/ARD	Counts(5)
	Avg. Conc	St Dev(1)	Avg. Conc	St Dev(1)				
PARTICULATE MATTER (GRAVIMETRY)								
Particulate matter 2.5µm	10.44	5.38	11.29	8.35	10%	6%	61%	222
ANIONS AND CATIONS BY IC								
Ammonium	0.80	0.87	0.88	1.00	11%	8%	71%	272
Sodium	0.20	0.21	0.21	0.23	24%	13%	53%	222
Potassium	0.06	0.08	0.07	0.08	20%	16%	77%	231
Nitrate	1.68	2.38	1.83	2.60	11%	8%	69%	278
Sulfate	1.61	1.04	1.76	1.27	7%	7%	101%	279
TRACE ELEMENTS BY XRF								
Aluminum	0.144	0.298	0.139	0.285	26%	23%	87%	94
Barium	0.027	0.015	0.023	0.015	20%	60%	**303%**	15
Bromine	0.005	0.002	0.005	0.005	18%	28%	155%	170
Calcium	0.064	0.071	0.069	0.076	27%	12%	**45%**	221
Chromium	0.006	0.007	0.007	0.020	46%	28%	61%	31
Copper	0.011	0.011	0.012	0.013	25%	16%	64%	182
Chlorine	0.094	0.181	0.093	0.178	40%	17%	**43%**	173
Iron	0.130	0.167	0.139	0.213	20%	8%	**38%**	280
Lead	0.018	0.013	0.020	0.016	21%	25%	119%	11
Manganese	0.006	0.006	0.007	0.007	24%	22%	90%	104
Nickel	0.004	0.006	0.003	0.002	38%	25%	65%	55
Magnesium	0.041	0.032	0.048	0.035	32%	21%	66%	65
Selenium	0.004	0.001	0.005	0.002	27%	30%	113%	11
Titanium	0.016	0.026	0.016	0.024	23%	25%	110%	60
Vanadium	0.005	0.003	0.005	0.002	16%	32%	197%	11
Silicon	0.154	0.401	0.161	0.393	18%	15%	83%	255

Analyte	Sampler 1		Sampler 2		Avg Rel Diff (ARD)(2)	Avg Rel AQS Unc (AvAQS)(3)	Ratio(4) AvAQS/ARD	Counts(5)
	Avg. Conc	St Dev(1)	Avg. Conc	St Dev(1)				
Zinc	0.018	0.036	0.021	0.044	23%	18%	77%	221
Sulfur	0.557	0.353	0.613	0.497	7%	7%	98%	280
Potassium	0.068	0.084	0.074	0.094	12%	10%	80%	277
Sodium	0.196	0.193	0.209	0.206	20%	19%	96%	166
ORGANIC AND ELEMENTAL CARBON BY IMPROVE_A METHOD (Sampled by URG 3000N)								
OC IMPROVE TOR	1.99	0.96	1.98	1.03	8%	N/A	N/A	278
OC IMPROVE TOT	2.14	1.05	2.16	1.13	8%	N/A	N/A	278
EC IMPROVE TOR	0.70	0.48	0.64	0.44	16%	N/A	N/A	276
EC IMPROVE TOT	0.54	0.44	0.46	0.37	17%	N/A	N/A	277
O1 IMPROVE	0.22	0.16	0.24	0.17	24%	N/A	N/A	257
O2 IMPROVE	0.50	0.23	0.49	0.25	11%	N/A	N/A	278
O3 IMPROVE	0.67	0.37	0.63	0.37	13%	N/A	N/A	278
O4 IMPROVE	0.44	0.24	0.44	0.25	12%	N/A	N/A	277
OP IMPROVE TOR	0.22	0.12	0.24	0.15	24%	N/A	N/A	192
OP IMPROVE TOT	0.36	0.20	0.38	0.22	18%	N/A	N/A	247
E1 IMPROVE	0.78	0.44	0.79	0.46	11%	N/A	N/A	277
E2 IMPROVE	0.08	0.10	0.05	0.04	28%	N/A	N/A	273
TC IMPROVE	2.69	1.35	2.62	1.40	9%	N/A	N/A	278

1 The standard deviations are a function of the natural variability of the environmental levels and are not indicative of the analytical precision.
2 ARD: Calculated as the average of the absolute value of the relative difference between the two samplers' values, divided by the square root of 2. See text for description.
3 AvAQS: Average value of the relative uncertainties as reported to AQS. See text for description.
4 AvAQS/ARD is the ratio of reported uncertainties divided by the uncertainty determined by average relative difference of the collocated samples. Values greater than 200% or less than 50% are shown in bold.
5 Counts are the number of individual observations included in the statistics. Only observations where both concentration values were above twice the uncertainty are included in the statistics.

The precision values determined from the collocation data are shown in the column titled "Avg Rel. Diff" (ARD). This is simply the average of the unsigned differences between the two samplers, and is calculated using the following formula:

$$ARD = \frac{1}{n\sqrt{2}} \sum \frac{|C_1 - C_2|}{(C_1 + C_2)/2}$$

Where

- C_1 and C_2 are the concentrations from the primary and collocated samplers, respectively

- The factor of $1/\sqrt{2}$ is used to convert the difference to a single-sampler basis
- The summation is over all valid concentration values where the concentration (C_1 or C_2) is greater than twice the uncertainty reported to AQS.

The precision values estimated based on uncertainties reported to AQS during 2014 are summarized under the column titled "Avg Rel AQS Unc." (AvAQS). This is the average of all the relative uncertainties reported to AQS over the collocation data set, and is calculated as follows:

$$AvAQS = \frac{1}{n}\sum_{i}\sum_{j}\frac{U_{ij}}{C_{ij}}$$

Where

- U_{ij} and C_{ij} refer to the uncertainty and concentration for the i^{th} exposure with the j^{th} sampler (j=1 or 2).
- n refers to the total number of measurements (i.e., 2 * i)
- The criteria for inclusion in the average (index i) is the same as in the previous equation.

The next column provides the ratio of AvAQS to ARD defined above. This is essentially the average under- or over-estimate of the uncertainty for each chemical species reported during 2014. The final column shows the number of sampling events included in the averages subject to the criteria defined above. Ratios greater than 200% or less than 50% indicate situations in which the uncertainties reported to AQS were different from the uncertainty estimated from collocation data by a factor of 2 or more. Barium (303%), Calcium (45%), Chlorine (43%) and Iron (38%) disagreed by more than a factor of 2. Compared to 2013, Calcium and Iron showed larger variability between the collocated samplers.

5.4 Analysis of Trip and Field Blanks

CSN Field Blanks for the MET ONE SASS samplers were collected at a frequency of 3% during 2014. No Trip Blank samples are currently being collected for the MET ONE SASS samplers. Quartz backup filter collection was at 5%, while the quartz 24 hour blank samples were collected at a 10% frequency. Data from these blanks allow evaluation of contamination, which may come from a number of different sources. In addition, the Field Blank data can sometimes signal problems in the analytical laboratories or with filters received from the manufacturers, as was the case during 2013 when chromium contamination was discovered (as described in Section 2). **Table 5-6** shows the distributions (percentiles) for field blanks and 24-hour blanks during 2014.

For XRF analysis, the average and median Field Blanks were well below the average MDLs for all elements. The manufacturer-originated chromium background contamination issue in Teflon Filters that was described previously did not appear to affect the mean field blank chromium loading in 2014.

5.5 Analysis of Backup Filters for the URG 3000N

URG 3000N samplers used for sampling for carbon on quartz filters were installed 2007 through 2009, replacing sampling by the MetOne. Two new types of blank filters are defined for use with the URG 3000N: “backup filters,” and “24-hour blanks.”

The results for the 24-hour blanks, which are only run for quartz filters with the URG 3000N sampler, are included in **Table 5-6**. These blanks are somewhat analogous to Field Blanks because they are exposed in the field without airflow. However, 24-hour blanks are exposed for a much longer period of time than are the Field Blanks used for nylon and Teflon filters. See the CSN Field QAPP and the relevant SOPs for more information about how each type of blank is handled. The 24-hour blank results most likely include some portion of the well-known adsorption artifact, plus contamination picked up during shipping, handling, and analysis.

Table 5-6. Concentration Percentiles for Field and 24-hour Blanks (Reporting Batches 169 through 180).

Analyte	Mean ($\mu g/m^3$)	Percentiles of Concentration ($\mu g/m^3$)						
		5	10	25	Median	75	90	95
Cations and anions by ion chromatography (Field Blanks)								
Ammonium	0.00065	0	0	0	0	0	0	0.0023
Potassium	0.0054	0	0	0	0	0	0.0036	0.022
Sodium	0.022	0	0	0	0	0.019	0.031	0.044
Nitrate	0.012	0	0	0	0	0.022	0.04	0.052
Sulfate	0.021	0	0	0	0	0.021	0.037	0.05
Mass by gravimetry								
Particulate matter 2.5µm	1.02	0.00	0.21	0.42	0.73	1.33	2.29	2.64
Organic and elemental carbon by IMPROVE A Method (24-hour Blanks)								
OC IMPROVE TOR	0.12	0.051	0.06	0.077	0.1	0.13	0.19	0.24
OC IMPROVE TOT	0.12	0.051	0.06	0.077	0.1	0.13	0.19	0.25
EC IMPROVE TOR	0.0021	0	0	0	0	0	0.0046	0.013
EC IMPROVE TOT	0.0008	0	0	0	0	0	0.0005	0.0025
O1 IMPROVE	0.019	0	0.0015	0.01	0.017	0.025	0.033	0.04
O2 IMPROVE	0.031	0.012	0.015	0.02	0.027	0.036	0.048	0.06
O3 IMPROVE	0.064	0.028	0.032	0.04	0.051	0.072	0.1	0.13
O4 IMPROVE	0.0051	0	0	0	0	0.0056	0.013	0.021
OP IMPROVE TOR	0.0007	0	0	0	0	0	0	0.0002
OP IMPROVE TOT	0.0019	0	0	0	0	0	0.0035	0.01
E1 IMPROVE	0.002	0	0	0	0	0	0.0035	0.011
E2 IMPROVE	0.0006	0	0	0	0	0	0.0009	0.0033
E3 IMPROVE	0.00011	0	0	0	0	0	0	0
TC IMPROVE	0.12	0.051	0.06	0.077	0.1	0.14	0.19	0.25
Trace elements by XRF (Field Blanks)								
Aluminum	0.0024	0	0	0	0	0	0.0021	0.0047
Antimony	0.0016	0	0	0	0	0	0.0044	0.0082
Arsenic	0.00015	0	0	0	0	0.00012	0.00061	0.00084

Analyte	Mean (µg/m³)	Percentiles of Concentration (µg/m³)						
		5	10	25	Median	75	90	95
Barium	0.00016	0	0	0	0	0	0	0
Bromine	0.0004	0	0	0	0	0.00064	0.0012	0.0015
Cadmium	0.0015	0	0	0	0	0.0012	0.0059	0.0083
Calcium	0.005	0	0	0	0	0	0.0016	0.0024
Cerium	0.00008	0	0	0	0	0	0	0
Cesium	0.00029	0	0	0	0	0	0.00082	0.0018
Chlorine	0.0013	0	0	0	0	0	0.00048	0.0018
Chromium	0.00083	0	0	0	0	0.00038	0.0017	0.0031
Cobalt	0.00016	0	0	0	0	0.00024	0.00057	0.00073
Copper	0.00033	0	0	0	0	0	0.00044	0.00097
Indium	0.0015	0	0	0	0	0	0.0059	0.0094
Iron	0.0056	0	0	0	0.00031	0.0023	0.0077	0.019
Lead	0.00016	0	0	0	0	0	0.00059	0.00094
Magnesium	0.0013	0	0	0	0	0	0.0022	0.0033
Manganese	0.00011	0	0	0	0	0	0.00019	0.00058
Nickel	0.00023	0	0	0	0	0.000094	0.00049	0.001
Phosphorus	0.00014	0	0	0	0	0	0	0
Potassium	0.0014	0	0	0	0	0	0.0015	0.0019
Rubidium	0.0002	0	0	0	0	0.00025	0.00079	0.001
Selenium	0.00011	0	0	0	0	0	0.00042	0.00079
Silicon	0.005	0	0	0	0	0.002	0.0044	0.009
Silver	0.00092	0	0	0	0	0	0.0035	0.0071
Sodium	0.00091	0	0	0	0	0	0	0.0021
Strontium	0.0002	0	0	0	0	0	0.00059	0.0011
Sulfur	0.0077	0	0	0	0	0.00047	0.0017	0.0033
Tin	0.001	0	0	0	0	0	0.0033	0.0059
Titanium	0.00024	0	0	0	0	0	0.00059	0.0015
Vanadium	0.00026	0	0	0	0	0.00026	0.001	0.0014
Zinc	0.00032	0	0	0	0	0	0	0.00036
Zirconium	0.00033	0	0	0	0	0	0	0.0022

"Backup Filters" are quartz filters placed immediately after the routine (front) filter. **Table 5-7** shows the percentile points of the backup filters acquired during 2014. Results from the backup filters might be one approach to assess the organic carbon artifact. However, a draft recommendation made by the EPA and the IMPROVE Steering Committee is to use monthly median 24-hr blanks[10], although it is yet to be finalized.

[10] "Recommendations to Users of CSN and IMPROVE Speciation Data Regarding Sampling Artifact Correction for $PM_{2.5}$ Organic Carbon", Memorandum from Neil Frank, US EPA, to PM NAAQS Review Docket EPA-HQ-OAR-2007-0492, June 14, 2012.

Table 5-7. Concentration Percentiles for URG 3000N Backup Filters

Analyte	Mean	Percentiles of Concentration (as ug/m^3)						
		5	10	20	50 (median)	70	90	95
OC IMPROVE TOR	0.2782	0.0814	0.1155	0.1792	0.2571	0.3488	0.4530	0.5308
OC IMPROVE TOT	0.2831	0.0814	0.1155	0.1804	0.2591	0.3543	0.4676	0.5522
EC IMPROVE TOR	0.0060	0.0000	0.0000	0.0000	0.0003	0.0073	0.0190	0.0265
EC IMPROVE TOT	0.0011	0.0000	0.0000	0.0000	0.0000	0.0000	0.0024	0.0057
O1 IMPROVE	0.0573	0.0000	0.0071	0.0236	0.0468	0.0769	0.1166	0.1425
O2 IMPROVE	0.0816	0.0265	0.0354	0.0521	0.0743	0.1039	0.1344	0.1595
O3 IMPROVE	0.1126	0.0377	0.0502	0.0703	0.1003	0.1371	0.1884	0.2223
O4 IMPROVE	0.0250	0.0000	0.0024	0.0094	0.0190	0.0334	0.0534	0.0681
OP IMPROVE TOR	0.0018	0.0000	0.0000	0.0000	0.0000	0.0000	0.0019	0.0101
OP IMPROVE TOT	0.0067	0.0000	0.0000	0.0000	0.0000	0.0073	0.0214	0.0314
E1 IMPROVE	0.0056	0.0000	0.0000	0.0000	0.0000	0.0061	0.0175	0.0241
E2 IMPROVE	0.0022	0.0000	0.0000	0.0000	0.0000	0.0022	0.0073	0.0111
E3 IMPROVE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
TC IMPROVE	0.2842	0.0814	0.1156	0.1813	0.2595	0.3548	0.4687	0.5522

6.0 External Audits

6.1 Performance Evaluation (PE) Audit Results

Annual interlaboratory intercomparison studies have been conducted since 2007 as part of EPA's QA oversight for the CSN and the Interagency Monitoring of Protected Visual Environments (IMPROVE) Program. The PE samples for these annual studies are prepared at the National Air and Radiation Environmental Laboratory (NAREL) located in Montgomery, AL. The filters used as PE samples are prepared by multiple collocation of samplers at the NAREL facility. Since the samples (except for metallic weights included in the gravimetry evaluation) are of unknown mass or concentration, agreement among the participating laboratories is the primary metric of performance.

The multi-lab PE study requires each participating laboratory to analyze a set of blind PE samples. Each lab received detailed instructions for analyzing the samples and reporting the results to NAREL. PE samples are provided for the following $PM_{2.5}$ speciation analyses:

- Gravimetric Mass Analysis
  - Teflon® filters
  - Metallic transfer weights
- Ion Chromatography (IC) Analysis – Nylon filters
- Carbon by Thermal Optical Analysis (TOA) – quartz filters
  - IMPROVE_A Method (by TOR/TOT)
  - CSN Method (by TOT) (previously referred to as the STN method)
- Elemental analysis by X-Ray Fluorescence (XRF) – Teflon® filters
  - 25 mm filters
  - 47 mm filters

6.1.1 Interlaboratory Performance Evaluation Study, 2014

Participants in the 2014 interlaboratory study, in addition to RTI, included:

- California Air Resources Board (CARB)
- Desert Research Institute (DRI)
- Oregon Division of Environmental Quality (ODEQ)
- South Coast Air Quality Management District (AQMD)
- University of California, Davis (UCD)
- EPA NAREL

Unknowns were distributed to RTI and the other labs in February 2014 for gravimetry, XRF, ion chromatography, and OC/EC. RTI submitted its results to NAREL on March 14, 2014.

6.1.2 Interlaboratory Performance Results

A final report summarizing the findings from the interlaboratory performance evaluation is available online at:

http://www.epa.gov/ttnamti1/files/ambient/pm25/qa/multilabspeciationpt92013.pdf

RTI's performance on gravimetric mass, IC, OC/EC and XRF has been uniformly within the range of the other laboratories and in good agreement with the designated reference labs.

6.2 Technical Systems Audit (TSA)

EPA did not perform a TSA during 2014. The last TSA was performed in 2012 by EPA NAREL. The findings from that audit were summarized in a Technical Memorandum dated November 14, 2012, which is available online at

http://www.epa.gov/ttnamti1/files/ambient/pm25/spec/tsa2012final.pdf

The report included evaluation of RTI's analytical results for the unknown samples that had been provided by the auditors. No deficiencies were noted.

7.0 List of References

7.1 List of CSN Documents

Type	Title	Date Revised	Author	Document No.
SOP	Standard Operating Procedure for Sample Handling and Archiving Laboratory (SHAL)	2/18/2009	O'Rourke	
SOP	Standard Operating Procedure for Shipping Filters to and from an Off-Site Laboratory	2/18/2009	O'Rourke	
SOP	Standard Operating Procedure for Long-Term Archiving of PM Filters and Extracts	8/24/2009	C. Haas	
SOP	Standard Operating Procedure for Procurement and Acceptance Testing of Teflon, Nylon, and Quartz Filters	9/19/2011	E. Hardison	
SOP	Standard Operating Procedure for Cleaning Nylon Filters Used for the Collection of $PM_{2.5}$ Material	8/25/2009	E. Hardison	
SOP	Standard Operating Procedure for Particulate Matter (PM) Gravimetric Analysis	7/8/2008	Greene	
SOP	Analysis of Elements in Air Particulates by X-Ray Fluorescence (Kevex 770 & 772)	2/3/2009	Chester	
SOP	Kevex XRF Spectrometer Calibration (CHESTER LabNet Proprietary Method)	1/8/2008	Chester	
SOP	Kevex Spectrometer Data Generation, Interpretation and Reporting (CHESTER LabNet Proprietary Method)	1/30/2009	Chester	
SOP	Sample Receipt and Log In Chester LabNet Proprietary Method	6/20/2008	Chester	
SOP	Standard Operating Procedure for the X-Ray Fluorescence Analysis of Particulate Matter Deposits on Teflon Filters	8/19/2009	McWilliams	
SOP	Standard Operating Procedure for $PM_{2.5}$ Anion Analysis	8/26/2009	E. Hardison	
SOP	Standard Operating Procedure for $PM_{2.5}$ Cation Analysis	8/26/2009	E. Hardison	
SOP	DRI Model 2001 Thermal/Optical Carbon Analysis (TOR/TOT) of Aerosol Filter Samples – Method IMPROVE_A	10/22/2012	DRI	

Type	Title	Date Revised	Author	Document No.
SOP	Standard Operating Procedure for the Determination of Carbon Fractions in Particulate Matter Using the IMPROVE_A Heating Protocol on a DRI Model 2001 Analyzer	2/13/2009	Peterson	
SOP	Standard Operating Procedures for Temperature Calibration of the Sample Thermocouple in a Sunset Laboratory or a DRI Model 2001 Carbon Aerosol Analyzer	2/16/2009	Peterson	
SOP	Standard Operating Procedure for the Determination of Organic, Elemental, and Total Carbon in Particulate Matter Using a Thermal/Optical-Transmittance Carbon Analyzer	2/13/2009	Peterson	
SOP	Standard Operating Procedure for the Determination of Carbon Fractions in Particulate Matter Using the IMPROVE_A Heating Protocol on a Sunset Laboratory Dual-Mode Analyzer	2/17/2009	Peterson	
SOP	DRI Standard Operating Procedure: Analysis of Semi-Volatile Organic Compound by GC/MS	9/24/2008	DRI	
SOP	Standard Operating Procedure for Sample Preparation and Analysis of PM_{10} and $PM_{2.5}$ Samples by Scanning Electron Microscopy	7/8/2009	Crankshaw	
SOP	Standard Operating Procedure for Coating and Extracting Annular Denuders with Sodium Carbonate	2/17/2009	Eaton	
SOP	Standard Operating Procedures for Coating Aluminum Honeycomb Denuders With Magnesium Oxide	2/17/2009	Eaton	
SOP	Standard Operating Procedure for Coating Annular Denuders with XAD-4 Resin	5/9/2008	Eaton	
SOP	Procedures for Coating R&P Speciation Sampler Chemcomb™ Denuders with Sodium Carbonate	5/21/2008	Eaton	
SOP	Standard Operating Procedure for Coating and Extracting Denuders for Capture of Ammonia and Its Measurement	2/17/2009	Eaton	
SOP	Standard Operating Procedure for Coating and Extracting Compact Parallel-Plate Denuders for Determining Ammonia Determination	3/12/2010	Eaton	
SOP	Standard Operating Procedure for Database Operations	5/8/2008	Rickman	
SOP	Standard Operating Procedure for Assigning Data Validation Flags for the Chemical Speciation Network	5/15/2008	Wall	
SOP	Standard Operating Procedure—Speciation Data Processing Disaster Recovery Plan	5/21/2008	Rickman	

Type	Title	Date Revised	Author	Document No.
SOP	Standard Operating Procedure for the X-Series ICP-MS for the Analysis of Particulate Deposits on Teflon Filters	1/23/2012	Weber	
SOP	DRI Standard Operating Procedure: Procedure for Light Transmission Analysis	7/14/2008	DRI	
SOP	Standard Operating Procedure for Document Control and Storage for the $PM_{2.5}$ Chemical Speciation Program	2/18/2009	D. Haas	
SOP	Standard Operating Procedure for Corrective Action for the $PM_{2.5}$ Chemical Speciation Program	5/21/2008	Flanagan/Haas	
SOP	Standard Operating Procedure for Training for Staff Working on the $PM_{2.5}$ Chemical Speciation Program	5/8/2008	Haas	
QAPP	QAPP for PM2.5 of Chemical Speciation Samples	1/27/2014	RTI	RTI/0212053/01QA
Report	Tests of Acceptance of X-Ray Fluorescence Instrument #4 Operated by RTI International	11/4/2009	McWilliams/Flanagan	0212053.001.T06/01D
Report	2009 Annual Data Summary Report	3/1/2010	RTI and Subs	RTI/0212053/01ADS
Report	2010 Annual Data Summary Report	2/28/2011	RTI and Subs	RTI/0212053/02ADS
Report	2011 Annual Data Summary Report	2/28/2012	RTI and Subs	RTI/0212053/03ADS
Report	2012 Annual Data Summary Report	7/1/2013	RTI and Subs	RTI/0212053/04ADS
Report	2013 Annual Data Summary Report	12/9/2014	RTI and Subs	RTI/0212053/05ADS
Report	2014 Annual Data Summary Report	8/25/2015	RTI and Subs	RTI/0212053/06ADS

Appendix A

Method Detection Limits

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Appendix A
Method Detection Limits (Network-wide Maximum)

Analysis	Analyte	Mass (µg)	Concentration (µg/m^3) by sampler type	
			SASS	URG 3000N
Gravimetry	Particulate matter 2.5µm	11	1.3	
Anions and Cations	Ammonium	0.24	0.028	
	Potassium	0.23	0.026	
	Sodium	0.29	0.033	
	Nitrate	0.21	0.024	
	Sulfate	0.16	0.018	
Organic and elemental carbon*	E1 IMPROVE	0.12		0.0038
	E2 IMPROVE	0.13		0.0039
	E3 IMPROVE	0.34		0.011
	EC IMPROVE TOR	0.42		0.013
	EC IMPROVE TOT	0.35		0.011
	O1 IMPROVE	0.20		0.0062
	O2 IMPROVE	0.46		0.015
	O3 IMPROVE	1.01		0.033
	O4 IMPROVE	0.25		0.0078
	OC IMPROVE TOR	1.5		0.046
	OC IMPROVE TOT	1.5		0.048
	OP IMPROVE TOR	0.14		0.0045
	OP IMPROVE TOT	0.27		0.0086
	TC IMPROVE	1.6		0.052
Trace Elements	Aluminum	0.24	0.028	
	Antimony	0.50	0.057	
	Arsenic	0.026	0.0028	
	Barium	0.57	0.062	
	Bromine	0.022	0.0025	
	Cadmium	0.22	0.024	
	Calcium	0.073	0.0084	
	Cerium	0.84	0.090	
	Cesium	0.44	0.048	
	Chlorine	0.11	0.012	
	Chromium	0.025	0.0029	
	Cobalt	0.019	0.0020	
	Copper	0.024	0.0028	
	Indium	0.32	0.036	
	Iron	0.032	0.0034	
	Lead	0.061	0.0066	
	Magnesium	0.18	0.020	
	Manganese	0.028	0.0030	
	Nickel	0.018	0.0019	
	Phosphorus	0.15	0.018	

Analysis	Analyte	Mass (µg)	Concentration (µg/m^3) by sampler type	
			SASS	URG 3000N
	Potassium	0.11	0.012	
	Rubidium	0.025	0.0028	
	Selenium	0.025	0.0029	
	Silicon	0.18	0.020	
	Silver	0.36	0.041	
	Sodium	0.53	0.060	
	Strontium	0.034	0.0039	
	Sulfur	0.095	0.011	
	Tin	0.35	0.040	
	Titanium	0.051	0.0059	
	Vanadium	0.037	0.0043	
	Zinc	0.034	0.0039	
	Zirconium	0.22	0.0250	

* MDLs and uncertainties for OC/EC are currently not reported to AQS pending EPA direction on uncertainty calculations. Values shown in this table are MDLs reported by DRI for the samples analyzed during 2014.

Appendix B
Data Completeness Summary

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Table B-1. Percentage of Routine Exposure Records – STN Sites
Monthly Percent Data Completeness by Site

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					167	**168**	**169**	**170**	**171**	**172**	**173**	**174**	**175**	**176**	**177**	**178**
Allen Park	MI	261630001	5	SASS with URG 3000N	100	100	90	100	100	100	100	100	100	77	100	100
Allen Park	MI	261630001	5	URG 3000N	100	100	28	100	100	100	100	100	100	91	100	100
Beacon Hill - Met One	WA	530330080	6	SASS with URG 3000N	100	86	89	100	100	100						
Beacon Hill - Met One	WA	530330080	6	URG 3000N	100	86	94	100	100	86						
Beacon Hill - Seq	WA	530330080	6	SASS with URG 3000N						100	100	100	74	100	100	100
Beacon Hill - Seq	WA	530330080	6	URG 3000N						100	100	100	90	100	100	100
Blair Street	MO	295100085	6	SASS with URG 3000N	100	100	90	100	100	91	80	100	100	100	100	90
Blair Street	MO	295100085	6	URG 3000N	100	89	94	95	100	100	100	90	100	67	100	100
Burlington	VT	500070012	5	SASS with URG 3000N	70	100	100	4	100	100	75	86	88	100	86	100
Burlington	VT	500070012	5	URG 3000N	83	100	100	33	100	100	75	71	43	90	33	100
Capitol - Met One	LA	220330009	5	SASS with URG 3000N	100	88	80	82	100	100	90	80	100	100		
Capitol - Met One	LA	220330009	5	URG 3000N	100	89	89	40	100	100	70	90	100	100		
Capitol - Seq	LA	220330009	5	SASS with URG 3000N										71	100	100
Capitol - Seq	LA	220330009	5	URG 3000N										100	100	100
Chamizal - Met One	TX	481410044	5	SASS with URG 3000N	100	100	62	91	100	100	100	88				
Chamizal - Met One	TX	481410044	5	URG 3000N	95	100	94	100	100	100	100	88				
Chamizal - Seq	TX	481410044	5	SASS with URG 3000N								57	62	93	98	100
Chamizal - Seq	TX	481410044	5	URG 3000N								100	88	100	100	100
Chicopee	MA	250130008	5	SASS with URG 3000N	100											
Chicopee	MA	250130008	5	URG 3000N	83											
Chicopee - Seq	MA	250130008	5	SASS with URG 3000N	89	100	72	100	86	100	100	100	100	100	100	100
Chicopee - Seq	MA	250130008	5	URG 3000N	100	100	90	100	100	100	100	100	100	100	100	83
Com Ed - Met One	IL	170310076	5	SASS with URG 3000N	100											
Com Ed - Met One	IL	170310076	5	URG 3000N	100											

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					167	168	169	170	171	172	173	174	175	176	177	178
Com Ed - Seq	IL	170310076	5	SASS with URG 3000N	100	89	40	91	89	93	100	92	100	75	100	100
Com Ed - Seq	IL	170310076	5	URG 3000N	100	80	90	100	100	86	100	57	100	86	100	100
Criscuolo Park	CT	090090027	5	SASS with URG 3000N	100	86	89	88	100	100	100	89	100	100	86	88
Criscuolo Park	CT	090090027	5	URG 3000N	83	71	94	100	100	100	100	89	100	100	92	100
Deer Park - Met One	TX	482011039	6	SASS with URG 3000N	100	100	100	100	100	100	100	100	90	99	100	100
Deer Park - Met One	TX	482011039	6	URG 3000N	100	100	100	95	100	100	100	100	100	100	100	100
Deer Park Collocated - Met One	TX	482011039	7	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Deer Park Collocated - Met One	TX	482011039	7	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
El Cajon	CA	060730003	5	SASS with URG 3000N	100	86	100	100	83							
El Cajon	CA	060730003	5	URG 3000N	100	86	100	100	83							
Elizabeth Lab	NJ	340390004	5	SASS with URG 3000N	100	86	89	100	99	100	88	100	100	100	86	100
Elizabeth Lab	NJ	340390004	5	URG 3000N	100	86	94	100	100	100	88	100	100	100	92	100
Essex - Met One	MD	240053001	5	SASS with URG 3000N	82	86	89	89	100	100	100	100				
Essex - Met One	MD	240053001	5	URG 3000N	95	86	88	100	88	100	100	100				
Essex - Seq	MD	240053001	5	SASS with URG 3000N									100	100	100	100
Essex - Seq	MD	240053001	5	URG 3000N									100	100	100	100
Fargo NW	ND	380171004	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Fargo NW	ND	380171004	5	URG 3000N	100	100	100	100	100	35	80	100	100	100	100	100
G.T. Craig	OH	390350060	5	SASS with URG 3000N	100	88	88	80	99	91	88	100	88	100	100	100
G.T. Craig	OH	390350060	5	URG 3000N	100	100	50	100	100	100	88	100	93	100	100	100
G.T. Craig - Collocated	OH	390350060	6	SASS with URG 3000N	100	65	79	39	57	100	100	100	100	100	100	100
G.T. Craig - Collocated	OH	390350060	6	URG 3000N	100	100	88	100	100	100	100	100	100	83	100	75
Garinger High School	NC	371190041	5	SASS with URG 3000N	100	89	100	100	100	100						
Garinger High School	NC	371190041	5	URG 3000N	91	56	94	90	89	75						
Garinger High School - Seq	NC	371190041	5	SASS with URG 3000N						100	100	100	100	100	100	100
Garinger High School - Seq	NC	371190041	5	URG 3000N						100	100	100	100	100	100	100

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					167	**168**	**169**	**170**	**171**	**172**	**173**	**174**	**175**	**176**	**177**	**178**
Hawthorne	UT	490353006	5	SASS with URG 3000N	92	89	80	74	69	100	100	90	90	100	90	100
Hawthorne	UT	490353006	5	URG 3000N	18	89	94	100	78	100	100	80	94	100	94	90
Henrico Co.	VA	510870014	5	SASS with URG 3000N	100	86	89	100	100	100	100	79	35	92	86	100
Henrico Co.	VA	510870014	5	URG 3000N	94	86	88	100	100	100	100	100	100	100	92	89
Hinton - Met One	TX	481130069	5	SASS with URG 3000N	100	83										
Hinton - Met One	TX	481130069	5	URG 3000N	100	83										
Hinton - Seq	TX	481130069	5	SASS with URG 3000N		100	59	100	100	100	92	100	100	100	100	100
Hinton - Seq	TX	481130069	5	URG 3000N		0	75	100	100	100	100	100	100	86	100	67
Indpls. Washington Park	IN	180970078	5	SASS with URG 3000N	100	100	100	100	100	100	100	0	88	92	86	100
Indpls. Washington Park	IN	180970078	5	URG 3000N	100	100	94	100	100	100	100	0	36	90	100	100
Jackson NCORE	MS	280490020	5	SASS with URG 3000N	100	71	100	100	88	91	88	99	100	80	86	100
Jackson NCORE	MS	280490020	5	URG 3000N	94	71	94	100	100	100	88	88	100	100	92	100
JFK Center	KS	202090021	5	SASS with URG 3000N	100	86	100	100	100	90	88	100	87	100	100	91
JFK Center	KS	202090021	5	URG 3000N	100	86	100	100	100	94	88	100	100	100	100	100
La Casa	CO	080310026	5	SASS with URG 3000N	100	88	100	78	100	100	100	100	100	100	86	100
La Casa	CO	080310026	5	URG 3000N	100	100	100	100	100	100	100	100	86	90	92	100
Lawrenceville	PA	420030008	6	SASS with URG 3000N	100	89	100	100	100	100	91	100	100	100	86	100
Lawrenceville	PA	420030008	6	URG 3000N	100	86	100	100	100	100	100	100	100	100	92	100
McMillan Reservoir - Met One	DC	110010043	5	SASS with URG 3000N	100	100	90	100	90	82	90	90	100	91	100	99
McMillan Reservoir - Met One	DC	110010043	5	URG 3000N	100	89	94	95	100	95	100	90	100	91	100	100
MLK	DE	100032004	5	SASS with URG 3000N	80	48		31	90	55	80	100	100	82	89	100
MLK	DE	100032004	5	URG 3000N	91	0		70	80	75	70	100	100	82	94	100
New Brunswick	NJ	340230006	5	SASS with URG 3000N	100	86	89	89	100	79	83	97	99	100	86	100
New Brunswick	NJ	340230006	5	URG 3000N	100	86	94	94	100	94	88	89	100	100	92	100
New Brunswick (Collocated)	NJ	340230006	6	SASS with URG 3000N	93	74	75	77	73	96	75	96	100	100	100	100
New Brunswick	NJ	340230006	6	URG 3000N	100	80	88	83	75	80	88	100	80	83	100	100

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					167	168	169	170	171	172	173	174	175	176	177	178
(Collocated)																
North Birmingham	AL	010730023	5	SASS with URG 3000N	86	62										
North Birmingham	AL	010730023	5	URG 3000N	100	83										
North Birmingham - Seq	AL	010730023	5	SASS with URG 3000N		93	84	85	93	94	100	83	99	92	100	90
North Birmingham - Seq	AL	010730023	5	URG 3000N		100	100	83	100	100	100	86	100	100	38	100
Northeast Wastewater Treatment Plant	PA	421010048	5	SASS with URG 3000N	100	75	91	91	88	91	100	100	90	91	100	100
Northeast Wastewater Treatment Plant	PA	421010048	5	URG 3000N	100	75	95	95	89	95	100	100	89	91	100	100
Peoria Site 1127	OK	401431127	5	SASS with URG 3000N	90	83										
Peoria Site 1127	OK	401431127	5	URG 3000N	94	83										
Peoria Site 1127 - Seq	OK	401431127	5	SASS with URG 3000N		100	80	100	100	100	100	100	100	83	100	100
Peoria Site 1127 - Seq	OK	401431127	5	URG 3000N		100	90	100	100	100	100	100	100	86	100	100
Philips	MN	270530963	5	SASS with URG 3000N	99	100	100	100	100	100	100	100	90	100		
Philips	MN	270530963	5	URG 3000N	100	100	100	100	100	100	100	100	94	73		
Philips - Seq	MN	270530963	5	SASS with URG 3000N											100	100
Philips - Seq	MN	270530963	5	URG 3000N											100	100
Phoenix Supersite	AZ	040139997	7	SASS with URG 3000N	94	89	100	100	90	100	100	99	99	100	100	100
Phoenix Supersite	AZ	040139997	7	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Phoenix Supersite - Seq	AZ	040139997	7	SASS with URG 3000N												100
Phoenix Supersite - Seq	AZ	040139997	7	URG 3000N												50
Portland - SE Lafayette	OR	410510080	6	SASS with URG 3000N	78	67		100	88	100	100	100	98	100	89	100
Portland - SE Lafayette	OR	410510080	6	URG 3000N	38	33		100	89	100	100	80	94	91	88	100
Reno	NV	320310016	5	SASS with URG 3000N	100	100	67	0	44	100						
Reno	NV	320310016	5	URG 3000N	100	100	100	100	100	100						
Reno - Seq	NV	320310016	5	SASS with URG 3000N						100	100	100	100	100	100	100
Reno - Seq	NV	320310016	5	URG 3000N						100	100	100	100	100	100	100
Riverside-Rubidoux - Seq	CA	060658001	5	SASS with URG 3000N	100	100	70	82	100	100	100	100	100	92	100	99

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					167	**168**	**169**	**170**	**171**	**172**	**173**	**174**	**175**	**176**	**177**	**178**
Riverside-Rubidoux - Seq	CA	060658001	5	URG 3000N	100	100	90	100	100	100	100	100	100	100	100	100
Riverside-Rubidoux (Collocated)	CA	060658001	6	SASS with URG 3000N	100	100	100	87	100	100	100	100	100	100	100	98
Riverside-Rubidoux (Collocated)	CA	060658001	6	URG 3000N	100	100	100	100	100	100	100	100	100	83	100	100
Roxbury (Boston)	MA	250250042	5	SASS with URG 3000N	100	100	100	100	100	100						
Roxbury (Boston)	MA	250250042	5	URG 3000N	100	100	100	95	100	100						
Roxbury (Boston) - collocated	MA	250250042	6	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Roxbury (Boston) - collocated	MA	250250042	6	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Roxbury (Boston) - Seq	MA	250250042	5	SASS with URG 3000N						100	100	100	100	100	100	100
Roxbury (Boston) - Seq	MA	250250042	5	URG 3000N						100	100	100	100	100	100	100
Sacramento - Del Paso Manor	CA	060670006	5	SASS with URG 3000N	100	100	100	100	99	100	100	100	100	100		
Sacramento - Del Paso Manor	CA	060670006	5	URG 3000N	100	100	100	100	100	100	100	100	100	100		
Sacramento Del Paso Manor - Seq	CA	060670006	5	SASS with URG 3000N											100	93
Sacramento Del Paso Manor - Seq	CA	060670006	5	URG 3000N											100	100
San Jose - Jackson Street	CA	060850005	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	89
San Jose - Jackson Street	CA	060850005	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	78
SER-DNR Headquarters	WI	550790026	5	SASS with URG 3000N	100	100	100	100	100	100	90	100	70	91	100	90
SER-DNR Headquarters	WI	550790026	5	URG 3000N	95	89	94	95	100	100	90	90	83	100	94	50
Shelby Farms	TN	471570075	6	SASS with URG 3000N	100	89	80	91	89	100	90	89	100	100		
Shelby Farms	TN	471570075	6	URG 3000N	100	89	94	95	89	100	90	80	100	75		
Shelby Farms - Seq	TN	471570075	6	SASS with URG 3000N										100	100	100
Shelby Farms - Seq	TN	471570075	6	URG 3000N										100	100	100
Simi Valley	CA	061112002	5	SASS with URG 3000N	90	71	44	0								
Simi Valley	CA	061112002	5	URG 3000N	94	71	25	0								

Site	**State**	**AQS Code**	**POC**	**Sampler Type**	**Report Batch**											
					167	**168**	**169**	**170**	**171**	**172**	**173**	**174**	**175**	**176**	**177**	**178**
South DeKalb - Met One	GA	130890002	5	SASS with URG 3000N	100	86	100	100	88	100	88	100	100	100	75	100
South DeKalb - Met One	GA	130890002	5	URG 3000N	100	86	100	100	88	94	88	100	100	100	83	100
St. Lukes Meridian (IMS)	ID	160010010	5	SASS with URG 3000N	94	88	91	100	90	77	100	100				
St. Lukes Meridian (IMS)	ID	160010010	5	URG 3000N	100	89	100	100	100	100	100	100				
St. Lukes Meridian (IMS) - Seq	ID	160010010	5	SASS with URG 3000N								100	100	100	100	89
St. Lukes Meridian (IMS) - Seq	ID	160010010	5	URG 3000N								100	75	100	100	100
Sydney	FL	120573002	5	SASS with URG 3000N	70	94	65	86	93	86	93	94	95	82	100	100
Sydney	FL	120573002	5	URG 3000N	95	100	100	95	100	100	100	100	100	36	100	60
Univ. of Florida Ag School - Seq	FL	120111002	5	SASS with URG 3000N	100	46	85	24	34	84	85	87	52		100	100
Univ. of Florida Ag School - Seq	FL	120111002	5	URG 3000N	100	100	100	100	100	100	100	86	100		100	100
Woolworth St	NE	310550019	5	SASS with URG 3000N	94	82	96	96	96	96	96	96	96	96	82	85
Woolworth St	NE	310550019	5	URG 3000N	94	86	100	100	88	100	100	100	100	100	92	100
WV - Guthrie Agricultural Center	WV	540390011	5	SASS with URG 3000N	100	86	100	89	100	100						
WV - Guthrie Agricultural Center	WV	540390011	5	URG 3000N	100	86	100	94	100	100						
WV Guthrie Ag Center - Seq	WV	540390011	5	SASS with URG 3000N						100	100	83	35	100	89	82
WV Guthrie Ag Center - Seq	WV	540390011	5	URG 3000N						100	100	71	88	100	100	100

Table B-2. Percentage of Routine Exposure Records – Non-STN Sites Monthly Percent Data Completeness by Site

					Report Batch											
Site	**State**	**AQS Code**	**POC**	**Sampler Type**	**167**	**168**	**169**	**170**	**171**	**172**	**173**	**174**	**175**	**176**	**177**	**178**
(NC) - Lexington	NC	370570002	5	SASS with URG 3000N	100	100	100	100	100	60	100	100	100	100	100	75
(NC) - Lexington	NC	370570002	5	URG 3000N	100	100	100	100	100	60	100	100	100	100	100	100
(PA) Liberty	PA	420030064	6	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
(PA) Liberty	PA	420030064	6	URG 3000N	100	100	100	100	75	100	100	100	100	83	100	100
5 Points	OH	391530023	5	SASS with URG 3000N	100	57	67	42	57	82	100	100	100	100	100	75
5 Points	OH	391530023	5	URG 3000N	100	100	90	100	100	100	100	100	100	33	38	75
AL - Phenix City	AL	011130001	5	SASS with URG 3000N	100	100	100	100	100	100	100	80	100	100	100	100
AL - Phenix City	AL	011130001	5	URG 3000N	60	100	100	100	100	80	100	100	100	100	100	100
Albany Co HD	NY	360010005	5	SASS with URG 3000N	100											
Albany Co HD	NY	360010005	5	URG 3000N	100											
Albany Co HD - Seq	NY	360010005	5	SASS with URG 3000N	100	100	100	100	100	100	89	100	79	81	98	100
Albany Co HD - Seq	NY	360010005	5	URG 3000N	100	100	100	100	100	100	80	83	90	71	100	100
Arendtsville	PA	420010001	5	SASS with URG 3000N	100	100	100	100	98	100	100	100	100	83	100	100
Arendtsville	PA	420010001	5	URG 3000N	100	80	100	100	100	80	100	100	100	100	100	100
Arnold West - Met One	MO	290990019	6	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	91	92	100
Arnold West - Met One	MO	290990019	6	URG 3000N	100	100	100	95	78	100	100	100	100	82	94	100
Ashland Health Department	KY	210190017	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Ashland Health Department	KY	210190017	5	URG 3000N	100	100	88	100	100	100	100	100	100	100	100	100
Athens - Met One	GA	130590001	5	SASS with URG 3000N	100	60	100	100	100	100	100	100	100	100	100	75
Athens - Met One	GA	130590001	5	URG 3000N	100	80	100	100	100	100	88	100	100	100	100	75
Augusta - Met One	GA	132450091	5	SASS with URG 3000N	100	80	100	60	80	80	100	100	100	63	56	68
Augusta - Met One	GA	132450091	5	URG 3000N	80	80	100	60	80	80	100	100	100	83	75	50
Blaine Anoka County Airport	MN	270031002	5	SASS with URG 3000N	92	100	100	100	100	91	100	100	90	100		

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					167	**168**	**169**	**170**	**171**	**172**	**173**	**174**	**175**	**176**	**177**	**178**
Blaine Anoka County Airport	MN	270031002	5	URG 3000N	91	67	94	95	100	85	70	90	89	73		
Blaine Anoka County Airport - Seq	MN	270031002	5	SASS with URG 3000N											100	99
Blaine Anoka County Airport - Seq	MN	270031002	5	URG 3000N											100	100
Bonne Terre - Met One	MO	291860005	5	SASS with URG 3000N	100	100	98	91	100	91	100	90	99	90	89	99
Bonne Terre - Met One	MO	291860005	5	URG 3000N	100	100	100	45	67	95	100	90	100	100	88	100
Bountiful	UT	490110004	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	80	100	100	100
Bountiful	UT	490110004	5	URG 3000N	80	100	100	100	100	100	100	100	80	100	100	100
Buffalo - Met One	NY	360290005	6	SASS with URG 3000N	100	100	100	86	100	60	80	100	100	100	100	100
Buffalo - Met One	NY	360290005	6	URG 3000N	80	100	100	100	75	60	50	80	100	100	100	100
Buncombe County Board of Education	NC	370210034	5	SASS with URG 3000N	100	100	100	100	94	0	0	40	100	100	100	100
Buncombe County Board of Education	NC	370210034	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Butte-Greeley School	MT	300930005	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Butte-Greeley School	MT	300930005	5	URG 3000N	100	71	100	100	100	100	75	0	100	100	100	100
Camden-NJ	NJ	340070002	5	SASS with URG 3000N	92	61	78	89	100	100	88	100	99	100	86	100
Camden-NJ	NJ	340070002	5	URG 3000N	89	71	75	94	88	100	88	100	100	100	83	100
Cannons Lane	KY	211110067	6	SASS with URG 3000N	99	100	100	100	80	100	100	100	92	100	100	100
Cannons Lane	KY	211110067	6	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Canton Fire Station	OH	391510017	5	SASS with URG 3000N	100	100	100	100	100	80	100	96	100	100	100	100
Canton Fire Station	OH	391510017	5	URG 3000N	100	100	100	100	100	100	100	100	80	100	100	75
Chesterfield	SC	450250001	5	SASS with URG 3000N	85	100	100	100	80	100	100	60	40	100	100	100
Chesterfield	SC	450250001	5	URG 3000N	80	100	100	100	80	100	100	40	100	100	100	100
Cheyenne NCore - Seq	WY	560210100	5	SASS with URG 3000N	99	100	100	99	100	81	100	99	100	100	100	80
Cheyenne NCore - Seq	WY	560210100	5	URG 3000N	100	60	100	100	100	100	100	100	100	100	100	83
Children's Park	AZ	040191028	5	SASS with URG 3000N	83	33	100	90	100	100	100	100	100	100	100	100
Children's Park	AZ	040191028	5	URG 3000N	91	67	100	50	100	100	100	100	100	100	75	100

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					167	**168**	**169**	**170**	**171**	**172**	**173**	**174**	**175**	**176**	**177**	**178**
Columbus - Met One	GA	132150011	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	85	100	100	100
Columbus - Met One	GA	132150011	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Commerce City	CO	080010006	5	SASS with URG 3000N	80	100	100	100	100	100	77	56	79	100	100	100
Commerce City	CO	080010006	5	URG 3000N	80	100	100	100	100	100	100	80	100	100	100	100
Dearborn	MI	261630033	5	SASS with URG 3000N	100	100	83	100	100	100	100	100	100	100	100	100
Dearborn	MI	261630033	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Del Norte - Met One	NM	350010023	5	SASS with URG 3000N	100	83										
Del Norte - Met One	NM	350010023	5	URG 3000N	100	83										
Del Norte - Seq	NM	350010023	5	SASS with URG 3000N		0	100	100	100	100	99	100	100	100	100	100
Del Norte - Seq	NM	350010023	5	URG 3000N		100	100	83	100	100	100	100	100	100	100	83
Division St.	NY	360610134	5	SASS with URG 3000N	100											
Division St.	NY	360610134	5	URG 3000N	100											
Division St. - Seq	NY	360610134	5	SASS with URG 3000N	100	100	90	100	99	100	100	100	100	93	100	90
Division St. - Seq	NY	360610134	5	URG 3000N	100	80	80	100	100	100	100	100	100	100	100	100
Douglas - Met One	GA	130690002	5	SASS with URG 3000N	100	100	100	98	100	100	100	100	100	100	100	100
Douglas - Met One	GA	130690002	5	URG 3000N	100	100	100	100	100	100	100	100	100	83	100	100
Dover	DE	100010003	5	SASS with URG 3000N	100	100	100	100	100	40						
Dover	DE	100010003	5	URG 3000N	100	100	100	100	100	40						
Downtown Library	OH	391130032	5	SASS with URG 3000N	100	100	100	98	100	80	60	80	95	78	79	100
Downtown Library	OH	391130032	5	URG 3000N	100	100	100	83	100	100	50	100	100	83	88	100
East Providence	RI	440071010	5	SASS with URG 3000N	93	100	100	99	78	91	92	100	100	100		
East Providence	RI	440071010	5	URG 3000N	91	67	89	90	67	90	60	90	89	82		
East Providence - Seq	RI	440071010	5	SASS with URG 3000N											100	99
East Providence - Seq	RI	440071010	5	URG 3000N											100	100
El Cajon - Floyd Smith Drive	CA	060731018	5	SASS with URG 3000N												59
El Cajon - Floyd Smith Drive	CA	060731018	5	URG 3000N												60

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					167	168	169	170	171	172	173	174	175	176	177	178
Elkhart Prairie Street	IN	180390008	5	SASS with URG 3000N	65	100	100	98	69	100	100	100	100	100	100	100
Elkhart Prairie Street	IN	180390008	5	URG 3000N	100	100	100	100	75	100	75	100	100	100	100	100
Erie	PA	420490003	5	SASS with URG 3000N	100	100	87	100	100	100	80	100	100	100	100	100
Erie	PA	420490003	5	URG 3000N	100	100	100	83	100	100	88	100	100	100	100	100
Evansville Buena Vista Rd	IN	181630021	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Evansville Buena Vista Rd	IN	181630021	5	URG 3000N	100	100	100	100	100	100	100	100	100	83	100	75
Fairbanks State Bldg	AK	020900010	6	SASS with URG 3000N	100	63	92	100	100	100	90	100	100	100	100	100
Fairbanks State Bldg	AK	020900010	6	URG 3000N	100	88	90	100	100	100	90	100	11	36	100	100
Florence	PA	421255001	5	SASS with URG 3000N	100	100	100	100	100	100	98	100	80	67	100	100
Florence	PA	421255001	5	URG 3000N	100	100	100	50	100	100	100	60	60	83	100	100
Freemansburg	PA	420950025	5	SASS with URG 3000N	100	100	100	100	100	78	100	100	100	67	65	100
Freemansburg	PA	420950025	5	URG 3000N	100	100	100	100	100	80	100	100	100	67	100	100
Fresno - Garland	CA	060190011	5	SASS with URG 3000N	100	100	76	100	89	91	100	100	90	100	100	100
Fresno - Garland	CA	060190011	5	URG 3000N	95	100	94	100	89	95	90	100	94	91	100	90
Gary litri	IN	180890022	5	SASS with URG 3000N	100	100	100	100	100	80	100	100	99	71	100	100
Gary litri	IN	180890022	5	URG 3000N	100	100	100	100	100	80	100	100	75	57	100	100
Grand Rapids	MI	260810020	5	SASS with URG 3000N	92	100										
Grand Rapids	MI	260810020	5	URG 3000N	100	100										
Grand Rapids - Seq	MI	260810020	5	SASS with URG 3000N		57	62	100	100	100	100	100	100	86	100	100
Grand Rapids - Seq	MI	260810020	5	URG 3000N		100	100	100	50	86	100	100	100	100	100	100
Granite City	IL	171190024	5	SASS with URG 3000N	9	9	9	8	9	9	44	96	76	96	96	96
Granite City	IL	171190024	5	URG 3000N	60	100	88	100	50	60	75	40	40	50	100	100
Grayson	KY	210430500	5	SASS with URG 3000N	100	100	100	86	100	100	100	100	100	100	99	100
Grayson	KY	210430500	5	URG 3000N	100	100	100	83	100	100	100	100	100	100	100	100
Green Bay East High School	WI	550090005	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	85	100	100	100
Green Bay East High School	WI	550090005	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Greensburg	PA	421290008	5	SASS with URG 3000N	100	100	100	67	100	100	100	83	100	99	80	100

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					167	**168**	**169**	**170**	**171**	**172**	**173**	**174**	**175**	**176**	**177**	**178**
Greensburg	PA	421290008	5	URG 3000N	80	100	100	100	100	100	100	100	100	100	100	100
Greenville ESC	SC	450450015	5	SASS with URG 3000N	100	98	100	100	100	60	100	100	100	100	100	100
Greenville ESC	SC	450450015	5	URG 3000N	80	80	100	100	100	100	100	100	100	100	100	100
Harrisburg	PA	420430401	5	SASS with URG 3000N	80	100	100	87	100	83	100	100	100	100	100	100
Harrisburg	PA	420430401	5	URG 3000N	80	100	100	100	100	100	100	100	100	83	100	100
Hattie Avenue	NC	370670022	5	SASS with URG 3000N	97	60	100	83	75	83	80	100	100	100	100	100
Hattie Avenue	NC	370670022	5	URG 3000N	100	100	100	83	75	100	88	100	100	100	100	100
Head Start	OH	390990014	5	SASS with URG 3000N	100	100	83	71	78	83	72		100	100	100	100
Head Start	OH	390990014	5	URG 3000N	100	100	100	100	100	100	83		100	100	100	75
Hickory	NC	370350004	5	SASS with URG 3000N	100	100	100	83	75	60	0	0	0			
Hickory	NC	370350004	5	URG 3000N	100	100	100	100	100	80	100	100	100			
Horicon Palmatory	WI	550270001	5	SASS with URG 3000N	100	100	100	99	98	100	100	100	100	100	100	100
Horicon Palmatory	WI	550270001	5	URG 3000N	100	100	100	100	100	95	90	100	100	100	100	90
Houghton Lake	MI	261130001	5	SASS with URG 3000N	100	100	100	100	100	100	98	100	100	100	100	100
Houghton Lake	MI	261130001	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
HU-Beltsville Met One - Seq	MD	240330030	5	SASS with URG 3000N	100	89	80	100	100	100	100	100	100	100	100	100
HU-Beltsville Met One - Seq	MD	240330030	5	URG 3000N	100	80	90	100	100	100	100	100	100	100	100	100
Huntsville Old Airport	AL	010890014	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	87	70	100
Huntsville Old Airport	AL	010890014	5	URG 3000N	40	80	100	50	75	100	100	80	0	50	100	75
IS 52 - Seq	NY	360050110	5	SASS with URG 3000N				100	100	100	99	100	100	91	90	100
IS 52 - Seq	NY	360050110	5	URG 3000N				100	100	100	100	100	100	100	100	100
Jasper Post Office	IN	180372001	5	SASS with URG 3000N	100	100	100	83	100	100	100	100	100	100	100	100
Jasper Post Office	IN	180372001	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Jefferson Elementary - Met One	IA	191630015	5	SASS with URG 3000N	100	68	100	91	92	100	98	92	100	99		
Jefferson Elementary - Met One	IA	191630015	5	URG 3000N	100	100	50	100	100	100	100	100	100	100		

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					167	168	169	170	171	172	173	174	175	176	177	178
Jefferson Elementary - Seq	IA	191630015	5	SASS with URG 3000N											100	100
Jefferson Elementary - Seq	IA	191630015	5	URG 3000N											100	100
Jeffersonville Walnut St	IN	180190006	5	SASS with URG 3000N	100	100	100	83	100	100	100	100	100	100	100	100
Jeffersonville Walnut St	IN	180190006	5	URG 3000N	60	100	100	100	75	100	100	100	80	100	100	100
Jerome Mack Middle School	NV	320030540	5	SASS with URG 3000N	90	86	100	99	100	100	99	100	100	89	86	100
Jerome Mack Middle School	NV	320030540	5	URG 3000N	94	86	100	100	100	94	100	100	86	70	92	100
Johnstown	PA	420210011	5	SASS with URG 3000N	100	100	100	100	100	100	100	98	100	100	100	100
Johnstown	PA	420210011	5	URG 3000N	100	100	100	83	100	100	100	100	100	83	100	100
Kapolei	HI	150030010	5	SASS with URG 3000N	99	92	89	74	100	90	89	90	77	86	55	90
Kapolei	HI	150030010	5	URG 3000N	100	100	94	80	100	94	91	90	100	88	71	90
Karnack - Met One	TX	482030002	5	SASS with URG 3000N	100	100	100	100	81	100	100	100	100	98	100	75
Karnack - Met One	TX	482030002	5	URG 3000N	100	100	100	100	100	100	88	100	100	100	100	75
Lancaster	PA	420710007	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Lancaster	PA	420710007	5	URG 3000N	100	100	100	100	100	100	100	100	100	67	100	100
Lawrence County	TN	470990002	5	SASS with URG 3000N	100	100	80	100	100	80	100	100	100	100	99	82
Lawrence County	TN	470990002	5	URG 3000N	100	100	50	83	100	60	75	100	100	100	100	100
Lexington Health Department	KY	210670012	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	75
Lexington Health Department	KY	210670012	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	75
Liberty - Met One	MO	290470005	5	SASS with URG 3000N	100	100	100	91	100	100	100	100	100	100	89	100
Liberty - Met One	MO	290470005	5	URG 3000N	100	100	100	95	100	100	100	100	100	100	88	100
Lindon	UT	490494001	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	83	100	100
Lindon	UT	490494001	5	URG 3000N	100	100	100	100	75	100	100	100	100	100	100	100
Linn County Health	IA	191130040	5	SASS with URG 3000N	85	100	100	100	100	100	100	80	100	100	100	100
Linn County Health	IA	191130040	5	URG 3000N	100	100	100	83	75	100	100	80	80	100	88	100
Lockeland School - Met One	TN	470370023	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	86	100	100

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					167	168	169	170	171	172	173	174	175	176	177	178
Lockeland School - Met One	TN	470370023	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Lorain	OH	390933002	5	SASS with URG 3000N	100	50	100	100	100	100	99	100	100	83	100	100
Lorain	OH	390933002	5	URG 3000N	100	50	20	100	100	100	88	100	80	100	100	100
Macon - Met One	GA	130210007	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Macon - Met One	GA	130210007	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	88	100
Maple Canyon	OH	390490081	6	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Maple Canyon	OH	390490081	6	URG 3000N	100	100	100	100	100	100	100	100	80	33	100	100
Marysville - 7th Ave	WA	530611007	5	SASS with URG 3000N	80	100	80	100	100	80	100	100	50	100	100	100
Marysville - 7th Ave	WA	530611007	5	URG 3000N	80	80	100	100	100	80	100	100	50	100	100	100
Mechanicsburg	IN	180650003	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	79	100
Mechanicsburg	IN	180650003	5	URG 3000N	100	100	38	100	100	100	100	100	100	83	100	100
Millbrook	NC	371830014	5	SASS with URG 3000N	100	100	100	100	100	100	100	80	80	100		
Millbrook	NC	371830014	5	URG 3000N	100	89	100	100	100	100	90	100	89	100		
Millbrook - Seq	NC	371830014	5	SASS with URG 3000N										86	89	100
Millbrook - Seq	NC	371830014	5	URG 3000N										100	100	100
MN - Rochester	MN	271095008	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
MN - Rochester	MN	271095008	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
MOMS	AL	011011002	5	SASS with URG 3000N	100	100	100	100	100	100	80	100	100	100	100	100
MOMS	AL	011011002	5	URG 3000N	100	100	100	100	100	100	100	100	100	83	88	75
Moundsville Armory	WV	540511002	5	SASS with URG 3000N	100	85	100	73	0		100	100	100	100	100	100
Moundsville Armory	WV	540511002	5	URG 3000N	100	100	100	100	100		100	100	100	100	100	100
Naperville	IL	170434002	5	SASS with URG 3000N	96	96	76	80	96	76	96	96	96	96	67	96
Naperville	IL	170434002	5	URG 3000N	100	100	25	83	100	60	100	100	100	80	50	100
National Trail High School	OH	391351001	5	SASS with URG 3000N	100	88	91	100	100	98	100	100	100	100		
National Trail High School	OH	391351001	5	URG 3000N	100	88	50	100	100	100	100	90	100	100		
National Trail High School - Seq	OH	391351001	5	SASS with URG 3000N										100	86	100

					Report Batch											
Site	**State**	**AQS Code**	**POC**	**Sampler Type**	**167**	**168**	**169**	**170**	**171**	**172**	**173**	**174**	**175**	**176**	**177**	**178**
National Trail High School - Seq	OH	391351001	5	URG 3000N										100	88	100
New Garden	PA	420290100	5	SASS with URG 3000N	100	100	68	83	50	43	25	80	80	78	100	100
New Garden	PA	420290100	5	URG 3000N	100	100	100	83	75	100	88	100	80	100	88	100
Newark	NJ	340130003	5	SASS with URG 3000N	100	86	89	89	100	100	88	100	100	100	86	100
Newark	NJ	340130003	5	URG 3000N	100	86	94	94	100	89	88	100	50	100	92	89
NJ-Chester	NJ	340273001	5	SASS with URG 3000N	100	86	89	100	100	100	88	100	100	100	73	100
NJ-Chester	NJ	340273001	5	URG 3000N	100	86	94	100	75	100	88	100	100	90	92	100
NLR Parr	AR	051190007	5	SASS with URG 3000N	100	89	90	100	100	82	100	100	90	100	99	100
NLR Parr	AR	051190007	5	URG 3000N	100	89	100	100	78	90	100	100	94	100	81	70
North Los Angeles	CA	060371103	5	SASS with URG 3000N	90	89	89	100	100	91	100	90	100	91	100	100
North Los Angeles	CA	060371103	5	URG 3000N	41	100	94	100	100	100	100	90	94	91	100	100
North Los Angeles - Seq	CA	060371103	5	SASS with URG 3000N												100
North Los Angeles - Seq	CA	060371103	5	URG 3000N												100
Northbrook	IL	170314201	5	SASS with URG 3000N	96	96	77	78	85	87	67	96	85	89	96	96
Northbrook	IL	170314201	5	URG 3000N	100	78	0	80	78	95	90	100	100	100	100	100
Northbrook - Seq	IL	170314201	5	SASS with URG 3000N												96
Northbrook - Seq	IL	170314201	5	URG 3000N												100
OCUSA Campus	OK	401091037	5	SASS with URG 3000N	100	100	80	100	100	100	100	85	100	100	80	100
OCUSA Campus	OK	401091037	5	URG 3000N	100	100	100	100	100	100	100	100	100	83	88	100
ODOT Garage	OH	390870012	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	99	100	99	100
ODOT Garage	OH	390870012	5	URG 3000N	100	100	100	83	75	100	88	100	100	100	88	100
Parklane	SC	450790007	5	SASS with URG 3000N	97	97	96	96	86	97	97	96	97	96	97	96
Parklane	SC	450790007	5	URG 3000N	50	67	100	100	89	100	100	100	28			
PerkinstownCASNET	WI	551198001	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
PerkinstownCASNET	WI	551198001	5	URG 3000N	100	100	100	83	100	100	100	100	100	83	100	100
Pinnacle State Park - Met One	NY	361010003	5	SASS with URG 3000N	100											

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					167	**168**	**169**	**170**	**171**	**172**	**173**	**174**	**175**	**176**	**177**	**178**
Pinnacle State Park - Met One	NY	361010003	5	URG 3000N	100											
Pinnacle State Park - Seq	NY	361010003	5	SASS with URG 3000N	82	80	100	100	100	100	100	94	79	92	100	100
Pinnacle State Park - Seq	NY	361010003	5	URG 3000N	100	100	100	100	100	100	100	100	88	100	100	100
Platteville	CO	081230008	5	SASS with URG 3000N	100	100	100	100	75	100	80	80	60	83	100	100
Platteville	CO	081230008	5	URG 3000N	100	100	100	100	75	100	100	80	100	100	100	100
Port Huron	MI	261470005	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Port Huron	MI	261470005	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Public Health Building - Met One	IA	191530030	5	SASS with URG 3000N	82	100	100	100	100	100	100	85	100	100	100	98
Public Health Building - Met One	IA	191530030	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Queens College - Met One	NY	360810124	6	SASS with URG 3000N	100	100	100	100	99	100	100	100	100	100		
Queens College - Met One	NY	360810124	6	URG 3000N	95	100	89	95	100	100	100	100	100	100		
Queens College - Seq	NY	360810124	6	SASS with URG 3000N										100	100	80
Queens College - Seq	NY	360810124	6	URG 3000N										75	100	100
Reading Airport	PA	420110011	5	SASS with URG 3000N	100	100	100	100	100	100	98	100	100	100	100	100
Reading Airport	PA	420110011	5	URG 3000N	100	100	100	100	100	100	50	100	100	100	100	100
Ritner	PA	421010055	5	SASS with URG 3000N	100	100	83	99	98	99	100	100	100	100	100	100
Ritner	PA	421010055	5	URG 3000N	100	100	100	100	75	100	88	100	100	100	100	100
Rochester Primary - Met One	NY	360551007	5	SASS with URG 3000N	85	88	91	99	100	81	100	100				
Rochester Primary - Met One	NY	360551007	5	URG 3000N	92	75	95	100	100	45	100	89				
Rochester Primary - Seq	NY	360551007	5	SASS with URG 3000N								100	100	100	80	90
Rochester Primary - Seq	NY	360551007	5	URG 3000N								0	100	83	100	100
Rockwell	NC	371590021	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Rockwell	NC	371590021	5	URG 3000N	80	100	100	100	100	100	100	100	100	100	100	100
Rome Elementary	GA	131150003	5	SASS with URG 3000N	100	100	100	80	100	100	100	100	100	100	80	100
Rome Elementary	GA	131150003	5	URG 3000N	100	100	100	100	100	100	100	80	80	100	63	75

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					167	**168**	**169**	**170**	**171**	**172**	**173**	**174**	**175**	**176**	**177**	**178**
Rossville - Met One	GA	132950002	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	86	100	100
Rossville - Met One	GA	132950002	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Scranton	PA	420692006	5	SASS with URG 3000N	100	100	100	100	100	25				100	100	100
Scranton	PA	420692006	5	URG 3000N	100	100	100	83	100	25				100	100	100
Shreveport Airport - Met One	LA	220150008	5	SASS with URG 3000N	97	96	43	0	100	100	82	63	75	100	100	100
Shreveport Airport - Met One	LA	220150008	5	URG 3000N	100	100	83	0	100	100	82	63	75	100	100	100
Sieben Flats	MT	300490004	5	SASS with URG 3000N	92	100	99	100	89	91	100	100	90	100	88	100
Sieben Flats	MT	300490004	5	URG 3000N	100	100	100	88	25	72	100	100	100	100	100	100
Sieben Flats - Seq	MT	300490004	5	SASS with URG 3000N												100
Sieben Flats - Seq	MT	300490004	5	URG 3000N												100
Sinclair Community College	OH	391130038	5	SASS with URG 3000N												100
Sinclair Community College	OH	391130038	5	URG 3000N												100
Sioux Falls School Site	SD	460990008	5	SASS with URG 3000N	75	89	88	92	100	100	90	60	70	91	100	100
Sioux Falls School Site	SD	460990008	5	URG 3000N	86	89	94	95	100	100	82	60	83	91	100	90
Skyview	FL	121030026	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	67	100	83	50
Skyview	FL	121030026	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	90	100
South Charleston Library	WV	540391005	5	SASS with URG 3000N		100	80	100	62	80						
South Charleston Library	WV	540391005	5	URG 3000N		100	88	100	100	60						
Spring Hill Elementary School	TN	470931020	5	SASS with URG 3000N	100	100	100	100	75	100	100	100	100	100	85	100
Spring Hill Elementary School	TN	470931020	5	URG 3000N	100	60	100	100	50	80	100	100	100	100	100	100
Springfield Pumping Station - Met One	IL	170310057	5	SASS with URG 3000N	100	100	99	100	100	100	100	100	100	100	100	100
Springfield Pumping Station - Met One	IL	170310057	5	URG 3000N	100	100	100	100	100	100	100	100	100	83	88	100
St Theo	OH	390350038	6	SASS with URG 3000N	80	100	80	100	75	80	100	100	97	86	97	81
St Theo	OH	390350038	6	URG 3000N	80	80	100	100	75	80	88	100	100	100	100	100

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					167	168	169	170	171	172	173	174	175	176	177	178
State College	PA	420270100	5	SASS with URG 3000N	100	100	100	80	40	100	100	100	100	100	80	100
State College	PA	420270100	5	URG 3000N	100	100	100	80	40	100	100	100	100	100	88	100
Sterling State Park	MI	261150006	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	75
Sterling State Park	MI	261150006	5	URG 3000N	100	100	100	100	100	100	100	100	100	83	100	75
Steubenville	OH	390810017	5	SASS with URG 3000N		100	80	52	75	100	100	80	100	100	80	100
Steubenville	OH	390810017	5	URG 3000N		100	100	100	100	80	100	60	20	17	100	100
SW HS	MI	261630015	5	SASS with URG 3000N	83	100	100	100	100	100	100	100	100	100	80	100
SW HS	MI	261630015	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Tacoma - Met One	WA	530530029	5	SASS with URG 3000N	100	77	100	100	78	100	100	100	60	100	100	100
Tacoma - Met One	WA	530530029	5	URG 3000N	80	100	100	100	75	100	100	100	60	67	50	100
Taft	OH	390610040	5	SASS with URG 3000N	92	100	100	100	100	100	100	100	100	91	100	100
Taft	OH	390610040	5	URG 3000N	95	100	100	100	100	100	100	100	100	91	100	100
Tallahassee Community College	FL	120730012	5	SASS with URG 3000N	100	100	100	100	100	100	100	85	100	87	79	70
Tallahassee Community College	FL	120730012	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	50	75
Tecumseh	MI	260910007	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	75
Tecumseh	MI	260910007	5	URG 3000N	100	100	100	100	100	100	50	80	100	83	100	75
Toledo Airport	OH	390950026	5	SASS with URG 3000N	100	98	100	100	75	100	80	80	80	100	83	100
Toledo Airport	OH	390950026	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
UTC	TN	470654002	5	SASS with URG 3000N	93	75	77	100	100	100	100	100	100	100	100	100
UTC	TN	470654002	5	URG 3000N	100	100	100	83	100	100	100	100	100	100	100	75
VANNEVAN	WA	530110023	5	SASS with URG 3000N	100	100	78	100	100	100	100	100	100	100	100	100
VANNEVAN	WA	530110023	5	URG 3000N	100	100	100	100	75	100	100	100	100	100	100	100
Waukesha, Cleveland Ave. Site	WI	551330027	5	SASS with URG 3000N	100	100	100	100	100	80	98	100	98	100	100	100
Waukesha, Cleveland Ave. Site	WI	551330027	5	URG 3000N	100	100	100	100	100	60	13	100	100	100	100	100
Whiteface - Met One	NY	360310003	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					167	168	169	170	171	172	173	174	175	176	177	178
Whiteface - Met One	NY	360310003	5	URG 3000N	100	100	100	83	100	100	100	100	100	100	88	100
Wichita Dept. of Env. Health - Met One	KS	201730010	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Wichita Dept. of Env. Health - Met One	KS	201730010	5	URG 3000N	100	100	100	100	100	80	100	100	100	100	100	100
Wylam	AL	010732003	5	SASS with URG 3000N	80	86	89	89	100	100						
Wylam	AL	010732003	5	URG 3000N	100	86	94	94	100	100						
Wylam - Seq	AL	010732003	5	SASS with URG 3000N						62	100	92	100	100	100	100
Wylam - Seq	AL	010732003	5	URG 3000N						100	100	100	100	100	100	100
Yakima Mental Health	WA	530770009	5	SASS with URG 3000N	80	100	100	100	100	100	100	100	100	100	100	75
Yakima Mental Health	WA	530770009	5	URG 3000N	100	100	75	83	100	60	13	100	100	100	100	100
York	PA	421330008	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	83	100	100	100
York	PA	421330008	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100