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

January 1 through December 31, 2013

Prepared for:
U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Research Triangle Park, NC 27711

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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. 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, 2013.

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 2013. RTI reported results of PE samples as part of a multi-lab study conducted by EPA's Montgomery Laboratory in early 2013. 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 performed by EPA in 2013. 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 Gravimetric Laboratory was also audited by the National Environmental Laboratory accreditation Program (NELAP) in February 2013. As noted in Table 3-3, the NELAP audit had two minor recommendations: a) add a review history page in the QAPP and b) add specific language about the computer backup server.

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 by IMPROVE_A), and 3.4 (X-ray Fluorescence).

Data quality for gravimetric mass results was found to be satisfactory during 2013. 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 Organic and Elemental Carbon (OC/EC) lab during 2013 (Sections 3.3). Interlaboratory performance comparison results were satisfactory. New URG 3000N samplers 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 3.4.2.4. Interlaboratory performance comparison results performed by EPA's National Air and Radiation Environmental Laboratory showed excellent agreement.

One significant data quality issue that was identified and addressed in 2013 was the detection of high chromium background in Teflon field blank samples and in Teflon Lot Blanks. This issue did not originate from an RTI Laboratory and was traced back to possible chromium contamination by the filter manufacturer. The high background was detected prior to reporting and was addressed by performing appropriate extensive Lot-specific background correction. The monitoring agencies were notified of the chromium background contamination and the flags that were applied. A total of 3224 filters from four Teflon Filter Lots (Lot #136532, 137100, 137101, 137102) distributed over four reporting batches (batches 166 through 169) were affected. All affected chromium data were flagged. Corrective actions have been implemented to verify filter specifications.

Operations in RTI's Sample Handling and Archiving Laboratory (SHAL) proceeded satisfactorily during 2013. No significant quality issues were reported by the denuder refurbishment laboratory (Section 3.5).

No significant data quality issues were reported by the data processing and data validation functions during 2013 (Sections 4.0 and 5.0). However, there was one instance in Batch 162 where a single sampling event was inadvertently omitted from the monthly data report to the monitoring agency due to an accidental database error. A corrective action has since been implemented that would prevent such errors.

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 were two Corrective Action Requests (CARs) issued during 2013. 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
004	Data Processing	Batch 162 Reporting Error – one event inadvertently omitted due to an accidental database error	The omitted record was separately processed and reported to the monitoring agency. A corrective action has been implemented beginning with Batch 163 to prevent such errors.	No data quality was affected, except for the omission from the original report.
005	QA, XRF, Gravimetry	High chromium background in blank Teflon filters	High background concentration of chromium was identified in field blanks and Teflon lot blanks (i.e., unused filters). This issue was traced back to a possible contamination by the filter manufacturer. High background was identified prior to reporting and appropriate background correction was performed. The monitoring agencies were notified of the chromium background contamination and the flags that were applied. A corrective active has been implemented.	All chromium data from affected Filter Lots were flagged due to the unusually high background correction necessitated by the chromium contamination.
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 184 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, 2013. 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. 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 for 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, 2013. 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 (>95%) is demonstrated overall. Some individual sites may have lower completeness, typically due to site maintenance 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 3.1.4 for uncertainty statistics for 2013.

2.2 Summary of Data Completeness

Appendix B of this report includes the data completeness summary for the Reporting Batches delivered in 2013. 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 95% during 2013. 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 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 2013.

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[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.

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 2013.

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 2013.

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 2013.

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 2013; see Section 3.3.1 for a summary of operational issues.

2.3.5 Sample Handling and Archiving Laboratory (SHAL)

There were no significant issues that affected data quality in the SHAL during 2013.

2.3.6 Data Processing

As described in Section 4.1, there was one instance where a single sampling event was inadvertently not included in the Batch 162 report. This was the first such case in the 13-year history of the program. The missing event was immediately processed and reported to the site (and included in the batch for AQS processing). As part of our corrective action, we implemented changes in our routine reporting procedures to ensure that any future missing event would be detected and processed.

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 that was identified during 2013, that was not restricted to any of the specific Laboratories, was manufacturer contamination of blank Teflon filters. 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 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. The impact was restricted to batches 164 through 168 in 2013 and batch 169 in 2014. A total of 4711 valid filters from four Teflon Filter Lots (Lot #136532, 137100, 137101, 137102) were affected. An XRF analysis of unused filter lot blanks from these affected Lots 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 Gravimetric Laboratory

The RTI Gravimetric Laboratory's two weigh chambers were used to tare 16,745 Teflon filters for the $PM_{2.5}$ speciation program between January 1 and December 31, 2013. During the same time period, the laboratory performed final (post-sampling) weighings of 15,749 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.

3.1.1 Quality Issues and Corrective Actions

No significant filter quality issues were identified in the Gravimetric Laboratory in 2013. The laboratory continued to proactively monitor mass balance data and to perform enhanced inspection of the Teflon filters purchased for use in the program. This inspection is performed in RTI's Optical Microscopy Laboratory on randomly selected filters. A technician examines filters under enhanced lighting using a stereomicroscope at magnifications of 10x to 45x. No pervasive problem with extraneous contaminating debris was identified in 2013 in either this enhanced inspection or in the routine visual inspection in the chamber. Lot stability tests indicated that the eleven Teflon filter lots used for the program in 2013 did not have issues with debris or outgassing.

The laboratory's environmental chambers experienced little downtime due to system failure in 2013. Two gear drive actuators for the chilled water valve and the desiccant by-pass damper were replaced in Chamber 2. Chamber 1 had two fan motors replaced. 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 2013, 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 chilled water to the entire building was lost two times. 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.

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. One new balance was deployed during 2013. The balance was thoroughly vetted prior to beginning to use it for the CSN. Therefore, no data was impacted by this change.

Working mass standards were removed from use during the year when due for re-verification by Henry Troemner LLC. Troemner is the country's largest independent commercial mass metrology laboratory offering weight calibration services. Troemner's weight calibration laboratories and processes are ISO/IEC 17025 compliant. Troemner has earned an accreditation for performing weight calibrations from the National Institute of Standards and Technology (NIST) - administered National Voluntary Laboratory Accreditation Program (NVLAP). 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. Troemner verifications have already been scheduled for May 2014 and September 2014.

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.

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. Three of the outlier laboratory blank weighings for two individual laboratory blank filters fell above the upper 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 2013. 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.

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 2013. Verified by the laboratory in conjunction with 2013 internal balance audit performed by RTI Quality Systems Program.	Chamber 1 100-mg S/N 41145 5/24/2013 Verification: 99.9979 mg ± 0.0025 Laboratory Tolerance Interval: 99.996 – 100.002 mg	Average = 99.997 mg Std Dev = 0.0006 for 582 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		100-mg S/N 58096 06/14/12 Verification: 99.9987 mg ± 0.0025 Laboratory Tolerance Interval: 99.996–100.002 mg	Average = 99.999 mg Std Dev = 0.0015 for 655 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		100-mg S/N 41144 09/12/12 Verification: 99.9991 mg ± 0.0025 Laboratory Tolerance Interval: 99.996 – 100.002 mg	Average = 99.997 mg Std Dev = 0.0010 for 694 weighings	Laboratory average falls within tolerance interval. Eight individual weighings of 99.996 mg fell 1 µg below lower limit.
		100-mg S/N 58097 06/14/12 Verification: 99.9986 mg ± 0.00025 Laboratory Tolerance Interval: 99.996 – 100.002 mg	Average = 99.998 mg Std Dev = 0.0008 for 421 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		100-mg S/N 83426 09/12/12 Verification: 100.0046 mg ± 0.00025 Laboratory Tolerance Interval: 100.002 – 100.008 mg	Average = 100.005 mg Std Dev = 0.0010 for 336 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 = 0.0006 for 582 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		200-mg S/N 58098 06/14/12 Verification: 200.001 mg ± 0.0025 Laboratory Tolerance Interval: 199.998 – 200.004 mg	Mean = 200.000 mg Std Dev = 0.0013 for 655 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		200-mg S/N 58099 05/24/13 Verification: 200.0002 mg ± 0.0025	Mean = 199.999 mg Std Dev = 0.0010 for 430 weighings	Laboratory average falls within tolerance interval. No weighing

QC Check	Requirements	QC Checks Applied in RTI Laboratory	Average Value Determined by Lab	Comments
		Laboratory Tolerance Interval: 199.997 – 200.003 mg		exceeded tolerance interval.
		200-mg S/N 41148 09/12/12 Verification: 199.999 mg ± 0.0025 Laboratory Tolerance Interval: 199.996 – 200.002 mg	Average = 199.997 mg Std Dev = 0.00010 for 710 weighings	Laboratory average falls within tolerance interval. Three individual weighings of 199.995 mg fell 1 μg below lower limit. Three individual weighings of 199.994 mg fell 2 μg below lower limit.
		200-mg S/N 83429 09/12/12 Verification: 200.0029 mg ± 0.0025 Laboratory Tolerance Interval: 199.999 – 200.005 mg	Average = 200.001 mg Std Dev = 0.0010 for 334 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		<u>Chamber 2</u> 100-mg S/N 83425 09/12/12 Verification: 100.0011 mg ± 0.0025 Laboratory Tolerance Interval: 99.998 – 100.004 mg	Average = 99.998 mg Std Dev = 0.0006 for 137 weighings	Laboratory average falls within tolerance interval. One individual weighing of 99.997 mg fell 1 μg below lower limit.
		100-mg S/N 58097 05/24/13 Verification: 99.9987 mg ± 0.00025 Laboratory Tolerance Interval: 99.996 – 100.002 mg	Average = 99.997 mg Std Dev = 0.0008 for 301 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		100-mg S/N 83252 05/24/13 Verification: 99.998 mg ± 0.0025 Laboratory Tolerance Interval: 99.995 – 100.001 mg	Mean = 99.996 mg Std Dev = 0.0008 for 560 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		100-mg S/N 83427 09/12/12 Verification: 100.006 mg ± 0.0025 Laboratory Tolerance Interval: 99.997 – 100.003 mg	Mean = 100.000 mg Std Dev = 0.0011 for 671 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		200-mg S/N 14060 02/02/13 Verification: 200.0059 mg ± 0.0025 Laboratory Tolerance Interval: 200.003 – 200.009 mg	Mean = 200.006 mg Std Dev = 0.0016 for 24 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.

QC Check	Requirements	QC Checks Applied in RTI Laboratory	Average Value Determined by Lab	Comments
		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 58099 06/14/12 Verification: 200.0013 mg ± 0.0025 Laboratory Tolerance Interval: 199.998 – 200.004 mg 200-mg S/N 83428 09/12/12 Verification: 199.9999 mg ± 0.0025 Laboratory Tolerance Interval: 199.997 – 200.003 mg	Mean = 200.000 mg Std Dev = 0.0008 for 560 weighings Mean = 199.999 mg Std Dev = 0.0008 for 301 weighings Mean = 199.997 mg Std Dev = 0.00005 for 137 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.
		200-mg S/N 83430 09/12/12 Verification: 200.0029 mg ± 0.0025 Laboratory Tolerance Interval: 199.998 – 200.004 mg	Mean = 200.001 mg Std Dev = 0.00010 for 647 weighings	Laboratory average falls within tolerance interval. One individual weighing of 200.005 mg fell 1 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 7, 2013, using NIST-traceable weight	N/A N/A	 Next inspection and external calibration scheduled for August 2014
Balance audits	Annually	Audits of all balances performed by RTI Quality Systems Program personnel on November 14, 2013, 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.

QC Check	Requirements	QC Checks Applied in RTI Laboratory	Average Value Determined by Lab	Comments
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, 2013 Chamber data loggers calibrated by Veriteq Data Logger Test and Calibration Services on July 14, 2013	N/A N/A	Chamber sensors, controllers, and process boards are calibrated on-site annually by Environmental Specialties Next calibration due July 2014
Laboratory (Filter) blanks	Initial weight ± 15 µg	1,874 total replicate weighings of 240 individual laboratory blanks	Average difference between final and initial weight = 1.6 µg Std Dev = 3.8 Min wt change = -9 µg Max wt change = 27 µg	3 total replicate weighings of 2 individual laboratory blank filters (0.2% of the replicate weighings; 0.83% of the individual laboratory blanks) exceeded the 15 µg criterion.
Replicates	Initial weight ± 15 µg	5,604 individual filters were weighed as pre-sampling (tared) replicates 1,994 individual filters were weighed as post-sampling replicates	Average = 0.19 µg Average = -0.05 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. 0 replicate weighings (0.0% of the weighings) exceeded the 15 µg criterion. These outliers would be 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.

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)	Comment
97426	12/6/2012	-0.002	-0.008	-0.003	0.002	Weight changes fall within required range
		0.002	-0.002	0.000	0.000	
		0.005	-0.003	0.001	0.000	
		0.000	-0.003	0.001	0.001	
		0.000	0.003	-0.002	0.000	
		0.001	-0.002	-0.002	0.003	
		-0.001	-0.001	0.000	0.000	
		-0.001	0.000	-0.002	0.003	
		-0.001	-0.001	0.003	0.000	
		-0.003	0.001	-0.003	0.002	
		0.000	0.000	-0.001	0.001	
		-0.001	-0.001	0.000	0.002	
99112	12/6/2012	0.000	0.001	-0.002	0.004	Weight changes fall within required range
		-0.003	0.005	-0.003	0.001	
		0.003	-0.001	-0.002	0.001	
		0.000	0.001	-0.001	0.001	
		-0.001	0.004	-0.004	0.002	
		0.001	0.004	-0.003	0.003	
		0.000	-0.009	0.000	-0.001	
		0.000	0.001	0.003	0.000	
		-0.005	0.001	0.001	0.001	
		-0.004	0.001	-0.002	0.000	
		-0.001	-0.001	-0.002	0.000	
		-0.001	0.004	-0.003	0.003	
99154	12/6/2012	0.006	-0.001	0.001	0.000	Weight changes fall within required range
		0.006	-0.002	0.002	0.000	
		0.003	-0.002	0.001	0.000	
		0.002	0.002	0.000	0.002	
		-0.001	0.000	-0.002	0.002	
		0.003	-0.003	0.000	0.001	
		0.003	-0.003	0.003	-0.001	
		0.005	0.000	-0.001	0.001	
		0.002	-0.002	0.000	-0.002	
		0.001	0.001	0.004	0.000	
		0.004	0.001	-0.001	0.000	
		-0.001	0.001	-0.001	0.001	

Lot	Received	24 Hours (mg)	48 Hours (mg)	72 Hours (mg)	96 Hours (mg)	Comment
135384	6/14/2013	-0.003	0.000	-0.002	0.002	Weight changes fall within required range
		-0.001	0.000	0.000	0.001	
		-0.002	-0.003	-0.002	0.003	
		-0.001	-0.003	0.000	-0.002	
		-0.002	0.004	-0.003	0.002	
		0.000	0.000	0.000	-0.002	
		-0.006	0.000	-0.001	0.000	
		-0.001	-0.001	-0.002	0.000	
		-0.003	0.001	-0.002	0.000	
		-0.002	0.001	-0.001	-0.001	
		-0.003	-0.004	-0.001	0.002	
		-0.002	0.002	-0.002	0.002	
136532	6/21/2013	0.000	0.000	-0.001	-0.001	Weight changes fall within required range
		0.003	0.000	-0.001	-0.002	
		0.004	-0.001	0.000	-0.002	
		-0.001	-0.001	0.001	-0.001	
		0.002	0.002	-0.001	-0.001	
		0.001	0.000	0.001	0.000	
		0.001	0.000	0.002	-0.001	
		0.000	0.003	0.001	0.001	
		0.003	-0.002	0.000	0.000	
		0.000	0.001	0.000	-0.002	
		0.003	-0.003	0.001	0.000	
		0.001	-0.001	0.002	0.000	
137100	7/1/2013	0.002	0.000	0.002		Weight changes fall within required range
		-0.012	-0.001	0.002		
		-0.018	-0.001	0.005		
		-0.012	-0.002	0.003		
		0.000	0.000	0.001		
		-0.008	0.000	-0.001		
		-0.004	-0.002	0.000		
		0.001	-0.005	-0.001		
		-0.002	-0.001	0.003		
		-0.002	-0.001	0.003		
		-0.007	0.000	0.000		
		-0.005	0.000	0.001		
137101	7/1/2013	-0.001	0.003	-0.002	0.001	Weight changes fall within required range
		0.000	0.001	-0.001	0.000	
		0.000	0.005	0.000	0.000	
		-0.005	-0.002	0.001	0.001	
		-0.001	0.000	0.000	-0.001	

Lot	Received	24 Hours (mg)	48 Hours (mg)	72 Hours (mg)	96 Hours (mg)	Comment
		0.001	0.003	0.000	-0.001	
		0.000	0.003	-0.002	-0.001	
		-0.001	-0.001	0.001	-0.001	
		0.000	0.000	0.003	-0.004	
		-0.001	0.003	0.000	-0.002	
		0.001	0.004	0.002	-0.001	
		-0.009	0.001	0.001	0.001	
136533	7/5/2013	0.001	0.001	0.001	0.000	Weight changes fall within required range
		-0.002	0.003	0.002	-0.001	
		-0.001	0.001	0.001	0.003	
		-0.004	0.006	-0.002	0.003	
		0.000	0.000	0.002	0.001	
		0.001	-0.001	0.000	0.001	
		-0.001	0.000	0.000	0.000	
		-0.002	0.001	0.001	-0.001	
		0.000	-0.002	0.003	-0.001	
		0.003	-0.012	-0.001	-0.003	
		0.000	-0.003	0.003	-0.002	
		-0.003	-0.002	0.000	0.002	
137102	7/5/2013	0.003	-0.002	0.000	0.001	Weight changes fall within required range
		0.001	-0.005	0.000	0.000	
		0.002	-0.003	0.002	0.000	
		-0.004	-0.006	0.000	-0.001	
		0.001	-0.003	0.001	0.000	
		-0.003	0.000	0.002	-0.001	
		0.001	-0.001	0.001	0.000	
		0.000	-0.004	0.000	0.000	
		0.003	-0.003	0.001	0.000	
		0.003	-0.003	0.002	0.000	
		0.000	-0.002	0.001	0.000	
		0.002	-0.003	0.000	0.002	
157463	11/19/2013	-0.002	0.001	0.000	-0.001	Weight changes fall within required range
		0.000	0.000	-0.001	0.002	
		-0.004	0.001	-0.001	0.001	
		-0.004	0.001	-0.002	0.002	
		0.000	0.000	0.000	0.000	
		-0.002	0.002	-0.001	-0.001	
		-0.002	0.000	0.001	0.000	
		-0.002	0.001	0.001	0.000	
		0.000	-0.001	0.000	-0.001	
		-0.002	0.002	0.000	0.000	

Lot	Received	24 Hours (mg)	48 Hours (mg)	72 Hours (mg)	96 Hours (mg)	Comment
		0.000	0.001	-0.001	0.001	
		0.000	0.000	0.001	0.000	
159978	11/27/2013	-0.004	0.000	0.002	0.003	Weight changes fall within required range
		-0.006	0.000	0.001	0.000	
		-0.004	-0.001	0.003	0.001	
		-0.004	-0.001	0.001	0.001	
		-0.006	0.000	0.000	0.003	
		-0.007	0.000	0.001	0.004	
		-0.003	0.001	0.001	-0.001	
		-0.005	0.000	0.003	0.001	
		-0.004	-0.001	0.003	0.003	
		-0.004	0.005	0.000	-0.001	
		-0.004	-0.001	0.000	0.000	
		-0.005	0.001	-0.001	-0.001	
160578	11/27/2013	-0.003	0.000	0.002		Weight changes fall within required range
		-0.003	-0.001	0.003		
		-0.002	0.000	0.003		
		-0.001	0.000	-0.002		
		-0.001	-0.001	0.001		
		-0.003	-0.002	0.003		
		0.002	0.000	0.001		
		-0.003	0.000	-0.001		
		0.000	-0.002	0.004		
		-0.001	-0.002	0.004		
		-0.002	0.001	-0.001		
		-0.002	-0.004	0.000		
160754	11/27/2013	-0.002	0.000	0.001		Weight changes fall within required range
		0.000	0.000	-0.001		
		-0.002	0.000	0.000		
		-0.001	0.000	0.001		
		-0.003	0.001	0.000		
		-0.002	0.001	0.000		
		-0.002	0.000	0.001		
		-0.002	-0.001	0.001		
		-0.003	0.002	-0.001		
		-0.002	0.001	0.000		
		-0.005	0.002	0.000		
		-0.003	0.001	0.000		
160767	12/5/2013	0.002	-0.002	0.000	0.000	Weight changes fall within required
		0.000	-0.001	-0.002	0.002	
		-0.001	-0.002	-0.001	0.000	

Lot	Received	24 Hours (mg)	48 Hours (mg)	72 Hours (mg)	96 Hours (mg)	Comment
		-0.001	0.001	-0.002	-0.001	range
		0.003	0.000	-0.003	0.001	
		0.000	0.002	-0.003	0.001	
		0.000	0.000	-0.003	0.000	
		0.001	-0.001	-0.001	-0.001	
		-0.002	-0.002	-0.001	0.001	
		0.001	-0.001	-0.002	-0.001	
		0.001	-0.001	-0.002	-0.001	
		0.001	-0.004	-0.003	0.000	
161068	12/5/2013	0.000	-0.004	0.000	0.001	Weight changes fall within required range
		0.001	-0.002	-0.003	0.004	
		0.000	-0.003	-0.004	0.003	
		0.002	-0.005	-0.002	0.003	
		0.001	-0.003	-0.001	0.006	
		0.002	-0.003	0.000	0.003	
		0.001	-0.002	-0.002	0.006	
		-0.001	-0.003	-0.001	0.003	
		0.000	-0.005	-0.003	0.005	
		0.000	-0.002	-0.002	0.004	
		-0.001	0.000	-0.001	0.006	
		0.002	-0.004	-0.004	0.006	

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.

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

Type of Evaluation	Date	Administered By	Significant Findings/Comments
Internal Audit	January 25, 2013	RTI FRM Project QA Officer	The auditor noted that the gravimetric chambers were clean and that the log books and records were up to date.
Proficiency Evaluation (PE)	June 26, 2013 (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 2012-2013. 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	February 25-26, 2013	National Environmental Laboratory Accreditation Program (NELAP)	Mitzi Miller of Dade Moeller & Associates represented the Louisiana Department of Environmental Quality (LDEQ) Environmental Laboratory Accreditation Program (LELAP) to conduct an onsite assessment of RTI's laboratory. The Corrective Action Plan from the assessment indicated only two minor findings for the Gravimetric Laboratory related to reviewing and updating the QAPP to include a review history page and specific language pertaining to the computer backup server. Findings for ICP-MS or XRF metals analysis were also minor.

3.2 Ions Analysis Laboratory

The Ion Analysis Laboratory used ten ion chromatograph systems to analyze 20,054 filter samples for cations (sodium, potassium, and ammonium) and anions (nitrate and sulfate). The analyses were performed for the CSN program during the period January 1 through December 31, 2013.

3.2.1 Quality Issues and Corrective Actions

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

3.2.2 Description of QA/QC Checks Applied

Ion chromatographic analyses were performed by personnel from RTI's Technology for Industry and the Environment Division – Environmental Chemistry Department (TIE-ECD). Ten Dionex ion chromatographic systems were used for performance of the measurements and are summarized in **Table 3-4**. Distribution of samples among these ten 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
A1	DX-500	SO_4^{2-}, NO_3^-
A2	DX-500	SO_4^{2-}, NO_3^-
A3	DX-600	SO_4^{2-}, NO_3^-
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^-
C1	DX-500	Na^+, NH_4^+, K^+
C2	DX-600	Na^+, NH_4^+, K^+
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^+

QA/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 QA/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; and (3) a commercially-prepared, NIST-traceable QA sample containing known concentrations of each ion.

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

QA/QC Check	Frequency	Requirements
Calibration Regression Parameters	Daily	r $\geq$0.999
Initial QA/QC Checks: ▪ RTI prepared QC sample at mid- to high-range concentration ▪ RTI prepared QC sample at lower-end concentration ▪ Commercially prepared, NIST- traceable QA sample	Daily, immediately after calibration Daily, immediately after calibration Daily, immediately after calibration	Measured concentrations within 10% of known values Measured concentrations within 10% of known values Measured concentrations within 10% of known values
Periodic QA/QC Checks: ▪ Replicate sample † ▪ QA/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.

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

Instrument	Nitrate	Sulfate	Sodium	Ammonium	Potassium
A1	0.059	0.066	NA	NA	NA
A2	0.058	0.090	NA	NA	NA
A3	0.066	0.074	NA	NA	NA
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
C1	NA	NA	0.290	0.160	0.134
C2	NA	NA	0.290	0.160	0.134
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 QA/QC Samples

Ion	Sample ID	Description/Specification
Anions	QA-CPI_LOW	0.6 ppm nitrate, 1.2 ppm sulfate
	QA-CPI_MED-HI	3.0 ppm nitrate, 6.0 ppm sulfate
	RTI-QC-HIGH	6.0 ppm nitrate, 12.0 ppm sulfate
	RTI-QC-LOW	0.6 ppm nitrate, 1.2 ppm sulfate
	RTI-QC-MED	1.5 ppm nitrate, 3.0 ppm sulfate
Cations	GFS 0.4 PPM QA	0.4 ppm each sodium, ammonium, and potassium
	GFS 4.0 PPM QA	4.0 ppm each sodium, ammonium, and potassium
	RTI 2.0 PPM QC Reg Std	2.0 ppm each sodium, ammonium, and potassium
	RTI 5.0 PPM QC	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 (standards prepared by RTI)
- Percent recovery for QA samples (commercial standards)
- 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 (prepared by RTI) samples and with low and medium-high QA samples (commercially prepared and NIST-traceable) for all of the instruments used for analysis.

Table 3-8. Average Percent Recovery for QA and QC Samples

Analyte	Sample ID	Count	Conc. µg/mL	Avg % Rec *	SD	Min	Max
Nitrate	QA-CPI_LOW	394	0.6	97.5%	1.8%	0.560	0.623
	QA-CPI_MED-HI	259	3.0	100.4%	2.0%	2.892	3.342
	QA-HIGH	257	6.0	101.0%	1.5%	5.845	6.377
	QA-LOW	506	0.6	97.3%	1.7%	0.555	0.641
	QA-MED	672	1.5	99.0%	1.6%	1.365	1.618
Sulfate	QA-CPI_LOW	394	1.2	98.8%	1.6%	1.107	1.245
	QA-CPI_MED-HI	259	6.0	100.9%	1.9%	5.680	6.633
	QA-HIGH	257	12.0	101.9%	1.3%	11.721	12.738
	QA-LOW	506	1.2	99.4%	1.6%	1.124	1.298
	QA-MED	672	3.0	101.0%	1.6%	2.793	3.239
Sodium	GFS 0.4 PPM QA	525	0.4	100.2%	2.7%	0.375	0.440
	GFS 4.0 PPM QA	533	4.0	100.0%	1.7%	3.771	4.244
	RTI 2.0 PPM QC	429	2.0	99.9%	1.4%	1.845	2.141
	RTI 5.0 PPM QC	413	5.0	100.1%	1.5%	4.574	5.236
Ammonium	GFS 0.4 PPM QA	525	0.4	102.1%	2.8%	0.362	0.456
	GFS 4.0 PPM QA	533	4.0	100.8%	1.4%	3.599	4.231
	RTI 2.0 PPM QC	429	2.0	99.2%	1.4%	1.766	2.047
	RTI 5.0 PPM QC	413	5.0	100.0%	2.0%	4.479	5.443
Potassium	GFS 0.4 PPM QA	525	0.4	97.3%	2.8%	0.357	0.420
	GFS 4.0 PPM QA	533	4.0	99.4%	1.4%	3.742	4.149
	RTI 2.0 PPM QC	429	2.0	99.9%	1.3%	1.855	2.104
	RTI 5.0 PPM QC	413	5.0	99.9%	1.3%	4.580	5.146

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

Average recoveries for the QA samples ranged from 97.3 to 102.1% 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 100 to 101.2%.

Table 3-9. Average Percent Recovery for Spikes

Analyte	Avg Recovery *	StDev	Count	Min	Max
Nitrate	101.0%	2.3%	542	92.9%	133.4%
Sulfate	100.8%	1.8%	542	93.6%	115.5%
Sodium	101.2%	1.8%	552	93.8%	110.0%
Ammonium	100.6%	1.9%	550	93.7%	110.4%
Potassium	100.0%	2.4%	552	90.7%	109.9%

* Acceptance criteria for average percent recovery is ± 10%

Table 3-10 presents filter blank (NQC BLANK) and reagent blank statistics for all analytes over the 12-month period.

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

Analyte	Type	Count	Avg	StDev	Min	Max
Nitrate	Reagent	659	0.001	0.004	0.000	0.036
	NQC	339	0.003	0.006	0.000	0.038
Sulfate	Reagent	659	0.002	0.005	0.000	0.040
	NQC	339	0.003	0.005	0.000	0.023
Sodium	Reagent	663	0.001	0.004	0.000	0.040
	NQC	50	0.001	0.003	0.000	0.011
Ammonium	Reagent	663	0.000	0.002	-0.012	0.014
	NQC	50	0.001	0.002	0.000	0.008
Potassium	Reagent	663	0.000	0.002	0.000	0.032
	NQC	50	0.000	0.002	0.000	0.008

* 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, 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. A comparison of the ranges reported between the two instruments indicates very close results.

Table 3-11 compares QA and QC samples run on separate instruments on the same day. Each day, the anion instruments ran at least two QC and three QA samples. Similarly, the cation instruments ran at least two QC and two QA samples on each instrument each day. This Table shows that the difference between two instruments analyzing the same QA or QC sample are very small. 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	QA/QC Type	Conc., ppm	Count	Average * Difference	Standard Deviation of Diff.	Minimum Diff.	Maximum Diff.
Nitrate	QA-CPI_LOW	1.2	41	-0.010	0.010	-0.037	0.008
	QA-CPI_MED-HI	6.0	21	0.004	0.027	-0.047	0.047
	QA-HIGH	12.0	23	0.055	0.040	-0.049	0.130
	QA-LOW	1.2	81	-0.008	0.010	-0.045	0.021
	QA-MED	3.0	116	-0.012	0.015	-0.056	0.019
Sulfate	QA-CPI_LOW	1.2	41	-0.011	0.011	-0.033	0.010
	QA-CPI_MED-HI	6.0	21	0.052	0.047	-0.059	0.146
	QA-HIGH	12.0	23	0.065	0.036	0.009	0.136
	QA-LOW	1.2	81	-0.010	0.013	-0.048	0.053
	QA-MED	3.0	116	0.000	0.021	-0.044	0.075
Sodium	GFS 0.4 PPM QA	0.4	76	0.007	0.004	-0.002	0.016
	GFS 4.0 PPM QA	4.0	76	-0.007	0.029	-0.147	0.041
	RTI 2.0 PPM QC	2.0	43	0.001	0.019	-0.068	0.072
	RTI 5.0 PPM QC	5.0	43	-0.004	0.047	-0.196	0.078
Ammonium	GFS 0.4 PPM QA	0.4	76	0.001	0.011	-0.020	0.037
	GFS 4.0 PPM QA	4.0	76	-0.011	0.095	-0.450	0.145
	RTI 2.0 PPM QC	2.0	43	-0.002	0.042	-0.225	0.052

Analyte	QA/QC Type	Conc., ppm	Count	Average * Difference	Standard Deviation of Diff.	Minimum Diff.	Maximum Diff.
	RTI 5.0 PPM QC	5.0	43	-0.042	0.159	-0.535	0.110
Potassium	GFS 0.4 PPM QA	0.4	76	0.008	0.007	-0.011	0.019
	GFS 4.0 PPM QA	4.0	76	0.000	0.020	-0.038	0.048
	RTI 2.0 PPM QC	2.0	43	-0.002	0.016	-0.020	0.055
	RTI 5.0 PPM QC	5.0	43	0.003	0.031	-0.061	0.088

* 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 2013, 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 June 26, 2013, indicated good performance by RTI’s IC lab.

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 16,755 quartz-fiber filters during the period January 1, 2013 through December 31, 2013 (sent to DRI twice per month in filter batches numbered 164 through 187). DRI performed 20,263 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. Eleven DRI Model 2001 Thermal/Optical Carbon Analyzers (designated as Units # 6 – 13, 16, 18, 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 2013.

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 20,262 analyses (this does not include the Yakima Winter sample received in filter batch 164), there were 1,393 runs flagged as invalid. In addition, 3,263 runs were assigned blank or backup flags (i.e., backup filters, trip blanks, SHAL blanks, and 24-hour field blanks) based on information that RTI provided to DRI on February 4, 2014. 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 February 2014, after all the 2013 data had been processed and validated.

There were 2,115 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. 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 twelve carbon aerosol analyzers used during the period. **Table 3-15** gives the laboratory blank statistics for each of the eleven 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.

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	8
v		Void (invalid) analysis result	1393
	v2	Replicate analysis failed acceptable limit	90
	v3	Potential contamination	26
	v5	Analytical instrument error	1222
	v6	Analyst error	38
	v7	Software malfunction	17
		Total (n, s, v)	1403
r		Replicate analysis	2115
	r1	First replicate analysis on same analyzer (duplicate)	127
	r5	Replicate on different analyzer	1988
		No n, s, v, or r flag	16744
		Total no. of original sample runs (incl. blank and replicate flags)	20262

Tables 3-16 through **3-19** give the analysis results by analyzer for the 24-hour field blanks, backup filters, trip blanks, and SHAL blanks, respectively. These blank filters were identified based upon the list of blank filters IDs provided to DRI by RTI on February 4, 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, backup filters, or trip blanks. 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, some of which may be sampled filters that were incorrectly identified as blanks. For SHAL, trip, and 24-hour field blanks, the number of filters with TC > 2.0 µg/cm^2 (excluding replicates) was 0, 16, and 149, respectively. For all types of blanks, it was found that nearly all the TC was in OC, with negligible quantities of EC.

Table 3-20 summarizes the results for each type of blank combined over all analyzers. Average TC concentration for the 161 SHAL blanks was 0.2 ± 0.2 µgC/cm^2, while it was 1.3 ± 0.9 µgC/cm^2 for the 176 trip blanks, 1.3 ± 1.2 µgC/cm^2 for the 1,423 field blanks was, and 2.6 ± 1.6 µgC/cm^2 for the 962 backup filters.

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	23	Mean	0.000	0.005	0.009	0.001	0.000	0.000	0.015	0.015	0.000	0.000	0.000	0.000	0.000	0.015
		StdDev	0.001	0.020	0.034	0.006	0.000	0.000	0.060	0.059	0.000	0.000	0.001	0.001	0.001	0.060
		Max	0.002	0.098	0.162	0.026	0.001	0.000	0.287	0.286	0.001	0.001	0.004	0.004	0.004	0.289
		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
7	8	Mean	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
		StdDev	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
		Max	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
		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	26	Mean	0.000	0.001	0.009	0.002	0.000	0.001	0.012	0.013	0.001	0.000	0.000	0.001	0.000	0.013
		StdDev	0.000	0.003	0.018	0.010	0.000	0.003	0.024	0.024	0.003	0.000	0.000	0.003	0.000	0.024
		Max	0.001	0.012	0.059	0.051	0.000	0.018	0.090	0.090	0.018	0.000	0.000	0.018	0.000	0.090
		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	22	Mean	0.000	0.001	0.003	0.000	0.000	0.000	0.003	0.003	0.000	0.000	0.000	0.001	0.001	0.004
		StdDev	0.000	0.003	0.006	0.001	0.000	0.000	0.007	0.007	0.000	0.001	0.001	0.001	0.001	0.008
		Max	0.000	0.013	0.025	0.003	0.000	0.000	0.025	0.025	0.000	0.005	0.004	0.005	0.005	0.025
		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	25	Mean	0.003	0.006	0.019	0.003	0.000	0.000	0.030	0.030	0.001	0.002	0.000	0.003	0.003	0.033
		StdDev	0.012	0.018	0.044	0.009	0.000	0.000	0.070	0.070	0.004	0.008	0.001	0.014	0.014	0.080
		Max	0.060	0.080	0.184	0.037	0.000	0.001	0.262	0.263	0.022	0.042	0.004	0.068	0.068	0.331
		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	0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.002
11	31	Mean	0.000	0.005	0.005	0.000	0.000	0.000	0.011	0.011	0.000	0.000	0.000	0.000	0.000	0.011
		StdDev	0.000	0.029	0.027	0.000	0.000	0.000	0.055	0.055	0.000	0.000	0.000	0.000	0.000	0.055
		Max	0.000	0.161	0.147	0.000	0.000	0.000	0.308	0.308	0.000	0.000	0.000	0.000	0.000	0.308
		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	22	Mean	0.005	0.013	0.026	0.001	0.000	0.000	0.045	0.045	0.001	0.001	0.003	0.005	0.005	0.050
		StdDev	0.018	0.034	0.049	0.005	0.000	0.000	0.087	0.087	0.002	0.003	0.010	0.011	0.011	0.088
		Max	0.083	0.147	0.225	0.023	0.000	0.000	0.372	0.372	0.011	0.010	0.037	0.037	0.037	0.372
		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	0.009	0.000	0.000	0.000	0.009	0.009	0.000	0.000	0.000	0.000	0.000	0.016
13	14	Mean	0.001	0.007	0.015	0.001	0.000	0.000	0.023	0.023	0.000	0.000	0.002	0.004	0.004	0.027
		StdDev	0.003	0.017	0.035	0.002	0.000	0.000	0.053	0.053	0.000	0.001	0.008	0.009	0.009	0.054
		Max	0.013	0.053	0.124	0.006	0.000	0.000	0.177	0.177	0.000	0.004	0.030	0.030	0.030	0.177
		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
16	28	Mean	0.001	0.015	0.027	0.002	0.000	0.000	0.045	0.045	0.000	0.000	0.000	0.000	0.000	0.045
		StdDev	0.004	0.058	0.050	0.010	0.000	0.000	0.115	0.115	0.000	0.000	0.000	0.000	0.000	0.115
		Max	0.020	0.306	0.255	0.051	0.000	0.000	0.611	0.611	0.000	0.002	0.000	0.002	0.002	0.611
		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	0.011	0.000	0.000	0.000	0.013	0.013	0.000	0.000	0.000	0.000	0.000	0.013
18	0	Mean														
		StdDev														
		Max														
		Min														
		Median														
20	2	Mean	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
		StdDev	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
		Max	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
		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	201	Mean	0.001	0.006	0.013	0.001	0.000	0.000	0.022	0.022	0.000	0.001	0.001	0.001	0.001	0.023
		StdDev	0.007	0.029	0.035	0.006	0.000	0.001	0.067	0.067	0.002	0.004	0.004	0.007	0.007	0.069
		Max	0.083	0.306	0.255	0.051	0.001	0.018	0.611	0.611	0.022	0.042	0.037	0.068	0.068	0.611
		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

* 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	276	Mean	0.001	0.002	0.008	0.001	0.000	0.003	0.012	0.015	0.000	0.001	0.004	0.005	0.003	0.018
		StdDev	0.003	0.009	0.027	0.007	0.002	0.023	0.040	0.049	0.006	0.009	0.017	0.028	0.014	0.053
		Max	0.035	0.095	0.306	0.084	0.014	0.353	0.385	0.438	0.099	0.141	0.149	0.371	0.152	0.456
		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	-0.002	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
7	140	Mean	0.002	0.004	0.015	0.002	0.001	0.003	0.024	0.026	0.001	0.001	0.003	0.005	0.002	0.029
		StdDev	0.008	0.019	0.050	0.011	0.006	0.016	0.083	0.085	0.005	0.008	0.015	0.020	0.014	0.091
		Max	0.068	0.148	0.419	0.102	0.067	0.143	0.639	0.639	0.056	0.069	0.130	0.146	0.146	0.639
		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	315	Mean	0.000	0.002	0.013	0.003	0.001	0.003	0.019	0.021	0.001	0.001	0.004	0.006	0.004	0.025
		StdDev	0.005	0.013	0.036	0.014	0.005	0.015	0.061	0.062	0.007	0.004	0.025	0.026	0.019	0.071
		Max	0.082	0.183	0.357	0.143	0.080	0.151	0.682	0.682	0.080	0.037	0.312	0.312	0.190	0.724
		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	260	Mean	0.001	0.004	0.021	0.002	0.000	0.001	0.028	0.030	0.000	0.001	0.002	0.003	0.001	0.031
		StdDev	0.005	0.018	0.056	0.010	0.001	0.008	0.081	0.084	0.003	0.004	0.010	0.012	0.009	0.084
		Max	0.060	0.127	0.586	0.103	0.020	0.082	0.802	0.855	0.032	0.040	0.103	0.116	0.116	0.850
		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	-0.005	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	265	Mean	0.001	0.007	0.017	0.003	0.000	0.002	0.028	0.031	0.001	0.001	0.002	0.004	0.002	0.032
		StdDev	0.007	0.023	0.043	0.012	0.001	0.011	0.075	0.081	0.012	0.009	0.009	0.021	0.018	0.083
		Max	0.088	0.171	0.368	0.093	0.011	0.085	0.621	0.706	0.197	0.102	0.092	0.299	0.299	0.706
		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	0.002	0.000	0.000	0.000	0.000	0.000	0.002
11	319	Mean	0.001	0.004	0.012	0.002	0.000	0.002	0.018	0.020	0.001	0.000	0.001	0.003	0.001	0.021
		StdDev	0.006	0.017	0.034	0.012	0.001	0.010	0.059	0.062	0.005	0.004	0.010	0.012	0.005	0.063
		Max	0.075	0.150	0.275	0.153	0.011	0.133	0.477	0.490	0.052	0.056	0.161	0.161	0.056	0.490
		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	284	Mean	0.007	0.006	0.018	0.003	0.000	0.003	0.035	0.037	0.001	0.003	0.004	0.007	0.005	0.042
		StdDev	0.020	0.021	0.043	0.013	0.003	0.013	0.074	0.077	0.005	0.009	0.022	0.027	0.020	0.083
		Max	0.134	0.236	0.298	0.101	0.040	0.136	0.662	0.662	0.047	0.066	0.278	0.278	0.173	0.662
		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	-0.006	0.000
		Median	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.003	0.000	0.000	0.000	0.000	0.000	0.006
13	178	Mean	0.000	0.005	0.014	0.002	0.000	0.002	0.022	0.023	0.001	0.001	0.002	0.004	0.002	0.025
		StdDev	0.002	0.018	0.038	0.013	0.000	0.009	0.064	0.066	0.004	0.004	0.010	0.013	0.008	0.069
		Max	0.017	0.161	0.271	0.132	0.001	0.072	0.532	0.532	0.034	0.040	0.092	0.094	0.082	0.569
		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
16	289	Mean	0.001	0.013	0.022	0.004	0.000	0.001	0.040	0.041	0.001	0.000	0.001	0.002	0.001	0.042
		StdDev	0.006	0.034	0.042	0.014	0.000	0.008	0.085	0.086	0.004	0.002	0.005	0.009	0.004	0.087
		Max	0.093	0.292	0.258	0.110	0.004	0.104	0.628	0.628	0.051	0.024	0.052	0.104	0.039	0.632
		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	-0.002	0.000
		Median	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.002
18	14	Mean	0.001	0.004	0.039	0.007	0.000	0.010	0.051	0.061	0.002	0.003	0.005	0.010	0.001	0.062
		StdDev	0.003	0.013	0.145	0.025	0.001	0.028	0.182	0.190	0.007	0.010	0.018	0.029	0.001	0.190
		Max	0.009	0.049	0.544	0.092	0.003	0.103	0.685	0.713	0.027	0.037	0.068	0.107	0.003	0.713
		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	36	Mean	0.038	0.033	0.012	0.001	0.000	0.000	0.084	0.084	0.000	0.000	0.000	0.000	0.000	0.084
		StdDev	0.121	0.094	0.027	0.004	0.000	0.001	0.237	0.238	0.001	0.000	0.000	0.001	0.001	0.238
		Max	0.668	0.517	0.106	0.026	0.000	0.005	1.291	1.291	0.005	0.000	0.002	0.005	0.005	1.291
		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	2376	Mean	0.002	0.006	0.016	0.003	0.000	0.002	0.026	0.028	0.001	0.001	0.003	0.004	0.002	0.030
		StdDev	0.018	0.024	0.042	0.012	0.003	0.013	0.077	0.079	0.006	0.006	0.015	0.020	0.014	0.082
		Max	0.668	0.517	0.586	0.153	0.080	0.353	1.291	1.291	0.197	0.141	0.312	0.371	0.299	1.291
		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	-0.006	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	165	Mean	0.108	0.365	0.616	0.085	0.009	0.032	1.183	1.206	0.044	0.016	0.001	0.052	0.029	1.234
		StdDev	0.096	0.295	0.451	0.171	0.095	0.180	0.948	1.024	0.331	0.089	0.004	0.325	0.243	1.202
		Max	0.603	2.735	2.423	1.601	1.206	2.213	8.441	9.449	4.206	1.107	0.047	4.113	3.106	12.554
		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	0.101	0.302	0.459	0.028	0.000	0.000	0.905	0.915	0.000	0.000	0.000	0.000	0.000	0.916
7	8	Mean	0.125	0.258	0.533	0.027	0.000	0.000	0.943	0.943	0.000	0.003	0.000	0.003	0.003	0.946
		StdDev	0.093	0.072	0.202	0.045	0.000	0.000	0.358	0.358	0.000	0.009	0.000	0.009	0.009	0.366
		Max	0.259	0.412	0.928	0.134	0.000	0.000	1.716	1.716	0.000	0.024	0.000	0.024	0.024	1.740
		Min	0.000	0.171	0.339	0.000	0.000	0.000	0.631	0.631	0.000	0.000	0.000	0.000	0.000	0.631
		Median	0.104	0.238	0.462	0.014	0.000	0.000	0.841	0.841	0.000	0.000	0.000	0.000	0.000	0.841
8	255	Mean	0.112	0.359	0.786	0.116	0.018	0.038	1.392	1.412	0.038	0.009	0.000	0.030	0.010	1.422
		StdDev	0.121	0.191	0.890	0.279	0.171	0.170	1.421	1.444	0.192	0.035	0.001	0.086	0.060	1.484
		Max	1.197	1.360	9.252	3.231	2.542	2.182	16.398	16.039	2.641	0.398	0.016	0.603	0.858	16.896
		Min	0.000	0.094	0.214	0.000	0.000	0.000	0.308	0.308	0.000	0.000	0.000	0.000	0.000	0.308
		Median	0.095	0.308	0.559	0.050	0.000	0.000	1.052	1.052	0.000	0.000	0.000	0.000	0.000	1.052
9	154	Mean	0.121	0.395	0.632	0.065	0.016	0.035	1.230	1.249	0.036	0.009	0.000	0.030	0.011	1.260
		StdDev	0.253	0.637	0.515	0.187	0.145	0.200	1.434	1.466	0.227	0.051	0.003	0.139	0.078	1.498
		Max	2.987	7.821	4.579	1.346	1.749	2.317	15.075	15.075	2.710	0.547	0.032	1.508	0.939	15.075
		Min	0.000	0.010	0.111	0.000	0.000	0.000	0.121	0.121	0.000	0.000	0.000	0.000	0.000	0.121
		Median	0.099	0.297	0.488	0.000	0.000	0.000	0.956	0.956	0.000	0.000	0.000	0.000	0.000	0.956
10	191	Mean	0.153	0.331	0.594	0.059	0.003	0.018	1.140	1.155	0.016	0.004	0.000	0.017	0.002	1.157
		StdDev	0.141	0.185	0.552	0.143	0.023	0.082	0.859	0.912	0.072	0.014	0.001	0.071	0.010	0.913
		Max	1.132	1.465	5.854	1.427	0.292	0.734	8.392	8.835	0.648	0.097	0.013	0.517	0.091	8.835
		Min	0.000	0.000	0.089	0.000	0.000	0.000	0.089	0.089	0.000	0.000	0.000	0.000	0.000	0.089
		Median	0.130	0.289	0.449	0.012	0.000	0.000	0.897	0.897	0.000	0.000	0.000	0.000	0.000	0.897
11	173	Mean	0.105	0.348	0.648	0.084	0.003	0.016	1.188	1.201	0.019	0.016	0.001	0.033	0.020	1.221
		StdDev	0.092	0.183	0.599	0.176	0.018	0.054	0.934	0.963	0.069	0.143	0.007	0.167	0.155	1.021
		Max	0.401	1.397	4.455	1.222	0.164	0.366	7.085	7.410	0.645	1.867	0.091	1.957	1.957	7.918
		Min	0.000	0.092	0.083	0.000	0.000	0.000	0.291	0.291	0.000	0.000	0.000	0.000	-0.029	0.291
		Median	0.102	0.314	0.465	0.018	0.000	0.000	0.964	0.964	0.000	0.000	0.000	0.000	0.000	0.964
12	173	Mean	0.176	0.396	0.743	0.119	0.011	0.026	1.445	1.460	0.036	0.012	0.001	0.038	0.023	1.483
		StdDev	0.138	0.213	0.797	0.221	0.053	0.090	1.210	1.245	0.160	0.045	0.004	0.167	0.154	1.313
		Max	0.813	2.043	8.658	1.650	0.526	0.643	11.712	11.914	1.856	0.525	0.034	2.038	1.992	11.914
		Min	0.000	0.159	0.207	0.000	0.000	0.000	0.439	0.439	0.000	0.000	0.000	0.000	0.000	0.439
		Median	0.158	0.359	0.566	0.060	0.000	0.000	1.197	1.209	0.000	0.000	0.000	0.000	0.000	1.213
13	124	Mean	0.187	0.361	0.667	0.058	0.000	0.014	1.272	1.287	0.016	0.006	0.000	0.022	0.008	1.295
		StdDev	0.126	0.146	0.765	0.162	0.000	0.046	1.038	1.068	0.045	0.033	0.003	0.059	0.037	1.074
		Max	0.711	1.063	7.064	1.212	0.000	0.294	9.593	9.788	0.280	0.343	0.032	0.352	0.352	9.838
		Min	0.000	0.135	0.192	0.000	0.000	0.000	0.391	0.391	0.000	0.000	0.000	0.000	0.000	0.391
		Median	0.181	0.332	0.500	0.000	0.000	0.000	1.062	1.062	0.000	0.000	0.000	0.000	0.000	1.069
16	153	Mean	0.104	0.420	0.722	0.089	0.003	0.014	1.337	1.349	0.012	0.007	0.000	0.016	0.005	1.353
		StdDev	0.185	0.261	0.479	0.146	0.024	0.044	0.915	0.935	0.037	0.021	0.002	0.039	0.020	0.938
		Max	1.605	2.238	3.684	1.054	0.241	0.362	6.697	6.819	0.241	0.166	0.021	0.176	0.166	6.819
		Min	0.000	0.032	0.282	0.000	0.000	0.000	0.321	0.321	0.000	0.000	0.000	0.000	0.000	0.321
		Median	0.068	0.366	0.615	0.054	0.000	0.000	1.163	1.163	0.000	0.000	0.000	0.000	0.000	1.172
18	2	Mean	0.353	0.377	0.604	0.126	0.000	0.056	1.461	1.517	0.010	0.050	0.001	0.062	0.006	1.523
		StdDev	0.059	0.062	0.041	0.053	0.000	0.067	0.097	0.163	0.014	0.042	0.002	0.058	0.009	0.155
		Max	0.395	0.421	0.633	0.164	0.000	0.103	1.529	1.632	0.020	0.080	0.003	0.103	0.012	1.632
		Min	0.311	0.333	0.575	0.089	0.000	0.009	1.393	1.402	0.000	0.021	0.000	0.021	0.000	1.414
		Median	0.353	0.377	0.604	0.126	0.000	0.056	1.461	1.517	0.010	0.050	0.001	0.062	0.006	1.523
20	25	Mean	0.071	0.304	0.504	0.030	0.000	0.000	0.910	0.910	0.015	0.003	0.001	0.020	0.020	0.930
		StdDev	0.073	0.113	0.190	0.044	0.000	0.000	0.326	0.326	0.037	0.011	0.006	0.040	0.040	0.343
		Max	0.236	0.670	1.107	0.194	0.000	0.000	1.837	1.837	0.130	0.042	0.031	0.130	0.130	1.935
		Min	0.000	0.150	0.187	0.000	0.000	0.000	0.345	0.345	0.000	0.000	0.000	0.000	0.000	0.345
		Median	0.049	0.281	0.479	0.011	0.000	0.000	0.816	0.816	0.000	0.000	0.000	0.000	0.000	0.837
All	1423	Mean	0.130	0.368	0.678	0.086	0.008	0.025	1.271	1.287	0.028	0.010	0.000	0.030	0.013	1.300
		StdDev	0.151	0.291	0.660	0.196	0.096	0.126	1.125	1.159	0.172	0.066	0.004	0.154	0.119	1.207
		Max	2.987	7.821	9.252	3.231	2.542	2.317	16.398	16.039	4.206	1.867	0.091	4.113	3.106	16.896
		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	-0.029	0.053
		Median	0.110	0.321	0.512	0.029	0.000	0.000	1.005	1.007	0.000	0.000	0.000	0.000	0.000	1.011

* Excludes replicates

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

Analyzer No.	No.*	Statistic*	O1TC	O2TC	O3TC	O4TC	OPTRC	OPTTC	OCTRC	OCTTC	E1TC	E2TC	E3TC	ECTRC	ECTTC	TCTC
			IMPROVE_A Parameter (units are µg C/cm²)													
6	102	Mean	0.318	0.843	1.017	0.264	0.030	0.069	2.473	2.512	0.056	0.025	0.001	0.051	0.012	2.524
		StdDev	0.249	0.390	0.762	0.253	0.144	0.162	1.451	1.492	0.131	0.040	0.003	0.079	0.027	1.499
		Max	1.287	2.024	6.348	1.660	1.322	1.322	10.824	10.824	1.096	0.226	0.015	0.335	0.197	10.824
		Min	0.000	0.207	0.205	0.000	0.000	0.000	0.521	0.521	0.000	0.000	0.000	0.000	0.000	0.521
		Median	0.272	0.762	0.837	0.185	0.000	0.004	2.292	2.322	0.005	0.004	0.000	0.011	0.000	2.333
7	8	Mean	0.707	0.762	1.149	0.325	0.072	0.120	3.016	3.064	0.081	0.050	0.000	0.059	0.011	3.075
		StdDev	0.665	0.364	0.701	0.260	0.203	0.220	1.592	1.619	0.144	0.087	0.000	0.072	0.027	1.621
		Max	2.027	1.233	2.067	0.582	0.575	0.640	5.713	5.778	0.400	0.248	0.000	0.192	0.078	5.786
		Min	0.122	0.024	0.035	0.000	0.000	0.000	0.224	0.224	0.000	0.000	0.000	0.000	0.000	0.224
		Median	0.474	0.811	1.382	0.471	0.000	0.021	3.051	3.086	0.010	0.002	0.000	0.037	0.000	3.111
8	165	Mean	0.273	0.787	1.182	0.278	0.016	0.061	2.536	2.581	0.047	0.019	0.000	0.050	0.006	2.586
		StdDev	0.295	0.460	0.931	0.284	0.074	0.124	1.711	1.768	0.105	0.038	0.001	0.098	0.020	1.770
		Max	2.823	2.889	7.780	2.052	0.683	0.683	11.050	11.198	0.683	0.248	0.012	0.577	0.168	11.198
		Min	0.000	0.109	0.275	0.000	0.000	0.000	0.483	0.483	0.000	0.000	0.000	0.000	0.000	0.483
		Median	0.219	0.685	0.968	0.201	0.000	0.000	2.088	2.123	0.000	0.000	0.000	0.006	0.000	2.123
9	108	Mean	0.316	0.821	1.133	0.228	0.011	0.053	2.509	2.551	0.031	0.025	0.000	0.046	0.003	2.555
		StdDev	0.228	0.383	0.698	0.200	0.039	0.089	1.247	1.293	0.062	0.043	0.001	0.072	0.011	1.296
		Max	1.059	1.766	4.147	0.897	0.298	0.495	6.058	6.233	0.353	0.197	0.014	0.356	0.062	6.296
		Min	0.000	0.130	0.198	0.000	0.000	0.000	0.381	0.381	0.000	0.000	0.000	0.000	0.000	0.381
		Median	0.298	0.782	0.986	0.175	0.000	0.006	2.401	2.427	0.000	0.000	0.000	0.009	0.000	2.427
10	114	Mean	0.485	0.668	1.021	0.232	0.011	0.076	2.416	2.482	0.062	0.018	0.000	0.070	0.005	2.486
		StdDev	0.360	0.354	0.703	0.246	0.043	0.160	1.416	1.508	0.142	0.045	0.002	0.148	0.020	1.516
		Max	1.781	1.873	4.069	1.400	0.336	1.064	8.110	8.407	1.024	0.228	0.019	1.064	0.172	8.579
		Min	0.000	0.000	0.139	0.000	0.000	0.000	0.139	0.139	0.000	0.000	0.000	0.000	0.000	0.139
		Median	0.410	0.593	0.830	0.152	0.000	0.000	2.133	2.154	0.000	0.000	0.000	0.000	0.000	2.154
11	134	Mean	0.337	0.787	0.918	0.227	0.013	0.059	2.282	2.328	0.053	0.013	0.000	0.052	0.007	2.335
		StdDev	0.342	0.584	0.562	0.196	0.078	0.125	1.374	1.441	0.111	0.032	0.000	0.092	0.023	1.445
		Max	1.489	5.665	4.518	1.145	0.795	0.929	11.184	11.765	0.841	0.191	0.003	0.640	0.186	11.824
		Min	0.000	0.000	0.027	0.000	0.000	0.000	0.027	0.027	0.000	0.000	0.000	0.000	0.000	0.027
		Median	0.267	0.754	0.820	0.192	0.000	0.000	2.136	2.151	0.000	0.000	0.000	0.003	0.000	2.151
12	103	Mean	0.575	0.929	1.173	0.340	0.033	0.102	3.049	3.119	0.076	0.037	0.001	0.082	0.012	3.131
		StdDev	0.398	0.532	0.764	0.276	0.128	0.175	1.654	1.725	0.135	0.058	0.005	0.117	0.029	1.732
		Max	1.751	3.625	4.570	1.563	1.141	1.136	8.953	9.105	0.864	0.293	0.052	0.614	0.140	9.105
		Min	0.000	0.145	0.194	0.000	0.000	0.000	0.339	0.339	0.000	0.000	0.000	0.000	0.000	0.339
		Median	0.516	0.841	1.005	0.290	0.000	0.031	2.724	2.737	0.024	0.006	0.000	0.038	0.000	2.780
13	119	Mean	0.604	0.792	1.014	0.192	0.000	0.055	2.603	2.657	0.044	0.018	0.000	0.062	0.007	2.664
		StdDev	0.419	0.526	0.581	0.177	0.004	0.103	1.439	1.506	0.083	0.049	0.001	0.108	0.032	1.509
		Max	2.038	5.063	3.860	1.001	0.040	0.626	11.447	11.987	0.483	0.338	0.005	0.626	0.257	11.987
		Min	0.000	0.136	0.263	0.000	0.000	0.000	0.519	0.521	0.000	0.000	0.000	0.000	0.000	0.521
		Median	0.529	0.770	0.883	0.151	0.000	0.002	2.461	2.461	0.000	0.000	0.000	0.004	0.000	2.461
16	84	Mean	0.337	0.950	1.305	0.318	0.018	0.079	2.928	2.988	0.056	0.033	0.000	0.070	0.010	2.998
		StdDev	0.318	0.499	0.913	0.304	0.076	0.148	1.694	1.770	0.124	0.049	0.000	0.099	0.026	1.775
		Max	1.413	2.751	6.371	1.801	0.633	1.046	10.364	10.776	0.935	0.234	0.000	0.413	0.119	10.776
		Min	0.000	0.201	0.275	0.000	0.000	0.000	0.512	0.512	0.000	0.000	0.000	0.000	0.000	0.512
		Median	0.289	0.858	1.165	0.264	0.000	0.018	2.726	2.741	0.002	0.003	0.000	0.022	0.000	2.741
18	4	Mean	0.492	0.728	0.986	0.365	0.000	0.184	2.571	2.755	0.109	0.074	0.000	0.184	0.000	2.755
		StdDev	0.272	0.426	0.317	0.096	0.000	0.088	0.728	0.746	0.045	0.044	0.001	0.089	0.001	0.746
		Max	0.858	1.334	1.413	0.442	0.000	0.310	3.595	3.772	0.174	0.136	0.002	0.312	0.002	3.772
		Min	0.200	0.355	0.648	0.237	0.000	0.116	1.874	1.990	0.073	0.032	0.000	0.116	0.000	1.990
		Median	0.455	0.611	0.941	0.392	0.000	0.154	2.408	2.629	0.095	0.065	0.000	0.154	0.000	2.630
20	21	Mean	0.208	0.761	0.821	0.173	0.015	0.040	1.979	2.004	0.035	0.026	0.000	0.046	0.022	2.026
		StdDev	0.292	0.393	0.277	0.107	0.070	0.110	0.819	0.857	0.079	0.041	0.000	0.063	0.029	0.872
		Max	1.313	1.802	1.284	0.367	0.322	0.477	3.780	3.952	0.322	0.175	0.000	0.210	0.083	3.990
		Min	0.000	0.183	0.300	0.000	0.000	0.000	0.576	0.576	0.000	0.000	0.000	0.000	0.000	0.579
		Median	0.158	0.735	0.772	0.207	0.000	0.000	2.001	2.001	0.000	0.003	0.000	0.003	0.000	2.001
All	962	Mean	0.399	0.812	1.083	0.256	0.016	0.068	2.566	2.618	0.053	0.023	0.000	0.060	0.008	2.626
		StdDev	0.356	0.476	0.748	0.245	0.084	0.137	1.510	1.573	0.113	0.045	0.002	0.103	0.024	1.578
		Max	2.823	5.665	7.780	2.052	1.322	1.322	11.447	11.987	1.096	0.338	0.052	1.064	0.257	11.987
		Min	0.000	0.000	0.027	0.000	0.000	0.000	0.027	0.027	0.000	0.000	0.000	0.000	0.000	0.027
		Median	0.314	0.746	0.928	0.191	0.000	0.003	2.307	2.337	0.000	0.000	0.000	0.008	0.000	2.343

* Excludes replicates

Table 3-18. DRI Carbon Analysis Statistics for Trip 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	18	Mean	0.243	0.343	0.466	0.045	0.000	0.009	1.096	1.105	0.011	0.005	0.000	0.017	0.007	1.113
		StdDev	0.060	0.098	0.205	0.051	0.000	0.021	0.343	0.360	0.022	0.022	0.002	0.039	0.023	0.372
		Max	0.340	0.587	1.089	0.177	0.000	0.062	2.029	2.081	0.062	0.095	0.008	0.157	0.095	2.083
		Min	0.135	0.185	0.193	0.000	0.000	0.000	0.568	0.568	0.000	0.000	0.000	0.000	0.000	0.568
		Median	0.243	0.331	0.446	0.036	0.000	0.000	1.061	1.061	0.000	0.000	0.000	0.000	0.000	1.061
7	4	Mean	0.290	0.306	0.651	0.055	0.000	0.000	1.302	1.302	0.000	0.000	0.000	0.000	0.000	1.302
		StdDev	0.029	0.117	0.504	0.110	0.000	0.000	0.731	0.731	0.000	0.000	0.000	0.000	0.000	0.731
		Max	0.312	0.445	1.383	0.221	0.000	0.000	2.361	2.361	0.000	0.000	0.000	0.000	0.000	2.361
		Min	0.250	0.170	0.230	0.000	0.000	0.000	0.685	0.685	0.000	0.000	0.000	0.000	0.000	0.685
		Median	0.299	0.304	0.495	0.000	0.000	0.000	1.080	1.080	0.000	0.000	0.000	0.000	0.000	1.080
8	36	Mean	0.183	0.324	0.579	0.066	0.000	0.009	1.152	1.161	0.009	0.004	0.001	0.013	0.004	1.166
		StdDev	0.088	0.117	0.216	0.056	0.000	0.034	0.385	0.395	0.028	0.015	0.003	0.040	0.012	0.398
		Max	0.427	0.727	1.128	0.211	0.000	0.196	2.175	2.175	0.151	0.070	0.019	0.221	0.062	2.175
		Min	0.000	0.138	0.207	0.000	0.000	0.000	0.410	0.410	0.000	0.000	0.000	0.000	0.000	0.410
		Median	0.179	0.293	0.538	0.064	0.000	0.000	1.057	1.057	0.000	0.000	0.000	0.000	0.000	1.058
9	6	Mean	0.039	0.310	0.496	0.034	0.000	0.001	0.879	0.880	0.001	0.000	0.000	0.001	0.000	0.880
		StdDev	0.045	0.032	0.164	0.042	0.000	0.002	0.186	0.187	0.002	0.000	0.000	0.002	0.000	0.187
		Max	0.100	0.358	0.712	0.107	0.000	0.006	1.137	1.137	0.006	0.000	0.000	0.006	0.000	1.137
		Min	0.000	0.258	0.336	0.000	0.000	0.000	0.710	0.710	0.000	0.000	0.000	0.000	0.000	0.710
		Median	0.030	0.312	0.456	0.021	0.000	0.000	0.806	0.806	0.000	0.000	0.000	0.000	0.000	0.806
10	24	Mean	0.157	0.336	0.513	0.056	0.002	0.011	1.065	1.074	0.009	0.004	0.000	0.010	0.001	1.075
		StdDev	0.095	0.107	0.285	0.083	0.009	0.022	0.415	0.428	0.020	0.014	0.000	0.022	0.005	0.430
		Max	0.368	0.649	1.324	0.313	0.039	0.071	2.233	2.294	0.073	0.063	0.000	0.063	0.025	2.296
		Min	0.000	0.164	0.281	0.000	0.000	0.000	0.451	0.451	0.000	0.000	0.000	0.000	0.000	0.451
		Median	0.148	0.318	0.401	0.028	0.000	0.000	1.002	1.002	0.000	0.000	0.000	0.000	0.000	1.002
11	10	Mean	0.228	0.228	0.231	0.350	0.014	0.000	0.824	0.824	0.000	0.000	0.000	0.000	0.000	0.824
		StdDev	0.071	0.071	0.063	0.168	0.021	0.000	0.153	0.153	0.000	0.000	0.000	0.000	0.000	0.153
		Max	0.313	0.313	0.296	0.743	0.061	0.000	1.165	1.165	0.000	0.000	0.000	0.000	0.000	1.165
		Min	0.065	0.065	0.083	0.219	0.000	0.000	0.654	0.654	0.000	0.000	0.000	0.000	0.000	0.654
		Median	0.239	0.239	0.259	0.271	0.004	0.000	0.805	0.805	0.000	0.000	0.000	0.000	0.000	0.805
12	35	Mean	0.183	0.457	0.657	0.176	0.027	0.049	1.500	1.522	0.037	0.013	0.000	0.022	0.000	1.522
		StdDev	0.092	0.177	0.543	0.175	0.077	0.098	0.912	0.945	0.082	0.030	0.000	0.070	0.000	0.945
		Max	0.406	1.183	3.222	0.955	0.353	0.401	5.565	5.565	0.401	0.119	0.000	0.401	0.000	5.565
		Min	0.003	0.241	0.238	0.000	0.000	0.000	0.516	0.516	0.000	0.000	0.000	0.000	0.000	0.516
		Median	0.174	0.445	0.459	0.119	0.000	0.000	1.234	1.266	0.000	0.000	0.000	0.000	0.000	1.266
13	16	Mean	0.175	0.322	0.710	0.121	0.019	0.037	1.348	1.366	0.037	0.000	0.000	0.017	0.000	1.366
		StdDev	0.103	0.254	1.189	0.319	0.077	0.116	1.756	1.803	0.116	0.000	0.000	0.047	0.000	1.803
		Max	0.354	1.046	3.768	0.954	0.309	0.451	6.086	6.228	0.451	0.000	0.000	0.142	0.000	6.228
		Min	0.009	0.113	0.137	0.000	0.000	0.000	0.398	0.398	0.000	0.000	0.000	0.000	0.000	0.398
		Median	0.156	0.266	0.296	0.000	0.000	0.000	0.750	0.750	0.000	0.000	0.000	0.000	0.000	0.750
16	24	Mean	0.166	0.435	0.844	0.121	0.002	0.013	1.567	1.579	0.014	0.005	0.000	0.017	0.005	1.584
		StdDev	0.091	0.135	0.916	0.256	0.005	0.036	1.212	1.241	0.036	0.010	0.000	0.039	0.013	1.244
		Max	0.324	0.818	4.517	1.202	0.024	0.155	6.479	6.634	0.155	0.039	0.000	0.168	0.052	6.647
		Min	0.009	0.195	0.256	0.000	0.000	0.000	0.554	0.554	0.000	0.000	0.000	0.000	0.000	0.554
		Median	0.179	0.414	0.538	0.020	0.000	0.000	1.238	1.238	0.000	0.000	0.000	0.000	0.000	1.238
18	0	Mean														
		StdDev														
		Max														
		Min														
		Median														
20	3	Mean	0.074	0.244	0.419	0.011	0.000	0.000	0.748	0.748	0.000	0.000	0.000	0.000	0.000	0.748
		StdDev	0.016	0.048	0.105	0.010	0.000	0.000	0.053	0.053	0.000	0.000	0.000	0.000	0.000	0.053
		Max	0.092	0.277	0.540	0.020	0.000	0.000	0.808	0.808	0.000	0.000	0.000	0.000	0.000	0.808
		Min	0.065	0.189	0.358	0.000	0.000	0.000	0.708	0.708	0.000	0.000	0.000	0.000	0.000	0.708
		Median	0.065	0.265	0.358	0.014	0.000	0.000	0.728	0.728	0.000	0.000	0.000	0.000	0.000	0.728
All	176	Mean	0.181	0.362	0.605	0.092	0.008	0.019	1.247	1.258	0.017	0.005	0.000	0.014	0.003	1.261
		StdDev	0.094	0.155	0.581	0.168	0.043	0.062	0.866	0.890	0.055	0.018	0.002	0.044	0.011	0.891
		Max	0.427	1.183	4.517	1.202	0.353	0.451	6.479	6.634	0.451	0.119	0.019	0.401	0.095	6.647
		Min	0.000	0.083	0.137	0.000	0.000	0.000	0.398	0.398	0.000	0.000	0.000	0.000	0.000	0.398
		Median	0.186	0.338	0.455	0.047	0.000	0.000	1.041	1.044	0.000	0.000	0.000	0.000	0.000	1.044

* Excludes replicates

Table 3-19. 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	21	Mean	0.011	0.014	0.118	0.004	0.000	0.001	0.146	0.147	0.004	0.000	0.001	0.005	0.004	0.151
		StdDev	0.026	0.019	0.121	0.016	0.000	0.002	0.142	0.143	0.015	0.001	0.002	0.015	0.015	0.155
		Max	0.092	0.059	0.523	0.073	0.000	0.009	0.621	0.621	0.071	0.004	0.007	0.071	0.071	0.691
		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	0.003	0.077	0.000	0.000	0.000	0.084	0.084	0.000	0.000	0.000	0.000	0.000	0.084
7	1	Mean	0.000	0.000	0.495	0.036	0.000	0.000	0.532	0.532	0.000	0.000	0.000	0.000	0.000	0.532
		StdDev	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Max	0.000	0.000	0.495	0.036	0.000	0.000	0.532	0.532	0.000	0.000	0.000	0.000	0.000	0.532
		Min	0.000	0.000	0.495	0.036	0.000	0.000	0.532	0.532	0.000	0.000	0.000	0.000	0.000	0.532
		Median	0.000	0.000	0.495	0.036	0.000	0.000	0.532	0.532	0.000	0.000	0.000	0.000	0.000	0.532
8	26	Mean	0.001	0.013	0.145	0.000	0.001	0.002	0.160	0.160	0.001	0.000	0.002	0.003	0.002	0.162
		StdDev	0.003	0.018	0.121	0.001	0.003	0.005	0.125	0.125	0.005	0.001	0.009	0.009	0.009	0.125
		Max	0.018	0.051	0.614	0.003	0.016	0.018	0.638	0.638	0.018	0.003	0.046	0.044	0.044	0.638
		Min	0.000	0.000	0.018	0.000	0.000	0.000	0.021	0.021	0.000	0.000	0.000	0.000	0.000	0.021
		Median	0.000	0.002	0.130	0.000	0.000	0.000	0.148	0.148	0.000	0.000	0.000	0.000	0.000	0.152
9	21	Mean	0.000	0.003	0.137	0.000	0.000	0.000	0.140	0.140	0.000	0.000	0.000	0.000	0.000	0.141
		StdDev	0.000	0.008	0.112	0.001	0.002	0.002	0.111	0.111	0.002	0.001	0.000	0.001	0.001	0.111
		Max	0.000	0.031	0.435	0.003	0.008	0.008	0.435	0.435	0.008	0.006	0.000	0.006	0.006	0.435
		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	0.097	0.000	0.000	0.000	0.103	0.103	0.000	0.000	0.000	0.000	0.000	0.103
10	22	Mean	0.012	0.015	0.140	0.001	0.000	0.000	0.167	0.167	0.000	0.000	0.000	0.000	0.000	0.167
		StdDev	0.028	0.027	0.128	0.003	0.000	0.000	0.151	0.151	0.000	0.000	0.000	0.000	0.000	0.151
		Max	0.090	0.084	0.513	0.012	0.000	0.000	0.573	0.573	0.000	0.000	0.000	0.000	0.000	0.573
		Min	0.000	0.000	0.029	0.000	0.000	0.000	0.029	0.029	0.000	0.000	0.000	0.000	0.000	0.029
		Median	0.000	0.000	0.091	0.000	0.000	0.000	0.117	0.117	0.000	0.000	0.000	0.000	0.000	0.117
11	14	Mean	0.008	0.006	0.098	0.011	0.000	0.000	0.124	0.124	0.000	0.000	0.000	0.000	0.000	0.124
		StdDev	0.018	0.015	0.107	0.030	0.000	0.000	0.140	0.140	0.000	0.000	0.000	0.000	0.000	0.140
		Max	0.062	0.050	0.349	0.099	0.000	0.000	0.442	0.442	0.000	0.000	0.000	0.000	0.000	0.442
		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	0.061	0.000	0.000	0.000	0.069	0.069	0.000	0.000	0.000	0.000	0.000	0.069
12	17	Mean	0.031	0.026	0.226	0.013	0.000	0.001	0.296	0.297	0.001	0.000	0.000	0.001	0.000	0.297
		StdDev	0.079	0.033	0.168	0.027	0.000	0.004	0.232	0.233	0.004	0.001	0.000	0.004	0.000	0.233
		Max	0.242	0.090	0.539	0.077	0.000	0.018	0.847	0.847	0.015	0.004	0.000	0.018	0.000	0.847
		Min	0.000	0.000	0.036	0.000	0.000	0.000	0.036	0.036	0.000	0.000	0.000	0.000	0.000	0.036
		Median	0.000	0.003	0.155	0.000	0.000	0.000	0.227	0.227	0.000	0.000	0.000	0.000	0.000	0.227
13	13	Mean	0.003	0.024	0.146	0.002	0.000	0.000	0.175	0.175	0.000	0.000	0.000	0.000	0.000	0.175
		StdDev	0.010	0.031	0.170	0.006	0.000	0.000	0.204	0.204	0.000	0.000	0.000	0.000	0.000	0.204
		Max	0.036	0.078	0.637	0.021	0.000	0.000	0.771	0.771	0.000	0.000	0.000	0.000	0.000	0.771
		Min	0.000	0.000	0.030	0.000	0.000	0.000	0.033	0.033	0.000	0.000	0.000	0.000	0.000	0.033
		Median	0.000	0.014	0.085	0.000	0.000	0.000	0.104	0.104	0.000	0.000	0.000	0.000	0.000	0.104
16	20	Mean	0.005	0.033	0.196	0.005	0.000	0.000	0.238	0.238	0.000	0.001	0.000	0.001	0.001	0.240
		StdDev	0.014	0.038	0.138	0.014	0.000	0.000	0.160	0.160	0.000	0.005	0.000	0.005	0.005	0.162
		Max	0.058	0.138	0.560	0.050	0.000	0.000	0.620	0.620	0.000	0.021	0.000	0.021	0.021	0.620
		Min	0.000	0.000	0.048	0.000	0.000	0.000	0.061	0.061	0.000	0.000	0.000	0.000	0.000	0.061
		Median	0.000	0.024	0.151	0.000	0.000	0.000	0.177	0.177	0.000	0.000	0.000	0.000	0.000	0.177
18	0	Mean														
		StdDev														
		Max														
		Min														
		Median														
20	6	Mean	0.000	0.017	0.254	0.001	0.000	0.000	0.272	0.272	0.000	0.000	0.000	0.000	0.000	0.272
		StdDev	0.000	0.018	0.153	0.002	0.000	0.000	0.157	0.157	0.000	0.000	0.000	0.000	0.000	0.157
		Max	0.000	0.038	0.416	0.005	0.000	0.000	0.445	0.445	0.000	0.000	0.000	0.000	0.000	0.445
		Min	0.000	0.000	0.033	0.000	0.000	0.000	0.033	0.033	0.000	0.000	0.000	0.000	0.000	0.033
		Median	0.000	0.015	0.319	0.000	0.000	0.000	0.332	0.332	0.000	0.000	0.000	0.000	0.000	0.332
All	161	Mean	0.008	0.016	0.157	0.004	0.000	0.001	0.185	0.186	0.001	0.000	0.000	0.001	0.001	0.187
		StdDev	0.031	0.026	0.138	0.015	0.001	0.003	0.164	0.165	0.006	0.002	0.004	0.007	0.007	0.166
		Max	0.242	0.138	0.637	0.099	0.016	0.018	0.847	0.847	0.071	0.021	0.046	0.071	0.071	0.847
		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	0.109	0.000	0.000	0.000	0.129	0.129	0.000	0.000	0.000	0.000	0.000	0.130

* Excludes replicates

Table 3-20. DRI Carbon Analysis Annual Statistics for CSN Blank Categories

Type of Blank	No.*	Statistic*	IMPROVE_A Parameter (units are µg C/cm²)													
			O1TC	O2TC	O3TC	O4TC	OPTRC	OPTTC	OCTRC	OCTTC	E1TC	E2TC	E3TC	ECTRC	ECTTC	TCTC
SHAL	161	Mean	0.008	0.157	0.004	0.000	0.001	0.001	0.185	0.186	0.001	0.000	0.000	0.001	0.001	0.187
		StdDev	0.031	0.138	0.015	0.001	0.003	0.006	0.164	0.165	0.006	0.002	0.004	0.007	0.007	0.166
		Max	0.242	0.637	0.099	0.016	0.018	0.071	0.847	0.847	0.071	0.021	0.046	0.071	0.071	0.847
		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	0.109	0.000	0.000	0.000	0.000	0.129	0.129	0.000	0.000	0.000	0.000	0.000	0.130
		MDL	0.093	0.415	0.045	0.004	0.008	0.018	0.493	0.494	0.018	0.005	0.011	0.021	0.020	0.499
Trip	176	Mean	0.181	0.362	0.605	0.092	0.008	0.019	1.247	1.258	0.017	0.005	0.000	0.014	0.003	1.261
		StdDev	0.094	0.155	0.581	0.168	0.043	0.062	0.866	0.890	0.055	0.018	0.002	0.044	0.011	0.891
		Max	0.427	1.183	4.517	1.202	0.353	0.451	6.479	6.634	0.451	0.119	0.019	0.401	0.095	6.647
		Min	0.000	0.083	0.137	0.000	0.000	0.000	0.398	0.398	0.000	0.000	0.000	0.000	0.000	0.398
		Median	0.186	0.338	0.455	0.047	0.000	0.000	1.041	1.044	0.000	0.000	0.000	0.000	0.000	1.044
		LQL	0.282	0.466	1.742	0.503	0.128	0.186	2.598	2.669	0.166	0.054	0.005	0.131	0.032	2.674
24-Hour Field	1423	Mean	0.130	0.368	0.678	0.086	0.008	0.025	1.271	1.287	0.028	0.010	0.000	0.030	0.013	1.300
		StdDev	0.151	0.291	0.660	0.196	0.096	0.126	1.125	1.159	0.172	0.066	0.004	0.154	0.119	1.207
		Max	2.987	7.821	9.252	3.231	2.542	2.317	16.398	16.039	4.206	1.867	0.091	4.113	3.106	16.896
		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	-0.029	0.053
		Median	0.110	0.321	0.512	0.029	0.000	0.000	1.005	1.007	0.000	0.000	0.000	0.000	0.000	1.011
		LQL	0.452	0.872	1.980	0.589	0.287	0.379	3.375	3.478	0.516	0.197	0.011	0.461	0.357	3.622
Backup	962	Mean	0.399	0.812	1.083	0.256	0.016	0.068	2.566	2.618	0.053	0.023	0.000	0.060	0.008	2.626
		StdDev	0.356	0.476	0.748	0.245	0.084	0.137	1.510	1.573	0.113	0.045	0.002	0.103	0.024	1.578
		Max	2.823	5.665	7.780	2.052	1.322	1.322	11.447	11.987	1.096	0.338	0.052	1.064	0.257	11.987
		Min	0.000	0.000	0.027	0.000	0.000	0.000	0.027	0.027	0.000	0.000	0.000	0.000	0.000	0.027
		Median	0.314	0.746	0.928	0.191	0.000	0.003	2.307	2.337	0.000	0.000	0.000	0.008	0.000	2.343
		LQL	1.069	1.429	2.245	0.736	0.253	0.411	4.529	4.719	0.339	0.135	0.007	0.310	0.073	4.733

* Excludes replicates

3.3.3.2 Calibrations

Table 3-21 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 18 was removed from routine operation and assigned to experimental use effective March 18, 2013. Analyzer 20, which was put into regular service October 24, 2012, was reassigned to experimental use effective March 4, 2013.

Table 3-22 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 3-23** 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 1-50 ppm. The scheduled February 2014 tests were completed in time for this report.

Table 3-21. DRI Multi-Point Calibration Statistics

Analyzer No.	Date	Slope	Correlation	Comment
6	12/06/12	21.44	0.9936	
	04/03/13	21.48	0.9907	
	05/21/13	20.86	0.9843	
	07/02/13	21.24	0.9935	
	07/10/13	20.20	0.9830	
	08/13/13	22.26	0.9962	
	08/26/13	21.72	0.9950	
	12/30/13	21.66	0.9903	
	03/11/14	22.00	0.9891	
7	10/11/12	20.51	0.9858	
	04/26/13	22.00	0.9955	
	05/07/13	19.44	0.9757	
	07/03/13	20.51	0.9903	
	08/22/13	21.17	0.9974	
	09/23/13	20.54	0.9884	
	01/13/14	21.99	0.9888	
8	12/07/12	20.48	0.9870	
	05/13/13	20.09	0.9810	
	08/13/13	21.59	0.9894	
	10/14/13	22.47	0.9915	
	12/18/13	22.26	0.9908	
	03/27/14	21.92	0.9936	
9	12/20/12	21.51	0.9859	
	04/18/13	22.04	0.9875	
	07/01/13	21.15	0.9894	
	07/22/13	20.83	0.9903	
	10/24/13	23.10	0.9882	
	12/17/13	20.55	0.9840	
	01/14/14	20.76	0.9844	
10	08/16/12	20.60	0.9854	
	02/18/13	20.87	0.9839	
	03/05/13	21.56	0.9890	
	03/29/13	20.50	0.9909	
	05/04/13	23.23	0.9960	
	05/21/13	21.46	0.9822	
	08/20/13	20.72	0.9910	
	02/20/14	22.84	0.9933	
11	09/26/12	21.24	0.9823	
	03/14/13	21.32	0.9866	
	10/24/13	22.06	0.9900	
	10/29/13	21.23	0.9940	Repeated cal due to leak for earlier cal
	03/18/14	22.04	0.9956	
12	08/16/12	20.76	0.9863	
	02/24/13	21.37	0.9802	
	04/01/13	20.90	0.9888	
	08/27/13	20.71	0.9947	
	10/03/13	22.55	0.9575	
	02/13/14	22.54	0.9973	
13	11/19/12	20.82	0.9846	
	06/04/13	20.46	0.9887	
	08/14/13	20.69	0.9894	
	09/03/13	22.26	0.9976	
	09/09/13	21.32	0.9920	
	12/14/14	21.86	0.9874	
16	12/15/12	21.21	0.9858	
	03/10/13	22.69	0.9873	
	09/13/13	22.54	0.9933	
	11/12/13	22.74	0.9935	
	12/03/13	22.55	0.9891	
	02/05/14	23.33	0.9976	
18	11/09/12	20.14	0.9783	
	03/08/13	21.42	0.9812	
	04/05/13	21.29	0.9913	Offline 3/18/13
20	11/07/12	20.37	0.9844	
	01/27/13	19.89	0.9898	
	02/05/13	19.92	0.9772	Offline 3/4/13

Table 3-22. DRI Multi-Point Temperature Calibration Statistics

			Analyzer No.										
Cal No.	**Param.**	**Units**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**16**	**18***	**20****
1	Slope		1.016	1.013	1.018	1.025	1.030	1.022	1.028	1.012	1.014	1.007	1.035
	Intercept	° C	8.300	2.574	5.777	-1.487	7.299	2.734	-2.798	9.721	11.295	8.915	5.119
	r^2		0.9991	0.9994	0.9995	0.9993	0.9996	0.9995	0.9992	0.9992	0.9993	0.9994	0.9990
	Date		Nov-12	Oct-12	Dec-12	Dec-12	Aug-12	Sep-12	Aug-12	Nov-12	Dec-12	Nov-12	Oct-12
2	Slope		1.027	1.041	1.037	1.012	1.015	1.019	1.020	0.995	1.012	1.012	1.027
	Intercept	° C	19.010	8.913	7.583	8.746	7.956	11.669	7.135	12.689	11.214	-2.414	2.341
	r^2		0.9990	0.9906	0.9970	0.9993	0.9994	0.9990	0.9998	0.9985	1.0000	0.9994	0.9992
	Date		May-13	Apr-13	May-13	Apr-13	Feb-13	Mar-13	Feb-13	May-13	Mar-13	Apr-13	Jan-13
3	Slope		1.023	1.010	1.017	1.026	1.030	1.026	1.014	1.038	1.013		1.028
	Intercept	° C	5.621	3.047	8.049	1.829	7.697	5.347	5.848	8.060	10.288		1.8475
	r^2		0.9987	0.9996	0.9959	0.9993	0.9967	0.9976	0.9991	0.9967	0.9975		0.9988
	Date		Jun-13	Jun-13	Dec-13	Apr-13	Aug-13	Oct-13	Aug-13	Oct-13	Sep-13		May-14
4	Slope		1.042	1.025	1.033	1.021	1.015	1.018	1.023	1.026	1.008		
	Intercept	° C	8.355	2.671	5.825	1.813	6.630	9.199	4.959	10.315	22.383		
	r^2		0.9989	0.9997	0.9997	0.9995	0.9993	0.9993	0.9990	0.9985	0.9977		
	Date		Dec-13	Jun-13	Mar-14	Jun-13	Feb-14	Mar-14	Feb-14	Jan-14	Jan-14		
5	Slope		1.016	0.986		1.023							
	Intercept	° C	9.268	14.417		11.591							
	r^2		0.9994	0.9999		0.9982							
	Date		Mar-14	Dec-13		Oct-13							
6	Slope					1.037							
	Intercept	° C				10.389							
	r^2					0.9983							
	Date					Dec-13							

* Analyzer #18 taken out of regular service 3/18/13.

** Analyzer #20 taken out of regular service 3/4/13.

Table 3-23. DRI Oxygen Test Statistics

	Date		August 2012		February 2013		August 2013		February 2014	
Analyzer No.	Temp	(°C)	140	580	140	580	140	580	140	580
6	Mean O_2	(ppm)	27.2	20.6	3.1	3.1	7.7	7.2	14.2	15.1
	Std Dev	(ppm)	2.2	2.0	3.1	3.1	1.2	1.1	1.9	1.9
7	Mean O_2	(ppm)	45.0	15.0	12.1	7.3	6.9	6.4	13.2	10.4
	Std Dev	(ppm)	7.7	3.0	3.3	3.2	1.2	1.1	2.1	1.9
8	Mean O_2	(ppm)	5.6	33.6	14.3	14.7	18.4	16.3	18.1	14.9
	Std Dev	(ppm)	4.2	4.4	3.2	3.2	1.5	1.3	2.0	1.8
9	Mean O_2	(ppm)	33.6	33.5	2.1	1.9	12.7	9.4	10.8	11.2
	Std Dev	(ppm)	20.8	2.5	3.1	3.1	1.4	1.1	1.9	1.9
10	Mean O_2	(ppm)	24.2	23.3	3.1	3.1	2.9	3.0	12.4	12.5
	Std Dev	(ppm)	2.6	4.5	3.1	3.1	1.0	1.1	1.9	1.8
11	Mean O_2	(ppm)	47.5	27.5	7.8	5.3	14.0	13.3	20.7	20.4
	Std Dev	(ppm)	8.4	1.8	3.2	3.2	1.2	1.2	1.9	1.9
12	Mean O_2	(ppm)	50.4	30.4	43.3	44.6	33.9	32.8	12.0	12.1
	Std Dev	(ppm)	13.7	3.6	3.3	3.2	1.8	1.2	1.9	1.9
13	Mean O_2	(ppm)	8.5	27.1	3.1	3.1	10.7	12.6	9.7	10.0
	Std Dev	(ppm)	5.3	3.5	3.1	3.1	1.1	1.1	2.0	1.9
16	Mean O_2	(ppm)	35.4	16.1	3.1	3.1	8.6	7.4	10.3	11.4
	Std Dev	(ppm)	5.3	1.5	3.1	3.1	1.3	1.1	1.9	2.0
18	Mean O_2	(ppm)	Not in Service		3.1	3.1	Not in Service		Not in Service	
	Std Dev	(ppm)	Mar '11 - Oct '12		3.1	3.1	After 3/18/13		After 3/18/13	
20	Mean O_2	(ppm)	Not in Service		3.1	3.1	Not in Service		Not in Service	
	Std Dev	(ppm)	Until 10/24/12		3.1	3.1	After 3/4/13		After 3/4/13	

Figure 3-1 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 3-24**.

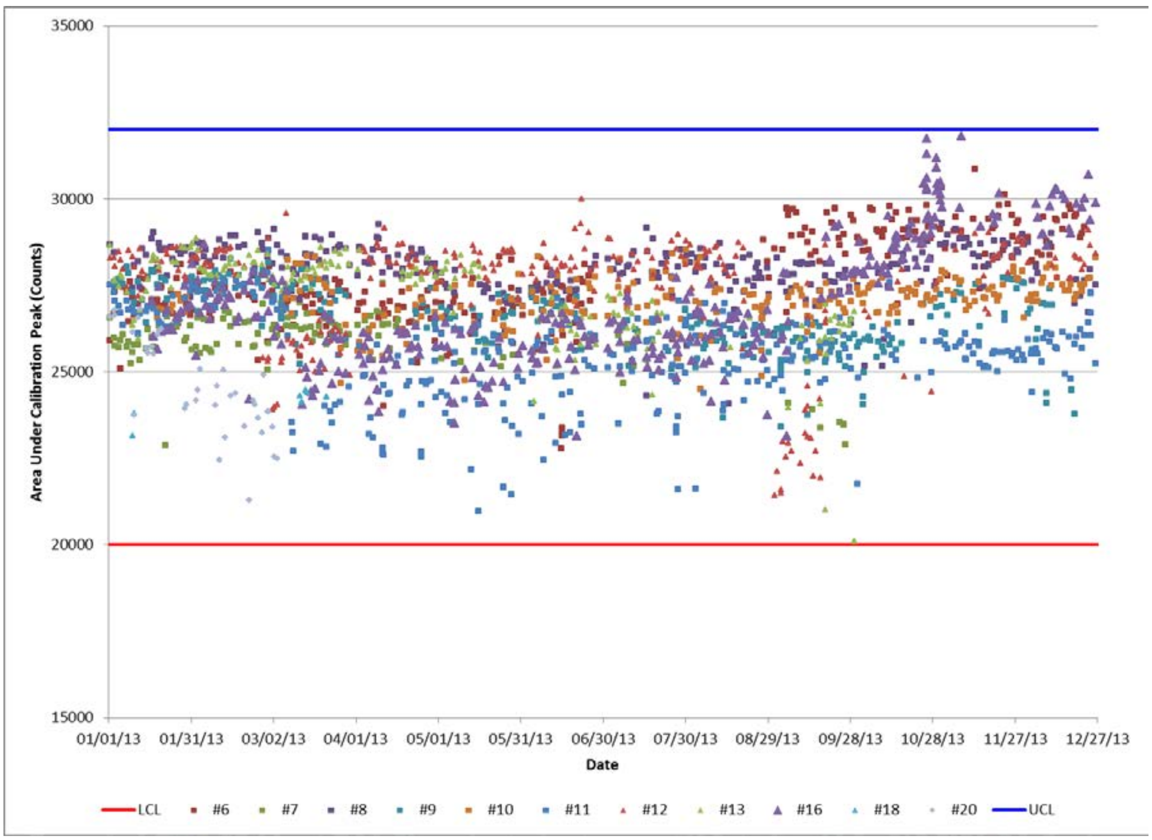


Figure 3-1. DRI Carbon Analyzer Daily AutoCalibration Response during 2013

Table 3-24. Summary of Instrument Maintenance Performed as a Result of Autocalibration Peak Response

Analyzer No.	Date	Resolution
6	01/13/13	Cal peak low – repaired leak
7	02/05/13	Cal peak low – replaced reducing ferrule
8	07/18/13 07/23/13	Cal peak drops – replaced reducing ferrule Cal peak drops – balanced flows
9	10/11/13 12/10/13 12/16/13	Cal peak low – tightened reducing ferrule and balanced flows Cal peak low – replaced Carle valve Cal peak low – replaced methanator, replaced electrometer and adjusted connections
10	02/01/13	Cal peak low – tightened reducing ferrule
11	04/18/13 05/07/13	Cal peak low – fixed software error Cal peak low – tightened reducing ferrule and repaired leak
12	---	
13	---	
16	03/04/13 03/07/13 05/22/13 05/24/13 05/28/13 05/29/13 10/31/13	Cal peak low – repaired leak Cal peak low – boat wire fell off; replaced broken thermocouple and recalibrated analyzer Cal peak low – replaced O-ring Cal peak low – repaired leak Cal peak low – repaired leak Cal peak low – realigned breech, adjusting pistons Cal peak dropped – balanced flows
18	---	
20	02/28/13	Cal peak keeps dropping – balanced flows

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 3-25** 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 2,115 replicate or duplicate analyses were analyzed during the reporting period. Of the 2,115 replicates or duplicates, 26 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 2,089 remaining, 126 were duplicate analyses and 1,963 were replicate analyses.

Table 3-25. DRI Replicate Analysis Criteria and Statistics

Range	Criteria	Statistic	Replicates No.	Replicates TC	Replicates OC	Replicates EC	Duplicates No.	Duplicates TC	Duplicates OC	Duplicates EC	Units
All		Count	1963				126				
TC, OC, & EC < 10 µg C/cm^2	TC, OC < ±1.0 µg C/cm^2	Count		338	475	1690		29	31	116	
	EC < ±2.0 µg C/cm^2	No. Fail		2	7	0		0	0	0	
		%Fail		0.6	1.5	0.0		0.0	0.0	0.0	%
		Mean		0.290	0.312	0.322		0.235	0.230	0.197	µg C/cm^2
		StdDev		0.241	0.255	0.319		0.194	0.184	0.192	µg C/cm^2
		Max		1.173	1.354	2.396		0.675	0.834	0.929	µg C/cm^2
		Min		0.002	0.000	0.000		0.022	0.012	0.000	µg C/cm^2
		Median		0.217	0.240	0.222		0.144	0.171	0.147	µg C/cm^2
TC, OC, & EC ≥ 10 µg C/cm^2	TC, OC %RPD < 10%	Count		1625	1488	273		97	95	10	
	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		1.92	1.91	3.80		1.54	1.87	3.26	%RPD
		StdDev		1.33	1.32	2.61		1.23	1.39	4.65	%RPD
		Max		7.75	7.75	14.64		4.94	7.12	13.67	%RPD
		Min		0.00	0.00	0.08		0.04	0.03	0.03	%RPD
		Median		1.71	1.71	3.34		1.28	1.52	1.26	%RPD

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.

The revised SOP states that the criteria for EC < 10 µg C/cm^2 is ± 2.0 µg C/cm^2 to achieve consistency with EC criteria of an RPD < 20% for EC ≥ 10 µg C/cm^2. 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 3-26 gives estimated minimum detection limits (MDLs) for IMPROVE_A parameters for filter batches 164 through 187 (~2013). The MDLs in **Table 3-26** 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

Table 3-26. Estimated MDLs and LQLs for IMPROVE_A Parameters for 2013

Type of			IMPROVE_A Parameter (units are µg C/cm^2)													
Blank	No.*	Statistic*	O1TC	O2TC	O3TC	O4TC	OPTRC	OPTTC	OCTRC	OCTTC	E1TC	E2TC	E3TC	ECTRC	ECTTC	TCTC
System	201	Mean	0.001	0.006	0.013	0.001	0.000	0.000	0.022	0.022	0.000	0.001	0.001	0.001	0.001	0.023
		StdDev	0.007	0.029	0.035	0.006	0.000	0.001	0.067	0.067	0.002	0.004	0.004	0.007	0.007	0.069
		Max	0.083	0.306	0.255	0.051	0.001	0.018	0.611	0.611	0.022	0.042	0.037	0.068	0.068	0.611
		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
		MDL	0.022	0.087	0.106	0.019	0.000	0.004	0.202	0.202	0.007	0.011	0.011	0.020	0.020	0.208
Lab	2376	Mean	0.002	0.006	0.016	0.003	0.000	0.002	0.026	0.028	0.001	0.001	0.003	0.004	0.002	0.030
		StdDev	0.018	0.024	0.042	0.012	0.003	0.013	0.077	0.079	0.006	0.006	0.015	0.020	0.014	0.082
		Max	0.668	0.517	0.586	0.153	0.080	0.353	1.291	1.291	0.197	0.141	0.312	0.371	0.299	1.291
		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	-0.006	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	0.053	0.071	0.127	0.036	0.008	0.040	0.230	0.238	0.019	0.019	0.046	0.060	0.041	0.247
SHAL	161	Mean	0.008	0.016	0.157	0.004	0.000	0.001	0.185	0.186	0.001	0.000	0.000	0.001	0.001	0.187
		StdDev	0.031	0.026	0.138	0.015	0.001	0.003	0.164	0.165	0.006	0.002	0.004	0.007	0.007	0.166
		Max	0.242	0.138	0.637	0.099	0.016	0.018	0.847	0.847	0.071	0.021	0.046	0.071	0.071	0.847
		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	0.109	0.000	0.000	0.000	0.129	0.129	0.000	0.000	0.000	0.000	0.000	0.130
		MDL	0.093	0.077	0.415	0.045	0.004	0.008	0.493	0.494	0.018	0.005	0.011	0.021	0.021	0.499
Trip	176	Mean	0.181	0.362	0.605	0.092	0.008	0.019	1.247	1.258	0.017	0.005	0.000	0.014	0.003	1.261
		StdDev	0.094	0.155	0.581	0.168	0.043	0.062	0.866	0.890	0.055	0.018	0.002	0.044	0.011	0.891
		Max	0.427	1.183	4.517	1.202	0.353	0.451	6.479	6.634	0.451	0.119	0.019	0.401	0.095	6.647
		Min	0.000	0.083	0.137	0.000	0.000	0.000	0.398	0.398	0.000	0.000	0.000	0.000	0.000	0.398
		Median	0.186	0.338	0.455	0.047	0.000	0.000	1.041	1.044	0.000	0.000	0.000	0.000	0.000	1.044
		LQL	0.282	0.466	1.742	0.503	0.128	0.186	2.598	2.669	0.166	0.054	0.005	0.131	0.032	2.674
24-Hour	1423	Mean	0.130	0.368	0.678	0.086	0.008	0.025	1.271	1.287	0.028	0.010	0.000	0.030	0.013	1.300
Field		StdDev	0.151	0.291	0.660	0.196	0.096	0.126	1.125	1.159	0.172	0.066	0.004	0.154	0.119	1.207
		Max	2.987	7.821	9.252	3.231	2.542	2.317	16.398	16.039	4.206	1.867	0.091	4.113	3.106	16.896
		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	-0.029	0.053
		Median	0.110	0.321	0.512	0.029	0.000	0.000	1.005	1.007	0.000	0.000	0.000	0.000	0.000	1.011
		LQL	0.452	0.872	1.980	0.589	0.287	0.379	3.375	3.478	0.516	0.197	0.011	0.461	0.357	3.622
Backup	962	Mean	0.399	0.812	1.083	0.256	0.016	0.068	2.566	2.618	0.053	0.023	0.000	0.060	0.008	2.626
		StdDev	0.356	0.476	0.748	0.245	0.084	0.137	1.510	1.573	0.113	0.045	0.002	0.103	0.024	1.578
		Max	2.823	5.665	7.780	2.052	1.322	1.322	11.447	11.987	1.096	0.338	0.052	1.064	0.257	11.987
		Min	0.000	0.000	0.027	0.000	0.000	0.000	0.027	0.027	0.000	0.000	0.000	0.000	0.000	0.027
		Median	0.314	0.746	0.928	0.191	0.000	0.003	2.307	2.337	0.000	0.000	0.000	0.008	0.000	2.343
		LQL	1.069	1.429	2.245	0.736	0.253	0.411	4.529	4.719	0.339	0.135	0.007	0.310	0.073	4.733

* Excludes replicates

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 the MDLs reported in the SOP in order to be more conservative in its assessments of data quality.

Table 3-26 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, backup filters, and trip blanks, based on blank identification information provided to DRI after the analyses were completed.

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, but a final report has not yet been issued. Previous reports may be found at EPA's Ambient Monitoring Technical Information center (AMTIC) website at:

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

The last final TSA report (issued June 11, 2011 for the TSDA conducted July 27, 2010) found that DRI's Carbon laboratory performed good laboratory practices, good QC practices, and good record keeping. The auditors were impressed with the new software that provided a graphical interface with all the instruments at a single workstation. No deficiencies were observed.

3.3.6.2 Performance Evaluations

Inter-laboratory comparisons and PEs, including DRI's Carbon Laboratory, have been conducted annually from 2005 through 2013. The 2014 comparison is currently underway. 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 $PM_{2.5}$.

3.3.6.4 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 an estimated 15,606 filters for 33 elements during the period of January 1 through December 31, 2013.

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:

- 02/19/13 – Preventive maintenance performed, checked voltages, resolution, and stability. Replaced solenoid on lid latch.
- 03/29/13 – Replaced vacuum pump
- 09/10/13 – Preventive maintenance performed, checked voltages, resolution, and stability
- 11/26/13 – Replaced E/I board

The following repairs and maintenance were performed for XRF 2:

- 09/12/13 – Preventive maintenance performed, checked voltages, resolution, and stability

The following repair and maintenance was performed for XRF 3:

- 02/20/13 – Preventive maintenance performed, checked voltages, resolution, and stability
- 09/18/13 – Preventive maintenance performed, checked voltages, resolution, and stability
- 11/14/13 – Replaced Q box 24Vdc fan

The following repair and maintenance was performed for XRF 4:

- 03/28/13 – Preventive maintenance performed, checked voltages, resolution, and stability
- 05/02/13 – Preventive maintenance performed, checked voltages, resolution, and stability
- 07/12/13 – Replaced HVPS
- 12/11/13 – Replaced X-ray tube

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 3-27**.

Table 3-27. 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 3-28 through 3-31**. The percent coefficient of variation (%CV) for the average of all data for each of the six elements ranged between 0.20 and 0.87% for XRF 1, between 0.25 and 0.64% for XRF 2, between 0.27 and 0.62% for XRF 3, and between 0.24 and 0.62% for XRF 4, indicating excellent precision.

Table 3-28. Summary of RTI XRF 1 Laboratory QC Precision Data, µg/cm^2, 1/1/2013 through 12/31/2013

Element	n	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Si	502	4.95	5.07	5.00	0.0244	0.49	0.018
Ti	502	6.57	6.89	6.78	0.0589	0.87	0.658
Fe	502	6.90	7.00	6.94	0.0203	0.29	-0.001
Cd	502	5.50	5.60	5.55	0.0224	0.40	-0.021
Se	502	3.95	4.05	4.00	0.0217	0.54	0.016
Pb	502	9.06	9.17	9.11	0.0187	0.20	0.092

Table 3-29. Summary of RTI XRF 2 Laboratory QC Precision Data, µg/cm², 1/1/2013 through 12/31/2013

Element	N	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Si	471	5.18	5.31	5.24	0.0233	0.44	0.006
Ti	471	8.55	8.69	8.63	0.0219	0.25	-0.009
Fe	471	7.23	7.39	7.30	0.0210	0.29	-0.030
Cd	471	4.32	4.49	4.41	0.0281	0.64	0.023
Se	471	2.95	3.04	2.99	0.0187	0.62	0.034
Pb	471	7.79	7.98	7.90	0.0315	0.40	-0.063

Table 3-30. Summary of RTI XRF 3 Laboratory QC Precision Data, µg/cm², 1/1/2013 through 12/31/2013

Element	n	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Si	514	4.67	4.80	4.74	0.0229	0.48	-0.012
Ti	514	5.49	5.60	5.55	0.0247	0.45	-0.118
Fe	514	6.18	6.31	6.25	0.0248	0.40	-0.047
Cd	514	5.55	5.80	5.75	0.0276	0.48	0.079
Se	514	3.86	4.01	3.92	0.0242	0.62	-0.374
Pb	514	8.79	9.00	8.92	0.0244	0.27	-0.034

Table 3-31. Summary of RTI XRF 4 Laboratory QC Precision Data, µg/cm², 1/1/2013 through 12/31/2013

Element	n	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Si	267	4.47	4.61	4.54	0.0271	0.60	-0.373
Ti	267	5.93	6.05	6.00	0.0239	0.40	0.070
Fe	267	6.49	6.60	6.55	0.0235	0.36	0.005
Cd	267	5.45	5.57	5.51	0.0237	0.43	0.059
Se	267	3.74	3.86	3.80	0.0237	0.62	-0.109
Pb	267	8.85	8.99	8.92	0.0217	0.24	-0.061

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 3-32 through 3-35** show recovery for 8 elements of the 33 elements normally measured. The average recovery values for all the elements ranged between 90 and 113% 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 3-32. Recovery Determined from Analysis of NIST SRM 2783 for RTI XRF 1, 1/1/2013 through 12/31/2013

Element	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Al	91	101	95	0.0616	2.79	3.879
K	92	101	96	0.0138	2.70	0.016
Ca	93	105	98	0.0446	3.46	-3.124
Mn	90	110	100	0.0351	4.88	0.124
Fe	93	101	96	0.0634	2.30	-1.992
Cu	90	104	96	0.0016	4.11	0.009
Zn	100	113	106	0.0074	3.91	0.135
Pb	90	110	101	0.0021	6.69	0.082

Table 3-33. Recovery Determined from Analysis of NIST SRM 2783 for RTI XRF 2, 1/1/2013 through 12/31/2013

Element	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Al	97	108	102	0.0678	2.88	1.242
K	96	110	103	0.0170	3.14	1.382
Ca	90	102	94	0.0448	3.59	-0.581
Mn	90	110	104	0.0013	4.02	0.021
Fe	93	103	97	0.0712	2.56	0.319
Cu	95	108	100	0.0014	3.53	-0.033
Zn	98	110	104	0.0063	3.38	-0.198
Pb	90	110	100	0.0015	4.80	-0.091

Table 3-34. Recovery Determined from Analysis of NIST SRM 2783 for RTI XRF 3, 1/1/2013 through 12/31/2013

Element	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Al	94	106	99	0.0677	2.95	-2.330
K	91	101	96	0.0146	2.89	0.611
Ca	90	103	96	0.0418	3.29	-0.086
Mn	94	110	104	0.0012	3.65	-0.003
Fe	92	100	96	0.0600	2.19	-4.556
Cu	90	107	98	0.0016	4.09	0.068
Zn	99	110	105	0.0062	3.30	0.063
Pb	90	106	96	0.0014	4.72	-0.088

Table 3-35. Recovery Determined from Analysis of NIST SRM 2783 for RTI XRF 4, 1/1/2013 through 12/31/2013

Element	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Al	94	105	98	0.0701	3.07	-3.765
K	92	101	95	0.0143	2.83	-1.242
Ca	91	103	97	0.0448	3.52	-3.930
Mn	90	108	100	0.0013	4.11	0.004
Fe	90	99	95	0.0631	2.31	0.063
Cu	94	110	102	0.0018	4.28	0.117
Zn	96	110	105	0.0053	2.81	0.312
Pb	91	109	98	0.0015	4.86	0.165

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 3-36** shows the correlation coefficients and average RPDs for the replicate analysis. The correlation coefficients for XRF 1 range from 0.9967 to 0.9999, the correlation coefficients for XRF 2 range from 0.9975 to 0.9999, the correlation coefficients for XRF 3 range from 0.9986 to 0.9999, and the correlation coefficients for XRF 4 range from 0.9970 to 0.9999 indicating acceptable replication with all four instruments. Also, for the six elements, the average RPD was within ±2% on XRF 1, within ±3% for XRF 2 and XRF 3, and within ±2% on XRF 4.

Table 3-36. Summary of Replicate Results for XRF 1, XRF 2, XRF 3, and XRF 4

Element	n	Correlation Coefficient	Average RPD
XRF 1			
Si	295	0.9967	-1.35
S	295	0.9998	-0.12
K	295	0.9999	-0.25
Ca	295	0.9997	1.15
Fe	295	0.9999	0.02
Zn	295	0.9991	0.11
XRF 2			
Si	286	0.9975	2.38
S	286	0.9998	0.12
K	286	0.9992	0.09
Ca	286	0.9990	-0.03
Fe	286	0.9999	-0.02
Zn	286	0.9989	0.52
XRF 3			
Si	304	0.9986	1.60
S	304	0.9997	0.91
K	304	0.9994	0.07
Ca	304	0.9986	1.27
Fe	304	0.9999	0.52
Zn	304	0.9993	-2.16
XRF 4			
Si	293	0.9970	1.07
S	293	0.9998	-1.38
K	293	0.9993	-0.64
Ca	293	0.9992	1.95
Fe	293	0.9999	0.51
Zn	293	0.9989	-1.41

Assessment of Between-Instrument Comparability

Overview of Round-Robin Samples Run During 2013

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 3-37** summarizes the number of round-robin filters analyzed during 2013.

Table 3-37. Numbers of Round-Robin Filter Analyses Performed during 2013

Laboratory	Instrument	Filters Analyzed
CLN	Kevex 770	24
CLN	Kevex 772*	24
RTI	XRF 1	24
RTI	XRF 2	24
RTI	XRF 3	24
RTI	XRF 4	22

* - CLN 772 is not an approved instrument in the CSN PM2.5 Program, but CLN analyzed all 2013 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 2013.

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 3-38 through 3-40** show linear regression results for which the data for the filters are regressed versus the median for the six instruments for each filter. The

Table 3-38. Regression Results for 9 Elements RTI XRF Instrument XRF 1 and XRF 2

Element	RTI 1				RTI 2			
	n	Correlation Coefficient	Slope	Intercept	n	Correlation Coefficient	Slope	Intercept
Si	24	0.9883	1.0161	-0.0480	24	0.9945	1.0315	-0.0209
S	24	0.9996	0.9838	0.1300	24	0.9993	1.0008	-0.0830
K	24	0.9992	0.9716	0.0293	24	0.9982	1.0640	-0.0380
Ca	24	0.9981	0.9966	0.0083	24	0.9897	0.9895	-0.0446
Fe	24	0.9995	1.0150	0.0219	24	0.9997	1.0180	-0.0084
Ni	24	0.9814	1.0318	-0.0008	24	0.9836	0.9756	-0.0002
Cu	24	0.9795	1.0183	-0.0140	24	0.9927	0.9910	0.0070
Zn	24	0.9998	1.0001	0.0011	24	0.9993	0.9940	0.0087
Pb	24	0.9620	1.1366	-0.0050	24	0.9597	1.0875	-0.0032

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

Table 3-39. Regression Results for 9 Elements RTI XRF Instrument XRF 3 and XRF 4

Element	RTI 3				RTI 4			
	n	Correlation Coefficient	Slope	Intercept	N	Correlation Coefficient	Slope	Intercept
Si	24	0.9911	0.9632	0.0097	22	0.9916	0.9727	0.0265
S	24	0.9994	0.9791	0.1516	22	0.9983	0.9826	0.1091
K	24	0.9990	0.9584	0.0426	22	0.9990	0.9876	-0.0279
Ca	24	0.9839	0.9759	0.0007	22	0.9971	1.0000	-0.0138
Fe	24	0.9987	0.9997	-0.0613	22	0.9998	0.9994	0.0104
Ni	24	0.9725	1.0019	-0.0008	22	0.9786	0.8804	-0.0009
Cu	24	0.9879	1.0225	0.0002	22	0.9689	1.1199	0.0003
Zn	24	0.9994	1.0165	-0.0168	22	0.9994	1.0165	0.0006
Pb	24	0.9744	0.9809	-0.0096	22	0.9635	1.0621	-0.0068

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

Table 3-40. Regression Results for 9 Elements
CLN XRF Instrument 770 and 772

Element	770				772			
	n	Correlation Coefficient	Slope	Intercept	N	Correlation Coefficient	Slope	Intercept
Si	24	0.9696	0.9127	0.0139	24	0.9818	1.1406	-0.0049
S	24	0.9953	1.0275	0.5182	24	0.9993	1.0305	-0.2914
K	24	0.9979	1.0292	0.0004	24	0.9997	1.0073	-0.0013
Ca	24	0.9971	1.1409	-0.0071	24	0.9896	1.1441	-0.0486
Fe	24	0.9980	0.9971	0.0291	24	0.9997	0.9714	-0.0079
Ni	24	0.9334	1.0916	0.0027	24	0.9147	0.8142	0.0068
Cu	24	0.9827	0.9369	0.0034	24	0.9764	0.9418	-0.0023
Zn	24	0.9972	1.0483	-0.0130	24	0.9980	0.9872	0.0011
Pb	24	0.9603	0.8361	0.0040	24	0.9743	0.9731	0.0145

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

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 Pb (RTI and CLN) and Si (CLN). These results indicate general agreement of the instruments within 10% of the median value.

Note: Four instruments from RTI and two from CLN were used in the calculations for the regression results.

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 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 (Watson, 2003):

Counting uncertainty = slope * A * sqrt (3 * 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
- 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)[4,5,6]. 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

[4] 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

[5] 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.

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

3.4.1.5 Audits, PEs, Training, and Accreditations

In February 2013, 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 June 26, 2013, indicated good performance by RTI's XRF lab.

3.4.2 Chester LabNet X-Ray Fluorescence Laboratory

During the period covered by this report, Chester operated one Kevex 770 XRF instrument analyzing 1225 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:

- 05/17/13 – Replaced vacuum pump
- 070/1/13 – Realigned pre-filter bar, and recalibrated direct excitation by 0.85x
- 09/03/13 – Energy calibration performed
- 10/28/13 – Energy calibration performed

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 3-41.**

Table 3-41. 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 3-42**. The percent coefficient of variation (%CV) for the average of all data for each of the six elements ranged between 1.98 and 4.77%.

Table 3-42. Summary of Chester XRF 770 Laboratory QC Precision Data 1/1/2013 through 12/31/2013

Element	n	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Si	104	90.5	108.7	97.5	4.65	4.77	9.31
Ti	104	92.2	105.6	99.3	2.58	2.60	-2.03
Fe	104	92.6	106.7	99.1	2.34	2.36	-1.18
Cd	104	98.2	110.2	103.3	2.04	1.98	3.18
Se	104	91.4	107.8	98.7	3.27	3.31	-0.71
Pb	104	91.2	110.3	99.0	3.26	3.29	-0.43

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 3-43** shows recovery for 12 elements spanning the atomic mass range of the 33 elements normally measured. The min and max recovery values for all the elements ranged between 86.7% and 147.0%. Analysis of NIST Particle Standard SRM2783 yielded recoveries of 99.8% for Ca and 105.0% 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 3-43** 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 3-43. Recovery Determined from Analysis of NIST SRMs 1832, 1833, 2708 and 2783 for Chester XRF 770 -- 1/1/2013 through 12/31/2013

Element	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Al	94.7	112.5	104.6	3.23	3.09	3.86
Si	92.0	107.4	100.8	2.87	2.85	3.30
Si	86.7	96.2	91.3	2.27	2.49	-4.10
S	94.6	136.6	99.0	5.54	5.59	0.22
K	94.3	136.0	102.0	5.29	5.19	2.26
Ca	92.6	107.7	99.8	3.13	3.13	2.66
Ti	89.7	122.6	95.2	4.39	4.61	-0.43
V	93.7	147.0	103.7	7.32	7.05	11.08
Mn	98.5	106.6	103.3	1.86	1.80	4.53
Fe	90.3	97.3	92.7	1.37	1.47	-1.64
Cu	91.0	111.0	104.9	3.34	3.18	0.01
Zn	96.3	119.5	105.0	3.74	3.56	-0.69
Pb	86.8	102.0	95.0	3.73	3.93	-4.61

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 3-44** shows the correlation coefficient and average RPDs for the replicate analysis. The correlation coefficients range from 0.9963 to 0.9993.

Table 3-44. Replicate Data for Chester XRF 770

Kevex 770			
Element	n	Correlation Coefficient	Average RPD
Al	62	.9963	0.66
Si	115	.9977	-2.22
S	118	.9977	-1.07
K	118	.9970	-0.45
Ca	118	.9982	-1.34
Fe	118	.9979	0.21
Zn	111	.9993	4.05

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 with 2x uncertainty can fall into several categories:

- The wrong sample can be re-analyzed, which is easily deduced and easily 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 calculated MDLs are presented in Appendix 2 of the RTI QAPP for Chemical Speciation of $PM_{2.5}$ Filter Samples.

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 2013 calendar year, there were no quality issues reported.

3.5.2 Operational Discussion

3.5.2.1 Numbers of Denuder Serviced

Table 3-45 lists the denuders refurbished and the number of refurbishments completed in 2013.

Table 3-45. Denuder Refurbishments, January 1, 2013 through December 31, 2013

Denuder Type	Total Refurbished
Aluminum Honeycomb	861

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 no major quality issues in the SHAL during 2013.

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 13 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 from RTI to the site operator if necessary.

3.6.3 Summary of QC Results and Field Site Completeness

During calendar year 2013, the SHAL shipped out and received back more than 31,936 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 at the sites such as malfunctioning samplers, 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 3-46** lists those sites with less than 95% of their filters run on the intended sampling date during 2013.

Table 3-46. Sites with Less than 95% of Filters Run on Intended Sampling Date

AQS Site Code	POC	Location	Events[(1)]	On Date	Percent
471570075	6	Shelby Farms	240	196	82
340070002	5	Camden-NJ	178	150	84
390350060	6	G.T. Craig (Collocated)	106	90	85
460990008	5	Sioux Falls School Site	234	201	86
340130003	5	Newark	196	172	88
150030010	5	Kapolei	240	211	88
340230006	5	New Brunswick	198	176	89
340390004	5	Elizabeth Lab	200	178	89
340273001	5	Chester	182	162	89
060658001	6	Riverside-Rubidoux (Collocated)	122	111	91
132450091	5	Augusta - Met One	118	109	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 2013. A summary of email and phone communications with site operators and data users is presented in **Table 3-47**. In consultation with EPA, RTI has prepared a list of frequently asked questions (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 3-47. Summary of SHAL Communications with Site Operators and Data Users

Description	Number of Communications
Site will send cooler late	111
Site needs schedule	30
Site did not receive cooler	71
Change of operator/site information	80
Sampler problems/questions	192
Field Blank/Trip Blank ran as routine sample	0
Request change of ship date from RTI	17
Site is stopping	31
Miscellaneous QA Issues	354
Data questions/reporting	285
Other	165
Total	1,336

3.6.6 Audits, PEs, Training, and Accreditations

- 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 2013 is shown in **Table 3-48**.

Table 3-48. Review of SHAL Technician Processing Filter Modules

Module Type	Number Observed	Findings	Findings Reviewed with Technician
MET ONE	115	10	10
URG 3000N	115	10	10

3.6.7 Chemical Speciation Site Changes 2013

A network wide change was implemented effective 3/21/13 in the CSN. As a cost saving measure, a number of the blanks collected were reduced. Trip blanks for the quartz filter which had been collected at a frequency of 2% of scheduled events were eliminated entirely. And the backup quartz filter which had been collected at a frequency of 10% of scheduled events was reduced to 5% of scheduled events.

The Chicopee (250130008) site in MA requested to sample with the MET ONE SASS sampler only until the URG 3000N sampler was repaired. Site sampled with the MET ONE SASS only from 1/19/13 through 3/5/13.

The Camden (340070002) site in NJ began sampling on 1/28/13. Site will be sampling on the Alternate 1-day-in-3 frequency.

The Alabama (TN) site (471570024) in TN is stopping permanently. Last event was 1/28/13.

The Wylam (010732003) site in AL changed from the 1-day-in-6 sampling frequency to the 1-day-in-3 sampling frequency. First event on the new collection schedule was 1/31/13.

The outgoing shipment of CSN filter packages from RTI was picked up by UPS on 5/8/13 but was delayed in transit by one day. Filters scheduled to sample on 5/13/13 may not have arrived at the field sampling locations in time to set up for sampling due to the delay.

The MLK (100032004) site in DE restarted with the 6/6/13 event. The site had been down since 1/7/13.

The Jackson nCore (280490020) site in MS started sampling on 7/3/13. This location will be running on the Alternate 1-day-in-3 frequency. This site replaces the Jackson UMC (280490019) site which stopped sampling 7/11/12.

The Luna Pier (261150005) site in MI stopped sampling permanently. Last event was 7/30/13.

The Sterling State Park (261150006) site in MI is a new site. This location will be running on the 1-day-in-6 sampling frequency. First event was 8/8/13.

The VAN4PLN2 (530110013) site in WA stopped sampling permanently. Last event was 8/26/13. The samplers are being moved to a new location VANNEVAN (530110023) which began sampling on 9/1/13.

The Bakersfield (060290014) site in CA is no longer available for CSN sampling. The routine and collocated speciation samplers both stopped 9/10/13.

The Mingo Junction (390811001) site in OH stopped sampling permanently. Last event was 9/25/13.

The Butte-Greeley School (300930005) site in MT changed from the 1-day-in-6 sampling frequency to the Alternate 1-day-in-3 frequency beginning with the 10/1/13 event. This change in collection frequency will be for six months.

The Baxter Water Treatment Plant (421011002) site in PA stopped sampling. The last event was 10/10/13. The speciation samplers were moved to the Northeast Wastewater Treatment Plant (421010048) site. The first event at the new location was 10/22/13.

The Children’s Park (040191028) site in AZ changed from the 1-day-in-3 sampling frequency to the Alternate 1-day-in-3 frequency. The first Alternate date for this site was 11/18/13.

The South Charleston Library (540391005) site in WV had been down since 8/14/13. Site started sampling again beginning with the 11/18/13 event.

The Steubenville (390810017) site in OH began sampling on 12/6/13.

As part of a pilot study, the number of icepacks in the speciation filter packages was reduced from eight to six for the following sites from 8/17/2013 to 9/28/2013: Phoenix Supersite, AZ (040139997), Fresno-Garland, CA (060190011), South Dekalb, GA (130890002), Del Norte, NM (350010023) and Chamizal, TX (481410044).

Beginning with the 12/18/13 shipments from RTI, and until March 2014, the number of icepacks in the speciation filter packages was reduced from eight to six for the winter months as a cost saving measure. Exceptions were the Kapolei (150030010) site in HI and those sites on the Sequential Sampling schedule.

During 2013, fourteen of the CSN sites changed to the Sequential Sampling schedule. These sites are listed below with the first sequential sampling date.

Cheyenne nCore	(560210100)	WY	5/10/13
HU-Beltsville	(240330030)	MD	5/10/13
Riverside Rubidoux	(060658001)	CA	5/10/13
Univ. of Fla. Ag School	(120111002)	FL	5/10/13
Albany Co HD	(360010005)	NY	10/19/13
Chicopee	(250130008)	MA	10/19/13
Com Ed	(170310076)	IL	10/19/13
Division St	(360610134)	NY	10/19/13
Pinnacle State Park	(361010003)	NY	10/19/13
Del Norte	(350010023)	NM	12/6/13
Grand Rapids	(260810020)	MI	12/6/13
Hinton	(481130069)	TX	12/6/13
North Birmingham	(010730023)	AL	12/6/13
Peoria Site 1127	(401431127)	OK	12/6/13

4.0 Data Processing

4.1 Quality Issues and Corrective Actions

During processing of Batch 162, it was noted that an event was accidentally not included in the report batch. This was the first such case in the 13-year history of the program. The missing event was immediately processed and reported to the site (and included in the batch for AQS processing). As part of our corrective action, we implemented changes in our routine reporting procedures to ensure that any future missing event would be detected and processed. This includes verifying that only those events that were initially identified as not to be included (based on samples not received by the due date) in the report prior to processing, were the ones excluded from the final processed data report.

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). Note that the number of records reported per event varies with sampler type. Thus, the number of records per event will vary depending on how many of each sampler type was operating during that period. In addition, the totals in Table 4-1 exclude backup filters (which are always run as part of another event) to prevent double counting of events.

Table 4-1. Events Posted to Web Site

Report		Sampling Date				Blanks			Backup Filters (3)
Report	Date	Earliest	Latest	Total (1)	Routine	Field	Trip	24 Hour(2)	Routine
157	2/15/2013	12/5/2012	1/10/2013	1,747	1,213	0	176	179	179
158	3/15/2013	1/4/2013	2/12/2013	1,646	1,411	78	1	78	78
159	4/15/2013	2/9/2013	3/13/2013	1,506	1,154	0	0	176	176
160	5/15/2013	3/8/2013	4/7/2013	1,237	1,077	0	0	80	80
161	6/14/2013	4/4/2013	5/10/2013	1,926	1,397	177	0	176	176
162	7/15/2013	5/10/2013	6/12/2013	1,308	1,227	0	0	81	0
163	8/15/2013	6/6/2013	7/9/2013	1,527	1,267	4	0	176	80
164	9/13/2013	7/9/2013	8/11/2013	1,487	1,325	79	0	83	0
165	10/15/2013	8/2/2013	9/10/2013	1,624	1,268	0	0	178	178
166	11/18/2013	9/1/2013	10/8/2013	1,385	1,125	91	0	169	0
167	12/13/2013	9/25/2013	11/13/2013	1,649	1,401	82	0	85	81
168	1/15/2014	11/9/2013	12/10/2013	1,210	1,127	0	0	83	0
Total				18,252	14,992	511	177	1,544	1,028

1) Counts for Routine Events and Total Events do not include backup filters or 24-hour blanks.

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
Batch	Date	Earliest	Latest	Total[(1)]	Routine	Field	Trip	24 Hour[(2)]	Filters[(3)]
157	2/15/2013	12/5/2012	1/10/2013	269,484	247,432		8,448	8,592	5,012
158	3/15/2013	1/4/2013	2/12/2013	305,600	287,456	12,168	48	3,744	2,184
159	4/15/2013	2/9/2013	3/13/2013	124,228	117,540			4,224	2,464
160	5/15/2013	3/8/2013	4/7/2013	112,856	109,816			1,920	1,120
161	6/14/2013	4/4/2013	5/10/2013	162,978	142,484	13,806		4,224	2,464
162	7/15/2013	5/10/2013	6/12/2013	129,370	127,426			1,944	
163	8/15/2013	6/6/2013	7/9/2013	137,190	131,534	312		4,224	1,120
164	9/13/2013	7/9/2013	8/11/2013	145,954	137,800	6,162		1,992	
165	10/15/2013	8/2/2013	9/10/2013	138,636	131,872			4,272	2,492
166	11/18/2013	9/1/2013	10/8/2013	128,154	117,000	7,098		4,056	
167	12/13/2013	9/25/2013	11/13/2013	155,274	145,704	6,396		2,040	1,134
168	1/15/2014	11/9/2013	12/10/2013	119,200	117,208			1,992	
Total				1,928,924	1,813,272	45,942	8,496	43,224	17,990

1) Counts for Total Events include routine events, trip and 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 and trip 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. In addition, the number of records posted per event varies with sampler type.

Table 4-3. Events Posted to AQS

Report Batch	Routine(1)	Blanks			Backup Filters(2)
		24 Hour(2)	Field	Trip	
155	1,283	175	177	0	175
156	1,259	79	0	0	79
157	1,214	179	0	176	179
158	1,413	78	78	1	78
159	1,160	176	0	0	176
160	1,080	80	0	0	80
161	1,398	176	177	0	176
162	1,230	81	0	0	0
163	1,271	176	4	0	80
164	1,332	83	79	0	0
165	1,277	178	0	0	178
Total	13,917	1,461	515	177	1,201

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 3000 N samplers only.

Table 4-4. Records Posted to AQS

Report Batch	Routine	Blanks			Backup Filters[1]
		24 Hour[1]	Field	Trip	
155	74,120	2,275	7,965		2,275
156	72,744	1,027			1,027
157	70,328	2,327		2,288	2,327
158	81,721	1,014	3,510	13	1,014
159	66,841	2,288			2,288
160	62,427	1,040			1,040
161	80,987	2,288	7,965		2,288
162	71,075	1,053			
163	73,369	2,288	180		1,040
164	76,850	1,079	3,555		
165	73,544	2,314			2,314
Total	804,006	18,993	23,175	2,301	15,613

(1) URG 3000 N only.

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 4-5. Change Requests per Report Batch*[(1)]*

	Report Batch											
	155	156	157	158	159	160	161	162	163	164	165	166
Change Requests[1]	5	9	5	6	7	3	7	4	11	11	5	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

During 2013, Dr. Doraiswamy succeeded Dr. James Flanagan as the QA manager of the CSN project. As part of his succession training, the QA manager met with each of the RTI laboratory supervisors and examined their procedures and the SOPs. 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 2013. 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 2013 the flag percentages were low and stable. During 2013, 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. The complete definitions of all flags are given in the report (.rtf) files that are posted on the Web Site.

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 of the packages is always higher than this goal. Figure 5-1 shows the temperature average, 10^{th}, 50^{th}, 90^{th} percentiles, and interquartile range plotted monthly through the end of 2013. 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.

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

Flag	Description	157	158	159	160	161	162	163	164	165	166	167	168
1	Critical Criteria Not Met												
2	Operational criteria not met	0.01%	0.09%	0.00%	0.00%	0.01%				0.04%	0.00%	0.02%	0.01%
3	Possible field contamination	0.41%	0.60%	0.68%	0.71%	0.63%	0.79%	0.73%	0.74%	0.62%	0.44%	0.84%	0.02%
4	Possible lab contamination										0.79%	0.80%	0.16%
5	Outlier - cause unknown	3.58%	2.81%	4.04%	4.57%	3.63%	3.81%	3.32%	4.18%	3.75%	4.23%	4.32%	5.09%
IA	African Dust							0.06%	0.14%				
IE	Demolition		0.20%	0.37%	0.09%		0.16%	0.32%	0.49%	0.32%	0.08%	0.32%	0.40%
IH	Fireworks							0.30%	0.07%				
II	High Pollen Count				0.47%	0.25%	0.08%						
IJ	High Winds	0.07%		0.08%	0.28%	0.12%		0.07%			0.08%	0.07%	
IL	Other	1.08%	1.08%	1.35%	0.99%	0.90%	1.39%	1.05%	1.46%	1.02%	0.56%	0.99%	0.38%
IM	Prescribed Fire												
IP	Structural Fire												0.08%
IS	Volcanic Eruptions								0.05%				
IT	Wildfire-U. S.					0.06%	0.08%	0.30%	0.86%	0.92%			
IU	Wildland Fire Use Fire-U. S.												
W	Flow Rate Average Out of Spec.	0.03%	0.09%	0.02%	0.18%	0.15%	0.10%	0.07%	0.05%	0.04%	0.06%	0.05%	0.04%
X	Filter Temperature Difference Out of Spec.	0.57%	0.45%	0.84%	0.96%	0.99%	0.54%	0.88%	0.31%	0.67%	0.50%	0.48%	0.84%
Y	Elapsed Sample Time Out of Spec.												

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

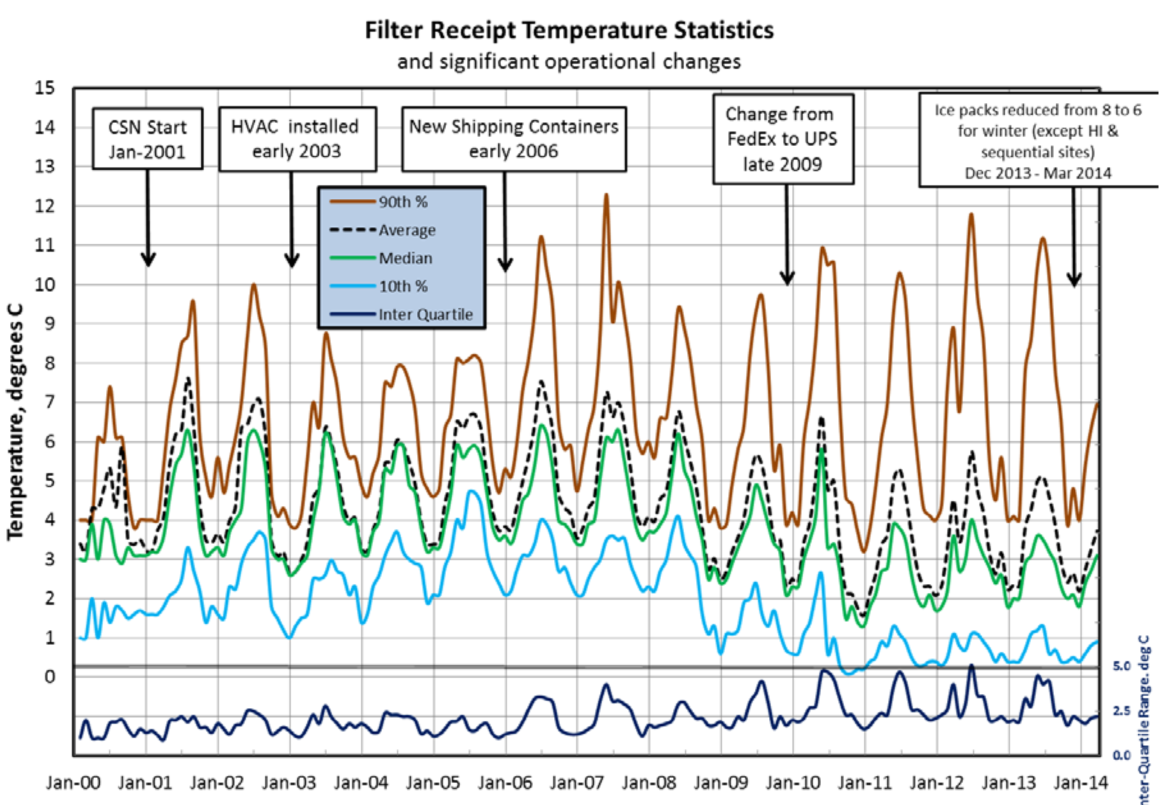
Flag	Description	157	158	159	160	161	162	163	164	165	166	167	168
AB	Technician Unavailable	0.44%	0.62%	0.52%	0.56%	0.08%	0.69%	0.35%	0.33%	0.54%	0.42%	0.18%	0.48%
AC	Construction/Repairs in Area										0.16%	0.18%	0.08%
AD	Shelter Storm Damage	0.02%											
AF	Scheduled but not Collected	2.43%	2.69%	1.09%	0.97%	1.28%	2.18%	1.03%	1.51%	1.44%	1.53%	1.60%	3.11%
AG	Sample Time out of Limits	0.49%	0.84%	0.46%	0.60%	0.60%	0.85%	0.65%	0.57%	0.40%	0.70%	0.23%	0.35%
AH	Sample Flow Rate out of Limits	0.86%	0.70%	0.72%	0.96%	0.57%	0.92%	1.12%	0.91%	0.69%	0.37%	0.36%	1.07%
AI	Insufficient Data (Can't Calculate)		0.03%			0.03%	0.02%	0.13%	0.05%	0.13%	0.10%	0.02%	0.02%
AJ	Filter Damage	0.11%	0.36%	0.25%	0.15%	0.24%	0.23%	0.38%	0.19%	0.28%	0.16%	0.25%	0.12%
AK	Filter Leak					0.05%			0.02%			0.03%	
AL	Voided by Operator	0.11%	0.07%	0.15%	0.23%	0.02%	0.26%	0.29%	0.14%	0.04%	0.30%	0.15%	0.15%
AM	Miscellaneous Void			0.08%			0.10%	0.10%	0.03%	0.00%	0.05%	0.07%	0.15%
AN	Machine Malfunction	0.55%	0.72%	0.75%	0.38%	0.42%	0.53%	1.90%	1.32%	0.55%	0.89%	0.39%	1.09%
AO	Bad Weather		0.07%	0.08%		0.01%		0.13%			0.04%		0.10%
AP	VANDALISM		0.07%					0.06%					
AQ	Collection Error	0.18%	0.10%	0.12%	0.17%	0.03%	0.36%	0.06%	0.17%	0.11%	0.26%	0.20%	0.14%
AR	Lab Error	0.12%	0.20%	0.06%	0.37%	0.18%	0.15%	0.14%	0.12%	0.16%	0.20%	0.14%	0.03%
AS	Poor Quality Assurance Results	0.00%	0.03%	0.00%	0.19%	0.00%	0.02%		0.05%	0.26%			
AU	Monitoring Waived	0.09%	0.08%	0.02%	0.02%	0.01%	0.07%	0.04%	0.04%	0.11%	0.24%	0.02%	0.02%
AV	Power Failure	0.32%	0.47%	0.21%	0.21%	0.49%	0.28%	0.60%	0.18%	0.40%	0.14%	0.02%	0.50%
AW	Wildlife Damage												
BA	Maintenance/Routine Repairs	0.02%	0.17%	0.13%	0.12%	0.06%	0.02%	0.24%	0.14%	0.12%	0.08%	0.12%	0.17%
BB	Unable to Reach Site	0.25%	0.20%						0.05%	0.02%			
BE	Building/Site Repairs												
BI	Lost or Damaged in Transit									0.02%			
BJ	Operator Error												

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

Flag	Description	157	158	159	160	161	162	163	164	165	166	167	168
BFC	Blank Filter Contamination										0.79%	0.80%	0.15%
DFM	Filter missing	0.05%	0.06%	0.02%	0.12%	0.03%	0.05%	0.09%	0.03%	0.10%	0.05%	0.03%	0.02%
DST	Shipping temperature out of specifications	21.1%	11.7%	12.1%	14.9%	34.1%	42.5%	35.3%	42.2%	26.4%	26.4%	12.7%	12.1%
FC1	Channel 1 used instead of designated channel		0.01%	0.02%					0.02%				
FC2	Channel 2 used instead of designated channel		0.04%	0.04%					0.04%				
FC3	Channel 3 used instead of designated channel	0.70%	0.80%	0.82%	0.73%	0.58%	0.91%	0.73%	0.92%	0.90%	0.83%	1.44%	1.60%
FC4	Channel 4 used instead of designated channel	0.28%	0.30%	0.31%	0.24%	0.21%	0.32%	0.26%	0.36%	0.42%	0.32%	0.57%	0.63%
FC5	Channel 5 used instead of designated channel	1.24%	1.24%	1.31%	1.54%	1.53%	1.55%	1.46%	1.49%	1.21%	1.10%	0.91%	0.98%
FC6	Channel 6 used instead of designated channel	0.52%	0.52%	0.55%	0.64%	0.64%	0.65%	0.61%	0.62%	0.51%	0.46%	0.38%	0.41%
FC7	Channel 7 used instead of designated channel	0.12%	0.04%	0.09%	0.05%	0.07%	0.08%	0.16%	0.11%	0.27%	0.08%	0.11%	0.09%
FCE	Corrected - operator data entry error	0.88%	1.20%	1.78%	1.23%	1.09%	1.22%	1.22%	1.78%	1.55%	1.19%	1.20%	1.10%
FES	Field environmental data taken from other flow channel	0.07%	0.07%	0.05%	0.10%	0.07%	0.07%	0.12%	0.09%	0.08%	0.14%	0.07%	0.11%
FHT	Pickup Holding Time Exceeded	24.2%	9.9%	17.8%	17.7%	10.4%	8.4%	14.9%	15.9%	9.4%	15.9%	16.0%	19.7%
LFA	Filter inspection flags* - filter wet	0.06%	0.14%	0.09%	0.02%	0.09%	0.05%	0.05%		0.004%	0.02%		0.02%
LFH	Filter inspection flags* - Holes in filter			0.04%	0.04%			0.04%	0.05%				0.04%
LFL	Filter inspection flags* -Loose Material							0.07%	0.08%	0.05%		0.001%	
LFO	Filter inspection flags* -Other (wrinkling, warping, etc.)			0.04%		0.001%							
LFP	Filter inspection flags* -Pinholes										0.001%		
LFT	Filter inspection flags* - Tear	0.02%	0.16%	0.08%	0.13%	0.09%		0.19%	0.07%	0.10%	0.04%	0.03%	
LLI	Analysis Invalid - Other											0.003%	
QAC	Anion/Cation total charge ratio out of limits	0.52%	0.32%	0.38%	0.28%	0.37%	0.43%	0.36%	0.37%	0.37%	0.82%	0.51%	0.26%
QL1	Outlier based on Level 1 check (e.g., Sulfur/Sulfate Ratio outside limits)	0.20%	0.30%	0.26%	0.24%	0.20%	0.26%	0.25%	0.28%	0.26%	0.26%	0.22%	0.20%
QMB	Total mass balance outside limits	2.94%	2.25%	3.47%	4.13%	3.13%	3.19%	2.72%	3.60%	3.19%	3.12%	3.68%	4.70%
RTS	Refrigeration lost prior to analysis	0.10%											

As shown in **Figure 5-1**, during 2013, in an effort to save shipping costs, a small pilot study was performed to determine the impact of reducing the number of icepacks from 8 to 6 for each filter package. Five sites from regions subject to high ambient temperatures were selected for this study. These include (AQS site codes in parenthesis): Phoenix Supersite, AZ 040139997), Fresno-Garland, CA (060190011), South Dekalb, GA (130890002), Del Norte, NM (350010023) and Chamizal, TX (481410044). Between 8/17/2013 to 9/28/2013, filter packages were shipped with only 6 icepacks. A statistical analysis of the filter receipt temperatures recorded during the pilot study, in comparison to prior year using the 8-icepacks and similar ambient conditions (i.e., temperature), showed that the number of ice packs, in general, was either non-significant or marginally significant at the 95% confidence level. Moreover, differences in temperature were explained mainly by monitoring location, influenced primarily by the Del Norte site. This implied that 6 icepacks might provide the same amount of temperature control as 8 icepacks, although there may be other factors that influence the variability. One of the common issues include insufficient freezing of icepacks prior to return shipment. All sites were returned to using 8 icepacks following the completion of the pilot study. Based on these results, a second study was initiated to determine the impact during the winter period. All sites, except the Kapolei, HI, site, and those on sequential sampling, began using 6 icepacks from 12/18/2013 to 3/31/2014. As shown in Figure 5-1, the temperature distribution during these months is in general quite similar to the temperature distribution in Dec 2012 to Mar 2013, with the 75^{th} percentile being less than 4 °C.

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 2013, 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 2013.

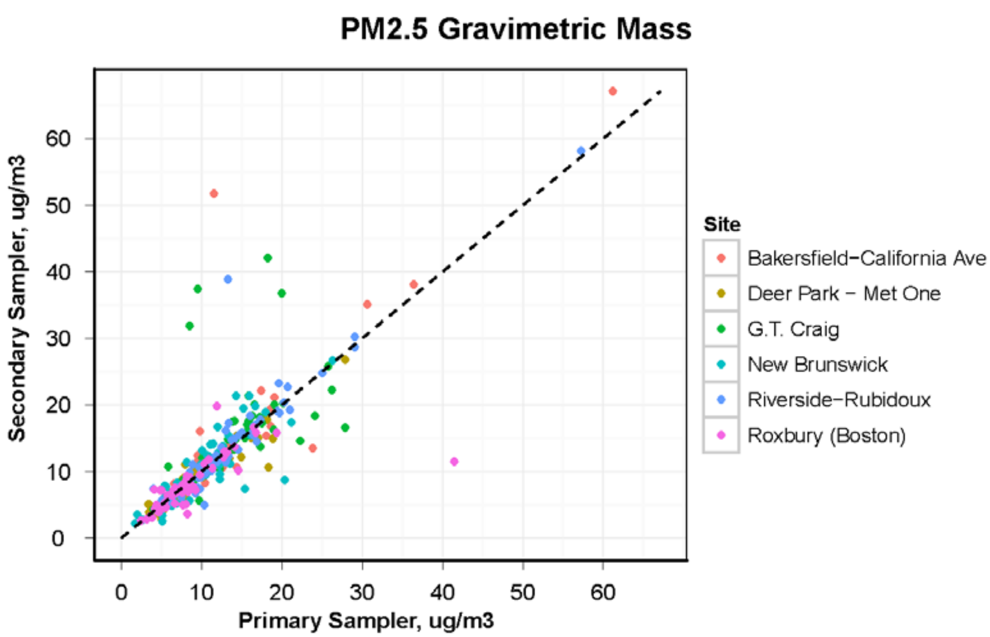
Location Name	State	AQS Code	Sampler Type
Bakersfield-California Ave*	California	060290014	MetOne SASS + URG 3000N
Deer Park	Texas	482011039	MetOne SASS + URG 3000N
G.T. Craig	Ohio	390350060	MetOne SASS + URG 3000N*
New Brunswick	New Jersey	340230006	MetOne SASS + URG 3000N
Riverside-Rubidoux	California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

** The collocated URG 3000N sampler at Bakersfield-California Ave site was out of service for most of 2013 due to sampler problems and is therefore not included in Figure 5-2 statistics for organic and elemental carbon.*

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.

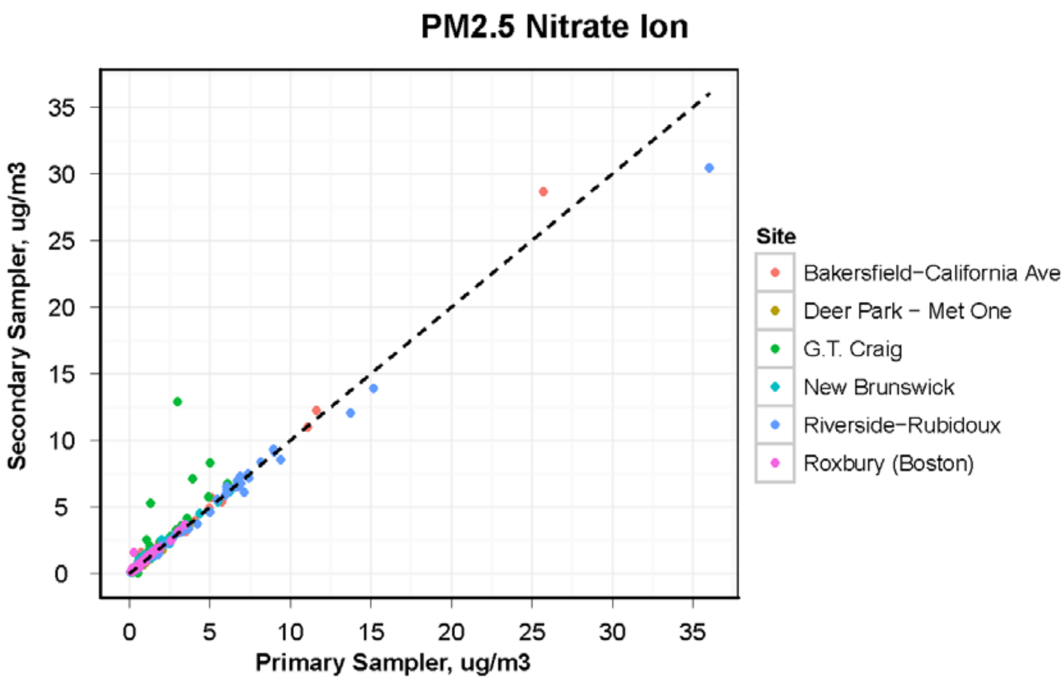
The figures that follow (**Figure 5-2**) show examples of the comparisons for $PM_{2.5}$ mass, nitrate, sulfate, sulfur and organic and elemental carbon (IMPROVE_A TOR and TOT methods). Also included in the figure are linear least-squares regression parameters (slope, intercept, R^2) by site for each of these species. These figures demonstrate good or excellent agreement for the major analytes; however, precision for the species sampled at the G.T. Craig site are visibly poorer than for the other five sites. In addition, the Deer Park site showed larger variability for carbon species than the other four sites (i.e., excluding Bakersfield site as noted above due to sampler issues for most of 2013).

Figure 5-2 Collocation Data for Selected Species During 2013.



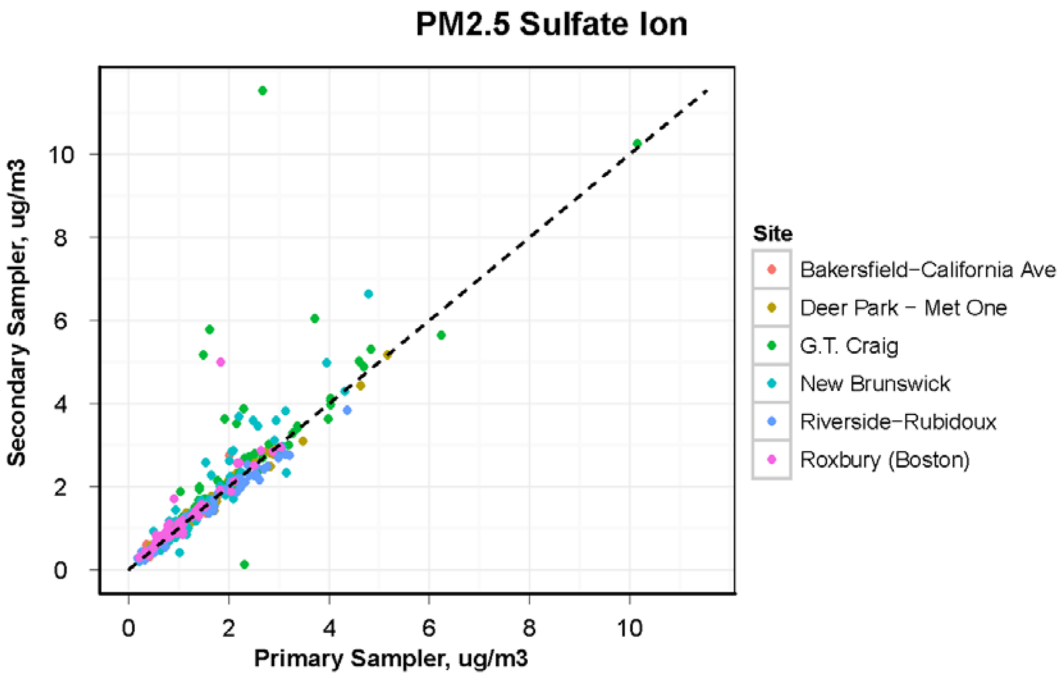
Site	Intercept	Slope	R2
Bakersfield−California Ave	1.10	1.00	0.68
Deer Park − Met One	0.86	0.86	0.91
G.T. Craig	6.60	0.67	0.22
New Brunswick	0.65	0.94	0.73
Riverside−Rubidoux	0.20	1.00	0.83
Roxbury (Boston)	4.10	0.43	0.43

Figure 5-2 (continued).



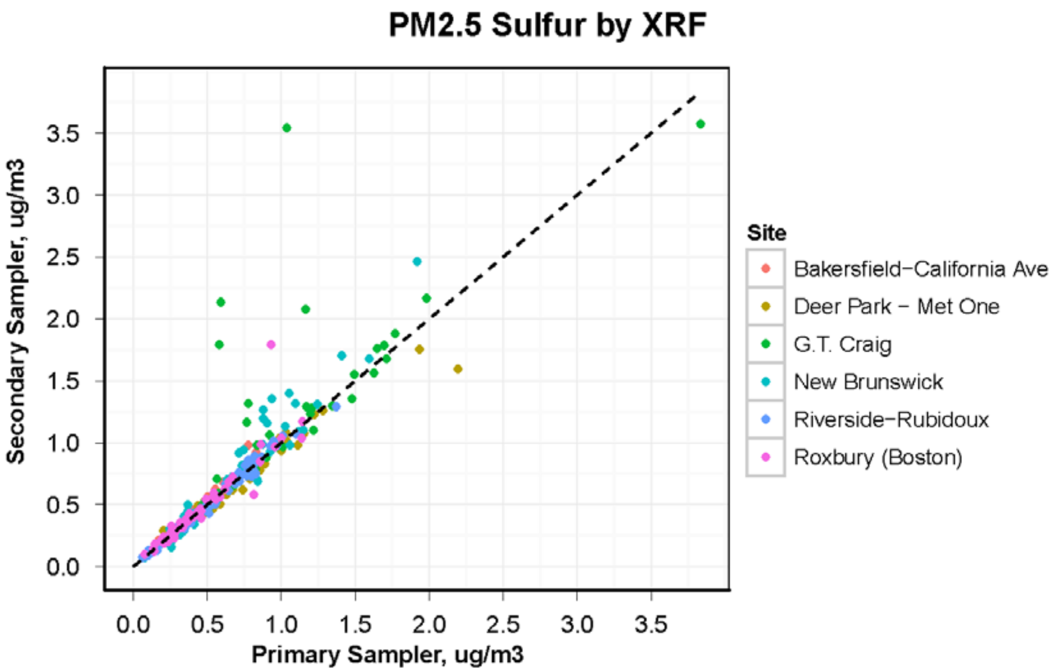
Site	Intercept	Slope	R2
Bakersfield−California Ave	−0.150	1.10	1.00
Deer Park − Met One	−0.015	0.98	0.98
G.T. Craig	−0.075	1.40	0.62
New Brunswick	0.050	0.99	0.99
Riverside−Rubidoux	0.430	0.87	0.99
Roxbury (Boston)	0.035	1.00	0.93

Figure 5-2 (continued).



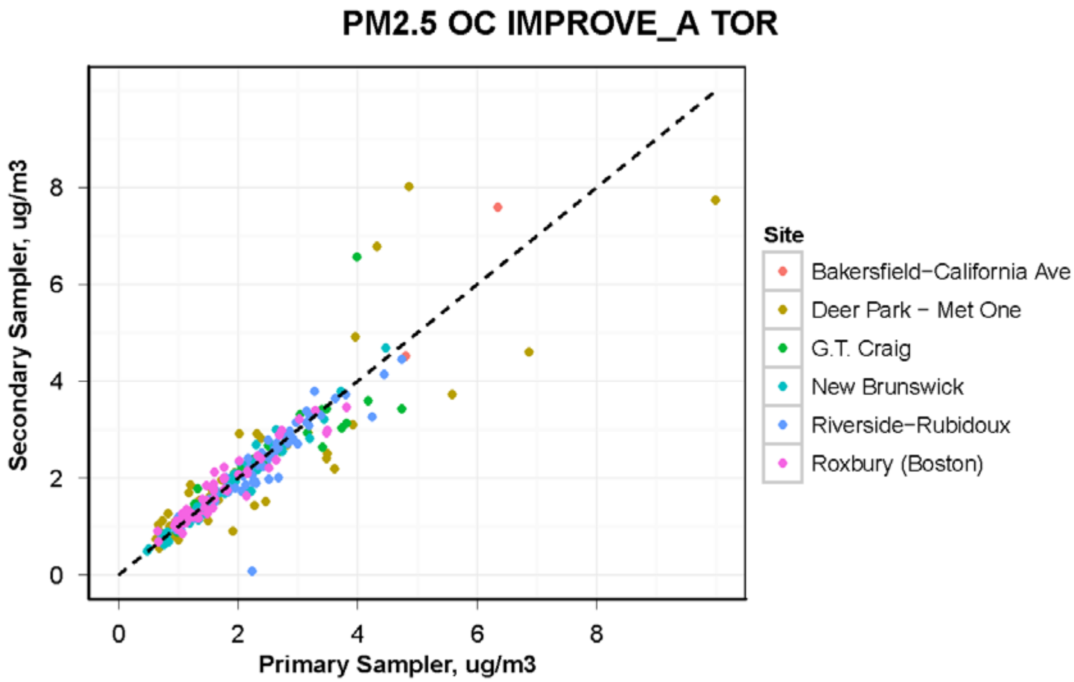
Site	Intercept	Slope	R2
Bakersfield−California Ave	−0.013	1.00	0.94
Deer Park − Met One	0.099	0.94	0.98
G.T. Craig	0.710	0.93	0.49
New Brunswick	−0.130	1.20	0.89
Riverside−Rubidoux	0.080	0.88	0.98
Roxbury (Boston)	0.046	1.10	0.73

Figure 5-2 (continued).



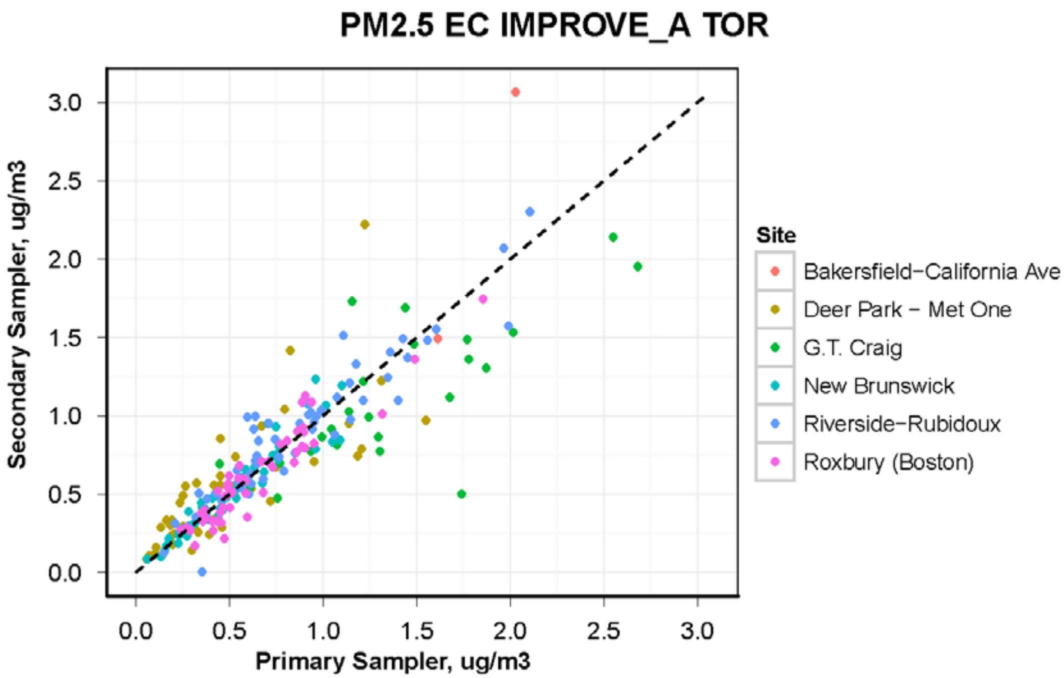
Site	Intercept	Slope	R2
Bakersfield−California Ave	−0.0170	1.10	0.97
Deer Park − Met One	0.0810	0.84	0.96
G.T. Craig	0.2500	0.91	0.57
New Brunswick	−0.0780	1.20	0.94
Riverside−Rubidoux	−0.0061	1.00	0.99
Roxbury (Boston)	−0.0280	1.10	0.84

Figure 5-2 (continued).



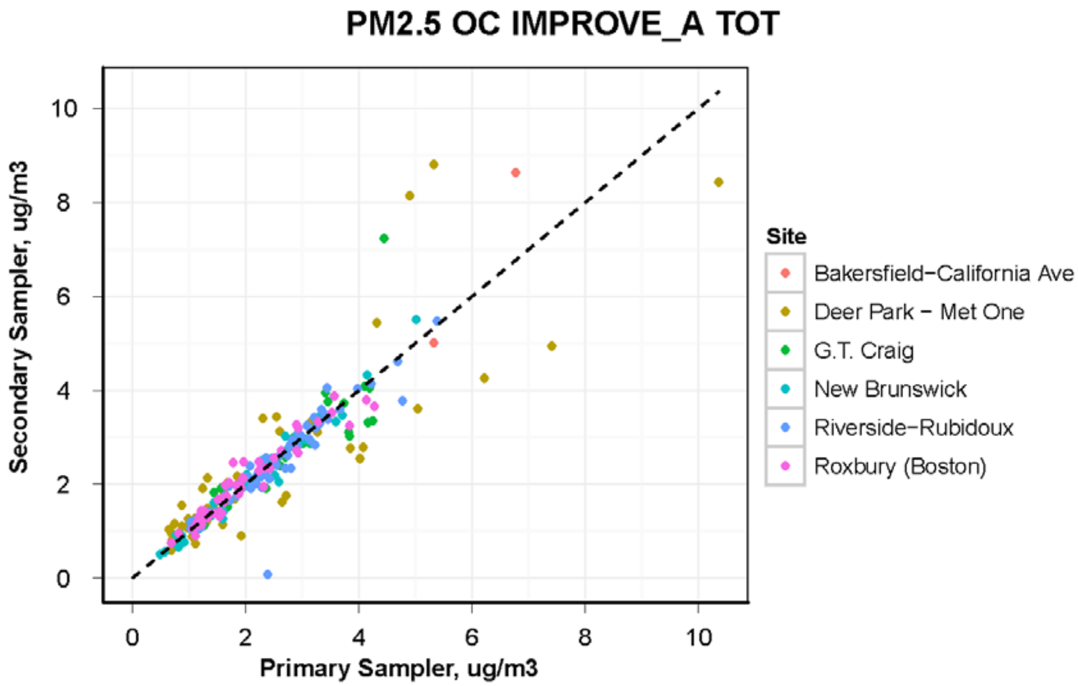
Site	Intercept	Slope	R2
Deer Park − Met One	0.370	0.81	0.75
G.T. Craig	0.310	0.87	0.66
New Brunswick	−0.019	1.00	0.96
Riverside−Rubidoux	0.055	0.93	0.82
Roxbury (Boston)	0.200	0.90	0.91

Figure 5-2 (continued).



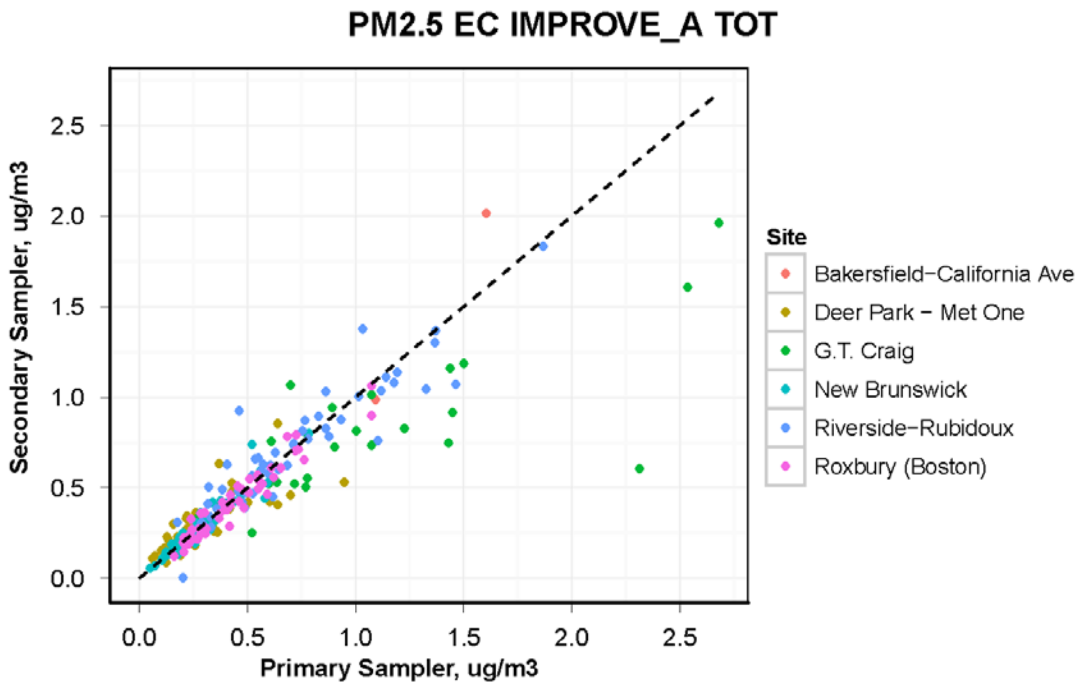
Site	Intercept	Slope	R2
Deer Park − Met One	0.1100	0.85	0.62
G.T. Craig	0.2500	0.64	0.58
New Brunswick	0.0150	0.98	0.89
Riverside−Rubidoux	0.0800	0.94	0.89
Roxbury (Boston)	0.0067	0.94	0.89

Figure 5-2 (continued).



Site	Intercept	Slope	R2
Deer Park − Met One	0.380	0.84	0.73
G.T. Craig	−0.022	1.00	0.69
New Brunswick	−0.041	1.00	0.97
Riverside−Rubidoux	−0.017	0.97	0.86
Roxbury (Boston)	0.180	0.92	0.93

Figure 5-2 (continued).



Site	Intercept	Slope	R2
Deer Park − Met One	0.1000	0.64	0.62
G.T. Craig	0.2900	0.47	0.60
New Brunswick	0.0056	0.98	0.91
Riverside−Rubidoux	0.0800	0.88	0.87
Roxbury (Boston)	0.0081	0.94	0.93

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, 2013

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	11.59	7.07	11.88	8.15	11%	6%	57%	306
ANIONS AND CATIONS BY IC								
Ammonium	0.88	1.22	0.93	1.21	11%	8%	73%	307
Sodium	0.22	0.23	0.23	0.24	17%	13%	74%	232
Potassium	0.05	0.03	0.06	0.04	25%	18%	73%	245
Nitrate	1.96	3.29	2.03	3.25	9%	8%	81%	313
Sulfate	1.63	1.14	1.75	1.38	10%	7%	76%	313
TRACE ELEMENTS BY XRF								
Aluminum	0.135	0.212	0.129	0.219	26%	21%	80%	116
Barium	0.036	0.079	0.039	0.079	23%	55%	**233%**	15
Bromine	0.005	0.004	0.005	0.004	19%	27%	139%	201
Calcium	0.071	0.076	0.071	0.086	22%	11%	51%	266
Chromium	0.011	0.025	0.006	0.013	41%	28%	67%	111
Copper	0.009	0.010	0.010	0.012	23%	17%	73%	237
Chlorine	0.087	0.151	0.085	0.156	33%	18%	56%	221
Iron	0.136	0.155	0.139	0.178	14%	8%	54%	307
Lead	0.011	0.007	0.012	0.010	21%	31%	150%	19
Manganese	0.006	0.004	0.006	0.005	21%	23%	111%	120
Nickel	0.003	0.002	0.002	0.002	32%	28%	87%	60
Magnesium	0.046	0.029	0.044	0.032	25%	21%	84%	89
Titanium	0.013	0.014	0.013	0.015	21%	26%	121%	77
Silicon	0.162	0.324	0.171	0.369	15%	14%	93%	286
Zinc	0.016	0.025	0.017	0.028	17%	16%	95%	262
Sulfur	0.615	0.424	0.647	0.487	7%	7%	109%	307
Potassium	0.068	0.050	0.072	0.061	10%	9%	95%	307
Sodium	0.195	0.204	0.200	0.211	19%	20%	105%	214

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)				
ORGANIC AND ELEMENTAL CARBON BY IMPROVE_A METHOD (Sampled by URG 3000N)								
OC IMPROVE TOR	2.12	1.20	2.08	1.18	9%	N/A	N/A	239
OC IMPROVE TOT	2.33	1.31	2.32	1.34	9%	N/A	N/A	239
EC IMPROVE TOR	0.72	0.47	0.71	0.45	13%	N/A	N/A	238
EC IMPROVE TOT	0.50	0.41	0.47	0.33	12%	N/A	N/A	238
O1 IMPROVE	0.20	0.17	0.20	0.19	34%	N/A	N/A	219
O2 IMPROVE	0.56	0.30	0.56	0.30	10%	N/A	N/A	239
O3 IMPROVE	0.70	0.44	0.66	0.38	12%	N/A	N/A	238
O4 IMPROVE	0.46	0.27	0.45	0.27	14%	N/A	N/A	238
OP IMPROVE TOR	0.27	0.21	0.29	0.24	26%	N/A	N/A	177
OP IMPROVE TOT	0.44	0.30	0.47	0.36	20%	N/A	N/A	235
E1 IMPROVE	0.87	0.51	0.88	0.54	11%	N/A	N/A	238
E2 IMPROVE	0.06	0.05	0.06	0.04	25%	N/A	N/A	231
TC IMPROVE	2.83	1.56	2.79	1.55	9%	N/A	N/A	239

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 2013 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 2013. 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. Mass (57%), Calcium (51%) and Iron (54%), which showed less than 50% agreement in 2012 have improved during 2013. Only Barium (233%) disagreed by more than a factor of 2.

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 2013. No Trip Blank samples are currently being collected for the MET ONE SASS samplers. There were changes to the frequency of blank sample collections beginning 3/21/2013. Trip Blanks for the URG 3000N samplers, which were collected at a frequency of 2% until March 2013, were eliminated completely afterwards. Quartz backup filter collection was reduced from10% to 5% and quartz 24 hour blank samples continue to be 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 2013.

For XRF analysis, the average and median Field Blanks were well below the average MDLs for all elements. Higher values are found for chromium in the higher percentiles due to the high chromium background found on Teflon Filters. Nevertheless, since the chromium contamination was detected at an earlier stage and the manufacturer was notified promptly, the impact was restricted to just three reporting batches during 2013. Consequently, the mean field blank chromium loading over the entire year was only marginally high, compared to the level of contamination found on the filters. For ions, the median for sulfate was somewhat higher than the other ions, but is similar to values observed in previous years. The washed nylon filter lab blanks (Table 3-10), when converted to µg/m^3 basis, showed a maximum of approximately 0.06 µg/m^3. Thus, the sulfate field blank concentration is within acceptable range.

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 157 through 168).

Analyte	Mean (µg/m^3)	Percentiles of Concentration (µg/m^3)						
		5	10	25	Median	75	90	95
Cations and anions by ion chromatography (Field Blanks)								
Ammonium	0.0032	0.0000	0.0000	0.0000	0.0000	0.0064	0.0120	0.0140
Potassium	0.0046	0.0000	0.0000	0.0000	0.0000	0.0000	0.0075	0.0200
Sodium	0.0230	0.0000	0.0000	0.0000	0.0140	0.0280	0.0500	0.0740
Nitrate	0.0057	0.0000	0.0000	0.0000	0.0000	0.0000	0.0260	0.0390
Sulfate	0.0290	0.0000	0.0000	0.0000	0.0260	0.0400	0.0660	0.0780
Mass by gravimetry								
Particulate matter 2.5µ	0.69	-0.10	0.00	0.21	0.52	0.94	1.50	2.10
Organic and elemental carbon by IMPROVE A Method (24-hour Blanks)								
OC IMPROVE TOR	0.1500	0.0570	0.0680	0.0840	0.1100	0.1700	0.2700	0.3700
OC IMPROVE TOT	0.1500	0.0570	0.0680	0.0840	0.1200	0.1700	0.2800	0.3800
EC IMPROVE TOR	0.0034	0.0000	0.0000	0.0000	0.0000	0.0010	0.0095	0.0170
EC IMPROVE TOT	0.0012	0.0000	0.0000	0.0000	0.0000	0.0000	0.0014	0.0046
O1 IMPROVE	0.0190	0.0000	0.0000	0.0060	0.0130	0.0230	0.0380	0.0570
O2 IMPROVE	0.0450	0.0190	0.0220	0.0280	0.0360	0.0490	0.0800	0.1100
O3 IMPROVE	0.0750	0.0280	0.0330	0.0430	0.0570	0.0800	0.1300	0.1700
O4 IMPROVE	0.0110	0.0000	0.0000	0.0000	0.0046	0.0130	0.0280	0.0440
OP IMPROVE TOR	0.0010	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0004
OP IMPROVE TOT	0.0031	0.0000	0.0000	0.0000	0.0000	0.0000	0.0085	0.0170
E1 IMPROVE	0.0032	0.0000	0.0000	0.0000	0.0000	0.0000	0.0081	0.0160
E2 IMPROVE	0.0012	0.0000	0.0000	0.0000	0.0000	0.0000	0.0031	0.0063
E3 IMPROVE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
TC IMPROVE	0.1500	0.0570	0.0680	0.0850	0.1200	0.1700	0.2800	0.3800
Trace elements by XRF (Field Blanks)								
Aluminum	0.0044	0.0000	0.0000	0.0000	0.0000	0.0000	0.0051	0.0100

Analyte	Mean (µg/m³)	Percentiles of Concentration (µg/m³)						
		5	10	25	Median	75	90	95
Antimony	0.0053	0.0000	0.0000	0.0000	0.0000	0.0079	0.0170	0.0220
Arsenic	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0007	0.0011
Barium	0.0008	0.0000	0.0000	0.0000	0.0000	0.0000	0.0029	0.0058
Bromine	0.0003	0.0000	0.0000	0.0000	0.0000	0.0005	0.0010	0.0013
Cadmium	0.0017	0.0000	0.0000	0.0000	0.0000	0.0007	0.0071	0.0094
Calcium	0.0008	0.0000	0.0000	0.0000	0.0000	0.0000	0.0014	0.0025
Cerium	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0007	0.0013
Cesium	0.0012	0.0000	0.0000	0.0000	0.0000	0.0021	0.0049	0.0060
Chlorine	0.0012	0.0000	0.0000	0.0000	0.0000	0.0007	0.0024	0.0053
Chromium	0.0082	0.0000	0.0000	0.0000	0.0010	0.0028	0.0350	0.0590
Cobalt	0.0002	0.0000	0.0000	0.0000	0.0000	0.0003	0.0006	0.0010
Copper	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0007	0.0012
Indium	0.0017	0.0000	0.0000	0.0000	0.0000	0.0000	0.0059	0.0110
Iron	0.0026	0.0000	0.0000	0.0000	0.0003	0.0018	0.0052	0.0110
Lead	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0007	0.0015
Magnesium	0.0019	0.0000	0.0000	0.0000	0.0000	0.0000	0.0053	0.0150
Manganese	0.0003	0.0000	0.0000	0.0000	0.0000	0.0001	0.0011	0.0018
Nickel	0.0003	0.0000	0.0000	0.0000	0.0000	0.0001	0.0009	0.0016
Phosphorus	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0018
Potassium	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0007	0.0019
Rubidium	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0007	0.0010
Selenium	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0005	0.0008
Silicon	0.0019	0.0000	0.0000	0.0000	0.0000	0.0021	0.0054	0.0082
Silver	0.0010	0.0000	0.0000	0.0000	0.0000	0.0000	0.0035	0.0071
Sodium	0.0072	0.0000	0.0000	0.0000	0.0000	0.0025	0.0230	0.0400
Strontium	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0007	0.0011
Sulfur	0.0008	0.0000	0.0000	0.0000	0.0000	0.0000	0.0015	0.0022
Tin	0.0026	0.0000	0.0000	0.0000	0.0000	0.0024	0.0094	0.0150
Titanium	0.0003	0.0000	0.0000	0.0000	0.0000	0.0004	0.0011	0.0015
Vanadium	0.0002	0.0000	0.0000	0.0000	0.0000	0.0002	0.0009	0.0014
Zinc	0.0004	0.0000	0.0000	0.0000	0.0000	0.0002	0.0008	0.0014
Zirconium	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0022	0.0039

"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 2013. 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[7], although it is yet to be finalized.

[7] "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 3000N Backup Filters

Analyte	Mean	Percentiles of Concentration (as ug/m^3)						
		5	10	20	50 (median)	70	90	95
OC IMPROVE TOR	0.2747	0.0783	0.1084	0.1665	0.2492	0.3461	0.4616	0.5460
OC IMPROVE TOT	0.2802	0.0783	0.1084	0.1668	0.2518	0.3518	0.4774	0.5757
EC IMPROVE TOR	0.0063	0.0000	0.0000	0.0000	0.0008	0.0087	0.0199	0.0283
EC IMPROVE TOT	0.0008	0.0000	0.0000	0.0000	0.0000	0.0000	0.0026	0.0055
O1 IMPROVE	0.0427	0.0000	0.0006	0.0158	0.0334	0.0595	0.0892	0.1221
O2 IMPROVE	0.0869	0.0275	0.0355	0.0532	0.0801	0.1103	0.1464	0.1677
O3 IMPROVE	0.1159	0.0370	0.0488	0.0690	0.0991	0.1385	0.1965	0.2456
O4 IMPROVE	0.0275	0.0000	0.0022	0.0102	0.0204	0.0370	0.0585	0.0770
OP IMPROVE TOR	0.0017	0.0000	0.0000	0.0000	0.0000	0.0000	0.0015	0.0098
OP IMPROVE TOT	0.0073	0.0000	0.0000	0.0000	0.0003	0.0087	0.0223	0.0348
E1 IMPROVE	0.0056	0.0000	0.0000	0.0000	0.0000	0.0069	0.0161	0.0243
E2 IMPROVE	0.0025	0.0000	0.0000	0.0000	0.0000	0.0033	0.0081	0.0127
E3 IMPROVE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
TC IMPROVE	0.2810	0.0783	0.1087	0.1668	0.2527	0.3518	0.4774	0.5757

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, 2013

Participants in the 2013 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 National Exposure Research Laboratory (NERL)
- EPA NAREL

Unknowns were distributed to RTI and the other labs in early 2013 for gravimetry, XRF, ion chromatography, and OC/EC. RTI submitted its results to NAREL on February 28, 2013.

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/ttn/amtic/files/ambient/pm25/qa/MultilabSpeciationPT2012.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. The report did note variability in OC/EC and TC data among the laboratories.

6.2 *Technical Systems Audit (TSA)*

EPA did not perform a TSA during 2013. 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	

Type	Title	Date Revised	Author	Document No.
SOP	Standard Operating Procedure—Speciation Data Processing Disaster Recovery Plan	5/21/2008	Rickman	
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

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 2.5u	11	1.2	
Anions and Cations	Ammonium	0.24	0.028	
	Potassium	0.23	0.026	
	Sodium	0.29	0.032	
	Nitrate	0.21	0.024	
	Sulfate	0.16	0.018	
Organic and elemental carbon*	E1 IMPROVE	0.12		0.0042
	E2 IMPROVE	0.13		0.0044
	E3 IMPROVE	0.34		0.012
	EC IMPROVE TOR	0.42		0.015
	EC IMPROVE TOT	0.35		0.012
	O1 IMPROVE	0.20		0.0068
	O2 IMPROVE	0.46		0.016
	O3 IMPROVE	0.85		0.029
	O4 IMPROVE	0.25		0.0086
	OC IMPROVE TOR	1.5		0.051
	OC IMPROVE TOT	1.5		0.053
	OP IMPROVE TOR	0.14		0.0049
	OP IMPROVE TOT	0.27		0.0095
	TC IMPROVE	1.7		0.057
Trace Elements	Aluminum	0.24	0.026	
	Antimony	0.50	0.054	
	Arsenic	0.026	0.0028	
	Barium	0.57	0.061	
	Bromine	0.022	0.0024	
	Cadmium	0.22	0.023	
	Calcium	0.073	0.0081	
	Cerium	0.84	0.089	
	Cesium	0.44	0.047	
	Chlorine	0.11	0.012	
	Chromium	0.025	0.0028	
	Cobalt	0.019	0.0020	
	Copper	0.024	0.0027	
	Indium	0.32	0.035	
	Iron	0.032	0.0034	
	Lead	0.061	0.0065	
	Magnesium	0.18	0.019	
	Manganese	0.028	0.0030	
	Nickel	0.018	0.0019	
	Phosphorus	0.15	0.017	

Analysis	Analyte	Mass (μg)	Concentration (μg/m^3) by sampler type	
			SASS	URG 3000N
	Potassium	0.11	0.012	
	Rubidium	0.025	0.0027	
	Selenium	0.025	0.0028	
	Silicon	0.18	0.020	
	Silver	0.36	0.040	
	Sodium	0.53	0.058	
	Strontium	0.034	0.0037	
	Sulfur	0.095	0.011	
	Tin	0.35	0.038	
	Titanium	0.051	0.0057	
	Vanadium	0.037	0.0041	
	Zinc	0.034	0.0039	
	Zirconium	0.22	0.024	

* 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 2013.

Appendix B

Data Completeness Summary

B-2

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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											
					155	156	157	158	159	160	161	162	163	164	165	166
Allen Park	MI	261630001	5	URG 3000N	100	100	100	100	100	100	95	80	94	91	100	89
Allen Park	MI	261630001	5	SASS with URG 3000N	100	100	90	100	100	100	100	100	100	100	100	100
Bakersfield-California Ave	CA	060290014	5	URG 3000N	100	100	100	94	83	100	94	100	44	89	38	
Bakersfield-California Ave	CA	060290014	5	SASS with URG 3000N	100	94	100	85	86	89	100	100	100	100	78	
Bakersfield-California Ave (Collocated)	CA	060290014	6	SASS with URG 3000N	80	100	90	83	80	100	83	100	80	60	80	0
Bakersfield-California Ave (Collocated)	CA	060290014	6	URG 3000N	88	100	35	0	0	0	0	0	0	0	0	0
Baxter Water Treatment Plant	PA	421011002	5	SASS with URG 3000N	95	99	100	100	100	100	99	100	100	100	100	50
Baxter Water Treatment Plant	PA	421011002	5	URG 3000N	98	97	100	100	100	100	100	100	100	100	100	50
Beacon Hill - Met One	WA	530330080	6	URG 3000N	100	100	100	100	92	93	100	100	100	100	94	100
Beacon Hill - Met One	WA	530330080	6	SASS with URG 3000N	100	100	100	100	86	88	100	100	100	100	89	100
Blair Street	MO	295100085	6	SASS with URG 3000N	99	99	100	100	100	100	88	98	100	91	100	100
Blair Street	MO	295100085	6	URG 3000N	100	100	100	100	100	100	95	100	50	100	100	100
Burlington	VT	500070012	5	SASS with URG 3000N	100	100	100	100	100	88	89	100	100	100	100	57
Burlington	VT	500070012	5	URG 3000N	97	100	100	100	100	93	94	100	94	100	100	57
Capitol - Met One	LA	220330009	5	URG 3000N	98	97	63	89	100	94	95	80	94	82	100	89
Capitol - Met One	LA	220330009	5	SASS with URG 3000N	100	95	80	81	100	89	91	80	81	81	100	89
Chamizal - Met One	TX	481410044	5	URG 3000N	100	100	97	100	100	100	100	100	100	100	94	22
Chamizal - Met One	TX	481410044	5	SASS with URG 3000N	100	100	94	86	100	89	100	90	90	100	90	100
Chicopee	MA	250130008	5	URG 3000N	89	97	46		50	94	90	70	50	82	94	88

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					155	156	157	158	159	160	161	162	163	164	165	166
Chicopee	MA	250130008	5	SASS with URG 3000N	100	100	100	100	92	100	100	100	100	99	99	100
Com Ed - Met One	IL	170310076	5	SASS with URG 3000N	94	94	100	95	86		89	100	89	100	100	100
Com Ed - Met One	IL	170310076	5	URG 3000N	97	97	100	97	58		94	100	50	100	100	100
Criscuolo Park	CT	090090027	5	URG 3000N	97	100	96	88	100	100	100	88	100	100	94	100
Criscuolo Park	CT	090090027	5	SASS with URG 3000N	94	100	100	79	100	91	92	88	100	100	100	99
Deer Park - Met One	TX	482011039	6	SASS with URG 3000N	100	99	100	100	89	89	91	100	100	100	100	100
Deer Park - Met One	TX	482011039	6	URG 3000N	100	100	97	95	81	100	100	100	100	100	100	89
Deer Park Collocated - Met One	TX	482011039	7	URG 3000N	100	100	100	92	100	100	100	100	100	100	63	40
Deer Park Collocated - Met One	TX	482011039	7	SASS with URG 3000N	100	100	100	100	80	100	83	98	100	100	100	100
East Providence	RI	440071010	5	URG 3000N	14	97	89	93	88	94	95	70	94	82	94	67
East Providence	RI	440071010	5	SASS with URG 3000N	100	100	100	100	99	100	100	100	100	100	100	90
El Cajon	CA	060730003	5	SASS with URG 3000N	100	100	100	95	100	100	100	100	100	100	100	100
El Cajon	CA	060730003	5	URG 3000N	100	100	100	97	100	100	100	100	100	100	94	100
Elizabeth Lab	NJ	340390004	5	URG 3000N	94	86	100	94	100	100	94	100	100	100	100	100
Elizabeth Lab	NJ	340390004	5	SASS with URG 3000N	89	100	100	89	100	100	89	100	100	100	100	100
Essex - Met One	MD	240053001	5	SASS with URG 3000N	94	94	93	95	99	100	100	100	100	99	78	98
Essex - Met One	MD	240053001	5	URG 3000N	86	97	96	97	100	100	94	75	60	100	81	100
Fargo NW	ND	380171004	5	URG 3000N	100	94	83	85	50	100	100	100	100	91	100	89
Fargo NW	ND	380171004	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	70	100	99	100
Fresno - Garland	CA	060190011	5	SASS with URG 3000N	96	92	95	100	100	100	100	90	100	100	100	100
Fresno - Garland	CA	060190011	5	URG 3000N	97	95	92	91	100	100	100	80	100	100	100	100
G.T. Craig	OH	390350060	5	SASS with URG 3000N	100	89	93	86	100	100	100	91	92	100	100	100
G.T. Craig	OH	390350060	5	URG 3000N	100	100	81	94	100	93	100	88	0	22	100	100
G.T. Craig - Collocated	OH	390350060	6	SASS with URG 3000N	100	90	90	69	64	99	83	85	100	100	100	100
G.T. Craig - Collocated	OH	390350060	6	URG 3000N		0	50	8	13	0	30	60	0	20	100	100

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					155	156	157	158	159	160	161	162	163	164	165	166
Garinger High School	NC	371190041	5	SASS with URG 3000N	95	95	100	97	100	100	91	89	92	92	100	100
Garinger High School	NC	371190041	5	URG 3000N	95	97	88	92	88	94	85	80	94	82	94	78
Hawthorne	UT	490353006	5	SASS with URG 3000N	100	88	83	87	100	80	100	90	90	91	100	100
Hawthorne	UT	490353006	5	URG 3000N	100	93	95	95	100	94	100	90	89	91	100	78
Henrico Co.	VA	510870014	5	URG 3000N	94	100	96	97	100	93	100	75	100	100	100	100
Henrico Co.	VA	510870014	5	SASS with URG 3000N	94	100	93	95	100	75	90	100	100	100	100	100
Hinton - Met One	TX	481130069	5	URG 3000N	100	100	96	97	100	100	94	100	100	100	29	100
Hinton - Met One	TX	481130069	5	SASS with URG 3000N	100	100	94	94	100	100	96	85	83	93	100	100
Indpls. Washington Park	IN	180970078	5	SASS with URG 3000N	99	100	100	100	100	100	100	91	91	100	91	86
Indpls. Washington Park	IN	180970078	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Jackson NCORE	MS	280490020	5	URG 3000N									67	89	100	86
Jackson NCORE	MS	280490020	5	SASS with URG 3000N									67	100	100	100
JFK Center	KS	202090021	5	URG 3000N	100	100	67	97	100	100	100	100	100	100	100	86
JFK Center	KS	202090021	5	SASS with URG 3000N	100	100	100	95	100	91	100	88	100	100	100	100
La Casa	CO	080310026	5	URG 3000N	96	100	100	97	100	100	100	100	100	100	100	86
La Casa	CO	080310026	5	SASS with URG 3000N	94	100	94	94	100	100	100	100	100	92	100	100
Lawrenceville	PA	420030008	6	URG 3000N	100	97	100	97	100	100	100	100	100	100	100	100
Lawrenceville	PA	420030008	6	SASS with URG 3000N	99	90	100	95	86	100	100	100	100	100	100	100
McMillan Reservoir - Met One	DC	110010043	5	URG 3000N	98	100	100	100	100	100	95	100	100	91	89	100
McMillan Reservoir - Met One	DC	110010043	5	SASS with URG 3000N	95	95	100	100	100	100	91	100	100	100	100	100
MLK	DE	100032004	5	SASS with URG 3000N	95	94	22					50	89	73	59	85
MLK	DE	100032004	5	URG 3000N	98	67	74					50	88	50	83	100
New Brunswick	NJ	340230006	5	URG 3000N	83	97	100	97	50	93	100	100	94	100	100	100
New Brunswick	NJ	340230006	5	SASS with URG 3000N	69	94	100	94	100	68	100	91	89	92	100	100
New Brunswick	NJ	340230006	6	SASS with URG 3000N	76	86	98	99	99	100	78	77	76	94	94	95

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					155	156	157	158	159	160	161	162	163	164	165	166
(Collocated)																
New Brunswick (Collocated)	NJ	340230006	6	URG 3000N	88	90	100	100	50	100	50	80	60	100	100	100
North Birmingham	AL	010730023	5	SASS with URG 3000N	100	96	100	91	100	98	100	100	100	86	93	93
North Birmingham	AL	010730023	5	URG 3000N	90	100	50	97	100	100	100	88	13	0	25	100
Parklane	SC	450790007	5	SASS with URG 3000N	92	96	92	97	97	96	96	88	97	96	96	97
Parklane	SC	450790007	5	URG 3000N	98	100	100	100	100	100	100	90	100	100	100	100
Peoria Site 1127	OK	401431127	5	SASS with URG 3000N	100	100	100	90	100	100	100	88	92	100	92	100
Peoria Site 1127	OK	401431127	5	URG 3000N	100	100	100	37	0	43	100	50	0	78	100	86
Philips	MN	270530963	5	SASS with URG 3000N	95	95	100	95	99	90	82	70	90	100	100	100
Philips	MN	270530963	5	URG 3000N	97	97	100	100	100	94	50	100	100	100	100	100
Phoenix Supersite	AZ	040139997	7	URG 3000N	100	100	100	98	100	100	95	100	100	100	100	100
Phoenix Supersite	AZ	040139997	7	SASS with URG 3000N	100	100	100	95	100	100	100	100	100	100	100	100
Portland - SE Lafayette	OR	410510080	6	SASS with URG 3000N	100	100	100	100	100	100	99	89	100	99	90	100
Portland - SE Lafayette	OR	410510080	6	URG 3000N	100	100	100	100	100	100	100	90	100	100	50	100
Reno	NV	320310016	5	SASS with URG 3000N	100	100	100	100	100	100	100	90	100	100	100	100
Reno	NV	320310016	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Riverside-Rubidoux	CA	060658001	5	URG 3000N	100	100	100	100	100	100	100					
Riverside-Rubidoux	CA	060658001	5	SASS with URG 3000N	100	100	92	100	100	100	90					
Riverside-Rubidoux - Seq	CA	060658001	5	URG 3000N								100	100	100	100	100
Riverside-Rubidoux - Seq	CA	060658001	5	SASS with URG 3000N								100	100	100	100	100
Riverside-Rubidoux (Collocated)	CA	060658001	6	URG 3000N	100	100	100	100	100	100	100	80	100	80	100	100
Riverside-Rubidoux (Collocated)	CA	060658001	6	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											
					155	156	157	158	159	160	161	162	163	164	165	166
Roxbury (Boston)	MA	250250042	5	URG 3000N	100	100	100	100	100	94	70	90	28	64	100	100
Roxbury (Boston)	MA	250250042	5	SASS with URG 3000N	95	100	100	100	90	100	100	90	100	100	100	100
Roxbury (Boston) - collocated	MA	250250042	6	URG 3000N	94	100	100	100	100	100	100	100	80	100	100	100
Roxbury (Boston) - collocated	MA	250250042	6	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Sacramento - Del Paso Manor	CA	060670006	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Sacramento - Del Paso Manor	CA	060670006	5	SASS with URG 3000N	100	95	100	100	100	100	100	100	100	100	100	100
San Jose - Jackson Street	CA	060850005	5	URG 3000N	96	100	100	100	92	100	100	88	100	89	100	100
San Jose - Jackson Street	CA	060850005	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	89	100	100
SER-DNR Headquarters	WI	550790026	5	SASS with URG 3000N	100	95	100	100	100	100	100	90	90	100	100	100
SER-DNR Headquarters	WI	550790026	5	URG 3000N	98	63	100	100	88	38	95	90	94	91	100	100
Shelby Farms	TN	471570075	6	SASS with URG 3000N	90	100	100	95	100	100	100	90	90	100	82	100
Shelby Farms	TN	471570075	6	URG 3000N	92	100	100	100	100	100	45	90	100	100	100	100
Sieben Flats	MT	300490004	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	94	100
Sieben Flats	MT	300490004	5	SASS with URG 3000N	100	100	100	100	99	100	100	88	100	100	100	100
Simi Valley	CA	061112002	5	SASS with URG 3000N	89	67	93	90	86	71	60	88	56	56	11	57
Simi Valley	CA	061112002	5	URG 3000N	94	81	96	94	92	83	78	88	31	56	13	57
South DeKalb - Met One	GA	130890002	5	SASS with URG 3000N	100	99	100	91	100	100	100	100	100	100	100	100
South DeKalb - Met One	GA	130890002	5	URG 3000N	100	97	100	97	100	100	100	100	100	100	100	100
St. Lukes Meridian	ID	160010010	5	URG 3000N	100	100	100	100	94	50	100	100	100	100	100	100

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					155	156	157	158	159	160	161	162	163	164	165	166
(IMS)																
St. Lukes Meridian (IMS)	ID	160010010	5	SASS with URG 3000N	100	100	99	100	100	100	100	85	92	100	100	100
Sydney	FL	120573002	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Sydney	FL	120573002	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	92	90	83
Univ. of Florida Ag School	FL	120111002	5	SASS with URG 3000N	89	93	99	95	100	100	99					
Univ. of Florida Ag School	FL	120111002	5	URG 3000N	97	100	100	97	92	93	94					
Univ. of Florida Ag School - Seq	FL	120111002	5	URG 3000N								40	100	100	100	100
Univ. of Florida Ag School - Seq	FL	120111002	5	SASS with URG 3000N								68	0	4	94	100
Woolworth St	NE	310550019	5	URG 3000N	100	100	100	97	100	100	44	50	94	89	100	100
Woolworth St	NE	310550019	5	SASS with URG 3000N	96	96	96	91	96	96	96	96	96	96	96	96
WV - Guthrie Agricultural Center	WV	540390011	5	URG 3000N	97	100	42	42	100	71	94	75	31	78	100	100
WV - Guthrie Agricultural Center	WV	540390011	5	SASS with URG 3000N	94	100	93	90	100	63	100	88	78	100	100	100

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

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					155	156	157	158	159	160	161	162	163	164	165	166
5 Points	OH	391530023	5	SASS with URG 3000N	100	91	91	93	83	78	100	80	100	100	98	100
5 Points	OH	391530023	5	URG 3000N	100	100	100	92	100	100	100	80	100	100	100	100
AL - Phenix City	AL	011130001	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	80	100	100	100
AL - Phenix City	AL	011130001	5	URG 3000N	67	0	58	100	100	100	90	60	40	100	100	100
Alabama (TN)	TN	471570024	5	SASS with URG 3000N	100	100	100	100								
Alabama (TN)	TN	471570024	5	URG 3000N	100	100	100	100								
Albany Co HD	NY	360010005	5	URG 3000N	95	97	59	91	89	94	85	70	44	91	100	100
Albany Co HD	NY	360010005	5	SASS with URG 3000N	100	100	89	89	85	100	82	90	90	100	100	100
Arendtsville	PA	420010001	5	SASS with URG 3000N	90	92	91	81	100	100	100	100	100	100	100	80
Arendtsville	PA	420010001	5	URG 3000N	94	100	100	100	100	100	100	100	100	100	88	80
Arnold West - Met One	MO	290990019	6	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Arnold West - Met One	MO	290990019	6	SASS with URG 3000N	100	100	95	100	100	100	100	100	92	100	100	100
Ashland Health Department	KY	210190017	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	85	100	100	100
Ashland Health Department	KY	210190017	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	80
Athens - Met One	GA	130590001	5	URG 3000N	67	100	100	100	100	100	90	80	80	100	100	100
Athens - Met One	GA	130590001	5	SASS with URG 3000N	88	92	100	100	100	100	100	100	100	100	100	85
Augusta - Met One	GA	132450091	5	URG 3000N	100	100	100	92	100	100	90	100	100	80	88	100
Augusta - Met One	GA	132450091	5	SASS with URG 3000N	97	99	95	83	100	100	83	80	100	100	80	100
Blaine Anoka County Airport	MN	270031002	5	URG 3000N	95	97	93	95	88	94	90	80	94	91	89	78
Blaine Anoka County	MN	270031002	5	SASS with URG 3000N	100	100	92	100	100	100	100	89	100	100	100	89

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					155	156	157	158	159	160	161	162	163	164	165	166
Airport																
Bonne Terre - Met One	MO	291860005	5	SASS with URG 3000N	100	75	100	100	100	99	100	100	98	100	82	90
Bonne Terre - Met One	MO	291860005	5	URG 3000N	97	0	88	100	100	100	100	90	100	100	100	100
Bountiful	UT	490110004	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	98
Bountiful	UT	490110004	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Buffalo - Met One	NY	360290005	6	URG 3000N	100	100	100	100	100	100	100	80	100	60	100	100
Buffalo - Met One	NY	360290005	6	SASS with URG 3000N	92	100	100	100	100	78	100	100	100	99	100	80
Buncombe County Board of Education	NC	370210034	5	URG 3000N	100	90	100	100	50	100	100	100	80	100	100	100
Buncombe County Board of Education	NC	370210034	5	SASS with URG 3000N	100	90	100	100	100	100	100	85	100	98	96	100
Butte-Greeley School	MT	300930005	5	URG 3000N	100	100	94	100	13	100	100	100	80	40	38	100
Butte-Greeley School	MT	300930005	5	SASS with URG 3000N	100	100	90	100	80	100	100	100	80	100	80	100
Camden-NJ	NJ	340070002	5	SASS with URG 3000N				100	88	100	100	100	100	100	75	100
Camden-NJ	NJ	340070002	5	URG 3000N				100	43	93	100	100	100	100	100	100
Cannons Lane	KY	211110067	6	SASS with URG 3000N	100	100	100	100	100	100	100	100	91	75	100	100
Cannons Lane	KY	211110067	6	URG 3000N	100	94	100	100	94	94	100	100	100	100	100	100
Canton Fire Station	OH	391510017	5	URG 3000N	100	100	100	92	100	100	100	100	100	100	100	100
Canton Fire Station	OH	391510017	5	SASS with URG 3000N	100	92	100	78	100	100	100	100	100	100	100	100
Chester	NJ	340273001	5	URG 3000N	86	97	100	97	100	100	63	0		100	100	86
Chester	NJ	340273001	5	SASS with URG 3000N	75	95	100	94	91	100	100	100	100	100	100	86
Chesterfield	SC	450250001	5	SASS with URG 3000N	90	100	99	100	100	99	100	83	98	100	100	100
Chesterfield	SC	450250001	5	URG 3000N	50	100	100	100	100	100	100	100	100	100	100	100
Cheyenne NCore	WY	560210100	5	URG 3000N	100	97	100	94	100	93	100					
Cheyenne NCore	WY	560210100	5	SASS with URG 3000N	100	94	100	91	100	100	100					
Cheyenne NCore - Seq	WY	560210100	5	SASS with URG 3000N								100	92	100	100	100
Cheyenne NCore - Seq	WY	560210100	5	URG 3000N								100	100	100	100	100
Children's Park	AZ	040191028	5	URG 3000N	95	97	63	93	88	94	95	70	50	82	94	78
Children's Park	AZ	040191028	5	SASS with URG 3000N	91	95	90	91	78	89	91	70	90	82	90	78

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					155	156	157	158	159	160	161	162	163	164	165	166
Clarksville	TN	471251009	5	SASS with URG 3000N	100	100	100									
Clarksville	TN	471251009	5	URG 3000N	100	100	100									
Columbus - Met One	GA	132150011	5	URG 3000N	100	100	100	100	75	100	100	100	100	80	100	100
Columbus - Met One	GA	132150011	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Commerce City	CO	080010006	5	URG 3000N	92	100	100	100	100	100	100	100	100	100	100	100
Commerce City	CO	080010006	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	80	80
Dearborn	MI	261630033	5	SASS with URG 3000N	100	100	100	100	100	100	81	100	100	100	100	100
Dearborn	MI	261630033	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	88	100
Del Norte - Met One	NM	350010023	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	94	98	100	99	100	100	88	100	89	100	100
Division St.	NY	360610134	5	URG 3000N	88	100	46	92	88	94	95	70	50	82	94	78
Division St.	NY	360610134	5	SASS with URG 3000N	78	100	85	91	100	100	91	100	100	100	100	78
Douglas - Met One	GA	130690002	5	URG 3000N	100	100	100	100	100	100	90	100	100	100	100	100
Douglas - Met One	GA	130690002	5	SASS with URG 3000N	100	100	100	100	100	100	83	100	80	100	100	100
Dover	DE	100010003	5	URG 3000N	100	100	100	92	100	100	100	80	100	100	100	80
Dover	DE	100010003	5	SASS with URG 3000N	100	100	100	92	100	100	100	80	100	100	100	100
Downtown Library	OH	391130032	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	38	60
Downtown Library	OH	391130032	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	60
Elkhart Prairie Street	IN	180390008	5	SASS with URG 3000N	100	92	100	100	100	100	100	100	100	100	100	100
Elkhart Prairie Street	IN	180390008	5	URG 3000N	67	100	100	100	100	100	100	80	100	100	100	100
Erie	PA	420490003	5	URG 3000N	100	100	100	100	100	100	100	100	80	100	100	100
Erie	PA	420490003	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	88	100	50	100	100	100	88	80
Evansville Buena Vista Rd	IN	181630021	5	SASS with URG 3000N	82	100	100	100	100	100	100	100	100	100	100	100
Fairbanks State Bldg	AK	020900010	6	SASS with URG 3000N	100	100	100	96	90	89	100	100	100	100	100	100
Fairbanks State Bldg	AK	020900010	6	URG 3000N	100	97	100	100	100	44	100	100	100	100	100	100
Florence	PA	421255001	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	40	100	100	100

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					155	156	157	158	159	160	161	162	163	164	165	166
Florence	PA	421255001	5	URG 3000N	100	100	100	100	100	100	100	100	80	100	100	100
Freemansburg	PA	420950025	5	URG 3000N	94	100	100	100	100	100	100	100	80	100	100	100
Freemansburg	PA	420950025	5	SASS with URG 3000N	90	100	100	100	100	100	100	100	100	100	100	100
Gary litri	IN	180890022	5	URG 3000N	94	100	100	100	100	100	100	60	100	100	100	100
Gary litri	IN	180890022	5	SASS with URG 3000N	90	100	100	92	97	100	98	100	100	100	100	100
Grand Rapids	MI	260810020	5	SASS with URG 3000N	100	100	100	95	100	100	100	88	100	89	100	100
Grand Rapids	MI	260810020	5	URG 3000N	100	100	100	97	92	93	100	100	100	100	100	100
Granite City	IL	171190024	5	SASS with URG 3000N	86	96	97	81	96	96	80	96	96	80	96	65
Granite City	IL	171190024	5	URG 3000N			100	100	100	50	80	100	40	80	50	100
Grayson	KY	210430500	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	83	100	100	100
Grayson	KY	210430500	5	URG 3000N	100	100	100	100	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	100	100	100	100
Green Bay East High School	WI	550090005	5	URG 3000N	100	100	88	50	100	100	100	100	100	100	100	100
Greensburg	PA	421290008	5	URG 3000N	100	100	94	100	100	100	100	100	60	100	100	80
Greensburg	PA	421290008	5	SASS with URG 3000N	100	100	100	100	100	100	100	98	98	100	100	100
Greenville ESC	SC	450450015	5	SASS with URG 3000N	100	100	100	100	99	100	100	100	100	100	100	100
Greenville ESC	SC	450450015	5	URG 3000N	94	100	100	100	100	100	100	100	100	100	100	100
Harrisburg	PA	420430401	5	SASS with URG 3000N	92	92	92	100	100	100	87	100	85	100	100	100
Harrisburg	PA	420430401	5	URG 3000N	100	100	100	100	100	100	50	100	100	100	100	100
Hattie Avenue	NC	370670022	5	SASS with URG 3000N	100	100	90	93	100	100	100	100	100	100	76	93
Hattie Avenue	NC	370670022	5	URG 3000N	100	100	94	75	100	50	100	100	100	100	100	100
Head Start	OH	390990014	5	URG 3000N	50	100	100	82	100	75	100	100	100	80	100	100
Head Start	OH	390990014	5	SASS with URG 3000N	100	70	90	83	100	100	98	65	100	100	100	96
Hickory	NC	370350004	5	URG 3000N	100	100	81	50	25	75	100	100	100	100	100	80
Hickory	NC	370350004	5	SASS with URG 3000N	100	100	100	92	100	100	100	100	80	80	100	80
Horicon Palmatory	WI	550270001	5	SASS with URG 3000N	100	100	100	100	88	100	100	90	100	91	100	88
Horicon Palmatory	WI	550270001	5	URG 3000N	100	100	100	100	100	100	95	100	100	100	100	100

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					155	156	157	158	159	160	161	162	163	164	165	166
Houghton Lake	MI	261130001	5	SASS with URG 3000N	100	100	100	87	100	100	100	100	100	100	100	98
Houghton Lake	MI	261130001	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
HU-Beltsville Met One	MD	240330030	5	SASS with URG 3000N	94	94	93	94	100	100	100					
HU-Beltsville Met One	MD	240330030	5	URG 3000N	97	97	96	97	100	100	100					
HU-Beltsville Met One - Seq	MD	240330030	5	SASS with URG 3000N								100	94	100	100	100
HU-Beltsville Met One - Seq	MD	240330030	5	URG 3000N								100	100	100	100	100
Huntsville Old Airport	AL	010890014	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Huntsville Old Airport	AL	010890014	5	URG 3000N	100	100	81	83	100	100	90	80	100	60	25	100
Jasper Post Office	IN	180372001	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	80	100	100
Jasper Post Office	IN	180372001	5	URG 3000N	94	100	100	100	100	100	100	100	100	100	100	100
Jefferson Elementary - Met One	IA	191630015	5	URG 3000N	100	100	94	95	100	94	100	100	89	100	50	100
Jefferson Elementary - Met One	IA	191630015	5	SASS with URG 3000N	100	100	90	95	100	89	100	100	80	91	90	100
Jeffersonville Walnut St	IN	180190006	5	URG 3000N	100	100	100	100	100	100	50	80	100	100	100	100
Jeffersonville Walnut St	IN	180190006	5	SASS with URG 3000N	100	100	100	100	100	100	83	100	100	100	100	100
Jerome Mack Middle School	NV	320030540	5	URG 3000N	100	100	100	97	92	93	94	75	75	100	100	71
Jerome Mack Middle School	NV	320030540	5	SASS with URG 3000N	100	100	100	95	100	100	92	78	99	100	100	86
Johnstown	PA	420210011	5	URG 3000N	100	100	100	100	100	100	100	100	80	100	100	100
Johnstown	PA	420210011	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Kapolei	HI	150030010	5	URG 3000N	57	100	97	100	94	100	100	80	100	91	89	89
Kapolei	HI	150030010	5	SASS with URG 3000N	87	100	95	100	90	71	100	81	100	90	96	99
Karnack - Met One	TX	482030002	5	SASS with URG 3000N	100	100	100	100	98	100	100	100	98	100	99	100
Karnack - Met One	TX	482030002	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Lancaster	PA	420710007	5	URG 3000N	100	100	100	100	88	100	100	100	100	80	100	100

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					155	156	157	158	159	160	161	162	163	164	165	166
Lancaster	PA	420710007	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	65
Laurel	MS	280670002	5	SASS with URG 3000N	100	90	100									
Laurel	MS	280670002	5	URG 3000N	100	90	100									
Lawrence County	TN	470990002	5	URG 3000N	71	100	100	100	100	100	100	100	75	100	100	100
Lawrence County	TN	470990002	5	SASS with URG 3000N	90	100	100	100	100	100	100	100	100	83	100	100
Lexington (NC)	NC	370570002	5	URG 3000N	100	100	100	100	88	100	100	80	80	100	100	100
Lexington (NC)	NC	370570002	5	SASS with URG 3000N	100	100	100	94	85	50	97	100	100	100	100	100
Lexington Health Department	KY	210670012	5	URG 3000N	100	90	88	100	100	100	100	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	100
Liberty (PA)	PA	420030064	6	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Liberty (PA)	PA	420030064	6	SASS with URG 3000N	92	100	100	100	100	100	100	100	100	100	100	100
Liberty - Met One	MO	290470005	5	URG 3000N	100	100	100	100	94	100	100	100	100	100	94	100
Liberty - Met One	MO	290470005	5	SASS with URG 3000N	100	100	100	100	89	100	100	100	100	100	100	99
Lindon	UT	490494001	5	URG 3000N	94	100	100	100	100	100	100	100	80	100	100	100
Lindon	UT	490494001	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Linn County Health	IA	191130040	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Linn County Health	IA	191130040	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Lockeland School - Met One	TN	470370023	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Lockeland School - Met One	TN	470370023	5	URG 3000N	100	100	100	83	100	100	100	100	80	100	100	100
Lorain	OH	390933002	5	SASS with URG 3000N	90	100	100	100	100	100	100	100	100	100	100	75
Lorain	OH	390933002	5	URG 3000N	94	100	13	33	88	75	100	100	83	100	100	75
Luna Pier	MI	261150005	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	50		
Luna Pier	MI	261150005	5	URG 3000N	100	100	100	100	100	100	100	100	100	50		
Macon - Met One	GA	130210007	5	URG 3000N	100	100	100	100	100	100	100	60	100	100	75	100
Macon - Met One	GA	130210007	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	87	80	100

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					155	156	157	158	159	160	161	162	163	164	165	166
Maple Canyon	OH	390490081	6	URG 3000N	100	100	100	100	100	100	90	80	100	100	100	100
Maple Canyon	OH	390490081	6	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Marysville - 7th Ave	WA	530611007	5	URG 3000N	100	100	100	92	100	100	100	100	80	100	100	80
Marysville - 7th Ave	WA	530611007	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	80
Mechanicsburg	IN	180650003	5	SASS with URG 3000N	100	83	100	100	100	56	100	100	100	80	100	100
Mechanicsburg	IN	180650003	5	URG 3000N	100	100	100	100	75	100	90	100	100	60	100	100
Millbrook	NC	371830014	5	SASS with URG 3000N	92	100	100	91	89	100	93	80	100	100	84	100
Millbrook	NC	371830014	5	URG 3000N	100	100	100	100	100	100	85	80	100	100	100	100
Mingo Junction	OH	390811001	5	SASS with URG 3000N	100	90	100	100	100	75	100	100	100	100	100	33
Mingo Junction	OH	390811001	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	33
MN - Rochester	MN	271095008	5	URG 3000N	100	100	100	100	100	100	50	100	100	100	100	100
MN - Rochester	MN	271095008	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
MOMS	AL	011011002	5	SASS with URG 3000N	100	90	70	100	100	100	99	100	100	100	100	100
MOMS	AL	011011002	5	URG 3000N	100	100	50	100	100	100	100	60	20	100	50	100
Moundsville Armory	WV	540511002	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Moundsville Armory	WV	540511002	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	80	80	100
Naperville	IL	170434002	5	URG 3000N	100	100	25	83	63	0	67	100	100	100	100	100
Naperville	IL	170434002	5	SASS with URG 3000N	96	96	96	96	96	96	96	96	78	96	96	96
National Trail High School	OH	391351001	5	URG 3000N	94	100	93	95	100	100	100	100	100	91	100	100
National Trail High School	OH	391351001	5	SASS with URG 3000N	95	100	100	100	90	100	93	100	100	93	100	100
New Garden	PA	420290100	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
New Garden	PA	420290100	5	URG 3000N	100	100	100	100	100	75	80	0	0	40	100	100
Newark	NJ	340130003	5	SASS with URG 3000N	94	100	100	94	100	100	100	100	92	100	100	89
Newark	NJ	340130003	5	URG 3000N	96	100	100	94	100	100	100	100	100	100	100	100
NLR Parr	AR	051190007	5	SASS with URG 3000N	97	95	99	100	100	100	93	100	100	100	100	89
NLR Parr	AR	051190007	5	URG 3000N	100	97	100	100	100	100	100	90	100	100	100	89
North Los Angeles	CA	060371103	5	SASS with URG 3000N	95	100	100	100	89	100	91	100	100	100	90	100

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					155	156	157	158	159	160	161	162	163	164	165	166
North Los Angeles	CA	060371103	5	URG 3000N	97	100	97	100	100	100	95	100	100	100	89	100
Northbrook	IL	170314201	5	SASS with URG 3000N	96	96	96	96	85	96	96	96	96	4		
Northbrook	IL	170314201	5	URG 3000N	100	100	100	95	69	6	35	90	100	100		
OCUSA Campus	OK	401091037	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
OCUSA Campus	OK	401091037	5	SASS with URG 3000N	100	100	100	100	100	100	100	98	100	100	100	100
ODOT Garage	OH	390870012	5	URG 3000N	100	100	100	83	88	100	100	100	100	100	100	60
ODOT Garage	OH	390870012	5	SASS with URG 3000N	100	73	100	100	80	100	100	100	83	85	83	80
PerkinstownCASNET	WI	551198001	5	SASS with URG 3000N	100	100	100	100	100	100	100	80	100	100	100	100
PerkinstownCASNET	WI	551198001	5	URG 3000N	100	100	100	100	100	100	100	80	100	100	100	100
Pinnacle State Park - Met One	NY	361010003	5	SASS with URG 3000N	90	100	94	100	100	90	100	100	100	82	74	42
Pinnacle State Park - Met One	NY	361010003	5	URG 3000N	92	93	63	95	88	88	95	70	50	82	94	11
Platteville	CO	081230008	5	SASS with URG 3000N	89	100	100	100	80	100	87	100	100	83	100	80
Platteville	CO	081230008	5	URG 3000N	67	100	100	100	88	100	100	100	100	100	100	80
Port Huron	MI	261470005	5	SASS with URG 3000N	90	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	URG 3000N	100	100	100	100	100	100	100	100	100	80	100	100
Public Health Building - Met One	IA	191530030	5	SASS with URG 3000N	99	100	99	100	80	100	100	100	100	100	100	100
Queens College - Met One	NY	360810124	6	URG 3000N	98	100	100	87	94	100	100	100	100	100	100	100
Queens College - Met One	NY	360810124	6	SASS with URG 3000N	100	100	99	100	89	100	100	100	100	100	99	100
Reading Airport	PA	420110011	5	SASS with URG 3000N	90	100	100	94	100	100	100	100	100	100	100	100
Reading Airport	PA	420110011	5	URG 3000N	94	100	94	100	100	100	100	80	100	100	100	100
Ritner	PA	421010055	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Ritner	PA	421010055	5	URG 3000N	100	100	100	92	100	100	100	100	100	100	100	100

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					155	156	157	158	159	160	161	162	163	164	165	166
Rochester Primary - Met One	NY	360551007	5	URG 3000N	89	97	63	91	93	90	100	100	33	91	94	89
Rochester Primary - Met One	NY	360551007	5	SASS with URG 3000N	85	95	95	95	88	82	100	90	90	90	100	80
Rockwell	NC	371590021	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	85	100
Rockwell	NC	371590021	5	URG 3000N	100	100	100	92	100	50	90	60	100	80	100	100
Rome Elementary	GA	131150003	5	SASS with URG 3000N	100	100	90	100	100	100	100	100	75	100	100	100
Rome Elementary	GA	131150003	5	URG 3000N	100	100	100	83	100	100	100	100	100	83	88	100
Rossville - Met One	GA	132950002	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	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	100	100	100	100	100	100	100
Scranton	PA	420692006	5	URG 3000N	100	90	58	100	100	100	100	100	60	100	13	100
Shreveport Airport - Met One	LA	220150008	5	SASS with URG 3000N	100	100	100	80	100	75	100	80	100	100	80	100
Shreveport Airport - Met One	LA	220150008	5	URG 3000N	94	90	94	80	100	100	100	100	100	100	50	100
Sioux Falls School Site	SD	460990008	5	SASS with URG 3000N	95	95	91	85	90	89	81	82	89	75	100	100
Sioux Falls School Site	SD	460990008	5	URG 3000N	97	98	63	92	94	94	44	82	94	75	100	100
Skyview	FL	121030026	5	URG 3000N	100	100	100	80	100	100	90	80	100	100	100	100
Skyview	FL	121030026	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
South Charleston Library	WV	540391005	5	SASS with URG 3000N	83	100	70	58	100	100	100	100	100	85	100	
South Charleston Library	WV	540391005	5	URG 3000N	88	100	100	100	100	100	100	100	100	20	0	
Spring Hill Elementary School	TN	470931020	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Spring Hill Elementary School	TN	470931020	5	URG 3000N	100	100	100	100	100	100	90	100	100	100	75	100
Springfield Pumping Station - Met One	IL	170310057	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	80	100	100	100
Springfield Pumping	IL	170310057	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					155	156	157	158	159	160	161	162	163	164	165	166
Station - Met One																
St Theo	OH	390350038	6	URG 3000N	92	100	100	100	100	100	100	100	100	100	50	80
St Theo	OH	390350038	6	SASS with URG 3000N	80	100	100	100	100	97	87	100	100	96	85	82
State College	PA	420270100	5	SASS with URG 3000N	100	100	99	100	100	100	97	99	60	100	80	97
State College	PA	420270100	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Sterling State Park	MI	261150006	5	URG 3000N										100	100	100
Sterling State Park	MI	261150006	5	SASS with URG 3000N										100	100	100
SW HS	MI	261630015	5	URG 3000N	100	90	100	100	100	75	100	80	100	100	100	100
SW HS	MI	261630015	5	SASS with URG 3000N	100	100	100	100	100	75	100	100	100	100	100	100
Tacoma - Met One	WA	530530029	5	URG 3000N		100	100	100	100	75	100	100	40	100	63	100
Tacoma - Met One	WA	530530029	5	SASS with URG 3000N		90	100	92	100	100	100	100	100	100	40	100
Taft	OH	390610040	5	SASS with URG 3000N	95	100	100	100	100	100	93	99	100	100	100	100
Taft	OH	390610040	5	URG 3000N	98	97	100	100	100	100	95	100	100	100	94	100
Tallahassee Community College	FL	120730012	5	URG 3000N	100	100	100	100	100	100	100	100	100	80	100	100
Tallahassee Community College	FL	120730012	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	83	45	100	100
Tecumseh	MI	260910007	5	URG 3000N	100	100	100	92	100	100	90	100	100	100	100	80
Tecumseh	MI	260910007	5	SASS with URG 3000N	100	100	100	100	100	100	83	80	100	83	100	100
Toledo Airport	OH	390950026	5	URG 3000N	100	70	100	92	88	100	100	80	100	80	100	100
Toledo Airport	OH	390950026	5	SASS with URG 3000N	100	90	99	81	75	89	98	61	93	93	93	78
UTC	TN	470654002	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	60	65	96	93
UTC	TN	470654002	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	88	80
VAN4PLN2	WA	530110013	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	
VAN4PLN2	WA	530110013	5	URG 3000N	100	88	100	100	100	100	100	100	100	100	100	
VANNEVAN	WA	530110023	5	URG 3000N											100	100
VANNEVAN	WA	530110023	5	SASS with URG 3000N											100	100
Waukesha, Cleveland Ave. Site	WI	551330027	5	SASS with URG 3000N	100	100	100	100	100	100	83	100	85	100	60	100

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					155	156	157	158	159	160	161	162	163	164	165	166
Waukesha, Cleveland Ave. Site	WI	551330027	5	URG 3000N	100	90	67	100	100	100	100	100	100	100	100	100
Whiteface - Met One	NY	360310003	5	URG 3000N	100	100	100	100	100	100	100	80	100	100	100	100
Whiteface - Met One	NY	360310003	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	85	100	100
Wichita Dept. of Env. Health - Met One	KS	201730010	5	SASS with URG 3000N	100	100	100	100	100	100	100	83	80	100	100	100
Wichita Dept. of Env. Health - Met One	KS	201730010	5	URG 3000N	100	100	100	100	100	75	100	100	80	100	100	100
Wylam	AL	010732003	5	SASS with URG 3000N	100	100	100	94	78	88	100	100	100	89	100	100
Wylam	AL	010732003	5	URG 3000N	100	100	100	31	25	50	100	100	100	89	100	100
Yakima Mental Health	WA	530770009	5	SASS with URG 3000N	100	100	100	83	100	100	100	100	100	100	80	100
Yakima Mental Health	WA	530770009	5	URG 3000N	100	100	100	92	100	100	100	100	100	100	100	100
York	PA	421330008	5	URG 3000N	100	100	94	100	100	100	90	100	100	80	100	100
York	PA	421330008	5	SASS with URG 3000N	100	100	100	100	100	97	100	100	60	100	100	100