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July 1, 2013

Ms. Margaret Dougherty
U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
MC MD-14
Research Triangle Park, NC 27711

Dear Ms. Dougherty:

Attached is the PDF version of the Annual Data Summary Report for the PM2.5 Chemical Speciation Program, EPA Contract PR-NC-08-10001.

If you have any questions or comments, please feel free to call me at 541-6483, or e-mail at rkmj@rti.org. Thank you for your continued support.

Sincerely,

RKM Jayanty,

R. K. M. Jayanty, Ph.D.
Program Manager

/dmh

Attachment

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RTI/0212053/04ADS

July 1, 2013

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

January 1 through December 31, 2012

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

EPA Contract No. PR-NC-09-010

Prepared by
RTI International*
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RTI INTERNATIONAL

**RTI International is a trade name of Research Triangle Institute.*

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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 53speciation 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 and 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. 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, 2012.

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 2012. RTI reported results of PE samples as part of a multi-lab study conducted by EPA’s Montgomery Laboratory in early 2012. These PE samples encompassed all the major analyses being performed under the CSN contract. The PE report is still in preparation, but the compiled data 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. RTI also participated in the Technical Systems Audit (TSA) conducted by EPA in July 2012. The 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 audited by the National Environmental Laboratory accreditation Program (NELAP) in December 2010.

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 2012. Issues included problems with the weighing chamber environmental controls. These issues were dealt with aggressively so that a minimum of data had to be flagged as outside holding time or environmental criteria, as described in Section 3.1.

Minimal problems with laboratory operations and filter media were reported by the Ion Analyses Lab (Section 3.2) and by the DRI Organic and Elemental Carbon (OC/EC) lab during 2012 (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.

Operations in RTI’s Sample Handling and Archiving Laboratory (SHAL) proceeded satisfactorily during 2012, except for one event when the walk-in cooler malfunctioned. The cooler was repaired within 24-hours and the impact of this outage on the data is believed to be minimal. A small number of samples were missed due to late return of shipping containers (“coolers”) from the field sites. No significant differences in receipt temperatures between 2012 and previous years were observed. No significant quality issues were reported by the denuder refurbishment laboratory (Section 3.5).

No significant quality issues were reported by the data processing and data validation functions during 2012 (Sections 4.0 and 5.0). Data continues to be reviewed and posted to a secure Web site on a monthly basis for review. Finalized data are posted to the EPA Air Quality System (AQS) database approximately 60 days after initial posting (Section 4.0). A number of data users with total number of communications exceeding 1000, contacted SHAL, data processing, and QA personnel with questions about specific data items, or to request explanations about apparent discrepancies. RTI attempts to answer such questions promptly, and works closely with the agencies to determine the most appropriate data flags for particular situations.

Estimation of MDLs and Uncertainties

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

Quality Issues

There were no Corrective Action Requests (CARs) issued during 2012. 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
None	SHAL	Power Outage/ Surge	When power was restored, a power surge damaged the walk-in cooler. Cooler was repaired in 18 hours.	Little effect on the results of the filters.
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 currently supports 179 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 53 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, 2012. RTI is supporting the $PM_{2.5}$ CSN by shipping ready-to-use filter packs and 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, denuders, and absorbent cartridges) 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, 2012. 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 or Teflon 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 2012.

2.2 Summary of Data Completeness

Appendix B of this report includes the data completeness summary for the Reporting Batches delivered in 2012. 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 2012. 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 2012.

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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.

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 2012.

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 2012.

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 2012.

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

As a result of the changeover to the IMPROVE_A OC/EC method, all of the reportable CSN carbon analyses 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 2012; see Section 3.3.1 for a summary of operational issues.

2.3.5 Sample Handling and Archiving Laboratory (SHAL)

As described in Section 3.6.1, there was one major quality issue in the SHAL during 2012. On Thursday July 26, 2012, there was a malfunction of the walk-in cooler where newly received packages from the field site are stored prior to module disassembly and distribution of the exposed filters to the laboratories. The walk-in cooler was repaired within 24 hours, but packages inside the cooler reached a maximum temperature of 21°C (69.8°F) during the downtime. A total of 28 events from sample dates of July 20, 23 and 26 were affected. The impact of this outage on data quality is thought to be minimal, and the results were posted to AQS without any qualifier. The state monitoring agencies were notified of the failure, and RTI added an appropriate validity status flag to the AQS data if requested to do so by a state agency.

2.3.6 Data Processing

There were no new quality issues or corrective actions taken during this reporting period. The uncertainties for the carbon values for the samples collected by URG 3000N have not yet been posted into AQS, pending direction from EPA about the method to be used for calculations. Blank-corrected 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

None.

3.0 Laboratory Quality Control Summaries

3.1 Gravimetric Laboratory

The RTI Gravimetric Laboratory's two weigh chambers were used to tare 18,387 Teflon filters for the $PM_{2.5}$ speciation program between January 1 and December 31, 2012. During the same time period, the laboratory performed final (post-sampling) weighings of 18,024 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 2012. 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 2012 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 2012 did not have issues with debris or outgassing.

The laboratory's environmental chambers experienced little downtime due to system failure in 2012. The gear drive actuator for the chilled water was replaced in Chamber 2. Independent of replacing the actuator valve, Chamber 2 also had a leak fixed at the solder joint in the cooling water coil inside the plenum. 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. 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 2012, the high bay that houses the chambers had minor problems with the building's chilled water supply and air compressor. 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 five times and fuses were blown on the building's air compressor and condensing unit one time. RTI's Facilities and Maintenance HVAC team quickly responded to fix these issues. A scheduled downtime was also necessary to fix a leaking pipe on the building's boiler. RTI's Facilities and Maintenance arranged this date with the Gravimetric Laboratory 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. These devices are in addition to the MT U-shaped ionizers that have been used during weigh sessions for many years. One balance was retired during 2012. This balance was rarely used for the CSN project, and there were no outstanding unsampled filters when the balance was retired. 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. RTI switched to Henry Troemner LLC in 2012 because the North Carolina Department of Agriculture and Consumer Services (NCDA&CS) Standards Laboratory stopped performing the verification needed by the Gravimetric Laboratory. 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 June 2013 and September 2013.

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 **Table 3-1**; however, a small number of outliers were noted. Four of the outlier laboratory blank weighings for four 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 2012. 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 2012. Verified by the laboratory in conjunction with 2012 internal balance audit performed by RTI Quality Systems Program.	Chamber 1 100-mg S/N 41145 04/27/11 Verification: 99.99891 mg ± 0.00094 Laboratory Tolerance Interval: 99.996 – 100.002 mg	Average = 99.997 mg Std Dev = 0.0008 for 261 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		06/14/2012 Verification: 99.9996 mg ± 0.0025 Laboratory Tolerance Interval: 99.996 – 100.002 mg	Average = 99.997 mg Std Dev = 0.0007 for 380 weighings	Laboratory average falls within tolerance interval. Nine individual weighings of 99.996 mg fell 1 µg below lower limit.
		100-mg S/N 58096 04/27/11 Verification: 99.99877 mg ± 0.00094 Laboratory Tolerance Interval: 99.997–100.003 mg	Average = 99.999 mg Std Dev = 0.0007 for 348 weighings	Laboratory average falls within tolerance interval. One individual weighings of 99.996 mg fell 1 µg below lower limit.
		06/14/12 Verification: 99.9987 mg ± 0.0025 Laboratory Tolerance Interval: 99.996–100.002 mg	Average = 99.999 mg Std Dev = 0.0006 for 756 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		100-mg S/N 41144 08/15/11 Verification: 99.99859 mg ± 0.00094 Laboratory Tolerance Interval: 99.996 – 100.002 mg	Average = 99.998 mg Std Dev = 0.0006 for 991 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		09/12/12 Verification: 99.9991 mg ± 0.0025 Laboratory Tolerance Interval: 99.996 – 100.002 mg	Average = 99.998 mg Std Dev = 0.0014 for 71 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		100-mg S/N 14059 08/15/11 Verification: 99.99056 mg ± 0.00094 Laboratory Tolerance Interval: 99.988–99.994 mg	Average = 99.988 mg Std Dev = 0.0007 for 633 weighings	Laboratory average falls within tolerance interval. Four individual weighings of 99.987 mg fell 1 µg below lower limit. One individual weighings of 99.986 mg fell 2 µg below lower limit.

QC Check	Requirements	QC Checks Applied in RTI Laboratory	Average Value Determined by Lab	Comments
		200-mg S/N 41147 04/27/11 Verification: 200.00396 mg ± 0.00095 Laboratory Tolerance Interval: 200.001–200.07 mg	Average = 200.002 mg Std Dev = 0.0007 for 261 weighings	Average = 200.003 mg Std Dev = 0.0007 for 736 weighings
		6/14/12 Verification: 200.0038 mg ± 0.0025 Laboratory Tolerance Interval: 200.001–200.07 mg	Average = 200.002 mg Std Dev = 0.0009 for 270 weighings	Laboratory average falls within tolerance interval. Twelve individual weighing of 200.000 mg fell 1 μg below lower limit.
		200-mg S/N 58098 04/27/11 Verification: 200.00287 mg ± 0.00095 Laboratory Tolerance Interval: 200.000-200.006 mg	Mean = 200.001 mg Std Dev = 0.0006 for 348 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		06/14/12 Verification: 200.001 mg ± 0.0025 Laboratory Tolerance Interval: 199.998 – 200.004 mg	Mean = 200.001 mg Std Dev = 0.0007 for 759 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		200-mg S/N 41148 08/15/11 Verification: 200.00008 mg ± 0.00095 Laboratory Tolerance Interval: 199.997 – 200.003 mg	Average = 199.999 mg Std Dev = 0.0009 for 991 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		09/12/12 Verification: 199.999 mg ± 0.0025 Laboratory Tolerance Interval: 199.996 – 200.002 mg	Average = 199.998 mg Std Dev = 0.00015 for 70 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		200-mg S/N 14056 08/15/11 Verification: 199.99152 mg ± 0.00095 Laboratory Tolerance Interval: 199.989-199.995 mg	Average = 199.990 mg Std Dev = 0.0013 for 938 weighings	Laboratory average falls within tolerance interval. One individual weighing of 199.988 mg fell 1 μg below lower limit.
		<u>Chamber 2</u> 100-mg S/N RTI01 08/15/11 Verification: 99.98604 mg ± 0.00094 Laboratory Tolerance Interval: 99.983 – 99.989 mg	Average = 99.986 mg Std Dev = 0.0009 for 619 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
		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 106 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		100-mg S/N 41143 04/27/11 Verification: 99.98791 mg ± 0.00094 Laboratory Tolerance Interval: 99.985 – 99.991 mg	Mean = 99.988 mg Std Dev = 0.0010 for 287 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		100-mg S/N 83252 06/14/12 Verification: 100.0011 mg ± 0.0025 Laboratory Tolerance Interval: 99.998 – 100.004 mg	Mean = 99.998 mg Std Dev = 0.0007 for 502 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		200-mg S/N 41146 04/27/11 Verification: 200.00146 mg ± 0.00095 Laboratory Tolerance Interval: 199.998 – 200.004 mg	Mean = 199.999 mg Std Dev = 0.0012 for 287 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		06/14/12 Verification: 200.002 mg ± 0.0025 Laboratory Tolerance Interval: 199.999 – 200.005 mg	Mean = 200.001 mg Std Dev = 0.0009 for 502 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		200-mg S/N 18659 08/15/11 Verification: 199.9727 mg ± 0.00095 Laboratory Tolerance Interval: 199.970 – 199.976 mg	Mean = 199.972 mg Std Dev = 0.0011 for 619 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		200-mg S/N 83428 09/12/12 Verification: 199.9999 mg ± 0.0025 Laboratory Tolerance Interval: 199.997 – 200.003 mg	Mean = 199.998 mg Std Dev = 0.00094 for 106 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
Balance calibrations	Auto (internal) calibration daily	Daily	N/A	
	External calibration annually or as needed	All balances inspected and externally calibrated by Mettler Toledo on August 3, 2012, using NIST-traceable weight	N/A	Next inspection and external calibration scheduled for August 2013

QC Check	Requirements	QC Checks Applied in RTI Laboratory	Average Value Determined by Lab	Comments
Balance audits	Annually	Audits of all balances performed by RTI Quality Systems Program personnel on October 25, 2012, using Class S-1 NIST-traceable weights	N/A	Audit included environmental evaluation, level test, scale-clarity test, zero-adjustment test, off-center (corner load) test, precision test, and accuracy test; all balances performed satisfactorily.
RH/T monitoring devices calibrations	Annually	Chamber temperature and humidity sensors, temperature and humidity controllers, and process alarm control board (mother board) calibrated by Bahnson Environmental Specialties on January 11, 2012 Chamber data loggers calibrated by Veriteq Data Logger Test and Calibration Services on August 13, 2012	N/A N/A	Chamber sensors, controllers, and process boards are calibrated on-site annually by Environmental Specialties Next calibration due August 2013
Laboratory (Filter) blanks	Initial weight ± 15 µg	2,057 total replicate weighings of 289 individual laboratory blanks	Average difference between final and initial weight = 2.3 µg Std Dev = 3.6 Min wt change = -19 µg Max wt change = 14 µg	4 total replicate weighings of 4 individual laboratory blank filters (0.2% of the replicate weighings; 1.4% of the individual laboratory blanks) exceeded the 15 µg criterion.
Replicates	Initial weight ± 15 µg	6,645 individual filters were weighed as pre-sampling (tared) replicates 1,757 individual filters were weighed as post-sampling replicates	Average = 0.61 µg Average = 0.75 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.
Lot blanks (Lot stability filters) [Lot stability tests are performed to	The filters are weighed until a 24-hour weight change < ± 5 µg is demonstrated.	Whatman Lot 65167 (rec'd 11/28/2011)	24 hours = +2 µg 48 hours = +4 µg 72 hours = 0 µg 96 hours = -1 µg	Weight changes fall within required range

QC Check	Requirements	QC Checks Applied in RTI Laboratory	Average Value Determined by Lab	Comments
ensure filters are conditioned at least as long as the stability test indicates. All lot stability tests performed on 12 filters – 2 filters randomly selected from each of 6 randomly selected boxes]			24 hours = +3 µg 48 hours = -5 µg 72 hours = +3 µg 96 hours = +3 µg	Weight changes fall within required range
			24 hours = 0 µg 48 hours = +3 µg 72 hours = 0 µg 96 hours = -1 µg	Weight changes fall within required range
			24 hours = -4 µg 48 hours = +5 µg 72 hours = -1 µg 96 hours = 0 µg	Weight changes fall within required range
			24 hours = 0 µg 48 hours = +1 µg 72 hours = +2 µg 96 hours = +1 µg	Weight changes fall within required range
			24 hours = -1 µg 48 hours = +1 µg 72 hours = -1 µg 96 hours = +3 µg	Weight changes fall within required range
			24 hours = -2 µg 48 hours = +6 µg 72 hours = +2 µg 96 hours = -2 µg	Weight changes fall within required range
			24 hours = 0 µg 48 hours = +6 µg 72 hours = -1 µg 96 hours = 0 µg	Weight changes fall within required range
			24 hours = -1 µg 48 hours = +7 µg 72 hours = -5 µg 96 hours = 0 µg	Weight changes fall within required range
			24 hours = -1 µg 48 hours = +7 µg 72 hours = -2 µg 96 hours = -1 µg	Weight changes fall within required range
			24 hours = -3 µg 48 hours = +8 µg 72 hours = -2 µg 96 hours = -1 µg	Weight changes fall within required range
			24 hours = +3 µg 48 hours = +2 µg 72 hours = 0 µg 96 hours = 0 µg	Weight changes fall within required range
Lot blanks (Lot stability filters) (cont'd)	The filters are weighed until a 24-hour weight change < ± 5 µg is demonstrated.	Whatman Lot 67003 (rec'd 12/21/2011)	24 hours = +2 µg 48 hours = 0 µg 72 hours = +1 µg 96 hours = 0 µg	Weight changes fall within required range

QC Check	Requirements	QC Checks Applied in RTI Laboratory	Average Value Determined by Lab	Comments
			24 hours = +3 µg 48 hours = -2 µg 72 hours = +2 µg 96 hours = 0 µg	Weight changes fall within required range
			24 hours = 0 µg 48 hours = +1 µg 72 hours = 0 µg 96 hours = -4 µg	Weight changes fall within required range
			24 hours = -4 µg 48 hours = -4 µg 72 hours = +3 µg 96 hours = -4 µg	Weight changes fall within required range
			24 hours = 0 µg 48 hours = +9 µg 72 hours = -10 µg 96 hours = 0 µg	Weight changes fall within required range
			24 hours = -1 µg 48 hours = 0 µg 72 hours = +4 µg 96 hours = -3 µg	Weight changes fall within required range
			24 hours = -2 µg 48 hours = +1 µg 72 hours = 0 µg 96 hours = 0 µg	Weight changes fall within required range
			24 hours = 0 µg 48 hours = +2 µg 72 hours = -2 µg 96 hours = +1 µg	Weight changes fall within required range
			24 hours = -1 µg 48 hours = +3 µg 72 hours = +1 µg 96 hours = -2 µg	Weight changes fall within required range
			24 hours = -1 µg 48 hours = -3 µg 72 hours = -3 µg 96 hours = 0 µg	Weight changes fall within required range
			24 hours = -3 µg 48 hours = -1 µg 72 hours = +2 µg 96 hours = -4 µg	Weight changes fall within required range
Lot blanks (Lot stability filters) (cont'd)	The filters are weighed until a 24-hour weight change < ± 5 µg is demonstrated.	Whatman Lot 71450 (rec'd 1/18/2012)	24 hours = +3 µg 48 hours = -1 µg 72 hours = -3 µg 96 hours = +1 µg	Weight changes fall within required range
			24 hours = +1 µg 48 hours = -2 µg 72 hours = 0 µg 96 hours = -2 µg	Weight changes fall within required range

QC Check	Requirements	QC Checks Applied in RTI Laboratory	Average Value Determined by Lab	Comments
			24 hours = 0 µg 48 hours = 0 µg 72 hours = 0 µg 96 hours = +1 µg	Weight changes fall within required range
			24 hours = 0 µg 48 hours = 0 µg 72 hours = -1 µg 96 hours = +1 µg	Weight changes fall within required range
			24 hours = -1 µg 48 hours = +1 µg 72 hours = +1 µg 96 hours = -1 µg	Weight changes fall within required range
			24 hours = +2 µg 48 hours = +1 µg 72 hours = -1 µg 96 hours = +2 µg	Weight changes fall within required range
			24 hours = 0 µg 48 hours = -1 µg 72 hours = +1 µg 96 hours = 0 µg	Weight changes fall within required range
			24 hours = +1 µg 48 hours = +5 µg 72 hours = +1 µg 96 hours = -2 µg	Weight changes fall within required range
			24 hours = +1 µg 48 hours = +2 µg 72 hours = +2 µg 96 hours = +1 µg	Weight changes fall within required range
			24 hours = 0 µg 48 hours = +1 µg 72 hours = -2 µg 96 hours = +2 µg	Weight changes fall within required range
			24 hours = +4 µg 48 hours = +2 µg 72 hours = +2 µg 96 hours = +3 µg	Weight changes fall within required range
			24 hours = -2 µg 48 hours = +3 µg 72 hours = -3 µg 96 hours = -1 µg	Weight changes fall within required range
Lot blanks (Lot stability filters) (cont'd)	The filters are weighed until a 24-hour weight change < ± 5 µg is demonstrated.	Whatman Lot 82606 (rec'd 5/29/2012)	24 hours = +1 µg 48 hours = +3 µg 72 hours = +1 µg 96 hours = -2 µg	Weight changes fall within required range
			24 hours = 0 µg 48 hours = 0 µg 72 hours = -3 µg 96 hours = -1 µg	Weight changes fall within required range

QC Check	Requirements	QC Checks Applied in RTI Laboratory	Average Value Determined by Lab	Comments
			24 hours = 0 µg 48 hours = +2 µg 72 hours = -1 µg 96 hours = 0 µg	Weight changes fall within required range
			24 hours = +4 µg 48 hours = +2 µg 72 hours = -2 µg 96 hours = -1 µg	Weight changes fall within required range
			24 hours = 0 µg 48 hours = -1 µg 72 hours = 0 µg 96 hours = 0 µg	Weight changes fall within required range
			24 hours = +3 µg 48 hours = -1 µg 72 hours = -1 µg 96 hours = -1 µg	Weight changes fall within required range
			24 hours = +2 µg 48 hours = +4 µg 72 hours = -2 µg 96 hours = -3 µg	Weight changes fall within required range
			24 hours = +2 µg 48 hours = -1 µg 72 hours = -2 µg 96 hours = -1 µg	Weight changes fall within required range
			24 hours = +3 µg 48 hours = 0 µg 72 hours = -2 µg 96 hours = 0 µg	Weight changes fall within required range
			24 hours = 0 µg 48 hours = +1 µg 72 hours = 0 µg 96 hours = -2 µg	Weight changes fall within required range
			24 hours = +1 µg 48 hours = 0 µg 72 hours = -3 µg 96 hours = -1 µg	Weight changes fall within required range
			24 hours = -1 µg 48 hours = 0 µg 72 hours = +1 µg 96 hours = -1 µg	Weight changes fall within required range
			24 hours = -2 µg 48 hours = 0 µg 72 hours = +1 µg 96 hours = -2 µg	Weight changes fall within required range
Lot blanks (Lot stability filters) (cont’d)	The filters are weighed until a 24-hour weight change < ± 5 µg is demonstrated.	Whatman Lot 84703 (rec’d 6/13/2012)	24 hours = -1 µg 48 hours = -4 µg 72 hours = +2 µg 96 hours = -1 µg	Weight changes fall within required range

QC Check	Requirements	QC Checks Applied in RTI Laboratory	Average Value Determined by Lab	Comments
			24 hours = -2 µg 48 hours = -3 µg 72 hours = 0 µg 96 hours = +2 µg	Weight changes fall within required range
			24 hours = 0 µg 48 hours = 0 µg 72 hours = -1 µg 96 hours = +2 µg	Weight changes fall within required range
			24 hours = -1 µg 48 hours = -6 µg 72 hours = +4 µg 96 hours = +1 µg	Weight changes fall within required range
			24 hours = -4 µg 48 hours = -1 µg 72 hours = -1 µg 96 hours = +6 µg	Weight changes fall within required range
			24 hours = 0 µg 48 hours = -2 µg 72 hours = +2 µg 96 hours = +1 µg	Weight changes fall within required range
			24 hours = -1 µg 48 hours = -1 µg 72 hours = 0 µg 96 hours = +5 µg	Weight changes fall within required range
			24 hours = 0 µg 48 hours = -4 µg 72 hours = +5 µg 96 hours = -1 µg	Weight changes fall within required range
			24 hours = +2 µg 48 hours = -1 µg 72 hours = 0 µg 96 hours = +3 µg	Weight changes fall within required range
			24 hours = -4 µg 48 hours = 0 µg 72 hours = +2 µg 96 hours = +4 µg	Weight changes fall within required range
			24 hours = -9 µg 48 hours = -2 µg 72 hours = +5 µg 96 hours = -3 µg	Weight changes fall within required range
			24 hours = -2 µg 48 hours = -2 µg 72 hours = +3 µg 96 hours = -3 µg	Weight changes fall within required range
Lot blanks (Lot stability filters) (cont'd)	The filters are weighed until a 24-hour weight change < ± 5 µg is demonstrated.	Whatman Lot 86128 (rec'd 7/16/2012)	24 hours = -3 µg 48 hours = -4 µg 72 hours = +3 µg 96 hours = -2 µg	Weight changes fall within required range

QC Check	Requirements	QC Checks Applied in RTI Laboratory	Average Value Determined by Lab	Comments
			24 hours = 0 µg 48 hours = -4 µg 72 hours = +1 µg 96 hours = -1 µg	Weight changes fall within required range
			24 hours = +7 µg 48 hours = -8 µg 72 hours = -3 µg 96 hours = -1 µg	Weight changes fall within required range
			24 hours = +1 µg 48 hours = 0 µg 72 hours = 0 µg 96 hours = 0 µg	Weight changes fall within required range
			24 hours = +11 µg 48 hours = -8 µg 72 hours = -2 µg 96 hours = -5 µg	Weight changes fall within required range
			24 hours = -2 µg 48 hours = +2 µg 72 hours = +4 µg 96 hours = -4 µg	Weight changes fall within required range
			24 hours = +5 µg 48 hours = +6 µg 72 hours = 0 µg 96 hours = -1 µg	Weight changes fall within required range
			24 hours = 0 µg 48 hours = +5 µg 72 hours = -3 µg 96 hours = -1 µg	Weight changes fall within required range
			24 hours = -2 µg 48 hours = -3 µg 72 hours = 0 µg 96 hours = -4 µg	Weight changes fall within required range
			24 hours = +1 µg 48 hours = -7 µg 72 hours = +5 µg 96 hours = -4 µg	Weight changes fall within required range
			24 hours = +2 µg 48 hours = 0 µg 72 hours = +3 µg 96 hours = +3 µg	Weight changes fall within required range
			24 hours = +5 µg 48 hours = +4 µg 72 hours = -1 µg 96 hours = -3 µg	Weight changes fall within required range
Lot blanks (Lot stability filters) (cont'd)	The filters are weighed until a 24-hour weight change < ± 5 µg is demonstrated.	Whatman Lot 90174 (rec'd 8/10/2012)	24 hours = -6 µg 48 hours = -2 µg 72 hours = +3 µg 96 hours = -2 µg	Weight changes fall within required range

QC Check	Requirements	QC Checks Applied in RTI Laboratory	Average Value Determined by Lab	Comments
			24 hours = -36 µg 48 hours = -1 µg 72 hours = -1 µg 96 hours = -1 µg	Weight changes fall within required range
			24 hours = 0 µg 48 hours = 0 µg 72 hours = +1 µg 96 hours = +2 µg	Weight changes fall within required range
			24 hours = +1 µg 48 hours = -1 µg 72 hours = -1 µg 96 hours = +3 µg	Weight changes fall within required range
			24 hours = +5 µg 48 hours = -2 µg 72 hours = -2 µg 96 hours = +1 µg	Weight changes fall within required range
			24 hours = -1 µg 48 hours = -1 µg 72 hours = +2 µg 96 hours = -4 µg	Weight changes fall within required range
			24 hours = +5 µg 48 hours = -1 µg 72 hours = 0 µg 96 hours = 0 µg	Weight changes fall within required range
			24 hours = -1 µg 48 hours = +1 µg 72 hours = -1 µg 96 hours = +3 µg	Weight changes fall within required range
			24 hours = -3 µg 48 hours = -2 µg 72 hours = -1 µg 96 hours = +4 µg	Weight changes fall within required range
			24 hours = -2 µg 48 hours = 0 µg 72 hours = +4 µg 96 hours = +1 µg	Weight changes fall within required range
			24 hours = -7 µg 48 hours = +7 µg 72 hours = 0 µg 96 hours = 0 µg	Weight changes fall within required range
			24 hours = -6 µg 48 hours = 0 µg 72 hours = +2 µg 96 hours = +3 µg	Weight changes fall within required range
Lot blanks (Lot stability filters) (cont'd)	The filters are weighed until a 24-hour weight change < ± 5 µg is demonstrated.	Whatman Lot 91153 (rec'd 9/12/2012)	24 hours = -2 µg 48 hours = -2 µg 72 hours = +1 µg 96 hours = +1 µg	Weight changes fall within required range

QC Check	Requirements	QC Checks Applied in RTI Laboratory	Average Value Determined by Lab	Comments
			24 hours = +1 µg 48 hours = -3 µg 72 hours = 0 µg 96 hours = -2 µg	Weight changes fall within required range
			24 hours = -3 µg 48 hours = -2 µg 72 hours = -1 µg 96 hours = +2 µg	Weight changes fall within required range
			24 hours = -1 µg 48 hours = -1 µg 72 hours = -1 µg 96 hours = +1 µg	Weight changes fall within required range
			24 hours = -8 µg 48 hours = -4 µg 72 hours = -2 µg 96 hours = -2 µg	Weight changes fall within required range
			24 hours = -2 µg 48 hours = -9 µg 72 hours = -8 µg 96 hours = +1 µg	Weight changes fall within required range
			24 hours = -1 µg 48 hours = +3 µg 72 hours = -4 µg 96 hours = +5 µg	Weight changes fall within required range
			24 hours = -5 µg 48 hours = -1 µg 72 hours = -1 µg 96 hours = -1 µg	Weight changes fall within required range
			24 hours = +1 µg 48 hours = -3 µg 72 hours = +4 µg 96 hours = 0 µg	Weight changes fall within required range
			24 hours = -9 µg 48 hours = -4 µg 72 hours = +2 µg 96 hours = +4 µg	Weight changes fall within required range
			24 hours = 0 µg 48 hours = -6 µg 72 hours = +1 µg 96 hours = +4 µg	Weight changes fall within required range
			24 hours = -4 µg 48 hours = -4 µg 72 hours = -1 µg 96 hours = 0 µg	Weight changes fall within required range
Lot blanks (Lot stability filters) (cont'd)	The filters are weighed until a 24-hour weight change < ± 5 µg is demonstrated.	Whatman Lot 95636 (rec'd 10/9/2012)	24 hours = -1 µg 48 hours = +1 µg 72 hours = +2 µg 96 hours = -1 µg	Weight changes fall within required range

QC Check	Requirements	QC Checks Applied in RTI Laboratory	Average Value Determined by Lab	Comments
			24 hours = 0 µg 48 hours = -3 µg 72 hours = +3 µg 96 hours = +1 µg	Weight changes fall within required range
			24 hours = -2 µg 48 hours = +10 µg 72 hours = +2 µg 96 hours = -1 µg	Weight changes fall within required range
			24 hours = -2 µg 48 hours = 0 µg 72 hours = -1 µg 96 hours = +3 µg	Weight changes fall within required range
			24 hours = -10 µg 48 hours = +1 µg 72 hours = -1 µg 96 hours = 0 µg	Weight changes fall within required range
			24 hours = +2 µg 48 hours = -1 µg 72 hours = +2 µg 96 hours = +1 µg	Weight changes fall within required range
			24 hours = -3 µg 48 hours = +3 µg 72 hours = -2 µg 96 hours = +4 µg	Weight changes fall within required range
			24 hours = -6 µg 48 hours = +8 µg 72 hours = -1 µg 96 hours = -2 µg	Weight changes fall within required range
			24 hours = -3 µg 48 hours = +14 µg 72 hours = -4 µg 96 hours = -4 µg	Weight changes fall within required range
			24 hours = -2 µg 48 hours = 0 µg 72 hours = +2 µg 96 hours = -5 µg	Weight changes fall within required range
			24 hours = -2 µg 48 hours = +5 µg 72 hours = -2 µg 96 hours = -4 µg	Weight changes fall within required range
			24 hours = -2 µg 48 hours = +2 µg 72 hours = +1 µg 96 hours = -2 µg	Weight changes fall within required range
Lot blanks (Lot stability filters) (cont'd)	The filters are weighed until a 24-hour weight change < ± 5 µg is demonstrated.	Whatman Lot 96611 (rec'd 10/31/2012)	24 hours = -3 µg 48 hours = +2 µg 72 hours = 0 µg 96 hours = 0 µg	Weight changes fall within required range

QC Check	Requirements	QC Checks Applied in RTI Laboratory	Average Value Determined by Lab	Comments
			24 hours = -1 µg 48 hours = 0 µg 72 hours = +3 µg 96 hours = -2 µg	Weight changes fall within required range
			24 hours = -4 µg 48 hours = +2 µg 72 hours = +2 µg 96 hours = 0 µg	Weight changes fall within required range
			24 hours = 0 µg 48 hours = 0 µg 72 hours = +2 µg 96 hours = 0 µg	Weight changes fall within required range
			24 hours = -2 µg 48 hours = +1 µg 72 hours = -1 µg 96 hours = 0 µg	Weight changes fall within required range
			24 hours = -4 µg 48 hours = +1 µg 72 hours = -1 µg 96 hours = +1 µg	Weight changes fall within required range
			24 hours = -5 µg 48 hours = +5 µg 72 hours = +2 µg 96 hours = 0 µg	Weight changes fall within required range
			24 hours = -8 µg 48 hours = +1 µg 72 hours = -3 µg 96 hours = +1 µg	Weight changes fall within required range
			24 hours = -7 µg 48 hours = +1 µg 72 hours = +4 µg 96 hours = 0 µg	Weight changes fall within required range
			24 hours = -4 µg 48 hours = +1 µg 72 hours = +1 µg 96 hours = 0 µg	Weight changes fall within required range
			24 hours = -3 µg 48 hours = -1 µg 72 hours = +6 µg 96 hours = -2 µg	Weight changes fall within required range
			24 hours = -4 µg 48 hours = +1 µg 72 hours = 0 µg 96 hours = +1 µg	Weight changes fall within required range
Lot blanks (Lot stability filters) (cont'd)	The filters are weighed until a 24-hour weight change < ± 5 µg is demonstrated.	Whatman Lot 99154 (rec'd 11/28/2012)	24 hours = +1 µg 48 hours = -2 µg 72 hours = +2 µg 96 hours = 0 µg	Weight changes fall within required range

QC Check	Requirements	QC Checks Applied in RTI Laboratory	Average Value Determined by Lab	Comments
			24 hours = 0 µg 48 hours = -3 µg 72 hours = +6 µg 96 hours = +2 µg	Weight changes fall within required range
			24 hours = +3 µg 48 hours = -4 µg 72 hours = +3 µg 96 hours = -2 µg	Weight changes fall within required range
			24 hours = -2 µg 48 hours = -5 µg 72 hours = +2 µg 96 hours = 0 µg	Weight changes fall within required range
			24 hours = +1 µg 48 hours = -3 µg 72 hours = +5 µg 96 hours = -2 µg	Weight changes fall within required range
			24 hours = +3 µg 48 hours = -5 µg 72 hours = +8 µg 96 hours = -2 µg	Weight changes fall within required range
			24 hours = -2 µg 48 hours = +1 µg 72 hours = +2 µg 96 hours = +1 µg	Weight changes fall within required range
			24 hours = -1 µg 48 hours = -2 µg 72 hours = +1 µg 96 hours = 0 µg	Weight changes fall within required range
			24 hours = -4 µg 48 hours = 0 µg 72 hours = +2 µg 96 hours = -2 µg	Weight changes fall within required range
			24 hours = -1 µg 48 hours = +1 µg 72 hours = +1 µg 96 hours = -2 µg	Weight changes fall within required range
			24 hours = -1 µg 48 hours = -2 µg 72 hours = +3 µg 96 hours = +2 µg	Weight changes fall within required range
			24 hours = +2 µg 48 hours = -3 µg 72 hours = +1 µg 96 hours = +1 µg	Weight changes fall within required range

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. The three Mettler Toledo balances use the same MDL, while the Sartorius balance MDL is slightly different as expected with a different design.

3.1.5 Audits, Performance Evaluations, Training, and Accreditations

Table 3-2 contains information regarding audits, performance evaluations (PEs), training, and accreditations for the Gravimetric Laboratory.

Table 3-2. Description of Audits, PEs, Training, and Accreditations

Type of Evaluation	Date	Administered By	Significant Findings/Comments
Technical Systems Audit	July 24-25, 2012	EPA's audit team included Jewell Smiley and Steve Taylor, from NAREL, with Dennis Crumpler from the Office of Air Quality Planning and Standards (OAQPS)	A Technical Systems Audit (TSA) was conducted as part of the EPA's quality assurance oversight for the $PM_{2.5}$ Chemical Speciation Network (CSN). The weighing experiments produced excellent results for the test filters between RTI and NAREL and acceptable results for the metallic weights. Other observations made during the audit of the gravimetric laboratory area indicated excellent management of the area, well trained analysts, very good record keeping and very good quality control practices.
Proficiency Evaluation (PE)	July 24, 2012 (results finalized) December 2012	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 2011-2012. 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. EPA NAREL initiated an experimental inter-comparison of speciation laboratories. Analyses were performed on real-world samples collected in Montgomery, AL. RTI's analysis and report of the PT samples will be submitted to NAREL in February 2013 and results are expected in 2013.
Accreditation	Updated Scope of Accreditation Certificate issued August 17, 2012	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).

3.2 Ions Analysis Laboratory

The Ion Analysis Laboratory used ten ion chromatograph systems to analyze 14,221 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, 2012.

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 Environmental Industrial Sciences Division – Environmental Chemistry Department (EISD-ECD). Ten Dionex ion chromatographic systems were used for performance of the measurements and are summarized in **Table 3-3**. Distribution of samples among these ten instruments was determined by laboratory workload and instrument availability.

Table 3-3. 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 3-4**. 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.

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.

Table 3-4. 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	Daily, immediately after calibration	Measured concentrations within 10% of known values
▪ RTI prepared QC sample at lower-end concentration	Daily, immediately after calibration	Measured concentrations within 10% of known values
▪ Commercially prepared, NIST- traceable QA sample	Daily, immediately after calibration	Measured concentrations within 10% of known values
Periodic QA/QC Checks:		
▪ Replicate sample †	Every 20 samples	RPD** = 5% at 100x MDL* RPD = 10% at 10x MDL* RPD = 100% at MDL*
▪ QA/QC sample	Every 20 samples	Measured concentrations within 10% of known values
▪ Matrix spiked sample extract	Every 20 samples	Recoveries within 90 to 100% of target values
▪ Duplicates ‡	At least one per day	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.

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 3-5**. The observed value for any ion being measured must be within 10% of the known value for the QA/QC samples (**Table 3-6**), 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 3-5. 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 3-6. 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 3-7 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 3-7. Average Percent Recovery for QA and QC Samples

Analyte	Sample ID	Count	Conc. µg/mL	Avg % Rec *	SD	Min	Max
Nitrate	QA-CPI_LOW	347	0.6	97.4%	2.2%	0.550	0.663
	QA-CPI_MED-HI	250	3.0	100.9%	1.6%	2.945	3.270
	RTI-QC-HIGH	245	6.0	100.8%	1.8%	5.552	6.419
	RTI-QC-LOW	362	0.6	96.5%	1.8%	0.558	0.631
	RTI-QC-MED	558	1.5	97.9%	1.6%	1.398	1.625
Sulfate	QA-CPI_LOW	347	1.2	98.8%	1.8%	1.124	1.327
	QA-CPI_MED-HI	250	6.0	101.5%	1.4%	5.930	6.502
	RTI-QC-HIGH	245	12.0	100.4%	1.8%	11.068	12.875
	RTI-QC-LOW	362	1.2	97.6%	1.7%	1.114	1.279
	RTI-QC-MED	558	3.0	98.6%	1.7%	2.797	3.262

Analyte	Sample ID	Count	Conc. µg/mL	Avg % Rec *	SD	Min	Max
Sodium	GFS 0.4 PPM QA	491	0.4	99.2%	2.3%	0.369	0.430
	GFS 4.0 PPM QA	483	4.0	101.0%	1.4%	3.840	4.203
	RTI 2.0 PPM QC Reg Std	438	2.0	99.6%	1.6%	1.904	2.114
	RTI 5.0 PPM QC	432	5.0	100.7%	1.6%	4.806	5.292
Ammonium	GFS 0.4 PPM QA	491	0.4	99.7%	3.2%	0.345	0.429
	GFS 4.0 PPM QA	483	4.0	100.1%	1.9%	3.551	4.301
	RTI 2.0 PPM QC Reg Std	438	2.0	99.7%	1.8%	1.817	2.168
	RTI 5.0 PPM QC	432	5.0	100.6%	2.0%	4.532	5.420
Potassium	GFS 0.4 PPM QA	491	0.4	97.2%	2.9%	0.349	0.433
	GFS 4.0 PPM QA	483	4.0	100.6%	1.4%	3.752	4.198
	RTI 2.0 PPM QC Reg Std	438	2.0	99.5%	1.7%	1.873	2.126
	RTI 5.0 PPM QC	432	5.0	100.2%	1.6%	4.647	5.260

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

Average recoveries for the QC samples ranged from 96.5 to 100.8% for the year. Average recoveries for the QA samples ranged from 97.2 to 101.5% for the year. These recoveries are well within our acceptance range of 90 to 110%.

Table 3-8 shows percent recovery for all analyte spikes for the year. Average recoveries for the spikes ranged from 100.1 to 101.1%.

Table 3-8. Average Percent Recovery for Spikes

Analyte	Avg Recovery *	StDev	Count	Min	Max
Nitrate	100.4%	1.8%	685	90.9%	110.4%
Sulfate	100.3%	1.5%	685	93.3%	108.5%
Sodium	100.6%	2.1%	658	95.2%	113.1%
Ammonium	101.1%	2.1%	658	92.4%	114.7%
Potassium	100.1%	2.2%	658	93.2%	111.7%

* Acceptance criteria for average percent recovery is ± 10%

Table 3-9 presents filter blank (NQC BLANK) and reagent blank statistics for all analytes over the 12-month period.

Table 3-9. Filter Blank (NQC) and Reagent Blank Values (ppm) for all Analytes

Analyte	Type	Count	Avg	StDev	Min	Max
Nitrate	Reagent	685	0.001	0.005	0.000	0.037
	NQC	373	0.003	0.008	0.000	0.037
Sulfate	Reagent	685	0.009	0.009	-0.001	0.040
	NQC	373	0.009	0.007	0.000	0.026
Sodium	Reagent	678	0.000	0.003	0.000	0.032
	NQC	50	0.000	0.001	0.000	0.007
Ammonium	Reagent	678	0.000	0.001	0.000	0.013
	NQC	50	0.000	0.000	0.000	0.000
Potassium	Reagent	678	0.000	0.000	0.000	0.010
	NQC	50	0.000	0.000	0.000	0.000

* NQC is a blank filter extract analyzed to test the acceptability of the cleaned nylon filter batches. One nylon filter is tested from each bottle used for filter cleaning. If the ion loading for any ion is >1 μg, 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 3-10 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 3-10. 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	37	-0.009	0.007	-0.024	0.003
	QA-CPI_MED-HI	6.0	25	0.013	0.016	-0.011	0.045
	RTI-QC-HIGH	12.0	25	0.071	0.025	0.004	0.125
	RTI-QC-LOW	1.2	52	-0.008	0.007	-0.023	0.010
	RTI-QC-MED	3.0	129	-0.007	0.017	-0.038	0.038
Sulfate	QA-CPI_LOW	1.2	37	-0.006	0.014	-0.032	0.027
	QA-CPI_MED-HI	6.0	25	0.071	0.033	0.018	0.129
	RTI-QC-HIGH	12.0	25	0.094	0.048	-0.016	0.198
	RTI-QC-LOW	1.2	52	-0.006	0.010	-0.030	0.016
	RTI-QC-MED	3.0	129	0.018	0.035	-0.032	0.198
Sodium	GFS 0.4 PPM QA	0.4	110	0.002	0.008	-0.031	0.016
	GFS 4.0 PPM QA	4.0	110	-0.025	0.047	-0.158	0.082
	RTI 2.0 PPM QC	2.0	92	-0.021	0.032	-0.118	0.048
	RTI 5.0 PPM QC	5.0	92	-0.039	0.069	-0.229	0.148
Ammonium	GFS 0.4 PPM QA	0.4	110	0.003	0.014	-0.032	0.030
	GFS 4.0 PPM QA	4.0	110	-0.031	0.072	-0.368	0.064
	RTI 2.0 PPM QC	2.0	92	0.000	0.030	-0.079	0.073
	RTI 5.0 PPM QC	5.0	92	-0.046	0.111	-0.614	0.067
Potassium	GFS 0.4 PPM QA	0.4	110	-0.001	0.012	-0.049	0.029

Analyte	QA/QC Type	Conc., ppm	Count	Average * Difference	Standard Deviation of Diff.	Minimum Diff.	Maximum Diff.
	GFS 4.0 PPM QA	4.0	110	-0.028	0.044	-0.163	0.072
	RTI 2.0 PPM QC	2.0	92	-0.022	0.031	-0.110	0.041
	RTI 5.0 PPM QC	5.0	92	-0.044	0.069	-0.229	0.116

* 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.

3.2.6 Audits, Performance Evaluations, Training, and Accreditations

In January 2012, 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 indicated good performance by RTI’s IC lab. The lab also participated in the EPA TSA in July 2012. The auditors reported that they found no deficiencies associated with the IC laboratory and that the laboratory appeared to be well-managed with good laboratory practices, including good documentation.

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 18,195 quartz-fiber filters during calendar year 2012 (these were sent to DRI in filter batches numbered 139 through 163). DRI performed 22,008 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. Twelve DRI Model 2001 Thermal/Optical Carbon Analyzers (designated as units # 6 – 13, 16, 18, 19 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 2012.

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 3-11.** It specifies the frequency and standards required for the specified checks, along with the acceptance criteria and corrective actions.

Table 3-12 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 22,008 runs, there were 1,615 runs flagged as invalid. In addition, 4,246 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 5, 2013. 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 2013, after all the 2012 data had been processed and validated.

There were 2,197 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 3-13 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 3-14 gives the laboratory blank statistics for each of the twelve 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 0.20 µg C/cm2 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 3-13 and 3-14 include all reported laboratory and system blank data that met the blank criterion for TC before reported samples were analyzed using the IMPROVE_A method for this and other projects. DRI now 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 updated SOP distinguishes lab blanks from system blanks.

Table 3-11. 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 $\geq$10 μg C/cm^2 ±20% when EC $\geq$ 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 3-12. DRI Carbon Laboratory-Assigned Data Flags

Validation Flag Category	Validation Flag Subcategory	Description	No. of Sample Runs
n		Foreign substance on sample	8
s		Suspect analysis result	4
v		Void (invalid) analysis result	1615
	v2	Replicate analysis failed acceptable limit	85
	v3	Potential contamination	34
	v5	Analytical instrument error	1430
	v6	Analyst error	45
	v7	Software malfunction	21
		Total (n, s, v)	3242
r		Replicate analysis	2197
	r1	First replicate analysis on same analyzer (duplicate)	93
	r5	Replicate on different analyzer	2104
		No n, s, v, or r flag	16569
		Total no. of original sample runs (incl. blank and replicate flags)	22008

Table 3-13. DRI Carbon Laboratory System Blank Statistics for Each Analyzer

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	3	Mean	0.000	0.000	0.001	0.000	0.000	0.000	0.002	0.002	0.000	0.000	0.004	0.004	0.004	0.005
		StdDev	0.000	0.000	0.002	0.000	0.000	0.000	0.003	0.003	0.000	0.000	0.006	0.006	0.006	0.009
		Max	0.000	0.001	0.004	0.000	0.000	0.000	0.005	0.005	0.000	0.000	0.011	0.011	0.011	0.015
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	3	Mean	0.002	0.009	0.000	0.000	0.000	0.000	0.010	0.010	0.000	0.000	0.000	0.000	0.000	0.010
		StdDev	0.003	0.015	0.000	0.000	0.000	0.000	0.018	0.018	0.000	0.000	0.000	0.000	0.000	0.018
		Max	0.005	0.026	0.000	0.000	0.000	0.000	0.031	0.031	0.000	0.000	0.000	0.000	0.000	0.031
		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	3	Mean	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.002	0.002	0.002
		StdDev	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.003	0.003	0.003
		Max	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.000	0.000	0.005	0.005	0.005
		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	3	Mean	0.000	0.014	0.025	0.006	0.000	0.000	0.045	0.045	0.000	0.000	0.022	0.022	0.022	0.068
		StdDev	0.000	0.025	0.043	0.011	0.000	0.000	0.079	0.079	0.000	0.000	0.039	0.039	0.039	0.117
		Max	0.000	0.043	0.074	0.018	0.000	0.000	0.136	0.136	0.000	0.000	0.067	0.067	0.067	0.203
		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	4	Mean	0.000	0.013	0.013	0.000	0.000	0.000	0.026	0.026	0.000	0.001	0.000	0.001	0.001	0.027
		StdDev	0.000	0.025	0.025	0.000	0.000	0.000	0.051	0.051	0.000	0.002	0.001	0.002	0.002	0.051
		Max	0.000	0.052	0.051	0.000	0.000	0.000	0.102	0.102	0.000	0.004	0.001	0.004	0.004	0.104
		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	0.001	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.001	0.001	0.003
11	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
12	4	Mean	0.000	0.013	0.020	0.012	0.000	0.000	0.045	0.045	0.000	0.000	0.000	0.000	0.000	0.045
		StdDev	0.000	0.026	0.037	0.024	0.000	0.000	0.059	0.059	0.000	0.000	0.000	0.000	0.000	0.059
		Max	0.000	0.053	0.075	0.048	0.000	0.000	0.128	0.128	0.000	0.000	0.000	0.000	0.000	0.128
		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	0.002	0.000	0.000	0.000	0.026	0.026	0.000	0.000	0.000	0.000	0.000	0.026
13	1	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
16	3	Mean	0.000	0.020	0.035	0.005	0.000	0.000	0.060	0.060	0.000	0.008	0.000	0.008	0.008	0.068
		StdDev	0.000	0.034	0.032	0.009	0.000	0.000	0.075	0.075	0.000	0.014	0.001	0.014	0.014	0.089
		Max	0.000	0.059	0.072	0.016	0.000	0.000	0.146	0.146	0.000	0.023	0.001	0.025	0.025	0.171
		Min	0.000	0.000	0.010	0.000	0.000	0.000	0.010	0.010	0.000	0.000	0.000	0.000	0.000	0.010
		Median	0.000	0.000	0.023	0.000	0.000	0.000	0.023	0.023	0.000	0.000	0.000	0.000	0.000	0.023
18	1	Mean	0.000	0.087	0.070	0.000	0.000	0.000	0.158	0.158	0.000	0.000	0.000	0.000	0.000	0.158
		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	0.087	0.070	0.000	0.000	0.000	0.158	0.158	0.000	0.000	0.000	0.000	0.000	0.158
		Min	0.000	0.087	0.070	0.000	0.000	0.000	0.158	0.158	0.000	0.000	0.000	0.000	0.000	0.158
		Median	0.000	0.087	0.070	0.000	0.000	0.000	0.158	0.158	0.000	0.000	0.000	0.000	0.000	0.158
19	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	29	Mean	0.000	0.011	0.013	0.003	0.000	0.000	0.027	0.027	0.000	0.001	0.003	0.004	0.004	0.031
		StdDev	0.001	0.024	0.026	0.010	0.000	0.000	0.051	0.051	0.001	0.004	0.013	0.013	0.013	0.059
		Max	0.005	0.087	0.075	0.048	0.000	0.000	0.158	0.158	0.005	0.023	0.067	0.067	0.067	0.203
		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 3-14. DRI Carbon Laboratory Lab Blank Statistics for Each Analyzer

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	203	Mean	0.005	0.013	0.026	0.005	0.000	0.002	0.049	0.051	0.000	0.001	0.002	0.003	0.001	0.052
		StdDev	0.039	0.050	0.084	0.023	0.001	0.012	0.172	0.176	0.005	0.007	0.010	0.016	0.011	0.177
		Max	0.497	0.411	0.648	0.197	0.008	0.138	1.354	1.354	0.064	0.070	0.131	0.153	0.153	1.354
		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	209	Mean	0.006	0.013	0.025	0.006	0.001	0.004	0.051	0.054	0.003	0.003	0.007	0.012	0.009	0.063
		StdDev	0.035	0.050	0.065	0.031	0.005	0.017	0.165	0.174	0.013	0.012	0.023	0.036	0.029	0.185
		Max	0.353	0.451	0.444	0.295	0.063	0.203	1.419	1.621	0.148	0.145	0.199	0.260	0.227	1.621
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.003	0.000
		Median	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.004
8	253	Mean	0.003	0.009	0.022	0.005	0.001	0.003	0.039	0.042	0.001	0.003	0.005	0.008	0.006	0.048
		StdDev	0.024	0.035	0.070	0.023	0.011	0.029	0.142	0.158	0.012	0.017	0.028	0.047	0.038	0.164
		Max	0.348	0.339	0.602	0.228	0.178	0.421	1.268	1.689	0.137	0.142	0.339	0.421	0.344	1.689
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	230	Mean	0.002	0.013	0.025	0.006	0.001	0.003	0.046	0.049	0.001	0.003	0.003	0.006	0.003	0.052
		StdDev	0.023	0.045	0.074	0.028	0.008	0.022	0.154	0.158	0.005	0.017	0.018	0.035	0.029	0.176
		Max	0.327	0.365	0.683	0.287	0.117	0.264	1.295	1.295	0.072	0.184	0.182	0.401	0.401	1.696
		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	265	Mean	0.001	0.006	0.011	0.002	0.000	0.002	0.020	0.022	0.000	0.001	0.001	0.002	0.000	0.022
		StdDev	0.006	0.028	0.044	0.013	0.001	0.013	0.083	0.088	0.001	0.005	0.010	0.013	0.002	0.089
		Max	0.092	0.281	0.482	0.140	0.010	0.119	0.842	0.842	0.010	0.056	0.119	0.119	0.030	0.842
		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
11	248	Mean	0.000	0.004	0.012	0.001	0.000	0.001	0.018	0.019	0.000	0.001	0.002	0.002	0.001	0.020
		StdDev	0.004	0.020	0.057	0.011	0.000	0.010	0.086	0.092	0.003	0.005	0.010	0.015	0.008	0.094
		Max	0.069	0.194	0.572	0.156	0.002	0.135	0.880	1.015	0.040	0.059	0.115	0.141	0.077	1.015
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	266	Mean	0.002	0.009	0.020	0.005	0.000	0.003	0.036	0.038	0.002	0.002	0.002	0.005	0.002	0.040
		StdDev	0.009	0.030	0.059	0.023	0.003	0.030	0.106	0.118	0.008	0.012	0.014	0.032	0.013	0.121
		Max	0.107	0.275	0.507	0.187	0.037	0.472	0.797	0.845	0.090	0.171	0.211	0.472	0.187	0.845
		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	0.003
13	235	Mean	0.001	0.009	0.019	0.004	0.001	0.002	0.034	0.035	0.000	0.002	0.000	0.002	0.001	0.035
		StdDev	0.008	0.033	0.066	0.018	0.006	0.009	0.117	0.119	0.005	0.010	0.002	0.012	0.010	0.123
		Max	0.112	0.226	0.505	0.162	0.093	0.093	0.773	0.779	0.081	0.093	0.025	0.150	0.150	0.859
		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	236	Mean	0.004	0.011	0.028	0.007	0.001	0.005	0.050	0.054	0.002	0.004	0.005	0.010	0.006	0.061
		StdDev	0.027	0.036	0.090	0.028	0.009	0.029	0.165	0.175	0.013	0.016	0.026	0.043	0.028	0.187
		Max	0.281	0.291	0.808	0.194	0.142	0.295	1.339	1.339	0.129	0.162	0.214	0.394	0.251	1.339
		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
18	17	Mean	0.002	0.014	0.014	0.003	0.000	0.002	0.032	0.033	0.001	0.000	0.001	0.002	0.000	0.033
		StdDev	0.007	0.056	0.054	0.012	0.000	0.005	0.129	0.128	0.004	0.000	0.003	0.005	0.000	0.128
		Max	0.027	0.230	0.223	0.050	0.000	0.018	0.530	0.530	0.018	0.001	0.011	0.018	0.000	0.530
		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
19	74	Mean	0.002	0.012	0.024	0.010	0.000	0.001	0.048	0.048	0.000	0.002	0.002	0.004	0.004	0.052
		StdDev	0.012	0.033	0.050	0.032	0.003	0.004	0.115	0.115	0.004	0.008	0.011	0.013	0.013	0.120
		Max	0.095	0.167	0.243	0.179	0.029	0.029	0.536	0.536	0.033	0.054	0.078	0.078	0.078	0.536
		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	41	Mean	0.044	0.042	0.010	0.002	0.000	0.000	0.098	0.098	0.000	0.000	0.000	0.000	0.000	0.098
		StdDev	0.108	0.103	0.030	0.009	0.000	0.000	0.242	0.242	0.000	0.002	0.000	0.002	0.002	0.243
		Max	0.430	0.405	0.122	0.053	0.000	0.000	0.957	0.957	0.000	0.009	0.003	0.009	0.009	0.957
		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	2277	Mean	0.003	0.010	0.021	0.004	0.000	0.003	0.039	0.041	0.001	0.002	0.003	0.005	0.003	0.044
		StdDev	0.027	0.039	0.067	0.023	0.006	0.020	0.136	0.144	0.008	0.012	0.017	0.030	0.022	0.151
		Max	0.497	0.451	0.808	0.295	0.178	0.472	1.419	1.689	0.148	0.184	0.339	0.472	0.401	1.696
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.003	0.000
		Median	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

* Excludes replicates

Tables 3-15 through **3-18** 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 5, 2013. 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, 6, and 159, respectively. For all types of blanks, it was found that nearly all the TC was in OC, with negligible quantities of EC.

Table 3-19 summarizes the results for each type of blank combined over all analyzers. Average TC concentration for the 172 SHAL blanks was 0.3 ± 0.2 μg/cm^2, while it was 1.1 ± 0.5 μg/cm^2 for the 257 trip blanks, 1.3 ± 0.9 μg/cm^2 for the 1,479 field blanks, and 2.9 ± 1.4 μg/cm^2 for the 1,475 backup filters.

3.3.3.2 Calibrations

Table 3-20 provides summary statistics for full multi-point calibrations by analyzer for the period during which the project samples were analyzed. The multipoint calibrations are performed semi-annually or whenever major repairs or changes are made to the instruments. Separate calibrations are performed using four different sources of carbon: methane (CH_4), carbon dioxide (CO_2), sucrose ($C_{12}H_{22}O_{11}$), and potassium hydrogen phthalate (KHP). The average of the regression slopes through zero is obtained and used for converting counts to μg C. The slope represents the response of the entire analyzer to generic carbon compounds and includes the efficiencies of the oxidation and methanator zones and sensitivity of the FID. The slope and correlation are for a least squares fit to all points in calibration curves using the four sources of carbon while the scatter is the standard deviation (root mean square of the variance) of the actual points from the fitted curve. Note that analyzer 18 was removed from routine operation and assigned to experimental use from March 2011 through October 2012. It was returned to regular service 11/01/12. Also, analyzer 19 was removed from routine operation for experimental studies 04/18/12, tested, and officially assigned to experimental use 07/16/12. New analyzer 20 was put into regular service 10/24/12.

Table 3-15. 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	88	Mean	0.076	0.456	0.537	0.054	0.000	0.012	1.123	1.135	0.011	0.005	0.000	0.017	0.004	1.139
		StdDev	0.069	0.305	0.355	0.125	0.000	0.039	0.712	0.746	0.037	0.014	0.002	0.044	0.018	0.751
		Max	0.435	2.285	2.862	0.908	0.003	0.201	4.523	4.724	0.194	0.069	0.015	0.233	0.140	4.724
		Min	0.000	0.156	0.206	0.000	0.000	0.000	0.390	0.390	0.000	0.000	0.000	0.000	0.000	0.390
		Median	0.068	0.402	0.449	0.016	0.000	0.000	0.927	0.929	0.000	0.000	0.000	0.000	0.000	0.929
7	92	Mean	0.153	0.339	0.562	0.077	0.001	0.029	1.133	1.161	0.029	0.011	0.002	0.041	0.013	1.174
		StdDev	0.109	0.149	0.359	0.131	0.007	0.090	0.599	0.667	0.086	0.027	0.007	0.101	0.042	0.679
		Max	0.426	1.237	2.196	0.731	0.070	0.570	3.809	4.240	0.575	0.132	0.045	0.595	0.322	4.240
		Min	0.000	0.107	0.189	0.000	0.000	0.000	0.427	0.427	0.000	0.000	0.000	0.000	0.000	0.427
		Median	0.150	0.316	0.475	0.027	0.000	0.000	1.031	1.046	0.000	0.000	0.000	0.000	0.000	1.046
8	152	Mean	0.141	0.437	0.675	0.082	0.000	0.017	1.335	1.352	0.016	0.006	0.000	0.022	0.006	1.358
		StdDev	0.109	0.251	0.510	0.132	0.002	0.058	0.858	0.896	0.064	0.021	0.001	0.073	0.028	0.915
		Max	0.865	1.818	4.517	0.973	0.030	0.377	6.528	6.798	0.472	0.177	0.006	0.531	0.261	7.059
		Min	0.000	0.135	0.210	0.000	0.000	0.000	0.362	0.362	0.000	0.000	0.000	0.000	0.000	0.362
		Median	0.128	0.382	0.547	0.042	0.000	0.000	1.125	1.125	0.000	0.000	0.000	0.000	0.000	1.125
9	155	Mean	0.070	0.398	0.680	0.092	0.007	0.038	1.248	1.279	0.033	0.007	0.000	0.034	0.003	1.282
		StdDev	0.099	0.168	0.921	0.261	0.041	0.245	1.279	1.485	0.213	0.039	0.002	0.238	0.012	1.486
		Max	0.812	1.332	9.480	2.581	0.386	2.894	13.046	15.940	2.471	0.429	0.025	2.900	0.093	15.946
		Min	0.000	0.021	0.231	0.000	0.000	0.000	0.441	0.441	0.000	0.000	0.000	0.000	0.000	0.441
		Median	0.019	0.379	0.515	0.046	0.000	0.000	1.009	1.009	0.000	0.000	0.000	0.000	0.000	1.009
10	192	Mean	0.128	0.389	0.543	0.062	0.002	0.018	1.123	1.139	0.015	0.004	0.000	0.017	0.001	1.140
		StdDev	0.103	0.187	0.416	0.120	0.019	0.057	0.670	0.701	0.050	0.018	0.002	0.049	0.009	0.702
		Max	0.513	1.567	4.421	1.218	0.230	0.453	6.602	6.825	0.426	0.175	0.015	0.321	0.102	6.825
		Min	0.000	0.024	0.107	0.000	0.000	0.000	0.289	0.289	0.000	0.000	0.000	0.000	0.000	0.289
		Median	0.115	0.373	0.437	0.022	0.000	0.000	0.981	0.988	0.000	0.000	0.000	0.000	0.000	0.988
11	160	Mean	0.126	0.366	0.517	0.046	0.000	0.010	1.056	1.066	0.009	0.004	0.001	0.013	0.004	1.069
		StdDev	0.169	0.204	0.372	0.115	0.001	0.046	0.719	0.752	0.036	0.022	0.007	0.052	0.021	0.756
		Max	1.614	1.866	3.381	0.902	0.010	0.389	5.070	5.459	0.223	0.184	0.087	0.389	0.184	5.459
		Min	0.000	0.069	0.134	0.000	0.000	0.000	0.246	0.246	0.000	0.000	0.000	0.000	0.000	0.246
		Median	0.101	0.331	0.437	0.000	0.000	0.000	0.919	0.919	0.000	0.000	0.000	0.000	0.000	0.919
12	194	Mean	0.114	0.460	0.645	0.105	0.007	0.023	1.332	1.347	0.023	0.009	0.001	0.026	0.011	1.358
		StdDev	0.101	0.213	0.406	0.137	0.035	0.066	0.720	0.745	0.063	0.023	0.004	0.057	0.033	0.752
		Max	0.673	1.669	3.886	1.068	0.261	0.424	6.364	6.527	0.398	0.148	0.027	0.377	0.242	6.533
		Min	0.000	0.142	0.236	0.000	0.000	0.000	0.479	0.479	0.000	0.000	0.000	0.000	0.000	0.488
		Median	0.099	0.410	0.523	0.067	0.000	0.000	1.146	1.146	0.000	0.000	0.000	0.000	0.000	1.149
13	155	Mean	0.074	0.423	0.750	0.093	0.011	0.046	1.350	1.386	0.040	0.005	0.000	0.035	0.000	1.386
		StdDev	0.080	0.204	0.770	0.197	0.088	0.151	1.112	1.183	0.143	0.020	0.001	0.110	0.001	1.183
		Max	0.504	1.511	6.494	1.228	1.008	1.156	8.465	8.550	1.105	0.170	0.011	0.840	0.013	8.550
		Min	0.000	0.061	0.210	0.000	0.000	0.000	0.271	0.271	0.000	0.000	0.000	0.000	0.000	0.271
		Median	0.055	0.381	0.542	0.033	0.000	0.000	1.046	1.046	0.000	0.000	0.000	0.000	0.000	1.046
16	179	Mean	0.150	0.444	0.667	0.097	0.003	0.018	1.361	1.377	0.022	0.018	0.001	0.038	0.023	1.399
		StdDev	0.141	0.268	0.492	0.171	0.024	0.060	0.863	0.893	0.066	0.038	0.006	0.081	0.054	0.921
		Max	0.715	3.146	4.587	1.250	0.217	0.369	6.911	7.035	0.487	0.206	0.075	0.506	0.350	7.035
		Min	0.000	0.047	0.198	0.000	0.000	0.000	0.267	0.267	0.000	0.000	0.000	0.000	0.000	0.267
		Median	0.128	0.409	0.556	0.053	0.000	0.000	1.204	1.208	0.000	0.000	0.000	0.000	0.000	1.208
18	22	Mean	0.042	0.416	0.566	0.037	0.003	0.009	1.065	1.070	0.009	0.001	0.000	0.007	0.001	1.071
		StdDev	0.050	0.116	0.208	0.039	0.016	0.025	0.333	0.337	0.025	0.005	0.000	0.020	0.005	0.338
		Max	0.142	0.591	1.113	0.168	0.073	0.089	1.892	1.900	0.089	0.023	0.000	0.089	0.023	1.900
		Min	0.000	0.195	0.265	0.000	0.000	0.000	0.460	0.460	0.000	0.000	0.000	0.000	0.000	0.460
		Median	0.020	0.437	0.545	0.033	0.000	0.000	0.994	1.006	0.000	0.000	0.000	0.000	0.000	1.006
19	46	Mean	0.042	0.360	0.666	0.122	0.008	0.033	1.198	1.223	0.035	0.018	0.000	0.045	0.019	1.243
		StdDev	0.058	0.157	0.455	0.212	0.046	0.096	0.799	0.841	0.124	0.038	0.000	0.117	0.074	0.884
		Max	0.238	0.842	2.780	1.019	0.312	0.494	4.352	4.462	0.776	0.202	0.000	0.666	0.484	4.529
		Min	0.000	0.156	0.297	0.000	0.000	0.000	0.490	0.490	0.000	0.000	0.000	0.000	0.000	0.490
		Median	0.005	0.331	0.549	0.058	0.000	0.000	0.939	0.961	0.000	0.000	0.000	0.000	0.000	0.961
20	44	Mean	0.067	0.471	0.753	0.093	0.000	0.006	1.383	1.390	0.016	0.015	0.000	0.031	0.024	1.414
		StdDev	0.086	0.228	0.719	0.207	0.000	0.041	1.055	1.088	0.058	0.036	0.000	0.088	0.059	1.129
		Max	0.381	1.196	4.877	1.316	0.000	0.274	6.880	7.154	0.341	0.156	0.000	0.497	0.223	7.377
		Min	0.000	0.184	0.258	0.000	0.000	0.000	0.442	0.442	0.000	0.000	0.000	0.000	0.000	0.442
		Median	0.028	0.408	0.525	0.036	0.000	0.000	0.998	0.998	0.000	0.000	0.000	0.000	0.000	0.998
All	1479	Mean	0.111	0.415	0.630	0.082	0.004	0.023	1.241	1.260	0.022	0.008	0.000	0.027	0.008	1.268
		StdDev	0.116	0.219	0.555	0.165	0.037	0.108	0.874	0.939	0.100	0.027	0.004	0.105	0.033	0.949
		Max	1.614	3.146	9.480	2.581	1.008	2.894	13.046	15.940	2.471	0.429	0.087	2.900	0.484	15.946
		Min	0.000	0.021	0.107	0.000	0.000	0.000	0.246	0.246	0.000	0.000	0.000	0.000	0.000	0.246
		Median	0.094	0.381	0.507	0.039	0.000	0.000	1.046	1.049	0.000	0.000	0.000	0.000	0.000	1.052

* Excludes replicates

Table 3-16. DRI Carbon Analysis Statistics for Backup Filters

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	91	Mean	0.226	1.047	1.199	0.325	0.007	0.007	2.804	2.925	0.096	0.040	0.003	0.132	0.011	2.936
		StdDev	0.315	0.448	0.730	0.297	0.039	0.039	1.501	1.761	0.298	0.080	0.029	0.375	0.027	1.773
		Max	1.547	2.435	5.427	1.696	0.278	0.278	8.573	11.914	2.637	0.431	0.274	3.341	0.194	11.914
		Min	0.000	0.282	0.298	0.000	0.000	0.000	0.653	0.653	0.000	0.000	0.000	0.000	0.000	0.653
		Median	0.126	0.993	1.027	0.248	0.000	0.000	2.396	2.445	0.006	0.013	0.000	0.042	0.000	2.464
7	99	Mean	0.596	0.801	1.162	0.345	0.026	0.127	2.930	3.031	0.104	0.048	0.003	0.130	0.028	3.059
		StdDev	0.605	0.337	0.616	0.263	0.119	0.191	1.421	1.511	0.151	0.074	0.009	0.156	0.066	1.526
		Max	3.644	1.598	3.821	1.263	1.057	1.277	7.920	8.279	0.949	0.362	0.051	0.738	0.483	8.344
		Min	0.000	0.038	0.209	0.000	0.000	0.000	0.247	0.247	0.000	0.000	0.000	0.000	0.000	0.247
		Median	0.429	0.791	1.096	0.306	0.000	0.063	2.818	2.983	0.048	0.021	0.000	0.072	0.000	2.997
8	160	Mean	0.349	0.880	1.232	0.316	0.001	0.052	2.778	2.830	0.036	0.028	0.001	0.064	0.012	2.842
		StdDev	0.311	0.356	0.615	0.224	0.008	0.102	1.226	1.295	0.081	0.046	0.004	0.116	0.038	1.307
		Max	2.439	2.297	5.194	1.371	0.084	0.656	8.745	9.016	0.562	0.307	0.035	0.800	0.259	9.059
		Min	0.000	0.120	0.281	0.000	0.000	0.000	0.458	0.458	0.000	0.000	0.000	0.000	0.000	0.463
		Median	0.286	0.843	1.103	0.264	0.000	0.004	2.590	2.623	0.000	0.003	0.000	0.021	0.000	2.623
9	154	Mean	0.217	1.026	1.213	0.375	0.029	0.091	2.860	2.923	0.060	0.050	0.001	0.082	0.019	2.942
		StdDev	0.330	0.534	0.541	0.355	0.083	0.137	1.354	1.417	0.112	0.056	0.008	0.135	0.055	1.437
		Max	2.026	2.905	3.658	3.752	0.791	0.868	7.984	8.438	0.806	0.274	0.092	1.079	0.358	8.650
		Min	0.000	0.141	0.383	0.000	0.000	0.000	0.663	0.663	0.000	0.000	0.000	0.000	0.000	0.663
		Median	0.066	0.890	1.158	0.307	0.000	0.034	2.592	2.616	0.010	0.035	0.000	0.033	0.000	2.616
10	155	Mean	0.314	0.963	1.137	0.285	0.011	0.066	2.710	2.765	0.053	0.015	0.000	0.058	0.003	2.768
		StdDev	0.251	0.447	0.656	0.215	0.068	0.123	1.299	1.354	0.109	0.029	0.002	0.088	0.015	1.355
		Max	1.280	2.256	4.469	1.446	0.810	1.081	9.221	9.491	1.025	0.159	0.014	0.465	0.156	9.491
		Min	0.000	0.157	0.251	0.000	0.000	0.000	0.656	0.656	0.000	0.000	0.000	0.000	0.000	0.656
		Median	0.289	0.906	0.974	0.247	0.000	0.014	2.509	2.530	0.005	0.000	0.000	0.019	0.000	2.530
11	152	Mean	0.327	0.907	1.085	0.285	0.000	0.063	2.604	2.666	0.048	0.020	0.000	0.068	0.006	2.672
		StdDev	0.337	0.423	0.523	0.207	0.000	0.135	1.152	1.244	0.115	0.041	0.004	0.140	0.015	1.249
		Max	1.418	2.831	3.672	1.160	0.000	0.998	6.684	7.196	0.998	0.242	0.055	1.081	0.083	7.279
		Min	0.000	0.140	0.284	0.000	0.000	0.000	0.482	0.482	0.000	0.000	0.000	0.000	0.000	0.482
		Median	0.210	0.825	0.985	0.236	0.000	0.000	2.478	2.491	0.000	0.000	0.000	0.000	0.000	2.491
12	180	Mean	0.279	1.056	1.242	0.433	0.031	0.132	3.042	3.142	0.090	0.054	0.000	0.114	0.013	3.156
		StdDev	0.280	0.493	0.652	0.316	0.100	0.192	1.471	1.588	0.144	0.074	0.002	0.164	0.035	1.595
		Max	1.588	3.075	4.228	2.030	0.701	1.153	9.665	10.117	0.911	0.334	0.020	1.025	0.211	10.117
		Min	0.000	0.121	0.127	0.000	0.000	0.000	0.282	0.282	0.000	0.000	0.000	0.000	0.000	0.282
		Median	0.200	1.002	1.090	0.359	0.000	0.072	2.849	2.872	0.040	0.018	0.000	0.058	0.000	2.907
13	184	Mean	0.241	0.958	1.240	0.307	0.010	0.073	2.757	2.821	0.052	0.024	0.000	0.067	0.002	2.823
		StdDev	0.268	0.545	0.596	0.239	0.049	0.115	1.344	1.410	0.098	0.037	0.001	0.099	0.016	1.412
		Max	1.335	5.943	3.710	1.284	0.432	0.647	10.945	11.168	0.563	0.154	0.015	0.646	0.192	11.168
		Min	0.000	0.041	0.090	0.000	0.000	0.000	0.130	0.130	0.000	0.000	0.000	0.000	0.000	0.130
		Median	0.179	0.877	1.109	0.251	0.000	0.026	2.579	2.620	0.000	0.000	0.000	0.027	0.000	2.637
16	203	Mean	0.347	1.041	1.248	0.355	0.014	0.085	3.005	3.075	0.063	0.060	0.003	0.111	0.040	3.116
		StdDev	0.334	0.481	0.572	0.247	0.059	0.134	1.273	1.345	0.099	0.081	0.021	0.140	0.073	1.362
		Max	1.989	3.007	4.427	1.509	0.580	0.735	6.656	7.008	0.690	0.767	0.285	0.774	0.595	7.018
		Min	0.000	0.149	0.288	0.000	0.000	0.000	0.437	0.437	0.000	0.000	0.000	0.000	0.000	0.437
		Median	0.300	0.957	1.167	0.293	0.000	0.028	2.811	2.821	0.022	0.043	0.000	0.064	0.013	2.821
18	21	Mean	0.198	1.289	1.505	0.410	0.018	0.153	3.420	3.555	0.080	0.073	0.000	0.135	0.000	3.556
		StdDev	0.175	0.494	0.582	0.239	0.046	0.126	1.162	1.251	0.084	0.067	0.001	0.105	0.001	1.251
		Max	0.481	2.616	3.425	1.074	0.152	0.366	5.635	5.968	0.302	0.225	0.006	0.332	0.007	5.968
		Min	0.000	0.577	0.750	0.119	0.000	0.000	1.612	1.612	0.000	0.000	0.000	0.000	0.000	1.612
		Median	0.282	1.274	1.426	0.439	0.000	0.113	3.211	3.269	0.063	0.063	0.000	0.113	0.000	3.269
19	43	Mean	0.175	0.911	1.214	0.350	0.005	0.071	2.655	2.721	0.075	0.028	0.000	0.098	0.032	2.753
		StdDev	0.167	0.512	0.616	0.258	0.026	0.116	1.304	1.370	0.114	0.043	0.000	0.136	0.054	1.394
		Max	0.752	2.745	3.335	1.168	0.163	0.433	6.106	6.376	0.440	0.187	0.002	0.526	0.226	6.416
		Min	0.000	0.292	0.335	0.029	0.000	0.000	0.697	0.758	0.000	0.000	0.000	0.000	0.000	0.758
		Median	0.166	0.931	1.075	0.309	0.000	0.006	2.557	2.557	0.011	0.003	0.000	0.054	0.000	2.560
20	33	Mean	0.178	1.321	1.369	0.345	0.007	0.091	3.220	3.304	0.060	0.067	0.000	0.120	0.036	3.341
		StdDev	0.182	0.497	0.614	0.205	0.030	0.144	1.325	1.439	0.130	0.068	0.000	0.180	0.057	1.484
		Max	0.565	2.642	3.201	0.975	0.170	0.597	6.691	7.275	0.597	0.277	0.000	0.860	0.277	7.551
		Min	0.000	0.530	0.492	0.046	0.000	0.000	1.152	1.152	0.000	0.000	0.000	0.000	0.000	1.152
		Median	0.137	1.206	1.292	0.337	0.000	0.000	3.141	3.188	0.000	0.052	0.000	0.055	0.016	3.235
All	1475	Mean	0.305	0.982	1.209	0.340	0.014	0.088	2.849	2.924	0.064	0.039	0.001	0.090	0.016	2.940
		StdDev	0.339	0.476	0.609	0.266	0.066	0.167	1.333	1.426	0.134	0.061	0.011	0.160	0.046	1.437
		Max	3.644	5.943	5.427	3.752	1.057	3.341	10.945	11.914	2.637	0.767	0.285	3.341	0.595	11.914
		Min	0.000	0.038	0.090	0.000	0.000	0.000	0.130	0.130	0.000	0.000	0.000	0.000	0.000	0.130
		Median	0.226	0.912	1.096	0.285	0.000	0.024	2.634	2.684	0.008	0.009	0.000	0.036	0.000	2.701

* Excludes replicates

Table 3-17. DRI Carbon Analysis Statistics for Trip Blanks

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	5	Mean	0.153	0.462	0.409	0.051	0.000	0.000	1.073	1.074	0.001	0.001	0.000	0.002	0.002	1.075
		StdDev	0.029	0.123	0.176	0.046	0.000	0.000	0.303	0.303	0.002	0.002	0.000	0.004	0.003	0.304
		Max	0.182	0.655	0.621	0.101	0.000	0.001	1.304	1.305	0.003	0.005	0.000	0.009	0.008	1.313
		Min	0.116	0.317	0.195	0.000	0.000	0.000	0.640	0.640	0.000	0.000	0.000	0.000	0.000	0.640
		Median	0.164	0.445	0.407	0.060	0.000	0.000	1.271	1.271	0.000	0.000	0.000	0.000	0.000	1.271
7	15	Mean	0.240	0.285	0.401	0.033	0.000	0.011	0.958	0.969	0.007	0.003	0.001	0.011	0.000	0.969
		StdDev	0.088	0.108	0.139	0.034	0.000	0.026	0.295	0.298	0.024	0.009	0.002	0.026	0.001	0.298
		Max	0.411	0.527	0.621	0.118	0.000	0.094	1.522	1.547	0.094	0.025	0.006	0.094	0.003	1.547
		Min	0.099	0.105	0.136	0.000	0.000	0.000	0.340	0.340	0.000	0.000	0.000	0.000	0.000	0.340
		Median	0.201	0.247	0.376	0.027	0.000	0.000	0.928	0.928	0.000	0.000	0.000	0.000	0.000	0.928
8	42	Mean	0.185	0.331	0.501	0.040	0.000	0.001	1.058	1.059	0.003	0.003	0.001	0.006	0.005	1.064
		StdDev	0.062	0.113	0.197	0.046	0.000	0.007	0.360	0.362	0.009	0.010	0.002	0.014	0.013	0.364
		Max	0.341	0.664	1.022	0.178	0.000	0.047	1.962	1.962	0.036	0.057	0.012	0.057	0.057	1.968
		Min	0.000	0.147	0.226	0.000	0.000	0.000	0.441	0.441	0.000	0.000	0.000	0.000	0.000	0.441
		Median	0.189	0.315	0.450	0.026	0.000	0.000	1.003	1.003	0.000	0.000	0.000	0.000	0.000	1.011
9	23	Mean	0.150	0.349	0.561	0.054	0.006	0.008	1.119	1.122	0.007	0.001	0.000	0.003	0.000	1.122
		StdDev	0.074	0.081	0.233	0.048	0.025	0.026	0.370	0.369	0.026	0.004	0.000	0.008	0.000	0.369
		Max	0.287	0.539	1.165	0.153	0.120	0.120	2.071	2.071	0.120	0.016	0.000	0.036	0.000	2.071
		Min	0.000	0.229	0.262	0.000	0.000	0.000	0.516	0.516	0.000	0.000	0.000	0.000	0.000	0.516
		Median	0.141	0.333	0.495	0.045	0.000	0.000	1.044	1.079	0.000	0.000	0.000	0.000	0.000	1.079
10	49	Mean	0.165	0.345	0.501	0.048	0.000	0.028	1.060	1.088	0.019	0.010	0.000	0.029	0.000	1.088
		StdDev	0.085	0.116	0.423	0.125	0.000	0.134	0.620	0.740	0.082	0.059	0.002	0.134	0.001	0.741
		Max	0.452	0.702	2.637	0.729	0.000	0.886	4.252	5.138	0.477	0.409	0.008	0.886	0.005	5.138
		Min	0.018	0.174	0.156	0.000	0.000	0.000	0.474	0.474	0.000	0.000	0.000	0.000	0.000	0.474
		Median	0.163	0.335	0.405	0.000	0.000	0.000	0.932	0.932	0.000	0.000	0.000	0.000	0.000	0.932
11	20	Mean	0.187	0.266	0.353	0.024	0.000	0.000	0.831	0.831	0.000	0.000	0.000	0.000	0.000	0.832
		StdDev	0.083	0.096	0.157	0.036	0.000	0.000	0.316	0.316	0.001	0.000	0.000	0.001	0.001	0.316
		Max	0.340	0.473	0.731	0.122	0.000	0.000	1.428	1.428	0.004	0.000	0.000	0.004	0.004	1.428
		Min	0.047	0.073	0.121	0.000	0.000	0.000	0.273	0.273	0.000	0.000	0.000	0.000	0.000	0.273
		Median	0.192	0.279	0.309	0.004	0.000	0.000	0.816	0.816	0.000	0.000	0.000	0.000	0.000	0.816
12	30	Mean	0.225	0.346	0.454	0.043	0.000	0.005	1.068	1.073	0.005	0.001	0.000	0.006	0.001	1.074
		StdDev	0.109	0.111	0.179	0.059	0.001	0.019	0.353	0.360	0.016	0.004	0.001	0.019	0.003	0.360
		Max	0.535	0.650	0.930	0.180	0.004	0.085	1.725	1.767	0.063	0.024	0.003	0.085	0.018	1.767
		Min	0.046	0.142	0.186	0.000	0.000	0.000	0.499	0.499	0.000	0.000	0.000	0.000	0.000	0.499
		Median	0.197	0.346	0.413	0.010	0.000	0.000	1.016	1.016	0.000	0.000	0.000	0.000	0.000	1.016
13	28	Mean	0.095	0.405	0.622	0.062	0.002	0.017	1.187	1.202	0.018	0.001	0.000	0.017	0.002	1.204
		StdDev	0.090	0.214	0.406	0.088	0.009	0.055	0.683	0.726	0.064	0.003	0.000	0.056	0.011	0.733
		Max	0.371	1.252	2.126	0.363	0.050	0.248	3.445	3.643	0.304	0.012	0.000	0.254	0.056	3.699
		Min	0.000	0.214	0.214	0.000	0.000	0.000	0.477	0.477	0.000	0.000	0.000	0.000	0.000	0.477
		Median	0.094	0.348	0.465	0.031	0.000	0.000	0.969	0.969	0.000	0.000	0.000	0.000	0.000	0.969
16	34	Mean	0.129	0.367	0.487	0.054	0.000	0.000	1.037	1.037	0.001	0.006	0.000	0.008	0.008	1.045
		StdDev	0.078	0.127	0.179	0.050	0.000	0.000	0.330	0.330	0.006	0.016	0.000	0.020	0.020	0.333
		Max	0.299	0.744	0.948	0.185	0.000	0.000	2.096	2.096	0.032	0.059	0.003	0.091	0.091	2.114
		Min	0.000	0.178	0.231	0.000	0.000	0.000	0.551	0.551	0.000	0.000	0.000	0.000	0.000	0.551
		Median	0.117	0.365	0.450	0.040	0.000	0.000	1.011	1.011	0.000	0.000	0.000	0.000	0.000	1.011
18	0	Mean														
		StdDev														
		Max														
		Min														
		Median														
19	11	Mean	0.112	0.288	0.468	0.041	0.000	0.000	0.909	0.909	0.011	0.000	0.000	0.011	0.011	0.920
		StdDev	0.072	0.089	0.091	0.024	0.000	0.000	0.215	0.215	0.021	0.000	0.000	0.021	0.021	0.221
		Max	0.230	0.461	0.634	0.083	0.000	0.000	1.148	1.148	0.054	0.000	0.000	0.054	0.054	1.156
		Min	0.003	0.108	0.346	0.009	0.000	0.000	0.481	0.481	0.000	0.000	0.000	0.000	0.000	0.481
		Median	0.107	0.281	0.478	0.029	0.000	0.000	0.897	0.897	0.000	0.000	0.000	0.000	0.000	0.897
20	0	Mean														
		StdDev														
		Max														
		Min														
		Median														
All	257	Mean	0.165	0.343	0.492	0.046	0.001	0.010	1.047	1.056	0.008	0.004	0.000	0.012	0.003	1.058
		StdDev	0.091	0.130	0.279	0.073	0.008	0.063	0.453	0.494	0.044	0.027	0.001	0.063	0.011	0.495
		Max	0.535	1.252	2.637	0.729	0.120	0.886	4.252	5.138	0.477	0.409	0.012	0.886	0.091	5.138
		Min	0.000	0.073	0.121	0.000	0.000	0.000	0.273	0.273	0.000	0.000	0.000	0.000	0.000	0.273
		Median	0.164	0.326	0.442	0.027	0.000	0.000	0.964	0.964	0.000	0.000	0.000	0.000	0.000	0.964

* Excludes replicates

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

Analyzer			IMPROVE_A Parameter (units are µg C/cm^2)													
No.	No.*	Statistic*	O1TC	O2TC	O3TC	O4TC	OPTRC	OPTTC	OCTRC	OCTTC	E1TC	E2TC	E3TC	ECTRC	ECTTC	TCTC
6	10	Mean	0.007	0.091	0.159	0.002	0.000	0.000	0.260	0.260	0.000	0.000	0.000	0.000	0.000	0.260
		StdDev	0.014	0.053	0.089	0.005	0.000	0.000	0.137	0.137	0.000	0.000	0.000	0.000	0.000	0.137
		Max	0.045	0.168	0.349	0.015	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	0.057	0.000	0.000	0.000	0.057	0.057	0.000	0.000	0.000	0.000	0.000	0.057
		Median	0.002	0.105	0.168	0.000	0.000	0.000	0.244	0.244	0.000	0.000	0.000	0.000	0.000	0.244
7	11	Mean	0.002	0.046	0.196	0.010	0.000	0.008	0.254	0.261	0.003	0.004	0.001	0.009	0.001	0.262
		StdDev	0.003	0.045	0.123	0.028	0.000	0.025	0.108	0.112	0.011	0.014	0.004	0.028	0.003	0.113
		Max	0.011	0.136	0.528	0.092	0.000	0.084	0.528	0.528	0.035	0.046	0.014	0.095	0.011	0.528
		Min	0.000	0.000	0.105	0.000	0.000	0.000	0.105	0.105	0.000	0.000	0.000	0.000	0.000	0.105
		Median	0.000	0.049	0.166	0.000	0.000	0.000	0.249	0.249	0.000	0.000	0.000	0.000	0.000	0.250
8	27	Mean	0.038	0.078	0.220	0.009	0.000	0.000	0.345	0.345	0.001	0.002	0.001	0.004	0.004	0.350
		StdDev	0.067	0.069	0.147	0.020	0.000	0.000	0.271	0.271	0.004	0.006	0.003	0.010	0.010	0.274
		Max	0.218	0.263	0.574	0.064	0.000	0.000	1.031	1.031	0.016	0.025	0.016	0.041	0.041	1.031
		Min	0.000	0.000	0.031	0.000	0.000	0.000	0.031	0.031	0.000	0.000	0.000	0.000	0.000	0.031
		Median	0.000	0.055	0.172	0.000	0.000	0.000	0.257	0.257	0.000	0.000	0.000	0.000	0.000	0.257
9	21	Mean	0.011	0.091	0.281	0.014	0.002	0.002	0.399	0.399	0.002	0.003	0.000	0.003	0.003	0.402
		StdDev	0.032	0.061	0.168	0.024	0.009	0.009	0.240	0.240	0.009	0.009	0.000	0.009	0.009	0.244
		Max	0.132	0.258	0.626	0.075	0.041	0.041	0.937	0.937	0.041	0.032	0.000	0.032	0.032	0.937
		Min	0.000	0.016	0.009	0.000	0.000	0.000	0.057	0.057	0.000	0.000	0.000	0.000	0.000	0.057
		Median	0.000	0.066	0.276	0.000	0.000	0.000	0.402	0.402	0.000	0.000	0.000	0.000	0.000	0.402
10	18	Mean	0.025	0.086	0.150	0.002	0.000	0.000	0.264	0.265	0.000	0.000	0.000	0.000	0.000	0.265
		StdDev	0.055	0.055	0.106	0.008	0.000	0.001	0.161	0.161	0.000	0.001	0.000	0.001	0.000	0.161
		Max	0.205	0.249	0.390	0.032	0.000	0.005	0.586	0.586	0.000	0.005	0.000	0.005	0.000	0.586
		Min	0.000	0.021	0.000	0.000	0.000	0.000	0.030	0.030	0.000	0.000	0.000	0.000	0.000	0.030
		Median	0.002	0.076	0.128	0.000	0.000	0.000	0.226	0.226	0.000	0.000	0.000	0.000	0.000	0.226
11	12	Mean	0.040	0.030	0.146	0.000	0.000	0.000	0.216	0.216	0.000	0.000	0.000	0.000	0.000	0.216
		StdDev	0.066	0.047	0.110	0.000	0.000	0.000	0.159	0.159	0.000	0.000	0.000	0.000	0.000	0.159
		Max	0.203	0.141	0.341	0.000	0.000	0.000	0.530	0.530	0.000	0.000	0.000	0.000	0.000	0.530
		Min	0.000	0.000	0.040	0.000	0.000	0.000	0.040	0.040	0.000	0.000	0.000	0.000	0.000	0.040
		Median	0.000	0.002	0.097	0.000	0.000	0.000	0.166	0.166	0.000	0.000	0.000	0.000	0.000	0.166
12	16	Mean	0.037	0.103	0.266	0.018	0.000	0.003	0.424	0.426	0.004	0.005	0.001	0.010	0.007	0.433
		StdDev	0.056	0.073	0.148	0.033	0.000	0.010	0.260	0.260	0.011	0.017	0.002	0.019	0.017	0.263
		Max	0.154	0.270	0.523	0.091	0.000	0.039	1.028	1.028	0.039	0.068	0.008	0.068	0.068	1.051
		Min	0.000	0.000	0.059	0.000	0.000	0.000	0.087	0.087	0.000	0.000	0.000	0.000	0.000	0.087
		Median	0.003	0.094	0.259	0.000	0.000	0.000	0.369	0.388	0.000	0.000	0.000	0.000	0.000	0.406
13	23	Mean	0.013	0.056	0.129	0.002	0.000	0.000	0.199	0.199	0.000	0.000	0.000	0.000	0.000	0.199
		StdDev	0.035	0.052	0.117	0.010	0.000	0.002	0.175	0.175	0.002	0.000	0.000	0.002	0.000	0.175
		Max	0.155	0.250	0.464	0.046	0.000	0.008	0.796	0.796	0.008	0.000	0.000	0.008	0.000	0.796
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.022	0.022	0.000	0.000	0.000	0.000	0.000	0.022
		Median	0.000	0.048	0.086	0.000	0.000	0.000	0.149	0.149	0.000	0.000	0.000	0.000	0.000	0.149
16	24	Mean	0.029	0.071	0.178	0.003	0.000	0.001	0.281	0.281	0.000	0.002	0.000	0.002	0.001	0.282
		StdDev	0.053	0.056	0.104	0.010	0.000	0.002	0.170	0.171	0.000	0.005	0.001	0.005	0.005	0.172
		Max	0.167	0.218	0.453	0.047	0.000	0.010	0.675	0.675	0.000	0.025	0.006	0.025	0.025	0.675
		Min	0.000	0.000	0.082	0.000	0.000	0.000	0.092	0.092	0.000	0.000	0.000	0.000	0.000	0.092
		Median	0.000	0.069	0.133	0.000	0.000	0.000	0.211	0.211	0.000	0.000	0.000	0.000	0.000	0.211
18	4	Mean	0.000	0.036	0.315	0.014	0.000	0.000	0.366	0.366	0.000	0.023	0.000	0.023	0.023	0.389
		StdDev	0.000	0.035	0.253	0.028	0.000	0.000	0.313	0.313	0.000	0.047	0.000	0.047	0.047	0.358
		Max	0.000	0.080	0.681	0.057	0.000	0.000	0.817	0.817	0.000	0.094	0.000	0.094	0.094	0.911
		Min	0.000	0.000	0.130	0.000	0.000	0.000	0.147	0.147	0.000	0.000	0.000	0.000	0.000	0.147
		Median	0.000	0.033	0.224	0.000	0.000	0.000	0.249	0.249	0.000	0.000	0.000	0.000	0.000	0.249
19	6	Mean	0.034	0.043	0.266	0.018	0.000	0.000	0.361	0.361	0.011	0.000	0.000	0.011	0.011	0.372
		StdDev	0.084	0.055	0.204	0.045	0.000	0.000	0.267	0.267	0.028	0.000	0.000	0.028	0.028	0.287
		Max	0.205	0.149	0.592	0.109	0.000	0.000	0.735	0.735	0.068	0.000	0.000	0.068	0.068	0.803
		Min	0.000	0.000	0.053	0.000	0.000	0.000	0.056	0.056	0.000	0.000	0.000	0.000	0.000	0.056
		Median	0.000	0.034	0.228	0.000	0.000	0.000	0.342	0.342	0.000	0.000	0.000	0.000	0.000	0.342
20	0	Mean														
		StdDev														
		Max														
		Min														
		Median														
All	172	Mean	0.024	0.072	0.200	0.007	0.000	0.001	0.303	0.304	0.002	0.002	0.000	0.004	0.003	0.307
		StdDev	0.051	0.061	0.143	0.020	0.003	0.008	0.216	0.216	0.008	0.010	0.002	0.014	0.012	0.221
		Max	0.218	0.270	0.681	0.109	0.041	0.084	1.031	1.031	0.068	0.094	0.016	0.095	0.094	1.051
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.022	0.022	0.000	0.000	0.000	0.000	0.000	0.022
		Median	0.000	0.064	0.155	0.000	0.000	0.000	0.249	0.249	0.000	0.000	0.000	0.000	0.000	0.250

* Excludes replicates

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

Type of Blank	No.*	Statistic*	IMPROVE_A Parameter (units are µg C/cm^2)													
			O1TC	O2TC	O3TC	O4TC	OPTRC	OPTTC	OCTRC	OCTTC	E1TC	E2TC	E3TC	ECTRC	ECTTC	TCTC
SHAL	172	Mean	0.024	0.072	0.200	0.007	0.000	0.001	0.303	0.304	0.002	0.002	0.000	0.004	0.003	0.307
		StdDev	0.051	0.061	0.143	0.020	0.003	0.008	0.216	0.216	0.008	0.010	0.002	0.014	0.012	0.221
		Max	0.218	0.270	0.681	0.109	0.041	0.084	1.031	1.031	0.068	0.094	0.016	0.095	0.094	1.051
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.022	0.022	0.000	0.000	0.000	0.000	0.000	0.022
		Median	0.000	0.064	0.155	0.000	0.000	0.000	0.249	0.249	0.000	0.000	0.000	0.000	0.000	0.250
		MDL	0.152	0.182	0.428	0.061	0.009	0.023	0.649	0.649	0.023	0.031	0.005	0.041	0.035	0.663
Trip	257	Mean	0.165	0.343	0.492	0.046	0.001	0.010	1.047	1.056	0.008	0.004	0.000	0.012	0.003	1.058
		StdDev	0.091	0.130	0.279	0.073	0.008	0.063	0.453	0.494	0.044	0.027	0.001	0.063	0.011	0.495
		Max	0.535	1.252	2.637	0.729	0.120	0.886	4.252	5.138	0.477	0.409	0.012	0.886	0.091	5.138
		Min	0.000	0.073	0.121	0.000	0.000	0.000	0.273	0.273	0.000	0.000	0.000	0.000	0.000	0.273
		Median	0.164	0.326	0.442	0.027	0.000	0.000	0.964	0.964	0.000	0.000	0.000	0.000	0.000	0.964
		LQL	0.273	0.390	0.837	0.219	0.024	0.188	1.358	1.481	0.131	0.080	0.004	0.189	0.032	1.485
24-Hour Field	1479	Mean	0.111	0.415	0.630	0.082	0.004	0.023	1.241	1.260	0.022	0.008	0.000	0.027	0.008	1.268
		StdDev	0.116	0.219	0.555	0.165	0.037	0.108	0.874	0.939	0.100	0.027	0.004	0.105	0.033	0.949
		Max	1.614	3.146	9.480	2.581	1.008	2.894	13.046	15.940	2.471	0.429	0.087	2.900	0.484	15.946
		Min	0.000	0.021	0.107	0.000	0.000	0.000	0.246	0.246	0.000	0.000	0.000	0.000	0.000	0.246
		Median	0.094	0.381	0.507	0.039	0.000	0.000	1.046	1.049	0.000	0.000	0.000	0.000	0.000	1.052
		LQL	0.349	0.658	1.665	0.495	0.110	0.324	2.622	2.818	0.300	0.082	0.012	0.315	0.099	2.848
Backup	1475	Mean	0.305	0.982	1.209	0.340	0.014	0.088	2.849	2.924	0.064	0.039	0.001	0.090	0.016	2.940
		StdDev	0.339	0.476	0.609	0.266	0.066	0.167	1.333	1.426	0.134	0.061	0.011	0.160	0.046	1.437
		Max	3.644	5.943	5.427	3.752	1.057	3.341	10.945	11.914	2.637	0.767	0.285	3.341	0.595	11.914
		Min	0.000	0.038	0.090	0.000	0.000	0.000	0.130	0.130	0.000	0.000	0.000	0.000	0.000	0.130
		Median	0.226	0.912	1.096	0.285	0.000	0.024	2.634	2.684	0.008	0.009	0.000	0.036	0.000	2.701
		LQL	1.017	1.427	1.827	0.799	0.199	0.502	3.999	4.278	0.401	0.184	0.034	0.480	0.137	4.312

* Excludes replicates

Table 3-20. DRI Multi-Point Calibration Statistics

Analyzer No.	Date	Slope	Scatter	Correlation	Comment
6	12/21/11	21.21	0.18	0.9943	
	04/27/12	20.83	0.26	0.9949	
	05/24/12	20.03	0.37	0.9723	Reperformed due to failure in test.
	05/31/12	20.68	0.28	0.9844	
	06/21/12	19.93	0.11	0.9974	
	11/26/12	21.56	0.33	0.9823	Reperformed due to failure in test.
	12/06/12	21.44	0.20	0.9936	
7	11/17/11	22.20	0.24	0.9903	
	01/04/12	21.55	0.20	0.9936	
	04/25/12	21.05	0.29	0.9878	
	06/24/12	21.30	0.27	0.9885	
	10/11/12	20.51	0.27	0.9858	
8	08/27/11	21.22	0.33	0.9807	
	03/05/12	21.94	0.35	0.9904	
	05/15/12	21.26	0.25	0.9887	
	12/07/12	20.48	0.32	0.9870	
9	12/21/11	19.85	0.28	0.9844	
	04/17/12	21.04	0.24	0.9808	
	05/17/12	22.61	0.17	0.9951	
	06/03/12	22.22	0.14	0.9969	
	06/14/12	21.79	0.20	0.9930	
	12/20/12	21.51	0.28	0.9859	
10	08/16/11	21.48	0.16	0.9955	
	02/17/12	21.79	0.33	0.9889	
	08/16/12	20.60	0.27	0.9854	
11	12/20/11	20.43	0.23	0.9895	
	04/04/12	20.94	0.27	0.9916	
	09/26/12	21.24	0.34	0.9823	
12	09/20/11	21.44	0.28	0.9867	
	01/06/12	22.15	0.20	0.9935	
	02/17/12	23.06	0.27	0.9919	
	02/22/12	22.84	0.29	0.9902	Reperformed due to failure in test.
	08/16/12	20.76	0.27	0.9863	
13	11/17/11	21.61	0.26	0.9888	
	05/24/12	20.64	0.26	0.9875	
	11/19/12	20.82	0.28	0.9846	
16	12/23/11	22.21	0.17	0.9950	
	06/13/12	21.49	0.34	0.9811	
	12/15/12	21.21	0.28	0.9858	
18	11/01/12	21.77	0.25	0.9895	In experimental use only from March 2011 thru October 2012. Returned to regular service 11/01/12.
	11/09/12	20.14	0.33	0.9783	
19	11/17/11	20.79	0.24	0.9893	
	03/30/12	20.30	0.25	0.9832	
	05/07/12	22.09	0.17	0.9971	Reperformed due to failure in test.
	05/10/12	20.00	0.25	0.9876	
	07/09/12	21.63	0.35	0.9870	Reassigned to experimental use only 07/16/12.
20	10/24/12	20.75	0.25	0.9885	New to regular service 10/24/12.
	11/07/12	20.37	0.28	0.9844	
	01/27/13	19.89	0.22	0.9898	

Table 3-21 provides summary statistics for the multi-point temperature calibrations of each carbon analyzer. The temperature calibrations are performed every six months or after a major instrument repair. Criteria for an acceptable calibration are given in **Table 3-11**.

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

			Analyzer No.											
Cal No.	**Param.**	**Units**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**16**	**18***	**19****	**20*****
1	Slope		1.030	1.060	1.048	1.016	1.110	1.023	1.031	1.080	1.017	1.000	1.027	1.035
	Intercept	° C	4.203	-1.959	-1.351	-2.392	-4.816	13.989	-0.056	1.912	19.250	4.158	12.350	5.119
	r^2		0.9970	0.9981	0.9988	0.9992	0.9976	0.9980	0.9989	0.9956	-0.9988	0.9995	0.9972	0.9990
	Date		Dec-11	Nov-11	Aug-11	Dec-11	Aug-11	Oct-11	Aug-11	Nov-11	Dec-11	Apr-11	Nov-11	Oct-12
2	Slope		1.023	1.009	1.014	1.009	1.036	1.035	1.005	1.014	1.006	1.007	1.022	1.027
	Intercept	° C	5.033	4.866	7.850	2.885	10.267	-0.093	10.168	6.032	4.357	8.915	5.255	2.341
	r^2		0.9993	0.9995	0.9993	0.9992	0.9984	0.9980	0.9991	0.9994	0.9991	0.9994	0.9994	0.9992
	Date		May-12	Apr-12	Mar-12	Jun-12	Feb-12	Apr-12	Feb-12	May-12	Jun-12	Nov-12	May-12	Jan-13
3	Slope		1.016	1.013	1.011	1.025	1.030	1.022	1.028	1.012	1.014			
	Intercept	° C	8.300	2.574	10.275	-1.487	7.299	2.734	-2.798	9.721	11.295			
	r^2		0.9991	0.9994	0.9985	0.9993	0.9996	0.9995	0.9992	0.9992	0.9993			
	Date		Nov-12	Oct-12	May-12	Dec-12	Aug-12	Sep-12	Aug-12	Nov-12	Dec-12			
4	Slope				1.018									
	Intercept	° C			5.777									
	r^2				0.9995									
	Date				Dec-12									

* Analyzer 18 takenout of regular service during period March 2011 thru October 2012 and returned to regular service 11/01/12.

** Analyzer #19 taken out of regular service 04/18/12 and put into experimental use 07/16/12.

*** Analyzer #20 started regular service 10/24/12.

Table 3-22 provides a summary of the oxygen leak tests that are performed every six months or after major instrument repairs. The results are considered acceptable if the O_2 concentration is < 100 ppm. The O_2 contents were well below 100 ppm, in the range of 1-50 ppm. The scheduled February 2013 tests were completed in time for this report.

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. Counts that fall below 20,000 or above 32,000 result in instrument maintenance. Details of instrument maintenance performed during the reporting period as a result of the autocalibration check are included in **Table 3-23**.

Table 3-22. DRI Oxygen Test Statistics

Analyzer No.	Date Temp	(°C)	August 2011 140	August 2011 580	February 2012 140	February 2012 580	August 2012 140	August 2012 580	February 2013 140	February 2013 580
6	Mean O_2	(ppm)	10.5	12.0	40.1	45.0	27.2	20.6	3.1	3.1
	Std Dev	(ppm)	0.1	0.2	2.8	5.0	2.2	2.0	3.1	3.1
7	Mean O_2	(ppm)	49.7	25.6	21.5	11.1	45.0	15.0	12.1	7.3
	Std Dev	(ppm)	3.9	0.6	3.2	0.9	7.7	3.0	3.3	3.2
8	Mean O_2	(ppm)	7.1	1.1	9.7	19.9	5.6	33.6	14.3	14.7
	Std Dev	(ppm)	0.5	0.1	11.5	5.4	4.2	4.4	3.2	3.2
9	Mean O_2	(ppm)	4.3	4.9	13.0	10.0	33.6	33.5	2.1	1.9
	Std Dev	(ppm)	0.4	0.3	1.6	0.9	20.8	2.5	3.1	3.1
10	Mean O_2	(ppm)	5.5	10.3	19.7	11.7	24.2	23.3	3.1	3.1
	Std Dev	(ppm)	0.4	0.2	3.4	1.4	2.6	4.5	3.1	3.1
11	Mean O_2	(ppm)	14.5	11.5	17.8	10.3	47.5	27.5	7.8	5.3
	Std Dev	(ppm)	1.4	1.1	6.7	1.0	8.4	1.8	3.2	3.2
12	Mean O_2	(ppm)	12.4	2.3	16.4	13.6	50.4	30.4	43.3	44.6
	Std Dev	(ppm)	0.8	0.2	2.0	1.7	13.7	3.6	3.3	3.2
13	Mean O_2	(ppm)	29.2	37.7	46.8	30.3	8.5	27.1	3.1	3.1
	Std Dev	(ppm)	2.4	3.7	5.1	5.9	5.3	3.5	3.1	3.1
16	Mean O_2	(ppm)	4.0	2.8	4.7	16.2	35.4	16.1	3.1	3.1
	Std Dev	(ppm)	0.3	0.3	1.5	4.0	5.3	1.5	3.1	3.1
18	Mean O_2	(ppm)	6.3	7.7	7.6	8.3	Not in Service		3.1	3.1
	Std Dev	(ppm)	0.2	0.2	2.2	1.5	Mar '11 - Oct '12		3.1	3.1
19	Mean O_2	(ppm)	2.3	3.4	38.7	11.5	1.5	13.6	22.3	14.3
	Std Dev	(ppm)	0.2	0.3	10.8	6.0	3.3	4.8	3.2	3.2
20*	Mean O_2	(ppm)					Not in Service		3.1	3.1
	Std Dev	(ppm)					Until 10/24/12		3.1	3.1

* New - not in service until 10/24/12.

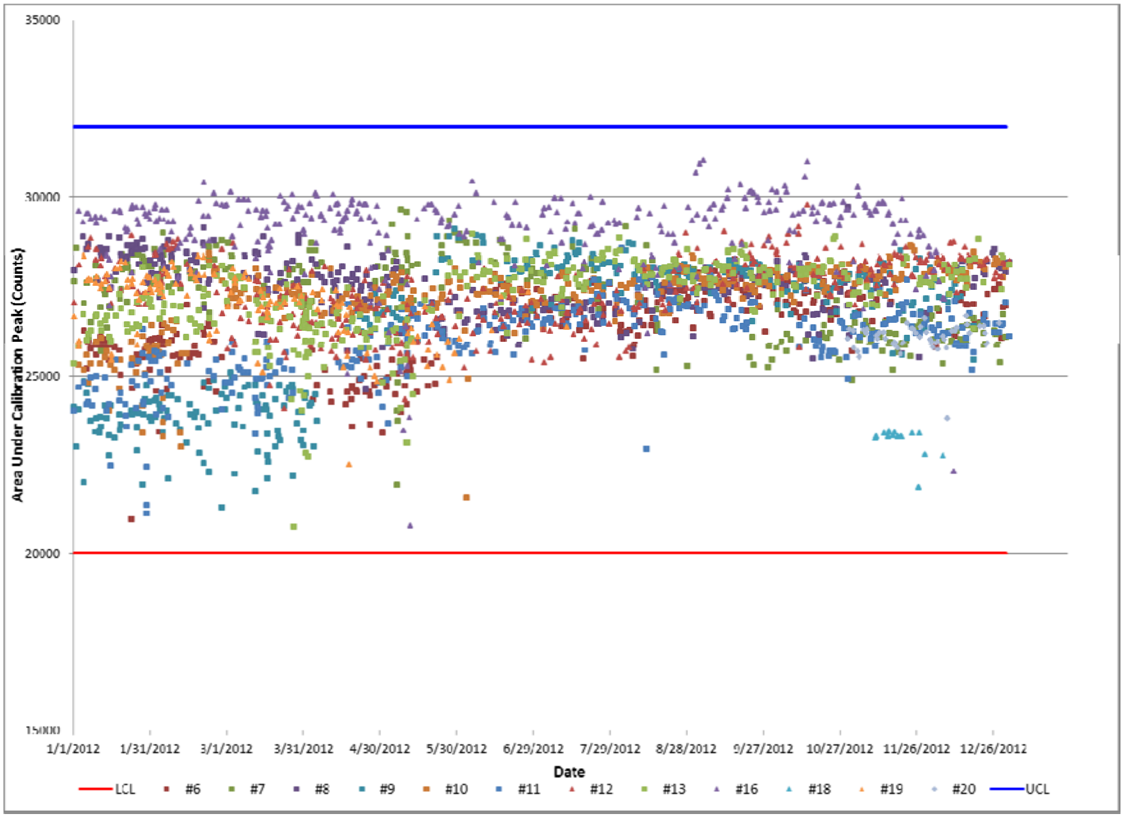

Figure 3-1. DRI Carbon Analyzer Daily AutoCalibration (cmdAutoCalibCheck) Response for Batches 139 thru 163 (01/01/12 – 12/31/12)

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

Analyzer No.	Date	Resolution
6	04/06/12 04/11/12 08/03/12 08/09/12 09/08/12	Drop in cal peak – repaired Carle valve High then very low cal peak – replaced Carle valve Cal peak low – replaced reducing ferrule Cal peak low – balanced flows Cal peak low – repaired leak
7	06/22/12	Cal peak low – adjusted flows
8	03/14/12 08/02/12 08/27/12	Cal peak high – repaired Carle valve Cal peak low – replaced leaking reducing ferrule Cal peak high – restarted software
9	04/05/12 11/16/12	Cal peak low – replaced methanator, cleaned FID collector and flame jet, replaced needle flame tip Cal peak low – tightened reducing ferrule to reduce leak
10	06/03/12	Cal peak low – repaired leak at oxygenator outlet
11	01/11/12 01/24/12 01/29/12	Cal peak low – repaired leak Cal peak low – repaired leak Cal peak low – repaired leak

Analyzer No.	Date	Resolution
	04/30/12 08/01/12 10/06/12	Cal peak low – replaced reducing ferrule and repaired leak Cal peak high – removed helium gas saver controller to resolve backvalve control issue Cal peak flows high – balanced flows
12	08/24/12	Cal peak flows high – balanced flows
13	03/26/12 10/30/12	Cal peak fluctuating – repaired Carle valve Cal peak low – replaced solenoid seal
16	04/11/12 05/10/12 08/02/12 08/24/12 09/04/12 12/06/12	Cal peak low – repaired leak Cal peak low – tested fittings around FID, repaired leak Cal peak low – replaced O-ring Cal peak low – adjusted sample boat position Cal peak dropped – adjusted sample boat position by adjusting piston Cal peak low – repaired Carle valve position
18	---	
19	01/03/12 01/26/12 03/13/12	Cal peak low – replaced reducing ferrule and repaired leak Cal peak low – aligned push rod Cal peak low – repaired Carle valve coupling
20	---	

3.3.3.3 Replicate and Duplicate Analyses

Replicate analysis results are from two or more punches from the same sample run on different analyzers. Duplicate analysis results are from two punches from the same sample run on the same analyzer. **Table 3-24** gives the criteria and summary statistics for replicate and duplicate IMPROVE_A carbon analyses run on all analyzers for the CSN filter samples during the reporting period. A replicate or duplicate analysis was selected randomly from every group of 10 samples. A total of 2,197 replicate or duplicate analyses were analyzed during the reporting period. Of the 2,197 replicates or duplicates, 15 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 2,182 remaining, 92 were duplicate analyses and 2,090 were replicate analyses.

Table 3-24. 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	2090				92				
TC, OC, & EC < 10 µg C/cm^2	TC, OC < ±1.0 µg C/cm^2	Count		380	513	1680		10	17	77	
	EC < ±2.0 µg C/cm^2	No. Fail		1	18	18		1	1	0	
		%Fail		0.3	3.5	1.1		10.0	5.9	0.0	%
		Mean		0.266	0.313	0.355		0.250	0.320	0.265	µg C/cm^2
		StdDev		0.232	0.295	0.398		0.336	0.332	0.274	µg C/cm^2
		Max		1.028	1.823	3.026		1.172	1.141	1.226	µg C/cm^2
		Min		0.000	0.000	0.000		0.043	0.018	0.000	µg C/cm^2
		Median		0.193	0.203	0.230		0.131	0.222	0.170	µg C/cm^2
TC, OC, & EC ≥ 10 µg C/cm^2	TC, OC %RPD < 10%	Count		1710	1577	410		82	75	15	
	EC %RPD < 20%	No. Fail		0	3	0		0	0	0	
		%Fail		0.0	0.2	0.0		0.0	0.0	0.0	%
		Mean		2.10	2.50	3.76		1.74	1.79	2.62	%RPD
		StdDev		1.47	1.85	2.76		1.27	1.39	1.87	%RPD
		Max		8.15	13.53	16.46		5.86	6.86	6.01	%RPD
		Min		0.00	0.00	0.03		0.03	0.05	0.40	%RPD
		Median		1.85	2.17	0.88		1.54	1.40	2.06	%RPD

3.3.4 Assessment of Duplicate and Replicate Analyses

Duplicate and replicate analysis results for TC, OC, and EC agree well, with higher 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 new 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 3-25 gives estimated MDLs for IMPROVE_A parameters for batches 139 through 163 (~2012). The MDLs in **Table 3-25** are determined as three times the standard deviation of DRI system and lab blanks and RTI SHAL blanks, although only the DRI lab blanks are also used to determine Carbon Laboratory MDLs. The DRI system and lab blanks are used to assess instrument performance as used in multiple projects.

Table 3-25. Estimated MDLs and LQLs for IMPROVE_A Parameters for 2012

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	81	Mean	0.000	0.005	0.014	0.001	0.000	0.000	0.020	0.020	0.000	0.001	0.002	0.002	0.002	0.023
		StdDev	0.001	0.016	0.026	0.006	0.000	0.000	0.039	0.039	0.001	0.003	0.009	0.009	0.009	0.043
		Max	0.005	0.087	0.157	0.048	0.004	0.000	0.158	0.158	0.010	0.023	0.067	0.067	0.067	0.203
		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	0.004
		MDL	0.003	0.048	0.078	0.018	0.001	0.000	0.116	0.116	0.004	0.008	0.026	0.027	0.027	0.130
Lab	2277	Mean	0.003	0.01	0.021	0.004	0.00041	0.0026	0.039	0.041	0.001	0.002	0.003	0.005	0.003	0.044
		StdDev	0.027	0.039	0.067	0.023	0.00611	0.0203	0.136	0.144	0.008	0.012	0.017	0.030	0.022	0.151
		Max	0.497	0.451	0.808	0.295	0.17758	0.4721	1.419	1.689	0.148	0.184	0.339	0.472	0.401	1.696
		Min	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	-0.003	0.000
		Median	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		MDL	0.08	0.118	0.202	0.068	0.01832	0.0609	0.409	0.431	0.024	0.035	0.052	0.089	0.065	0.452
SHAL	172	Mean	0.024	0.072	0.200	0.007	0.000	0.001	0.303	0.304	0.002	0.002	0.000	0.004	0.003	0.307
		StdDev	0.051	0.061	0.143	0.020	0.003	0.008	0.216	0.216	0.008	0.010	0.002	0.014	0.012	0.221
		Max	0.218	0.270	0.681	0.109	0.041	0.084	1.031	1.031	0.068	0.094	0.016	0.095	0.094	1.051
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.022	0.022	0.000	0.000	0.000	0.000	0.000	0.022
		Median	0.000	0.064	0.155	0.000	0.000	0.000	0.249	0.249	0.000	0.000	0.000	0.000	0.000	0.250
		MDL	0.152	0.182	0.428	0.061	0.009	0.023	0.649	0.649	0.023	0.031	0.005	0.041	0.035	0.663
Trip	257	Mean	0.165	0.343	0.492	0.046	0.001	0.010	1.047	1.056	0.008	0.004	0.000	0.012	0.003	1.058
		StdDev	0.091	0.130	0.279	0.073	0.008	0.063	0.453	0.494	0.044	0.027	0.001	0.063	0.011	0.495
		Max	0.535	1.252	2.637	0.729	0.120	0.886	4.252	5.138	0.477	0.409	0.012	0.886	0.091	5.138
		Min	0.000	0.073	0.121	0.000	0.000	0.000	0.273	0.273	0.000	0.000	0.000	0.000	0.000	0.273
		Median	0.164	0.326	0.442	0.027	0.000	0.000	0.964	0.964	0.000	0.000	0.000	0.000	0.000	0.964
		LQL	0.273	0.390	0.837	0.219	0.024	0.188	1.358	1.481	0.131	0.080	0.004	0.189	0.032	1.485
24-Hour Field	1479	Mean	0.111	0.415	0.630	0.082	0.004	0.023	1.241	1.260	0.022	0.008	0.000	0.027	0.008	1.268
		StdDev	0.116	0.219	0.555	0.165	0.037	0.108	0.874	0.939	0.100	0.027	0.004	0.105	0.033	0.949
		Max	1.614	3.146	9.480	2.581	1.008	2.894	13.046	15.940	2.471	0.429	0.087	2.900	0.484	15.946
		Min	0.000	0.021	0.107	0.000	0.000	0.000	0.246	0.246	0.000	0.000	0.000	0.000	0.000	0.246
		Median	0.094	0.381	0.507	0.039	0.000	0.000	1.046	1.049	0.000	0.000	0.000	0.000	0.000	1.052
		LQL	0.349	0.658	1.665	0.495	0.110	0.324	2.622	2.818	0.300	0.082	0.012	0.315	0.099	2.848
Backup	1475	Mean	0.305	0.982	1.209	0.340	0.014	0.088	2.849	2.924	0.064	0.039	0.001	0.090	0.016	2.940
		StdDev	0.339	0.476	0.609	0.266	0.066	0.167	1.333	1.426	0.134	0.061	0.011	0.160	0.046	1.437
		Max	3.644	5.943	5.427	3.752	1.057	3.341	10.945	11.914	2.637	0.767	0.285	3.341	0.595	11.914
		Min	0.000	0.038	0.090	0.000	0.000	0.000	0.130	0.130	0.000	0.000	0.000	0.000	0.000	0.130
		Median	0.226	0.912	1.096	0.285	0.000	0.024	2.634	2.684	0.008	0.009	0.000	0.036	0.000	2.701
		LQL	1.017	1.427	1.827	0.799	0.199	0.502	3.999	4.278	0.401	0.184	0.034	0.480	0.137	4.312

* Excludes replicates

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 3-25 also gives estimated lower quantifiable limits (LQLs) for the IMPROVE_A parameters. These LQLs are determined as three times the standard deviation of the 24-hour field blanks, 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 TSAs, 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 XRF, ions by ion chromatography , 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 July 27, 2010, with the final report issued June 1, 2011. The report may be found at EPA's Ambient Monitoring Technical Information center (AMTIC) website at:

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

The TSA report 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 2011. The 2012-13 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.

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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, 2012.

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:

- 02/16/12 – Preventive maintenance performed, checked voltages, resolution, and stability. Replaced power distribution and jump cord
- 09/27/12 – Replaced sample motor wheel

The following repairs and maintenance were performed for XRF 2:

- 10/10/12 – Preventive maintenance performed, checked voltages, resolution, and stability
- 11/16/12 – Replaced vacuum pump

The following repair and maintenance was performed for XRF 3:

- 09/27/12 – Preventive maintenance performed, checked voltages, resolution, and stability

The following repair and maintenance was performed for XRF 4:

- 03/02/12 – Preventive maintenance performed, checked voltages, resolution, and stability

3.4.1.2 Description of QC Checks Applied

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

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

QC Check	QC Frequency	Control Limits	Comments/ Corrective Action
Calibration	as needed	—	—
Calibration verification[1]	monthly	90–110% 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. The QC sample has six selected elements and is analyzed with each tray of samples. Comparison of the element's replicate values gives the measure of reproducibility or precision. The data used to monitor precision are presented in **Tables 3-27 through 3-30**. The percent coefficient of variation (%CV) for the average of all data for each of the six elements ranged between 0.23 and 0.60% for XRF 1, between 0.24 and 0.60% for XRF 2, between 0.26 and 0.63% for XRF 3, and between 0.22 and 0.60% for XRF 4, indicating excellent precision.

Table 3-27. Summary of RTI XRF 1 Laboratory QC Precision Data, $\mu g/cm^2$, 1/1/2012 through 12/31/2012

Element	n	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Si	592	4.94	5.06	5.00	0.0246	0.49	0.177
Ti	592	6.75	6.86	6.80	0.0207	0.30	0.017
Fe	592	6.89	7.03	6.94	0.0215	0.31	0.159
Cd	592	5.48	5.60	5.55	0.0252	0.45	0.052
Se	592	3.93	4.06	4.00	0.0238	0.60	0.624
Pb	592	9.05	9.17	9.12	0.0209	0.23	-0.059

Table 3-28. Summary of RTI XRF 2 Laboratory QC Precision Data, $\mu g/cm^2$, 1/1/2012 through 12/31/2012

Element	N	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Si	654	5.17	5.29	5.24	0.0239	0.46	-0.081
Ti	654	8.56	8.68	8.63	0.0209	0.24	-0.004
Fe	654	7.24	7.36	7.30	0.0195	0.27	-0.004
Cd	654	5.87	5.96	5.91	0.022	0.38	0.413
Se	654	4.30	4.47	4.41	0.0265	0.60	-0.047
Pb	654	7.85	8.00	7.91	0.0251	0.32	0.003

Table 3-29. Summary of RTI XRF 3 Laboratory QC Precision Data, $\mu g/cm^2$, 1/1/2012 through 12/31/2012

Element	n	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Si	223	5.16	5.26	5.20	0.0207	0.40	-0.443
Ti	223	7.35	7.45	7.40	0.0190	0.26	-0.045
Fe	223	6.90	7.01	6.95	0.0213	0.31	-0.028
Cd	223	4.24	4.37	4.28	0.0191	0.45	-0.611
Se	223	2.87	2.99	2.93	0.0183	0.63	-0.775
Pb	223	7.89	8.06	7.99	0.0261	0.33	-0.091

Table 3-30. Summary of RTI XRF 4 Laboratory QC Precision Data, $\mu g/cm^2$, 1/1/2012 through 12/31/2012

Element	n	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Si	454	4.48	4.60	4.55	0.0274	0.60	-0.069
Ti	454	5.93	6.06	6.00	0.0245	0.41	-0.037
Fe	454	6.50	6.60	6.55	0.0195	0.30	0.187
Cd	454	5.45	5.57	5.50	0.0239	0.43	-0.135
Se	454	3.76	3.86	3.82	0.0198	0.52	-0.184
Pb	454	8.88	8.99	8.93	0.0197	0.22	-0.005

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

Recovery or system accuracy was determined by the analysis of a NIST Standard Reference Material (SRM) filter. Recovery is calculated by comparisons of measured and expected values. **Tables 3-31 through 3-34** show recovery for 8 elements of the 33 elements normally measured. The average recovery values for all the elements ranged between 90 and 110% for XRF 1; between 92 and 110% for XRF 2; between 90 and 110% for XRF 3; and between 90 to 110% for XRF 4. Note that every month, 33 elements of the Micromatter calibration standards are analyzed as unknowns to verify calibration.

Table 3-31. Recovery Determined from Analysis of NIST SRM 2783 for RTI XRF 1, 1/1/2012 through 12/31/2012

Element	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Al	91	100	96	0.0554	2.49	0.902
K	94	103	98	0.0141	2.73	0.188
Ca	90	97	93	0.0310	2.54	-0.180
Mn	92	110	101	0.0016	4.86	-0.143
Fe	94	102	98	0.0654	2.33	3.581
Cu	91	108	99	0.0017	4.33	-0.004
Zn	100	110	104	0.0056	2.99	-0.394
Pb	91	110	103	0.0013	4.03	0.157

Table 3-32. Recovery Determined from Analysis of NIST SRM 2783 for RTI XRF 2, 1/1/2012 through 12/31/2012

Element	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Al	93	101	97	0.0522	2.33	-1.946
K	99	110	103	0.0154	2.82	-0.638
Ca	94	107	101	0.0429	3.23	-2.231
Mn	93	110	103	0.0012	3.60	0.030
Fe	92	101	97	0.0577	2.07	-1.048
Cu	92	108	100	0.0017	4.29	-0.099
Zn	97	110	104	0.0065	3.50	-0.260
Pb	92	109	101	0.0015	4.72	-0.149

Table 3-33. Recovery Determined from Analysis of NIST SRM 2783 for RTI XRF 3, 1/1/2012 through 12/31/2012

Element	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Al	96	104	100	0.0547	2.37	3.082
K	92	102	98	0.0154	2.99	0.448
Ca	90	107	93	0.0488	3.96	3.448
Mn	98	110	104	0.0013	3.87	0.196
Fe	94	106	97	0.0830	3.00	8.546
Cu	93	110	100	0.0015	3.84	0.052
Zn	100	109	105	0.0053	2.83	-0.304
Pb	91	109	99	0.0014	4.47	-0.038

Table 3-34. Recovery Determined from Analysis of NIST SRM 2783 for RTI XRF 4, 1/1/2012 through 12/31/2012

Element	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Al	93	102	96	0.0484	2.17	2.292
K	93	103	98	0.0142	2.74	-0.023
Ca	90	98	94	0.0348	2.81	0.710
Mn	91	110	102	0.0014	4.28	-0.012
Fe	93	100	97	0.0563	2.04	-0.981
Cu	91	110	101	0.0017	4.09	-0.131
Zn	101	110	105	0.0046	2.47	-0.110
Pb	95	110	103	0.0013	3.84	-0.038

Replicates were analyzed at a frequency of at least 5% of the number of filters analyzed in the RTI XRF Laboratory. Six elements were selected for comparison through regression analysis. **Table 3-35** shows the correlation coefficients and average RPDs for the replicate analysis. The correlation coefficients for XRF 1 range from 0.9981 to 0.9999, the correlation coefficients for XRF 2 range from 0.9992 to 0.9999, the correlation coefficients for XRF 3 range from 0.9972 to 0.9999, and the correlation coefficients for XRF 4 range from 0.9976 to 0.9999 indicating acceptable replication with all four instruments. Also, for the six elements, the average RPD was less than 2% on XRF 1 and XRF 2, less than 7% on XRF 3, and less than 1% on XRF 4.

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

Element	n	Correlation Coefficient	Average RPD
XRF 1			
Si	324	0.9999	0.56
S	324	0.9997	-0.35
K	324	0.9999	0.26
Ca	324	0.9999	-0.75
Fe	324	0.9999	-0.10
Zn	324	0.9981	1.08
XRF 2			
Si	411	0.9999	-0.77
S	411	0.9998	-0.73
K	411	0.9999	-0.04
Ca	411	0.9999	-0.92
Fe	411	0.9999	-0.89
Zn	411	0.9992	-1.59
XRF 3			
Si	121	0.9999	6.53
S	121	0.9995	-0.26
K	121	0.9972	0.25
Ca	121	0.9999	-1.43
Fe	121	0.9999	0.03
Zn	121	0.9982	1.40
XRF 4			
Si	293	0.9976	0.90
S	293	0.9997	0.56
K	293	0.9999	-0.45
Ca	293	0.9995	0.74
Fe	293	0.9999	0.07
Zn	293	0.9994	-0.34

Assessment of Between-Instrument Comparability

Overview of Round-Robin Samples Run During 2012

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

In the round-robin program, previously analyzed CSN filters are recycled through all the instruments in the two laboratories. **Table 3-36** summarizes the number of round-robin filters analyzed during 2012.

Table 3-36. Numbers of Round-Robin Filter Analyses Performed during 2012

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	24

* - CLN 772 is not an approved instrument in the CSN PM2.5 Program, but CLN analyzed all 2012 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 2012.

Assessment of Bias and Precision

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

One simple way to assess potential differences in performance of the different instruments is to perform linear regression in which the individual observations for each instrument are regressed against a reference value. **Tables 3-37 through 3-39** show linear regression results for which the data for the filters are regressed versus the median for the six instruments for each filter. The median value is used as the reference value, since the “true” value is unknown for these filters. Each instrument in the program reported zeros or low-level detections in some of the elements. This was especially noticeable for Ni, Cu, and Pb, which affected the calculation for slope and correlation coefficient for these elements. Note that the calculated uncertainty of these results for each instrument was not taken into account when doing the regression (i.e., no weighting factors were used). In general, the analyses showed excellent correlation. Intercepts were typically near zero indicating no consistent bias. The slopes were typically within ±10% of unity, although occasional drifts were noticed for Pb (RTI) and Si (CLN). These results indicate general agreement of the instruments within 10% of the median value.

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

Table 3-37. 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	0.9978	1.0036	-0.0158	24	0.9972	0.9654	0.0368
S	24	0.9997	0.9760	0.1118	24	0.9997	0.9880	0.0438
K	24	0.9994	0.9804	0.0012	24	0.9994	1.0384	-0.0114
Ca	24	0.9996	0.9811	0.0272	24	0.9982	0.9404	0.0166
Fe	24	0.9993	1.0120	0.0166	24	0.9981	1.0012	-0.0115
Ni	24	0.9971	0.9895	0.0027	24	0.9982	0.9362	0.0025
Cu	24	0.9894	1.0916	-0.0049	24	0.9957	1.0329	0.0006
Zn	24	0.9999	1.0038	-0.0062	24	0.9996	1.0006	-0.0007
Pb	24	0.9780	1.0756	-0.0046	24	0.9817	1.1360	-0.0105

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

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

Element	RTI 3				RTI 4			
	n	Correlation Coefficient	Slope	Intercept	N	Correlation Coefficient	Slope	Intercept
Si	24	0.9973	0.9720	-0.0115	24	0.9961	0.9674	0.0777
S	24	0.9995	0.9895	-0.0640	24	0.9996	1.0034	-0.0201
K	24	0.9989	0.9702	0.0197	24	0.9995	1.0023	-0.0279
Ca	24	0.9982	0.9721	-0.0267	24	0.9998	1.0110	-0.0094
Fe	24	0.9991	0.9900	0.0174	24	0.9996	1.0012	0.0075
Ni	24	0.9985	1.0111	0.0015	24	0.9994	1.0640	0.0003
Cu	24	0.9975	0.9733	0.0030	24	0.9916	1.0460	0.0054
Zn	24	0.9994	0.9866	0.0068	24	0.9993	1.0174	0.0048
Pb	24	0.9692	0.9718	-0.0211	24	0.9639	0.8981	0.0050

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

Table 3-39. 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	0.9909	1.1755	-0.1733	24	0.9939	1.1574	-0.0807
S	24	0.9975	1.0366	0.1143	24	0.9994	1.0350	-0.0821
K	24	0.9969	1.0519	-0.0292	24	0.9992	1.0088	0.0007
Ca	24	0.9994	1.0990	-0.0123	24	0.9992	1.0966	-0.0429
Fe	24	0.9989	1.0099	-0.0045	24	0.9956	0.9799	-0.0303
Ni	24	0.9949	1.1646	-0.0017	24	0.9934	0.9837	-0.0076
Cu	24	0.9782	1.0449	-0.0218	24	0.9923	0.9359	-0.0001
Zn	24	0.9993	1.0472	-0.0170	24	0.9994	0.9911	0.0008
Pb	24	0.9778	0.9708	0.0002	24	0.9871	0.9375	0.0236

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

3.4.1.4 Determination of Uncertainties and MDLs

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

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

Where

A = scaling factor

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

t = livetime

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)[3,4,5]. 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

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

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

3.4.1.5 Audits, PEs, Training, and Accreditations

EPA performed a TSA of RTI's CSN Laboratories in July 2012. The audit for XRF included the CSN contract as well as the EPA Pb contract. RTI was requested to perform analysis on one 47mm Teflon filter for 33 elements (this sample was from samples analyzed in the 2011 inter-laboratory study) and one 47mm Teflon filter for Pb only. The results of the two filters analyzed showed very good comparison versus expected values.

3.4.2 Chester LabNet X-Ray Fluorescence Laboratory

During the period covered by this report, Chester operated one Kevex 770 XRF instrument analyzing 1200 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:

- 1/23/12 – Pulse Processor reset, new energy calibration performed

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[3] 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

[4] 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.

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

- 2/1/12 – new Quality Assurance Standard (Micromatter 34104) characterized
- 6/25/12 – new 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 3-40.**

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

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

1 - Using NIST SRMs
2 – Micromatter QC

3.4.2.3 Summary of QC Results

Precision

Precision was monitored by the reproducibility of the multi-element Micromatter QC sample. The QC sample has six selected elements and is analyzed with each tray of samples. The comparison of the element's values gives the measure of reproducibility or precision. The data used to monitor precision are presented in **Table 3-41**. The percent coefficient of variation (%CV) for the average of all data for each of the six elements ranged between 1.71 and 3.11%.

Table 3-41. Summary of Chester XRF 770 Laboratory QC Precision Data 1/1/2012 through 12/31/2012

Element	n	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Si	99	95.3	110.2	101.1	2.60	2.57	0.42
Ti	99	92.7	109.2	102.2	3.18	3.11	6.56
Fe	99	93.1	108.7	102.0	2.93	2.87	6.48
Cd	99	92.4	105.8	100.7	1.72	1.71	-0.12
Se	99	95.7	109.2	101.7	2.52	2.48	2.53
Pb	99	95.4	109.6	101.7	2.44	2.40	2.35

Accuracy

Accuracy determinations are performed with three NIST thin film SRMs, four vapor deposited Micromatter standards, and one NIST particle size standard. Recovery is calculated by dividing the measured result by the expected value. **Table 3-42** 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 88.6 and 136.9%. Analysis of NIST Particle Standard SRM 2783 yielded recoveries of 96.9% for Ca and 103.8% for Zn. Averages over the reporting period were within the recovery goal of twice the standard deviation; however individual measurements were sometimes outside this criterion. Corrective actions were taken whenever a recovery was outside specifications as follows:

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

Table 3-42. Recovery Determined from Analysis of NIST SRMs 1832, 1833, 2708 and 2783 for Chester XRF 770 -- 1/1/2012 through 12/31/2012

Element	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Al	94.5	136.9	105.6	5.45	5.16	0.97
Si	93.3	109.6	101.5	2.83	2.79	-4.31
Si	88.6	102.5	96.5	2.46	2.55	0.54
S	92.3	107.9	97.5	2.83	2.91	3.50
K	98.3	108.0	102.8	2.08	2.02	-2.17
Ca	91.5	102.5	96.9	2.62	2.71	4.70
Ti	89.9	103.1	96.5	2.38	2.46	-3.82
V	92.3	110.7	97.3	3.04	3.13	6.43
Mn	90.4	102.8	97.8	3.05	3.12	8.33
Fe	90.2	101.0	97.2	2.53	2.61	-6.73
Cu	99.2	117.7	103.8	3.37	3.25	2.30
Zn	100.0	108.6	103.8	1.99	1.91	-0.59
Pb	93.7	111.7	100.3	2.93	2.92	-0.40

Reproducibility

Replicate analysis of field samples are used to assess reproducibility of the analytical system. Replicates were analyzed at a frequency of 10% of the filters analyzed. Six elements were selected for comparison through regression analysis. **Table 3-43** shows the correlation coefficient and average RPDs for the replicate analysis. The correlation coefficients range from 0.9939 to 0.9999.

Table 3-43. Replicate Data for Chester XRF 770

Kevex 770			
Element	**n**	**Correlation Coefficient**	**Average RPD**
Al	83	0.9939	2.99
Si	113	0.9972	-5.11
S	116	0.9986	-1.45
K	116	0.9974	0.03
Ca	118	0.9991	0.05
Fe	118	0.9994	-0.48
Zn	109	0.9999	-1.58

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 2012 calendar year, there were no quality issues reported.

3.5.2 Operational Discussion

3.5.2.1 Numbers of Denuder Serviced

Table 3-44 lists the denuders refurbished and the number of refurbishments completed in 2012.

Table 3-44. Denuder Refurbishments, January 1, 2012 through December 31, 2012

Denuder Type	Total Refurbished
Aluminum Honeycomb	728

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 was one major quality issue in the SHAL during 2012. On Thursday July 26, 2012 the walk-in cooler where newly received packages from the field site are stored at RTI International malfunctioned. The walk-in cooler was repaired within 24 hours, but packages inside the cooler reached a maximum temperature of 21°C (69.8°F) during this time. Although a deviation from RTI's normal procedures, there is likely to be little effect on the analytical results of the filters inside the cold room during the outage. This is due to the short duration of the temperature rise (relative to the sample collection/retrieval and normal assembly/ disassembly periods) as well as the relatively low temperatures experienced (i.e., room temperature storage).

Figure 3-2. SHAL Technician Loading the URG 3000N Cassette.

All filters that were stored in the cooler at the time of the outage were assigned a data qualifying flag of "RTS - Refrigeration Lost Prior to Analysis". This flag does not invalidate the data and the results were posted to AQS without any qualifier, unless a monitoring agency instructed RTI to add a flag as part of their regular data review process. A total of 28 events from sample dates of July 20, 23 and 26 were assigned the “RTS” data qualifying flag.

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 12 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 2012, the SHAL shipped out and received back more than 32,650 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 3-45** lists those sites with less than 95% of their filters run on the intended sampling date during 2012.

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

AQS Site Code	POC	Location	Events[(1)]	On Date	Percent
460990008	5	Sioux Falls School Site	334	234	70.1
390350060	6	G.T. Craig - Collocated	106	90	84.9
340130003	5	Newark	238	210	88.2
340273001	5	Chester	263	237	90.1
340390004	5	Elizabeth Lab	276	249	90.2
471570075	6	Shelby Farms	302	273	90.4
360010005	5	Albany Co HD	336	304	90.5
150030010	5	Kapolei	322	293	91.0
340230006	5	New Brunswick	282	257	91.1
490353006	5	Hawthorne	328	306	93.3
420490003	5	Erie	170	160	94.1
540390011	5	WV - Guthrie Agricultural Center	266	251	94.4
080310025	5	Denver Animal Shelter	214	203	94.9

[(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 2012. A summary of email and phone communications with site operators and data users is presented in **Table 3-46**. In consultation with EPA, RTI is in the process of preparing a list of frequently asked questions that can be posted on the AMTIC website that site operators and data users can refer to for clarification on common issues/questions.

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

Description	Number of Communications
Site will send cooler late	167
Site needs schedule	23
Site did not receive cooler	55
Change of operator/site information	121
Sampler problems/questions	140
Field Blank/Trip Blank ran as routine sample	0
Request change of ship date from RTI	23
Site is stopping	24
Miscellaneous QA Issues	355
Data questions/reporting	216
Other	141
Total	1265

3.6.6 Audits, PEs, Training, and Accreditations

- On July 24-25, 2012, a TSA was conducted by EPA at the RTI. From the Technical memorandum: "The SHAL staff is well aware that critical bookkeeping is required to insure sample integrity and to keep track of data as it is generated. SOPs were in place, barcodes were used extensively, and critical data was maintained within an electronic database as well as hand written forms. The SHAL was well organized, and no deficiencies were noted for the area of laboratory operations."
- 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 2012 is shown in **Table 3-47**.

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

Module Type	Number Observed	Findings	Findings Reviewed with Technician
MET ONE	120	8	8
URG 3000N	120	8	8

3.6.7 Chemical Speciation Site Changes 2012

The Fresno-First Street (060190008) site in CA stopped at the end of the 2011. The site was moved to the Fresno-Garland (60190011) site. The first sample date for the Fresno-Garland location was 1/1/12.

The Linn County Health (191130040) site in IA began sampling 1/4/12. Replacing "Army Reserve Center" (19113037) which stopped sampling at the end of 2011.

The Newark (340130003) site in NJ began sampling with the URG 3000N sampler. Previously had used MET ONE to collect Teflon, nylon and quartz filters. The first sample with the URG 3000N was 1/4/12.

The G.T. Craig Collocated (390350060) site in OH resumed sampling with collocated sampler on 1/16/12. The sampler had been down for repairs since 3/22/11.

The G.T. Craig (390350060) site in OH stopped sampling with the URG 3000N sampler after the 4/3/12 event. They continued sampling with the MET ONE (Teflon and nylon filter modules only). Both the primary and collocated samplers were involved. The primary site resumed sampling with the URG 3000N 7/17/12. The collocated site resumed sampling with the URG 3000N 11/29/12.

The McMillan Reservoir (110010043) site in DC changed from the Alternate 1-in-3-day schedule to the regular 1-in-3-day schedule. The change was effective 5/3/12.

The Portland-SE Lafayette (410510080) site in OR was down between 3/19/12 and 4/3/12. The site stopped sampling on 6/5/12 and resumed sampling on 9/15/12.

The Cheyenne nCore (560210100) site in WY started sampling 6/17/12. They changed to the alternate schedule 7/19/12.

The Jackson UMC (280490019) site in MS stopped 7/11/12. The site is being moved to a new location.

The Denver Animal shelter (080310025) site in CO stopped 9/3/12. The site was moved to the Las Casa (080310026) site. The first event was 10/18/12

The Univ. of Florida Ag School (120111002) site in FL changed from the regular 1-day-in-3 sampling schedule to the Alternate Schedule. The change was effective 9/19/12.

The Clarksville (471251009) site in TN and the Laurel (280670002) site in MS stopped permanently. Last event was 12/29/12.

4.0 Data Processing

4.1 Quality Issues and Corrective Actions

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

4.2 Operational Summary

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

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

4.3 Operational Changes and Improvements

No operational changes were made to data processing in 2012.

4.4 Monthly Data Postings to Web Site

Each month, RTI posts data for samples received on or before the 15^{th} 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
145	2/15/2012	12/8/2011	1/10/2012	1,612	1,255			179	178
146	3/15/2012	1/4/2012	2/9/2012	1,572	1,335	79		79	79
147	4/13/2012	2/9/2012	3/10/2012	1,658	1,119		180	180	179
148	5/14/2012	3/10/2012	4/10/2012	1,457	1,300			80	77
149	6/15/2012	4/6/2012	5/12/2012	1,704	1,171	179		177	177
150	7/13/2012	5/9/2012	6/12/2012	1,566	1,406			80	80
151	8/14/2012	6/8/2012	7/9/2012	1,520	1,165			178	177
152	9/14/2012	6/29/2012	8/13/2012	1,644	1,328	80	79	79	78
153	10/12/2012	8/10/2012	9/9/2012	1,559	1,210			175	174
154	11/15/2012	9/6/2012	10/9/2012	1,375	1,219			78	78
155	12/14/2012	10/6/2012	11/11/2012	1,807	1,280	177		175	175
156	1/15/2013	10/27/2012	12/12/2012	1,414	1,256			79	79
Total				18,888	15,044	515	259	1,539	1,531

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		Total[1]	Routine	Blanks			Backup Filters[3]
Batch	Date	Earliest	Latest			Field	Trip	24 Hour[2]	
145	2/15/2012	12/8/2011	1/10/2012	131,029	124,241			4,296	2,492
146	3/15/2012	1/4/2012	2/9/2012	141,044	132,117	5,925		1,896	1,106
147	4/13/2012	2/9/2012	3/10/2012	121,927	110,781		4,320	4,320	2,506
148	5/14/2012	3/10/2012	4/10/2012	131,674	128,676			1,920	1,078
149	6/15/2012	4/6/2012	5/12/2012	135,768	115,617	13,425		4,248	2,478
150	7/13/2012	5/9/2012	6/12/2012	141,874	138,834			1,920	1,120
151	8/14/2012	6/8/2012	7/9/2012	121,773	115,023			4,272	2,478
152	9/14/2012	6/29/2012	8/13/2012	146,412	135,288	6,240	1,896	1,896	1,092
153	10/12/2012	8/10/2012	9/9/2012	129,792	123,156			4,200	2,436
154	11/15/2012	9/6/2012	10/9/2012	127,134	124,170			1,872	1,092
155	12/14/2012	10/6/2012	11/11/2012	150,776	130,320	13,806		4,200	2,450
156	1/15/2013	10/27/2012	12/12/2012	130,922	127,920			1,896	1,106
Total				1,610,125	1,506,143	39,396	6,216	36,936	21,434

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, sites 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 (with the URG posting volatile and total nitrate).

4.5 Data User Support Activities

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

4.5.1 Data Change Requests

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

Table 4-3. Events Posted to AQS

Report Batch	Routine(1)	Blanks			Backup Filters(2)
		24 Hour(2)	Field	Trip	
143	1,358	177	180		177
144	1,237	78			78
145	1,265	179			179
146	1,354	80	80		80
147	1,139	180		180	180
148	1,321	80			80
149	1,183	177	179		177
150	1,426	80			80
151	1,190	178			178
152	1,348	79	80	79	79
153	1,231	177			177
154	1,225	78			78
Total	15,277	1,543	519	259	1,543

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 24 Hour(1)	Blanks Field	Blanks Trip	Backup Filters(1)
143	78,331	2,301	8,114		2,301
144	71,493	1,014			1,014
145	73,123	2,327			2,327
146	78,229	1,040	3,600		1,040
147	65,830	2,340		2,340	2,340
148	76,373	1,040			1,040
149	68,329	2,301	8,055		2,301
150	82,223	1,040			1,040
151	68,619	2,314			2,314
152	77,745	1,027	3,600	1,027	1,027
153	70,965	2,301			2,301
154	70,611	1,014			1,014
Total	881,871	20,059	23,369	3,367	20,059

1) URG 3000 N only.

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

	Report Batch											
	143	144	145	146	147	148	149	150	151	152	153	154
Change Requests[1]	4	4	2	6	6	9	3	7	6	7	8	6

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 May 22, 2012.

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

Internal surveillance activities by the Quality Assurance Staff during 2012 included walkthroughs of all the laboratories to verify compliance with the SOPs. Outstanding quality issues are 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 2012. 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)

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 2012 the flag percentages were low and stable. 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 2012. 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.

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.

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

Flag	Description	145	146	147	148	149	150	151	152	153	154	155	156
1	Critical Criteria Not Met							0.06%	0.02%				
2	Operational criteria not met					0.01%	0.01%				0.06%		
3	Possible field contamination	0.07%	0.54%	0.75%	0.58%	0.59%	0.72%	0.70%	0.75%	0.85%	0.68%	0.41%	0.38%
5	Outlier - cause unknown	3.97%	4.53%	4.89%	3.15%	4.64%	3.85%	7.32%	6.07%	5.16%	6.93%	3.99%	2.92%
IC	Chem. Spills and Industrial Accidents	0.29%											
ID	Cleanup After a Major Disaster	0.29%											
IE	Demolition				0.21%	0.32%	0.57%	0.50%					0.08%
IH	Fireworks	0.07%											
II	High Pollen Count			0.08%	0.44%	0.10%			0.05%	0.02%	0.04%		
IJ	High Winds	0.05%		0.24%	0.05%	0.14%	0.07%	0.08%	0.11%	0.05%	0.11%	0.33%	
IL	Other	0.29%	0.80%	0.75%	0.87%	0.83%	1.41%	0.96%	0.99%	1.49%	1.05%	0.68%	0.40%
IM	Prescribed Fire	0.05%				0.07%					0.05%	0.36%	0.18%
IP	Structural Fire							0.16%					
IT	Wildfire-U. S.						0.51%	1.41%	0.81%	1.87%	1.19%	0.42%	0.08%
IU	Wildland Fire Use Fire-U. S.										0.11%		
W	Flow Rate Average Out of Spec.	0.05%	0.03%		0.03%		0.05%			0.06%	0.06%		
X	Filter Temperature Difference Out of Spec.	0.68%	0.36%	0.53%	0.32%	0.82%	0.51%	0.95%	0.88%	1.35%	0.73%	0.35%	0.66%
Y	Elapsed Sample Time Out of Spec.	0.02%					0.05%					0.05%	0.08%

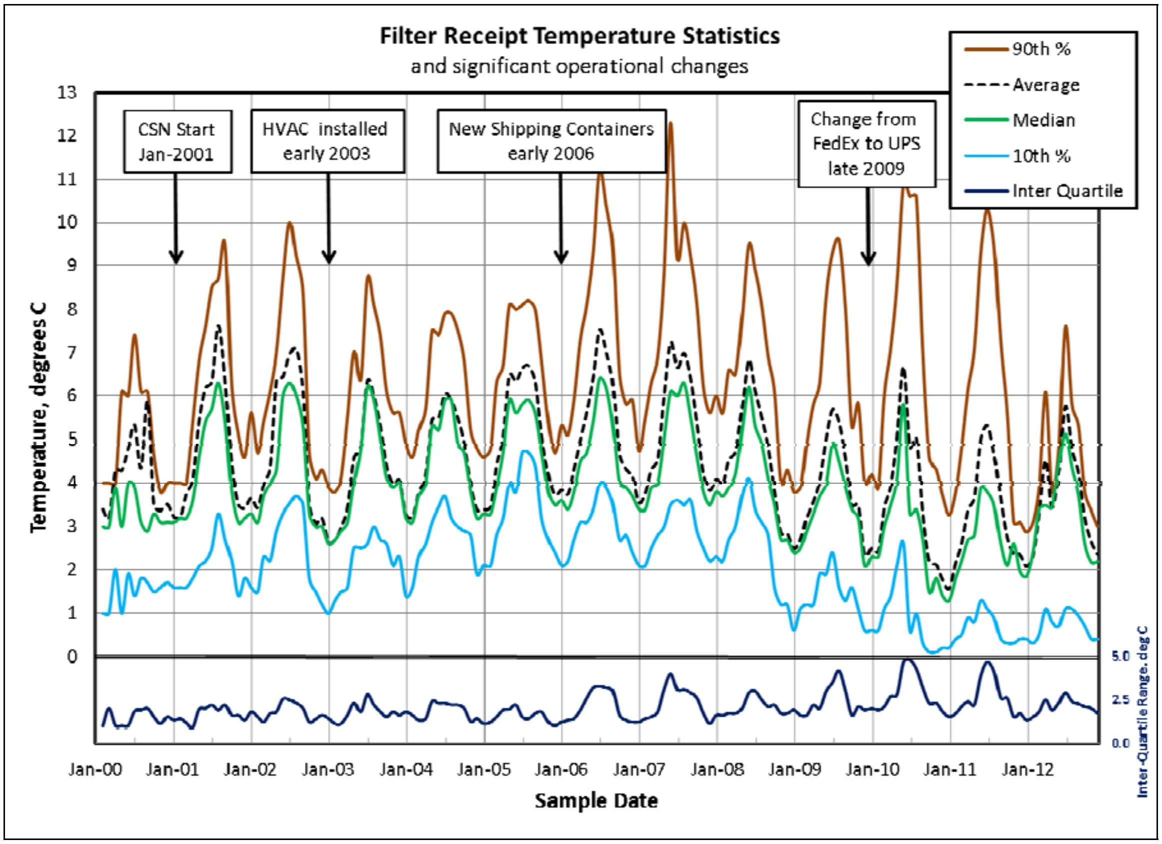
Table 5-2. Summary of Null Value Codes by Delivery Batch Number (percent of data records reported)

Flag	Description	145	146	147	148	149	150	151	152	153	154	155	156
AB	Technician Unavailable	0.47%	0.27%	0.23%	0.09%	0.28%	0.53%	0.10%	0.03%	0.48%	0.31%	0.28%	0.56%
AC	Construction/Repairs in Area	0.18%	0.10%	0.11%	0.03%	0.11%		0.10%	0.28%				
AD	Shelter Storm Damage							0.02%					
AF	Scheduled but Not Collected	1.17%	1.42%	1.37%	0.97%	0.50%	1.57%	0.97%	1.62%	1.59%	1.24%	1.32%	1.46%
AG	Sample Time Out of Limits	0.49%	0.45%	0.57%	0.59%	0.41%	0.73%	0.83%	0.67%	0.70%	0.66%	1.04%	0.45%
AH	Sample Flow Rate Out of Limits	0.83%	0.82%	0.54%	0.51%	0.46%	0.69%	0.39%	0.35%	0.50%	0.60%	0.38%	0.46%
AI	Insufficient Data (can't calculate)	0.07%		0.02%	0.12%	0.16%	0.08%	0.02%	0.02%	0.14%		0.10%	
AJ	Filter Damage	0.07%	0.22%	0.13%	0.14%	0.14%	0.17%	0.18%	0.22%	0.15%	0.30%	0.16%	0.28%
AK	Filter Leak												0.02%
AL	Voided by Operator	0.09%	0.24%	0.06%	0.20%	0.16%	0.40%	0.29%	0.28%	0.17%	0.28%	0.32%	0.17%
AM	Miscellaneous Void	0.05%					0.11%			0.06%		0.03%	0.08%
AN	Machine Malfunction	1.02%	0.61%	0.65%	0.62%	0.43%	0.35%	0.92%	1.01%	1.44%	1.06%	0.49%	0.40%
AO	Bad Weather		0.08%	0.08%	0.05%		0.08%	0.19%		0.08%		0.91%	0.05%
AP	Vandalism				0.31%	0.02%						0.07%	
AQ	Collection Error	0.12%	0.26%	0.13%	0.17%	0.35%	0.14%	0.11%	0.19%	0.30%	0.11%	0.13%	0.13%
AR	Lab Error	0.18%	0.04%	0.15%	0.10%	0.10%	0.03%	0.05%	0.16%	0.09%	0.10%	0.11%	0.01%
AU	Monitoring Waived	0.22%	0.03%	0.02%	0.09%	0.02%	0.14%	0.02%	0.02%	0.04%	0.04%	0.02%	
AV	(Power Failure (POWR)	0.30%	0.49%	0.23%	0.29%	0.25%	0.46%	0.83%	0.57%	0.56%	0.51%	1.04%	0.29%
AW	Wildlife Damage							0.12%					
AZ	QC Audit (AUDT)		0.05%		0.03%								
BA	Maintenance/Routine Repairs	0.07%	0.07%	0.12%	0.05%	0.12%		0.13%	0.11%	0.05%	0.04%	0.13%	0.23%
BB	Unable to Reach Site	0.14%	0.13%		0.07%				0.09%	0.08%		0.07%	0.02%
BE	Building/Site Repair				0.07%	0.05%		0.02%	0.02%				
BI	Lost or Damaged in Transit	0.02%											

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

Flag	Description	145	146	147	148	149	150	151	152	153	154	155	156
DFM	Filter Missing		0.06%	0.02%	0.03%	0.05%		0.04%	0.02%	0.05%		0.02%	
DST	Received Temperature >4C	11.38%	7.67%	11.00 %	33.05%	38.59%	22.53%	31.86%	47.98%	46.05%	22.77%	21.41%	14.28%
FC3	Channel 3 Used Instead of Designated Channel	0.56%	0.52%	0.56%	0.63%	0.67%	0.95%	0.84%	0.50%	0.90%	0.92%	0.64%	0.84%
FC4	Channel 4 Used Instead of Designated Channel	0.20%	0.19%	0.22%	0.23%	0.28%	0.38%	0.33%	0.18%	0.34%	0.35%	0.25%	0.34%
FC5	Channel 5 Used Instead of Designated Channel	0.99%	1.09%	1.30%	1.24%	1.07%	1.24%	0.99%	0.84%	1.06%	1.06%	0.85%	0.78%
FC6	Channel 6 Used Instead of Designated Channel	0.44%	0.48%	0.58%	0.55%	0.47%	0.55%	0.42%	0.35%	0.44%	0.44%	0.36%	0.33%
FC7	Channel 7 Used Instead of Designated Channel	0.11%	0.11%	0.16%	0.11%	0.07%	0.21%	0.10%	0.11%	0.08%	0.04%	0.11%	0.08%
FCE	Corrected - Operator Data Entry Error	1.10%	1.21%	1.28%	1.01%	0.76%	1.32%	1.72%	1.43%	1.10%	1.55%	1.03%	1.32%
FES	Field Environmental Data Taken From Another Flow Channel	0.05%	0.08%	0.04%	0.07%	0.08%	0.17%	0.16%	0.09%	0.02%	0.09%	0.06%	0.07%
FHT	Pickup Holding Time Exceeded	17.55%	16.64%	9.54%	16.24%	13.56%	16.89%	9.90%	14.36%	12.08%	13.47%	14.58%	17.36%
FSB	Sample is Blank						0.07%					0.07%	
LFA	Filter Inspection Flags* - Filter Wet		0.12%	0.05%	0.02%	0.04%	0.03%	0.04%	0.10%		0.06%	0.05%	0.07%
LFH	Filter Inspection Flags* - Holes in Filter			0.07%							0.06%	0.02%	
LFL	Filter Inspection Flags* -Loose Material										0.04%		
LFP	Filter Inspection Flags* -Pinholes								0.03%				
LFT	Filter Inspection Flags* - Tear	0.03%				0.07%	0.06%		0.06%	0.07%	0.11%	0.03%	0.09%
LFU	Filter Inspection Flags* -Non-uniformity												<0.005%
LRT	Laser Reflectance/Transmittance Flag												<0.005%
QAC	Anion/Cation Total Charge Ratio Out of Limits	0.31%	0.24%	0.29%	0.40%	0.30%	0.59%	0.61%	0.62%	0.53%	0.74%	0.47%	0.29%
QL1	Outlier Based on Level 1 Check (e.g., Sulfur/Sulfate Ratio Out of Limits)	0.09%	0.07%	0.09%	0.07%	0.07%	0.07%	0.23%	0.11%	0.12%	0.11%	0.10%	0.15%
QMB	Total Mass Balance Outside Limits	3.62%	4.27%	4.56%	2.72%	4.30%	3.23%	6.61%	5.44%	4.56%	6.21%	3.48%	2.52%
RTS	Refrigeration Lost Prior to Analysis								1.89%				

Figure 5-1. Filter Receipt Temperature Statistics.



- 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 2012, 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 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.

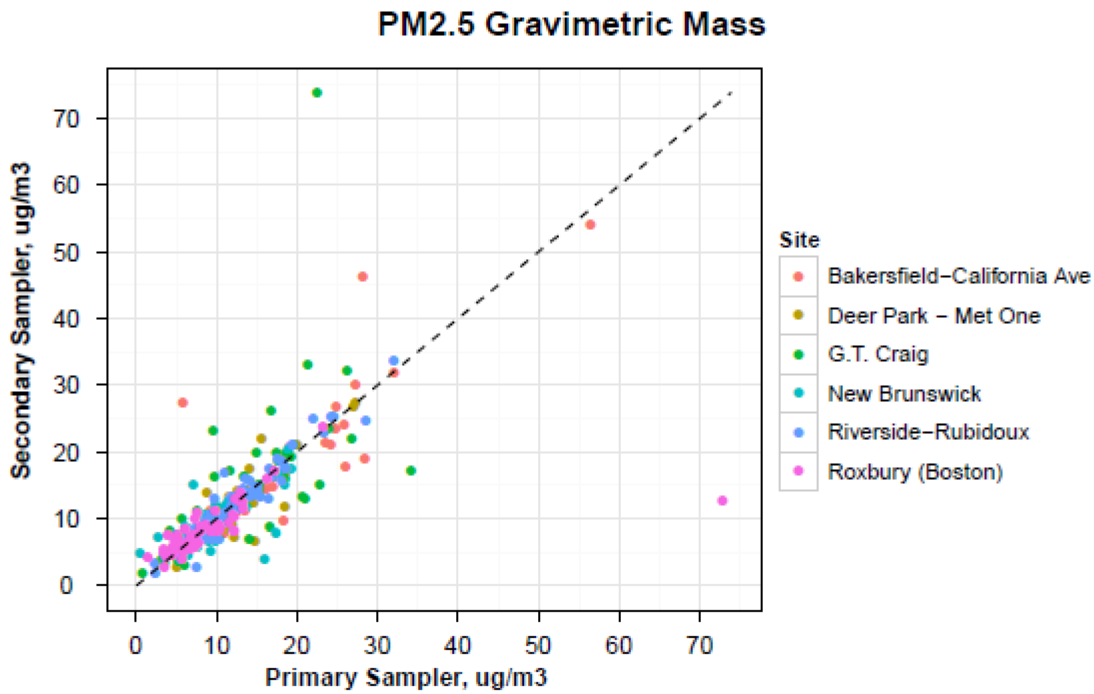
Table 5-4. Collocated Sites in the CSN During 2012.

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 G. T. Craig site was out of service for most of 2012 due to sampler problems and is therefore not included in Figure 5-2 for organic and elemental carbon.*

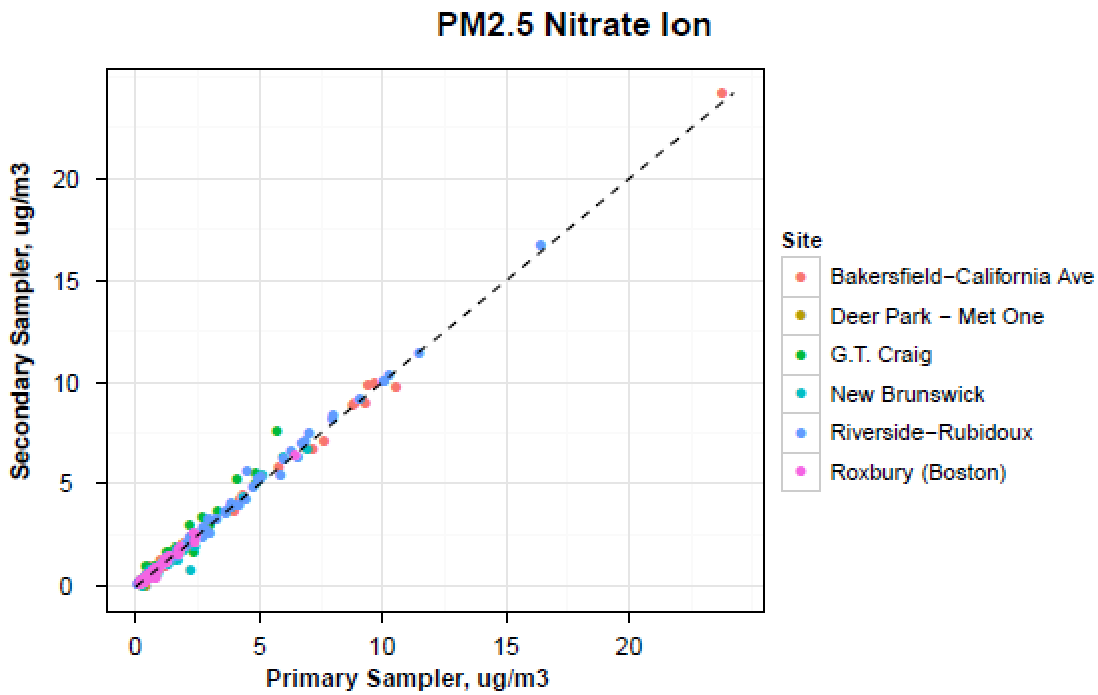
The figures that follow (**Figure 5-2**) show examples of the comparisons for $PM_{2.5}$ mass, nitrate, sulfate, sulfur and organic and elemental carbon (IMPROVE_A TOR and TOT methods). Also included in the figure are linear least-squares regression parameters (slope, intercept, R^2) by site for each of these species. These figures demonstrate good or excellent agreement for the major analytes; however, precision for the species sampled on Teflon at the G.T. Craig site are visibly poorer than for the other five sites. These include $PM_{2.5}$ Gravimetric Mass, and Sulfur.

Figure 5-2 Collocation Data for Selected Species During 2012.



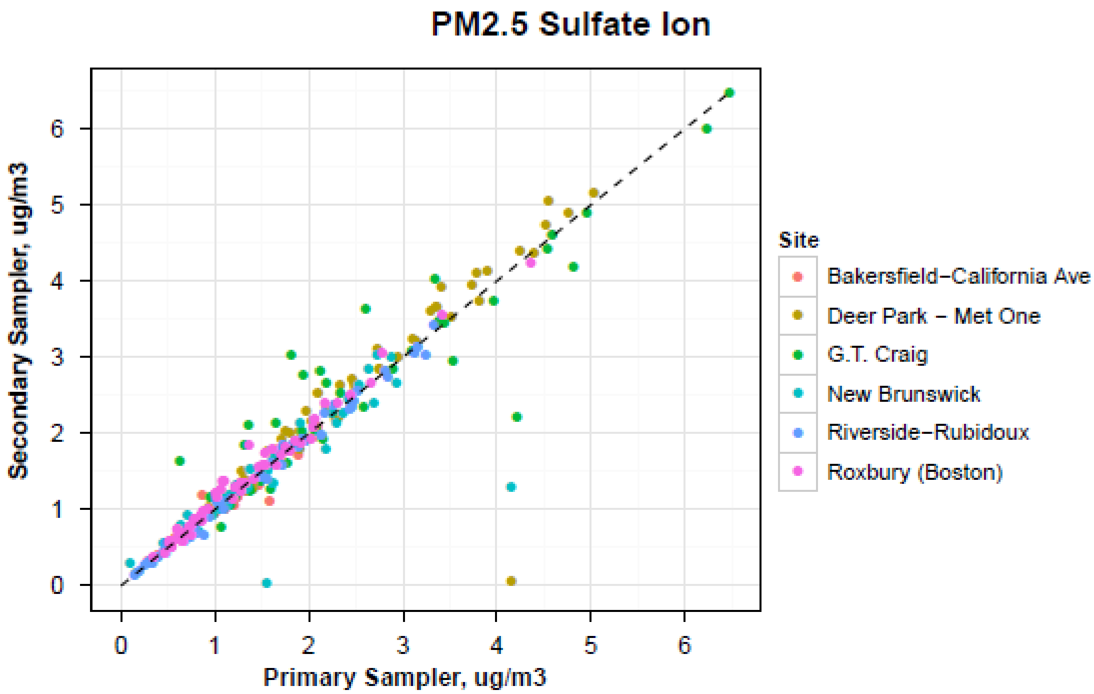
Site	Intercept	Slope	R2
Bakersfield−California Ave	0.8300	0.93	0.75
Deer Park − Met One	0.5900	0.93	0.81
G.T. Craig	2.3000	0.94	0.35
New Brunswick	3.1000	0.62	0.51
Riverside−Rubidoux	−0.0026	1.00	0.92
Roxbury (Boston)	6.4000	0.20	0.28

Figure 5-2 (continued).



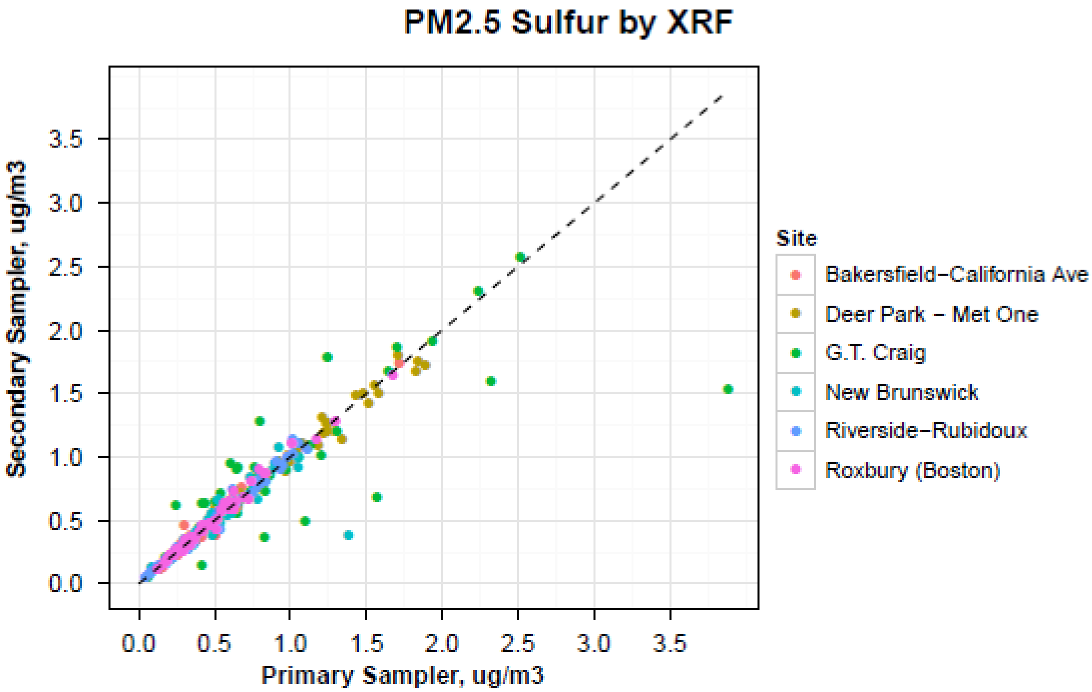
Site	Intercept	Slope	R2
Bakersfield−California Ave	−0.00320	1.0	1.00
Deer Park − Met One	−0.02100	1.0	0.98
G.T. Craig	−0.06800	1.2	0.97
New Brunswick	−0.05800	1.0	0.97
Riverside−Rubidoux	0.00041	1.0	1.00
Roxbury (Boston)	−0.00230	1.0	0.99

Figure 5-2 (continued).



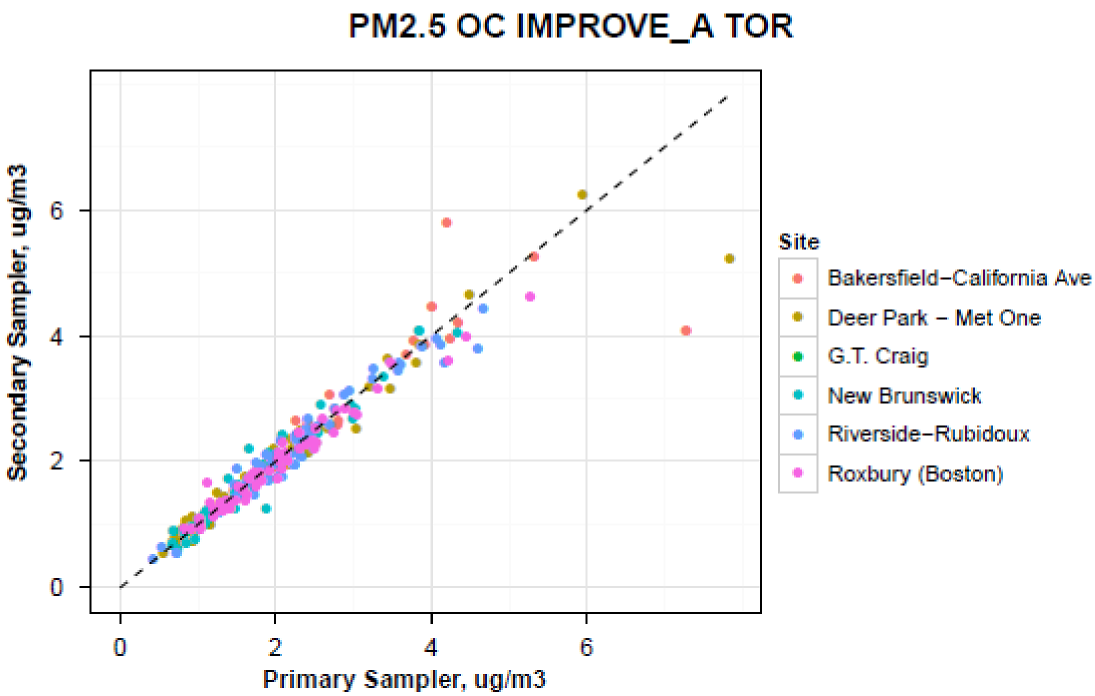
Site	Intercept	Slope	R2
Bakersfield−California Ave	0.012	0.97	0.98
Deer Park − Met One	0.180	0.95	0.77
G.T. Craig	0.340	0.89	0.88
New Brunswick	0.360	0.71	0.62
Riverside−Rubidoux	−0.011	0.99	0.99
Roxbury (Boston)	0.059	1.00	0.98

Figure 5-2 (continued).



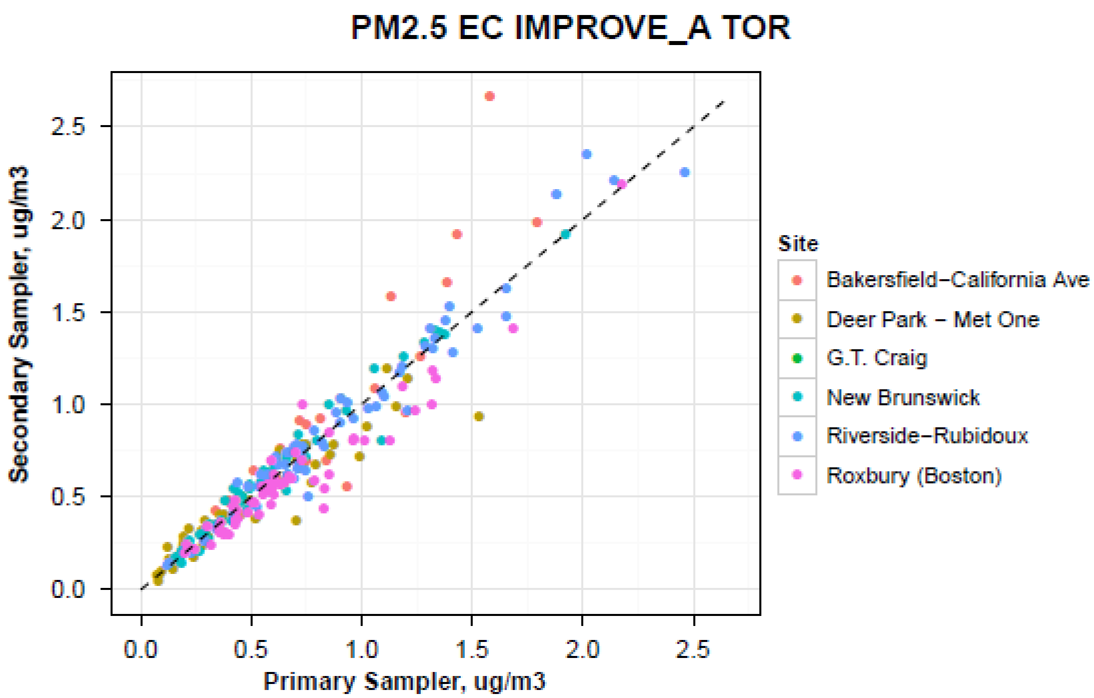
Site	Intercept	Slope	R2
Bakersfield−California Ave	−0.0034	1.00	0.97
Deer Park − Met One	0.0360	0.95	0.98
G.T. Craig	0.3100	0.62	0.63
New Brunswick	0.1500	0.69	0.61
Riverside−Rubidoux	−0.0019	1.00	0.99
Roxbury (Boston)	0.0075	1.00	0.99

Figure 5-2 (continued).



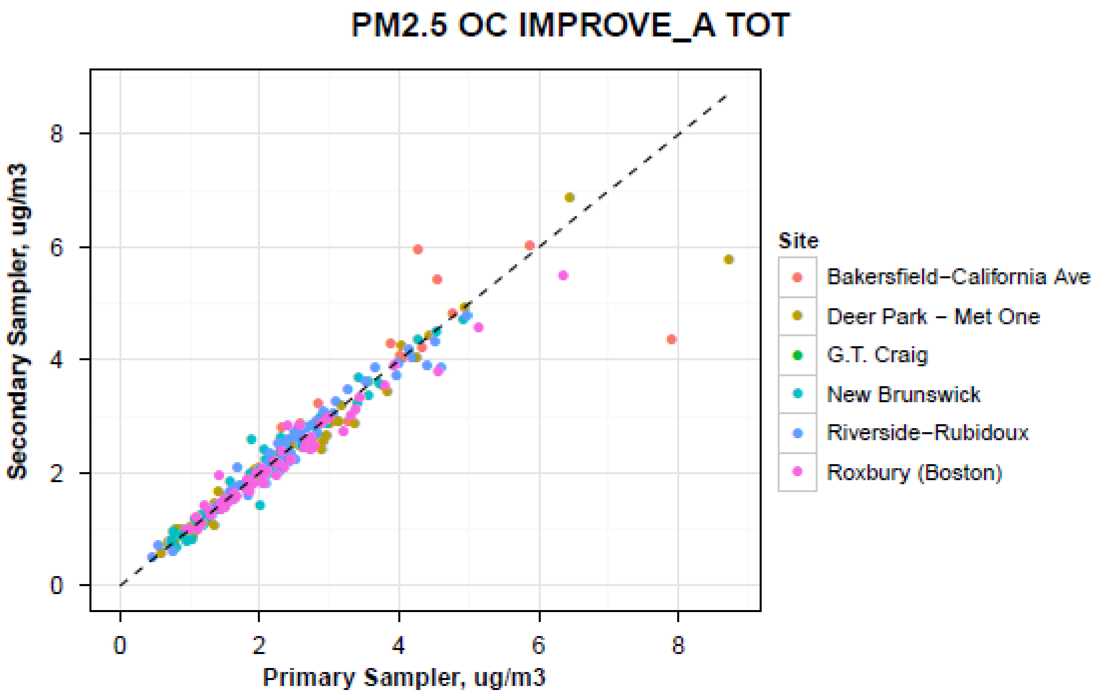
Site	Intercept	Slope	R2
Bakersfield−California Ave	0.990	0.68	0.65
Deer Park − Met One	0.260	0.84	0.93
New Brunswick	0.029	0.99	0.95
Riverside−Rubidoux	0.160	0.92	0.95
Roxbury (Boston)	0.200	0.87	0.96

Figure 5-2 (continued).



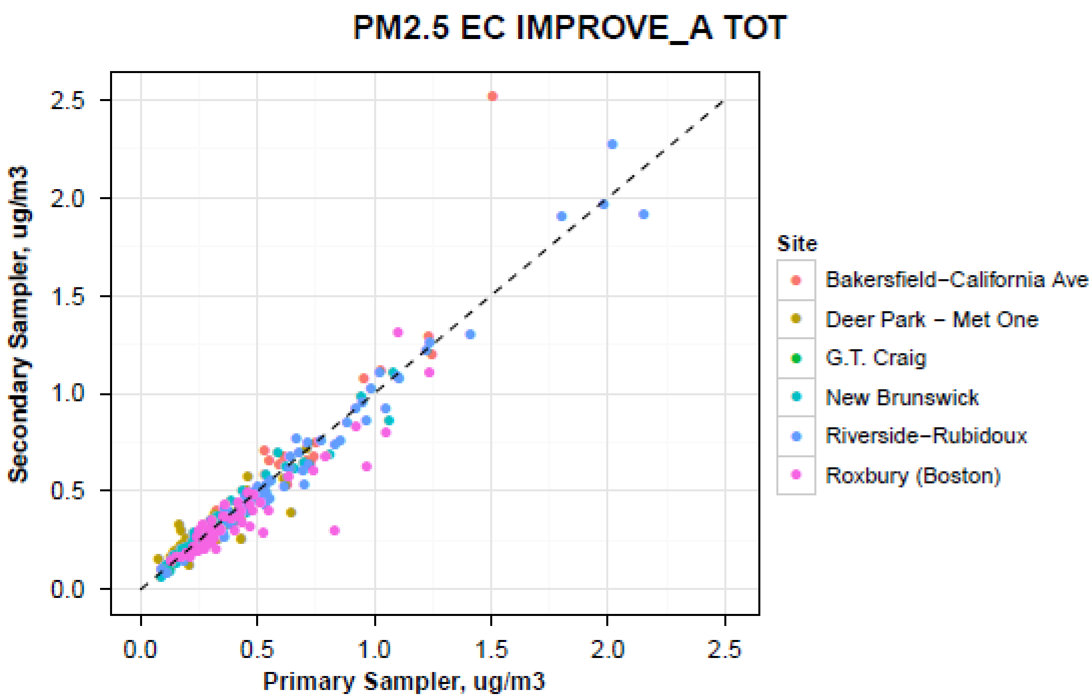
Site	Intercept	Slope	R2
Bakersfield−California Ave	−0.15000	1.30	0.80
Deer Park − Met One	0.07000	0.81	0.89
New Brunswick	0.02400	1.00	0.97
Riverside−Rubidoux	0.00098	1.00	0.96
Roxbury (Boston)	0.01900	0.86	0.91

Figure 5-2 (continued).



Site	Intercept	Slope	R2
Bakersfield−California Ave	1.000	0.70	0.64
Deer Park − Met One	0.270	0.84	0.93
New Brunswick	0.065	0.98	0.97
Riverside−Rubidoux	0.160	0.94	0.96
Roxbury (Boston)	0.240	0.85	0.96

Figure 5-2 (continued).



Site	Intercept	Slope	R2
Bakersfield−California Ave	−0.170	1.30	0.85
Deer Park − Met One	0.057	0.80	0.82
New Brunswick	0.024	0.93	0.96
Riverside−Rubidoux	−0.034	1.00	0.98
Roxbury (Boston)	0.029	0.81	0.82

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. 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, 2012

Analyte	Sampler 1		Sampler 2		Avg Rel Diff(2)	Avg Rel AQS Unc(3)	Ratio AQS/ARD	Counts
	Avg. Conc	St Dev(1)	Avg. Conc	St Dev(1)				
PARTICULATE MATTER (GRAVIMETRY)								
Particulate matter 2.5µm	12.14	7.49	11.99	7.64	13.1%	6.3%	**47.8%**	302
ANIONS AND CATIONS BY IC								
Ammonium	0.87	0.93	0.87	0.94	10.7%	7.9%	73.9%	293
Sodium	0.05	0.04	0.05	0.04	20.4%	16.6%	81.3%	207
Potassium	0.20	0.27	0.18	0.21	22.3%	11.7%	52.6%	248
Nitrate	1.95	2.74	1.99	2.79	7.7%	7.6%	99.5%	300
Sulfate	1.75	1.11	1.76	1.12	6.8%	7.3%	107.4%	301
TRACE ELEMENTS BY XRF								
Aluminum	0.13	0.20	0.13	0.22	27.1%	20.3%	75.0%	136
Bromine	0.01	0.00	0.01	0.00	18.0%	26.5%	147.3%	207
Calcium	0.08	0.09	0.10	0.27	23.0%	10.8%	**47.1%**	299
Chlorine	0.08	0.17	0.08	0.18	32.1%	18.6%	57.9%	220
Chromium	0.01	0.04	0.00	0.00	35.1%	30.5%	87.0%	70
Copper	0.01	0.01	0.01	0.01	26.5%	13.9%	52.6%	251
Iron	0.15	0.17	0.15	0.24	18.1%	7.5%	**41.4%**	303
Lead	0.01	0.00	0.01	0.00	20.1%	31.2%	155.3%	24
Magnesium	0.04	0.03	0.05	0.05	35.5%	19.3%	54.2%	82
Manganese	0.01	0.01	0.01	0.01	20.8%	23.7%	114.2%	133
Nickel	0.00	0.00	0.00	0.00	28.4%	24.1%	85.0%	60
Potassium	0.08	0.06	0.08	0.07	13.1%	9.0%	68.3%	302
Silicon	0.20	0.34	0.20	0.39	22.0%	13.1%	59.6%	280
Sodium	0.20	0.20	0.19	0.19	18.9%	18.1%	95.6%	209
Sulfur	0.63	0.46	0.62	0.41	6.7%	7.2%	108.8%	303
Titanium	0.01	0.02	0.01	0.02	28.2%	25.5%	90.4%	91
Vanadium	0.01	0.00	0.01	0.00	18.6%	27.4%	147.9%	24
Zinc	0.02	0.03	0.02	0.03	15.6%	14.8%	94.6%	276
ORGANIC AND ELEMENTAL CARBON BY IMPROVE_A METHOD (Sampled by URG 3000N)								
EC IMPROVE TOR	0.70	0.43	0.69	0.45	9.3%	N/A	N/A	247
EC IMPROVE TOT	0.46	0.34	0.45	0.36	9.3%	N/A	N/A	247
OC IMPROVE TOR	2.14	1.12	2.10	1.03	5.5%	N/A	N/A	247
OC IMPROVE TOT	2.38	1.25	2.34	1.15	5.2%	N/A	N/A	247
O1 IMPROVE	0.17	0.18	0.19	0.19	32.4%	N/A	N/A	191
O2 IMPROVE	0.58	0.28	0.55	0.26	8.7%	N/A	N/A	247
O3 IMPROVE	0.70	0.37	0.70	0.36	9.5%	N/A	N/A	247

Analyte	Sampler 1		Sampler 2		Avg Rel Diff(2)	Avg Rel AQS Unc(3)	Ratio AQS/ARD	Counts
	Avg. Conc	St Dev(1)	Avg. Conc	St Dev(1)				
O4 IMPROVE	0.49	0.28	0.48	0.26	11.1%	N/A	N/A	247
OP IMPROVE TOR	0.27	0.23	0.28	0.18	23.9%	N/A	N/A	187
OP IMPROVE TOT	0.47	0.32	0.46	0.27	13.8%	N/A	N/A	244
E1 IMPROVE	0.87	0.50	0.86	0.47	8.5%	N/A	N/A	247
E2 IMPROVE	0.06	0.03	0.05	0.02	20.0%	N/A	N/A	240
TC IMPROVE	2.84	1.45	2.79	1.38	5.1%	N/A	N/A	247

[1] The standard deviations are a function of the natural variability of the environmental levels and are not indicative of the analytical precision.
[2] Calculated as the average of the absolute value of the relative difference between the two samplers' values, divided by the square root of 2.
[3] Average value of the relative uncertainties as reported to AQS.
[4] AQS/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 reported to AQS during 2012 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 2012. 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. The following species disagreed by a factor of 2 or more; ratios are shown in parentheses:

- Gravimetric mass (48%), Calcium (47%) and Iron (41%) were less than 50%. Notably, Gravimetric Mass exhibited poorer collocation agreement during 2012 than during 2011. This may have been due in part to the issues with the G.T. Craig Teflon results previously noted.

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 2012. No Trip Blank samples are currently being collected for the MET ONE SASS samplers. For the URG 3000N samplers, Trip Blanks are collected at a frequency of 2%, and 24 hour Blank Filters and Backup filters are collected at a frequency of 10%. 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. **Table 5-6** shows the distributions (percentiles) for field blanks and 24-hour blanks during 2012.

For XRF analysis, the average and median Field Blanks were well below the average MDLs for all elements. 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 3-9), when converted to $\mu g/m^3$ basis, showed an average of 0.023 $\mu g/m^3$ and a maximum of 0.067 $\mu g/m^3$. 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 145 through 156).

Analyte	Mean ($\mu g/m^3$)	Percentiles of Concentration ($\mu g/m^3$)						
		5	10	25	Median	75	90	95
Cations and anions by ion chromatography (Field Blanks)								
Ammonium	0.0015	0.0000	0.0000	0.0000	0.0000	0.0020	0.0045	0.0084
Potassium	0.0013	0.0000	0.0000	0.0000	0.0000	0.0000	0.0024	0.0061
Sodium	0.0080	0.0000	0.0000	0.0000	0.0000	0.0101	0.0187	0.0324
Nitrate	0.0128	0.0000	0.0000	0.0000	0.0000	0.0274	0.0411	0.0524
Sulfate	0.0320	0.0000	0.0000	0.0082	0.0331	0.0463	0.0593	0.0674
Mass by gravimetry								
Particulate matter 2.5μ	0.8977	0.0000	0.1042	0.4167	0.7292	1.2500	1.8750	2.3958
Organic and elemental carbon by IMPROVE A Method (24-hour Blanks)								
E1 IMPROVE	0.0021	0.0000	0.0000	0.0000	0.0000	0.0000	0.0043	0.0135
E2 IMPROVE	0.0008	0.0000	0.0000	0.0000	0.0000	0.0000	0.0024	0.0054
E3 IMPROVE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
EC IMPROVE TOR	0.0027	0.0000	0.0000	0.0000	0.0000	0.0006	0.0065	0.0157
EC IMPROVE TOT	0.0008	0.0000	0.0000	0.0000	0.0000	0.0000	0.0009	0.0047
O1 IMPROVE	0.0127	0.0000	0.0000	0.0024	0.0113	0.0191	0.0266	0.0333
O2 IMPROVE	0.0431	0.0202	0.0239	0.0299	0.0396	0.0498	0.0632	0.0778
O3 IMPROVE	0.0650	0.0270	0.0314	0.0399	0.0528	0.0707	0.1022	0.1349
O4 IMPROVE	0.0082	0.0000	0.0000	0.0000	0.0039	0.0092	0.0185	0.0301
OC IMPROVE TOR	0.1293	0.0556	0.0655	0.0843	0.1103	0.1439	0.2015	0.2612
OC IMPROVE TOT	0.1312	0.0556	0.0655	0.0845	0.1109	0.1444	0.2036	0.2677
OP IMPROVE TOR	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
OP IMPROVE TOT	0.0022	0.0000	0.0000	0.0000	0.0000	0.0000	0.0042	0.0128
TC IMPROVE	0.1319	0.0556	0.0655	0.0847	0.1113	0.1450	0.2086	0.2745
Trace elements by XRF (Field Blanks)								
Aluminum	0.0016	0.0000	0.0000	0.0000	0.0000	0.0000	0.0030	0.0076
Antimony	0.0025	0.0000	0.0000	0.0000	0.0000	0.0028	0.0082	0.0141
Arsenic	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0004	0.0008
Barium	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0018	0.0042
Bromine	0.0004	0.0000	0.0000	0.0000	0.0000	0.0007	0.0012	0.0016
Cadmium	0.0022	0.0000	0.0000	0.0000	0.0000	0.0018	0.0093	0.0129
Calcium	0.0011	0.0000	0.0000	0.0000	0.0000	0.0011	0.0021	0.0032
Cerium	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0009	0.0014
Cesium	0.0012	0.0000	0.0000	0.0000	0.0000	0.0016	0.0046	0.0059
Chlorine	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0014	0.0020
Chromium	0.0015	0.0000	0.0000	0.0000	0.0006	0.0014	0.0023	0.0030
Cobalt	0.0002	0.0000	0.0000	0.0000	0.0000	0.0004	0.0007	0.0010
Copper	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0006	0.0012
Indium	0.0020	0.0000	0.0000	0.0000	0.0000	0.0013	0.0071	0.0127
Iron	0.0038	0.0000	0.0000	0.0000	0.0010	0.0024	0.0055	0.0083
Lead	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0009	0.0016
Magnesium	0.0013	0.0000	0.0000	0.0000	0.0000	0.0000	0.0029	0.0101
Manganese	0.0002	0.0000	0.0000	0.0000	0.0000	0.0001	0.0007	0.0012

Analyte	Mean (µg/m^3)	Percentiles of Concentration (µg/m^3)						
		5	10	25	Median	75	90	95
Nickel	0.0003	0.0000	0.0000	0.0000	0.0000	0.0001	0.0006	0.0011
Phosphorus	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0008
Potassium	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0007	0.0016
Rubidium	0.0002	0.0000	0.0000	0.0000	0.0000	0.0002	0.0009	0.0013
Selenium	0.0003	0.0000	0.0000	0.0000	0.0000	0.0003	0.0010	0.0014
Silicon	0.0008	0.0000	0.0000	0.0000	0.0000	0.0000	0.0029	0.0041
Silver	0.0011	0.0000	0.0000	0.0000	0.0000	0.0000	0.0044	0.0071
Sodium	0.0048	0.0000	0.0000	0.0000	0.0000	0.0020	0.0139	0.0254
Strontium	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0007	0.0014
Sulfur	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0015	0.0020
Tin	0.0022	0.0000	0.0000	0.0000	0.0000	0.0014	0.0087	0.0140
Titanium	0.0003	0.0000	0.0000	0.0000	0.0000	0.0002	0.0011	0.0014
Vanadium	0.0002	0.0000	0.0000	0.0000	0.0000	0.0002	0.0008	0.0011
Zinc	0.0003	0.0000	0.0000	0.0000	0.0000	0.0003	0.0008	0.0013
Zirconium	0.0009	0.0000	0.0000	0.0000	0.0000	0.0004	0.0033	0.0054

"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 2012. Results from the backup filters might be used to assess the organic carbon artifact; however EPA has not designated a specific equation for determining the artifact values from this data.

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
E1 IMPROVE	0.0071	0.0000	0.0000	0.0000	0.0008	0.0085	0.0203	0.0304
E2 IMPROVE	0.0042	0.0000	0.0000	0.0000	0.0009	0.0062	0.0117	0.0164
E3 IMPROVE	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002
EC IMPROVE TOR	0.0098	0.0000	0.0000	0.0000	0.0039	0.0122	0.0271	0.0383
EC IMPROVE TOT	0.0018	0.0000	0.0000	0.0000	0.0000	0.0006	0.0055	0.0097
O1 IMPROVE	0.0326	0.0000	0.0000	0.0060	0.0243	0.0436	0.0762	0.1037
O2 IMPROVE	0.1047	0.0385	0.0503	0.0712	0.0972	0.1285	0.1688	0.1970
O3 IMPROVE	0.1292	0.0530	0.0644	0.0879	0.1170	0.1533	0.1999	0.2442
O4 IMPROVE	0.0363	0.0033	0.0084	0.0180	0.0304	0.0475	0.0690	0.0864
OC IMPROVE TOR	0.3045	0.1165	0.1444	0.2084	0.2817	0.3741	0.4817	0.5779
OC IMPROVE TOT	0.3125	0.1173	0.1444	0.2097	0.2872	0.3842	0.5017	0.5992
OP IMPROVE TOR	0.0016	0.0000	0.0000	0.0000	0.0000	0.0000	0.0011	0.0082
OP IMPROVE TOT	0.0096	0.0000	0.0000	0.0000	0.0025	0.0117	0.0278	0.0395
TC IMPROVE	0.3143	0.1173	0.1452	0.2099	0.2883	0.3862	0.5058	0.6024

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)
  - CSN Method (by TOT)
- Elemental analysis by X-Ray Fluorescence (XRF) – Teflon® filters
  - 25 mm filters
  - 47 mm filters

6.1.1 Interlaboratory Performance Evaluation Study, 2012

Participants in the 2012 interlaboratory study, in addition to RTI, included:

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

Unknowns were distributed to RTI and the other labs in early 2012 for gravimetry, XRF, ion chromatography, and OC/EC. As with the 2011 interlaboratory study, the RTI XRF laboratory served as the reference lab for the 2012 round. As the reference lab for XRF, RTI analyzed all of the filters to be used as PE samples in late 2011 so that NAREL could distribute them to the other participating laboratories in early 2012. RTI did not re-analyze filters by XRF that it had analyzed as the reference laboratory. RTI submitted its results to NAREL on February 15, 2012.

6.1.2 Interlaboratory Performance Results

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

http://www.epa.gov/ttnamti1/files/ambient/pm25/qa/MultilabSpeciationPT2011.pdf

RTI's performance on gravimetric mass, IC, and XRF has been uniformly within the range of the other laboratories and in good agreement with the designated reference labs. However, significant variations have been noted within and among laboratories for the various OC/EC methods.

6.2 *Technical Systems Audit (TSA)*

EPA NAREL performed a TSA of RTI's CSN laboratory operations on July 24-25, 2012, as part of EPA's quality assurance oversight for the CSN program. The TSA included laboratory assessments as well as analysis of samples provided by the auditors.

The agenda included inspection of the following operational areas:

- Pb-TSP Analysis, ICP/MS Laboratory – Frank Weber
- X-Ray Fluorescence (XRF) Laboratory – Andrea McWilliams
- Gravimetric Laboratory – Paige Presler-Jur
- Organic Carbon/Elemental Carbon (OC/EC) Laboratory – Prakash Doraiswamy
- Ion Chromatography (IC) Laboratory – Eva Hardison
- Sample Handling and Archiving Laboratory (SHAL) – Jim O'Rourke

Also included in the audit discussions were the following RTI managers:

- Dr. R.K.M. Jayanty – RTI Services Program Manager
- Dr. Jim Flanagan – Quality Assurance Manager
- Mr. Ed Rickman – Data Management Technical Supervisor

The findings from the audit are summarized in a Technical Memorandum dated November 14, 2012. The report included evaluation of RTI's analytical results for the unknown samples that had been provided by the auditors. No deficiencies were noted. The report is available online at:

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

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	5/11/2012	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

Appendix A

Method Detection Limits

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Appendix A
Method Detection Limits (Network-wide Maximum)

Analysis	Analyte	Mass (µg)	Concentration (µg/m^3) by sampler type	
			SASS	URG 3000N
Gravimetry	Particulate matter 2.5µm	7.5	0.84	
Anions and Cations	Ammonium	0.24	0.026	
	Potassium	0.23	0.025	
	Sodium	0.29	0.032	
	Nitrate	0.21	0.023	
	Sulfate	0.16	0.018	
Organic and Elemental Carbon	E1 IMPROVE	11		0.097
	E2 IMPROVE	7.1		0.065
	E3 IMPROVE	7.1		0.065
	EC IMPROVE TOR	7.1		0.064
	EC IMPROVE TOT	7.1		0.064
	O1 IMPROVE	7.1		0.065
	O2 IMPROVE	7.1		0.065
	O3 IMPROVE	11		0.097
	O4 IMPROVE	11		0.097
	OC IMPROVE TOR	7.1		0.064
	OC IMPROVE TOT	7.1		0.064
	OP IMPROVE TOR	11		0.096
	OP IMPROVE TOT	7.1		0.064
	TC IMPROVE	11		0.097
Trace Elements	Aluminum	0.24	0.027	
	Antimony	0.5	0.056	
	Arsenic	0.026	0.0028	
	Barium	0.57	0.06	
	Bromine	0.022	0.0025	
	Cadmium	0.22	0.024	
	Calcium	0.073	0.0083	
	Cerium	0.84	0.088	
	Cesium	0.44	0.047	
	Chlorine	0.11	0.011	
	Chromium	0.025	0.0028	
	Cobalt	0.019	0.002	
	Copper	0.024	0.0026	
	Indium	0.32	0.035	
	Iron	0.032	0.0034	
	Lead	0.061	0.0064	
	Magnesium	0.18	0.019	
	Manganese	0.028	0.0029	
	Nickel	0.018	0.0019	
	Phosphorus	0.15	0.018	
	Potassium	0.11	0.011	
	Rubidium	0.025	0.0028	
	Selenium	0.025	0.0027	

Analysis	Analyte	Mass (µg)	Concentration (µg/m^3) by sampler type	
			SASS	URG 3000N
	Silicon	0.18	0.019	
	Silver	0.36	0.04	
	Sodium	0.53	0.057	
	Strontium	0.034	0.0038	
	Sulfur	0.095	0.011	
	Tin	0.35	0.039	
	Titanium	0.051	0.0058	
	Vanadium	0.037	0.0042	
	Zinc	0.034	0.0038	
	Zirconium	0.22	0.025	

Appendix B

Data Completeness Summary

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

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					143	144	145	146	147	148	149	150	151	152	153	154
Allen Park	MI	261630001	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	93	90	100
Allen Park	MI	261630001	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	94	100
Bakersfield-California Ave	CA	060290014	5	URG 3000N	100	94	88	93	93	100	94	100	100	100	100	100
Bakersfield-California Ave	CA	060290014	5	SASS with URG 3000N	100	89	56	100	88	100	78	100	100	100	99	100
Bakersfield-California Ave (Collocated)	CA	060290014	6	SASS with URG 3000N	100	80	63	50	100	67	50	67	100	83	80	80
Bakersfield-California Ave (Collocated)	CA	060290014	6	URG 3000N	100	100	0	33	0	0	50	0	0	40	88	80
Baxter Water Treatment Plant	PA	421011002	5	SASS with URG 3000N	100	91	99	100	90	100	91	100	100	100	100	90
Baxter Water Treatment Plant	PA	421011002	5	URG 3000N	85	100	100	100	94	100	100	100	100	100	100	100
Beacon Hill - Met One	WA	530330080	6	URG 3000N	100	93	100	100	100	86	100	71	88	94	86	75
Beacon Hill - Met One	WA	530330080	6	SASS with URG 3000N	100	75	100	100	100	88	100	50	89	90	88	57
Blair Street	MO	295100085	6	URG 3000N	100	100	100	94	100	100	100	100	50	95	94	100
Blair Street	MO	295100085	6	SASS with URG 3000N	100	100	99	99	100	100	100	99	99	98	99	99
Burlington	VT	500070012	5	SASS with URG 3000N	100	78	100	88	100	100	100	100	69	90	100	100
Burlington	VT	500070012	5	URG 3000N	100	94	100	93	100	100	94	100	100	94	100	100
Capitol - Met One	LA	220330009	5	SASS with URG 3000N	100	100	90	90	90	90	98	84	100	83	61	100
Capitol - Met One	LA	220330009	5	URG 3000N	100	100	89	100	94	33	100	95	93	91	83	94
Chamizal - Met One	TX	481410044	5	URG 3000N	100	100	94	100	100	100	100	100	100	95	100	100
Chamizal - Met One	TX	481410044	5	SASS with URG 3000N	100	100	90	100	100	100	100	100	100	100	100	90
Chicopee	MA	250130008	5	URG 3000N		100	89	89	89	89	94	90	94	95	89	89
Chicopee	MA	250130008	5	SASS with URG 3000N	91	100	81	100	100	100	90	93	100	100	100	100
Com Ed - Met One	IL	170310076	5	SASS with URG 3000N	100	88	100	38	100	88	100	100	100	100	100	89
Com Ed - Met One	IL	170310076	5	URG 3000N	94	93	100	86	100	93	100	100	100	94	100	100
Criscuolo Park	CT	090090027	5	URG 3000N	100	100	100	86	100	100	100	94	100	100	100	100
Criscuolo Park	CT	090090027	5	SASS with URG 3000N	100	100	100	88	99	100	100	100	100	100	100	100
Deer Park - Met One	TX	482011039	6	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					143	144	145	146	147	148	149	150	151	152	153	154
Deer Park - Met One	TX	482011039	6	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Deer Park Collocated - Met One	TX	482011039	7	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Deer Park Collocated - Met One	TX	482011039	7	SASS with URG 3000N	99	100	100	100	100	100	100	100	80	100	100	100
Denver Animal Shelter	CO	080310025	5	SASS with URG 3000N	100	89	89	89	89	100	90	100	89	82	67	
Denver Animal Shelter	CO	080310025	5	URG 3000N	100	93	93	100	100	93	100	100	86	94	80	
East Providence	RI	440071010	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
East Providence	RI	440071010	5	URG 3000N	95	83	89	83	94	39	94	90	94	95	6	0
El Cajon	CA	060730003	5	SASS with URG 3000N	99	100	61	100	100	100	100	100	100	100	100	57
El Cajon	CA	060730003	5	URG 3000N	100	93	81	100	100	100	100	100	100	100	79	50
Elizabeth Lab	NJ	340390004	5	URG 3000N	50	100	100	100	100	100	100	94	100	50	100	100
Elizabeth Lab	NJ	340390004	5	SASS with URG 3000N	100	63	100	88	88	100	89	67	88	70	77	100
Essex - Met One	MD	240053001	5	URG 3000N	100	93	93	100	100	100	100	86	100	100	100	100
Essex - Met One	MD	240053001	5	SASS with URG 3000N	100	88	88	100	100	100	100	87	100	100	100	100
Fargo NW	ND	380171004	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Fargo NW	ND	380171004	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	93	100	100
Fresno - First Street	CA	060190008	5	SASS with URG 3000N	100	80	100									
Fresno - First Street	CA	060190008	5	URG 3000N	100	89	100									
Fresno - Garland	CA	060190011	5	SASS with URG 3000N			74	100	100	90	100	100	100	100	100	100
Fresno - Garland	CA	060190011	5	URG 3000N			75	100	94	89	100	95	94	100	94	100
G.T. Craig	OH	390350060	5	SASS with URG 3000N	100	100	78	100	80	88	78	100	100	100	99	88
G.T. Craig	OH	390350060	5	URG 3000N	94	64	0	7	0	50				100	100	93
G.T. Craig - Collocated	OH	390350060	6	URG 3000N				80	100	33						
G.T. Craig - Collocated	OH	390350060	6	SASS with URG 3000N			100	69	100	83	100	100	100	100	99	60
Garinger High School	NC	371190041	5	SASS with URG 3000N	100	99	100	90	100	100	99	92	79	91	100	91
Garinger High School	NC	371190041	5	URG 3000N	95	83	94	89	94	89	94	90	94	95	89	94
Hawthorne	UT	490353006	5	URG 3000N	100	94	94	100	100	100	100	100	100	100	100	100
Hawthorne	UT	490353006	5	SASS with URG 3000N	100	80	100	100	100	100	100	100	90	100	100	100
Henrico Co.	VA	510870014	5	SASS with URG 3000N	100	63	100	88	100	100	100	100	75	90	100	100
Henrico Co.	VA	510870014	5	URG 3000N	100	93	100	100	100	100	100	100	86	94	100	100
Hinton - Met One	TX	481130069	5	URG 3000N	100	93	100	44	100	100	100	100	100	100	100	100
Hinton - Met One	TX	481130069	5	SASS with URG 3000N	100	88	100	100	100	100	100	100	100	100	100	100

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					143	**144**	**145**	**146**	**147**	**148**	**149**	**150**	**151**	**152**	**153**	**154**
Indpls. Washington Park	IN	180970078	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Indpls. Washington Park	IN	180970078	5	URG 3000N	94	100	100	100	100	100	100	100	100	100	100	100
Jackson UMC	MS	280490019	5	SASS with URG 3000N	90	88	88	100	100	100	89	99	84	0		
Jackson UMC	MS	280490019	5	URG 3000N	100	93	93	100	100	100	94	100	93	0		
JFK Center	KS	202090021	5	URG 3000N	100	83	94	100	100	100	100	100	86	100	100	100
JFK Center	KS	202090021	5	SASS with URG 3000N	100	25	100	100	98	100	100	100	100	100	88	100
Lawrenceville	PA	420030008	6	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Lawrenceville	PA	420030008	6	URG 3000N	100	100	94	100	100	100	100	100	100	100	100	100
McMillan Reservoir - Met One	DC	110010043	5	SASS with URG 3000N	100	100	91	100	100	100	100	99	89	83	100	100
McMillan Reservoir - Met One	DC	110010043	5	URG 3000N	100	100	100	100	100	93	100	100	81	70	100	50
MLK	DE	100032004	5	SASS with URG 3000N	100	90	100	89	89	100	99	100	90	90	99	99
MLK	DE	100032004	5	URG 3000N	90	72	44	100	94	100	100	100	50	95	100	100
New Brunswick	NJ	340230006	5	SASS with URG 3000N	90	63	100	100	100	100	100	89	89	80	100	88
New Brunswick	NJ	340230006	5	URG 3000N	50	93	100	100	100	100	100	94	100	94	100	100
New Brunswick (Collocated)	NJ	340230006	6	SASS with URG 3000N	57	95	80	67	100	86	97	83	67	0	19	93
New Brunswick (Collocated)	NJ	340230006	6	URG 3000N	88	100	88	67	100	100	100	83	100	80	38	100
North Birmingham	AL	010730023	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
North Birmingham	AL	010730023	5	URG 3000N	94	43	100	93	93	100	100	100	100	94	100	100
Parklane	SC	450790007	5	SASS with URG 3000N	96	86	97	96	96	97	96	96	96	96	77	96
Parklane	SC	450790007	5	URG 3000N	100	94	39	94	50	83	100	100	94	95	89	100
Peoria Site 1127	OK	401431127	5	URG 3000N	100	93	100	100	100	100	100	100	100	100	100	100
Peoria Site 1127	OK	401431127	5	SASS with URG 3000N	100	86	100	100	100	100	100	100	100	100	100	100
Philips	MN	270530963	5	URG 3000N	100	100	100	100	94	94	94	95	50	95	100	100
Philips	MN	270530963	5	SASS with URG 3000N	100	100	100	100	90	100	100	91	89	99	100	100
Phoenix Supersite	AZ	040139997	7	URG 3000N	100	94	100	100	100	100	100	100	88	100	100	100
Phoenix Supersite	AZ	040139997	7	SASS with URG 3000N	100	99	100	100	100	100	100	100	100	100	100	100
Portland - SE Lafayette	OR	410510080	6	SASS with URG 3000N	91	100	100	91	90	0	100	67				100
Portland - SE Lafayette	OR	410510080	6	URG 3000N	95	100	100	95	89	0	100	63				100
Reno	NV	320310016	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Reno	NV	320310016	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					143	144	145	146	147	148	149	150	151	152	153	154
Riverside-Rubidoux	CA	060658001	5	URG 3000N	100	100	100	100	100	100	100	95	100	100	100	100
Riverside-Rubidoux	CA	060658001	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Riverside-Rubidoux (Collocated)	CA	060658001	6	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Riverside-Rubidoux (Collocated)	CA	060658001	6	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Roxbury (Boston)	MA	250250042	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	94	100
Roxbury (Boston)	MA	250250042	5	SASS with URG 3000N	100	100	100	100	100	91	99	100	100	100	90	100
Roxbury (Boston) - collocated	MA	250250042	6	URG 3000N	100	100	100	100	100	100	100	100	100	100	88	100
Roxbury (Boston) - collocated	MA	250250042	6	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	80	100
Sacramento - Del Paso Manor	CA	060670006	5	SASS with URG 3000N	100	100	100	100	100	90	100	100	100	100	100	100
Sacramento - Del Paso Manor	CA	060670006	5	URG 3000N	95	100	100	100	100	50	100	100	100	100	100	100
San Jose - Jackson Street	CA	060850005	5	URG 3000N	100	86	100	100	100	100	100	100	100	100	100	50
San Jose - Jackson Street	CA	060850005	5	SASS with URG 3000N	100	88	100	100	100	100	100	100	100	100	100	100
SER-DNR Headquarters	WI	550790026	5	SASS with URG 3000N	100	100	100	100	90	100	100	91	100	100	100	100
SER-DNR Headquarters	WI	550790026	5	URG 3000N	45	100	100	100	94	100	100	95	100	100	100	100
Shelby Farms	TN	471570075	6	URG 3000N	100	100	44	100	100	100	100	100	100	100	100	83
Shelby Farms	TN	471570075	6	SASS with URG 3000N	100	100	100	92	100	92	100	100	100	100	100	100
Sieben Flats	MT	300490004	5	URG 3000N	100	100	94	100	100	100	100	100	100	94	93	100
Sieben Flats	MT	300490004	5	SASS with URG 3000N	99	100	100	99	100	100	100	100	100	89	86	100
Simi Valley	CA	061112002	5	URG 3000N	78	79	81	50	25	79	88	25	86	28	36	43
Simi Valley	CA	061112002	5	SASS with URG 3000N	50	63	67	14	56	38	78	44	75	50	63	75
South DeKalb - Met One	GA	130890002	5	SASS with URG 3000N	100	88	100	97	100	100	89	100	100	98	99	100
South DeKalb - Met One	GA	130890002	5	URG 3000N	83	36	81	93	100	93	44	100	100	100	100	100
St. Lukes Meridian (IMS)	ID	160010010	5	SASS with URG 3000N	100	84	100	86	100	100	100	100	100	100	100	100
St. Lukes Meridian (IMS)	ID	160010010	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					143	144	145	146	147	148	149	150	151	152	153	154
Sydney	FL	120573002	5	URG 3000N	100	100	100	100	100	94	100	95	100	100	100	100
Sydney	FL	120573002	5	SASS with URG 3000N	92	90	100	100	100	100	100	90	99	100	100	99
Univ. of Florida Ag School	FL	120111002	5	SASS with URG 3000N	100	90	100	99	100	100	99	100	100	100	100	100
Univ. of Florida Ag School	FL	120111002	5	URG 3000N	100	89	100	100	100	89	100	100	100	100	94	50
Woolworth St	NE	310550019	5	SASS with URG 3000N	96	84	96	96	96	96	96	95	96	94	96	96
Woolworth St	NE	310550019	5	URG 3000N	100	93	100	100	100	100	100	100	100	100	100	100
WV - Guthrie Agricultural Center	WV	540390011	5	SASS with URG 3000N	100	77	100	100	100	100	100	89	100	81	88	100
WV - Guthrie Agricultural Center	WV	540390011	5	URG 3000N	100	93	100	100	100	100	100	50	93	89	93	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											
					143	144	145	146	147	148	149	150	151	152	153	154
5 Points	OH	391530023	5	SASS with URG 3000N	100	99	65	71	100	83	100	100	100	100	100	100
5 Points	OH	391530023	5	URG 3000N	88	80	100	100	83	83	100	100	100	100	100	100
AL - Phenix City	AL	011130001	5	URG 3000N	0	100	50	100	100	100	100	100	100	100	100	100
AL - Phenix City	AL	011130001	5	SASS with URG 3000N	100	100	80	100	100	100	100	100	100	100	100	100
Alabama (TN)	TN	471570024	5	URG 3000N	100	100	100	100	100	100	100	100	100	80	100	100
Alabama (TN)	TN	471570024	5	SASS with URG 3000N	100	80	100	100	75	100	100	100	100	83	0	80
Albany Co HD	NY	360010005	5	URG 3000N	100	100	94	90	94	100	95	100	88	95	89	89
Albany Co HD	NY	360010005	5	SASS with URG 3000N	91	90	89	83	90	100	91	93	89	91	100	100
Arendtsville	PA	420010001	5	SASS with URG 3000N	80	100	100	100	100	100	100	100	100	100	100	100
Arendtsville	PA	420010001	5	URG 3000N	88	100	100	100	100	100	100	100	100	100	100	100
Army Reserve Center - Met One	IA	191130037	5	URG 3000N	100	100	100									
Army Reserve Center - Met One	IA	191130037	5	SASS with URG 3000N	100	100	100									
Arnold West - Met One	MO	290990019	6	SASS with URG 3000N	100	100	100	100	100	100	100	100	89	100	100	100
Arnold West - Met One	MO	290990019	6	URG 3000N	100	100	100	6	100	100	100	100	100	100	100	100
Ashland Health Department	KY	210190017	5	SASS with URG 3000N	100	100	100	100	100	100	100	87	100	100	100	100
Ashland Health Department	KY	210190017	5	URG 3000N	100	100	100	100	100	50	100	100	100	100	100	100
Athens - Met One	GA	130590001	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Athens - Met One	GA	130590001	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	80	80	100
Augusta - Met One	GA	132450091	5	SASS with URG 3000N	100	100	100	81	75	100	100	100	100	80	58	99
Augusta - Met One	GA	132450091	5	URG 3000N	100	100	100	67	83	100	100	100	100	80	38	100
Blaine Anoka County Airport	MN	270031002	5	URG 3000N	95	83	94	89	89	83	94	90	94	95	89	89
Blaine Anoka County Airport	MN	270031002	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	91
Bonne Terre - Met One	MO	291860005	5	URG 3000N	85	50	100	100	94	100	100	90	50	20	72	57
Bonne Terre - Met One	MO	291860005	5	SASS with URG 3000N	100	100	100	99	100	100	100	91	100	100	100	100
Bountiful	UT	490110004	5	SASS with URG 3000N	100	100	100	100	100	100	100	80	83	100	100	80
Bountiful	UT	490110004	5	URG 3000N	100	100	100	100	100	100	100	80	100	100	100	80

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					143	144	145	146	147	148	149	150	151	152	153	154
Buffalo - Met One	NY	360290005	6	SASS with URG 3000N	100	100	100	100	75	100	100	100	100	100	100	100
Buffalo - Met One	NY	360290005	6	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Buncombe County Board of Education	NC	370210034	5	URG 3000N	75	100	100	83	83	67	17	50	0	100	100	100
Buncombe County Board of Education	NC	370210034	5	SASS with URG 3000N	100	100	80	100	100	100	100	100	100	100	100	100
Butte-Greeley School	MT	300930005	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	80	100	100	100
Butte-Greeley School	MT	300930005	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	80
Cannons Lane	KY	211110067	6	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Cannons Lane	KY	211110067	6	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	93	100	82
Canton Fire Station	OH	391510017	5	URG 3000N	100	100	100	100	100	83	100	83	88	100	100	100
Canton Fire Station	OH	391510017	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Chester	NJ	340273001	5	URG 3000N	83	100	100	100	100	100	100	100	100	100	100	100
Chester	NJ	340273001	5	SASS with URG 3000N	100	100	100	89	100	100	100	100	100	100	100	100
Chesterfield	SC	450250001	5	URG 3000N	100	100	100	100	100	100	100	100	63	80	75	100
Chesterfield	SC	450250001	5	SASS with URG 3000N	98	100	99	86	100	98	99	100	60	82	100	100
Cheyenne NCore	WY	560210100	5	SASS with URG 3000N								100	100	100	91	88
Cheyenne NCore	WY	560210100	5	URG 3000N								100	100	100	100	100
Children's Park	AZ	040191028	5	SASS with URG 3000N	91	80	90	80	80	80	82	82	89	91	80	80
Children's Park	AZ	040191028	5	URG 3000N	95	89	94	89	89	89	94	85	94	95	89	89
Clarksville	TN	471251009	5	SASS with URG 3000N	100	100	80	67	100	100	100	100	100	99	100	100
Clarksville	TN	471251009	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Columbus - Met One	GA	132150011	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Columbus - Met One	GA	132150011	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Commerce City	CO	080010006	5	URG 3000N	100	100	100	100	100	67	100	33	0	60	75	20
Commerce City	CO	080010006	5	SASS with URG 3000N	100	60	100	100	100	100	100	100	100	80	100	100
Dearborn	MI	261630033	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	83
Dearborn	MI	261630033	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Del Norte - Met One	NM	350010023	5	SASS with URG 3000N	100	88	100	100	100	100	85	100	100	100	100	100
Del Norte - Met One	NM	350010023	5	URG 3000N	100	86	100	100	93	100	100	100	100	94	100	100
Division St.	NY	360610134	5	URG 3000N	85	69	95	89	89	39	89	90	88	95	89	39
Division St.	NY	360610134	5	SASS with URG 3000N	91	56	100	100	100	92	80	100	100	100	100	90
Douglas - Met One	GA	130690002	5	SASS with URG 3000N	100	80	100	100	100	100	100	100	83	100	100	100

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					143	144	145	146	147	148	149	150	151	152	153	154
Douglas - Met One	GA	130690002	5	URG 3000N	100	100	100	100	83	100	100	100	63	100	100	100
Dover	DE	100010003	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	78	100	100	100
Dover	DE	100010003	5	URG 3000N	100	100	100	100	100	100	100	100	50	100	100	100
Downtown Library	OH	391130032	5	URG 3000N	100	100	100	100	100	83	100	100	100	80	100	100
Downtown Library	OH	391130032	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	80	100	85
Elkhart Prairie Street	IN	180390008	5	URG 3000N	100	100	100	100	100	100	67	100	100	100	100	100
Elkhart Prairie Street	IN	180390008	5	SASS with URG 3000N	100	100	100	100	99	100	100	100	100	100	100	100
Erie	PA	420490003	5	SASS with URG 3000N	100	100	100	100	100	100	75	100	100	100	100	100
Erie	PA	420490003	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	88	100
Evansville Buena Vista Rd	IN	181630021	5	URG 3000N	88	100	88	100	100	83	100	83	50	80	50	40
Evansville Buena Vista Rd	IN	181630021	5	SASS with URG 3000N	80	100	100	100	56	100	100	100	100	100	99	100
Fairbanks State Bldg	AK	020900010	6	URG 3000N	100	100	100	100	100	100	100	100	100	100	94	100
Fairbanks State Bldg	AK	020900010	6	SASS with URG 3000N	100	92	100	100	100	100	92	100	100	91	100	100
Florence	PA	421255001	5	SASS with URG 3000N	100	100	100	100	100	86	100	100	100	100	100	100
Florence	PA	421255001	5	URG 3000N	100	100	100	100	100	83	100	100	100	100	100	100
Freemansburg	PA	420950025	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Freemansburg	PA	420950025	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Gary Iitri	IN	180890022	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	98	100
Gary Iitri	IN	180890022	5	URG 3000N	88	100	100	100	100	100	100	100	100	100	100	100
Grand Rapids	MI	260810020	5	SASS with URG 3000N	100	63	92	100	66	100	79	100	100	100	100	100
Grand Rapids	MI	260810020	5	URG 3000N	100	93	100	100	100	100	88	100	100	100	100	93
Granite City	IL	171190024	5	SASS with URG 3000N	77	98	80	81	96	96	91	96	96	96	96	96
Granite City	IL	171190024	5	URG 3000N	0	20	0	83	83	100	100	0	88	20	0	0
Grayson	KY	210430500	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	98	80
Grayson	KY	210430500	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	80
Green Bay East High School	WI	550090005	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	25	100	100	100	100	100
Greensburg	PA	421290008	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	85	100	100
Greensburg	PA	421290008	5	URG 3000N	25	100	100	83	100	100	100	100	100	100	88	100
Greenville ESC	SC	450450015	5	SASS with URG 3000N	100	100	100	82	100	100	100	100	100	100	100	100
Greenville ESC	SC	450450015	5	URG 3000N	100	100	100	83	83	0	0	83	100	100	50	100

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					143	144	145	146	147	148	149	150	151	152	153	154
Harrisburg	PA	420430401	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Harrisburg	PA	420430401	5	SASS with URG 3000N	100	100	100	87	100	100	100	100	100	85	100	100
Hattie Avenue	NC	370670022	5	URG 3000N	100	100	88	100	100	17	0	83	88	100	100	80
Hattie Avenue	NC	370670022	5	SASS with URG 3000N	100	100	80	100	100	98	100	100	65	100	100	80
Head Start	OH	390990014	5	URG 3000N	100	100	100	100	100	100	83	100	100	100	100	100
Head Start	OH	390990014	5	SASS with URG 3000N	100	80	63	86	100	100	100	98	100	80	100	100
Hickory	NC	370350004	5	SASS with URG 3000N	100	100	100	100	75	83	100	100	50	100	100	80
Hickory	NC	370350004	5	URG 3000N	100	100	100	100	100	100	100	100	50	100	100	80
Horicon Palmatory	WI	550270001	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Horicon Palmatory	WI	550270001	5	SASS with URG 3000N	100	100	100	100	100	100	99	99	100	100	100	91
Houghton Lake	MI	261130001	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	98	100
Houghton Lake	MI	261130001	5	URG 3000N	100	100	100	100	100	83	100	100	100	100	100	100
HU-Beltsville Met One	MD	240330030	5	SASS with URG 3000N	90	88	78	100	100	100	100	89	100	100	100	100
HU-Beltsville Met One	MD	240330030	5	URG 3000N	50	93	88	100	100	100	100	94	100	100	100	100
Huntsville Old Airport	AL	010890014	5	URG 3000N	100	80	100	100	100	100	100	100	88	100	100	100
Huntsville Old Airport	AL	010890014	5	SASS with URG 3000N	100	100	100	100	100	100	81	100	80	100	83	100
Jasper Post Office	IN	180372001	5	SASS with URG 3000N	100	100	100	100	100	100	99	100	100	100	65	100
Jasper Post Office	IN	180372001	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Jefferson Elementary - Met One	IA	191630015	5	SASS with URG 3000N	100	100	100	99	100	100	100	100	100	100	100	100
Jefferson Elementary - Met One	IA	191630015	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Jeffersonville Walnut St	IN	180190006	5	URG 3000N	100	100	100	67	100	100	100	100	100	100	100	100
Jeffersonville Walnut St	IN	180190006	5	SASS with URG 3000N	100	100	100	100	99	100	99	100	100	100	85	100
Jerome Mack Middle School	NV	320030540	5	SASS with URG 3000N	90	75	100	100	100	100	100	100	100	100	100	100
Jerome Mack Middle School	NV	320030540	5	URG 3000N	94	93	100	86	100	100	100	100	100	100	100	93
Johnstown	PA	420210011	5	SASS with URG 3000N	100	80	100	100	100	100	100	100	100	100	100	100
Johnstown	PA	420210011	5	URG 3000N	100	80	100	100	100	83	100	83	100	100	100	100
Kapolei	HI	150030010	5	SASS with URG 3000N	90	100	82	80	90	90	100	82	89	100	80	100
Kapolei	HI	150030010	5	URG 3000N	100	100	95	94	89	94	94	80	88	95	44	100
Karnack - Met One	TX	482030002	5	SASS with URG 3000N	100	80	100	100	100	100	100	100	100	100	80	100
Karnack - Met One	TX	482030002	5	URG 3000N	100	80	100	100	100	100	100	100	100	100	88	80

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Kingston	TN	471451001	5	SASS	100	100	100									
Lancaster	PA	420710007	5	SASS with URG 3000N	100	100	100	100	75	98	100	100	100	100	100	100
Lancaster	PA	420710007	5	URG 3000N	88	100	100	100	100	83	83	100	100	100	100	80
Laurel	MS	280670002	5	URG 3000N	100	100	100	100	100	100	100	83	100	100	88	100
Laurel	MS	280670002	5	SASS with URG 3000N	80	100	40	100	100	100	100	100	100	100	80	96
Lawrence County	TN	470990002	5	SASS with URG 3000N	100	100	100	100	100	100	75	100	100	100	100	100
Lawrence County	TN	470990002	5	URG 3000N	100	100	100	100	100	100	83	100	100	100	88	20
Lexington - (NC)	NC	370570002	5	SASS with URG 3000N	99	100	100	100	100	100	100	100	98	100	100	100
Lexington - (NC)	NC	370570002	5	URG 3000N	100	80	100	100	100	83	100	100	100	100	100	100
Lexington Health Department	KY	210670012	5	URG 3000N	88	100	100	100	100	100	100	100	100	100	100	100
Lexington Health Department	KY	210670012	5	SASS with URG 3000N	60	100	100	100	100	100	100	100	60	85	100	100
Liberty - (PA)	PA	420030064	6	SASS with URG 3000N	100	100	100	100	100	100	100	83	100	100	100	100
Liberty - (PA)	PA	420030064	6	URG 3000N	88	60	88	33	83	100	100	83	100	100	100	100
Liberty - Met One	MO	290470005	5	URG 3000N	100	100	100	100	100	100	94	100	100	100	100	100
Liberty - Met One	MO	290470005	5	SASS with URG 3000N	100	100	100	100	100	99	100	93	100	100	100	100
Lindon	UT	490494001	5	SASS with URG 3000N	100	100	100	100	75	100	100	100	100	100	100	85
Lindon	UT	490494001	5	URG 3000N	100	100	100	83	100	100	13	83	17	17	88	100
Linn County Health	IA	191130040	5	SASS with URG 3000N			100	100	100	100	100	100	100	100	100	100
Linn County Health	IA	191130040	5	URG 3000N			100	100	100	83	100	100	100	100	50	100
Lockeland School - Met One	TN	470370023	5	URG 3000N	100	100	88	100	100	100	100	100	100	100	100	80
Lockeland School - Met One	TN	470370023	5	SASS with URG 3000N	100	80	100	100	100	100	100	100	100	100	100	100
Lorain	OH	390933002	5	URG 3000N	50	100	88	100	100	83	33	100	88	100	100	100
Lorain	OH	390933002	5	SASS with URG 3000N	98	20	60	100	100	100	98	100	98	100	99	100
Luna Pier	MI	261150005	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	83
Luna Pier	MI	261150005	5	URG 3000N	100	100	100	100	100	100	100	100	88	100	100	100
Macon - Met One	GA	130210007	5	SASS with URG 3000N	100	78	100	100	81	100	100	100	100	100	100	100
Macon - Met One	GA	130210007	5	URG 3000N	100	80	100	100	100	100	100	100	100	100	100	100
Maple Canyon	OH	390490081	6	URG 3000N	100	100	100	100	100	100	100	100	88	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	83	100	100	100	100	100	100	100	100

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Marysville - 7th Ave	WA	530611007	5	SASS with URG 3000N	100	100	100	83	100	100	100	83	100	100	100	100
Mechanicsburg	IN	180650003	5	SASS with URG 3000N	80	100	100	100	100	100	100	100	100	100	100	100
Mechanicsburg	IN	180650003	5	URG 3000N	50	100	100	83	83	100	100	100	100	100	100	100
Millbrook	NC	371830014	5	SASS with URG 3000N	91	80	100	100	90	100	100	100	100	100	80	81
Millbrook	NC	371830014	5	URG 3000N	100	89	94	94	94	94	100	100	100	100	100	94
Mingo Junction	OH	390811001	5	SASS with URG 3000N	80	80	100	86	100	87	100	100	100	100	100	100
Mingo Junction	OH	390811001	5	URG 3000N	100	100	100	100	100	83	0	67	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
MN - Rochester	MN	271095008	5	URG 3000N	100	100	100	83	100	100	100	100	100	100	100	100
MOMS	AL	011011002	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	60
MOMS	AL	011011002	5	SASS with URG 3000N	80	100	80	100	100	83	100	100	100	100	100	60
Moundsville Armory	WV	540511002	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	60
Moundsville Armory	WV	540511002	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	80	100	80
Naperville	IL	170434002	5	SASS with URG 3000N	96	96	96	96	96	96	96	96	96	96	96	96
Naperville	IL	170434002	5	URG 3000N	100	100	100	83	100	100	100	83	100	100	100	100
National Trail High School	OH	391351001	5	SASS with URG 3000N	100	80	90	100	100	92	99	100	100	100	100	92
National Trail High School	OH	391351001	5	URG 3000N	100	89	78	100	94	0	33	40	94	100	39	100
New Garden	PA	420290100	5	URG 3000N	88	100	100	100	100	100	100	100	100	100	38	60
New Garden	PA	420290100	5	SASS with URG 3000N	80	100	100	100	100	100	100	100	100	83	60	78
Newark	NJ	340130003	5	URG 3000N			100	93	100	100	94	100	100	100	100	100
Newark	NJ	340130003	5	SASS	100	75	100									
Newark	NJ	340130003	5	SASS with URG 3000N			100	100	100	100	89	89	100	100	100	100
NLR Parr	AR	051190007	5	SASS with URG 3000N	83	70	100	90	80	100	100	100	100	100	100	82
NLR Parr	AR	051190007	5	URG 3000N	95	78	94	94	100	100	100	100	100	100	94	89
North Los Angeles	CA	060371103	5	SASS with URG 3000N	92	100	100	100	100	80	91	100	100	73	80	100
North Los Angeles	CA	060371103	5	URG 3000N	95	94	44	100	94	89	83	100	100	45	89	100
Northbrook	IL	170314201	5	URG 3000N	95	100	94	100	100	94	100	95	100	100	89	33
Northbrook	IL	170314201	5	SASS with URG 3000N	87	76	96	96	96	86	96	87	74	79	69	96
OCUSA Campus	OK	401091037	5	SASS with URG 3000N	58	100	100	100	100	100	100	98	100	100	100	100
OCUSA Campus	OK	401091037	5	URG 3000N	25	100	100	100	100	100	100	100	100	100	100	100
ODOT Garage	OH	390870012	5	SASS with URG 3000N	100	100	100	99	100	100	100	100	99	85	100	100
ODOT Garage	OH	390870012	5	URG 3000N	100	100	38	17	50	100	100	100	100	100	100	100

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PerkinstownCASNET	WI	551198001	5	SASS with URG 3000N	100	100	83	100	100	100	100	100	100	100	100	63
PerkinstownCASNET	WI	551198001	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	80
PHILA - AMS Laboratory	PA	421010004	7	URG 3000N	50	100	100									
PHILA - AMS Laboratory	PA	421010004	7	SASS with URG 3000N	100	100	98									
Pinnacle State Park - Met One	NY	361010003	5	URG 3000N	40	83	94	94	89	94	94	85	94	83	90	89
Pinnacle State Park - Met One	NY	361010003	5	SASS with URG 3000N	91	90	100	100	100	99	91	100	100	80	91	90
Platteville	CO	081230008	5	URG 3000N	100	100	100	100	100	83	50	100	100	100	100	100
Platteville	CO	081230008	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	85	100
Port Huron	MI	261470005	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	85	100	100	100
Port Huron	MI	261470005	5	URG 3000N	100	100	100	100	100	100	100	100	50	100	100	100
Public Health Building - Met One	IA	191530030	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Public Health Building - Met One	IA	191530030	5	SASS with URG 3000N	100	80	100	100	100	83	100	100	99	100	100	100
Queens College - Met One	NY	360810124	6	SASS with URG 3000N	100	91	100	100	100	100	100	100	100	100	91	100
Queens College - Met One	NY	360810124	6	URG 3000N	100	100	100	100	100	100	100	100	100	100	95	100
Reading Airport	PA	420110011	5	URG 3000N	88	100	100	100	100	100	100	100	100	100	100	100
Reading Airport	PA	420110011	5	SASS with URG 3000N	80	100	100	98	100	100	81	100	100	100	100	100
Ritner	PA	421010055	5	URG 3000N	100	100	100	100	100	100	100	83	100	100	100	100
Ritner	PA	421010055	5	SASS with URG 3000N	100	99	100	100	100	100	100	83	100	99	100	98
Rochester Primary - Met One	NY	360551007	5	SASS with URG 3000N	91	90	89	100	89	100	91	91	100	100	77	91
Rochester Primary - Met One	NY	360551007	5	URG 3000N	100	89	88	100	94	100	95	90	100	100	38	95
Rockwell	NC	371590021	5	URG 3000N	100	100	88	100	100	100	100	100	100	100	100	100
Rockwell	NC	371590021	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Rome Elementary	GA	131150003	5	SASS with URG 3000N	100	100	80	100	100	83	100	100	100	100	100	100
Rome Elementary	GA	131150003	5	URG 3000N	100	100	100	100	100	100	100	83	100	100	100	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	83	100	100	100	100	100	100
Scranton	PA	420692006	5	SASS with URG 3000N	67	100	100	100	100	100	100	100	100	100	100	100
Scranton	PA	420692006	5	URG 3000N	80	100	100	83	100	100	100	100	100	100	100	100
Shreveport Airport - Met	LA	220150008	5	URG 3000N	100	100	100	100	100	100	50	40	75	67	100	100

Site	State	AQS Code	POC	Sampler Type	Report Batch											
					143	144	145	146	147	148	149	150	151	152	153	154
One																
Shreveport Airport - Met One	LA	220150008	5	SASS with URG 3000N	100	100	100	100	100	100	100	40	60	67	60	100
Sioux Falls School Site	SD	460990008	5	URG 3000N	95	94	94	100	94	95	100	90	88	94	90	100
Sioux Falls School Site	SD	460990008	5	SASS with URG 3000N	91	90	90	100	90	91	100	82	89	90	82	100
Skyview	FL	121030026	5	SASS with URG 3000N	100	100	100	100	100	100	100	86	100	100	100	100
Skyview	FL	121030026	5	URG 3000N	88	100	100	100	100	100	100	100	100	100	100	80
South Charleston Library	WV	540391005	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	80
South Charleston Library	WV	540391005	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	80
Spring Hill Elementary School	TN	470931020	5	URG 3000N	75	100	100	67	83	100	100	100	100	100	100	80
Spring Hill Elementary School	TN	470931020	5	SASS with URG 3000N	80	100	100	100	100	100	100	100	100	100	100	100
Springfield Pumping Station - Met One	IL	170310057	5	URG 3000N	100	20	0	83	83	100	100	83	100	100	88	100
Springfield Pumping Station - Met One	IL	170310057	5	SASS with URG 3000N	100	20	0	83	74	92	96	81	96	96	100	100
St Theo	OH	390350038	6	URG 3000N	100	100	100	100	100	100	100	100	100	80	100	100
St Theo	OH	390350038	6	SASS with URG 3000N	100	45	100	86	99	87	100	100	100	100	97	100
State College	PA	420270100	5	URG 3000N	100	100	100	67	100	100	83	100	100	100	50	100
State College	PA	420270100	5	SASS with URG 3000N	100	100	100	49	100	100	100	86	100	100	60	100
SW HS	MI	261630015	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
SW HS	MI	261630015	5	URG 3000N	50	100	100	100	100	100	100	100	88	100	100	100
Tacoma - Met One	WA	530530029	5	URG 3000N	100	80	100	100	100	80	100	33	100	60	88	0
Tacoma - Met One	WA	530530029	5	SASS with URG 3000N	100	100	100	100	100	100	100	33	100	63	80	0
Taft	OH	390610040	5	SASS with URG 3000N	100	100	100	100	90	100	100	100	100	100	92	100
Taft	OH	390610040	5	URG 3000N	100	100	100	100	100	100	100	90	94	100	100	100
Tallahassee Community College	FL	120730012	5	SASS with URG 3000N	100	100	100	100	75	100	87	82	100	80	100	100
Tallahassee Community College	FL	120730012	5	URG 3000N	100	100	100	100	83	100	100	100	100	80	100	100
Tecumseh	MI	260910007	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Tecumseh	MI	260910007	5	SASS with URG 3000N	100	100	100	99	100	100	100	83	100	100	99	100
Toledo Airport	OH	390950026	5	URG 3000N	100	100	100	100	50	60	100	83	100	100	100	100
Toledo Airport	OH	390950026	5	SASS with URG 3000N	100	96	97	82	100	100	100	100	100	100	100	80

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UTC	TN	470654002	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
UTC	TN	470654002	5	URG 3000N	100	100	100	100	50	80	50	67	50	100	100	100
VAN4PLN2	WA	530110013	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
VAN4PLN2	WA	530110013	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	83	100	100
Waukesha, Cleveland Ave. Site	WI	551330027	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Waukesha, Cleveland Ave. Site	WI	551330027	5	SASS with URG 3000N	100	100	100	100	100	81	100	71	100	65	100	100
Whiteface - Met One	NY	360310003	5	SASS with URG 3000N	100	100	100	100	100	100	100	98	85	83	80	100
Whiteface - Met One	NY	360310003	5	URG 3000N	100	100	100	86	100	100	100	100	100	100	88	100
Wichita Dept. of Env. Health - Met One	KS	201730010	5	SASS with URG 3000N	100	100	100	100	100	100	100	98	100	100	100	100
Wichita Dept. of Env. Health - Met One	KS	201730010	5	URG 3000N	100	100	100	100	100	100	100	83	100	100	100	100
Wylam	AL	010732003	5	SASS with URG 3000N	100	100	100	100	100	80	100	100	100	100	100	99
Wylam	AL	010732003	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Yakima Mental Health	WA	530770009	5	SASS with URG 3000N	100	100	100	100	100	100	75	100	80	100	100	100
Yakima Mental Health	WA	530770009	5	URG 3000N	100	100	100	100	100	100	100	100	100	80	100	100
York	PA	421330008	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
York	PA	421330008	5	URG 3000N	100	100	100	100	83	100	100	83	100	100	100	100