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DRAFT
Semi-Annual
Data Summary Report for the Chemical Speciation of PM2.5 Filter Samples Project

April 1, 2001 through September 30, 2002

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

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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. The regulations (given in 40 CFR Parts 50, 53, and 58) apply to the mass concentrations (μg/cubic meter of air) of particles with aerodynamic diameters less than 10 micrometers (the PM10 standard) and less than 2.5 micrometers (the PM2.5 standard). Currently, a 1500-site mass measurements network and a 225-site chemical speciation monitoring network have been established.

The ambient air data from the first network, which measures solely the mass of particulate matter, will be used principally for NAAQS comparison purposes in identifying areas that meet or do not meet the NAAQS criteria and in supporting designation of an area as attainment or non-attainment.

The smaller chemical Speciation Trends Network (STN) consists of a core set of 54 trends analysis sites and some 171 other sites. Chemically speciated data will be used to serve the needs associated with development of emission mitigation approaches to reduce ambient PM2.5 concentration levels. Such needs include emission inventory establishment, air quality model evaluations, and source attribution analysis. Other uses of the data sets will be regional haze assessments, estimating personal exposure to PM2.5 and its components, and evaluating potential linkages to health effects.

RTI is assisting in the PM2.5 STN 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 quality assurance (QA) activities being performed are described in the RTI QA Project Plan (QAPP) for this project. This QAPP focuses on the QA activities associated with RTI's role in performing these analyses, as well as in validating and reporting the data, and should be considered a companion document to this annual QA report.

Prior to operation of the core and additional sites, EPA ran a prototype network informally known as the "mini-trends" network. This network was composed of approximately 13 monitoring stations at sites throughout the U.S. Each site had two or more PM2.5 chemical speciation monitors to enable various sampler intercomparisons. The mini-trends network ran from February 2000 to July 31, 2000. Subsequently, the network sites have been increased and as of September 30, 2002, RTI is providing support for 225 sites which include the 54 trends analysis sites under the STN.

1.2 Project/Task Description

The STN 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 mass and for an array of chemical constituents including elements (by EDXRF), soluble anions and cations (by ion chromatography), and carbonaceous species (using the Sunset thermal degradation/laser transmittance system). Analysis of semi-volatile organic compounds and examination of particles by electron or optical microscopy have been performed on a very limited basis.

3. Assembling validated sets of data from the analyses, preparing data reports for EPA management and the states, and entering data to the Aerometric Information Retrieval System (AIRS) data bank 60 days after initial data reports are first submitted to the DOPO and the states.

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

1.3 Schedule

The initial portion of the STN program was a six-month pilot project at 13 different sites. This "mini-trends" project was conducted from February 2000 to July 2000. This period gave all participants an opportunity to work out technical and logistical problems. Additional sites have been added. As of September 30, 2002, we were providing support to 225 sites which include the 54 STN sites. This QA report covers the collection and analysis of samples from April 1, 2002 through September 30, 2002.

1.4 Major Laboratory Operational Areas

This report addresses the operation of the Sample Handling and Archiving Laboratory (SHAL) and QA/QC for the four major analytical areas active this past year. These analytical areas are the: (1) gravimetric determination of particulate mass on Teflon® filters;
(2) determination of 48 elements on Teflon® filters using X-ray fluorescence spectrometry;
(3) determination of nitrate, sulfate, sodium, ammonium and potassium on nylon or Teflon filters using ion chromatography; and (4) determination of organic carbon, elemental carbon, carbonate carbon, and total carbon on quartz filters using thermal optical transmittance. Also addressed is denuder refurbishment, data processing, and QA and data validation.

1.5 Significant Corrective Actions Taken

Any significant problems and corrective actions taken during this period under each analytical laboratory are described in this section. A detailed description of the problems encountered and corrective actions taken are given in Section 2.0.

- Gravimetric Mass – No significant corrective actions have been taken.

- Elemental Analysis – No significant corrective actions have been taken. Currently three XRF instruments are used for elemental analysis. These instruments include: two Kevex (770 and 771) XRFs from Chester LabNet, one Thermo-Noran XRF from CES, and oen ThermoNoran XRF from RTI. Intercomparison studies have been performed between the four instruments, and approved by EPA prior to using them for analysis. The RTI XRF has experienced some tube stability problems, in which the instrument would arc during the analysis. In April 2002, the tube was replaced and samples were re-analyzed. A slight upward drift with silicon was noticed during July and August 2002, but the values for the SRMs and micromatter QC never exceeded the QC requirements. The instrument was re-calibrated to correct the drift in September 2002.

  Two corrective actions were taken in the CES XRF analysis. They included two changes in the SOP (1) to conduct an energy calibration at the start of each day, prior to replicate analysis, and (2) to ensure that filters do not undergo any orientation change between analyses.

- Ion Analysis – Beginning in September 2001, it was observed that the relative percent difference for replicate analyses were higher than usual for sodium and sulfate. A contamination problem was suspected and subsequently corrected by replacing all tubing in the ion chromatographs and establishing a more rigorous cleaning procedure for auto sampler vials and injection vials.

  A new Nylon filter cleaning procedure was implemented in September 2002.

- OE/EC Analysis – No significant corrective actions have been taken.

- Sample Handling and Archiving Laboratory (SHAL) – Initially, there were many anomalous data points for R&P samplers. The staff were retrained in the processing of the R&P modules. In order to minimize the blank filter contamination, RTI has also replaced the Kim wipes and plastic trays used during the cleaning process.

- Data Processing – No significant correction actions have been taken.

2.0 Laboratory Quality Control Summaries

2.1 Gravimetric Laboratory

2.1.1 Personnel and Facilities

RTI's "Technology Ventures" and "Environmental Sciences and Engineering" research units merged in the Fall of 2001 to more closely align complementary research programs. With this merger, the Chemical Speciation Gravimetry Laboratory assumed full responsibility for the controlled-environment chamber formerly maintained by the Center for Environmental Technology (CET) and for all equipment housed in the chamber. Chamber identification is now consistent with RTI's Heating, Ventilation, and Air Conditioning (HVAC) Department system references, which are based on date of installation. Chamber 1 (the former CET chamber) was the first chamber installed in RTI Building 11. It was installed before the inception of the PM2.5 Chemical Speciation Trends Network contract at RTI. Chamber 2 (the former CEM chamber) was installed after Chamber 1.

Along with the effort to more closely align complementary research programs in 2001, individual departments and programs reevaluated the names by which they were known to ensure that each department's name truly reflected its research thrusts and capabilities. As of October 1, 2002, the Earth and Mineral Sciences Department was renamed the Microanalytical Sciences Department. This name change was not accompanied by changes in department personnel or facilities. The Microanalytical Sciences Department maintains responsibility for the gravimetric analyses of Teflon® filters for the PM2.5 Chemical Speciation Trends Network. No personnel changes have occurred in the PM2.5 Gravimetry Laboratory since the submission of the previous QA report in April 2002. High quality gravimetric analyses for Chemical Speciation, FRM clients and others continue to be produced in a timely manner by three full-time analysts.

Since February 2002, Teflon® filters for the Chemical Speciation Trends Network have been weighed in both chambers. The continued use of two chambers has contributed to a reduction in laboratory turnaround time (TAT) to the current monthly average of four days. The two weigh chambers were used to tare 11,580 filters between February and August 2002. Six thousand fifty-nine of the filters were weighed in Chamber 2, and five thousand five hundred twenty-one filters were weighed in Chamber 1. **Tables 1 and 2** summarize facility problems and corrective actions for Chambers 2 and 1, respectively.

2.1.2 Statistical Summary of QC Results

The types and frequency of QC checks applied to the gravimetric analysis of filters for the PM2.5 Chemical Speciation Trends Network have not changed since the previous QA report. QC data for the laboratory are summarized in **Tables 3 and 4**.

Table 1. Gravimetry Laboratory - Corrective Actions in Response to Facility Problems – RTI HVAC Reference Chamber 2

Duration of Problem	Nature of Problem	Corrective Action
April 2002	Extensive renovation to Building 11, Bay 6	RTI Facilities and Maintenance personnel and subcontractors began an extensive renovation project outside Chambers 1 and 2. Renovations included removal of sheetrock walls, carpeting, floor tile, and mastic. Laboratory Supervisor had renovation project leader hang a polyethylene curtain over chamber doors during floor tile and sheetrock removal. Laboratory personnel capped Petrislides® during the most dust-producing activities. RTI HVAC technician covered the three Bay 6 air intake grills for Chambers 1 and 2 with course filter media.
05/15-16/02	High temperature Dialout alarm	05/15/02 - Temperature started to climb early evening, peaked at 26° C at 19:25, and held steady overnight. Datatalk® (software) received alarm from the chamber and started dialing out to the on-call tech at approximately 17:54. He acknowledged the alarm and returned to campus, but did not correct the problem. 05/16/02 - RTI HVAC technician most familiar with the chamber system determined that actuator on chill water valve had failed again and temporarily replaced it with a unit from a different manufacturer that he had in stock. Follow-up: Robert Helton of RTI HVAC was given approval to investigate a more suitable replacement for the actuators that keep failing. He contacted sales engineers from two national distributers, who suggested using a Belimo spring return actuator.
05/31/02	Water above Chamber 2	Friday, 05/31/02 - Renovation contractors working above the ceiling notified laboratory staff that a drain pan above the chamber was full and would overflow over the upcoming weekend if not emptied. Laboratory staff paged RTI HVAC personnel, who climbed above the ceiling and emptied drain pan. Follow-up: Laboratory Supervisor contacted HVAC Supervisor via email on 06/02/02 for information regarding the incident. It was not a drain pan, but a bucket, placed there because the chilled water valve was “sweating.” HVAC Supervisor indicated that he would insulate the valve as soon as insulating material arrived the following day.
08/01/02 - 08/10/02	Planned replacement of faulty actuators	08/01/02 - Robert Helton, RTI HVAC Department, informed Laboratory Supervisor that he had not found a better actuator replacement than the model identified in May, and scheduled weekend replacement to minimize impact on laboratory schedule. Saturday, 08/03/02 - Robert Helton replaced actuators on both chambers, but did not have enough time to finish tuning the loop. Saturday, 08/10/02 - Robert Helton completed the installation. Note: While working, Robert Helton discovered a condensation leak caused by torn insulation on the chilled water lines. They wrapped the lines in foam tape and placed a bucket beneath them.

Table 1. (Continued)

Duration of Problem	Nature of Problem	Corrective Action
08/15/02	Planned repairs to Building 11 water chiller; temporary loss of temperature control	Laboratory Supervisor was contacted by RTI HVAC Supervisor on 08/14/02 to schedule an emergency repair to a leaking nipple on one of the Building 11 water chillers. Repair was performed early morning 08/15/02 with minimal impact on chamber environment.
09/13/02	Planned shut-down of power to Bldg 11, Bay 6	RTI Electrical Department made arrangements with Laboratory Supervisor on Friday, 09/13/02, to cut power to Bay 6 on Saturday, 09/14/02, to service electrical equipment. Laboratory Supervisor came to RTI on Saturday afternoon to verify that chambers were online, found that Chamber 2 dehumidification system was not operating, reset breaker, and attempted to “push start” desiccant wheel in dehumidifier. When these attempts did not restart system, she telephoned RTI electrical and HVAC on-call technicians. HVAC on-call technician was also contacted by Datatalk® call-out alarm. By the time the technician arrived at RTI, the dehumidifier had restarted. He observed the system to verify that it was operating normally and suggested that the Laboratory Supervisor’s actions had resulted in the restart.
10/16/02	High temperature Dialout alarm	10/15/02 - Temperature started to climb at approximately 10:00, climbed to approximately 23.5° C by 16:00 p.m., dropped to 22.1° C, and then started climbing again around 22:00. 10/16/02 - Laboratory personnel discovered temperature increase when they arrived and telephoned RTI HVAC personnel. RTI HVAC personnel determined that the problem was either a differential pressure switch or air in the piping for the smaller of the two chillers that service Building 11. The end result was that the control system assumed that there was no water flow and shut down the chiller to prevent damage. The HVAC technician was on call for the week, so he had only minimal time to spend with the equipment. Note: At Laboratory Supervisor’s request, HVAC technician added Chamber 1 to Laboratory Supervisor’s Datatalk® access at this time.

Table 2. Gravimetry Laboratory - Corrective Actions in Response to Facility Problems – RTI HVAC Reference Chamber 1

NOTE: Began to routinely utilize Chamber 1 for Chemical Speciation project in February 2002

Duration of Problem	Nature of Problem	Corrective Action
4/02	Extensive renovation to Building 11, Bay 6	RTI Facilities and Maintenance personnel and subcontractors began an extensive renovation project outside Chambers 1 and 2. Renovations included removal of sheetrock walls, carpeting, floor tile, and mastic. Laboratory Supervisor had renovation project leader hang a polyethylene curtain over chamber doors during floor tile and sheetrock removal. Laboratory personnel capped Petrislides® during the most dust-producing activities. RTI HVAC technician covered the three Bay 6 air intake grills for Chambers 1 and 2 with course filter media.
04/02/02	High Temperature	Laboratory staff reported that they had contacted RTI HVAC personnel about high temperature Laboratory staff, but had received no response. Laboratory Supervisor followed up with a telephone call requesting that HVAC personnel be paged to check the system. HVAC personnel investigated and confirmed that temperature alarm had been triggered, but did not isolate cause. Since Chamber 2 was unaffected, chilled water system was deemed functional.
04/03/02	High Temperature	RTI HVAC personnel determined that the actuator had been damaged, contacted the manufacturer, and found that the valve assembly is now obsolete. Also determined that the recommended replacement valve and actuator had a 2 week lead time. Noted that an alternative would be to retrofit the existing valve with the new style actuator which is in stock in Florida. RTI HVAC personnel noted, “Both units would require the addition of an isolation transformer and signal conditioner.... As this actuator would work with both chamber chilled water valves, and given the time involved in getting replacements, I would strongly suggest that you consider keeping a spare actuator in stock.” When contacted by Laboratory Supervisor, HVAC Department confirmed that the modification they were recommending is identical to the modification made to the CEM chamber (Chamber 2) in July and August 2001 (see Table 1 notes for 07/14/01).
08/01/02 - 08/10/02	Planned replacement of faulty actuators	08/01/02 - Robert Helton, RTI HVAC Department, informed Laboratory Supervisor that he had not found a better actuator replacement than the model identified in May, and scheduled weekend replacement to minimize impact on laboratory schedule. Saturday, 08/03/02 - Robert Helton replaced actuators on both chambers, but did not have enough time to finish tuning the loop. Saturday, 08/10/02 - Robert Helton completed the installation. Note: While working, Robert Helton discovered a condensation leak caused by torn insulation on the chilled water lines. They wrapped the lines in foam tape and placed a bucket beneath them.
08/15/02	Planned repairs to Building 11 water chiller; temporary loss of temperature control	Laboratory Supervisor was contacted by RTI HVAC Supervisor on 08/14/02 to schedule an emergency repair to a leaking nipple on one of the Building 11 water chillers. Repair was performed early morning 08/15/02 with minimal impact on chamber environment.

Table 2. (Continued)

Duration of Problem	Nature of Problem	Corrective Action
10/16/02	High temperature Dialout alarm	10/15/02 - Temperature started to climb at approximately 10:00, climbed to approximately 23.5° C by 16:00 p.m., dropped to 22.1° C, and then started climbing again around 22:00. 10/16/02 - Laboratory personnel discovered temperature increase when they arrived and telephoned RTI HVAC personnel. RTI HVAC personnel determined that the problem was either a differential pressure switch or air in the piping for the smaller of the two chillers that service Building 11. The end result was that the control system assumed that there was no water flow and shut down the chiller to prevent damage. The HVAC technician was on call for the week, so he had only minimal time to spend with the equipment. Note: At Laboratory Supervisor's request, HVAC technician added Chamber 1 to Laboratory Supervisor's Datatalk® access at this time.

Table 3. Sample Throughput for the Gravimetry Laboratory

Number of Filters	Previous QA Report	This QA Report
Tared	7021 (8/13/01-2/11/02)	11580 (2/17/02-8/23/02)
Tared in Weigh Chamber 1	200	5521
Tared in Weigh Chamber 2	6821	6059
Retained by Grav Lab for use as Lab Blanks	35 (0.50%)	40 (0.35%)
Not Transferred to SHAL; does not include lab blanks	45 filters not picked up by SHAL	3 filters damaged before transfer to SHAL
Initially Transferred to SHAL to be Loaded into Sampler Modules	6941	11537
Not used by SHAL due to filter ID numbers being incompatible with project database	132	0
Used for Background Monitoring of SHAL Facilities after Maintenance Activities	0	9
Used for check for Delrin® or Impactor Oil Contamination	1	0
Total Transferred to and Retained by SHAL for Sampler Modules	6808	11528
Returned to Grav Lab by SHAL for Final Weighing	6634 (97.4% return rate) (9/27/01-4/4/02)	11025 (95.6% return rate) (3/12/02-10/7/02)
Voided by SHAL and Grav Lab	4 (0.06%)	4 (0.03%)
Flagged by Grav Lab for Exceeding 10-day Holding Time in Lab	489 (7.4%)	90 (0.82%)
Flagged by Grav Lab for Laboratory Environmental Criteria Being Out of Limits	0	291 (2.6%)

Table 4. Summary of QC Checks Applied in the Gravimetry Laboratory

QC Check	Requirements	QC Checks Applied to RTI Laboratory	Lab Mean	Comments
Working standard reference weights (mass reference standards)	Verified value ± 3 µg (CEM weights verified by North Carolina Department of Agriculture (NCDA) Standards Laboratory)	100-mg (Chamber 2) Verified Value = 99.957 mg (NCDA 8/01) 200-mg (Chambers 1 and 2) Verified Value = 199.978 mg (NCDA 8/01) 100-mg (Formerly the property of CET) Certified Weight Range = 99.990 - 100.010 mg (Original Purchase Certification 6/9/95)	99.955 mg ± 0.001 for 1430 weighings 199.977 mg ± 0.001 for 1503 weighings 99.992 mg ± 0.001 for 392 weighings	Lab mean falls within range. Lab mean falls within range. Lab mean falls within range. Note: The laboratory purchased six additional Class 1 reference standards (three 100-mg and three 200-mg), which were calibrated by Henry Troemner LLC on October 25, 2002, before delivery to RTI. Each work station is now equipped with a set of two standards.
Laboratory (Filter) Blanks	Initial weight ± 15 µg	399 total replicate weighings of 40 lab blanks	Mean difference between final and initial weight: 3 µg ± 3 µg	None of the 399 replicate weighings exceeded the 15 µg limit.
Replicates	Initial weight ± 15 µg	1154 Pre-sampled (Tared) Replicates (2/17/02 - 8/23/02) 1200 Post-sampled Replicates (3/12/02 - 10/7/0)	0 µg 0 µg	Max = 5 µg; within required range Max = 5 µg; within required range

Table 4. (Continued)

QC Check	Requirements	QC Checks Applied to RTI Laboratory	Lab Mean	Comments
Lot Blanks (Lot Stability Filters)	24-hour weight change < ± 5 µg	Whatman Lot 2017014 - 6 filters weighed (2 randomly selected from each of 3 randomly selected boxes) Whatman Lot 2043022 - 6 filters weighed (2 randomly selected from each of 3 randomly selected boxes) Whatman Lot 2050018 - 6 filters weighed (2 randomly selected from each of 3 randomly selected boxes) Whatman Lot 1093009 - 6 filters weighed (2 randomly selected from each of 3 randomly selected boxes) Whatman Lot 2070012 - 6 filters weighed (2 randomly selected from each of 3 randomly selected boxes)	24 hours = -1 µg 48 hours = 1 µg 72 hours = 0 µg 24 hours = -2 µg 48 hours = 0 µg 72 hours = 1 µg 96 hours = 0 µg 24 hours = -2 µg 48 hours = 3 µg 72 hours = 1 µg 96 hours = -1µg 24 hours = -1 µg 48 hours = 2 µg 72 hours = -2 µg 96 hours = 1 µg 24 hours = -6 µg 48 hours = -1 µg 72 hours = 1 µg 96 hours = -1 µg	Fall well within required range.
Lot Blank (Lot Stability Filters) (continued)	24-hr weight change < ± 5 µg	Whatman Lot 2207003 - 6 filters weighed (2 randomly selected from each of 3 randomly selected boxes)	24 hours = -3 µg 48 hours = -1 µg 72 hours = 1 µg 96 hours = -2 µg	Fall well within required range.
Calibrations • Working Mass Reference Standards	Annually	Last calibrated by NCDA on November 21, 2001	N/A	The laboratory purchased three additional Class 1 100-mg reference standards and three additional Class 1 200-mg reference standards in October 2002. These standards were calibrated by Henry Troemner LLC on October 25, 2002 before delivery to RTI. Each weighing station is now equipped with a set of two reference weights.

Table 4. (Continued)

QC Check	Requirements	QC Checks Applied to RTI Laboratory	Lab Mean	Comments
Calibrations (continued)				
• Balances (Chamber 2 Balance B- S/N 1118311244 and Chamber 1 Balance C - S/N 1118252777)	Auto (internal) calibration daily	Daily	N/A	
	External calibration annually or as needed	Last inspected and calibrated by Mettler Toledo on July 17, 2002 using NIST-traceable weights	N/A	
• RH/T Data Logger	Annually	Calibration of Dickson D200 Data Logger (S/N 98122054) by Dickson Calibration Services in January 2002 Purchased and placed in service third Dickson data logger (S/N 00102174) in April 2001 Placed Dickson data logger (S/N 01042219) in CET Weigh Chamber in February 2002	N/A	Data logger (S/N 98122054, purchased in 1998) removed from service due to RH being "out of spec" in January 2002 calibration. Both chambers currently equipped with calibrated Dickson data loggers (Chamber 2- S/N 00102174 and Chamber 1- S/N 01042219).
Audits				
• Balances (Chamber 2 Balance B - S/N 118311244 and Chamber 1 Balance - S/N 118252777) (internal audit)	Annually	Last performed by RTI QA October 8, 2002 using Class S-1 NIST-traceable weights	N/A	Included environmental evaluation, level test, scale-clarity test, zero-adjustment test, off-center (corner load error) test, precision test, and accuracy test; balances performed adequately. Auditor noted that balance in Chamber 1 displayed some drift that was resolved after allowing a 200-mg reference weight to sit on weigh pan for approximately 5 minutes after start-up possibly attributable to "warm-up" of balance's internal microprocessor.

2.1.3 Data Validity Discussion

Filters were assigned the appropriate Chemical Speciation Validity Flags on the basis of problems arising in the PM2.5 Gravimetry Laboratory. Problems consisted of excessive laboratory holdings times, laboratory environmental criteria being out of limits, and the use of a 100-mg standard reference weight (belonging to the former Center for Environmental Technology) which had not been recently calibrated. Each of the problems are discussed below.

Laboratory holding times exceeding 10 days: The analyses of ninety (0.82%) of the sampled filters were flagged due to laboratory holding times exceeding the 10-day limit. This problem was associated with a backlog of sampled Chemical Speciation filters in March 2002. The PM2.5 Gravimetry Laboratory has continued to take measures to avoid sample backlog and excessive holding times. These measures include the use of Weigh Chambers 1 and 2 for the equilibration and analysis of Chemical Speciation filters. The use of the both chambers allows two analysts to concurrently weigh Speciation filters, greatly increasing productivity. The gravimetry analysts have also worked on an overtime schedule in order to fulfill the SHAL's needs for tared filters and to avoid excessive laboratory holding times. Additional personnel from the Microanalytical Sciences Department assist with the equilibration of unsampled and sampled Chemical Speciation filters, allowing the gravimetry analysts to concentrate on the timely analysis of unsampled and sampled filters. Labeling each shelf containing sampled filters in the PM2.5 Gravimetry Laboratory with equilibration and expiration dates has continued since the previous QA report in order to avoid laboratory error which may result in excessive laboratory holding times.

Since submission of the April 2002 QA report, the addition of a laboratory-specific Chemical Speciation Chain of Custody Logbook has allowed for tracking each batch of sampled filters from the date of receipt to the date of transfer back to SHAL. A great effort is made to not place batches of sampled filters in cold storage so that the filters can be equilibrated on the same day that they are received. Batches may be placed in cold storage if they are received at the end of the work day. The filters in those batches are then equilibrated the next morning. Because SHAL transfers batches of sampled filters to the PM2.5 Gravimetry Laboratory early in the day, batches are placed in cold storage very infrequently. The date that the batches are transferred to the PM2.5 Gravimetry Laboratory is recorded in the Chemical Speciation Chain of Custody Logbook. The Gravimetry Lab analysts are notified two days ahead of the date that the batches are due back to SHAL, so that each batch of sampled filters is analyzed within seven days of receipt. These measures, along with the diligence of the gravimetry lab analysts, have resulted in greatly improved lab turn-around-times and a reduced number of filters flagged due to excessive laboratory holding times. Ninety filters were flagged for the period between April and October 2002, as opposed to four hundred eighty-nine filters for October 2001 to April 2002.

As of this writing, work continues on the development and implementation of database routines to further streamline sample handling and data acquisition. The training portion of the Gravimetry Laboratory's database application will be launched in November 2002. When operational, the application will link the PM2.5 Gravimetry Laboratory to the Chemical Speciation database in order to expedite the weighing and data transfer procedures and to provide more quality control measures.

Laboratory environmental criteria being out of limits: Three hundred and one filters, tare weighed on March 19, 2002 in Weigh Chamber 1, were flagged due to the laboratory environmental criteria being out of limits. The relative humidity (RH) in the weigh chamber ranged from 40% to 42.5% during the weigh session with an average RH of 39% and a standard deviation of 2.45 for the 24-hour period preceding the weigh session. RTI HVAC personnel shut down the chilled water system for the weigh chamber during the weekend before the weigh session in order to install a line reactor, resulting an increase in RH on March 18 and 19. Filters were tare weighed on March 19, 2002 in order to maintain the Chemical Speciation filter pickup schedule. All replicate weighings of the lab blank and duplicate weighings of sampled and unsampled filters from this batch of filters have been within the acceptable ranges as suggested by EPA Guidance Document 2.12.

Standard reference weight: When the gravimetric analysis of Chemical Speciation filters began in the Weigh Chamber 1 (formerly the CET Weigh Chamber), the 100-mg standard reference weight from Weigh Chamber 1 was used for replicate weighings, instead of one of the recently calibrated standard reference weights from the Weigh Chamber 2 (formerly the CEM Weigh Chamber). This problem was realized before submission of the April 2002 QA report. At that time, the Gravimetry Laboratory Supervisor advised the gravimetry laboratory analysts to discontinue using the 100-mg standard reference weight, and to transfer a standard reference weight from Weigh Chamber 2 for future use. A Chemical Speciation Trends Network Corrective Action Request (CAR) was completed in response to the problem. A copy of the completed form was included in the April 2002 QA report.

The 100-mg standard reference weight originating from Weigh Chamber 1 was again used for replicate weighings for a period of time after submission of the previous QA report. The original purchase certification information for the 100-mg standard reference weight from Weigh Chamber 1 has been obtained. The average of the replicate weighings of the 100-mg standard reference weight falls well within the certified weight range from the original Purchase Certification. The gravimetry analysts currently use a recently calibrated 200-mg standard reference weight from the Weigh Chamber 2 for replicate weighings performed during weigh sessions in Weigh Chamber 1.

The PM2.5 Laboratory Supervisor purchased six additional Class 1 reference standards (three 100-mg and three 200-mg), which were calibrated by Henry Troemner LLC on October 25, 2002, before delivery to RTI. Each work station is now equipped with a set of two standards. Since each balance is assigned its own set of standard reference weights, the possibility of use of the incorrect standard reference weight is greatly reduced. The PM2.5 Gravimetry Laboratory will have a sufficient number of standard reference weights to allow for staggered recertification of the weights at the North Carolina Department of Agriculture and Consumer Services metrology laboratory.

2.1.3.1 Invalidated Data – Four (0.04%) of the filters analyzed were invalidated. One filter was invalidated by the PM2.5 Gravimetry Laboratory due to an anomalous loading. Three filters were invalidated by SHAL because the filters had unreadable filter ID numbers and anomalous loadings. These filters were flagged appropriately.

2.1.4 Audits, Performance Evaluations, Training, and Accreditations

Since April 2002, the PM2.5 Gravimetry Laboratory has undergone one internal systems review by the Deputy Quality Assurance Officer for the Chemical Speciation Trends Network Laboratory. The laboratory anticipates its annual Performance Evaluation (PE) sample analysis in November 2002. The annual technical systems audit by EPA-NAREL and EPA/OAQPS is expected in February 2003.

The laboratory's Louisiana Environmental Laboratory Accreditation Program (LELAP) accreditation for the determination of PM2.5 in ambient air by gravimetric methods was renewed in July 2002.

In August 2002, QA officers for RTI's FRM and Chemical Speciation contracts administered a written examination to PM2.5 Gravimetry Laboratory personnel as indicated in **Table 5**.

Table 5. Gravimetry Laboratory Personnel Training

Administered by	Date/Activity	Results/Recommendations
QA officers for FRM and Chemical Speciaton projects	August 26 - September 3, 2002 Examination was administered to Gravimetry Laboratory. Purposes of the "open book" test were: 1) to help laboratory personnel review SOPs, the QAPP, and EPA document 2.12; 2) to document training for auditors; 3) to identify weaknesses in training in order to strengthen them.	QA officers reviewed tests and made corrections and/or comments. PM2.5 Gravimetry Laboratory personnel performed well on test. PM2.5 Laboratory Supervisor identified and addressed three topics which needed clarification according to test results. These areas included: 1) equilibration periods for filters; 2) acceptable temperature and humidity ranges in the weighing environment; 3) allowable holding times of sampled filters based on receipt temperature. Original tests were filed with Microanalytical Sciences Department training records and are available for review.

2.2 Ion Analysis Laboratory

2.2.1 Facilities

Ion chromatographic analyses are performed by personnel from RTI's Environmental Industrial Chemistry Department (EICD). Six ion chromatographic systems were used for performance of the measurements. These are described in **Table 6**. The use of these six systems was determined by the workload.

Table 6. Description of Ion Chromatographic Systems used for Analysis of PM2.5 Filter Samples

System No.	Dionex IC Model	Ions Measured
1	Model 500 (S1A)	SO_4, NO_3
2	Model 500 (S2A)	SO_4, NO_3
3	Model 500 (S3A)	SO_4, NO_3
4	DX-600 (D6A)	SO_4, NO_3
5	Model 500 (D5C)	Na, NH4, K
6	DX-600 (D6C)	Na, NH4, K

2.2.2 Description of QC Checks Applied

QC checks for ion analyses are summarized in **Table 7**. For ion analyses, a daily multipoint calibration (7 points for cations; 8 points for anions) is performed over the range 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) a QC sample containing concentrations of each ion in the mid- to high-range of the calibration standard concentrations, (2) a 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 reruns 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 7. Ion Analysis of PM2.5 - Quality Control/ Quality Assurance Checks

QA/QC Check	Frequency	Requirements
Calibration Regression Parameters	Daily	r $\geq$ 0.999
Initial QA/QC Checks:		
- QC sample at mid to high range concentration	Daily, immediately after calibration	Measured concentrations within 10% of known values
- 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

* MDL = Minimum Detectable Limit RPD = Relative Percent Difference

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 measures differs by more than 10 percent from the known value, the problem is identified and corrected. Any field samples are then analyzed.

During an analysis run, a duplicate sample, a QA/QC sample, and a spiked sample are analyzed at the rate of at least one every 20 field samples. Precision objectives for duplicate analyses are ±5 percent for concentrations that equal or exceed 100 times the minimum detectable limit (MDL), ±10 percent for concentrations at 10 times the MDL, and ±100 percent for concentrations at the MDL. The observed value for any ion being measured must be within 10 percent of the known value for the QA/QC samples, and ion recoveries for the spiked samples must be within 90 to 110 percent 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 reanalyzed.

2.2.3 Summary of QC Results

2.2.3.1 Anions – QC checks performed included:

- 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 8 shows recoveries for NO_3^- with low, medium, and high concentration QC samples (prepared by RTI) and with low and medium-high QA samples (commercially prepared and NIST-traceable) for the instrument used for anion analysis. Average recoveries for the three QC samples ranged from 97.4% to 102.1% over the six month period; average recoveries for the two QA samples ranged from 96.6% to 101.7%.

Table 9 shows recoveries for SO_4^{2-} with low, medium, and high QC samples and with low and medium-high QA samples for the instrument used for anion analysis. Average recoveries for the three QC samples ranged from 98.0% to 102.3% over the six month period; average recoveries for the two QA samples ranged from 97.0% to 102.2%.

Figure 1 shows a plot of the original nitrate concentration vs. the duplicate nitrate concentration for replicate measurements of the filter extracts. The plot shows excellent agreement for the duplicate measurements over the entire concentration range.

Figure 2 shows a plot of the original sulfate concentration vs. the duplicate sulfate concentration for replicate measurements of the filter extracts. Again, the plot shows excellent agreement for the duplicate measurements over the entire concentration range.

Table 10 shows percent recovery for nitrate and sulfate spikes by filter type for the six month period. There was no significant difference in the spike recoveries of nitrate or sulfate for the two different filter types. The average recoveries of nitrate for both types of filters ranged from 95.6% to 103.2%, while the average recoveries for sulfate ranged from 97.6% to 102.4%.

Table 11 presents filter blank (N BLANK) and reagent blank values for nitrate and sulfate over the six month period. The highest average value for filter blanks was 0.014 ppm (25 mL extract) for nitrate and 0.011 ppm for sulfate; the highest average reagent blank was 0.001 ppm for nitrate and 0.035 ppm for sulfate.

Table 8. Average Percent Recovery for Nitrate QA and QC Samples

Inst	QC Sample	Count	Conc.,ug/mL	Av NO3 Rec, %	SD NO3, %	Min NO3 Rec, %	Max NO3 Rec, %
D6A	QA-CPI_LOW	102	0.60	96.6%	2.3%	89.4%	101.1%
D6A	QA-LOW	140	0.60	97.4%	1.9%	91.1%	100.2%
D6A	QA-MED	166	1.50	97.7%	1.9%	92.1%	102.3%
D6A	QA-CPI_MED-HI	71	3.00	98.9%	2.6%	93.4%	103.8%
D6A	QA-HIGH	98	6.00	100.4%	2.0%	94.9%	103.1%
S1A	QA-CPI_LOW	6	0.60	99.0%	1.9%	97.1%	101.6%
S1A	QA-LOW	8	0.60	99.7%	1.0%	97.6%	100.5%
S1A	QA-MED	7	1.50	99.7%	0.4%	99.0%	100.3%
S1A	QA-CPI_MED-HI	4	3.00	102.0%	2.1%	99.9%	103.9%
S1A	QA-HIGH	5	6.00	102.0%	0.6%	101.4%	102.8%
S2A	QA-CPI_LOW	73	0.60	98.1%	1.1%	96.1%	100.9%
S2A	QA-LOW	95	0.60	99.4%	0.8%	98.1%	101.5%
S2A	QA-MED	115	1.50	99.1%	0.7%	97.4%	101.4%
S2A	QA-CPI_MED-HI	53	3.00	100.3%	0.7%	99.2%	102.9%
S2A	QA-HIGH	68	6.00	101.6%	0.4%	100.9%	102.7%
S3A	QA-CPI_LOW	52	0.60	98.7%	1.5%	96.7%	103.6%
S3A	QA-LOW	72	0.60	99.2%	1.0%	96.7%	102.9%
S3A	QA-MED	87	1.50	99.2%	0.8%	97.5%	101.7%
S3A	QA-CPI_MED-HI	37	3.00	101.7%	1.3%	99.4%	104.1%
S3A	QA-HIGH	53	6.00	102.1%	0.5%	101.2%	103.8%

Table 9. Average Percent Recovery for Sulfate QA and QC Samples

Inst	QC Sample	Count	Conc.,ug/mL	Av SO4 Rec, %	SD SO4, %	Min SO4 Rec, %	Max SO4 Rec, %
D6A	QA-CPI_LOW	102	1.20	97.0%	2.3%	89.9%	102.0%
D6A	QA-LOW	140	1.20	98.0%	2.2%	90.3%	101.2%
D6A	QA-MED	166	3.00	98.7%	1.9%	92.5%	103.1%
D6A	QA-CPI_MED-HI	71	6.00	99.4%	2.4%	93.8%	104.6%
D6A	QA-HIGH	98	12.00	100.3%	1.8%	95.1%	103.0%
S1A	QA-CPI_LOW	6	1.20	99.1%	0.8%	98.1%	100.0%
S1A	QA-LOW	8	1.20	100.0%	0.8%	98.0%	100.8%
S1A	QA-MED	7	3.00	100.8%	0.5%	99.6%	101.2%
S1A	QA-CPI_MED-HI	4	6.00	101.8%	1.0%	100.6%	102.7%
S1A	QA-HIGH	5	12.00	102.1%	0.7%	101.3%	102.8%
S2A	QA-CPI_LOW	73	1.20	98.1%	1.1%	94.4%	101.3%
S2A	QA-LOW	95	1.20	99.7%	0.9%	97.4%	102.5%
S2A	QA-MED	115	3.00	99.9%	0.7%	97.7%	101.7%
S2A	QA-CPI_MED-HI	53	6.00	100.8%	0.5%	99.5%	102.0%
S2A	QA-HIGH	68	12.00	101.6%	0.9%	99.3%	103.0%
S3A	QA-CPI_LOW	52	1.20	100.0%	2.7%	96.3%	111.0%
S3A	QA-LOW	72	1.20	101.2%	2.9%	96.9%	111.9%
S3A	QA-MED	87	3.00	100.9%	1.4%	97.3%	104.7%
S3A	QA-CPI_MED-HI	37	6.00	102.2%	1.3%	100.3%	105.9%
S3A	QA-HIGH	53	12.00	102.3%	1.1%	99.6%	105.5%

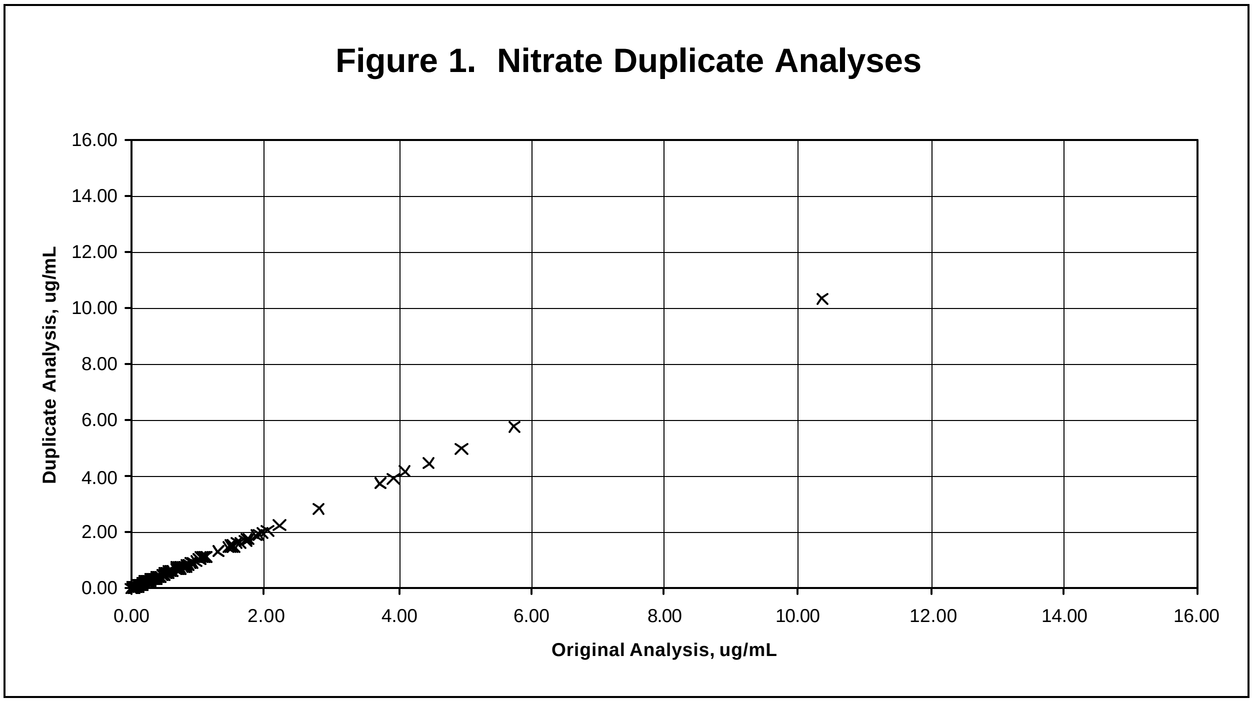


Figure 1. Nitrate Duplicate Analyses
Duplicate Analysis, ug/mL
Original Analysis, ug/mL
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00

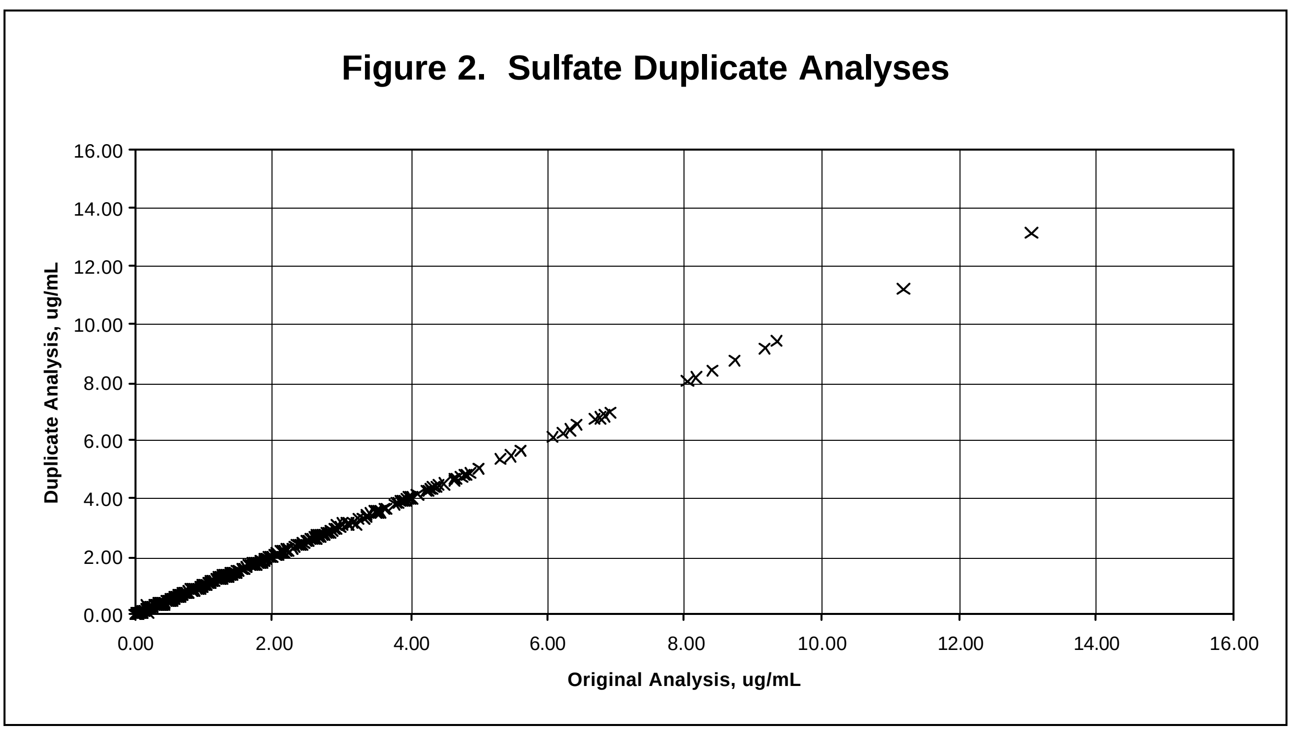


Figure 2. Sulfate Duplicate Analyses
Duplicate Analysis, ug/mL
Original Analysis, ug/mL
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00

Table 10. Average Percent Recovery for Nitrate and Sulfate Spikes

Inst:	D6A					
Filt:	Nylon					
Analyte:	Nitrate					
Date	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02
Avg	99.92%	98.88%	98.82%	97.84%	97.99%	95.73%
St Dev	1.22%	1.20%	1.08%	1.23%	3.94%	2.45%
Count	21	25	45	33	27	28
Min	98.10%	96.15%	97.24%	95.51%	94.36%	92.38%
Max	102.12%	101.01%	101.19%	100.88%	108.25%	101.35%

Inst:	D6A					
Filt:	Nylon					
Analyte:	Sulfate					
Date	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02
Avg	100.30%	99.19%	99.12%	98.97%	99.05%	97.58%
St Dev	1.10%	1.59%	1.39%	1.35%	2.88%	2.60%
Count	21	25	45	33	27	28
Min	97.54%	95.35%	95.45%	96.41%	94.73%	92.40%
Max	101.91%	101.40%	101.64%	101.43%	105.27%	102.17%

Inst:	D6A					
Filt:	Teflon					
Analyte:	Nitrate					
Date	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02
Avg	99.22%	99.35%	98.48%	96.58%	95.59%	97.69%
St Dev	0.96%	0.99%	0.77%	1.57%	0.38%	0.25%
Count	6	10	4	9	2	2
Min	98.04%	98.23%	97.98%	94.13%	95.32%	97.52%
Max	100.23%	101.29%	99.63%	98.51%	95.85%	97.87%

Inst:	D6A					
Filt:	Teflon					
Analyte:	Sulfate					
Date	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02
Avg	100.01%	100.39%	99.44%	98.97%	97.57%	98.54%
St Dev	1.28%	0.56%	0.97%	1.87%	2.74%	1.00%
Count	6	10	4	9	2	2
Min	97.71%	99.04%	98.33%	94.44%	95.64%	97.83%
Max	101.09%	101.24%	100.62%	100.48%	99.51%	99.24%

Table 10. (Continued)

Inst:	S1A					
Filt:	Nylon					
Analyte:	Nitrate					
Date:	**Apr-02**	**May-02**	**Jun-02**	**Jul-02**	**Aug-02**	**Sep-02**
Avg:	100.36%		101.39%	103.21%		
St Dev:	0.39%			2.21%		
Count:	4		1	4		
Min:	99.89%		101.39%	101.85%		
Max:	100.75%		101.39%	106.50%		

Inst:	S1A					
Filt:	Nylon					
Analyte:	Sulfate					
Date:	**Apr-02**	**May-02**	**Jun-02**	**Jul-02**	**Aug-02**	**Sep-02**
Avg:	100.33%		100.35%	102.38%		
St Dev:	0.92%			2.08%		
Count:	4		1	4		
Min:	98.97%		100.35%	100.91%		
Max:	100.89%		100.35%	105.36%		

Inst:	S2A					
Filt:	Nylon					
Analyte:	Nitrate					
Date:	**Apr-02**	**May-02**	**Jun-02**	**Jul-02**	**Aug-02**	**Sep-02**
Avg:	99.70%		99.83%	100.08%	99.63%	99.68%
St Dev:	0.85%		0.84%	1.21%	1.54%	1.65%
Count:	9		21	30	33	26
Min:	98.50%		98.30%	98.58%	96.61%	95.65%
Max:	101.17%		101.22%	103.73%	102.87%	102.30%

Inst:	S2A					
Filt:	Nylon					
Analyte:	Sulfate					
Date:	**Apr-02**	**May-02**	**Jun-02**	**Jul-02**	**Aug-02**	**Sep-02**
Avg:	99.85%		99.99%	100.30%	100.03%	100.16%
St Dev:	0.95%		0.95%	0.93%	1.27%	1.32%
Count:	9		21	30	33	26
Min:	98.44%		97.83%	98.76%	96.66%	95.76%
Max:	100.99%		101.13%	102.67%	102.51%	101.91%

Table 10. (Continued)

Inst:	S2A					
Filt:	Teflon					
Analyte:	Nitrate					
Date	**Apr-02**	**May-02**	**Jun-02**	**Jul-02**	**Aug-02**	**Sep-02**
Avg			98.98%	99.67%	99.85%	98.37%
St Dev			0.81%	1.29%	1.22%	0.66%
Count			4	6	8	8
Min			97.95%	97.67%	98.53%	97.50%
Max			99.77%	101.07%	102.08%	99.61%

Inst:	S2A					
Filt:	Teflon					
Analyte:	Sulfate					
Date	**Apr-02**	**May-02**	**Jun-02**	**Jul-02**	**Aug-02**	**Sep-02**
Avg			100.04%	100.56%	100.23%	98.87%
St Dev			0.70%	0.39%	0.75%	1.36%
Count			4	6	8	8
Min			99.35%	100.02%	98.99%	96.88%
Max			100.98%	101.23%	101.02%	100.91%

Inst:	S3A					
Filt:	Nylon					
Analyte:	Nitrate					
Date	**Apr-02**	**May-02**	**Jun-02**	**Jul-02**	**Aug-02**	**Sep-02**
Avg	99.57%	99.98%	99.06%	100.76%	99.10%	98.73%
St Dev	0.94%	1.00%	2.37%	1.73%	1.05%	0.47%
Count	25	25	10	16	13	3
Min	98.20%	98.18%	92.86%	98.42%	97.47%	98.40%
Max	101.50%	101.23%	101.30%	103.65%	100.89%	99.26%

Inst:	S3A					
Filt:	Nylon					
Analyte:	Sulfate					
Date	**Apr-02**	**May-02**	**Jun-02**	**Jul-02**	**Aug-02**	**Sep-02**
Avg	99.57%	100.19%	99.64%	101.01%	100.64%	99.28%
St Dev	2.26%	1.20%	2.85%	1.13%	0.79%	1.89%
Count	25	25	10	16	13	3
Min	93.58%	97.88%	92.60%	99.07%	98.50%	97.12%
Max	104.03%	102.15%	102.55%	102.66%	101.51%	100.64%

Table 10. (Continued)

Inst:	S3A				
Filt:	Teflon				
Analyte:	Nitrate				
Date:	**Apr-02**	**May-02**	**Jun-02**	**Jul-02**	**Aug-02**	**Sep-02**
Avg:	100.33%	99.66%	99.57%	102.06%		
St Dev:	1.49%	0.89%	0.34%			
Count:	7	12	2	1		
Min:	97.65%	98.53%	99.32%	102.06%		
Max:	101.97%	101.17%	99.81%	102.06%		

Inst:	S3A					
Filt:	Teflon					
Analyte:	Sulfate					
Date:	**Apr-02**	**May-02**	**Jun-02**	**Jul-02**	**Aug-02**	**Sep-02**
Avg:	100.71%	99.95%	100.54%	100.89%		
St Dev:	1.30%	1.90%	0.77%			
Count:	7	12	2	1		
Min:	98.51%	95.67%	100.00%	100.89%		
Max:	102.27%	102.17%	101.08%	100.89%		

Table 11. Filter Blank (N) and Reagent Blank Values (ppm) for Nitrate and Sulfate

Inst	Blank Type	Count	Av NO3	STD NO3	Min NO3	Max NO3
D6A	N BLANK	80	0.011	0.014	0.000	0.055
D6A	REAGENT	188	0.000	0.003	0.000	0.021
S1A	REAGENT	11	0.000	0.000	0.000	0.000
S2A	N BLANK	81	0.004	0.010	0.000	0.046
S2A	REAGENT	119	0.000	0.003	0.000	0.035
S3A	N BLANK	33	0.014	0.018	0.000	0.056
S3A	REAGENT	97	0.001	0.005	0.000	0.039

Inst	Blank Type	Count	Avg SO4	STD SO4	Min SO4	Max SO4
D6A	N BLANK	80	0.007	0.010	-0.012	0.040
D6A	REAGENT	188	0.006	0.012	-0.009	0.077
S1A	REAGENT	11	0.008	0.009	0.000	0.022
S2A	N BLANK	81	0.011	0.011	0.000	0.057
S2A	REAGENT	119	0.013	0.014	0.000	0.072
S3A	N BLANK	33	0.011	0.016	0.000	0.052
S3A	REAGENT	97	0.035	0.043	0.000	0.233

2.2.3.2 Cations – QC checks performed included:

- Percent recovery for QC samples
- Percent recovery for QA samples
- RPD for replicates
- Spike recovery tests
- Reagent and filter blank tests

Table 12 presents the average percent recovery value for sodium for both QA and QC samples for the instruments used for these measurements. The average recovery for the QA samples over the six month period ranged from 100.0% to 104.3%. The average recovery for the QC samples ranged from 99.7% to 100.4%.

Table 12. Average Percent Recovery for Sodium QA and QC Samples

Inst	Sample	Count	Conc., ug/mL	Av Na rec,%	SD Na, %	Min Na Rec, %	Max Na Rec, %
D5C	GFS 0.4 PPM QA	121	0.40	104.3%	8.2%	97.1%	190.2%
D5C	RTI 2.0 PPM QC	111	2.00	100.4%	1.1%	98.1%	105.7%
D5C	GFS 4.0 PPM QA	136	4.00	100.0%	0.8%	96.7%	101.7%
D5C	RTI 5.0 PPM QC	100	5.00	99.7%	0.7%	97.0%	101.5%
D6C	GFS 0.4 PPM QA	148	0.40	102.1%	1.3%	98.8%	109.9%
D6C	RTI 2.0 PPM QC	135	2.00	100.4%	0.8%	98.4%	104.4%
D6C	GFS 4.0 PPM QA	165	4.00	100.3%	0.5%	99.0%	101.8%
D6C	RTI 5.0 PPM QC	114	5.00	100.3%	0.5%	97.9%	101.8%

Table 13 presents the average percent recovery value for ammonium for both QA and QC samples for the instrument used for these measurements. The average recovery for the QA samples over the six month period ranged from 99.1% to 105.1%. The average recovery for the QC samples ranged from 98.0% to 100.0%.

Table 14 presents the average percent recovery value for potassium for both QA and QC samples for the instrument used for these measurements. The average recovery for the QA samples over the six month period ranged from 98.9% to 100.9%. The average recovery for the QC samples ranged from 99.6% to 100.5%.

Table 13. Average Percent Recovery for Ammonium QA and QC Samples

Inst	Sample	Count	Conc., ug/mL	Av NH4 rec,%	SD NH4, %	Min NH4 Rec, %	Max NH4 Rec, %
D5C	GFS 0.4 PPM QA	121	0.40	99.1%	4.7%	81.5%	119.5%
D5C	RTI 2.0 PPM QC	111	2.00	98.0%	2.0%	92.6%	104.8%
D5C	GFS 4.0 PPM QA	136	4.00	99.9%	1.6%	93.9%	104.6%
D5C	RTI 5.0 PPM QC	100	5.00	100.3%	1.7%	94.6%	105.2%
D6C	GFS 0.4 PPM QA	148	0.40	101.5%	1.5%	96.2%	104.9%
D6C	RTI 2.0 PPM QC	135	2.00	99.9%	0.9%	97.1%	101.9%
D6C	GFS 4.0 PPM QA	165	4.00	99.1%	0.8%	96.8%	101.4%
D6C	RTI 5.0 PPM QC	114	5.00	100.0%	0.7%	98.1%	101.3%

Table 14. Average Percent Recovery for Potassium QA and QC Samples

Inst	Sample	Count	Conc., ug/mL	Av K rec,%	SD K, %	Min K Rec, %	Max K Rec, %
D5C	GFS 0.4 PPM QA	121	0.40	100.9%	4.1%	88.6%	116.4%
D5C	RTI 2.0 PPM QC	111	2.00	100.3%	1.6%	96.7%	108.2%
D5C	GFS 4.0 PPM QA	136	4.00	98.9%	0.9%	95.9%	101.0%
D5C	RTI 5.0 PPM QC	100	5.00	99.6%	0.9%	96.8%	101.7%
D6C	GFS 0.4 PPM QA	148	0.40	99.3%	1.4%	92.5%	103.9%
D6C	RTI 2.0 PPM QC	135	2.00	100.5%	0.9%	98.4%	103.1%
D6C	GFS 4.0 PPM QA	165	4.00	99.4%	0.5%	98.1%	100.7%
D6C	RTI 5.0 PPM QC	114	5.00	100.4%	0.6%	98.2%	101.7%

Figure 3 shows a plot of the original sodium concentration vs. the duplicate sodium concentration for replicate measurements of the filter extracts. The scatter observed in the plot for the previous QA reporting period (October 2001 - March 2002) at the lower concentrations, which was attributed to trace sodium remaining on the nylon filters after cleaning, has been significantly reduced by RTI’s revision of the filter cleaning SOP.

Figure 4 shows a plot of the original ammonium concentration vs. the duplicate ammonium concentration for replicate measurements of the filter extracts. The plot shows excellent agreement for the duplicate measurements over the entire concentration range.

Figure 5 shows a plot of the original potassium concentration vs. the duplicate potassium concentration for replicate measurements of the filter extracts. Again, the plot shows good agreement for the duplicate measurements over the entire concentration range.

Figure 3. Sodium Duplicate Analyses

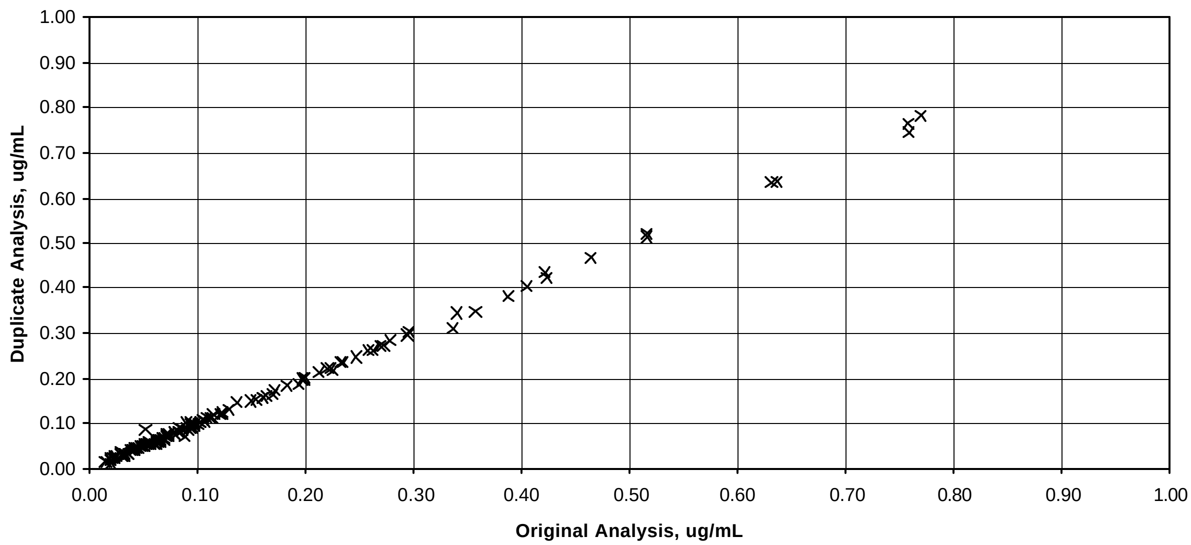


Figure 4. Ammonium Duplicate Analyses

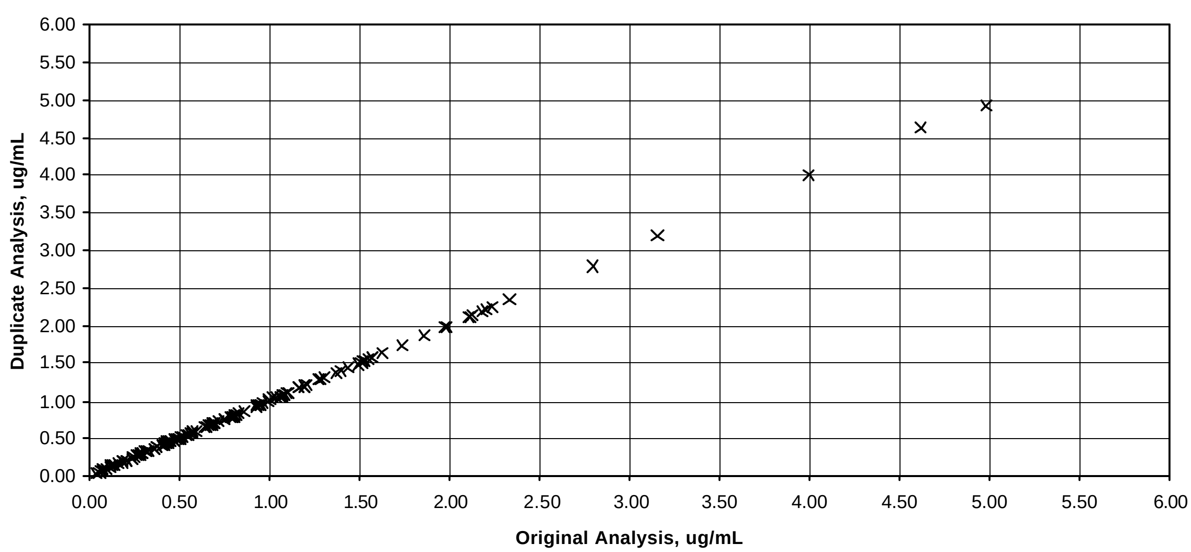


Figure 5. Potassium Duplicate Analyses

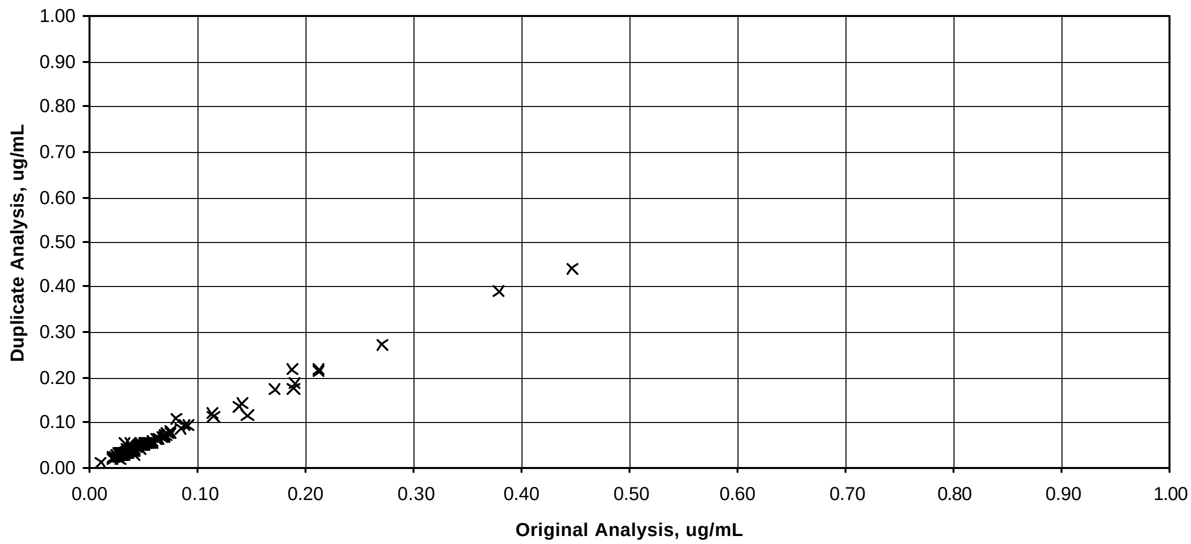


Table 15 shows average percent recovery for spikes of sodium, ammonium, and potassium by filter type over the six month period. There was no significant difference in the spike recoveries of sodium, ammonium, or potassium for the three different filter types. The average recovery values for all filter types ranged from 97.1% to 100.2% for sodium, 93.4% to 101.7% for ammonium, and 89.3% to 99.2% for potassium.

Table 16 presents filter (N BLANK) and reagent blank values for sodium, ammonium, and potassium for the instruments used for these measurements. The highest average sodium values over the six month period were 0.012 ppm for the nylon filter blanks (25 mL extract) and 0.011 ppm for the reagent blank. The highest average ammonium values were 0.000 ppm (25 mL extract) for the nylon filter blanks and 0.000 ppm for the reagent blanks. The highest average potassium value was 0.000 ppm for nylon filter blanks (25 mL extract) and the highest average value was 0.002 ppm for the reagent blank.

2.2.4 Data Validity Discussion

During this period, no data were invalidated as a result of errors in the ion chromatography (IC) laboratory. Any inconsistencies that were observed in the filter samples were flagged on the IC data report when it is submitted for entry into the database. For example, on a few occasions, two or more filters were found in one petri dish. The filters were extracted and analyzed as one, and this was noted on the data report for that batch of samples.

It was brought to our attention that the blank sodium values were high back in the fall of 2001. The high sodium blank values occurring at that time were not recognized as such at that time because of problems with the ICs. The ICs were not operating properly due to a black material in the deionized water (DI) supply. When the DI supply was corrected, the IC's operated properly and the high sodium blanks were verified. The nylon filter washing procedure was made more aggressive and the problem was resolved. This issue is described in detail in Appendix A, a report of the issue submitted to EPA in October 2002.

Table 15. Average Percent Recovery for Sodium, Ammonium, and Potassium Spikes

Inst:	D5C					
Filt:	Nylon					
Analyte:	Sodium					
Date:	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02
Avg:	99.7%	98.8%	98.8%	99.0%	98.0%	98.3%
St Dev:	0.1%	0.9%	1.5%	1.7%	2.7%	1.6%
Count:	2	21	31	29	30	16
Min:	99.6%	96.6%	94.5%	96.5%	86.1%	96.2%
Max:	99.7%	99.9%	102.3%	106.0%	101.2%	101.7%

Inst:	D5C					
Filt:	Nylon					
Analyte:	Ammonium					
Date:	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02
Avg:	94.5%	97.2%	96.4%	97.4%	96.4%	98.1%
St Dev:	0.6%	2.2%	2.1%	2.6%	3.0%	3.7%
Count:	2	21	31	29	30	16
Min:	94.0%	91.8%	92.2%	93.1%	91.2%	89.2%
Max:	94.9%	102.3%	100.4%	102.2%	102.0%	102.7%

Inst:	D5C					
Filt:	Nylon					
Analyte:	Potassium					
Date:	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02
Avg:	97.8%	95.7%	96.7%	96.0%	93.7%	94.7%
St Dev:	0.6%	1.9%	2.6%	2.0%	2.5%	2.5%
Count:	2	21	31	29	30	16
Min:	97.4%	92.6%	90.1%	92.0%	88.7%	89.3%
Max:	98.2%	98.6%	101.3%	99.0%	98.1%	98.1%

Inst:	D5C					
Filt:	Teflon					
Analyte:	Sodium					
Date:	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02
Avg:	98.7%	98.7%	99.8%	98.0%	97.8%	97.1%
St Dev:	0.1%	1.1%	1.0%	1.5%	0.9%	2.5%
Count:	2	12	6	14	13	8
Min:	98.7%	96.9%	98.4%	95.7%	96.6%	92.7%
Max:	98.8%	100.5%	101.1%	100.3%	99.8%	99.8%

Table 15. (Continued)

Inst: D5C
Filt: Teflon
Analyte: Ammonium

Date:	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02
Avg:	101.7%	96.7%	96.5%	95.3%	95.8%	93.4%
St Dev:	0.9%	4.3%	0.5%	4.1%	4.6%	4.7%
Count:	2	12	6	14	13	8
Min:	101.1%	89.9%	95.5%	91.1%	91.5%	90.4%
Max:	102.4%	103.6%	97.1%	107.1%	107.9%	104.2%

Inst: D5C
Filt: Teflon
Analyte: Potassium

Date:	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02
Avg:	92.1%	95.1%	97.6%	93.6%	89.3%	89.9%
St Dev:	0.5%	1.4%	1.4%	2.2%	2.2%	2.9%
Count:	2	12	6	14	13	8
Min:	91.7%	92.9%	96.5%	90.8%	83.9%	83.6%
Max:	92.4%	97.4%	99.8%	97.0%	92.2%	92.7%

Inst: D6C
Filt: Nylon
Analyte: Sodium

Date:	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02
Avg:	99.6%	99.2%	99.8%	100.1%	100.2%	99.4%
St Dev:	1.0%	0.6%	0.5%	1.6%	1.8%	1.2%
Count:	8	24	41	45	39	38
Min:	97.9%	97.9%	98.8%	97.1%	98.2%	97.8%
Max:	101.1%	100.0%	100.6%	107.0%	108.3%	104.2%

Inst: D6C
Filt: Nylon
Analyte: Ammonium

Date:	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02
Avg:	99.1%	99.0%	99.7%	98.6%	99.5%	98.7%
St Dev:	0.9%	1.4%	1.2%	8.7%	2.3%	2.0%
Count:	8	24	41	45	39	38
Min:	97.8%	95.7%	96.0%	42.3%	94.6%	92.9%
Max:	100.1%	101.3%	102.2%	105.4%	107.8%	103.6%

Table 15. (Continued)

Inst:	D6C					
Filt:	Nylon					
Analyte:	Potassium					
Date:	**Apr-02**	**May-02**	**Jun-02**	**Jul-02**	**Aug-02**	**Sep-02**
Avg:	95.7%	98.3%	99.2%	98.8%	98.6%	96.6%
St Dev:	2.1%	1.2%	1.0%	2.7%	2.4%	2.0%
Count:	8	24	41	45	39	38
Min:	92.2%	94.9%	97.3%	84.8%	95.2%	91.6%
Max:	98.6%	100.2%	101.1%	105.4%	107.6%	102.5%

Inst:	D6C					
Filt:	Teflon					
Analyte:	Sodium					
Date:	**Apr-02**	**May-02**	**Jun-02**	**Jul-02**	**Aug-02**	**Sep-02**
Avg:		99.6%	98.5%	98.3%		98.8%
St Dev:		0.5%	0.6%			0.9%
Count:		10	4	1		2
Min:		98.8%	98.1%	98.3%		98.2%
Max:		100.3%	99.5%	98.3%		99.5%

Inst:	D6C					
Filt:	Teflon					
Analyte:	Ammonium					
Date:	**Apr-02**	**May-02**	**Jun-02**	**Jul-02**	**Aug-02**	**Sep-02**
Avg:		99.3%	98.8%	99.2%		96.5%
St Dev:		1.4%	0.5%			2.8%
Count:		10	4	1		2
Min:		96.2%	98.5%	99.2%		94.5%
Max:		100.8%	99.6%	99.2%		98.5%

Inst:	D6C					
Filt:	Teflon					
Analyte:	Potassium					
Date:	**Apr-02**	**May-02**	**Jun-02**	**Jul-02**	**Aug-02**	**Sep-02**
Avg:		97.8%	97.1%	95.4%		93.1%
St Dev:		1.0%	0.9%			2.2%
Count:		10	4	1		2
Min:		96.4%	95.8%	95.4%		91.5%
Max:		99.6%	97.7%	95.4%		94.6%

Table 16. Filter Blank and Reagent Blank Values (ppm) for Sodium, Ammonium, and Potassium

Inst	TYPE (Short Name)	Count	Av Na	STD Na	Min Na	Max Na
D5C	N Blank	69	0.002	0.006	-0.002	0.033
D5C	Reagent Blank	118	0.001	0.004	0.000	0.023
D6C	N Blank	110	0.012	0.031	0.000	0.296
D6C	Reagent Blank	142	0.011	0.054	-0.004	0.628
Inst	**TYPE (Short Name)**	**Count**	**Avg NH4**	**STD NH4**	**Min NH4**	**Max NH4**
D5C	N Blank	69	0.000	0.000	0.000	0.000
D5C	Reagent Blank	118	0.000	0.000	0.000	0.000
D6C	N Blank	110	0.000	0.001	0.000	0.006
D6C	Reagent Blank	142	0.000	0.000	0.000	0.005
Inst	**TYPE (Short Name)**	**Count**	**Avg K**	**STD K**	**Min K**	**Max K**
D5C	N Blank	69	0.000	0.000	0.000	0.000
D5C	Reagent Blank	118	0.001	0.011	0.000	0.124
D6C	N Blank	110	0.000	0.000	0.000	0.000
D6C	Reagent Blank	142	0.002	0.024	0.000	0.290

2.2.5 Corrective Actions Taken

RTI modified the nylon filter washing procedure to add an extra deionized water rinse to reduce the sodium content to acceptable levels. A filter cleaning procedure that uses a dilute $LiCO_3$ rinse also is being tested A revised SOP will be prepared when the cleaning procedure is optimized.

2.3 OC/EC Laboratory

The OC/EC Laboratory analyzed and reported results for 10,351 quartz filter samples under the laboratory support contract during the period April 1, 2002, to September 30, 2002.

2.3.1 Description of QC Checks Applied

Quality control checks, acceptance criteria, and corrective actions for the OC/EC Laboratory are summarized in the table below.

QC Element	Frequency	Acceptance Criteria	Corrective Action
Method Detection Limit	annually	MDL $\leq$ 0.5 µg C/cm^2	Investigate the source of the problem and initiate corrective action, if necessary, to correct the problem before analyzing samples.
Calibration Peak Area	every analysis	Within 95% to 105% of average calibration peak area for that day	Discard the results of that analysis and, if necessary, repeat the analysis with a second punch from the same filter.
Instrument Blank	daily	Blank $\leq$0.3 µg/cm^2	Determine if the problem is with the filter or the instrument, and, if necessary, initiate corrective action to identify and solve any instrument problem before analyzing samples.
Three-Point Calibration	weekly	Correlation Coefficient (R^2) $\geq$0.99 [with force-fit through 0,0]	Determine the cause of the nonlinearity, and initiate actions that will identify and solve any problem that may have arisen. Then repeat the three-point calibration, which must yield satisfactory results before samples are analyzed.
Calibration Check	daily	(1) 90% to 110% recovery, and (2) calibration peak area 90% to 110% of average for the weekly 3-point calibration.	Initiate corrective action, if necessary, to solve the problem before analyzing samples.
Duplicate Analyses	10% of samples	(1) TC Values greater than 10 µg C/cm^2-- Less than 10% RPD, (2) TC Values 5 - 10 µg C/cm^2-- Less than 15% RPD, (3) TC Values less than 5 µg C/cm^2-- Within ±0.75 µg C/cm^2.	Flag analysis results for that filter with non-uniform filter deposit (LFU) flag.

2.3.2 Statistical Summary of QC Results

The OC/EC Laboratory had three carbon analyzers (designated as the Retrofit, Second, and Third analyzers) in operation during the April 1, 2002, to September 30, 2002, period. The statistical summaries in this section contain data from these three OC/EC analyzers.

The method detection limit for total carbon (TC) is determined annually. All three OC/EC carbon analyzers met the required limit of $\leq$0.5 µg C/cm^2 for all MDLs determined during the period. A new MDL was determined each time the oven was changed in an analyzer. The Retrofit analyzer MDL was 0.13 µg C/cm^2 on May 22, 0.12 µg C/cm^2 on August 2, and 0.10 µg C/cm^2 on August 2. The Second analyzer MDL was 0.17 µg C/cm^2 on May 22 and 0.12 µg C/cm^2 on August 27. The Third analyzer MDL was 0.15 µg C/cm^2 on May 21 and 0.07 µg C/cm^2 on August 3, 2001.

Calibration peak area, which is the response of the FID to the internal standard, is plotted for every analysis run on a given day. Any filter analysis for which the calibration peak area is outside the range of 95% to 105% of the average calibration peak area for that day is repeated with a second punch.

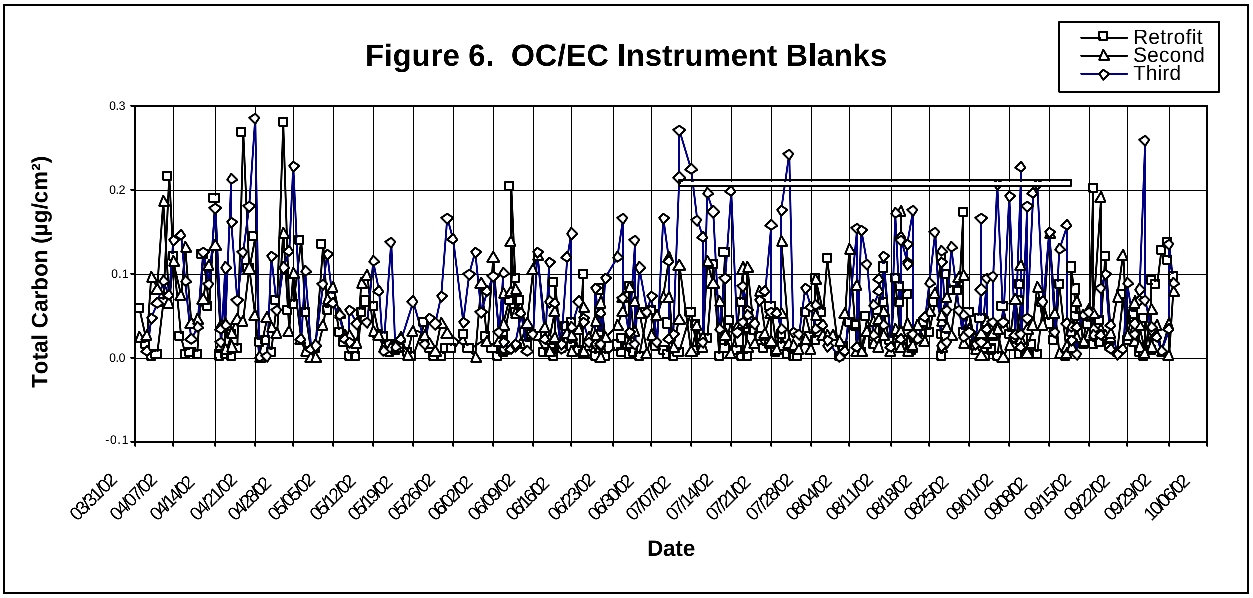
Routine quality control samples analyzed in the OC/EC Laboratory include (1) daily instrument blanks, (2) weekly three-point calibration standards, (3) daily mid-level calibration check standards, and (4) duplicate analyses on 10% of quartz filter samples analyzed. Each of these is described separately below.

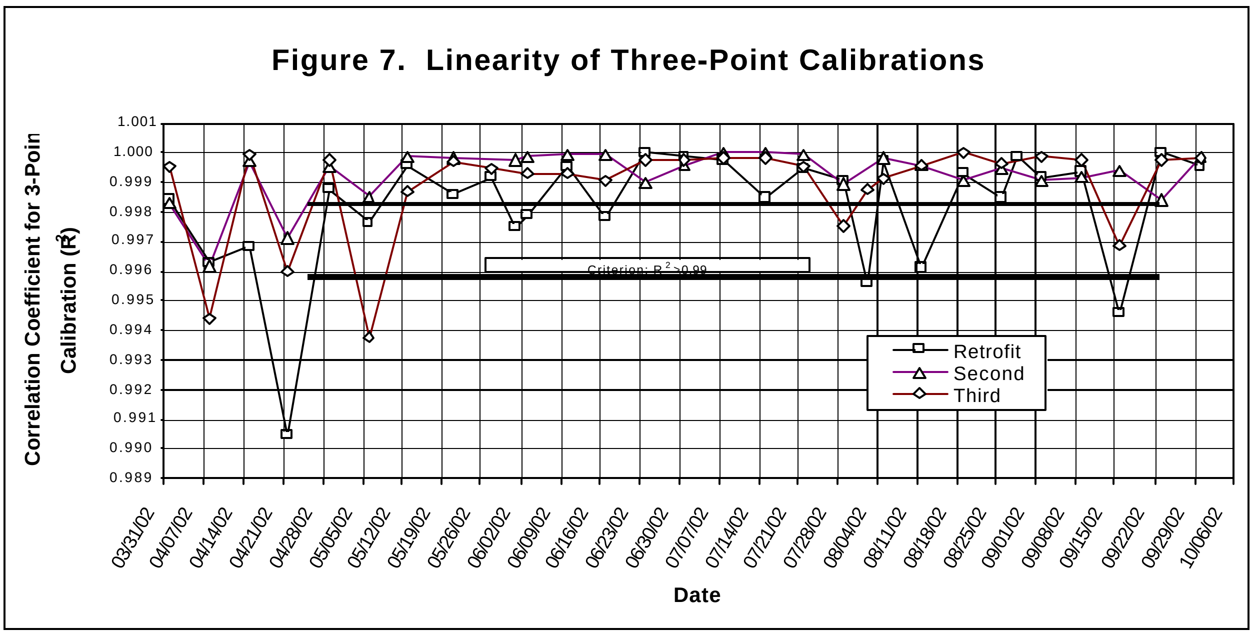
Figure 6 shows measured TC for daily instrument blanks and instrument blanks run after about 30 samples on the Retrofit, Second, and Third OC/EC analyzers during the reporting period (April 1, 2002, through September 30, 2002). The instrument blank must be $\leq$0.3 µg C/cm^2 (bold line at the top of Figure OC/EC1). Mean and standard deviation of blank responses by instrument over the reporting period are summarized in the table below.

	OC/EC Analyzer		
	Retrofit	**Second**	**Third**
No. of Instrument Blanks	231	232	237
Mean Response (µg C/cm^2)	0.041	0.045	0.081
Standard Deviation	0.048	0.038	0.080

None of the daily instrument blanks or instrument blanks run after 30 samples on any of the three instruments exceeded the acceptance criterion of $\leq$0.3 µg C/cm^2.

Figure 7 shows linearity (as R^2, force-fit through the origin) for all 3-point calibrations run on all three instruments during the reporting period. All three instruments met the $R^2 \geq 0.99$ (heavy line in Figure OC/EC2) requirement for every 3-point calibration.





Percent recovery of standards is used to make sure the instruments are functioning properly and are still calibrated correctly. **Figures OC/EC8a, OC/EC8b, and OC/EC8c** show percent recovery on the Retrofit, Second, and Third analyzers, respectively, for each of the three (low, middle, and high) calibration standards, as well as the average percent recovery for the three, used for each three-point calibration. All three instruments met the 90-110% criterion (heavy lines in figures) for recovery for all three standards in every 3-point calibration during the reporting period.

Figure 8a. Percent Recoveries for Three-Point Calibration Standards on the Retrofit OC/EC Analyzer

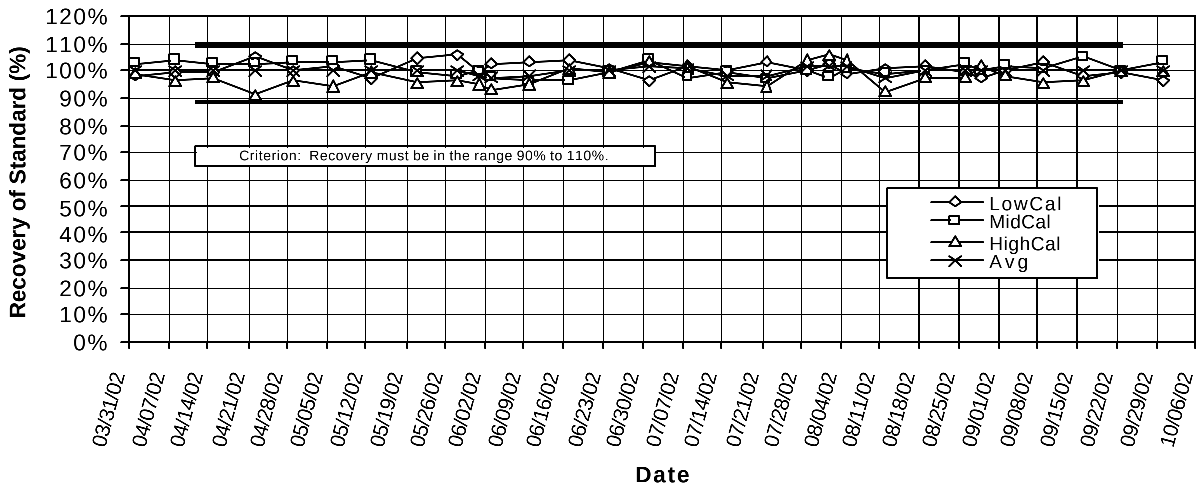
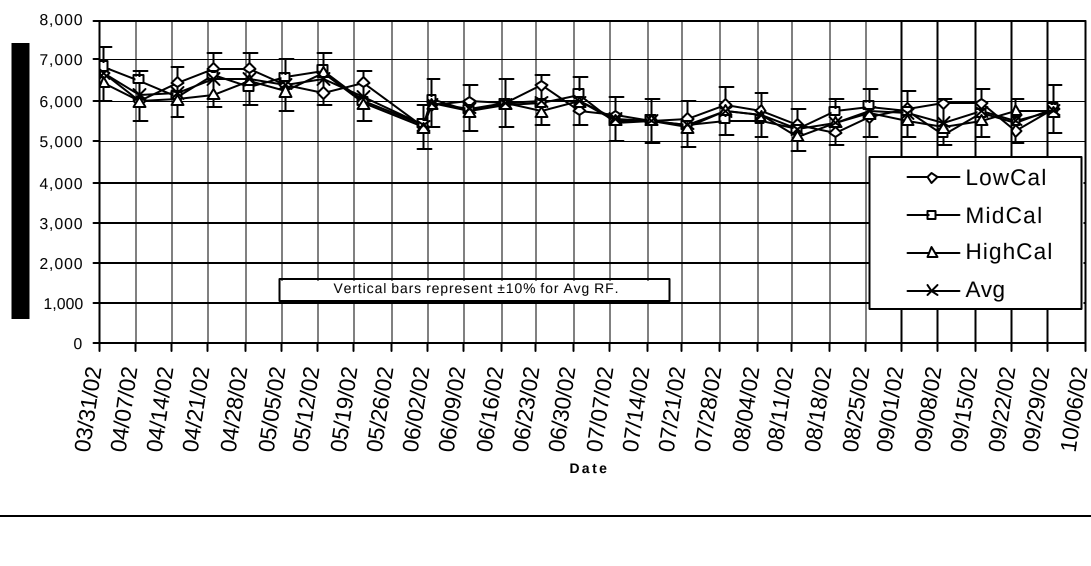
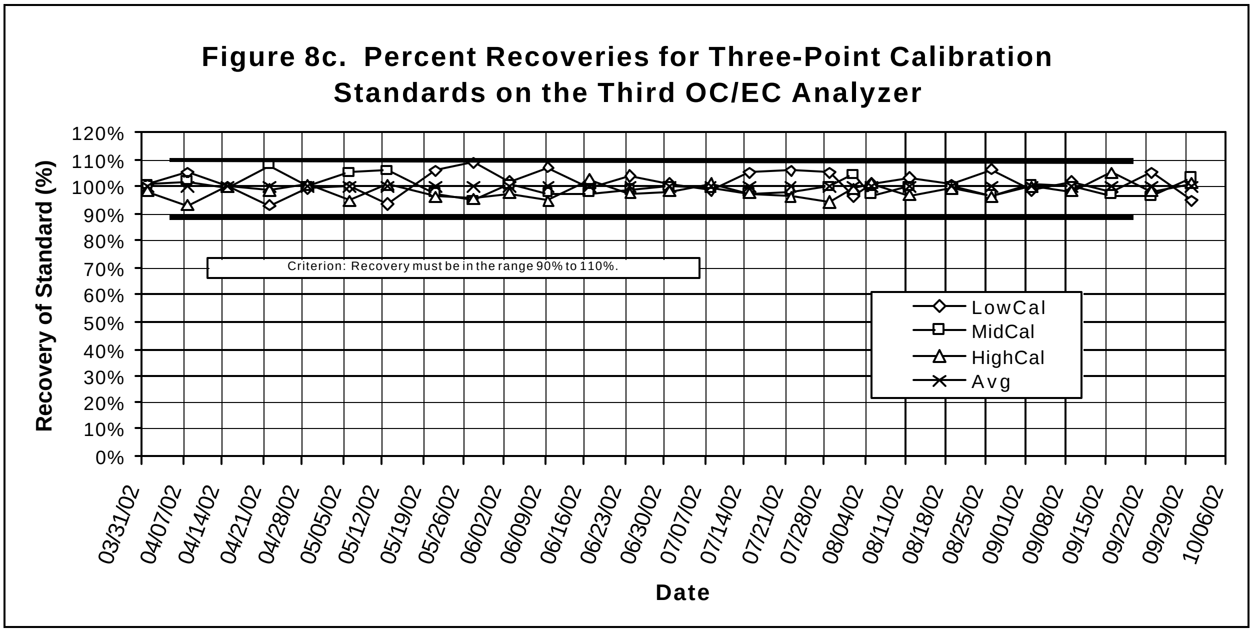


Figure 8b. FID Response Factors for Three-Point Calibration Standards on the Second OC/EC Analyzer





Response factors for the flame ionization detector (FID) are used to monitor FID performance. **Figures 9a, 9b, and 9c** show FID response factors for each of the three calibrations standards and the average FID response factor for each 3-point calibration on the Retrofit, Second, and Third instruments, respectively, during the reporting period. FID response is affected by slight changes in flow rate for hydrogen and other gases, but use of the internal methane standard at the end of every analysis compensates for such changes. All 3-point calibrations on all three analyzers met the acceptance criteria in Section 1.3.1. The ratio of FID area counts for the internal standard to the known mass of carbon in the internal standard injection loop is calculated separately for each analysis and used to calculate the mass of carbon volatilized from the filter punch during that analysis as shown in the following equation.

$$\text{mass } C_{\text{punch}} = \frac{\text{FID area counts}_{\text{punch}}}{\left[\dfrac{\text{FID area counts}_{\text{internal standard}}}{\text{mass } C_{\text{internal standard loop}}}\right]}$$

Figure **10** shows the slopes of 3-point calibration plots with force-fit through the origin for all three OC/EC analyzers during the reporting period.

Figure 9a. FID Response Factors for Three-Point Calibration Standards on the Retrofit OC/EC Analyzer

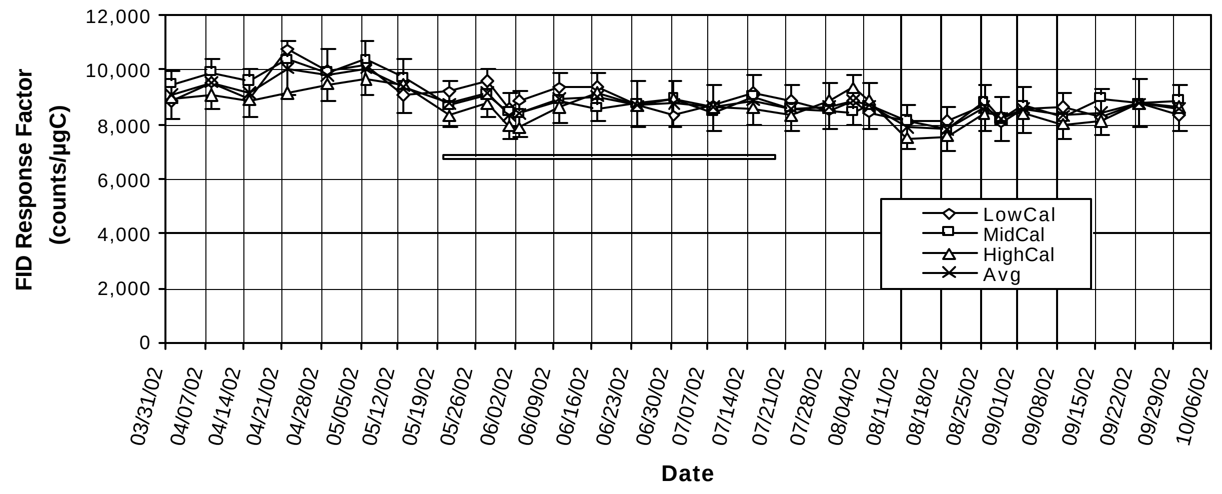
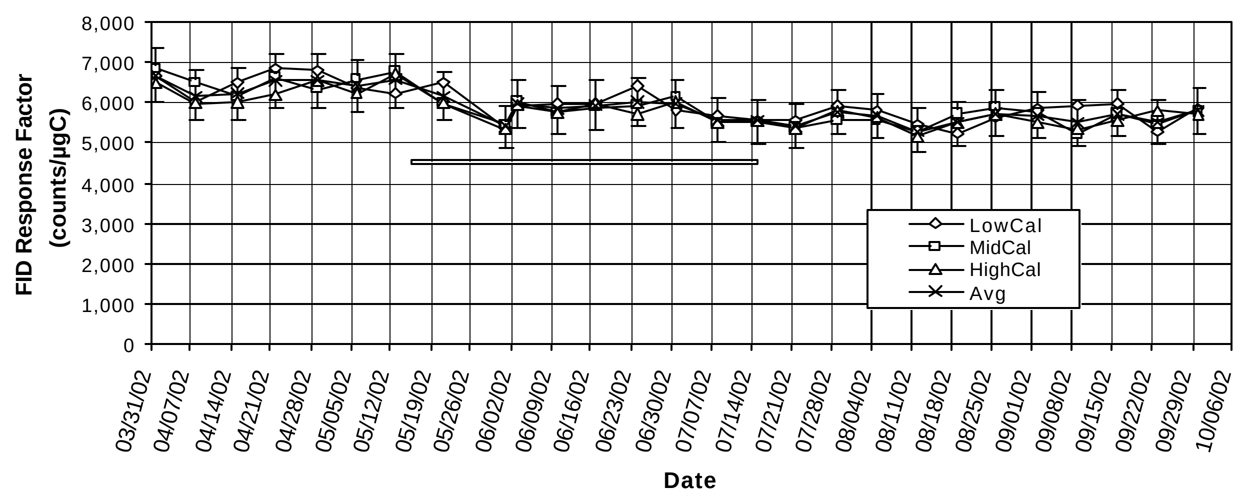


Figure 9b. FID Response Factors for Three-Point Calibration Standards on the Second OC/EC Analyzer



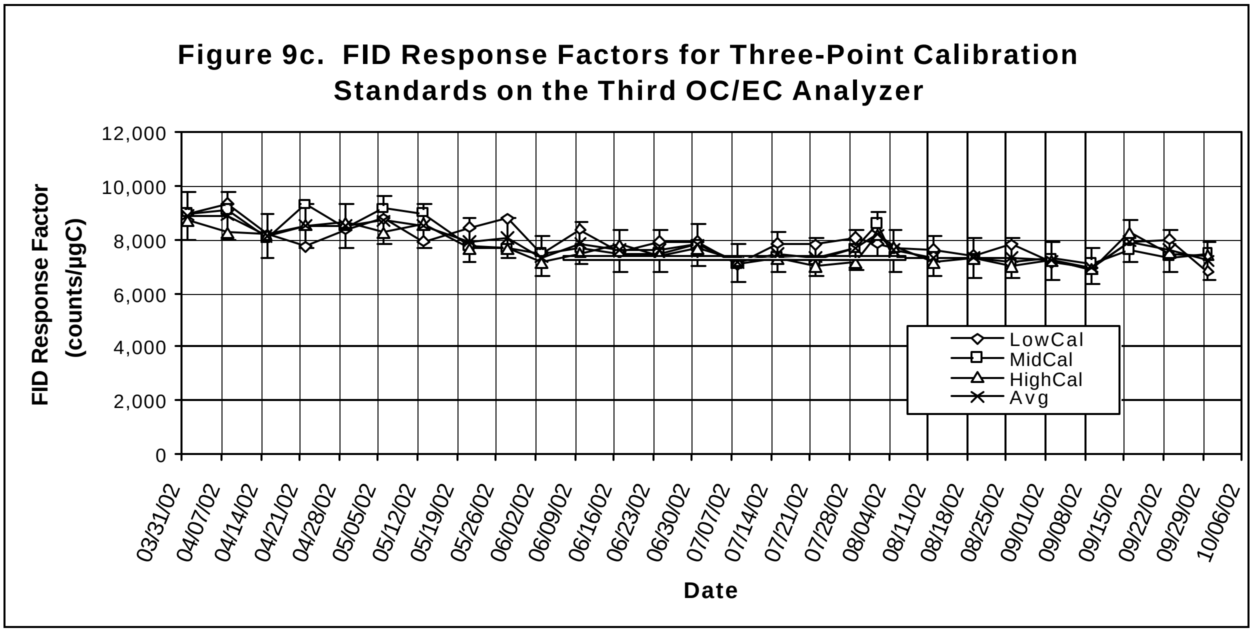


Figure 9c. FID Response Factors for Three-Point Calibration Standards on the Third OC/EC Analyzer
FID Response Factor (counts/µgC)
12,000
10,000
8,000
6,000
4,000
2,000
0
LowCal
MidCal
HighCal
Avg
03/31/02
04/07/02
04/14/02
04/21/02
04/28/02
05/05/02
05/12/02
05/19/02
05/26/02
06/02/02
06/09/02
06/16/02
06/23/02
06/30/02
07/07/02
07/14/02
07/21/02
07/28/02
08/04/02
08/11/02
08/18/02
08/25/02
09/01/02
09/08/02
09/15/02
09/22/02
09/29/02
10/06/02
Date

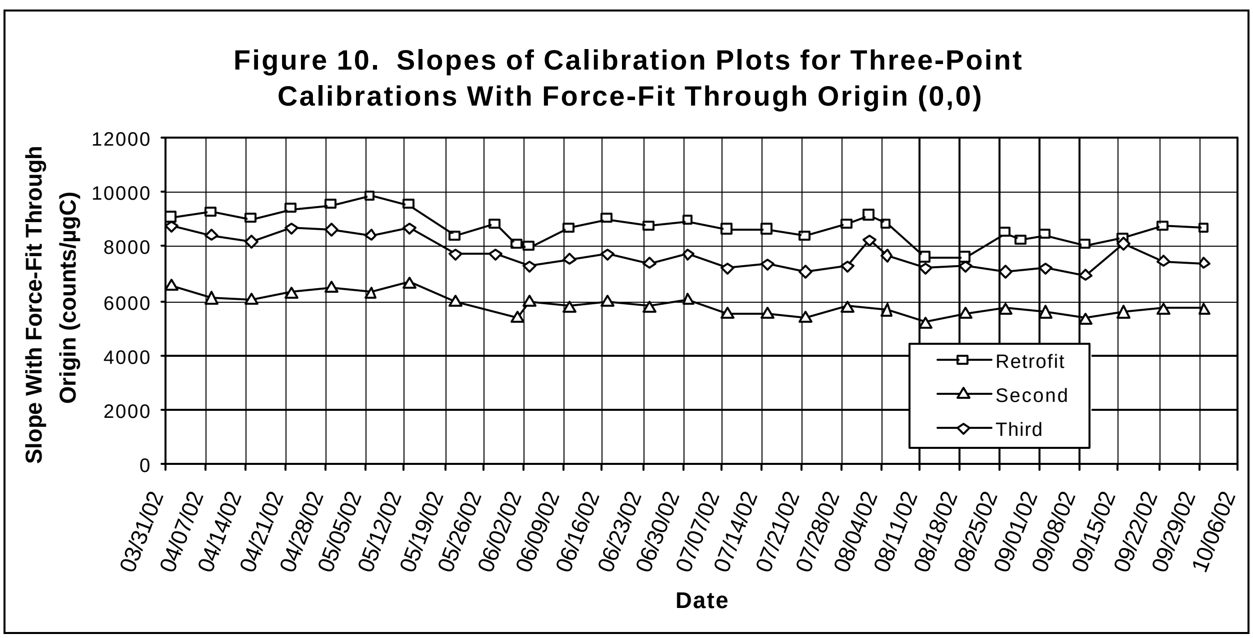
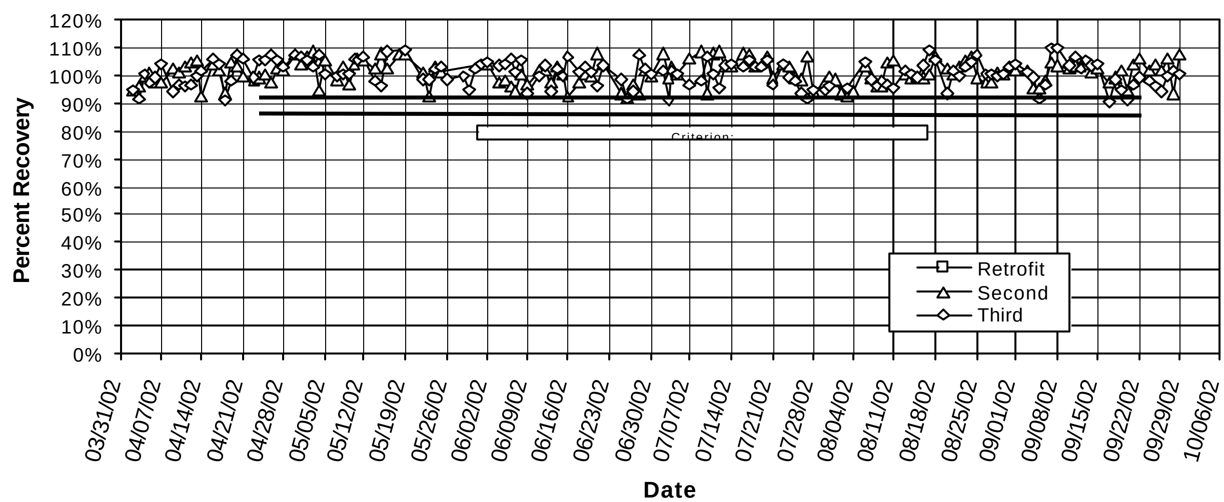


Figure 10. Slopes of Calibration Plots for Three-Point Calibrations With Force-Fit Through Origin (0,0)
Slope With Force-Fit Through Origin (counts/µgC)
12000
10000
8000
6000
4000
2000
0
Retrofit
Second
Third
03/31/02
04/07/02
04/14/02
04/21/02
04/28/02
05/05/02
05/12/02
05/19/02
05/26/02
06/02/02
06/09/02
06/16/02
06/23/02
06/30/02
07/07/02
07/14/02
07/21/02
07/28/02
08/04/02
08/11/02
08/18/02
08/25/02
09/01/02
09/08/02
09/15/02
09/22/02
09/29/02
10/06/02
Date

Figure **11** shows percent recovery for all daily calibration checks run on all three instruments during the reporting period. All daily calibration checks met the acceptance criterion of 90% to 110% recovery.

Figure 11. Daily Calibration Checks



Duplicate measurements are used to monitor the uniformity of filter loading and to indicate instrument stability. The acceptance criteria for duplicate measurements (in the Table above) are based on a significant absolute uncertainty at low (< 5 μg C/cm^2) TC loadings and the relative uncertainty at higher TC loadings. Figures **12a, 12b, and 12c** show relative percent difference of duplicate measurements versus filter concentration (μg C/cm^2) for the Retrofit, Second, and Third instruments, respectively, during the reporting period. Text boxes beside each figure show total number of duplicates run on that instrument and the numbers of filters that passed and that failed the appropriate duplicate criterion. Filters that failed to meet the appropriate duplicate acceptance criterion were flagged as having a nonuniform filter deposit (LFU).

2.3.3 Data Validity Discussion

Invalid Data Due to OC/EC Laboratory Errors. The ability to take a second or third punch from a quartz filter for analysis allows the OC/EC analyst to avoid invalidating data due to OC/EC Laboratory error except in extreme cases when an entire filter (or half-filter aliquot) is involved in an error. So far, this has occurred only when a filter or half-filter aliquot arrived at the OC/EC Laboratory in pieces so small that a full punch could not be taken as a single piece. Quartz filters are almost always torn around the edges during removal from the cassette filter holder in the SHAL but are only flagged as torn (1) by SHAL personnel if they arrive at RTI damaged or (2) by the OC/EC analyst if there is no portion of the filter large enough for the removal of a full punch for analysis as a single piece. The second occurrence is extremely rare.

Figure 12a: Relative Percent Difference of Duplicates vs. Average Value for TC on Retrofit OC/EC Analyzer - April 1, 2002, through September 30, 2002

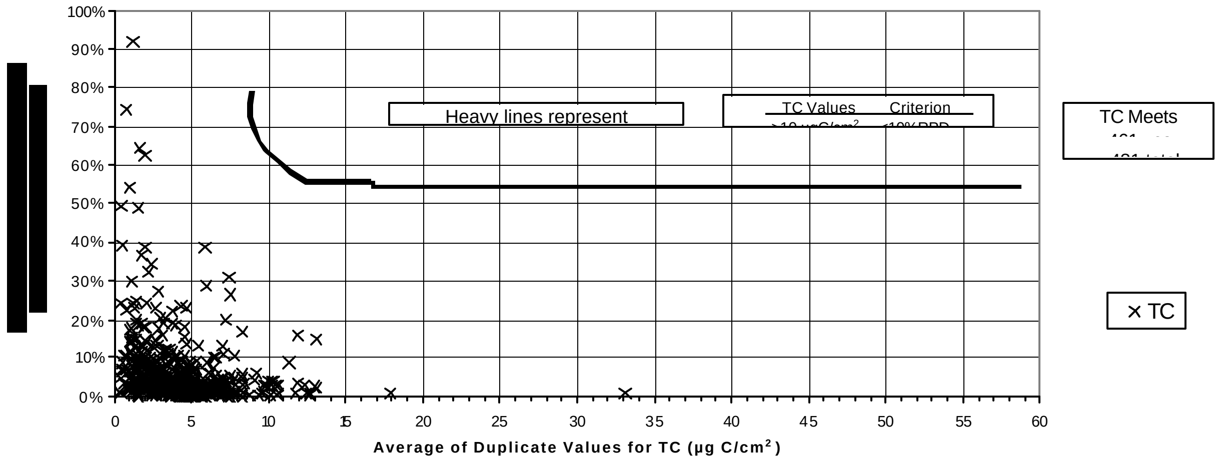


Figure 12b: Relative Percent Difference of Duplicates vs. Average Value for TC on Second OC/EC Analyzer - April 1, 2002, through September 30, 2002

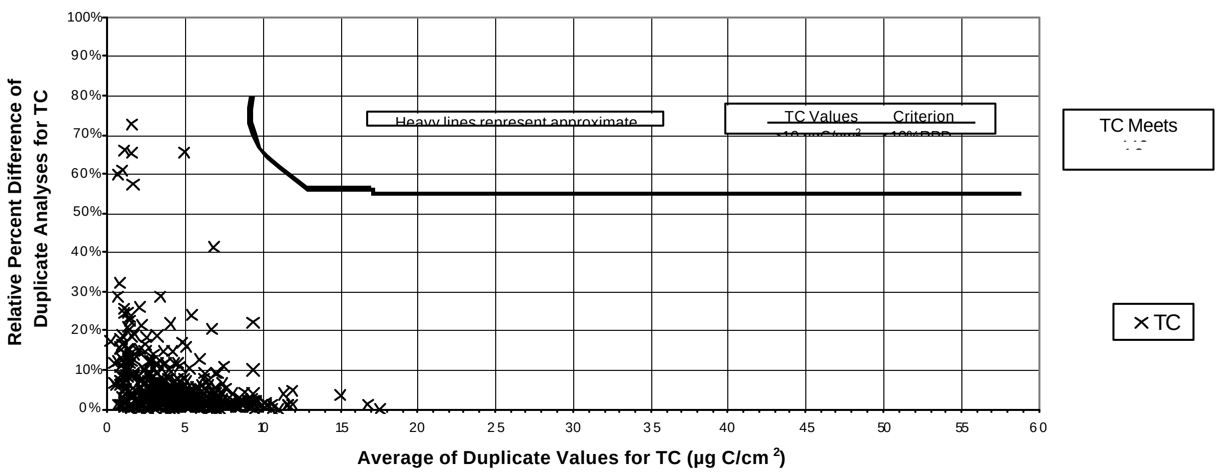
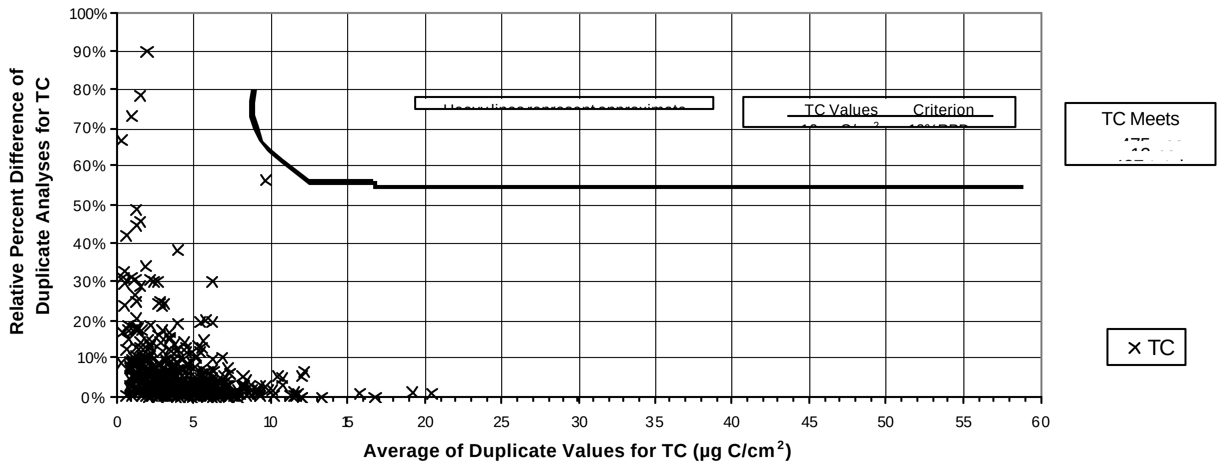


Figure 12c: Relative Percent Difference of Duplicates vs. Average Value for TC on Third OC/EC Analyzer - April 1, 2002, through September 30, 2002



Invalid Data Due to Other Causes. The OC/EC Laboratory simply analyzes filters that are delivered from the SHAL without any knowledge of the sampling or other field and transport data associated with those filters. OC/EC Laboratory personnel do not know if data for a filter will be invalidated for causes other than those associated with the OC/EC analysis.

2.3.4 Summary of Audit Findings and Recommendations

The February 5, 2002, audit of the OC/EC Laboratory did not result in any critical findings in the OC/EC Laboratory. A 2.10 µg/µL sucrose solution prepared and used as a standard at RTI was analyzed by NAREL chemists, and NAREL's measurement (2.14 µg/µL) differed from the RTI value by only 1.9%.

2.3.5 Corrective Actions Taken

No corrective actions were taken during the period April 1, 2002, through September 30, 2002.

2.4 X-ray Fluorescence Laboratories

During the reporting period, four XRF instruments were in use. Included were one at RTI, two at Chester LabNet, and one at Cooper Environmental Services. Each had been tested and accepted by the EPA for use in the PM2.5 Speciation Program.

Section 2.4.1 describes the checks common to all laboratories (and instruments within each laboratory). Sections 2.4.2, 2.4.3, and 2.4.4, respectively, describe the specific QC results for Chester, CES, and RTI.

2.4.1 Description of QC Checks Applied

QC elements for the analysis of elements by EDXRF, their frequency of application and control limits, and corrective actions are shown in **Table 17**.

Table 17. QC Procedures Used to Analyze EDXRF Elements

QC Element	Frequency	Control Limits	Corrective Action
Calibration	as needed	--	--
Calibration verification	weekly	within NIST uncertainties	recalibrate
Instrument precision	once per batch of $\leq$ 15	95–105% recovery	batch reanalysis
Excitation condition check	every sample	within analysis uncertainty	sample reanalysis
Sample replicate precision	10%	± 5 RPD	batch reanalysis

The two-sigma (95 percent confidence level) detection limits in units of µg/cm^2 are calculated from the analysis of a blank Teflon filter as follows:

$$\text{detection limit for element } i = 2\delta_i = \frac{2(2B_i)^{1/2}}{s_i t}$$

where,

B_i is the background counts for element i,
s_i is the sensitivity factor for element i,
and t is the counting lifetime.

Theoretically, detection limits may be decreased by simply increasing the counting lifetime. In practice, a point of diminishing returns is reached for real-world samples in which the background increases along with the analyte signal. At this point, further improvement in detection limits by increasing the counting time is not possible.

2.4.2 Chester LabNet

Chester LabNet was the original XRF subcontractor laboratory used for the STN program. During this period, Chester operated two Kevex XRF instruments which have been designated 770 and 771.

2.4.2.1 Statistical Summary of QC Results –

Precision

The precision is monitored by the reproducibility of the XRF signal in counts per second using standard samples. The counts for a select element are measured for each of the targets used. The comparison of the counts during calibration and during the run gives the measure of reproducibility or precision. The data used to monitor precision are presented in **Figures 13 through 25**.

When plotted over time, the recovery precision for Si(0), Se(4), Cd(5) on the 770 and Si(1), on the 771, appear to exhibit a time dependence. These changes per year are all less than 10 percent except for Si(0). The Si(0) will be carefully monitored. `The recovery for these elements appear to be within the uncertainty after correction for mass absorption and spectral overlap **(Tables 18a and 18b)**.

Table 18a. Summary of Chester QC Precision Recovery Data, Kevex 770, 04/01/2002 - 09/30/2002.

Percent Recoveries

Element	Avg.	Std Dev	% RSD	Max	Min	R	Slope/Year	
							Current	Previous
Si(0)	99.08	2.55	2.58	106.39	93.49	0.88199	11.58	-7.5
Si(1)	101.21	2.10	2.07	107.62	95.03	0.35065	1.50	1.6
Ti(2)	102.42	1.73	1.69	107.88	93.96	0.33371	1.12	3.95
Fe(3)	100.10	1.41	1.41	105.28	94.50	0.33176	0.90	-0.63
Se(4)	102.14	2.33	2.28	109.03	94.07	0.42054	2.40	3.8
Pb(4)	101.64	2.47	2.43	107.49	94.15	0.40790	2.40	5.49
Cd(5)	101.04	1.65	1.64	105.59	96.24	0.56480	3.08	3.29

N=329 for all data.

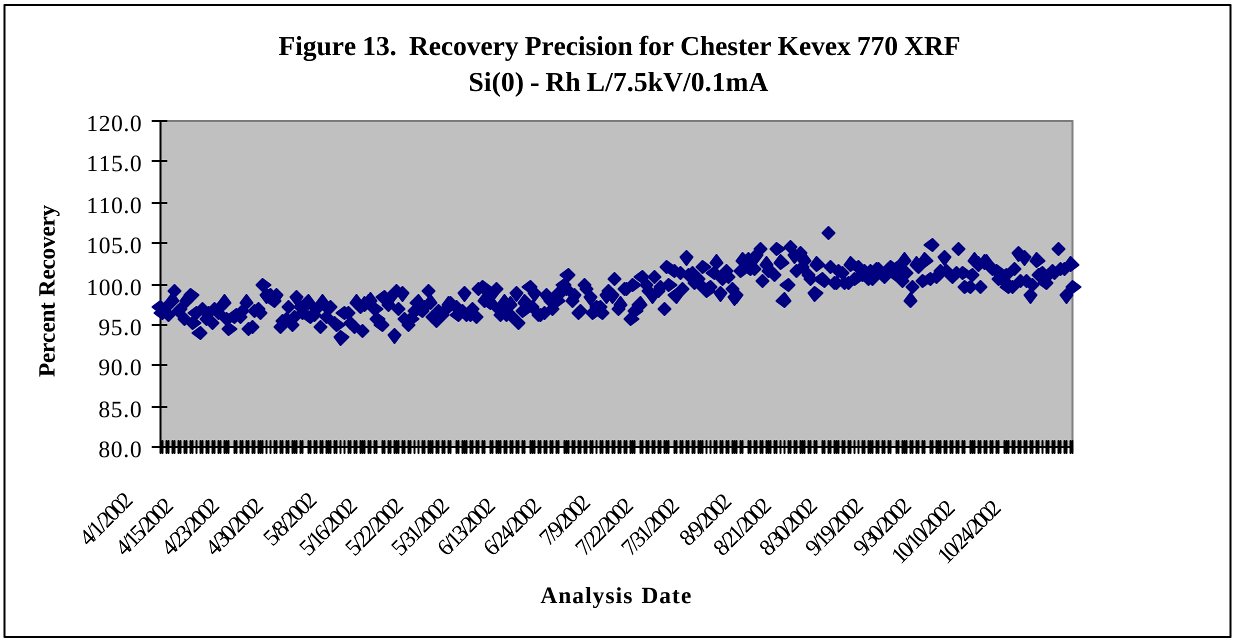


Figure 13. Recovery Precision for Chester Kevex 770 XRF
Si(0) - Rh L/7.5kV/0.1mA
Percent Recovery
120.0
115.0
110.0
105.0
100.0
95.0
90.0
85.0
80.0
4/1/2002
4/15/2002
4/23/2002
4/30/2002
5/8/2002
5/16/2002
5/22/2002
5/31/2002
6/13/2002
6/24/2002
7/9/2002
7/22/2002
7/31/2002
8/9/2002
8/21/2002
8/30/2002
9/19/2002
9/30/2002
10/10/2002
10/24/2002
Analysis Date

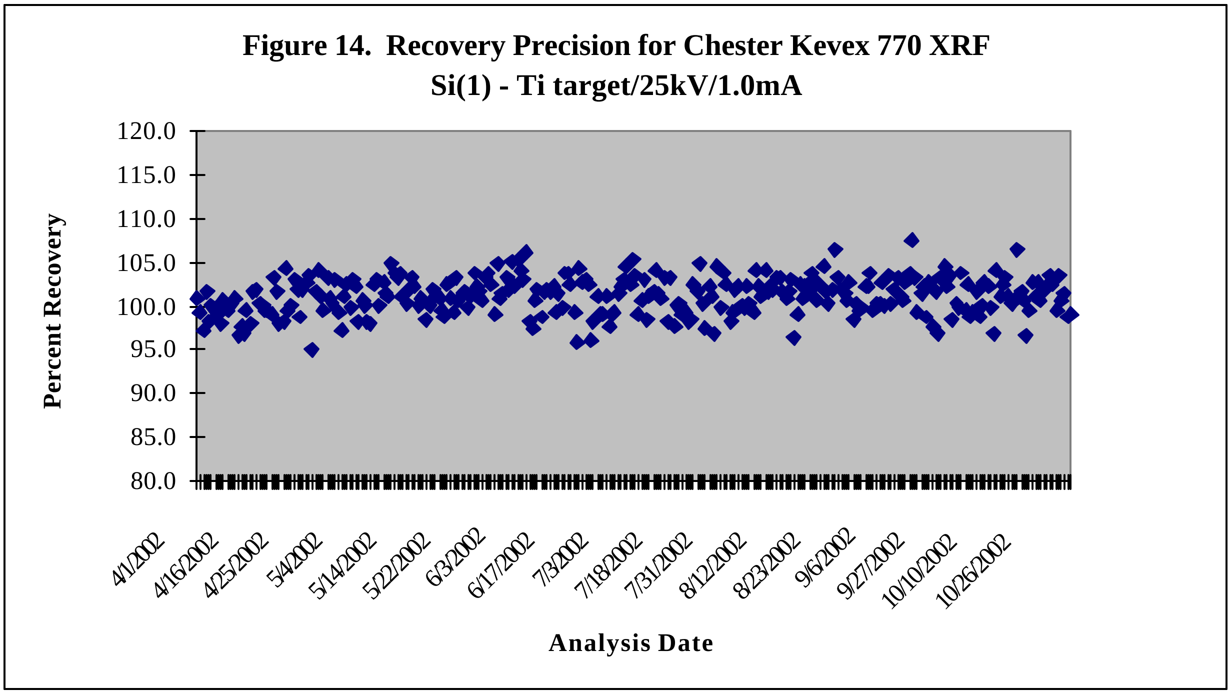


Figure 14. Recovery Precision for Chester Kevex 770 XRF
Si(1) - Ti target/25kV/1.0mA
Percent Recovery
120.0
115.0
110.0
105.0
100.0
95.0
90.0
85.0
80.0
4/1/2002
4/16/2002
4/25/2002
5/4/2002
5/14/2002
5/22/2002
6/3/2002
6/17/2002
7/3/2002
7/18/2002
7/31/2002
8/12/2002
8/23/2002
9/6/2002
9/27/2002
10/10/2002
10/26/2002
Analysis Date

Figure 15. Recovery Precision for Chester Kevex 770 XRF
Se(4) - Rh K/35kV/0.25mA

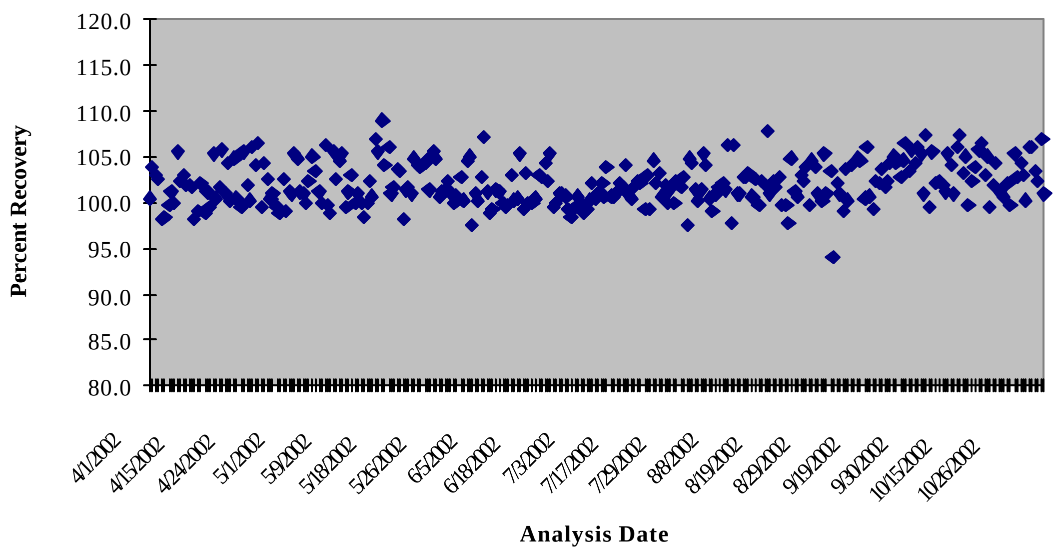


Figure 16. Recovery Precision for Chester Kevex 770 XRF
Pb(4) - Rh K/35kV/0.25mA

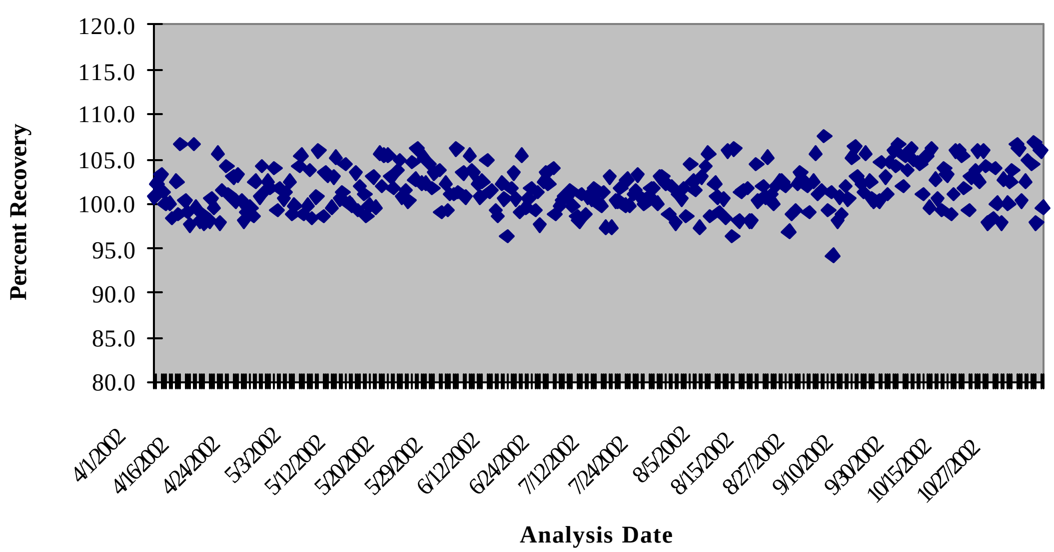


Figure 17. Recovery Precision for Chester Kevex 770 XRF
Cd(5) - Rh K/W filter/55kV/0.25mA

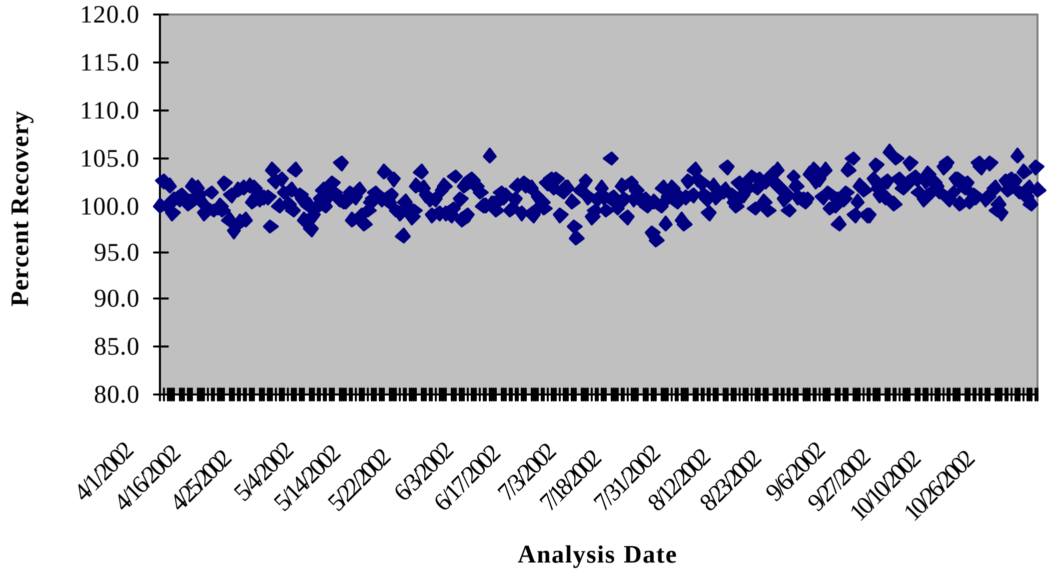
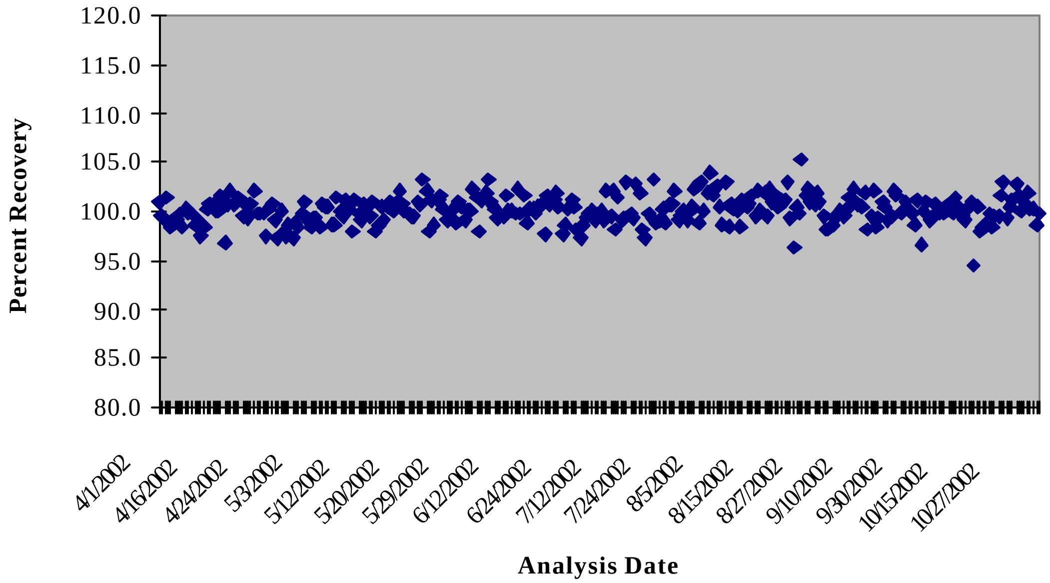


Figure 18. Recovery Precision for Chester Kevex 770
Fe(3) - Ge target/35kV/0.5mA



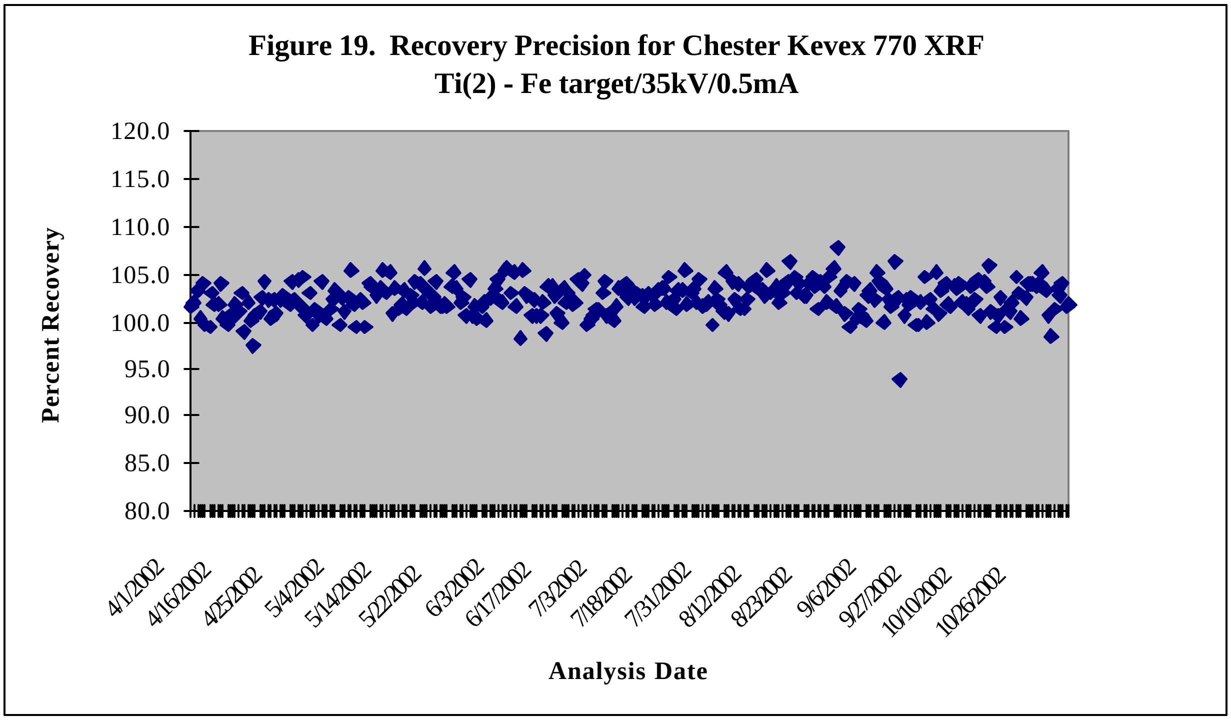


Figure 19. Recovery Precision for Chester Kevex 770 XRF
Ti(2) - Fe target/35kV/0.5mA
Percent Recovery
120.0
115.0
110.0
105.0
100.0
95.0
90.0
85.0
80.0
4/1/2002
4/16/2002
4/25/2002
5/4/2002
5/14/2002
5/22/2002
6/3/2002
6/17/2002
7/3/2002
7/18/2002
7/31/2002
8/12/2002
8/23/2002
9/6/2002
9/27/2002
10/10/2002
10/26/2002
Analysis Date

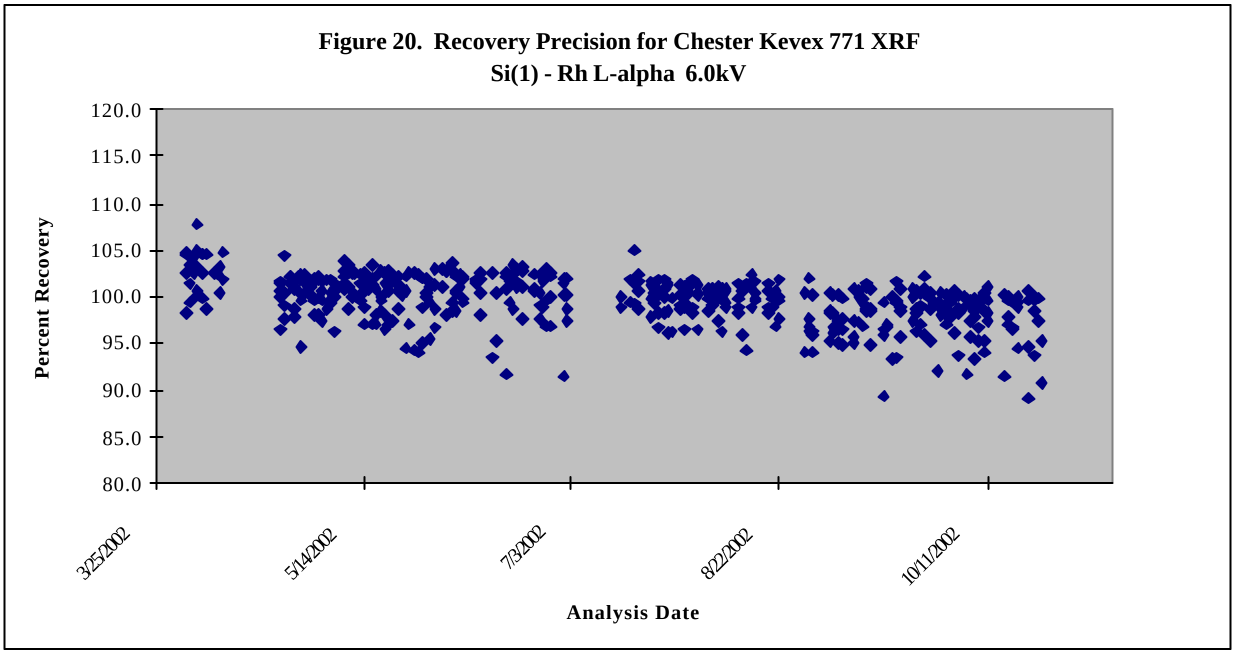


Figure 20. Recovery Precision for Chester Kevex 771 XRF
Si(1) - Rh L-alpha 6.0kV
Percent Recovery
120.0
115.0
110.0
105.0
100.0
95.0
90.0
85.0
80.0
3/25/2002
5/14/2002
7/3/2002
8/22/2002
10/11/2002
Analysis Date

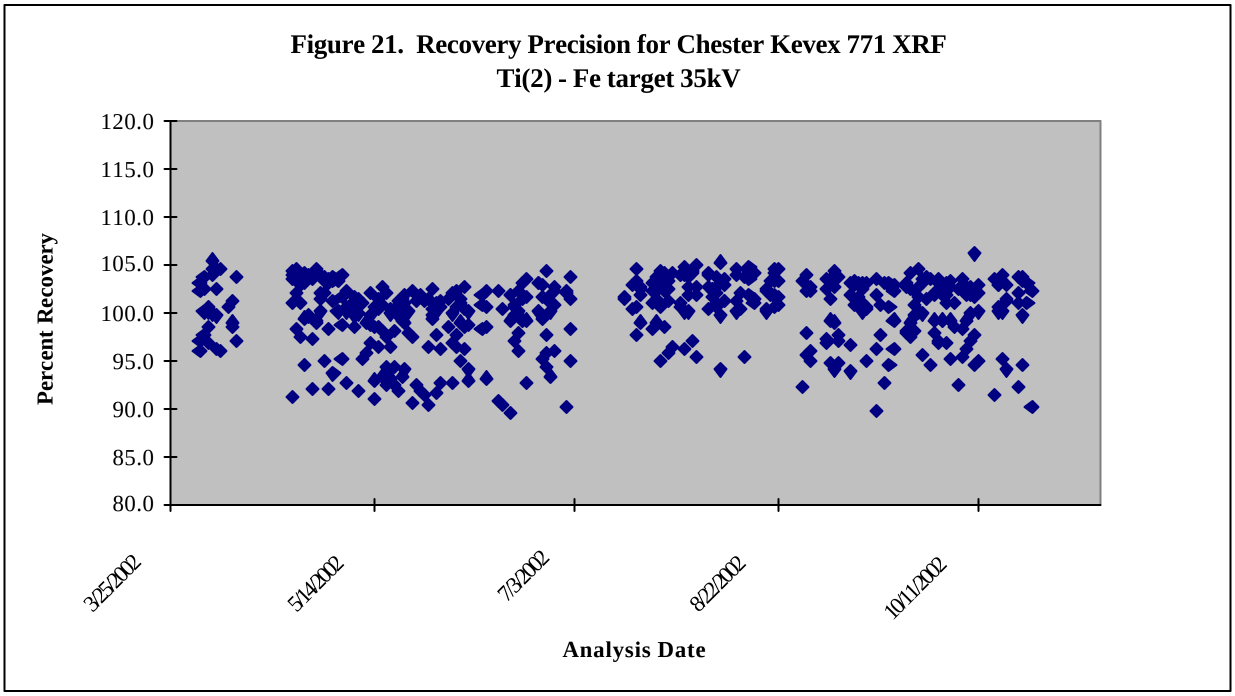


Figure 21. Recovery Precision for Chester Kevex 771 XRF
Ti(2) - Fe target 35kV
Percent Recovery
120.0
115.0
110.0
105.0
100.0
95.0
90.0
85.0
80.0
3/25/2002
5/14/2002
7/3/2002
8/22/2002
10/11/2002
Analysis Date

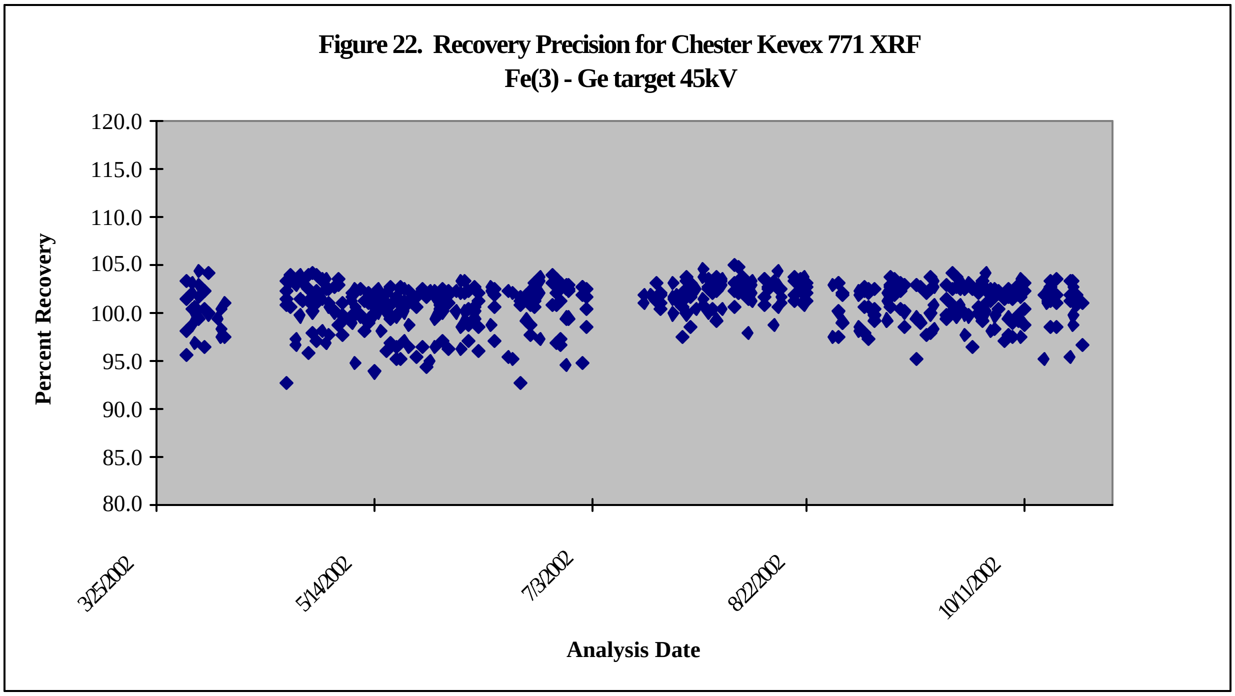


Figure 22. Recovery Precision for Chester Kevex 771 XRF
Fe(3) - Ge target 45kV
Percent Recovery
120.0
115.0
110.0
105.0
100.0
95.0
90.0
85.0
80.0
3/25/2002
5/14/2002
7/3/2002
8/22/2002
10/11/2002
Analysis Date

Figure 23. Recovery Precision for Chester Kevex 771 XRF
Pb(4) Rh K-alpha 35kV

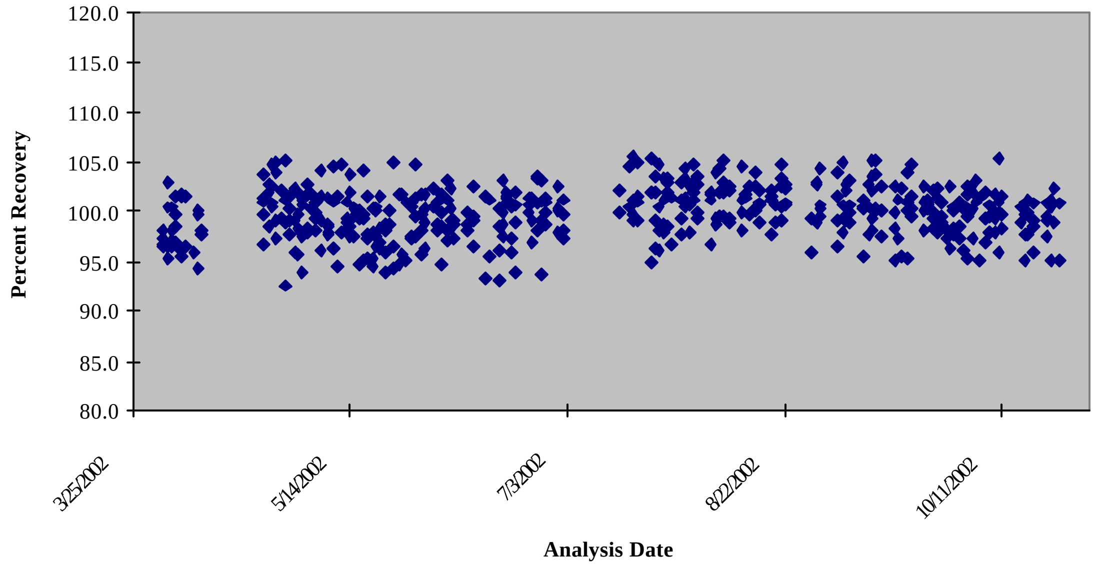


Figure 24. Recovery Precision for Chester Kevex 771 XRF
Se(4) - Rh K-alpha 35kV

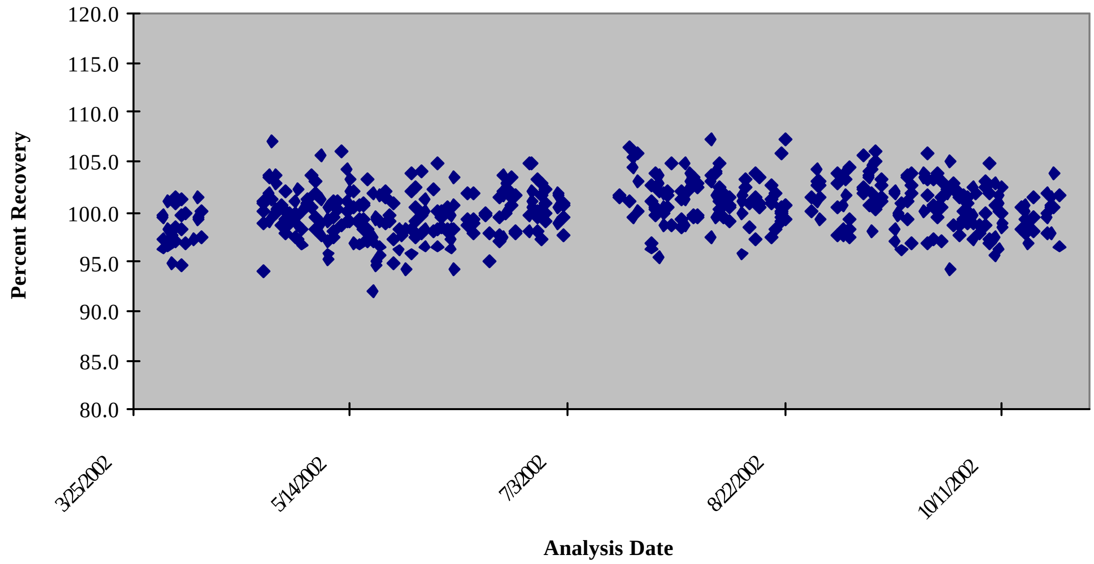


Figure 25. Recovery Precision for Chester Kevex 771 XRF
Cd(5) W filter 55kV

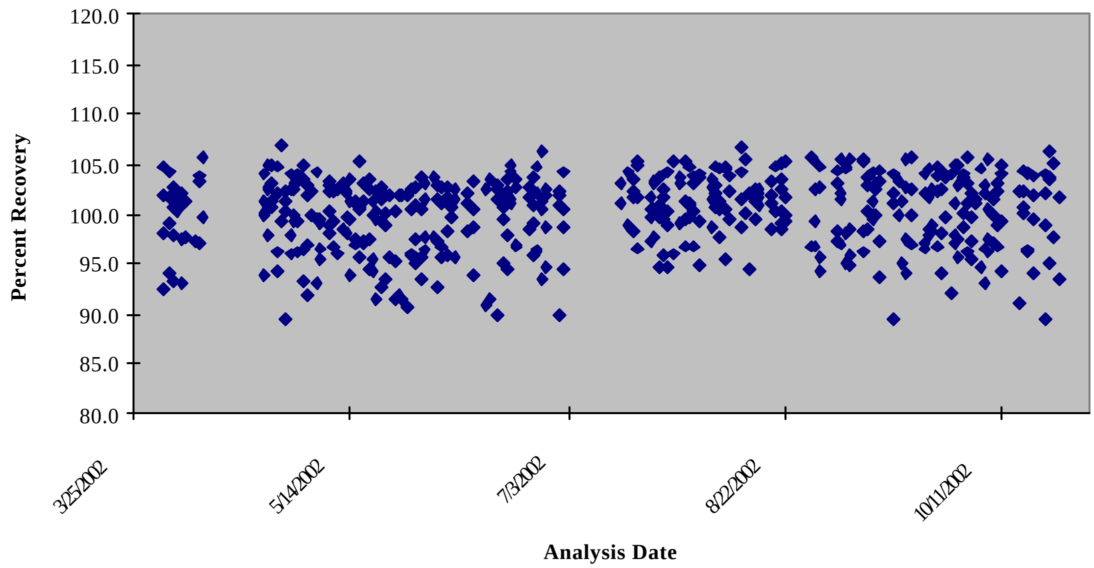


Table 18b. Summary of Chester QC Precision Recovery Data, Kevex 771, 04/01/2002 - 09/30/2002.

Element	Avg.	Std Dev	RSD	Max	Min	R	Slope/Year	
							Current	Previous
Si(1)	99.67	2.57	2.58%	107.68	89.06	0.39694	-7.27	2.77
Ti(2)	100.07	3.51	3.51%	106.06	89.46	0.53355	2.39	-4.86
Fe(3)	100.92	2.25	2.23%	105.07	92.79	0.56087	1.99	-5.97
Se(4)	100.36	2.48	2.47%	107.35	91.96	0.54006	3.31	-0.03
Pb(4)	99.82	2.53	2.54%	105.55	92.48	0.44111	2.24	-3.42
Cd(5)	100.15	3.58	3.58%	106.87	89.47	0.45492	2.25	-0.46

Recovery

Recovery or system accuracy is determined by the analysis of a series of NIST Standard Reference Materials filters. Recovery is calculated by comparison of measured and expected values. **Figures 26 through 51** show recovery for 12 select elements spanning the range of the 48 elements normally measured. All recovery values for all elements ranged between 93.6 and 111.6 percent for the 770 and between 86.1 and 115.6 percent for the 771, as shown in **Table 19**. The low value of 86.1% was for one value for sulfur; the next lowest value was 93.8% . The high value of 115.6% was for sulfur; the next highest value was 114.3%, and the third highest was 109.7%. The low value occurred at the start of the period and the high values occurred at the middle of the period. No trends were observed. All other elements were in control ($\geq$ 90%, $\leq$ 110%) at all times.

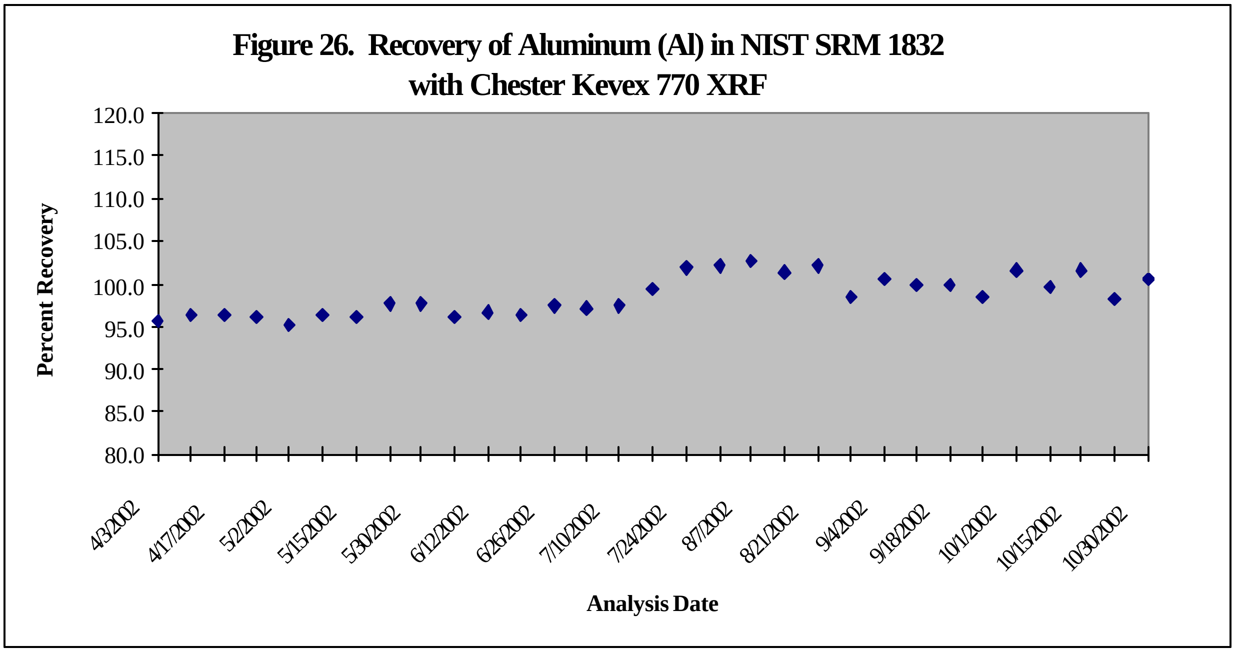


Table 19. Recovery Determined from Analysis of NIST Standard Reference Material Filters, Kevex 770 and 771.

Element	Kevex 770	Kevex 771
	Range % Recovery	Range % Recovery
Al	95.1 - 102.7	94.7 - 107.5
Si*	98.6 - 104.8	94.2 - 105.4
Si**	93.6 - 102.6	91.9 - 100.7
S	98.6 - 108.1	86.1 - 115.6
K	97.2 - 102.2	90.1 - 108.3
Ca	107.3 - 111.6	101.8 - 110.6
Ti	99.6 - 107.3	92.3 - 101.4
V	97.7 - 101.9	97.7 - 107.8
Mn	99.8 - 109.3	98.4 - 106.1
Fe	98.3 - 101.7	97.2 - 102.4
Cu	96.9 - 103.4	95.3 - 102.7
Zn	97.7 - 102.0	96.5 - 102.7
Pb	97.0 - 103.4	95.8 - 104.8

*SRM 1832. **SRM 1833.

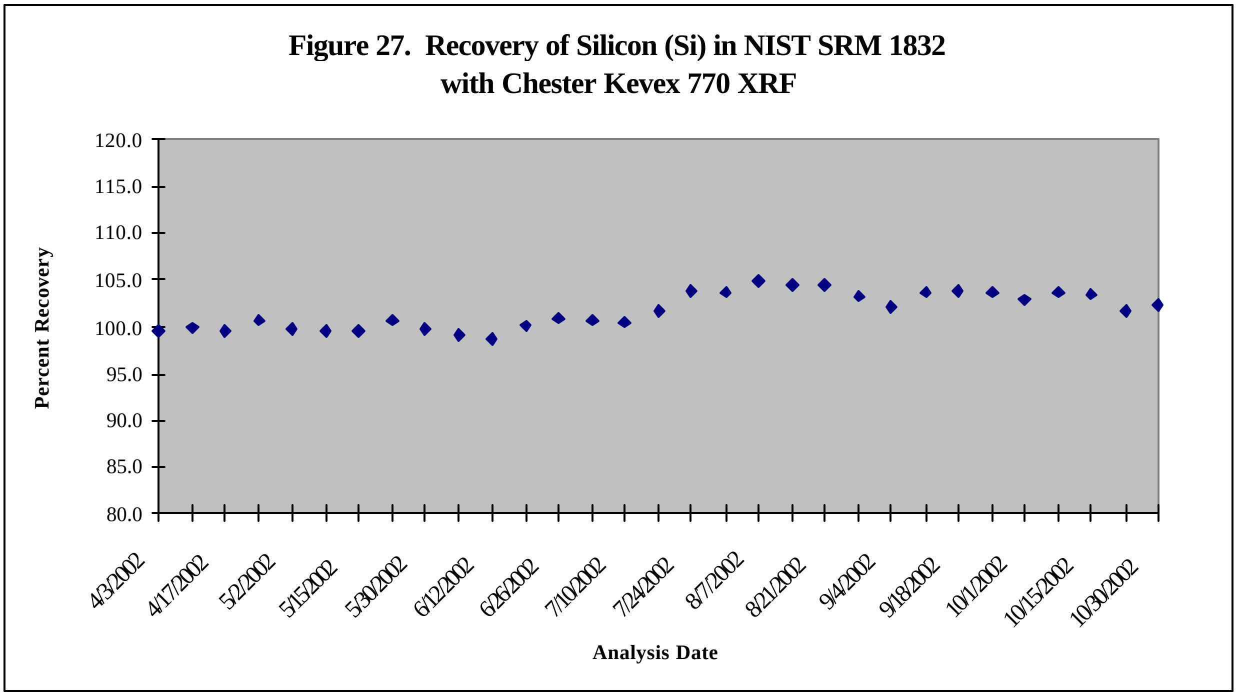


Figure 27. Recovery of Silicon (Si) in NIST SRM 1832
with Chester Kevex 770 XRF
Percent Recovery
120.0
115.0
110.0
105.0
100.0
95.0
90.0
85.0
80.0
4/3/2002
4/17/2002
5/2/2002
5/15/2002
5/30/2002
6/12/2002
6/26/2002
7/10/2002
7/24/2002
8/7/2002
8/21/2002
9/4/2002
9/18/2002
10/1/2002
10/15/2002
10/30/2002
Analysis Date

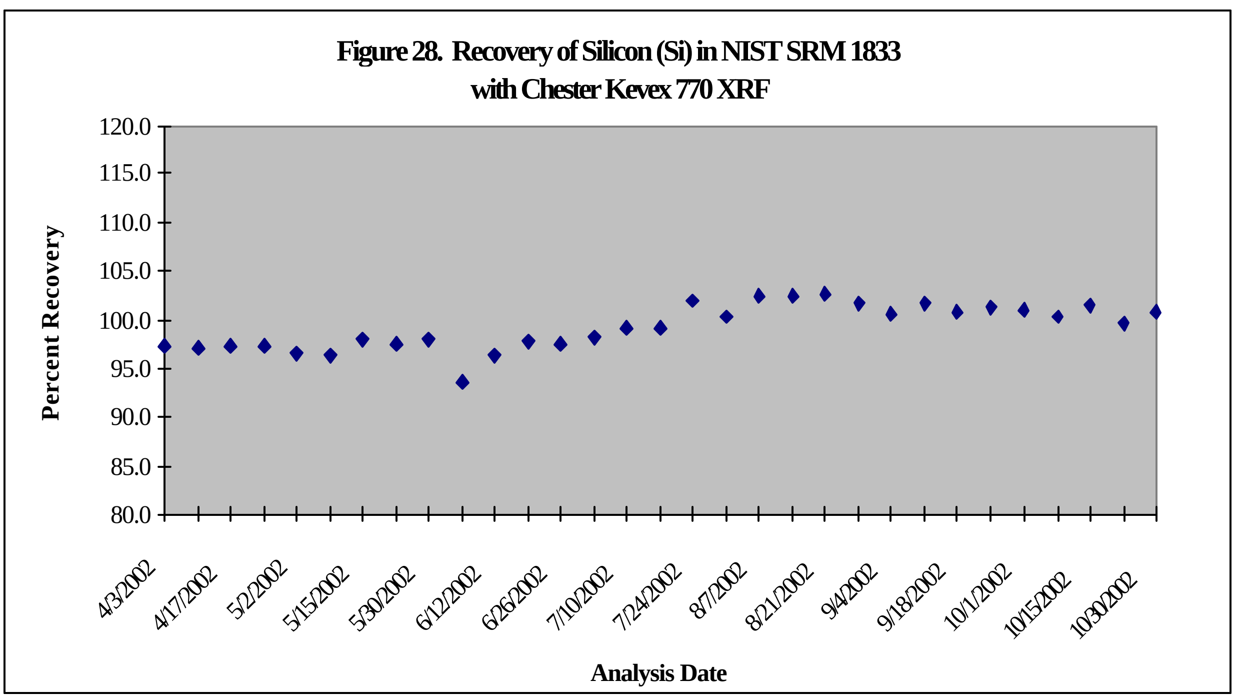


Figure 28. Recovery of Silicon (Si) in NIST SRM 1833
with Chester Kevex 770 XRF
Percent Recovery
120.0
115.0
110.0
105.0
100.0
95.0
90.0
85.0
80.0
4/3/2002
4/17/2002
5/2/2002
5/15/2002
5/30/2002
6/12/2002
6/26/2002
7/10/2002
7/24/2002
8/7/2002
8/21/2002
9/4/2002
9/18/2002
10/1/2002
10/15/2002
10/30/2002
Analysis Date

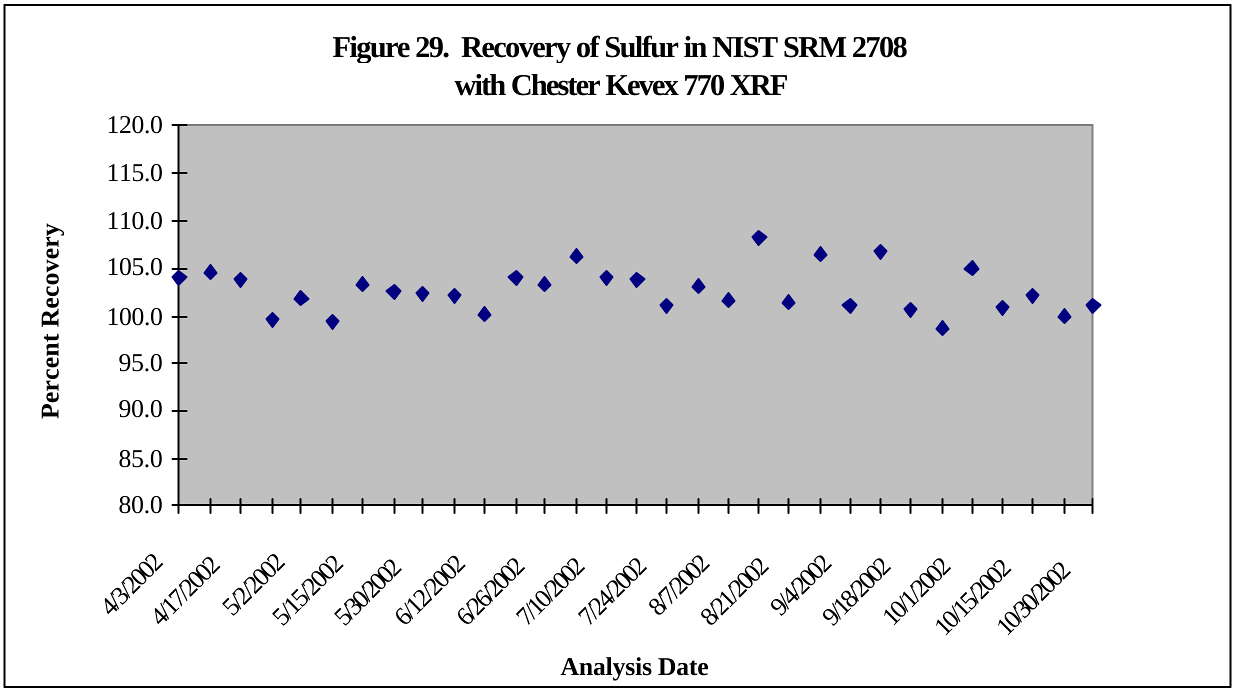


Figure 29. Recovery of Sulfur in NIST SRM 2708
with Chester Kevex 770 XRF
Percent Recovery
120.0
115.0
110.0
105.0
100.0
95.0
90.0
85.0
80.0
4/3/2002
4/17/2002
5/2/2002
5/15/2002
5/30/2002
6/12/2002
6/26/2002
7/10/2002
7/24/2002
8/7/2002
8/21/2002
9/4/2002
9/18/2002
10/1/2002
10/15/2002
10/30/2002
Analysis Date

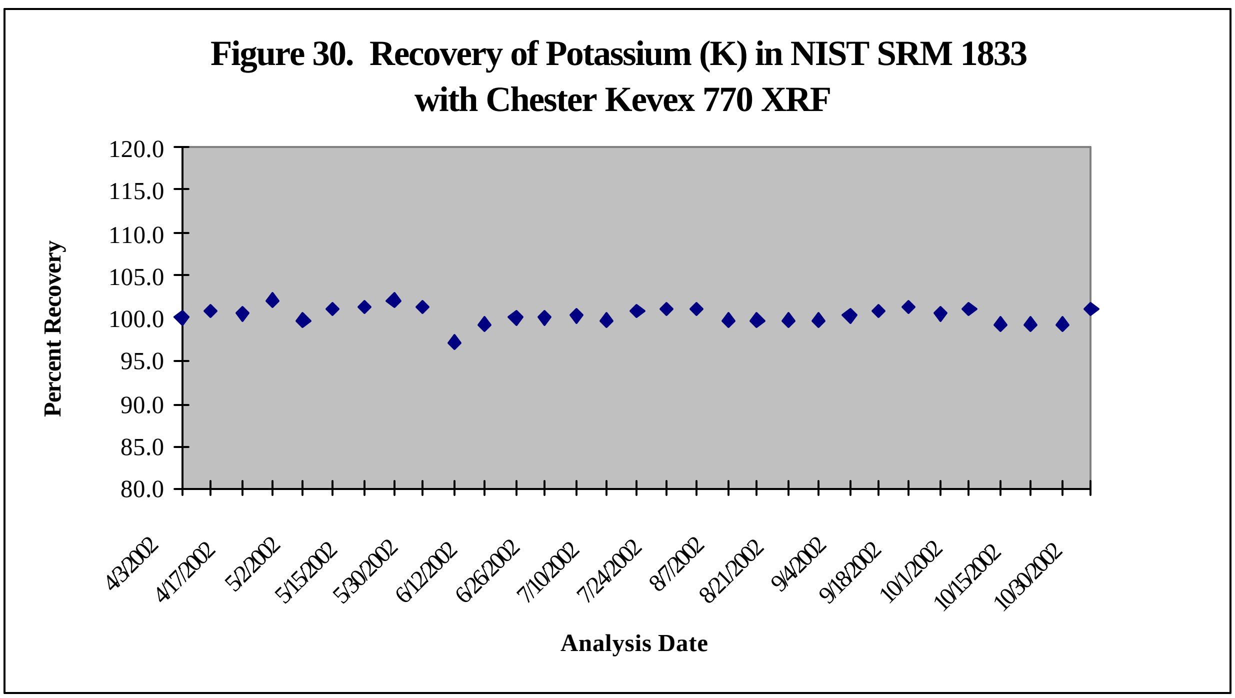


Figure 30. Recovery of Potassium (K) in NIST SRM 1833
with Chester Kevex 770 XRF
Percent Recovery
120.0
115.0
110.0
105.0
100.0
95.0
90.0
85.0
80.0
4/3/2002
4/17/2002
5/2/2002
5/15/2002
5/30/2002
6/12/2002
6/26/2002
7/10/2002
7/24/2002
8/7/2002
8/21/2002
9/4/2002
9/18/2002
10/1/2002
10/15/2002
10/30/2002
Analysis Date

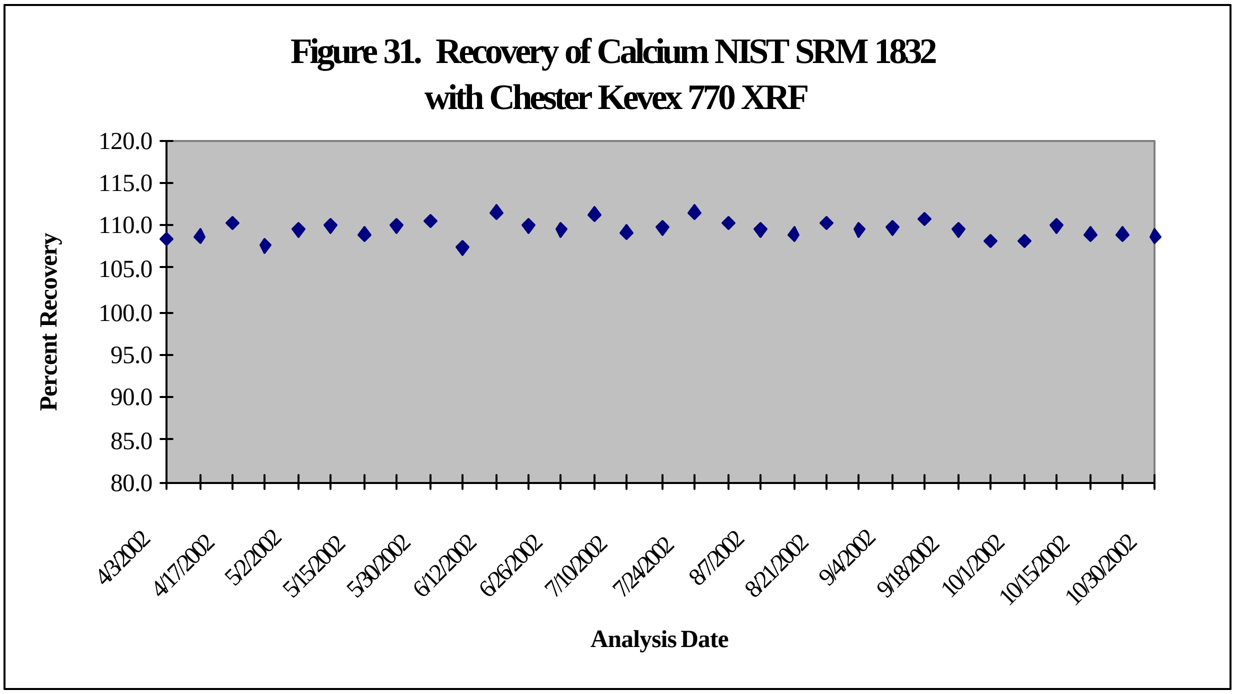


Figure 31. Recovery of Calcium NIST SRM 1832
with Chester Kevex 770 XRF
Percent Recovery
120.0
115.0
110.0
105.0
100.0
95.0
90.0
85.0
80.0
4/3/2002
4/17/2002
5/2/2002
5/15/2002
5/30/2002
6/12/2002
6/26/2002
7/10/2002
7/24/2002
8/7/2002
8/21/2002
9/4/2002
9/18/2002
10/1/2002
10/15/2002
10/30/2002
Analysis Date

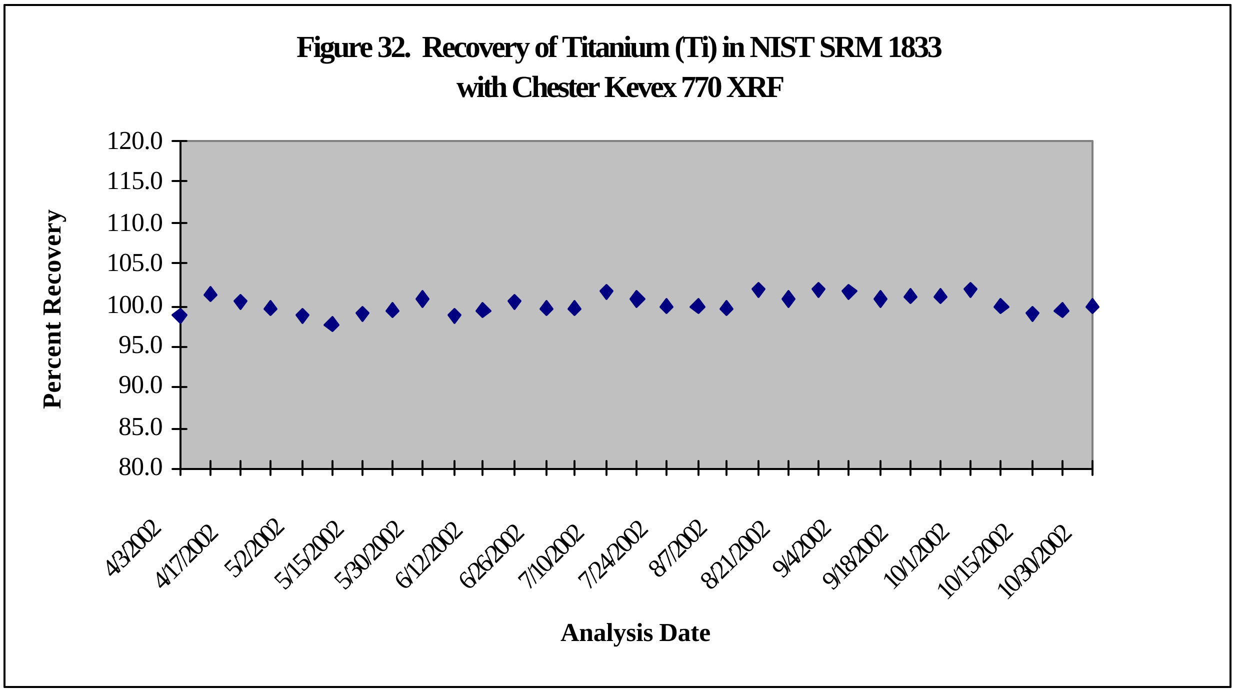


Figure 32. Recovery of Titanium (Ti) in NIST SRM 1833
with Chester Kevex 770 XRF
Percent Recovery
120.0
115.0
110.0
105.0
100.0
95.0
90.0
85.0
80.0
4/3/2002
4/17/2002
5/2/2002
5/15/2002
5/30/2002
6/12/2002
6/26/2002
7/10/2002
7/24/2002
8/7/2002
8/21/2002
9/4/2002
9/18/2002
10/1/2002
10/15/2002
10/30/2002
Analysis Date

Figure 33. Recovery of Vanadium (V) in NIST SRM 1832 with Chester Kevex 770 XRF

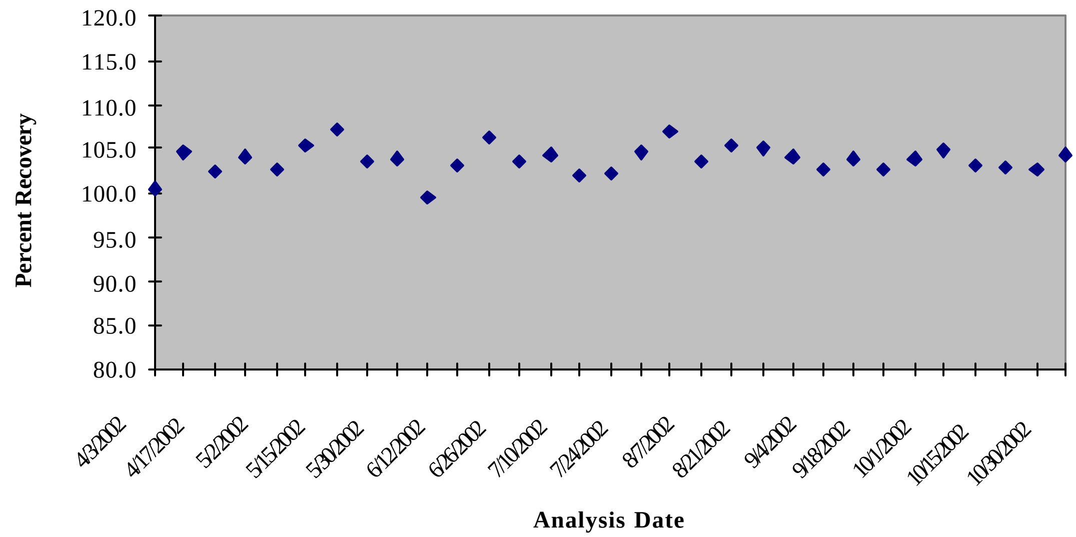


Figure 34. Recovery of Manganese (Mn) in NIST SRM 1832 with Chester Kevex 770 XRF

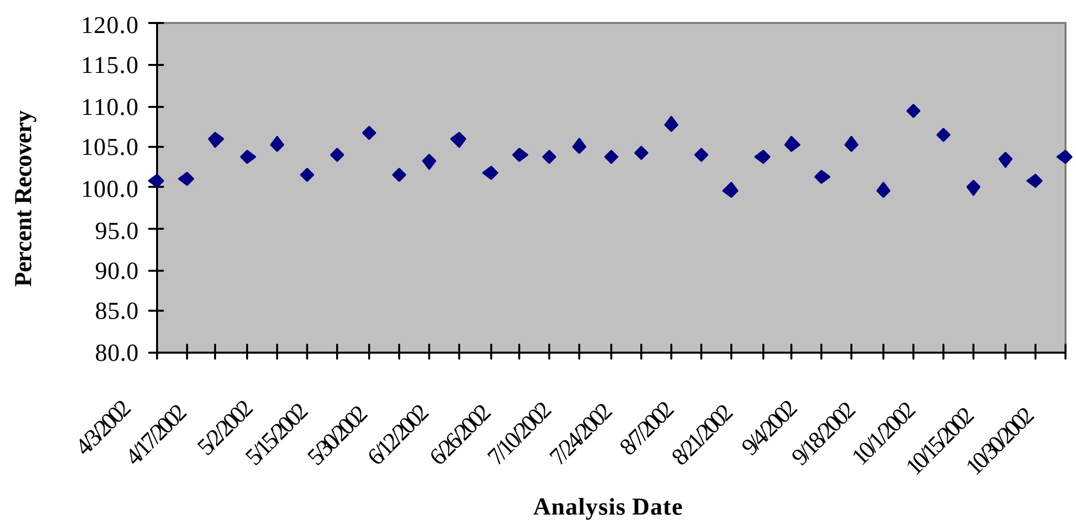


Figure 35. Recovery of Iron (Fe) in NIST SRM 1833 with Chester Kevex 770 XRF

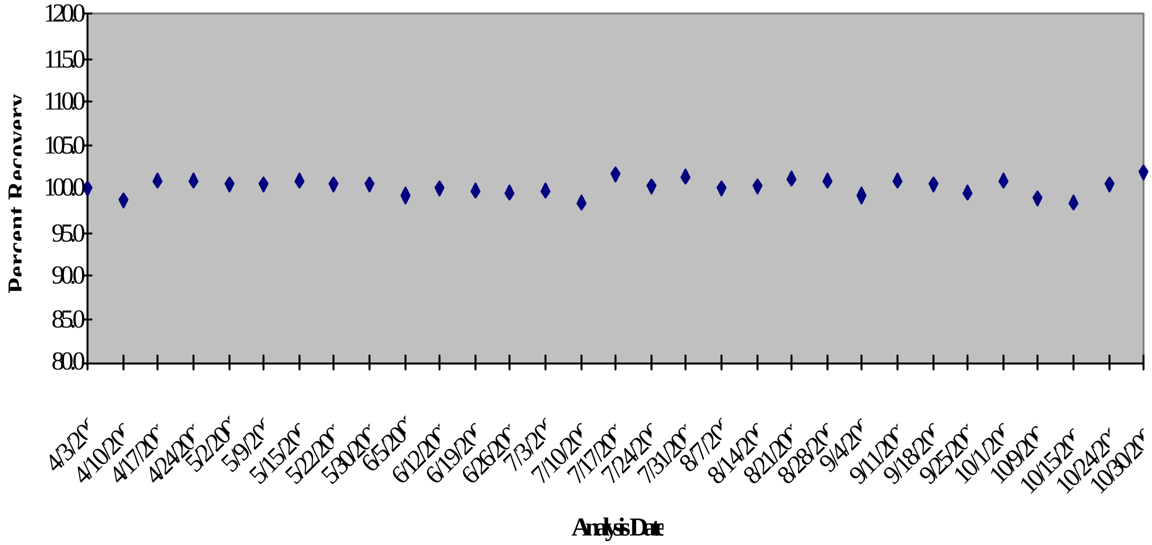


Figure 36. Recovery of Copper (Cu) in NIST SRM 1832 with Chester Kevex 770 XRF

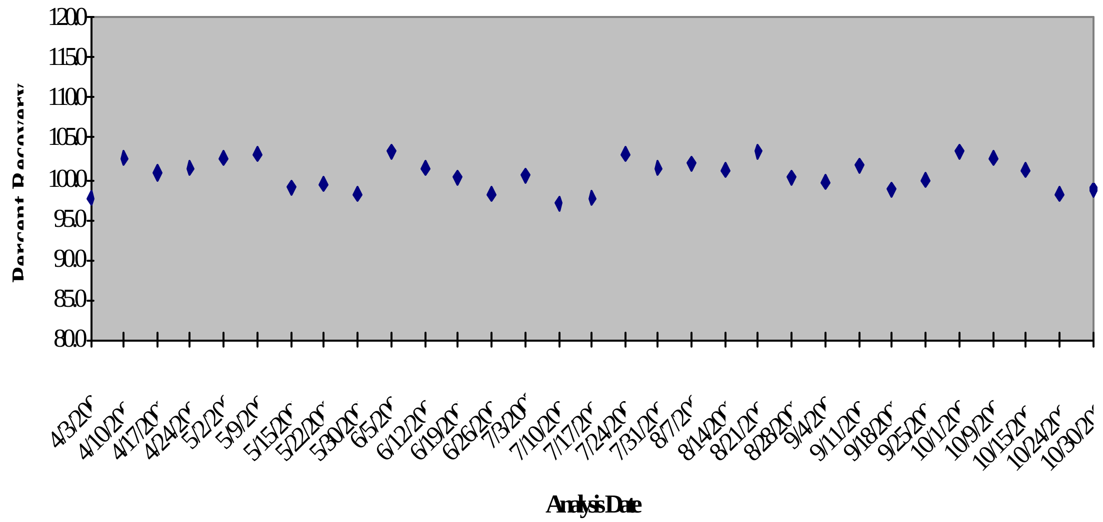


Figure 37. Recovery of Zinc (Zn) in NIST SRM 1833 with Chester Kevex 770 XRF

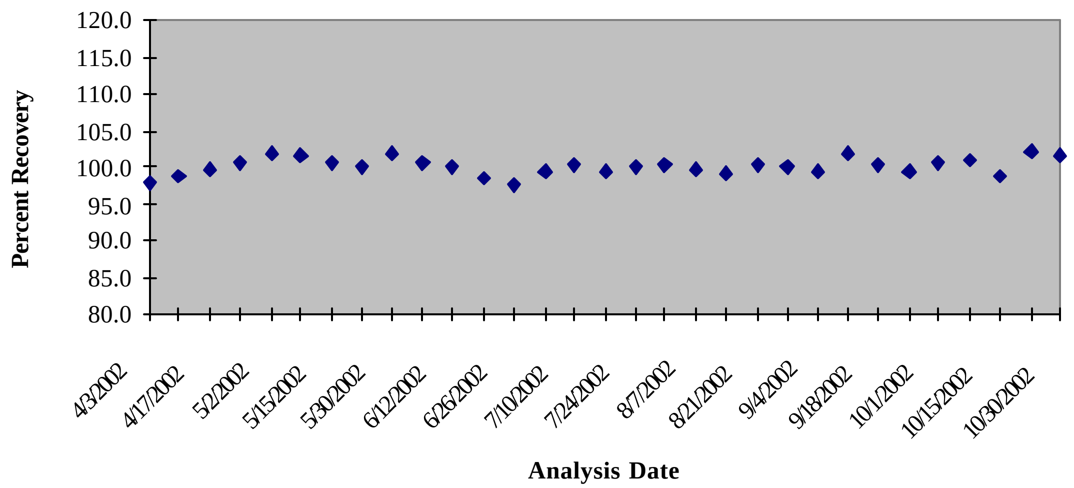


Figure 38. Recovery of Lead (Pb) in NIST SRM 1833 with Chester Kevex 770 XRF

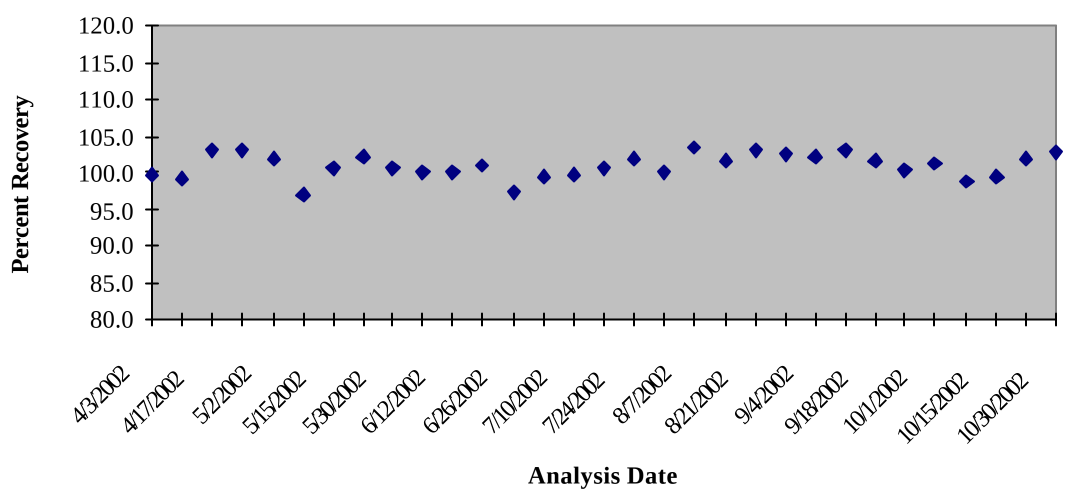


Figure 39. Recovery of Aluminum (Al) in NIST SRM 1832 with Chester 771 XRF

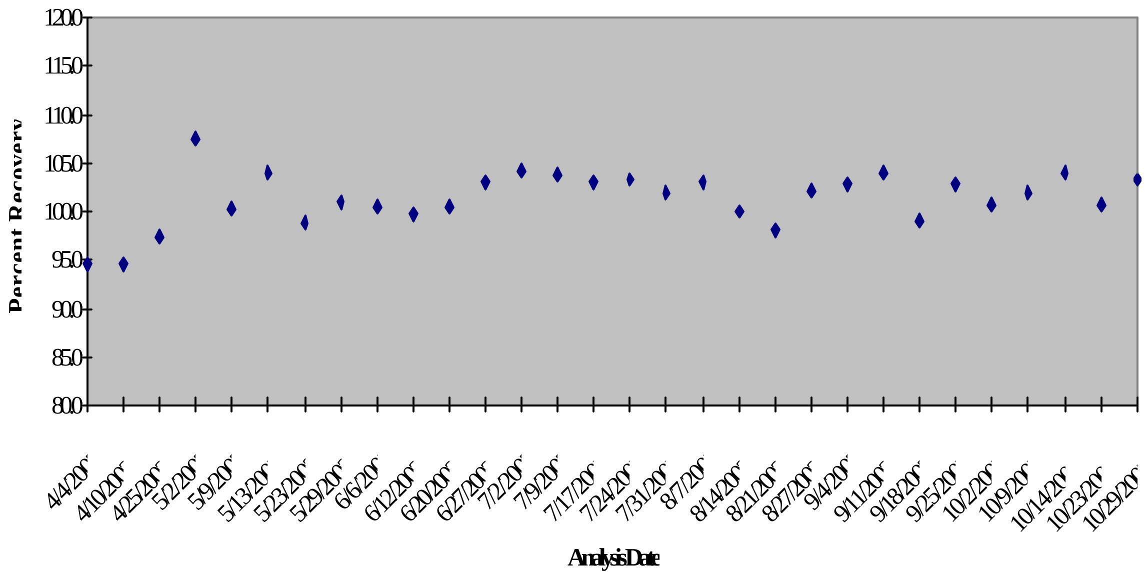
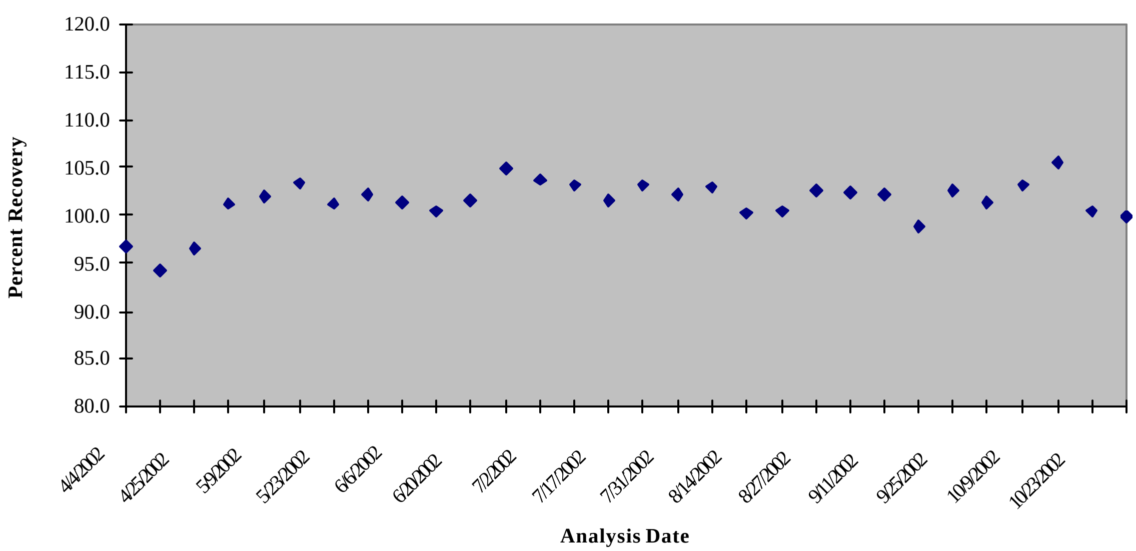


Figure 40. Recovery of Silicon (Si) in NIST SRM 1832 with Chester 771 XRF



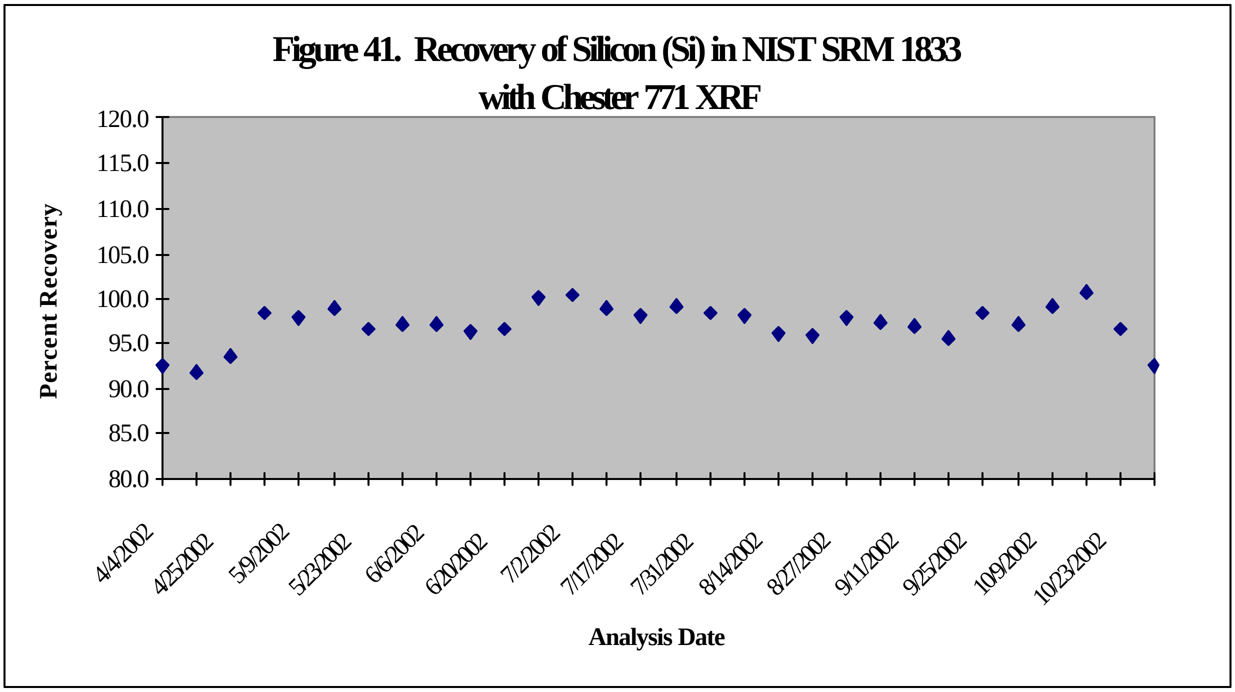


Figure 41. Recovery of Silicon (Si) in NIST SRM 1833
with Chester 771 XRF
Percent Recovery
120.0
115.0
110.0
105.0
100.0
95.0
90.0
85.0
80.0
4/4/2002
4/25/2002
5/9/2002
5/23/2002
6/6/2002
6/20/2002
7/2/2002
7/17/2002
7/31/2002
8/14/2002
8/27/2002
9/11/2002
9/25/2002
10/9/2002
10/23/2002
Analysis Date

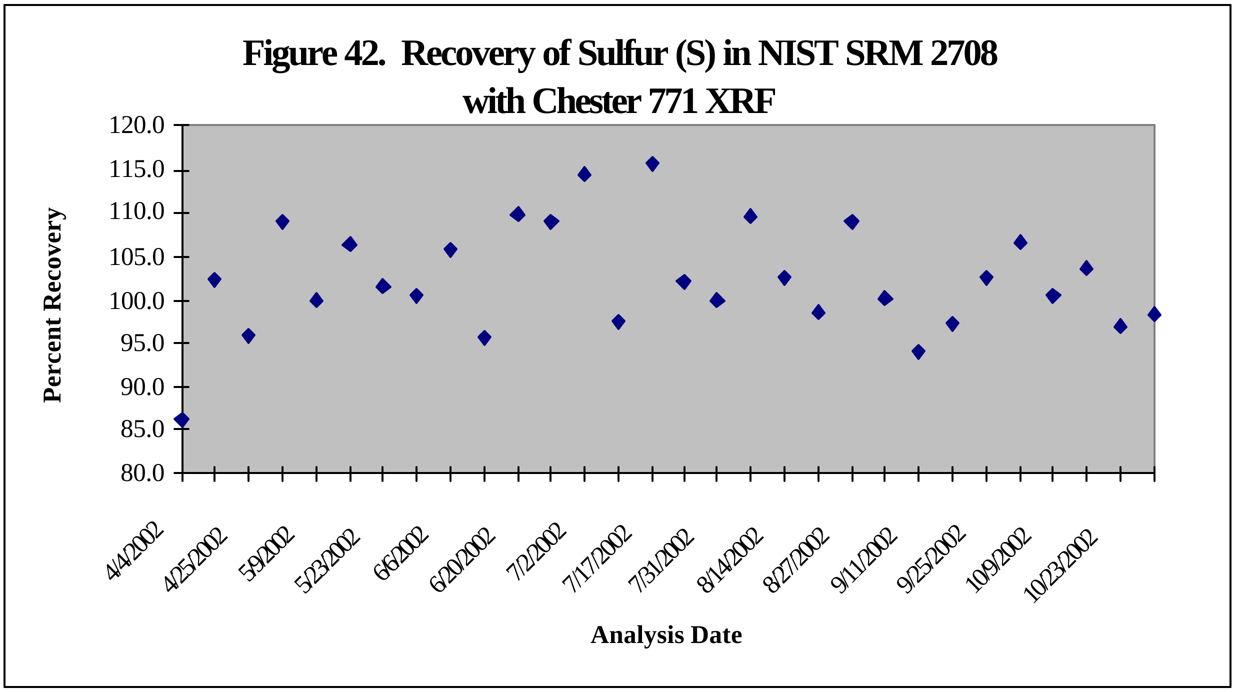


Figure 42. Recovery of Sulfur (S) in NIST SRM 2708
with Chester 771 XRF
Percent Recovery
120.0
115.0
110.0
105.0
100.0
95.0
90.0
85.0
80.0
4/4/2002
4/25/2002
5/9/2002
5/23/2002
6/6/2002
6/20/2002
7/2/2002
7/17/2002
7/31/2002
8/14/2002
8/27/2002
9/11/2002
9/25/2002
10/9/2002
10/23/2002
Analysis Date

Figure 43. Recovery of Potassium (K) in NIST SRM 1833 with Chester 771 XRF

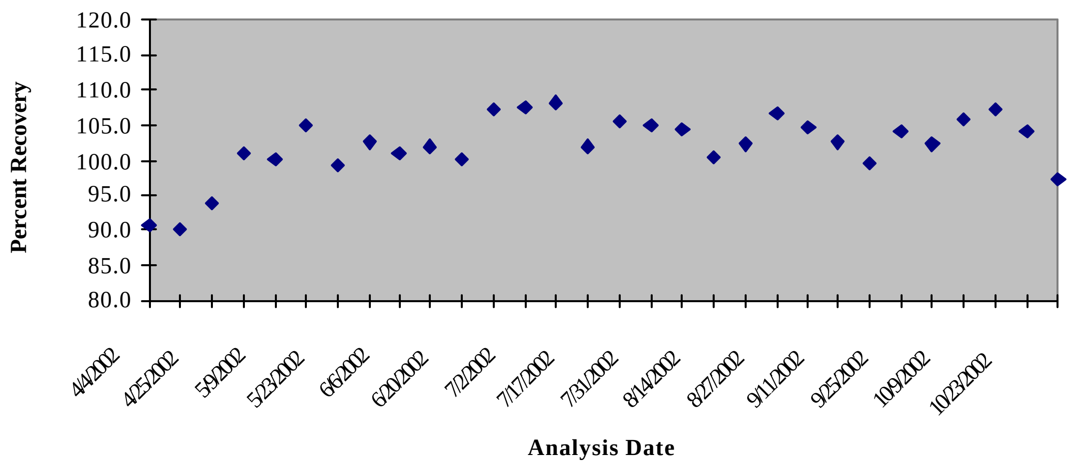


Figure 44. Recovery of Calcium (Ca) in NIST SRM 1832 with Chester 771 XRF

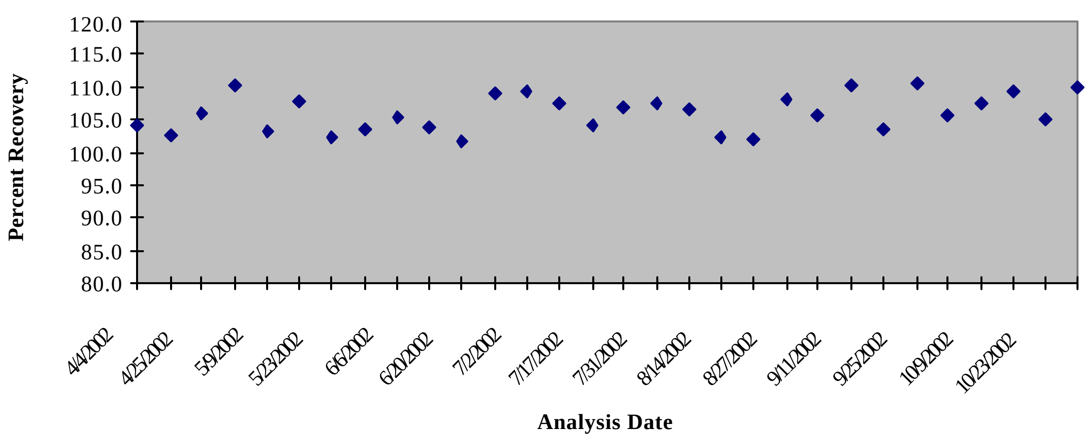


Figure 45. Recovery of Titanium (Ti) in NIST SRM 1833 with Chester 771 XRF

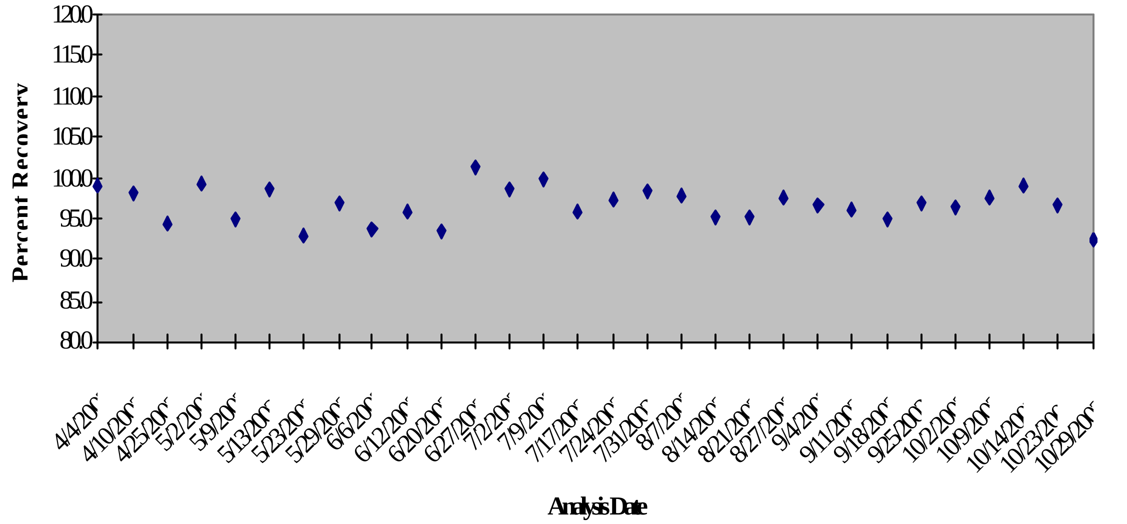


Figure 46. Recovery of Vanadium (V) in NIST SRM 1832 with Chester 771 XRF

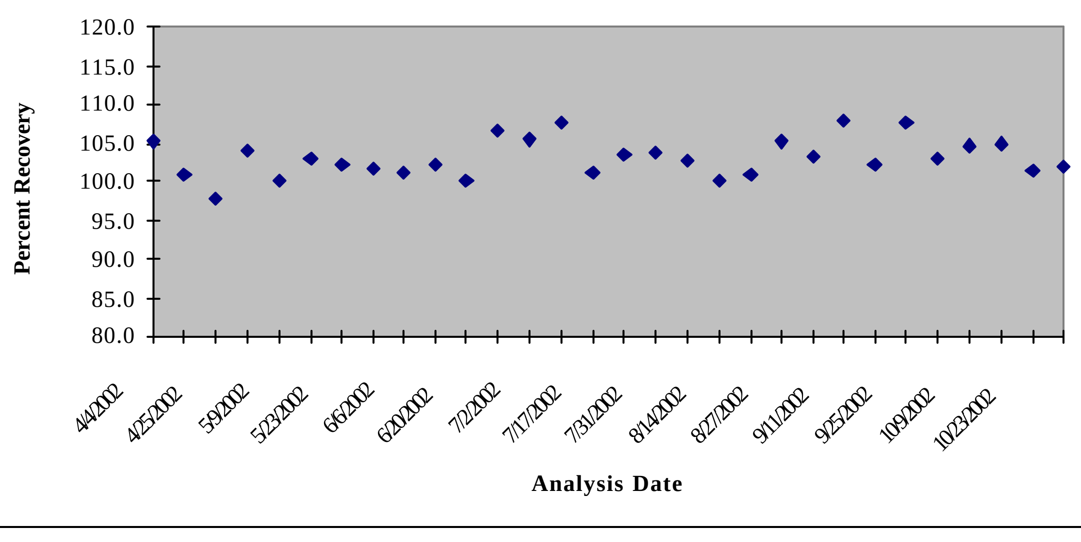


Figure 47. Recovery of Manganese (Mn) in NIST SRM 1832 with Chester 771 XRF

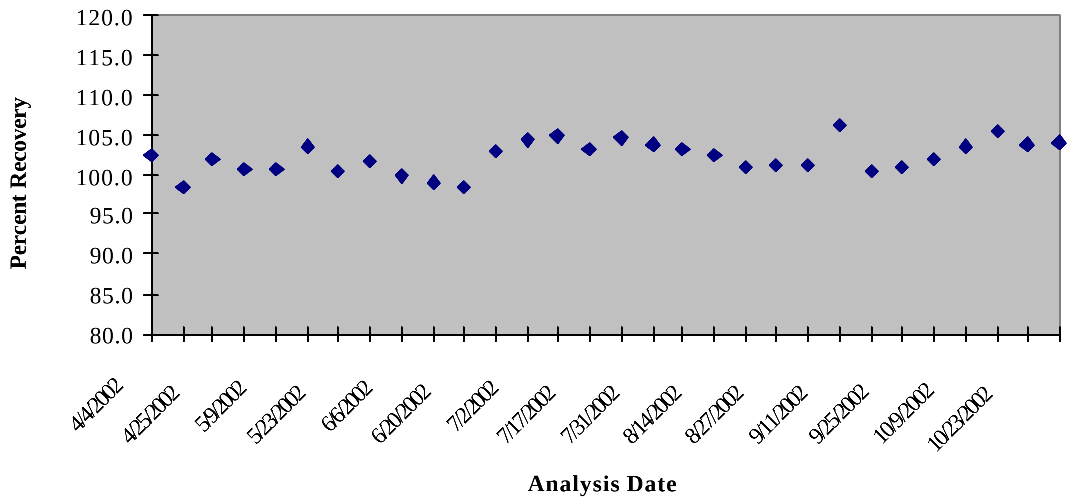
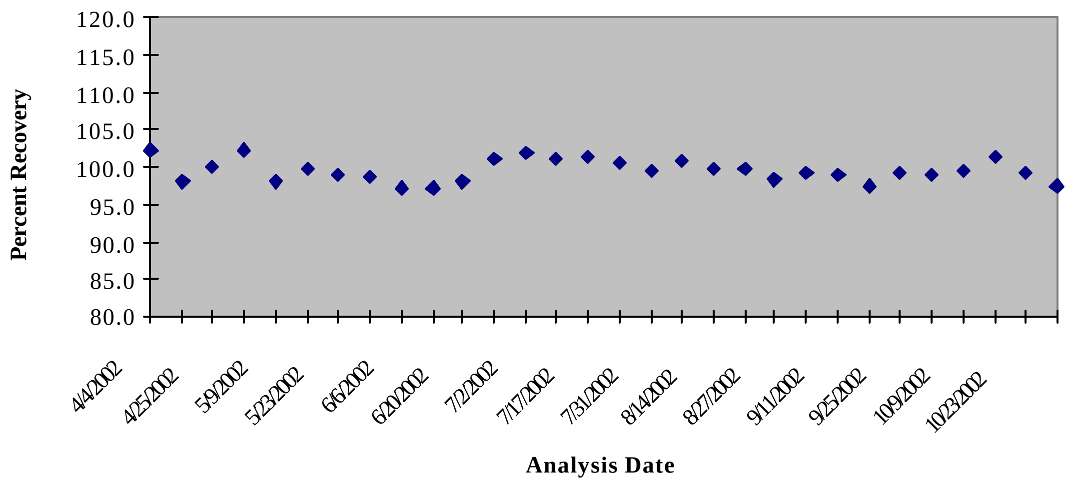


Figure 48. Recovery of Iron (Fe) in NIST SRM 1833 with Chester 771 XRF



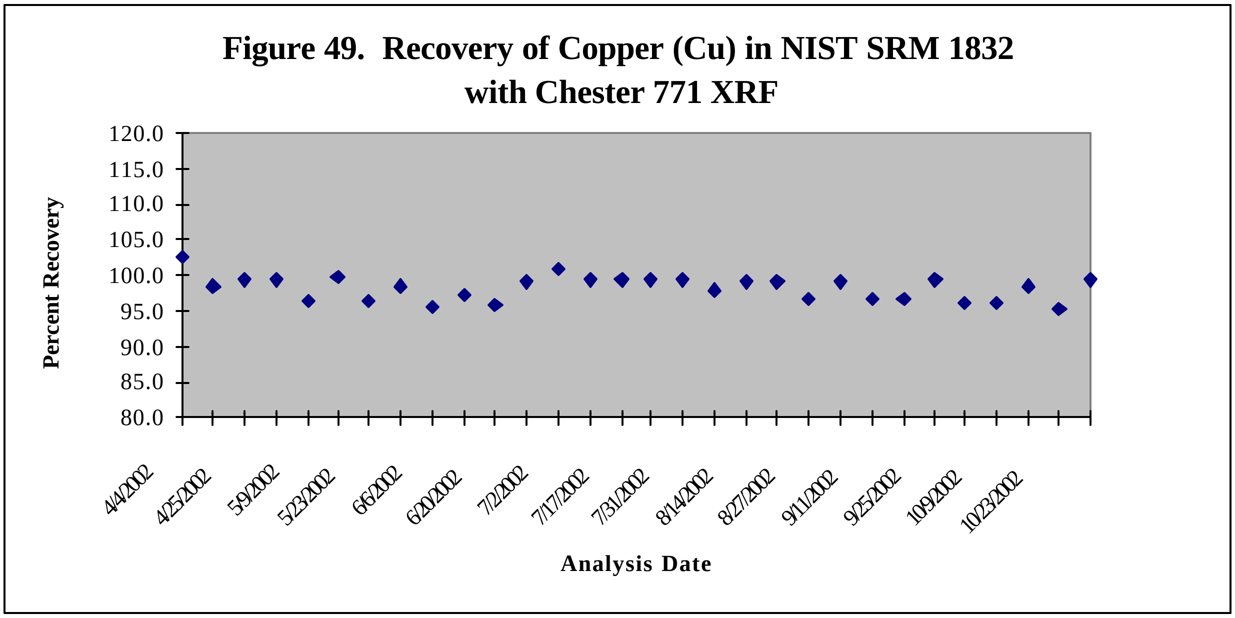


Figure 49. Recovery of Copper (Cu) in NIST SRM 1832
with Chester 771 XRF
Percent Recovery
120.0
115.0
110.0
105.0
100.0
95.0
90.0
85.0
80.0
4/4/2002
4/25/2002
5/9/2002
5/23/2002
6/6/2002
6/20/2002
7/2/2002
7/17/2002
7/31/2002
8/14/2002
8/27/2002
9/11/2002
9/25/2002
10/9/2002
10/23/2002
Analysis Date

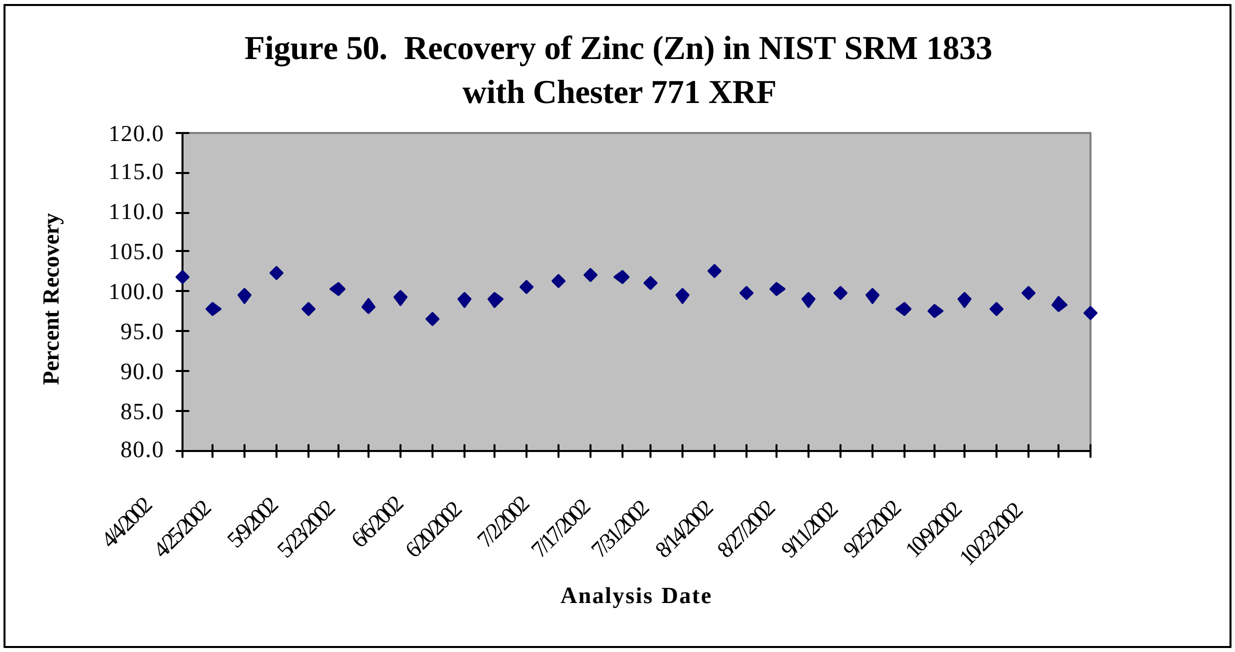
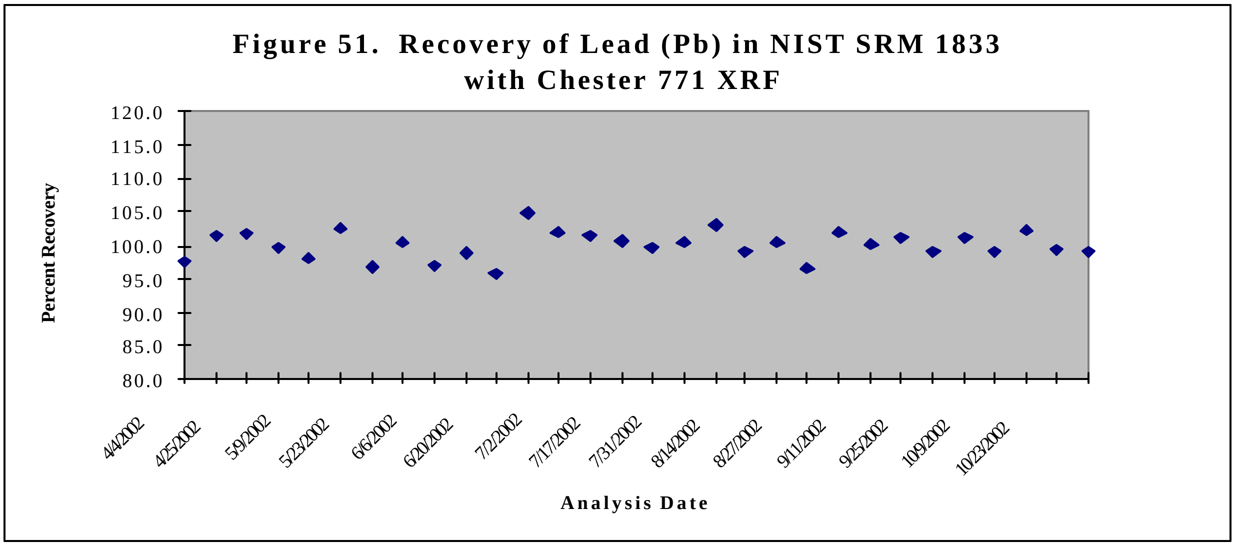


Figure 50. Recovery of Zinc (Zn) in NIST SRM 1833
with Chester 771 XRF
Percent Recovery
120.0
115.0
110.0
105.0
100.0
95.0
90.0
85.0
80.0
4/4/2002
4/25/2002
5/9/2002
5/23/2002
6/6/2002
6/20/2002
7/2/2002
7/17/2002
7/31/2002
8/14/2002
8/27/2002
9/11/2002
9/25/2002
10/9/2002
10/23/2002
Analysis Date



Replicates

Ten percent of the filters are reanalyzed and the results for select elements are compared. **Figures 52 through 63** compare replicate values for six elements through regression analysis. Note that slopes are all greater than 0.999 and correlation coefficients are all greater than 0.998 for the 770, indicating acceptable replication. Slopes for the 771 tended to be higher than for the 770. These values ranged from 0.999 to 1.08. Despite these higher values, the slope is still statistically indistinguishable from 1. The correlation coefficients are all greater than 0.997, indicating acceptable replication.

2.4.2.2 Data Validity Discussion – The data presented in Section 2.4.2 indicate that, with the exception of three sulfur recovery values, there were no problems with the XRF data. Occasional tears and/or pinholes in the filters were encountered. These were minor, and not considered to have a significant impact on the analysis results.

2.4.2.3 Corrective Actions – No changes were made in the analytical procedures used by the Chester LabNet XRF laboratory.

Figure 52. Results of Replicate Silicon (Si) Analyses with Chester 770 XRF

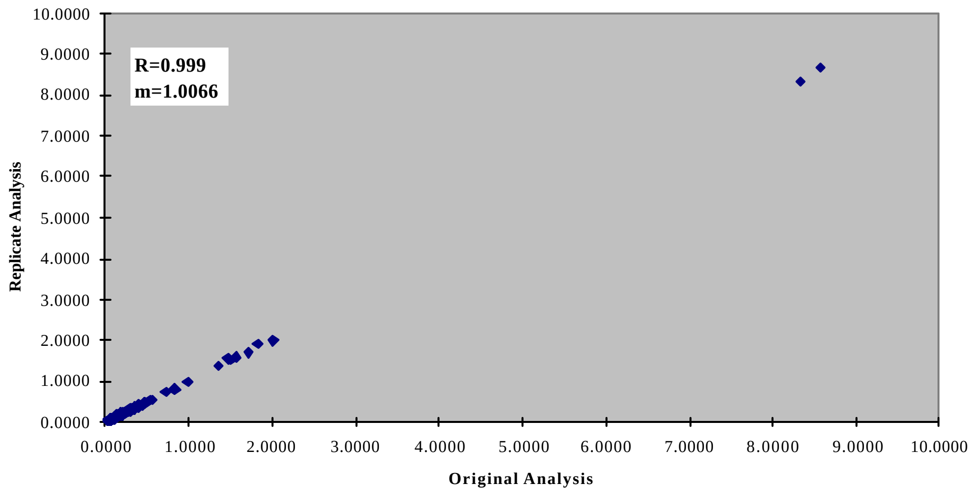


Figure 53. Results of Replicate Sulfur (S) Analyses with Chester 770

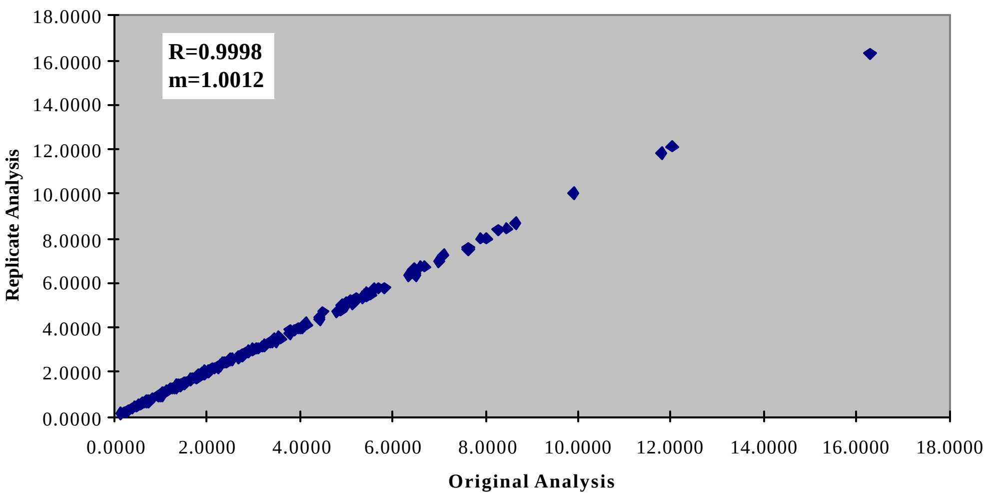


Figure 54. Results of Replicate Potassium (K) Analyses with Chester 770 XRF

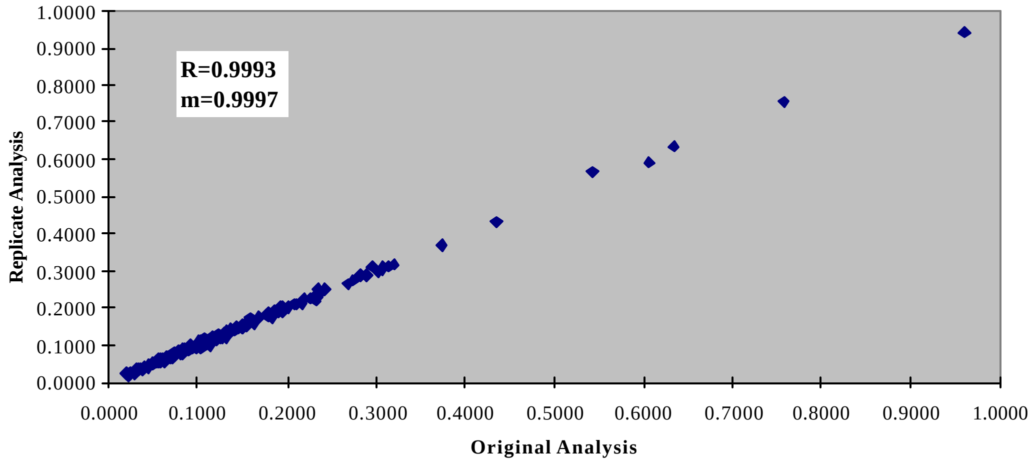


Figure 55. Results of Replicate Calcium (Ca) Analyses with Chester 770 XRF

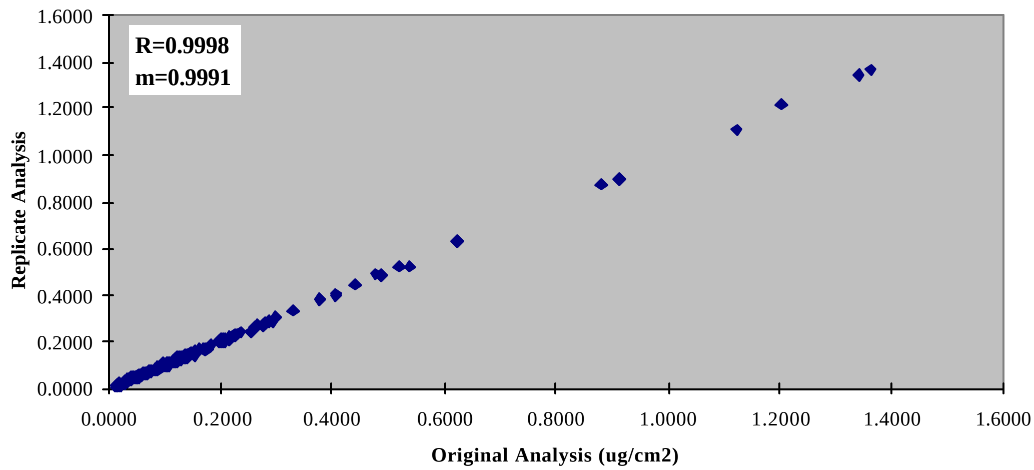


Figure 56. Results of Replicate Iron (Fe) Analyses with Chester 770 XRF

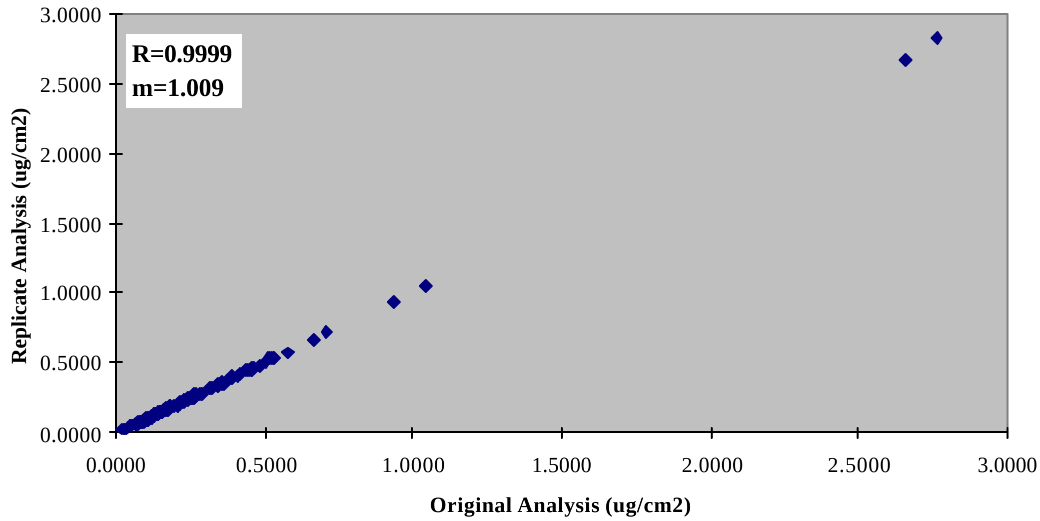


Figure 57. Results of Replicate Zinc (Zn) Analyses with Chester 770 XRF

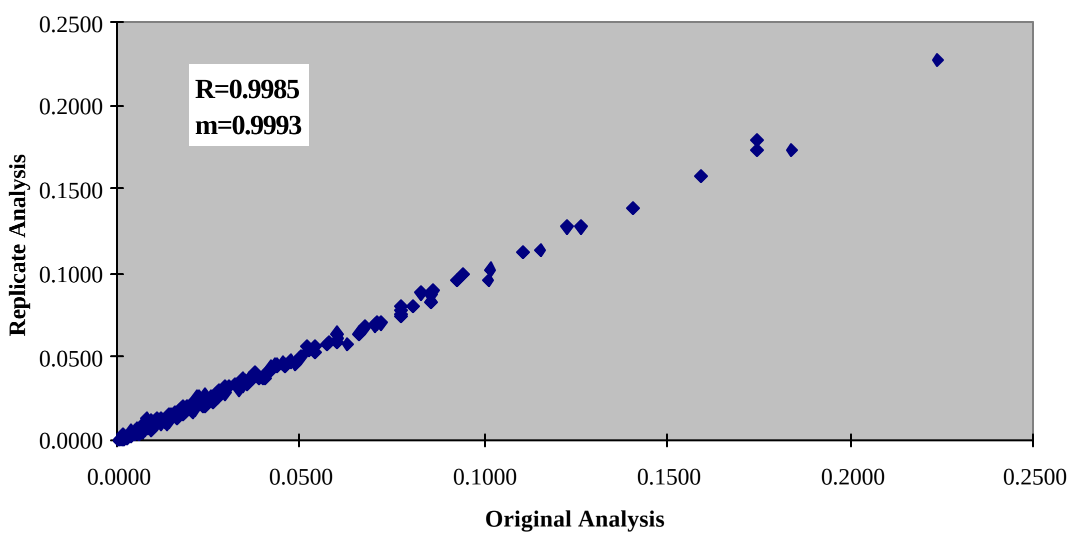


Figure 58. Results of Replicate Silicon (Si) Analysis with Chester 771 XRF

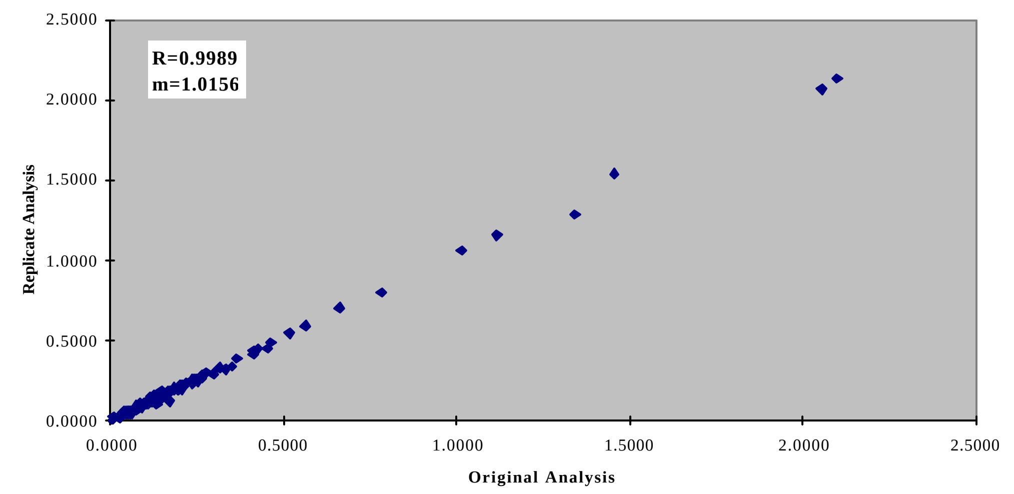
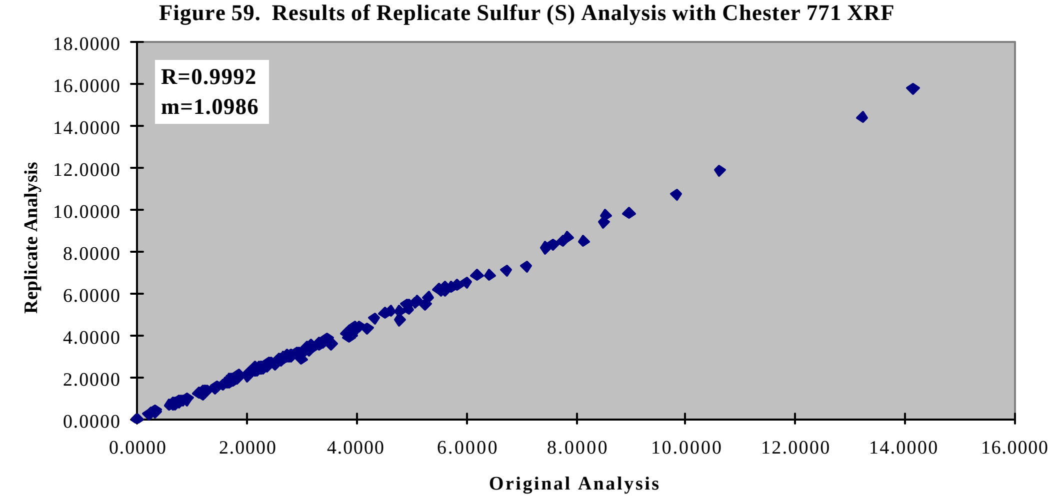


Figure 59. Results of Replicate Sulfur (S) Analysis with Chester 771 XRF



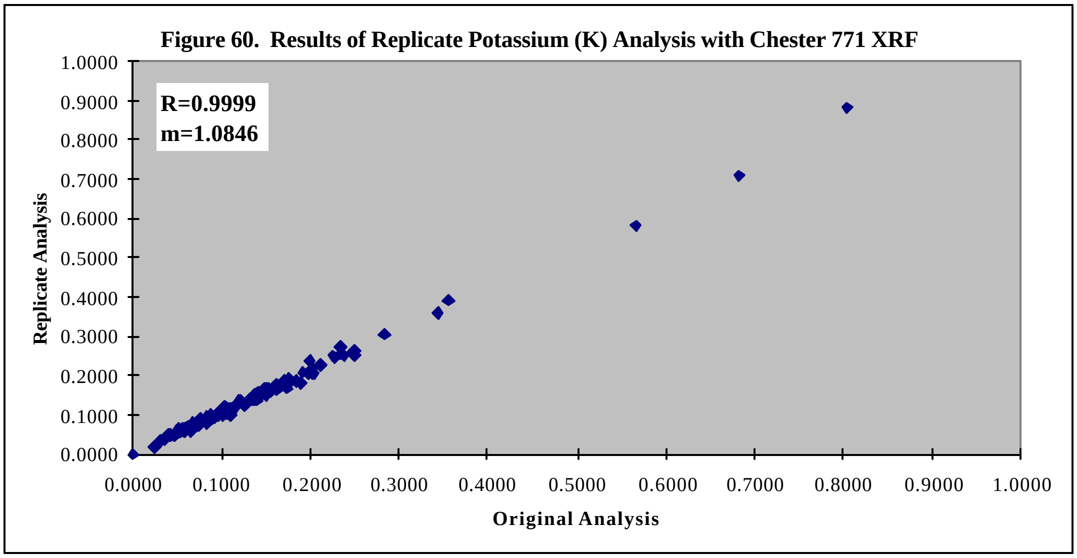


Figure 60. Results of Replicate Potassium (K) Analysis with Chester 771 XRF
R=0.9999
m=1.0846
Replicate Analysis
Original Analysis
0.0000
0.1000
0.2000
0.3000
0.4000
0.5000
0.6000
0.7000
0.8000
0.9000
1.0000

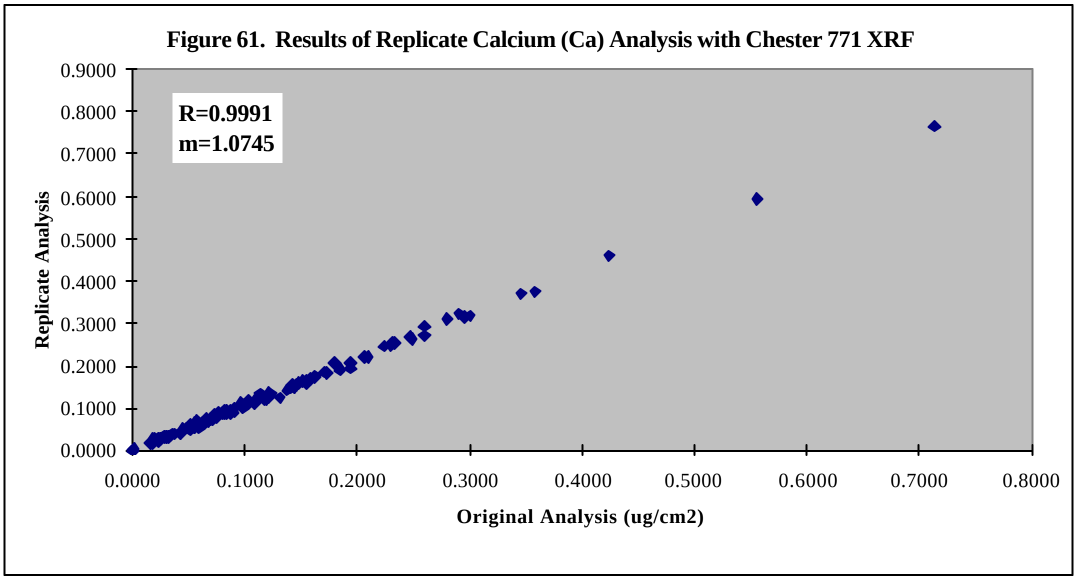


Figure 61. Results of Replicate Calcium (Ca) Analysis with Chester 771 XRF
R=0.9991
m=1.0745
Replicate Analysis
Original Analysis (ug/cm2)
0.0000
0.1000
0.2000
0.3000
0.4000
0.5000
0.6000
0.7000
0.8000
0.9000

Figure 62. Results of Replicate Iron (Fe) Analysis with Chester 771 XRF

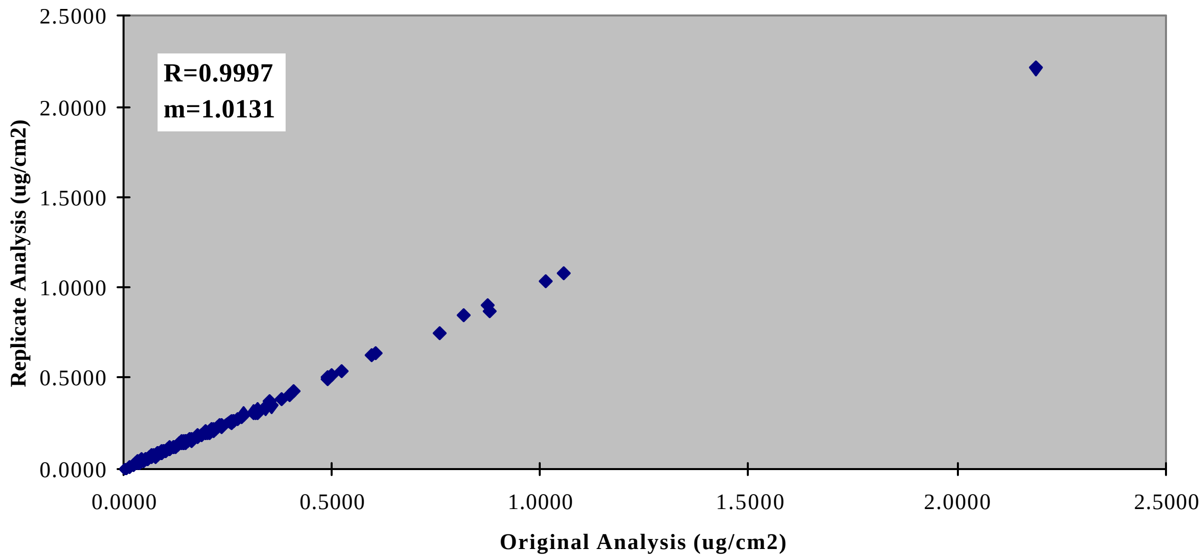
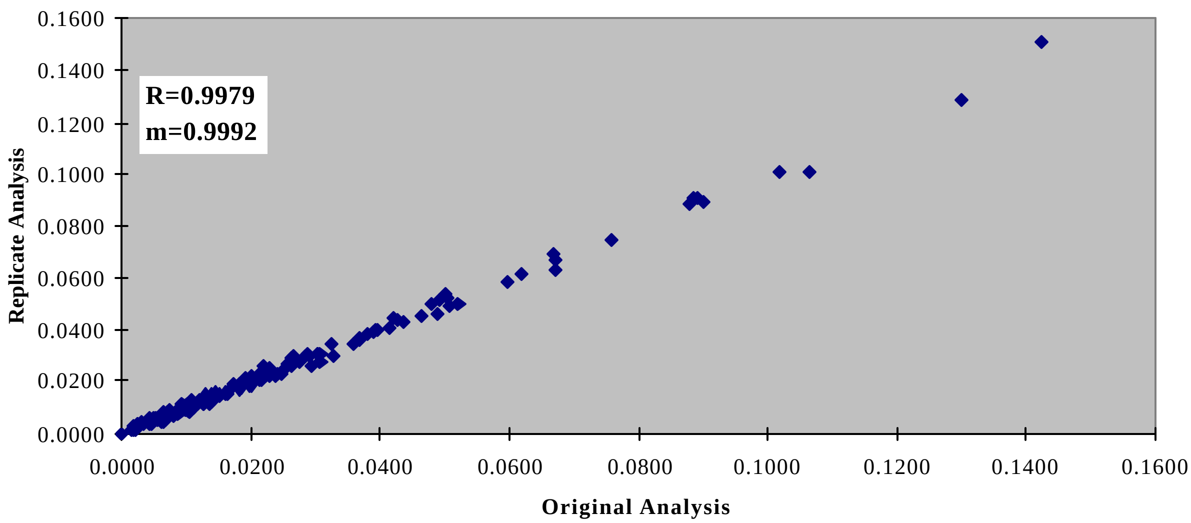


Figure 63. Results of Replicate Zinc (Zn) Analysis with Chester 771 XRF



2.4.3 Cooper Environmental Services (CES)

CES began analyzing STN samples on November 10, 2001. A QuanX XRF instrument is being used to perform the analyses.

2.4.3.1 Statistical Summary of QC Results –

Precision

The precision is monitored by the reproducibility of the XRF signal in counts per second using standard samples. The counts for a select element are measured for each of the targets used. The comparison of the counts during calibration and during the run gives the measure of reproducibility or precision. The data used to monitor precision for individual elements are presented in **Figures 64 through 69**. **Table 20** shows the results of daily precision checks. During the five month period, the daily analysis of the QA/QC standard never indicated instrument drift. A problem with the voltage control board caused the QC standard to fall outside of the ± 5% range once. The increase of all elemental concentrations within the standard alerted staff to the problem. There were no filters analyzed during the two hours of instability.

Table 20. Daily Replicate Measurement Results CES

	Si	V	Ni	Pb	Cd	Se
Initial Calibration Value	9.11	10.17	10.2	20.53	5.15	3.86
Average Daily Value	9.19	10.64	10.59	21.45	5.26	3.99
Standard Deviation	0.09	0.06	0.05	0.06	0.05	0.02
Rel Std Dev, percent	0.99	0.56	0.44	0.27	1.00	0.48
Percent Recovery						
Average	101	101	104	104	101	103
Standard Deviation	1.00	0.57	0.46	0.29	1.01	0.49
Rel Std Deviation	0.99	0.56	0.44	0.27	1.00	0.48

Figure 64. Recovery Precision for CES QuanX XRF with Silicon (Si)

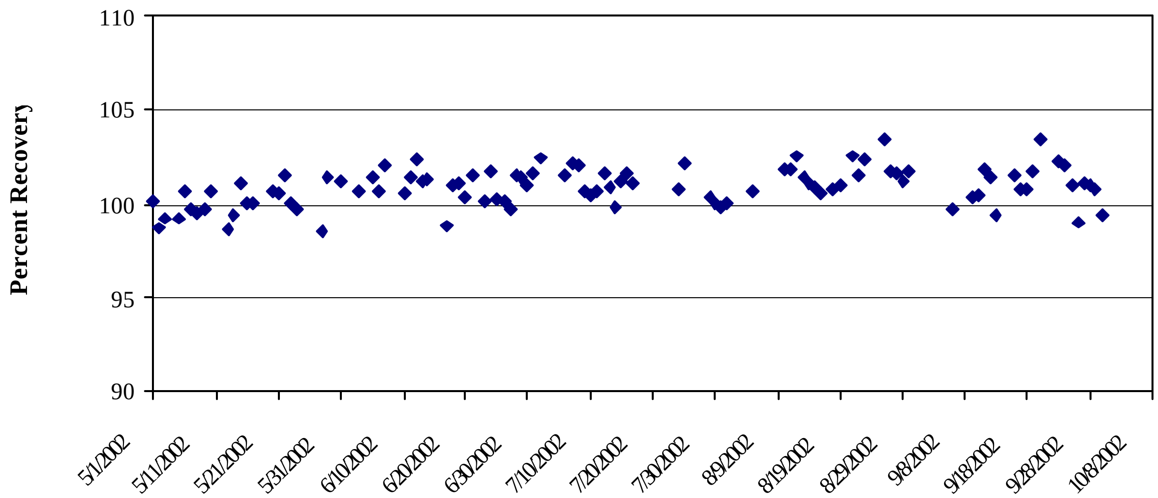


Figure 65. Recovery Precision for CES QuanX XRF with Vanadium (V)

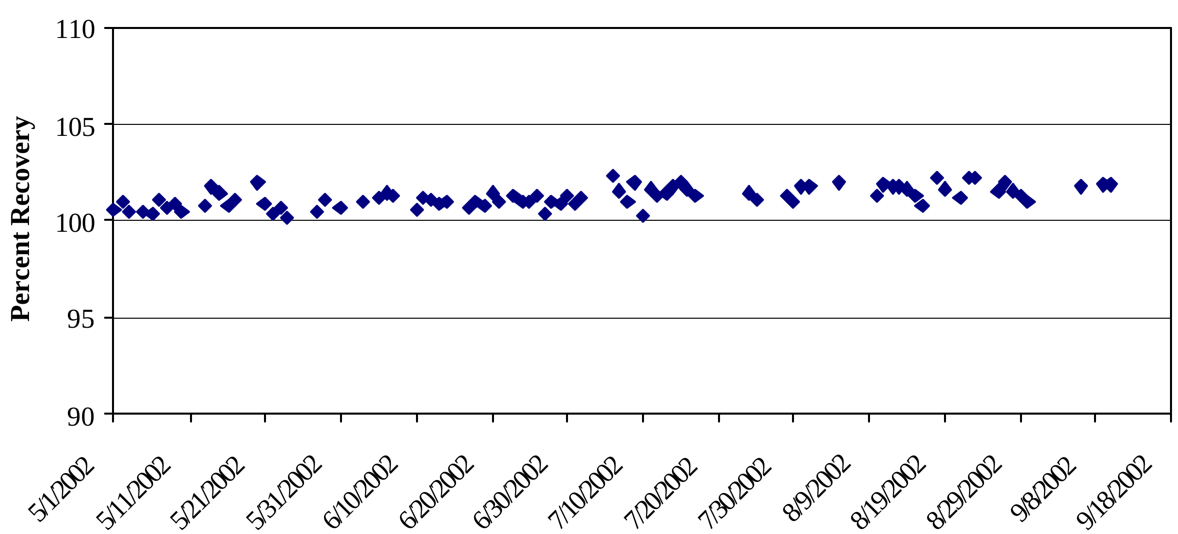


Figure 66. Recovery Precision for CES QuanX XRF with Nickel (Ni)

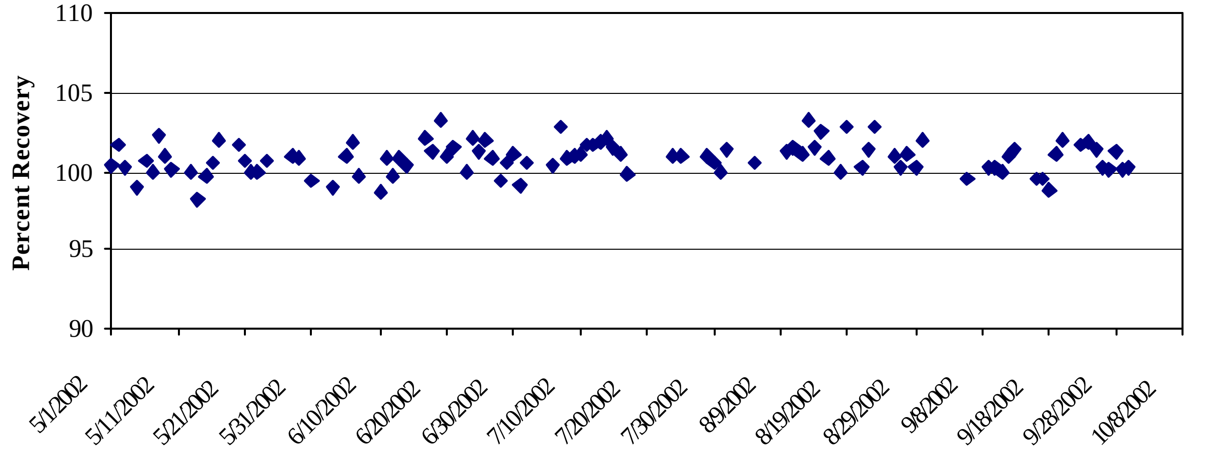
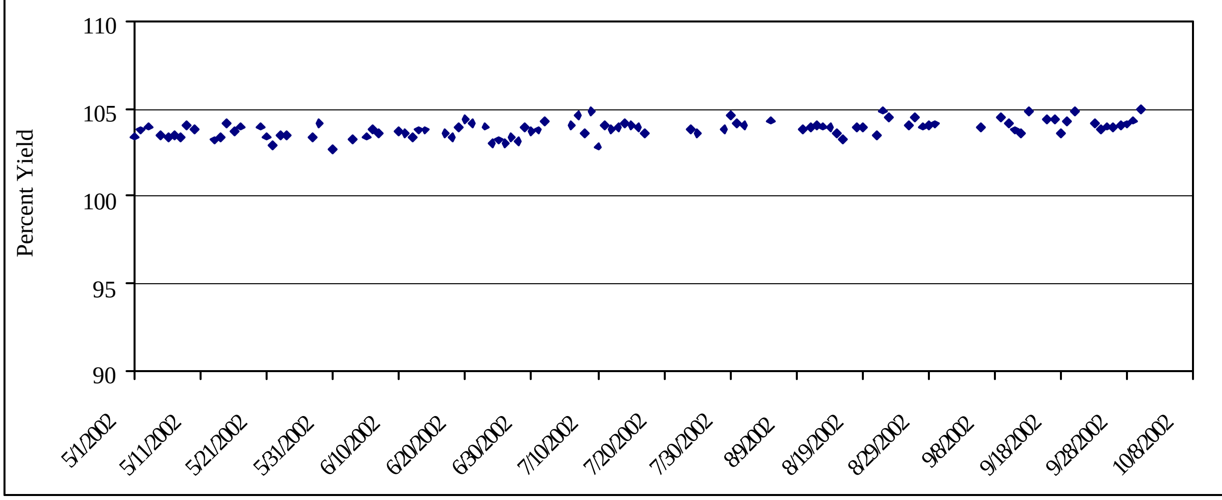


Figure 67. Recovery Precision for CES QuanX XRF with Lead (Pb)



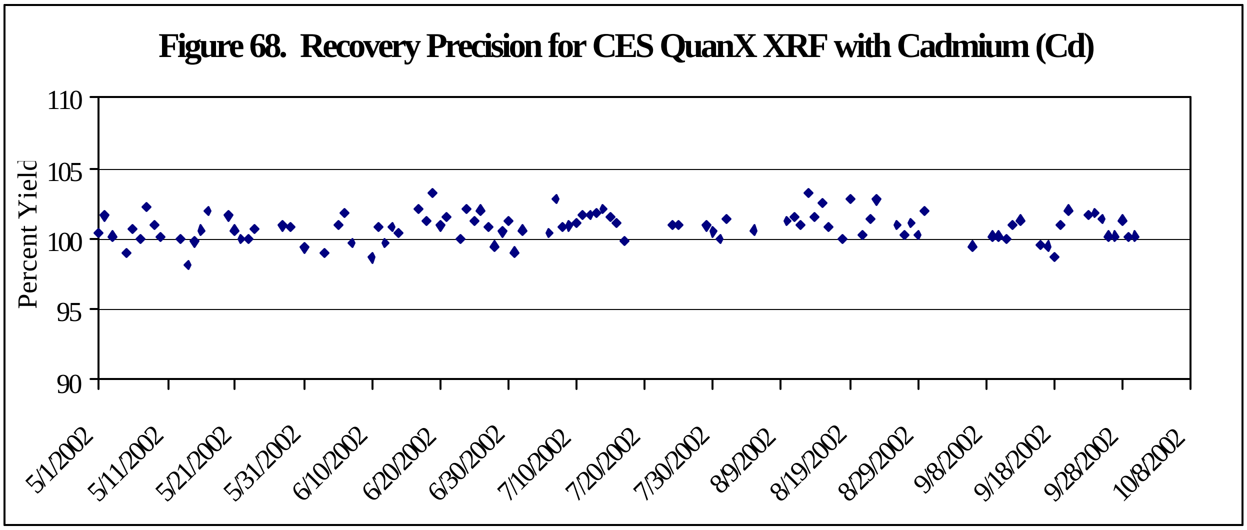


Figure 68. Recovery Precision for CES QuanX XRF with Cadmium (Cd)
Percent Yield
110
105
100
95
90
5/1/2002
5/11/2002
5/21/2002
5/31/2002
6/10/2002
6/20/2002
6/30/2002
7/10/2002
7/20/2002
7/30/2002
8/9/2002
8/19/2002
8/29/2002
9/8/2002
9/18/2002
9/28/2002
10/8/2002

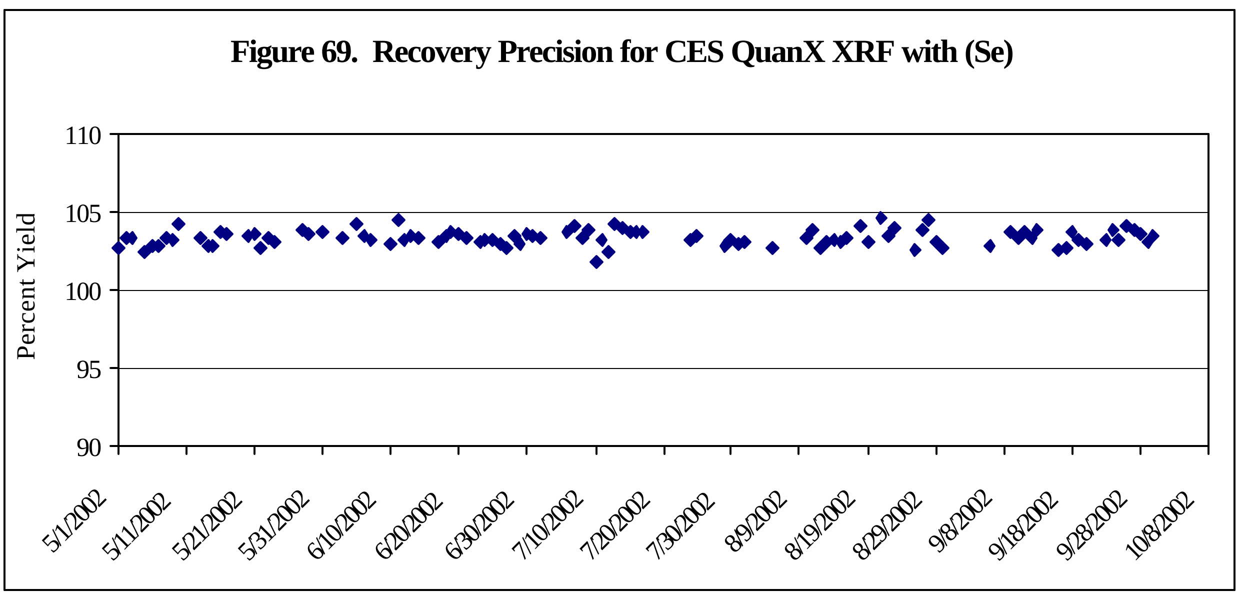


Figure 69. Recovery Precision for CES QuanX XRF with (Se)
Percent Yield
110
105
100
95
90
5/1/2002
5/11/2002
5/21/2002
5/31/2002
6/10/2002
6/20/2002
6/30/2002
7/10/2002
7/20/2002
7/30/2002
8/9/2002
8/19/2002
8/29/2002
9/8/2002
9/18/2002
9/28/2002
10/8/2002

Recovery

Recovery or system accuracy is determined by the analysis of a series of NIST Standard Reference Materials filters. Recovery is calculated by comparison of a measured and expected values. **Figures 70 through 82** show recovery for 12 select elements spanning the range of the 48 elements normally measured. All recovery values for all elements ranged between 89.8 and 109.7 percent as shown in **Table 21**. The QAPP requires that NIST values be within three-sigma of the certified values for the calibration to be considered accurate. All values except copper were within these boundaries. The copper consistently measures about 12% low. NIST and Dr. Cooper have acknowledged that the copper certified values are suspect and are investigating the issue.

Table 21. Recovery Determined from Analysis of NIST Standard Reference Material Filters, QuanX

Element	NIST/SRM 1228	NIST/SRM 987
	Range % Recovery	Range % Recovery
Al	94.0 - 97.9	----
Si	100.7 - 101.9	102.2 - 104.4
K	----	93.9 - 94.6
Ca	108.9 - 109.7	----
Ti	----	103.5 - 104.2
V	105.5 - 107.1	----
Mn	106.8 - 107.6	----
Co	99.5 - 102.5	----
Cu	89.8 - 92.5	----
Fe	----	102.6 - 103.2
Zn	----	102.4 - 103.7
Pb	----	101.7 - 102.7

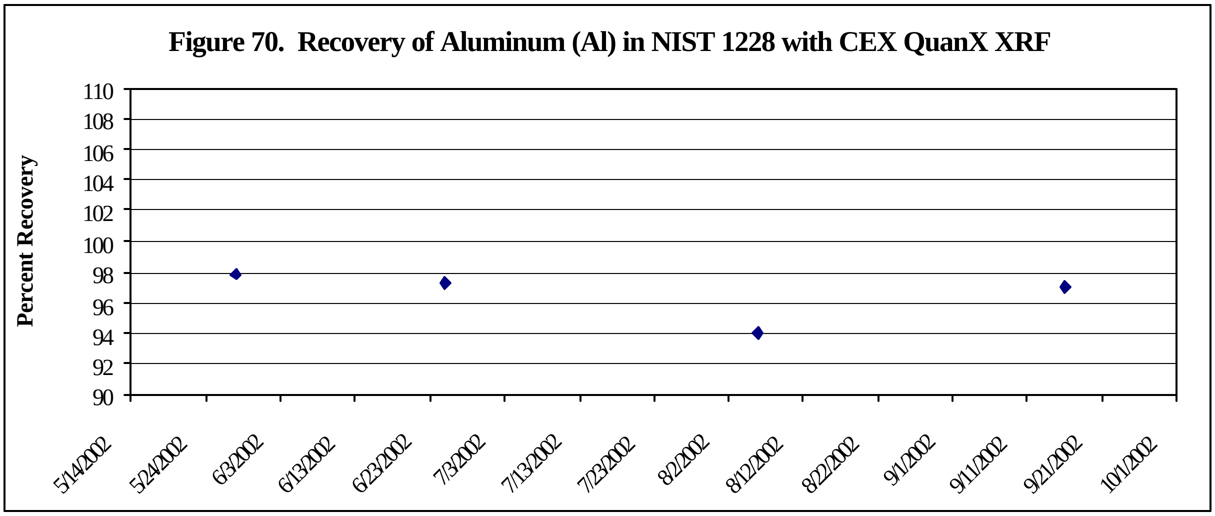


Figure 70. Recovery of Aluminum (Al) in NIST 1228 with CEX QuanX XRF
Percent Recovery
110
108
106
104
102
100
98
96
94
92
90
5/14/2002
5/24/2002
6/3/2002
6/13/2002
6/23/2002
7/3/2002
7/13/2002
7/23/2002
8/2/2002
8/12/2002
8/22/2002
9/1/2002
9/11/2002
9/21/2002
10/1/2002

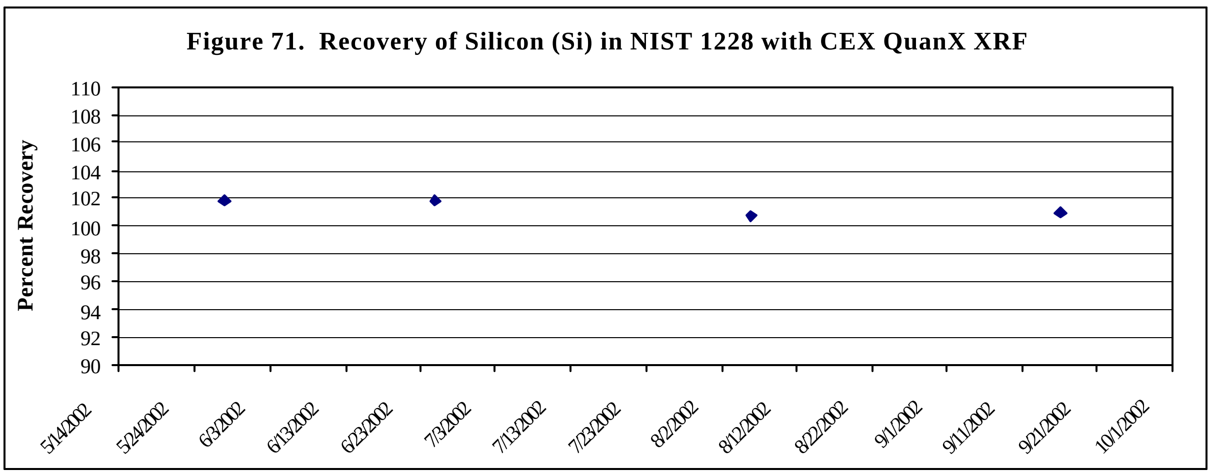


Figure 71. Recovery of Silicon (Si) in NIST 1228 with CEX QuanX XRF
Percent Recovery
110
108
106
104
102
100
98
96
94
92
90
5/14/2002
5/24/2002
6/3/2002
6/13/2002
6/23/2002
7/3/2002
7/13/2002
7/23/2002
8/2/2002
8/12/2002
8/22/2002
9/1/2002
9/11/2002
9/21/2002
10/1/2002

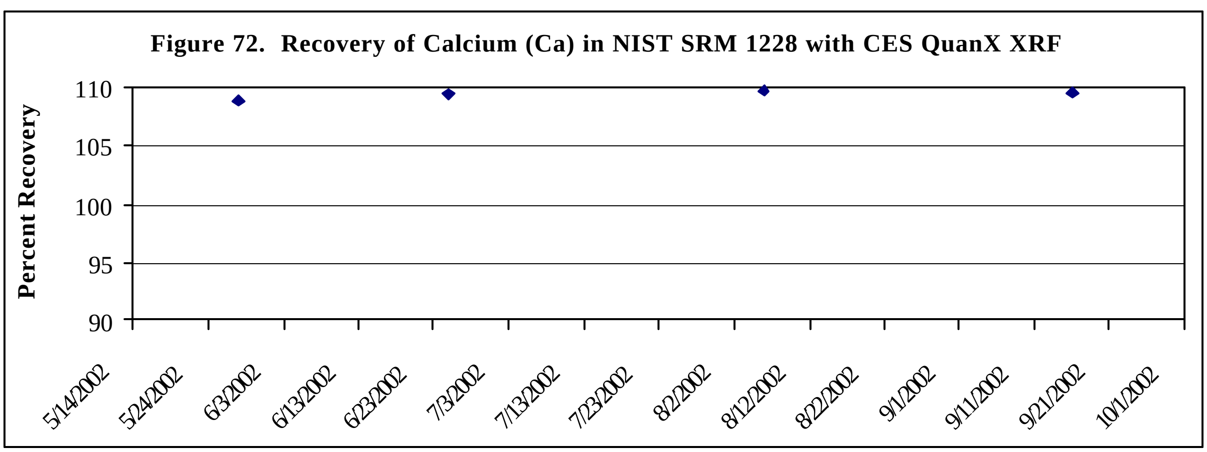


Figure 72. Recovery of Calcium (Ca) in NIST SRM 1228 with CES QuanX XRF
Percent Recovery
110
105
100
95
90
5/14/2002
5/24/2002
6/3/2002
6/13/2002
6/23/2002
7/3/2002
7/13/2002
7/23/2002
8/2/2002
8/12/2002
8/22/2002
9/1/2002
9/11/2002
9/21/2002
10/1/2002

Figure 73. Recovery of Vanadium (V) in NIST SRM 1228 with CES QuanX XRF

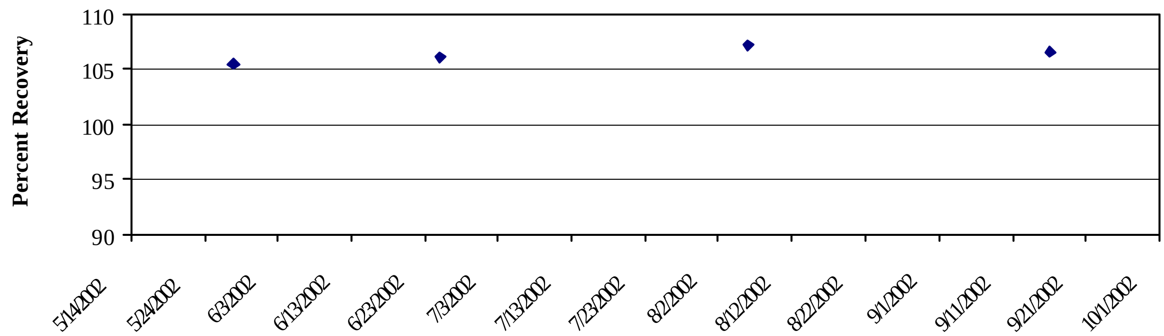


Figure 74. Recovery of Manganese (Mn) in NIST SRM 1228 with CES QuanX XRF

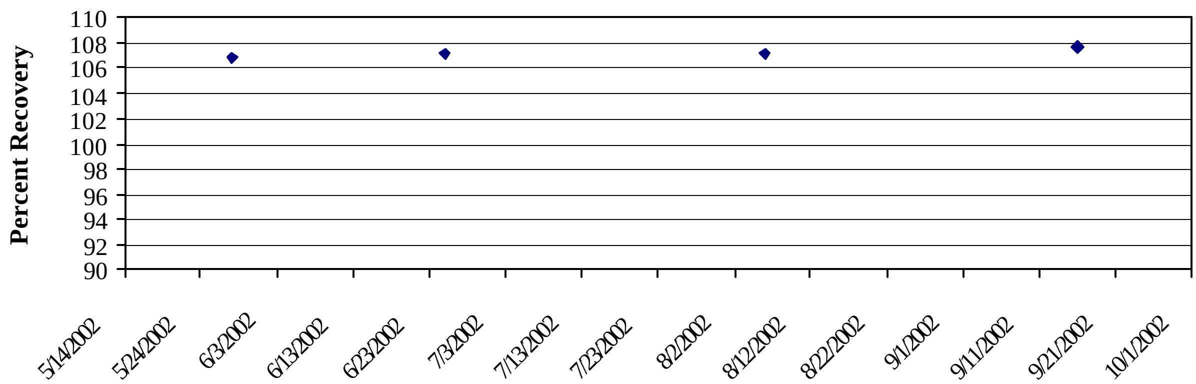


Figure 75. Recovery of Cobalt (Co) in NIST SRM 1228 with CES QuanX XRF

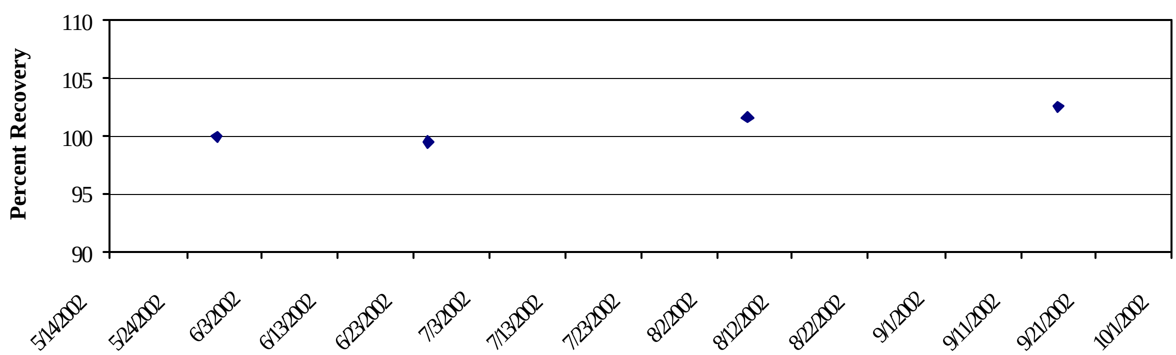


Figure 76. Recovery of Cooper (Cu) in NIST SRM 1228 with CEX QuanX XRF

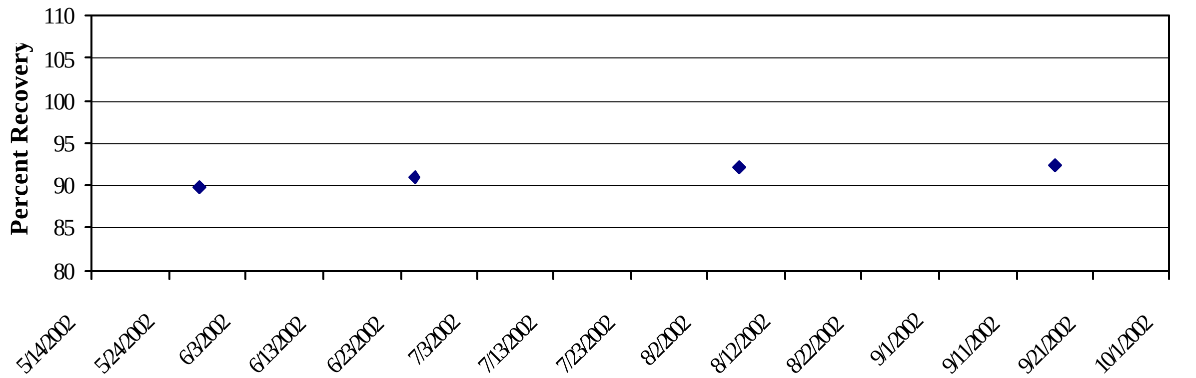


Figure 77. Recovery of Silicon (Si) in NIST 987 with CES QuanX XRF

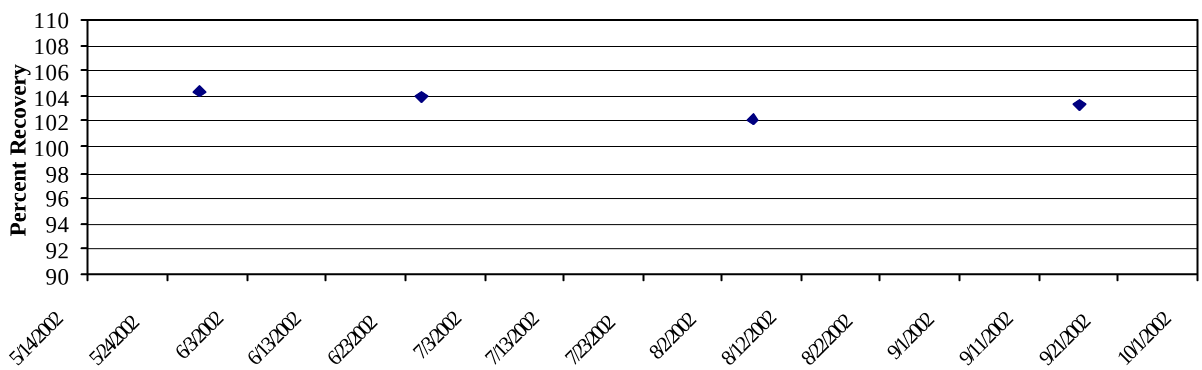


Figure 78. Recovery of Potassium (K) in NIST 987 for CES QuanX XRF

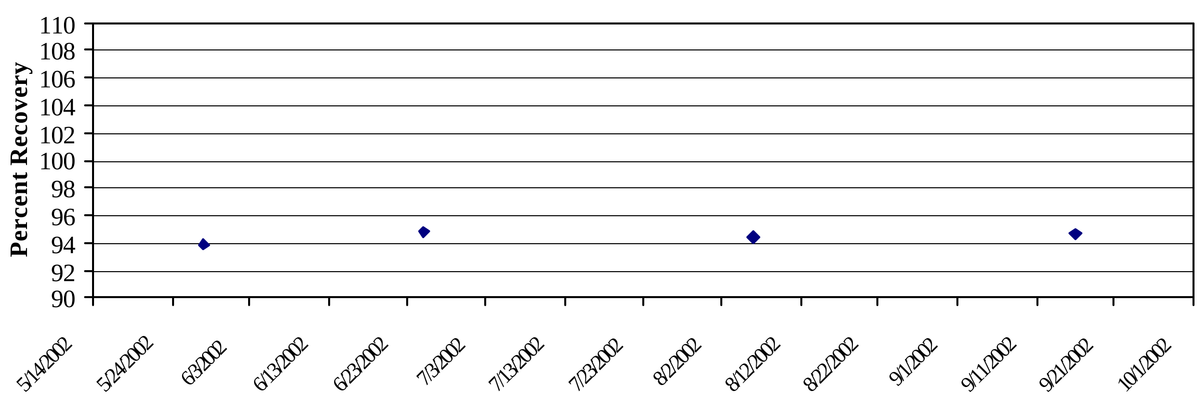


Figure 79. Recovery of Titanium (Ti) in NIST 987 with CES QuanX XRF

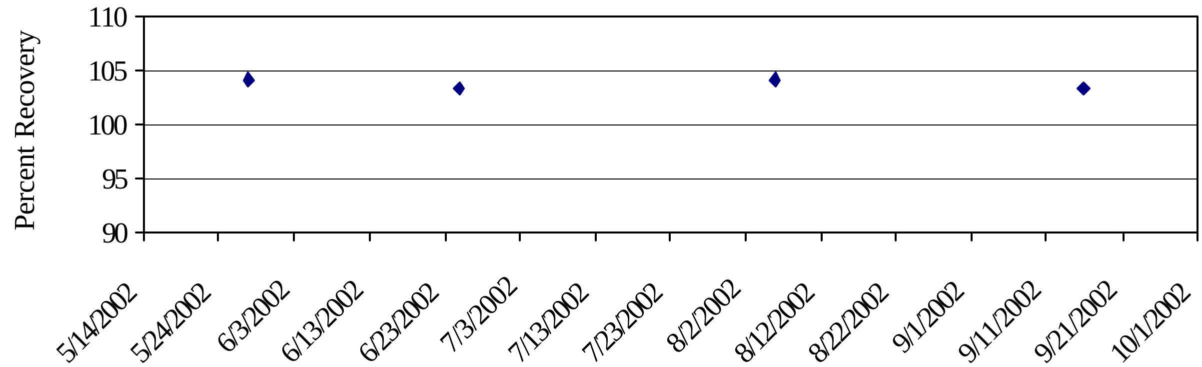


Figure 80. Recovery of Iron (Fe) in NIST 987 with CEX QuanX XRF

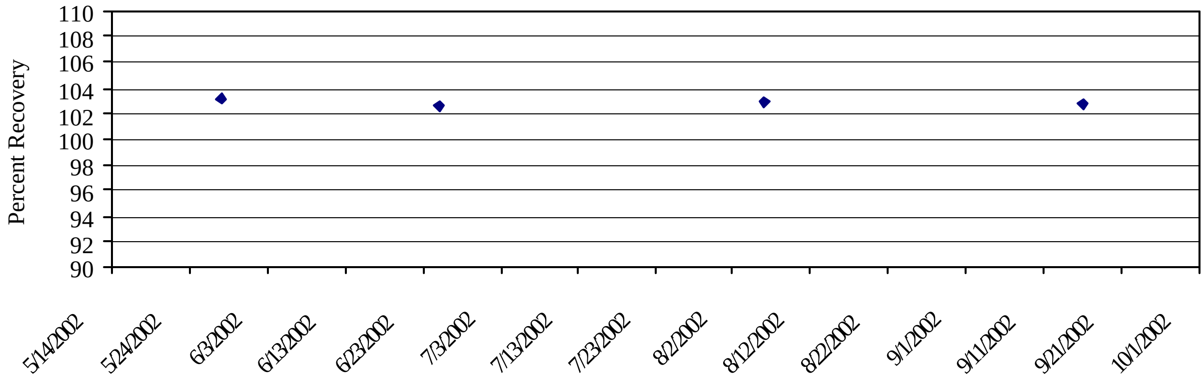


Figure 81. Recovery of Zinc (Zn) in NIST 987 with CES QuanX XRF

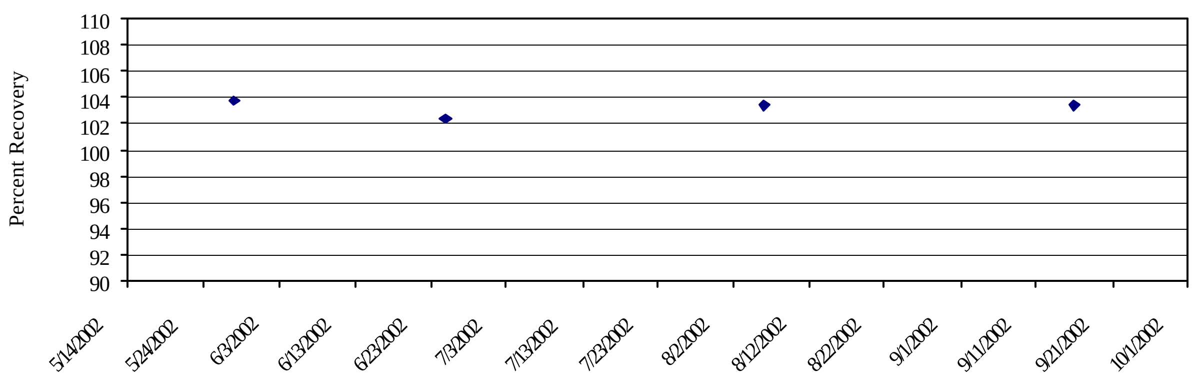
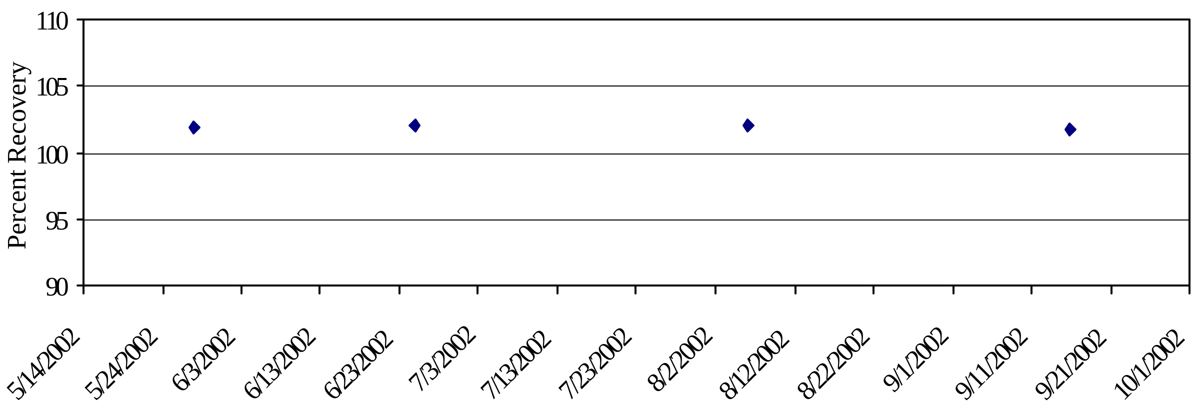


Figure 82. Recovery of Lead (Pb) in NIST 987 with CES QuanX XRF



Replicates

Ten percent of the filters are reanalyzed and the results for select elements are compared. **Figures 83 through 88** compare replicate values for eight elements through regression analysis. Note that slopes are all greater than 1.002 and correlation coefficients are all greater than 0.997, indicating acceptable replication.

On May 13, 2002, a replicate was analyzed representing an original analysis that occurred on May 10, 2002. The replicate analysis indicated high differences between the two analyses. This was attributed to the fact that the replicate was analyzed after two days of instrumental inactivity but before an energy calibration. Subsequent replicate analyses representing May 10, 2002 were in good agreement with the original analysis. This proves that the instrumental shift occurred after the filters were analyzed on May 10, 2002. This exemplifies the need to perform an energy calibration first thing every day. Subsequent to these results, a change was instituted in the SOP to conduct an energy calibration at the start of each day prior to replicate analysis.

On June 25, 2002, PM2.5 filter A180508V was analyzed and reanalyzed the next day. The comparison of the replicate data shows a 92.9 relative percent difference (RPD) in the measured chlorine value. Upon close investigation under a magnifying glass, the filter was determined to have a nonuniform deposit. If the filter was moved between analyses, the nonuniformity of the deposit would affect the results. Filter A179384W, originally analyzed June 25, 2002, was reanalyzed to yield a 100.5 RPD in the Titanium results. At this point, it was decided that the filters originally analyzed on June 25, 2002 would be rerun to ensure proper QA/QC of data. The replicate from the rerun was within QC limits. The reanalysis of all filters were reported as the true data values.

Figure 83. Results of Replicate Silicon (Si) Analyses with CES QuanX XRF

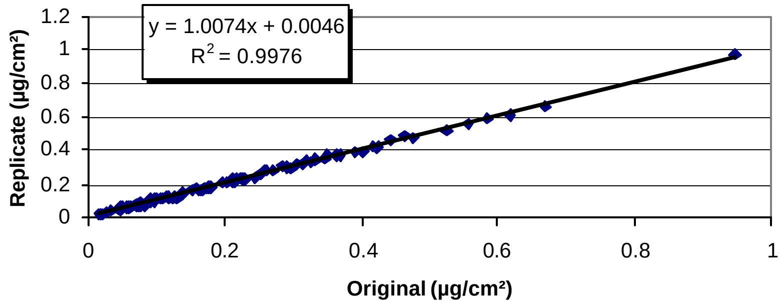


Figure 84. Results of Replicate Sulfur (S) Analyses with CES QuanX XRF

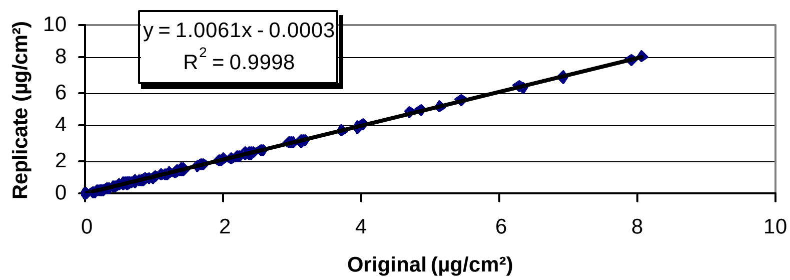


Figure 85. Resultes of Replicate Potassium (K) Analyses with CES QuanX XRF

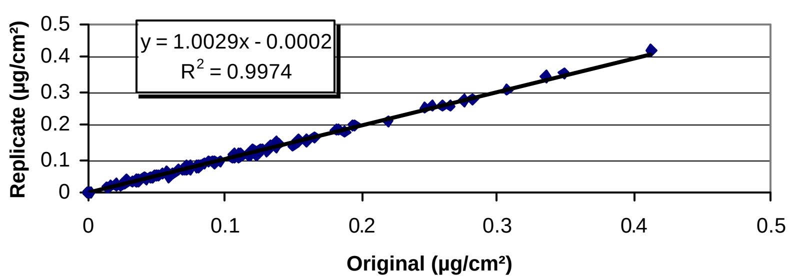


Figure 86. Results of Replicate Calcium (Ca) Analyses with CES QuanX XRF

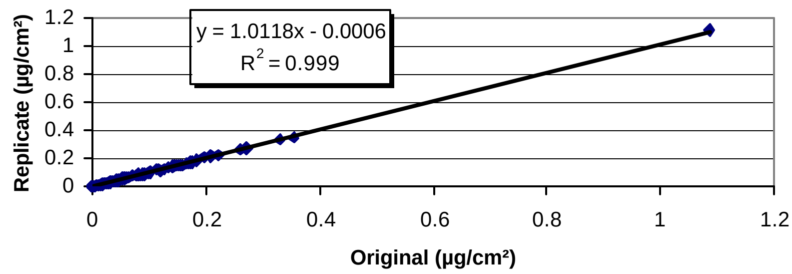


Figure 87. Results of Replicate Iron (Fe) Analyses with CES QuanX XRF

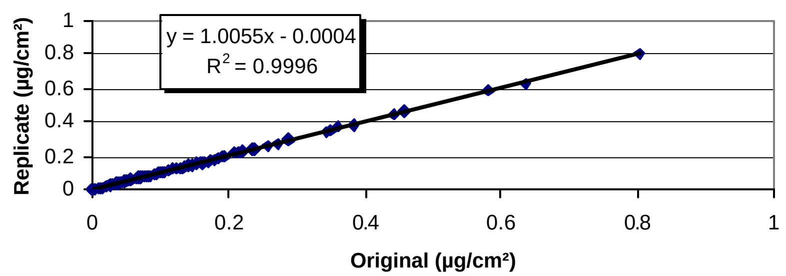
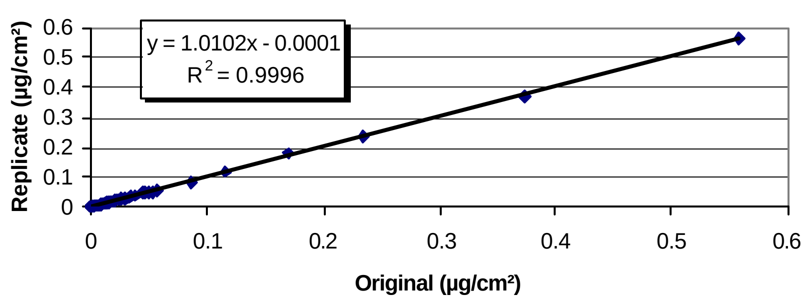


Figure 88. Results of Replicate Zinc (Zn) Analyses with CES QuanX XRF



On June 29, 2002, PM2.5 filter A180231L was analyzed and reanalyzed the next day. The replicate report showed RPD greater than 20% for Chromium, Copper, and Zirconium. A detailed spectral comparison of the two analyses showed real peak height differences for these elements. Using a magnifying glass, the filter was determined to have a nonuniform deposit. It is known that the original was removed from the analysis chamber between analyses. Nonuniformity of the deposit would affect the results. Filter A1806599 was reanalyzed and the resulting replicate report was within QC limits.

Following these results, a change in the SOP was instituted to ensure that filters do not undergo any orientation changes between analyses.

2.4.3.2 Data Validity Discussion – The data presented in Section 2.4.3 indicate no problems with the XRF data. The only problems encountered were occasional tears and/or pinholes in the filters. These were minor, and not considered to have a significant impact on the analysis results.

2.4.3.3 Corrective Actions – From May 1 to September 25, 2002, all elements within the Multi-Metal Standard were within 5% of the calibrated values. On September 25, an error message “Acquisition Failed to Initiate” was observed. When the energy calibration was run, the Gain DAC fluctuated more than usual. This is an indication of an unstable instrument. The Daily QC analysis showed high values for all elements. The XRF was cycled off and on. When the energy calibration and QC standard analyses were rerun, the XRF reported values within the acceptable range. The replicates from the previous days’ analysis were within comparable limits.

On September 26, ThermoNoran representative Ron checked the board voltages, reseated the circuit boards, and cleaned the dust out of the XRF. All diagnostics showed the instrument to be in good working order.

Throughout the next week the instrument shut off four times with an error message reading “ADC Failed to Respond”. The analysis of the QC standard proved to be within 5% of the calibrated value every time. The PC ADC interface board was reseated and cleaned and the problem did not occur for another two weeks.

The details of each error and subsequent maintenance can be found in the CES XRF Maintenance Log.

Two corrective actions included:

1. A change in the SOP to conduct an energy calibration at the start of each day prior to replicate analysis.

2. A change in the SOP to ensure filters do not undergo any orientation change between analyses.

2.4.4 RTI XRF Laboratory

RTI began analyzing STN samples by Thermo Noran XRF on February 1, 2002.

2.4.4.1 Statistical Summary of QC Results –

<u>Precision</u>

The precision is monitored by the reproducibility of the XRF signal in counts per second using standard samples. The counts for a select element are measured for each of the targets used. The comparison of the counts during calibration and during the run gives the measure of reproducibility or precision (**Table 22**). The data used to monitor precision are presented in **Figures 89 through 94**.

Table 22. Summary of RTI XRF Laboratory QC Precision Recovery Data, 4/1/02 through 9/30/02

Element	n	Min	Max	Average	Std Dev	%CV
Si	542	10.5	13.0	11.7	0.68	5.80
Ti	542	9.08	10.6	9.84	0.19	1.93
Fe	542	9.77	10.9	10.3	0.14	1.38
Se	542	5.48	5.95	5.73	0.08	1.46
Cd	542	3.92	4.15	4.05	0.04	0.95
Pb	542	10.6	11.2	10.9	0.11	0.99

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

Figure 89. Recovery Precision for RTI QuanX XRF with Si

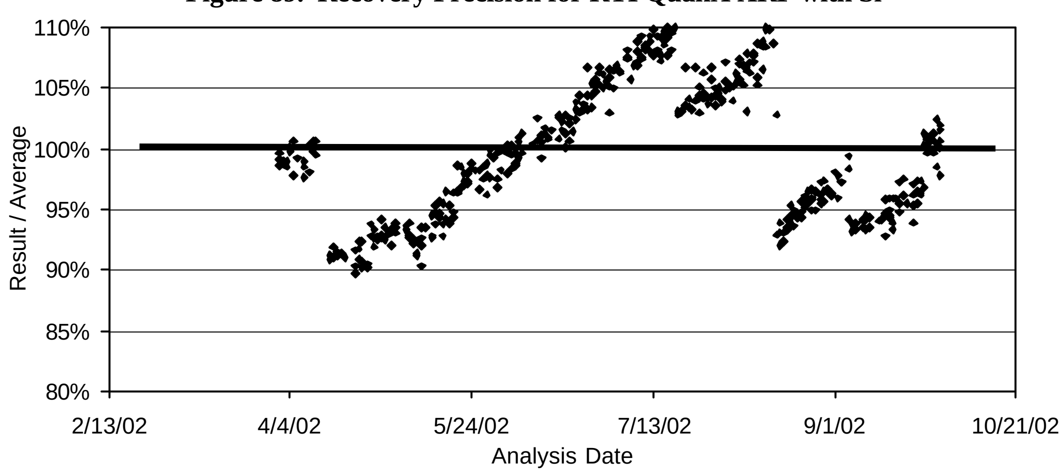


Figure 90. Recovery Precision for RTI QuanX XRF with Fe.

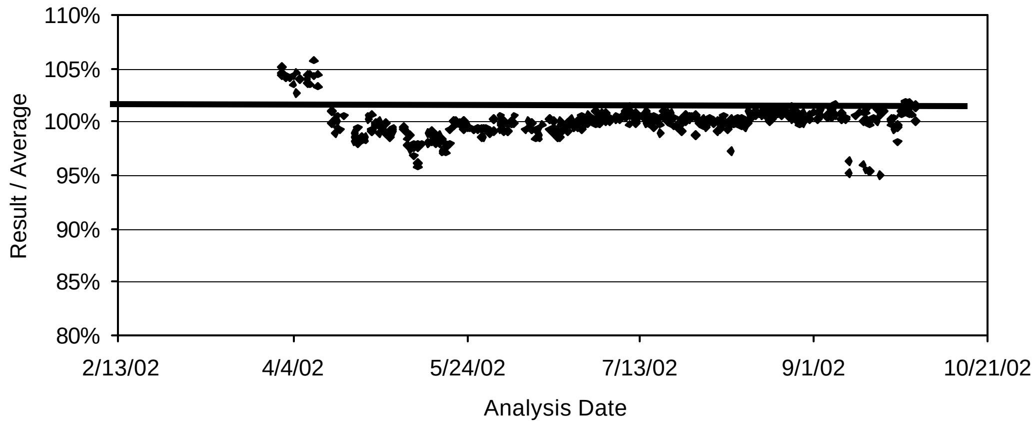


Figure 91. Recovery Precision for RTI QuanX XRF with Se.

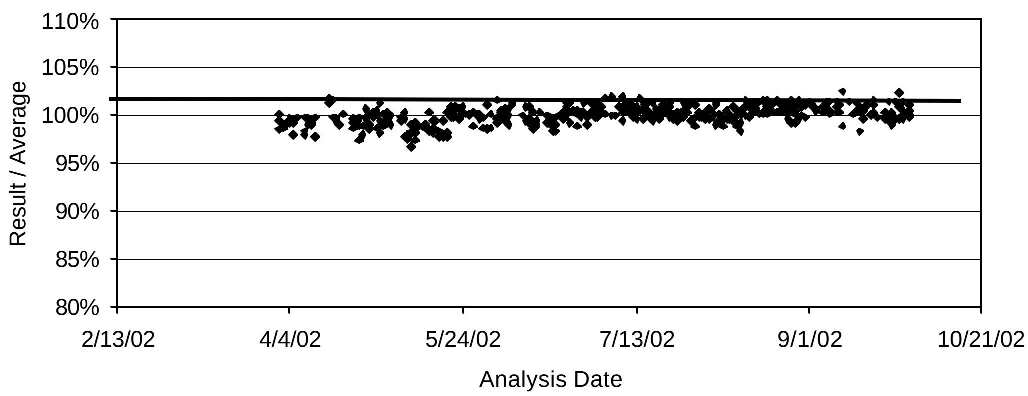


Figure 92. Recovery Precision for RTI QuanX XRF with Ti.

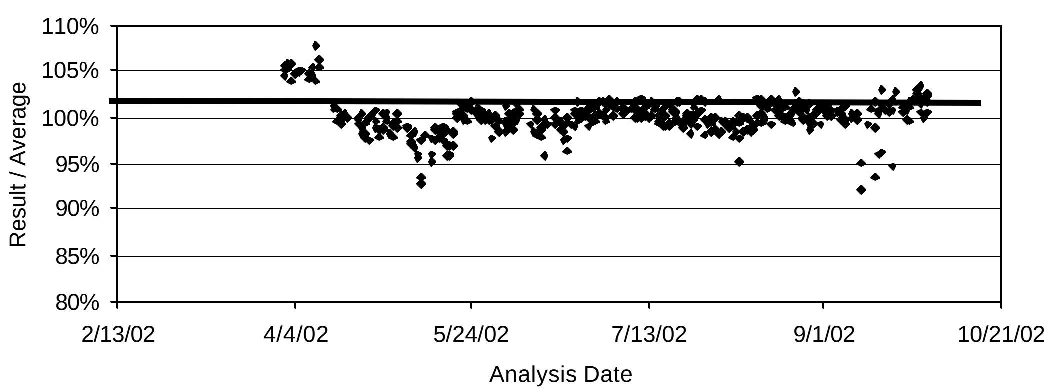


Figure 93. Recovery Precision for RTI QuanX XRF with Cd

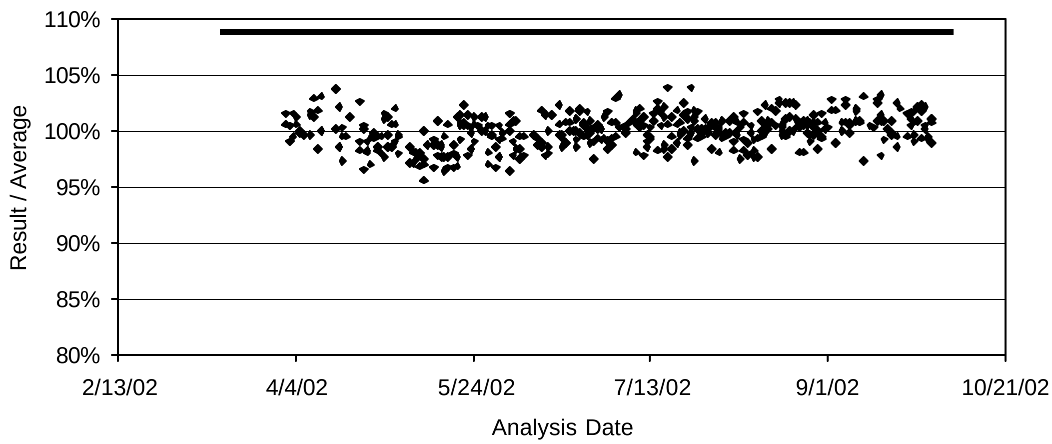
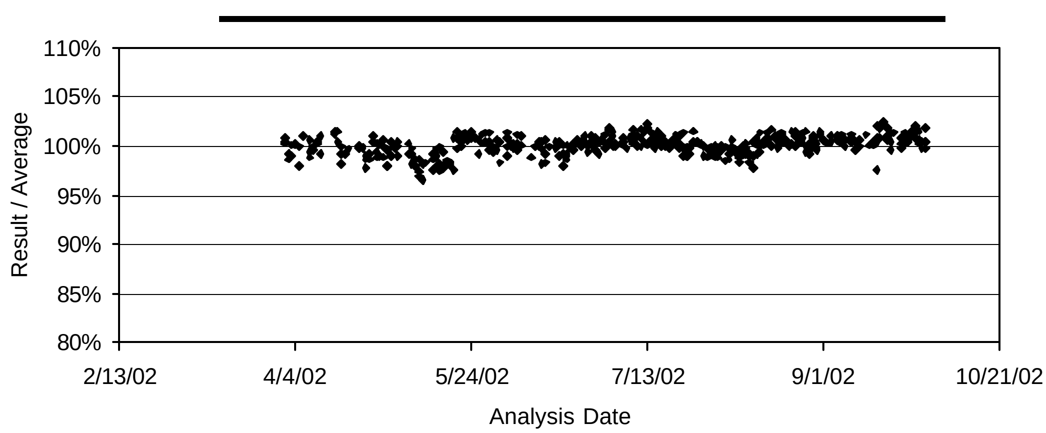


Figure 94. Recovery Precision for RTI QuanX XRF with Pb.



Recovery

Recovery or system accuracy is determined by the analysis of a series of NIST Standard Reference Materials filters. Recovery is calculated by comparison of measured and expected values. **Figures 95 through 107** show recovery for 12 select elements spanning the range of the 48 elements normally measured. All recovery values for all elements ranged between 90 and 107 percent as shown in **Table 23**.

Table 23. Recovery Determined from Analysis of NBS SRMs 1832 and 1833.

Element	Range % Recovery
Al	93 - 106
Si*	91 - 107
Si**	93 - 106
K	90 - 95
Ca	95 - 103
Ti	95 - 106
V	99 - 106
Mn	96 - 103
Fe	90 - 95
Co	97 - 105
Cu	92 - 99
Zn	90 - 96
Pb	101 - 106

*SRM 1832 **SRM 1833

Figure 95. Recovery of Al in NIST SRM 1832 with RTI Quan X XRF.

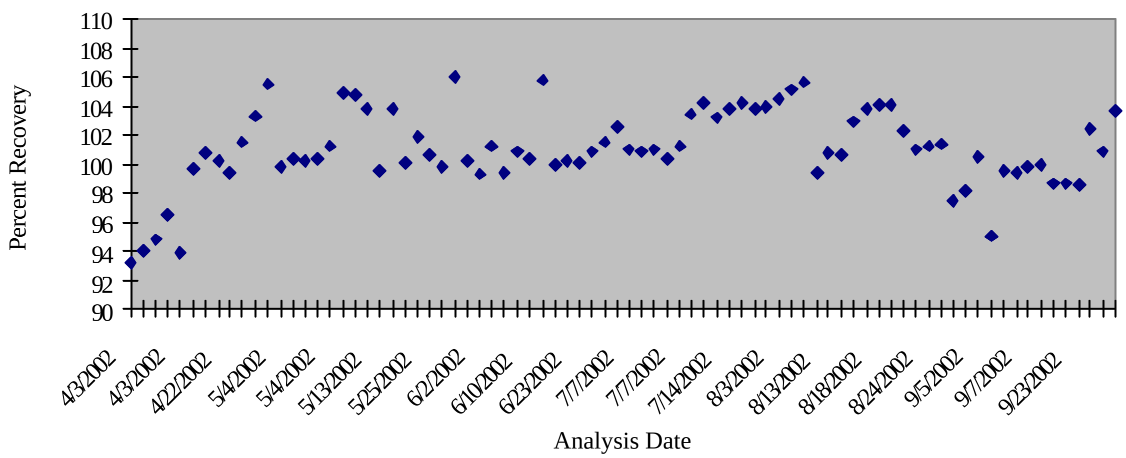


Figure 96. Recovery of Si in NIST SRM 1832 with RTI QuanX XRF

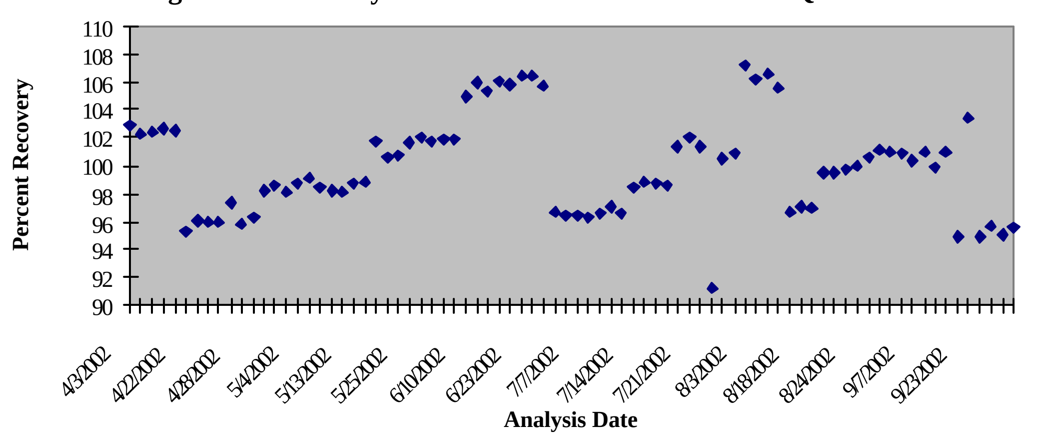


Figure 97. Recovery of Si in NIST SRM 1833 with RTI QuanX XRF

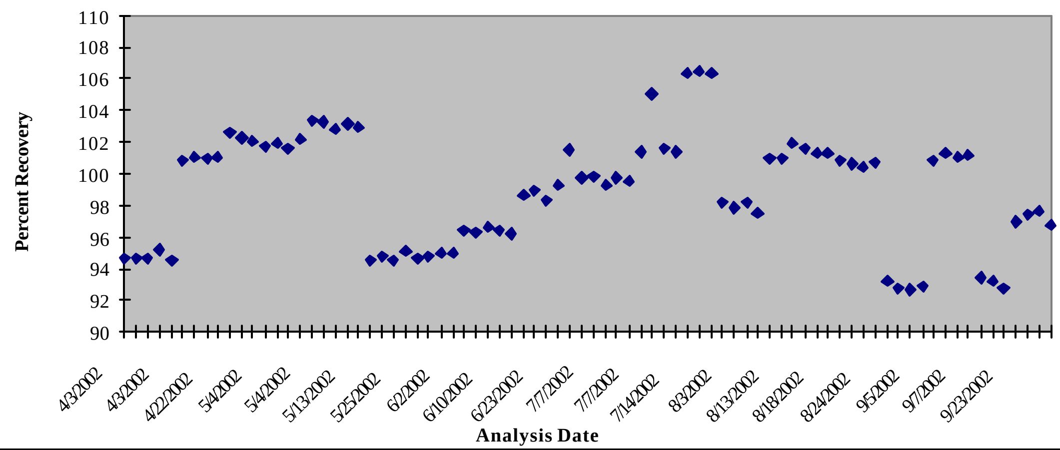


Figure 98. Recovery of K in SRM 1833 with RTI QuanX XRF

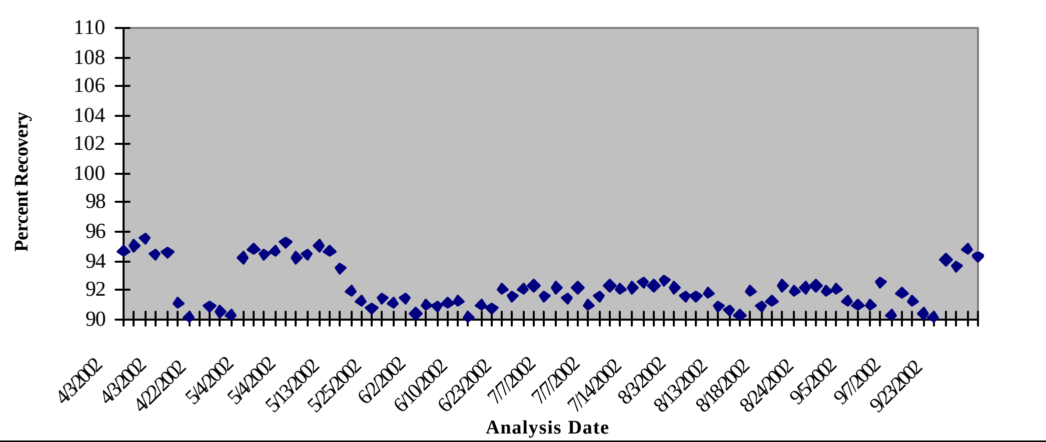


Figure 99. Recovery of Ca in SRM 1832 with RTI QuanX XRF.

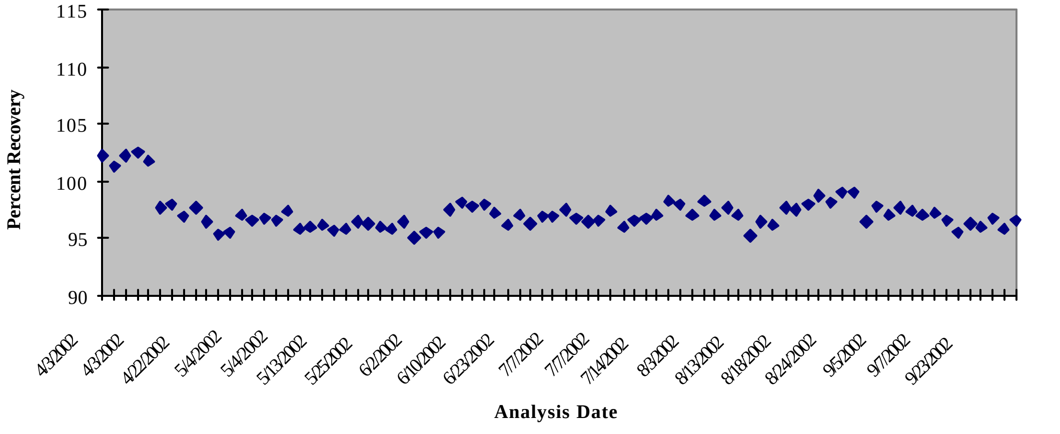


Figure 100. Recovery of Ti in SRM 1833 with RTI QuanX XRF.

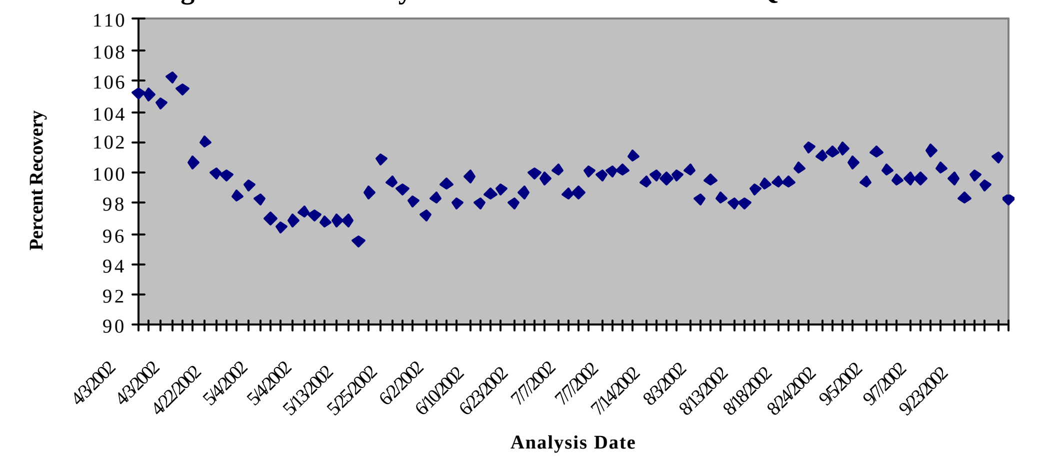


Figure 101. Recovery of V in SRM 1832 with RTI QuanX XRF.

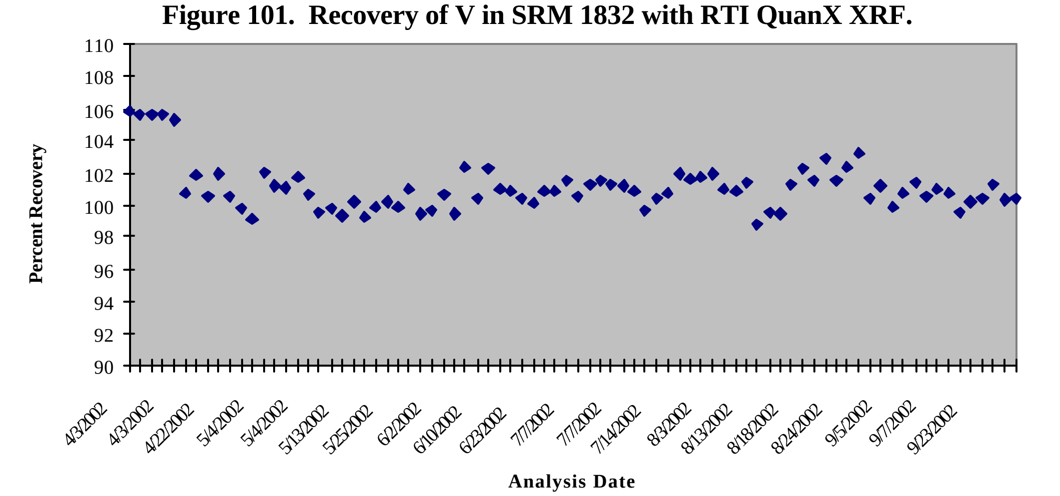


Figure 102. Recovery of Mn in SRM 1832 with RTI QuanX XRF.

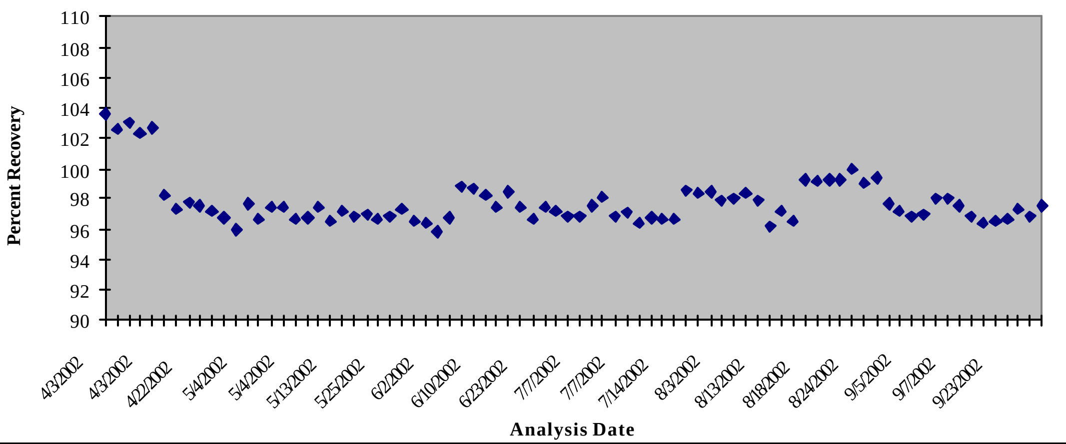


Figure 103. Recovery of Co in SRM 1832 with RTI QuanX XRF.

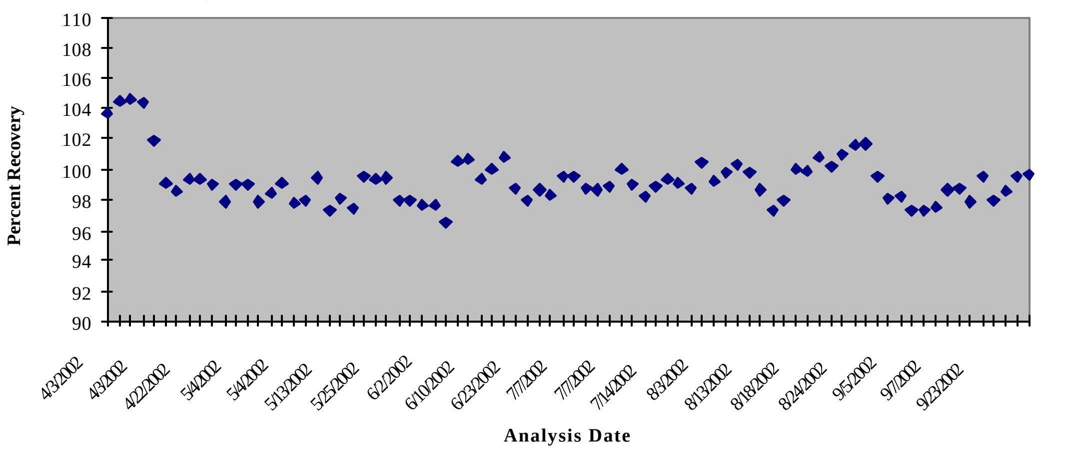


Figure 104. Recovery of Fe in NIST SRM 1833 with RTI QuanX XRF.

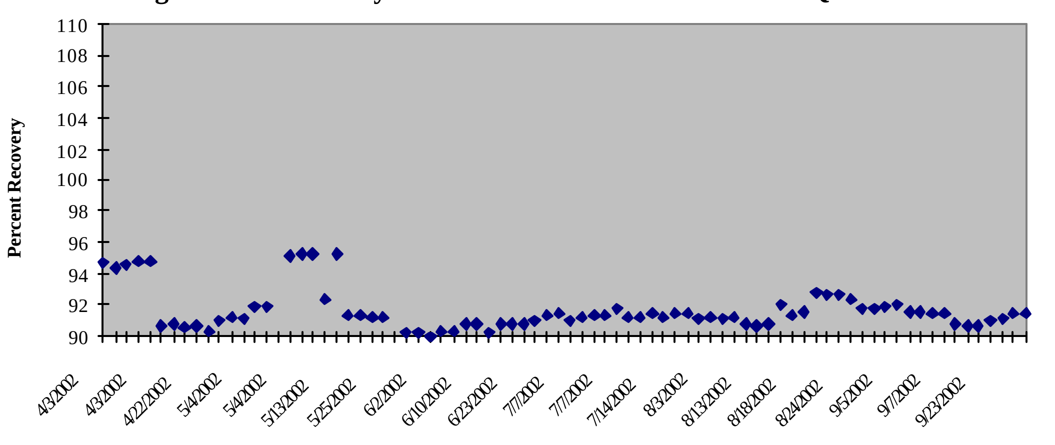


Figure 105. Recovery of Cu in NIST SRM 1832 with RTI QuanX XRF.

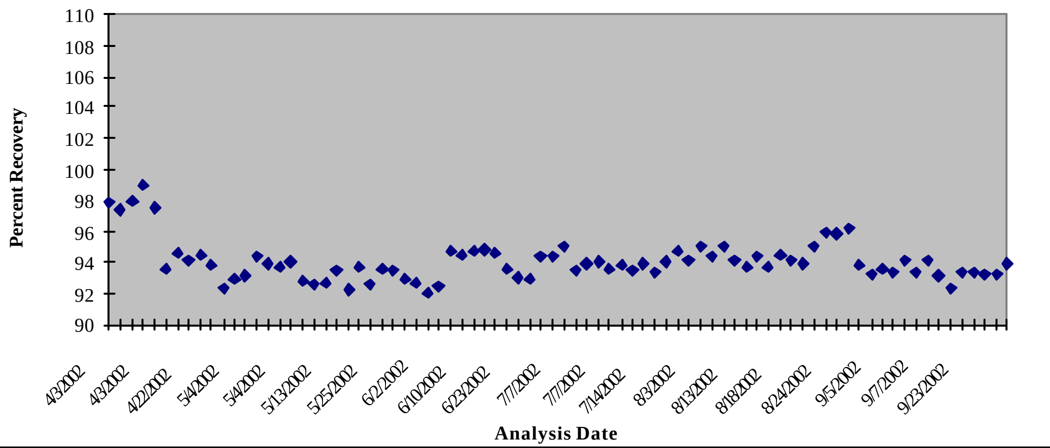


Figure 106. Recovery of Zn in NIST SRM 1833 with RTI QuanX XRF.

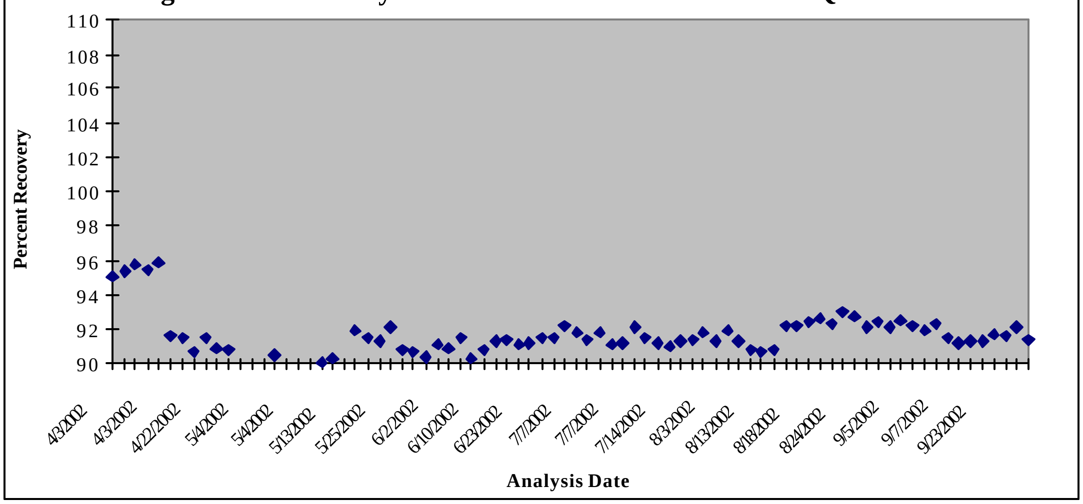
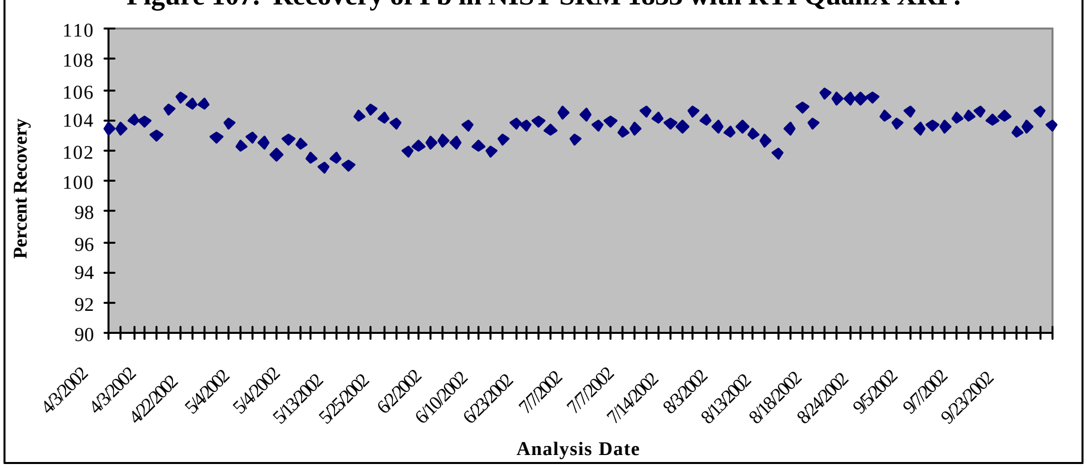


Figure 107. Recovery of Pb in NIST SRM 1833 with RTI QuanX XRF.



Replicates

Ten percent of the filters are re-analyzed and the results for select elements are compared. **Figures 108 through 113** compare replicate values for six elements through regression analysis. Note that slopes are all greater than 0.989 and correlation coefficients range from 0.9952 to 0.9994, indicating acceptable replication.

2.4.4.2 Data Validity Discussion – The data presented in Section 2.4.4 indicate no problems with the XRF data. The only problems encountered were occasional tears and/or pinholes in the filters and a problem with the stability of the tube April 2002. A drift for silicon is also indicated in the QC data, but the data never exceeded the QC requirements. These were minor, and not considered to have a significant impact on the analysis results.

2.4.4.3 Corrective Actions – The XRF experienced some tube stability problems, in which the instrument would arc during analysis. In April 2002, the tube was replaced and samples were re-analyzed where necessary.

The XRF showed a slight upward drift with silicon during July and August, but the values for the SRMs and the Micromatter QC never exceeded the QC requirements. The instrument was re-calibrated September 2002 to correct the drift.

2.4.5 Round-Robin Intercomparison Results

Four different XRF instruments have been approved for use with this program. Before being accepted for use by the STN Program, each instrument was put through a series of acceptance tests using NIST reference materials and exposed STN filters. The Round-Robin program is a filter exchange whose purpose is to verify equivalency of the four instruments on an ongoing basis. To do this, a set of filters exposed filters from the STN archive is being circulated among the laboratories by RTI. Seventy-two (72) round-robin filters were used during the reporting period.

Figure 114 presents the results for each round-robin analysis vs. the original measurement value. All elements are plotted on the same graph. The majority of the "original values" were generated using the Chester 770 instrument, which might introduce some bias into the regression line. The apparent lack of bias demonstrates the lack of drift from the original analysis of the filter and the round robin analyses.

Figure 115 shows the round-robin analyses vs. the median of all observations (original and round-robin measurements). The Median is used in an effort to get the best consensus value for each filter/element combination. In a few cases, the same filter has been analyzed more than once by the same laboratory. Linear correlation equations for each instrument vs. the median value are shown on Figure 115, along with correlation coefficients (R-square). As in the previous semi-annual QA Report, the slope of 0.9517 for the Chester 771 is somewhat lower than the other instruments' slopes. The RTI instrument's R-square value of 0.9736 is lower than the others, which are all above 0.99.

Figure 108. Results of Replicate SI Analysis with RTI QuanX XRF

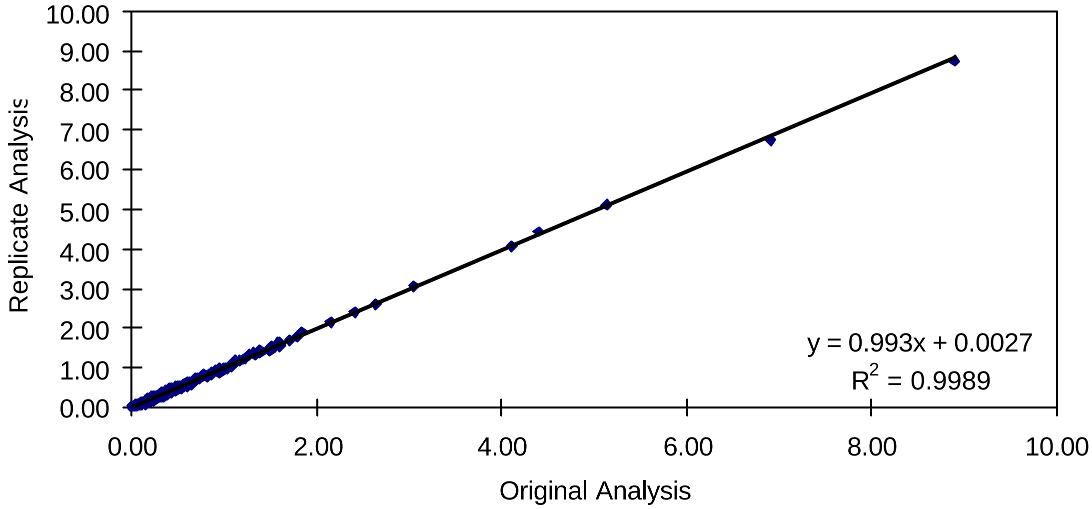


Figure 109. Results of Replicate S Analyses with RTI QuanX XRF

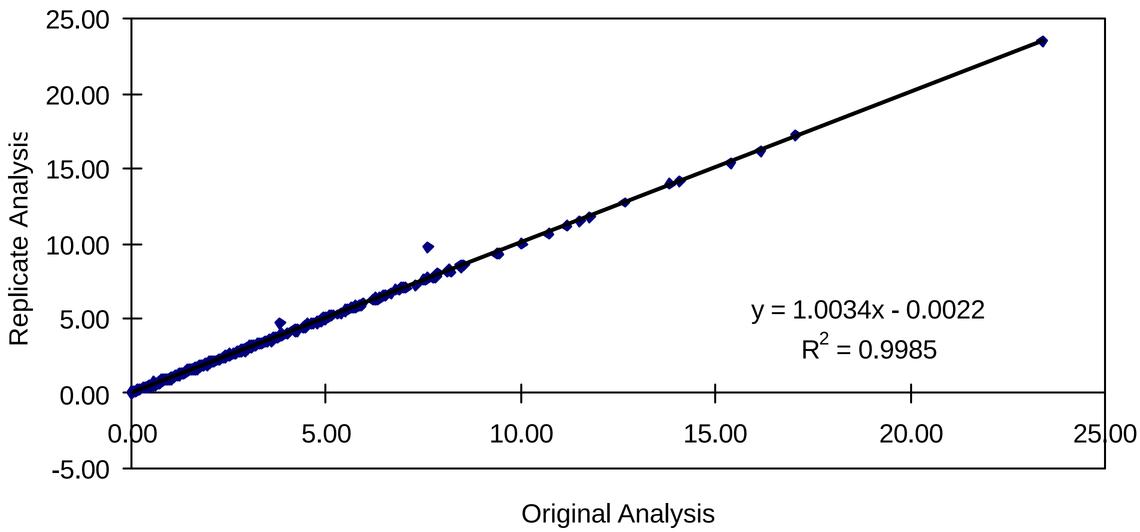


Figure 110. Results of Replicate K Analyses with RTI QuanX XRF

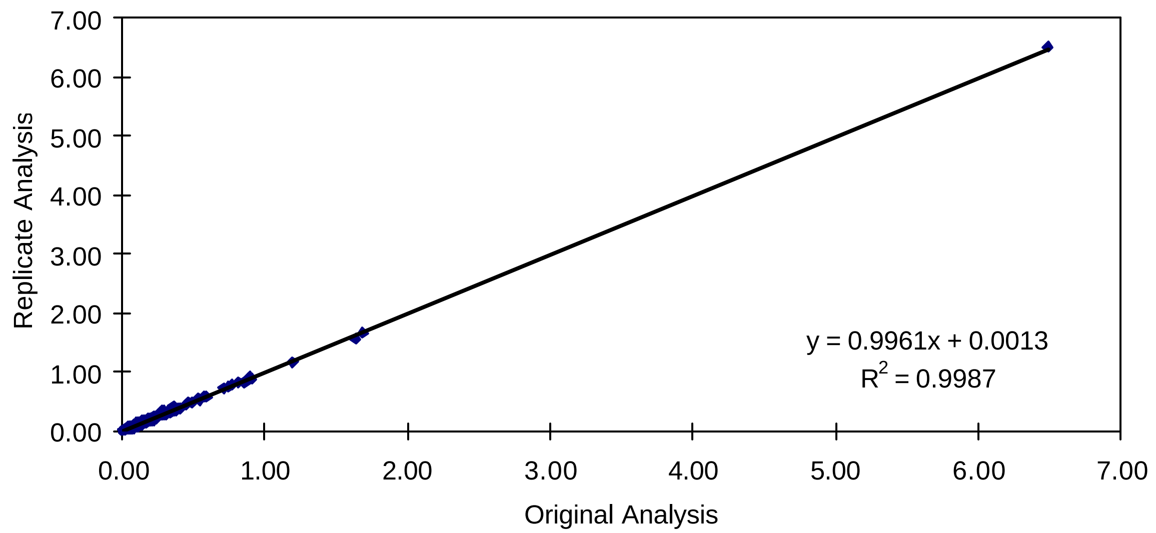


Figure 111. Results of Replicate Ca Analyses with RTI QuanX XRF

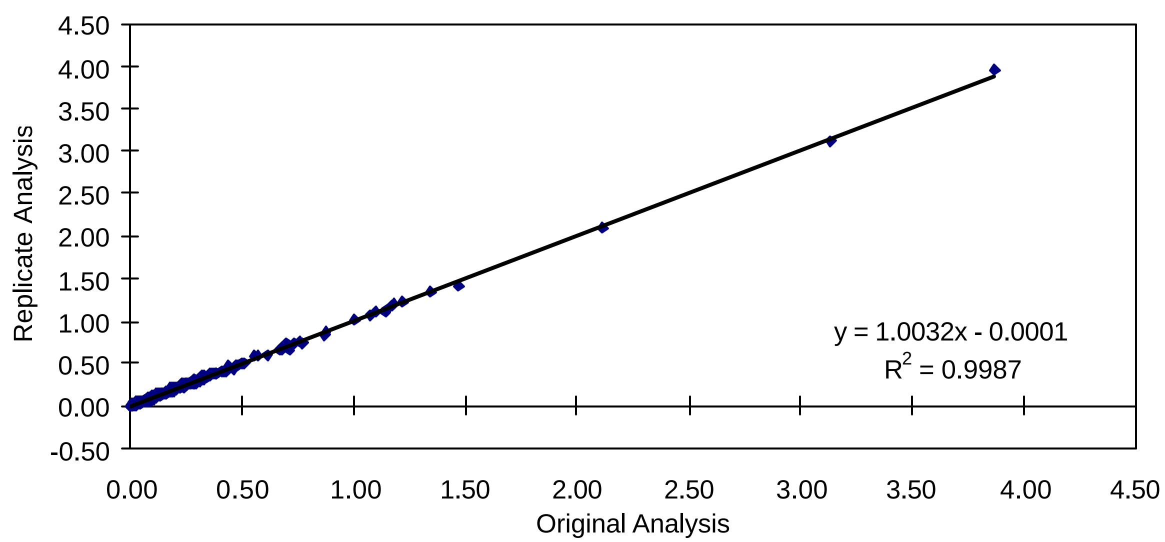


Figure 112. Results of Replicate Fe Analysis with RTI QuanX XRF

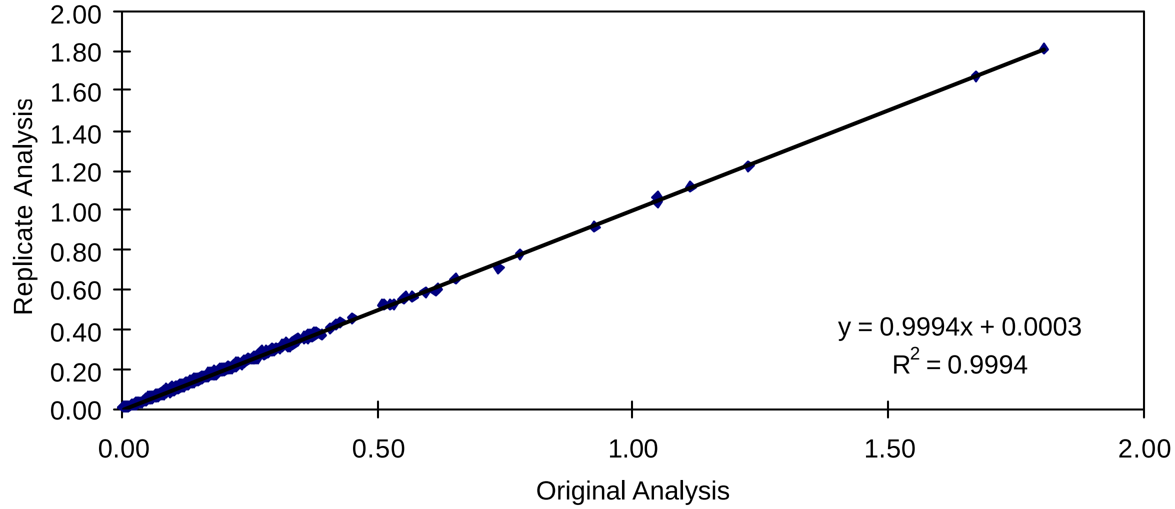
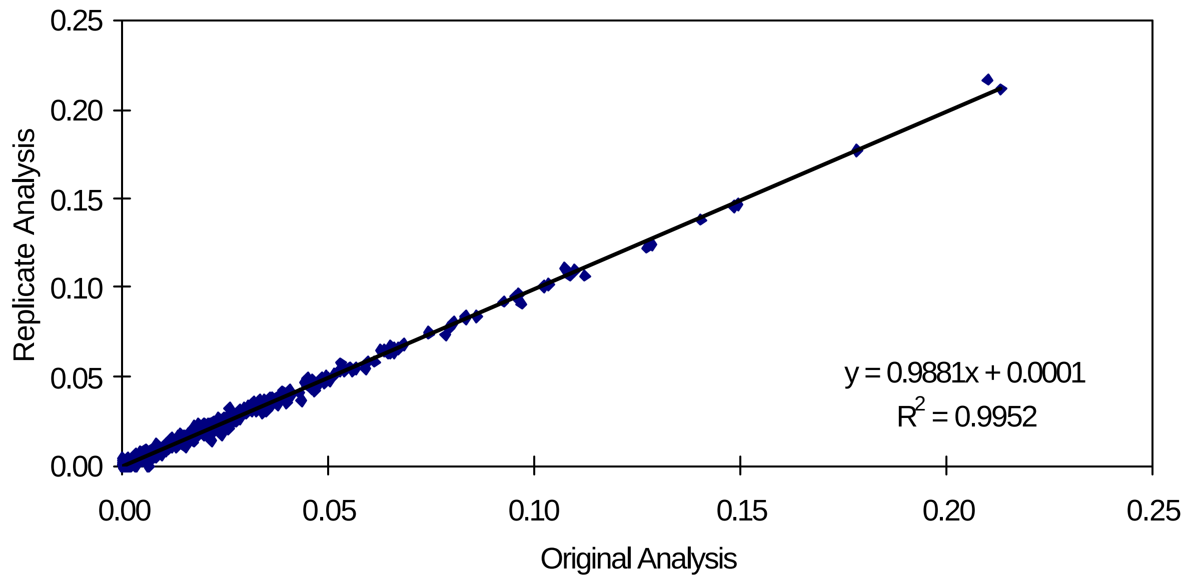


Figure 113. Results of Replicate Zn Analyses with RTI QuanX XRF



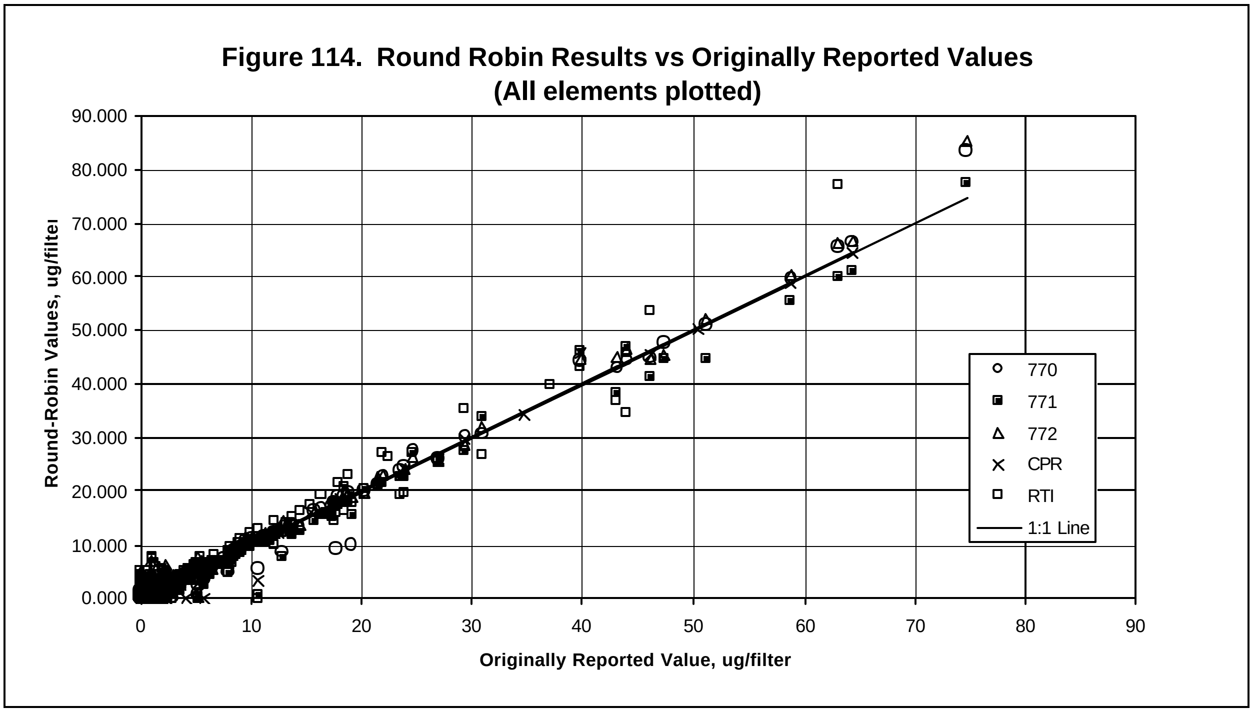


Figure 114. Round Robin Results vs Originally Reported Values
(All elements plotted)
Round-Robin Values, ug/filter
Originally Reported Value, ug/filter
770
771
772
CPR
RTI
1:1 Line

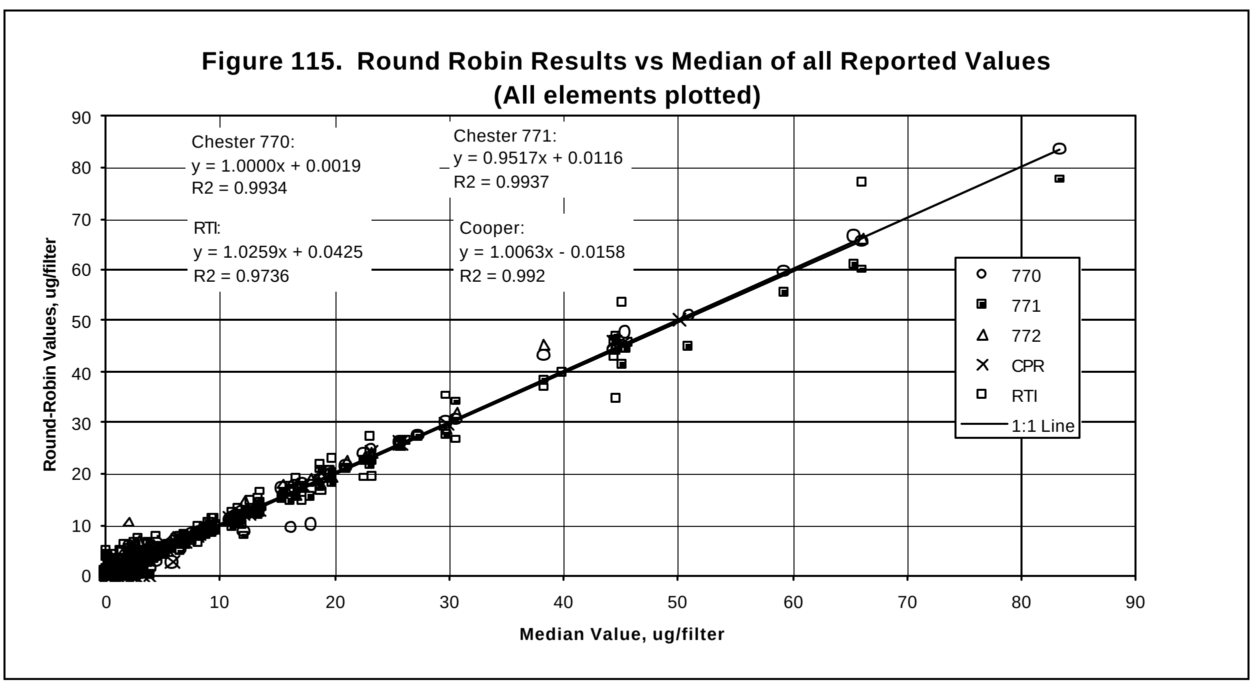


Figure 115. Round Robin Results vs Median of all Reported Values
(All elements plotted)
Chester 770:
y = 1.0000x + 0.0019
R2 = 0.9934
Chester 771:
y = 0.9517x + 0.0116
R2 = 0.9937
RTI:
y = 1.0259x + 0.0425
R2 = 0.9736
Cooper:
y = 1.0063x - 0.0158
R2 = 0.992
Round-Robin Values, ug/filter
Median Value, ug/filter
770
771
772
CPR
RTI
1:1 Line

2.5 Sample Handling and Archiving Laboratory (SHAL)

2.5.1 Description of QC Checks Applied

Numerous QC checks are built into the SHAL procedures. These include:

- Bar-code readers are used to input identification numbers from modules, bins, containers, and data forms to virtually eliminate data transcription errors.

- Barcoded labels with identification numbers are generated by computer and the ID numbers include a check-digit.

- The training of new employees includes a reciprocal check procedure, in which other SHAL technicians check the contents of each other's coolers before they are closed for shipment. This cross-checking procedure is also used when an excessive number of packing errors is reported.

- Blank filters are taken from the SHAL refrigerator and returned unopened to the laboratories for analysis. These QC filters results are being used to improve the overall quality of the program.

- Periodically all SHAL personnel review the latest version of the Standard Operating Procedure. A record of the review is included in the person's training file.

- The SHAL supervisor or his designee will observe a SHAL worker performing the handling of filter modules. A checklist of correct tasks has been prepared for each type of module. The checklist is used by the supervisor during the observation of the worker handling the filters and modules. Completed checklists are kept by the SHAL supervisor. Workers are briefed following the observation of any findings.

2.5.2 Corrective Actions Taken

Problem: EPA asked RTI to investigate the high mass values for blank filters.
Corrective Action: In a continuing effort to lower the levels of analytes found on blank filers, the SHAL is constantly trying to eliminate any sources of fibers from the work area. Suspected sources of fibers have been removed from the work tables and frequent cleaning of the working areas is being done. Computer monitors and keyboards are now vigorously cleaned on a weekly basis. Additional steps to improve cleanliness in the work area will be implemented as they are discovered. Recent analytical results for gravimetric mass on Field and Trip Blank filters indicate improvement in the blank values which may be a direct result of the implemented cleaning.

Problem: Late arriving coolers are still causing problems in the SHAL. **Corrective Action:** RTI has continued to track late arriving coolers (see Appendix B). RTI will inform the EPA DOPO of events which cannot be shipped due to late arriving coolers at RTI. The SHAL supervisor has also been sending EPA a listing of all coolers arriving on Monday. These coolers are either delayed in transit by the carrier or were shipped on a Friday from the site which is not the preferred return ship day.

Problem: Some coolers arriving at RTI during the summer months have had module temperatures above the 4 degrees Centigrade recommended receipt temperature. **Corrective Action:** The SHAL will continue to package filter modules for shipment as we have in the past in order to insure consistency with past shipments. EPA is studying the shipping issues and will inform RTI and the sites if changes to shipping procedures are to be implemented.

Problem: The SHAL received a number of nylon filters in batch 062802 that appeared to be missing the nylon coating. These filters came to the attention of the SHAL supervisor in early August of 2002. The filters were similar in appearance to very thin paper - not the usual nylon coating. **Corrective Action:** The SHAL inspected all filters in the batch and returned approximately 15 to the Ions Laboratory supervisor. Following this discovery as sampled filters were returned to RTI from the sites, the nylon filters were carefully inspected to determine if any defective filters had been sent out. Any suspect filters were invalidated and flagged appropriately.

2.5.3 Training

On October 30, a “refresher” training course on proper disassembly/assembly of Rupprecht and Patashnick ChemComb PM2.5 speciation sampler modules was given to all established and newer SHAL employees. Based on input received from employees, the SOP will be revised slightly to minimize the possibility of transfer of particulate matter and silicone grease from one module to the other during handling.

2.6 Denuder Refurbishment Laboratory

The Denuder Refurbishment Laboratory is located in RTI Building No. 3, laboratory 220. The purpose of the laboratory is to clean and refurbish the coatings on acid-gas-removing denuders used in samplers of chemical speciation networks operated by EPA and various State and local agencies which utilize the RTI/EPA contract. The laboratory follows these protocols:

- Procedure for Coating Annular Denuders with Magnesium Oxide
- Standard Operating Procedure for Coating and Extracting Annular Denuders with Sodium Carbonate
- Procedures for Coating R & P Speciation Sampler ChemComb\ Denuders with Sodium Carbonate
- Standard Operating Procedure for Coating Annular Denuders with XAD-4 Resin.

Denuders for the Andersen and URG speciation samplers are being cleaned and then re-coated with magnesium oxide. They are replaced at the sites at 3-month intervals. The last replacement was in October 2002; the next scheduled change-out will occurr in mid-January, 2003, and again in mid-April 2003.

MetOne aluminum honeycomb denuders are also 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. A major change-out of MetOne denuders occurred in July, 2001, for those modules that had been in use for 18 months to that point. RTI ordered uncoated aluminum honeycomb denuder substrates from MetOne, cleaned them with solvent and deionized water, and then coated them with magnesium oxide. This change-out is the first where RTI-coated MetOne denuders were used; all earlier MetOne denuders had been supplied by the manufacturer. Several other 18-month interval change-outs occurred in the past 6 months. The change-out occurs whenever the sampler (or group of samplers) has been in use for 18 months.

R & P ChemComb™ glass honeycomb denuders are cleaned and coated with sodium carbonate/glycerol. R & P denuders are replaced after each 24-hour sampling use.

No XAD-4 resin coated denuders (for removal of organic vapors) were ordered by EPA/OAQPS during the reporting interval.

The only significant problem encountered in the reporting period of operation has been the occasional receipt of broken or loose denuders.

In a separately tasked effort, RTI began an investigation to determine a way to recover anions from the MgO surfaces of denuders and to estimate the useful life of MgO denuders. A draft report was submitted to EPA in late September, 2002.

2.7 Data Processing

2.7.1 Operational Summary

The data processing system has continued to operate with minimal problems, although minor improvements and modifications continue to be made. Problems, Corrective Actions and Operational Improvements are discussed in Section 2.7.2, below.

2.7.2 Problems, Corrective Actions and Operational Improvements

2.7.2.1 Problems with long runtimes in EPA's Stats_CR – Starting in July 2002, we noticed that the Stats_CR step in posting AQS data was taking excessive time. By August 2002, the Stats_CR job had slowed to over 8 hours per batch (six batches were required to post each RTI monthly AQS report). Often the time required to run Stats_CR was so long that we would time out and have to resubmit the job (with an additional 8 to 12 hour wait). EPA was notified of the problem and was able to revise their procedures to fix the delays.

2.7.2.2 Additional Automated QA reports as part of monthly reporting procedures – We have continued to add to our monthly outliers report. Items added include reports to detect:

- Field data with unreasonable temperatures and barometric pressures
- Samples run on dates other than those scheduled. (This is not always an error, however reviewing this helps to find data entry and blank substitution errors).

In addition we have added a revised blank report, that better helps us track elevated blank values.

2.7.2.3 New AQS data review procedures – As we have gained more experience with AQS processing and review procedures, we have developed a number of checks that are applied before posting data to AIRS. Many of these checks were developed and performed by our QA officer as part of his monthly review. We have now prepared a formal checklist of these items and delegated these checks to our RTI data processing staff. This permitted the QA officer to focus on a higher-level data review, while ensuring that all routine checks are performed and their results documented.

2.7.2.4 Modifications to double-entry comparison procedures to prevent loading of incomplete data – All field channel data are double entered by two different operators. Each enters data into a different table. The results in each table are compared to the data in the other table before any matching data is copied into the main table (and then deleted from the individual tables). Additionally, we have checks that require all channels for a routine (non-blank) have data before that data is approved for reporting. As the number of field events grew, we noticed that we were seeing several events that were not getting all channels entered in the main table. As these events had incomplete data entry, they were not approved for reporting. Although our normal check procedures were detecting this problem, we were spending time to track down and correct each missing entry.

The incomplete field entry problem was traced back to the double-entry comparison routine, which was ignoring any channels entered only in the second table. Modifications were made to the comparison routine to fix this problem.

2.7.2.4 Addition of new automated remote backup procedures – We have been routinely (nightly) backing-up server data to tape and removing the tapes to an offsite location on a weekly basis. Although this provides a high level of protection against server failure, there was still the potential for data loss in case of catastrophic site failure (such as fire or flood). In addition, the time to restore a new system from backup tape could exceed a full day. To provide greater protection against data loss and service interruption, we have developed a program that automatically copies the most recent SQL Server backup and transaction files to a server located at RTI's 800 Park facility (approximately 1 mile from the main campus). The remote server also contains the same version of SQL Server and could be quickly converted to the primary server in case of major site or hardware malfunction. The new program is scheduled to run each business day on the half-hour (transaction logs are generated on the hour) during business hours. This is in addition to the automated nightly tape backups.

2.8 Quality Assurance and Data Validation

2.8.1 QA Activities

QA activities directly related to data validation are described in the PM2.5 Chemical Speciation Laboratory QAPP (January 2002), and include the following:

- Review of monthly data reports sent to the state monitoring agencies and EPA
  - Verification of data attribution to the correct site, POC, and date
  - Review of report formats
  - Troubleshooting when discrepancies are found
  - Running manual and partially-automated range checks
  - Reviewing the results of fully-automated validation checks
  - Application of Level 1 outlier screening criteria.
- Review of each data batch before it is sent to AIRS
  - Verification of data attribution to the correct site, POC, and date
  - Verification that changes requested by the state monitoring agencies have been correctly made by the Data Processing personnel
  - Review of data format to be sure that records and individual fields are of the correct length.
- Troubleshooting of sample and data problems that cross the boundaries between laboratories, the SHAL, and/or the data processing function.

2.8.2 Data Validation Procedures

The full scope of the Level 0 and Level 1 procedures carried out by RTI before data are delivered to the state monitoring agencies each month are described in the Laboratory QAPP (January 2002).

The data validation procedures described in previous QA Reports continue to be performed as described there and in the Laboratory QAPP. Some of the screening procedures have been automated to speed the monthly review process; however all questionable data identified by automated screening continue to be reviewed by a data validation staff member.

2.8.3 Internal Assessments

In October 2002, with the collaboration of the RTI QAO, the RTI Deputy QAO performed an internal assessment of the program. The purpose was to assess and improve the quality and efficiency of multiple complex processes. The focus of the assessment was on identifying the potential for improving processes for generating data of known and documented quality. These processes require the interactions of physical processes and data management across a large team of RTI, EPA, and state team members. Several incremental opportunities were identified; no significant problems were noted. The report is in preparation.

2.8.4 Corrective Actions

No corrective actions to the Data Validation System were taken during the period April 1, 2002, through September 30, 2002; however, numerous questions were identified in the data which were referred back to the SHAL, analytical laboratories, or field operator for resolution.

3.0 Data Validity and Completeness

3.1 Summary of Scheduled Samples

Routine samples were scheduled on 1-in-6 and 1-in-3 day schedules during the reporting period for this report, delivery batches 28 through 34. **Table 24** summarizes the delivery batch by delivery date covered by this report. To avoid confusion, RTI does not report partial results for any exposure session, but waits until all the analysis results are complete before an event is reported.

Table 24. Delivery Batches by Delivery Date

Delivery Batch Number	Report Date	Earliest Sample	Latest Sample	Number of Events
28	5/14/2002	2/1/2002	4/11/2002	1760
29	6/14/2002	2/25/2002	5/8/2002	2066
30	7/16/2002	4/2/2002	6/10/2002	2001
31	8/14/2002	4/29/2002	7/10/2002	1768
32	9/15/2002	6/25/2002	8/12/2002	1831
33	10/14/2002	8/9/2002	9/11/2002	1885
34	11/13/2002	9/8/2002	10/14/2002	1908

Turnaround times from sample receipt continued to decline during the reporting period, as shown in **Table 25**. Turnaround time is defined as the elapsed time from receipt of a cooler at the SHAL for a completed event, and the reporting of the data from that event.

Table 25. Data Turnaround Times

Batch	Delivery Date	Turnaround Time, days
28	5/14/02	56
29	6/14/02	50
30	7/16/02	48
31	8/14/02	43
32	9/15/02	47
33	10/14/02	45
34	11/13/02	44

3.2 Trip and Field Blanks

The number of blanks run during this period are summarized in **Table 26**. Blank data are not submitted to AIRS, but are reported to the state monitoring agencies and to EPA for statistical analysis. As required by the QAPP, trip blanks are being scheduled at a frequency of one per 30 regular exposure events, and field blanks are scheduled at a rate of one per 10 regular exposures. However, use of the "alternate schedule" at sites where operators do not work on weekends has resulted in a larger proportion of Trip Blanks than required by the QAPP. Some routine samples that are not run are converted to additional Trip Blanks or Field Blanks provided that the site operator indicates that the correct SOP has been followed. Other unexposed samples are designated "unsampled blanks" when it is not clear what protocol the operator followed.

Table 27 summarizes the Trip and Field Blank results for the reporting period. High sodium values, seen in the previous report, are much lower for Batches 28-34. RTI instituted a new filter washing procedure early in 2002 that is most likely responsible for the decline in sodium levels in recent batches. The comparatively high values for Organic Carbon, which are typically above 10 micrograms per filter, are thought to be caused by adsorption of carbon-containing compounds from the air during storage.

Table 26. Number of Blanks Reported in Batches 28 through 34

Delivery Batch	Blank Type	Number
28	FIELD BLANK	238
29	FIELD BLANK	321
30	FIELD BLANK	137
31	FIELD BLANK	264
32	FIELD BLANK	149
33	FIELD BLANK	268
34	FIELD BLANK	159
28	TRIP BLANK	61
29	TRIP BLANK	50
30	TRIP BLANK	233
31	TRIP BLANK	21
32	TRIP BLANK	43
33	TRIP BLANK	120
34	TRIP BLANK	48
28	UNSAMPLED	17
29	UNSAMPLED	31
30	UNSAMPLED	21
31	UNSAMPLED	45
32	UNSAMPLED	36
33	UNSAMPLED	43
34	UNSAMPLED	30

Table 27. Trip and Field Blanks Average for the Reporting Period (µg/filter)

Trip Blanks

ANALYSIS	ANALYTE	28	29	30	31	32	33	34
Cations - PM2.5 (NH4, Na, K)	Ammonium	0.10	0.03	0.05	0.02	0.05	0.01	0.06
Cations - PM2.5 (NH4, Na, K)	Potassium	0.04	0.00	0.04	0.15	0.00	0.00	0.01
Cations - PM2.5 (NH4, Na, K)	Sodium	0.63	0.53	0.58	1.36	0.83	0.55	0.69
Mass - PM2.5	Particulate matter 2.5u	12.59	9.54	12.57	8.10	7.09	7.61	7.63
Nitrate - PM2.5	Nitrate	0.53	0.75	0.49	1.25	1.06	0.54	1.14
Nitrate - PM2.5 (MASS/nylon)	Nitrate	0.64	0.99	0.60	0.51	0.46	0.62	1.96
Nitrate - PM2.5 (MASS/teflon)	Nitrate	0.61	0.75	0.61	0.34	0.97	0.57	0.86
Sulfate - PM2.5	Sulfate	1.28	1.53	0.55	1.63	1.58	0.85	0.94
OC/EC	Carbonate carbon	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OC/EC	Elemental carbon	1.49	1.18	1.53	1.00	1.40	1.62	1.54
OC/EC	OCX2	5.98	5.87	5.58	5.63	6.96	7.65	5.83
OC/EC	Organic carbon	13.14	13.15	12.97	12.36	16.27	18.07	14.86

Field Blanks

ANALYSIS	ANALYTE	28	29	30	31	32	33	34
Cations - PM2.5 (NH4, Na, K)	Ammonium	0.02	0.02	0.08	0.05	0.04	0.05	0.06
Cations - PM2.5 (NH4, Na, K)	Potassium	0.01	0.06	0.02	0.00	0.00	0.00	0.02
Cations - PM2.5 (NH4, Na, K)	Sodium	0.39	0.49	0.81	0.60	1.17	0.42	0.66
Mass - PM2.5	Particulate matter 2.5u	16.56	11.17	14.05	9.06	7.82	8.09	4.39
Nitrate - PM2.5	Nitrate	0.37	0.66	0.66	0.61	0.79	0.64	0.91
Nitrate - PM2.5 (MASS/nylon)	Nitrate	0.51	0.78	0.66	0.69	0.83	0.41	0.62
Nitrate - PM2.5 (MASS/teflon)	Nitrate	0.48	1.11	0.58	0.87	0.48	0.79	0.42
Sulfate - PM2.5	Sulfate	0.64	1.06	1.09	0.81	1.08	0.84	1.02
OC/EC	Carbonate carbon	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OC/EC	Elemental carbon	1.46	1.64	1.47	1.90	2.46	2.21	2.47
OC/EC	OCX2	5.34	5.98	6.70	6.39	7.59	6.32	4.64
OC/EC	Organic carbon	12.81	13.36	14.51	14.42	16.12	14.36	12.04

3.3 Data Completeness

Table 28 shows the percentage of routine exposure records in each delivery batch group that were valid (i.e., not invalidated with an AIRS Null Value Code). Blank cells indicate that no analyses were scheduled for a site during a particular delivery batch interval.

Table 28. Summary of Percent Valid AIRS Data by Delivery Batch

LOCATION NAME	POC	28	29	30	31	32	33	34
20th St. Fire Station	5	100.0%	99.0%	78.6%	100.0%	100.0%	100.0%	100.0%
5 Points	5	100.0%	98.9%	100.0%	100.0%	83.3%	100.0%	100.0%
Air Monitoring, VA DEQ	5	100.0%	94.0%	100.0%	100.0%	100.0%	91.7%	100.0%
Aldine	5	91.7%	79.0%	79.6%	76.0%	84.6%	69.2%	94.1%
Allen Park	5	100.0%	100.0%	100.0%	99.9%	100.0%	100.0%	92.4%
Alpine	5	93.8%	96.9%	80.0%	97.5%	99.4%	90.0%	100.0%
APCD (Barret)	5	100.0%	100.0%	85.7%	83.3%	100.0%	100.0%	100.0%
Arendtsville	5		100.0%	100.0%	99.0%	100.0%	100.0%	100.0%
Army Reserve Center	5	100.0%	87.5%	100.0%	100.0%	100.0%	100.0%	100.0%
Arnold	5	100.0%	100.0%	99.5%	100.0%	99.6%	93.6%	100.0%
Ashland Health Department	5	100.0%	98.9%	100.0%	100.0%	100.0%	100.0%	100.0%
Athens	5	100.0%	74.8%	85.7%	87.2%	100.0%	100.0%	100.0%
Augusta	5	93.8%	95.3%	100.0%	83.3%	97.2%	100.0%	70.6%
Bakersfield-California Ave	5	100.0%	100.0%	100.0%	100.0%	100.0%	91.7%	92.3%
Bakersfield-California Ave (Collocated)	6	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Bates House (USC)	5	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Bayland Park	5	96.5%	100.0%	100.0%	93.5%	93.8%	99.6%	100.0%
Beacon Hill	6	99.8%	91.7%	99.5%	100.0%	100.0%	100.0%	100.0%
Big Bend National Park	5	68.8%	99.2%	70.9%	46.9%	85.2%	72.2%	72.3%
Bismarck Residential	5	100.0%	99.1%	100.0%	100.0%	100.0%	83.3%	100.0%
Blair Street	6	100.0%	100.0%	99.6%	100.0%	91.1%	98.7%	100.0%
Bountiful	5	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Bowling Green-Kereiakes Park	5	100.0%	87.1%	100.0%	83.3%	100.0%	100.0%	87.2%
Boyd Park	5	100.0%	100.0%					
Bristol	5	100.0%	100.0%	100.0%	83.3%	100.0%	100.0%	100.0%
Buffalo	6	100.0%	98.2%	98.7%	100.0%	98.4%	100.0%	100.0%
Buncombe County Board of Education	5	100.0%	100.0%	83.3%	84.9%	100.0%	100.0%	83.3%
Burlington	5	100.0%	100.0%	100.0%	100.0%	100.0%	91.7%	100.0%
Camden	5	100.0%	99.0%	100.0%	90.9%	100.0%	93.6%	100.0%
Canal St. Post Office	5						91.7%	90.9%
Canton Health Dept.	5	87.5%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Capitol	5	76.6%	100.0%	97.8%	99.0%	91.5%	99.7%	84.1%
Chamizal	5	99.5%	83.8%	100.0%	91.9%	99.5%	92.2%	100.0%
Channelview	5	53.1%	84.4%	88.6%	85.0%	67.1%	93.5%	86.7%
Cherry Grove	5	100.0%	100.0%	100.0%	100.0%	65.9%	100.0%	100.0%
Chester	5	100.0%	98.7%	96.7%	51.3%	90.9%	100.0%	100.0%
Chester (PA)	5		100.0%	100.0%	83.3%	100.0%	100.0%	97.7%
Chesterfield	5	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Chickasaw	5	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Chicopee	5	50.0%	61.2%	42.5%	24.9%	29.6%	31.2%	90.6%
Children's Park	5	99.0%	100.0%	100.0%	99.0%	100.0%	100.0%	87.2%

Table 28. (Continued)

LOCATION NAME	POC	28	29	30	31	32	33	34
Chiwaukee Prairie Site	5	84.6%	100.0%	100.0%	100.0%	100.0%	87.2%	84.9%
Columbus	5	100.0%		100.0%	85.9%	100.0%	100.0%	83.9%
Com ED	5	99.7%	100.0%	99.9%	100.0%	100.0%	78.3%	100.0%
Commerce City	5	100.0%	100.0%	100.0%	100.0%	91.7%	91.7%	100.0%
Conroe Airport	5	85.8%	82.5%	64.3%	85.7%	81.7%	70.2%	94.4%
Cornell Elementary	5	87.5%	100.0%	85.7%	83.3%	78.4%	100.0%	100.0%
Courthouse Annex-Libby	5	100.0%	88.7%	100.0%	100.0%	80.0%	100.0%	100.0%
Covington - University College	5	81.9%	75.0%	100.0%	64.3%	100.0%	100.0%	100.0%
CPW	5	100.0%	94.0%	94.1%	90.9%	100.0%	100.0%	100.0%
Crossett	5	100.0%	57.0%	70.6%	73.4%	52.8%	100.0%	100.0%
Dallas Convention Center	5				100.0%	88.8%	88.9%	100.0%
Dearborn	5		98.4%	100.0%	100.0%	99.7%	95.8%	97.9%
Decatur	5	80.0%	100.0%	83.3%	100.0%	100.0%	100.0%	100.0%
Deer Park	6	95.6%	79.6%	67.3%	81.8%	83.3%	100.0%	100.0%
Deer Park (Collocated)	7	99.8%	99.9%	92.3%	80.0%	100.0%	85.4%	100.0%
Dona Park	5	99.6%	82.2%	99.8%	100.0%	100.0%	99.4%	80.9%
Douglas	5	95.0%	40.4%	94.8%	80.2%	93.8%	94.8%	78.1%
Dover	5	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Durango - Park School	5	83.1%	61.9%	66.7%	77.8%	100.0%	100.0%	100.0%
Duwamish	6			100.0%	32.0%	98.4%	87.2%	83.3%
East Charleston	5				66.7%	100.0%	86.7%	100.0%
El Cajon	5	100.0%	92.9%	93.5%	89.8%	100.0%	100.0%	100.0%
Elizabeth Lab	5	100.0%	98.9%	100.0%	100.0%	100.0%	99.3%	91.0%
Ellis County WMA	5	100.0%	100.0%	100.0%	100.0%	100.0%	99.7%	100.0%
Ellyson	6		100.0%	100.0%	100.0%	100.0%	87.2%	100.0%
Elmwood	5		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Erie	5		88.5%	100.0%	33.3%	81.9%	100.0%	66.7%
Essex	5	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Essex - Met One	6	100.0%						
Evansville - Mill Road	5							100.0%
Fargo NW	5	100.0%	100.0%	78.6%	93.0%	100.0%	99.3%	100.0%
Firearms Training (FT)	5							
Florence	5	100.0%	85.7%	100.0%	83.3%	200.0%	100.0%	68.2%
Florence Special	5				125.0%	100.0%		
Fort Meade	5	100.0%	51.8%	100.0%	100.0%	100.0%	100.0%	100.0%
Fort Meade - Met One	6				100.0%	92.9%		
Francis Elementary School	5				96.5%	100.0%	100.0%	70.6%
Freemansburg	5		87.5%	100.0%	100.0%	80.0%	100.0%	100.0%
Fresno - First Street	5	99.2%	98.9%	98.3%	95.0%	94.3%	79.8%	90.2%
G.T. Craig	5	91.6%	99.6%	100.0%	100.0%	100.0%	100.0%	87.2%
G.T. Craig - Collocated	6	93.0%	100.0%	93.5%	100.0%	100.0%	100.0%	100.0%
Galveston Airport	5	82.6%	92.9%	81.2%	99.6%	86.7%	91.7%	62.3%
Garden St.	5	90.0%	99.6%	100.0%	74.7%	93.6%	91.7%	100.0%
Garinger High School	5	100.0%	100.0%	88.2%	100.0%	100.0%	100.0%	100.0%
General Hospital	5	100.0%	100.0%	100.0%	84.9%	84.7%	69.8%	96.9%
Georgetown	5	99.8%	100.0%	100.0%				
Georgetown (Andersen)	6			100.0%	100.0%	100.0%	100.0%	100.0%
Grand Rapids	5			100.0%	100.0%	81.9%	100.0%	100.0%
Grant School Site	5	100.0%	99.6%	99.6%	100.0%			
Greensburg	5	100.0%	100.0%	100.0%	100.0%	200.0%	100.0%	87.2%

Table 28. (Continued)

LOCATION NAME	POC	28	29	30	31	32	33	34
Greensburg Special	5				150.0%	100.0%		
Grenada	5	100.0%	99.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Guaynabo	5	64.8%		92.2%	95.3%	92.4%	99.3%	99.3%
Guiding Hands School	5	100.0%	98.4%	99.6%	99.7%	99.7%	100.0%	100.0%
Gulfport	5	100.0%	92.9%	93.2%	82.7%	100.0%	99.9%	91.7%
Guthrie	5	92.3%	92.5%	100.0%	100.0%	83.3%	85.3%	100.0%
Hamshire	5	100.0%	94.4%	99.9%	93.3%	92.9%	99.6%	100.0%
Harrisburg	5		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Hattie Avenue	5	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Hattiesburg	5	100.0%	100.0%	100.0%	100.0%	100.0%	85.7%	100.0%
Hawthorne	5	99.4%	94.0%	100.0%	73.6%	99.3%	100.0%	100.0%
Haynes Pt.	2	100.0%	100.0%	94.2%	92.3%	100.0%	100.0%	93.6%
Hazard - Perry County Horse Park	5	100.0%	85.7%	100.0%	100.0%	100.0%	99.0%	100.0%
Hazelwood	5		100.0%	83.3%	100.0%	200.0%	100.0%	100.0%
Hazelwood Special	5				150.0%	100.0%		
Head Start	5	84.6%	100.0%	86.2%	100.0%	100.0%	100.0%	100.0%
Hendersonville	5	100.0%	71.4%		100.0%	100.0%	83.3%	98.7%
Hickory	5	87.2%	75.0%	33.3%	83.3%	98.4%	99.7%	100.0%
Hinton	5	99.9%	99.5%	99.5%	99.4%	92.9%	100.0%	100.0%
Houghton Lake	5	99.4%	91.7%	100.0%	100.0%	90.9%	91.7%	55.6%
HRM 3#	5							
IS 52	5	100.0%	89.3%	92.9%	100.0%	100.0%	100.0%	100.0%
Jackson Hinds Co.	5	85.7%	100.0%	100.0%	100.0%	100.0%	85.7%	100.0%
Jefferson Elementary (10th and Vine)	5	100.0%	94.1%	100.0%	100.0%	100.0%	100.0%	100.0%
Jenkins RD RTP Site	0				50.0%	84.8%	100.0%	100.0%
JFK Center	5	100.0%	100.0%	99.6%	90.9%	100.0%	100.0%	91.9%
Karnack	5	96.2%	94.4%	86.9%	81.3%	79.4%	93.3%	83.1%
Kaufman	5		98.4%	99.1%	99.9%	100.0%	100.0%	100.0%
Kelo	5	80.0%	87.5%	100.0%	100.0%	100.0%	100.0%	100.0%
Kingsport	5	83.3%	100.0%	100.0%	100.0%	100.0%	83.3%	100.0%
Lake Forest Park	6	99.1%	90.4%	100.0%	87.2%	100.0%	100.0%	100.0%
Lancaster	5		100.0%	100.0%	85.9%	100.0%	83.3%	98.7%
Laurel	5	100.0%	100.0%	71.4%	40.1%	100.0%	100.0%	100.0%
Lawrence County	5	100.0%	79.1%	100.0%	83.3%	60.0%	100.0%	66.7%
Lawrenceville	6	100.0%	100.0%	92.9%	100.0%	100.0%	100.0%	100.0%
Lawrenceville Special	6				250.0%	120.0%		
Lenoir Community College	5	100.0%	87.5%	100.0%	83.3%	100.0%	100.0%	100.0%
Lewis	5	100.0%	92.3%	100.0%	100.0%	100.0%	99.3%	100.0%
Lexington Health Department	5	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Liberty	5	100.0%	99.4%	94.5%	81.8%	72.7%	99.5%	99.5%
Lindon	5	80.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Lockeland School	5	100.0%	100.0%	83.3%	100.0%	100.0%	99.0%	100.0%
London-Laurel County	5	100.0%	100.0%	99.1%	99.7%	100.0%	100.0%	100.0%
Lorain	5	60.0%	89.1%	74.5%	100.0%	60.0%	98.2%	98.1%
LPH	5					100.0%	100.0%	100.0%
Luna Pier	5		98.4%	100.0%	99.5%	100.0%	100.0%	100.0%
Macon	5	33.3%			100.0%	100.0%	87.2%	83.3%
Mae Drive	5	100.0%	100.0%	59.4%	64.4%	100.0%	100.0%	90.0%

Table 28. (Continued)

LOCATION NAME	POC	28	29	30	31	32	33	34
Manchester	5	100.0%	100.0%	100.0%	87.2%	84.7%	100.0%	100.0%
Manitowoc, Woodland Dunes site	5	100.0%	100.0%	100.0%	87.2%	100.0%	100.0%	100.0%
Maple Canyon	6	100.0%	100.0%	98.7%	100.0%	100.0%	100.0%	100.0%
Maple Leaf	6	100.0%	89.1%	100.0%	100.0%	100.0%	100.0%	100.0%
Mauriceville	5	92.6%	88.8%	100.0%	100.0%	94.0%	100.0%	100.0%
Mayville Hubbard Township site	5	100.0%	93.5%	100.0%	100.0%	100.0%	100.0%	100.0%
McDonald Observatory	5		100.0%	72.8%	89.7%	90.9%	83.1%	100.0%
McMillan Reservoir	5	83.5%	100.0%	100.0%	99.4%	93.0%	100.0%	100.0%
Mendenhall	5	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Mesa County Health Department	5	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Middletown	5	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Midlothian Tower	5		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Millbrook	5	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	87.2%
Mille Lacs	5						100.0%	100.0%
Mingo	5	98.6%	91.3%	86.9%	98.6%	75.0%	100.0%	100.0%
Missoula County Health Dept.	5		100.0%	100.0%	92.3%	75.0%	99.9%	100.0%
MLK	5	100.0%	100.0%	100.0%	100.0%	100.0%	87.2%	100.0%
MN - Rochester	5	83.3%	100.0%	98.9%	84.9%	100.0%	99.2%	61.7%
MO Supersite Alton	5	86.1%	90.9%	100.0%	100.0%	100.0%	83.3%	100.0%
MOMS	5	100.0%	90.4%	100.0%	83.3%	100.0%	100.0%	100.0%
Nampa NNC	5	100.0%	100.0%	100.0%	100.0%	93.6%	98.7%	100.0%
New Baltimore SuperSite	5	96.2%	100.0%	92.3%	93.3%	100.0%	100.0%	91.7%
New Brunswick	5	90.9%	92.9%	92.9%	74.4%	100.0%	100.0%	94.1%
New Brunswick (Collocated)	6	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	98.7%
New Garden	5		100.0%	100.0%	83.3%	100.0%	71.4%	98.4%
NLR Parr	5	100.0%	83.7%	100.0%	96.6%	80.0%	83.3%	100.0%
North Birmingham	5	100.0%	100.0%	99.6%	100.0%	100.0%	100.0%	100.0%
North Los Angeles	5			100.0%	100.0%	100.0%	100.0%	100.0%
Northbrook	5							92.2%
NY Botanical Gardens	6	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	93.6%
OCUSA Campus	5	70.6%	87.1%	100.0%	100.0%	100.0%	100.0%	100.0%
Osborn	5	98.4%	84.7%					
Owensboro - KY Wesleyan College	5	89.1%	75.0%	100.0%	100.0%	100.0%	100.0%	73.4%
Paducah Middle School	5	100.0%	100.0%	85.7%	84.9%	100.0%	100.0%	100.0%
Pearl City	5						100.0%	
Peoria Site 1127	5	100.0%	99.6%	87.6%	100.0%	100.0%	93.1%	100.0%
PerkinstownCASNET	5	99.4%	100.0%	100.0%	90.9%	97.8%	90.9%	100.0%
Perry County	5		76.2%	81.0%	100.0%	84.7%	100.0%	78.6%
PHILA - AMS Laboratory	7	100.0%	89.1%	92.9%	100.0%	100.0%	91.0%	100.0%
Philips	5	99.5%	100.0%	100.0%	100.0%	100.0%	84.6%	100.0%
Phoenix Supersite	7	90.0%	100.0%	100.0%	100.0%	99.3%	100.0%	91.1%
Pinnacle State Park	5	90.9%	100.0%	94.5%	100.0%	100.0%	100.0%	92.4%
Platteville	5	100.0%	88.7%	87.2%	100.0%	100.0%	83.3%	61.7%
Pleasant Green (Central MO)	5							100.0%
Portland - SE Lafayette	6	100.0%	100.0%	92.9%	80.9%	100.0%	100.0%	99.0%
Portland N. Roselawn	6							100.0%
Portsmouth	5	91.5%	95.2%	94.1%	100.0%	100.0%	93.0%	86.1%
Providence	5	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 28. (Continued)

LOCATION NAME	POC	28	29	30	31	32	33	34
Queens College	6	99.3%	93.7%	92.3%	80.8%	92.4%	83.3%	90.0%
RBD	5	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Reno	5	93.2%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Riverside-Rubidoux	5	100.0%	100.0%	100.0%	100.0%	99.6%	100.0%	93.2%
Riverside-Rubidoux (Collocated)	6	100.0%	100.0%	93.0%	100.0%	100.0%	100.0%	100.0%
Roanoke	5	100.0%	100.0%	100.0%	84.9%	100.0%	100.0%	100.0%
Rochester Fire Headquarters	5	99.4%	99.4%	94.5%	80.0%	91.7%	91.9%	99.5%
Rome	5	78.1%	69.2%	99.1%	100.0%	48.4%	84.9%	100.0%
Roxbury (Boston)	5	91.5%	100.0%	100.0%	100.0%	76.9%	100.0%	100.0%
Roxbury (Boston) - collocated	6	93.0%	87.6%	98.9%	82.7%	81.5%	89.6%	88.8%
Sacramento - Del Paso Manor	5	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
San Jose - Fourth Street	5	100.0%	100.0%	93.8%				
Sault Ste Marie	5	100.0%	100.0%	100.0%	66.7%	100.0%	100.0%	100.0%
Savannah	5	95.0%	94.6%	83.7%	96.9%	97.5%	99.0%	99.0%
Scranton	5		89.1%	100.0%	83.3%	60.0%	100.0%	100.0%
Searcy	5	100.0%	100.0%	99.0%	69.8%	60.0%	100.0%	100.0%
Seney NWR	5	94.7%	97.1%	94.2%	99.4%	100.0%	95.7%	92.4%
SER-DNR Headquarters	5	90.9%	94.0%	85.7%	100.0%	100.0%	100.0%	100.0%
Shenandoah High School	5	100.0%	100.0%	100.0%	100.0%	100.0%	66.7%	83.3%
Sherwood Is. St. Pk.	5		100.0%	100.0%	90.9%	100.0%	91.7%	100.0%
Simi Valley	5	100.0%	100.0%	100.0%	100.0%	80.0%	100.0%	100.0%
South DeKalb	5	100.0%	100.0%	93.0%	81.8%	100.0%	99.9%	99.6%
Southfield	5	100.0%	80.0%					
Southwick Community Center	5	90.4%	66.7%	71.4%	100.0%	98.8%	100.0%	100.0%
Spring Hill Elementary School	5				83.4%	98.8%	100.0%	100.0%
Springfield Pumping Station	5	100.0%	100.0%	100.0%	97.7%	84.7%	100.0%	100.0%
St Theo	6	100.0%	100.0%	100.0%	100.0%	97.2%	100.0%	100.0%
St. Paul Harding	5	88.7%	100.0%	85.7%	87.2%	100.0%	100.0%	100.0%
State College	5		100.0%	100.0%	100.0%	100.0%	83.3%	100.0%
Sun Metro	5	100.0%	100.0%	99.4%	100.0%	100.0%	100.0%	92.3%
Taft	5	99.7%						
Tallahassee Community College	5	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Taylors Fire Station	5	100.0%	100.0%	71.4%	100.0%	100.0%	100.0%	100.0%
Toledo Airport	5	88.7%	100.0%	100.0%	100.0%	100.0%	87.2%	100.0%
TRNP - NU	5	100.0%	100.0%	100.0%	99.5%	100.0%	100.0%	100.0%
Urban League	5				100.0%	100.0%	100.0%	100.0%
UTC	5	100.0%	100.0%	87.9%	100.0%	100.0%	100.0%	100.0%
Washington Park	5	100.0%	100.0%	100.0%	100.0%	100.0%	99.3%	93.0%
Waukesha, Cleveland Ave. Site	5	98.7%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Whiteface	5	100.0%	93.3%	99.4%	100.0%	100.0%	100.0%	100.0%
Wilbur Wright Middle School	5	87.1%	100.0%	100.0%	100.0%	100.0%	87.2%	83.3%
William Owen Elem. School	5	84.9%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Woolworth St	5	83.1%	85.8%	92.3%	86.5%	97.7%	97.7%	89.8%
Wylam	5	99.0%	100.0%	100.0%	100.0%	100.0%	98.7%	100.0%
York	5		88.2%	94.6%	100.0%	100.0%	83.9%	87.2%