



# Clean Air Status and Trends Network

## Fourth Quarter 2022 Quality Assurance Report

### Summary of Quarterly Operations (October through December) with 2022 Annual Summary

EPA Contract No. 68HERH21D0006

#### Introduction

This quarterly report summarizes results from the Clean Air Status and Trends Network (CASTNET) quality assurance/quality control (QA/QC) program for data collected during fourth quarter 2022. It also provides an annual summary that includes data from the three previous quarters. The various QA/QC criteria and policies are documented in the CASTNET Quality Assurance Project Plan (QAPP; Wood, 2021; 2022). The QAPP is comprehensive and includes standards and policies for all components of project operation from site selection through final data reporting. It is reviewed annually and updated as warranted.

#### Significant Events for 2022

During first quarter 2022, the QA Manager reviewed the metrics for the annual site operator performance assessment for 2021 activities. These metrics are evaluated to determine where additional training is needed. For 2021, problems with site operations were not related to training issues. Problems mainly stemmed from issues related to shipping, weather, and COVID-19.

A Level 2 traveling transfer used for ozone performance evaluation audits and reverification of ozone Level 3 standards during the March 2022 site calibration visits had a solenoid balance failure causing the reverification of seven Level 3 transfer standards to be declared invalid. Wood restored the slope-intercept values for these Level 3 transfers and calibration factors for site analyzers back to their pre-audit values following confirmation of the solenoid balance test failure. Solenoid balance failures can be difficult to diagnose. Wood's CASTNET QA Manager began investigating the situation. In particular, the QA Manager evaluated the root cause of the continued use of the Level 2 ozone transfer after consecutive sites required adjustment. Wood's field laboratory runs a solenoid balance test prior to sending a transfer out for use in the field. While solenoid failures are hard to predict and detect, Wood does have procedures in place that should have prevented use of the transfer at multiple sites. Under Corrective Action (CA) 0115, the subcontractor field technician received follow-up training. Additionally, under CA\_0115, if one of the affected March sites was near a site scheduled for a routine calibration trip, Wood traveled to the March site to verify that the ozone analyzer and transfer were within criteria. For sites that did not receive a follow-up site visit, the site operator replaced the ozone transfer with a verified instrument shipped from the Gainesville field laboratory.

Documentation needed for the annual review by the American Association for Laboratory Accreditation (A2LA) in order to maintain International Organization for Standardization (ISO)/International Electrotechnical Commission (IEC) 17025:2017 accreditation for Wood's scope of laboratory and field operations methods was prepared and submitted to A2LA during second quarter 2022. The documentation was subsequently accepted by A2LA, and Wood received notice that the 17025:2017 accreditation was reaffirmed until the routine A2LA onsite assessment in spring 2023.

During mid-May 2022, Wood relocated its office, laboratories, and outdoor test site from the Newberry, FL location to its new location in Gainesville, FL. All documentation required by the A2LA to continue ISO/IEC accreditation after the move was completed and submitted to A2LA. Relocation activities included moving the analytical and field equipment laboratories separately. Perkin Elmer was hired to move select analytical instruments, and personnel from the field and laboratory groups moved smaller instruments and fragile items. Laboratory personnel moved samples in temperature-controlled coolers from the old cold room to the new cold room once the temperature in the new cold room had stabilized. A professional moving company handled the office furniture. The shelters and towers were moved by another company and were set up on the test site pad at the new office location. Operation of each of the instruments was verified prior to first use at the new location.

The annual management review report and presentation in support of ISO/IEC 17025:2017 accreditation was completed during third quarter 2022. The report included details of the move to the new location and procedures to verify operation of the analytical and equipment laboratories. The report was distributed to reviewers, and the presentation took place on July 29, 2022. The presentation was well received by the CASTNET management team, CASTNET QA Supervisor, and Wood's regional corporate management and QA representatives.

Wood continued to evaluate the cause of the positively biased converter efficiency results for NO<sub>y</sub> found by EEMS during the performance evaluation audit of the PND165, WY site in May 2022. During the routine calibration visit to the PND165, WY site on August 22–25, 2022, Wood's field technician performed troubleshooting for the high conversion efficiency (found to be ~113 percent on average). The ozone generator inside the NO/NO<sub>y</sub> analyzer was replaced. After replacement, the ozone generator flow was verified, and converter efficiency was found to be reasonable at 98 percent. Wood is investigating the effect on reported NO<sub>y</sub> data. If appropriate, a correction factor for the affected data will be determined and proposed to EPA. Data for NO are not affected.

The CASTNET QAPP Revision 9.5 was approved by EPA on September 6, 2022.

The acquisition of Wood Environment & Infrastructure Solutions, Inc. (Wood) by WSP was completed on September 21, 2022. The new company name is WSP USA Environment and Infrastructure, Inc. However, "Wood" will continue to be used until finalization of the name change has been completed across all licensing and state regulatory entities.

Wood proposed a change in key personnel from Anne Glubis to Kimberly Holland-Chominsky as the CASTNET QA Supervisor. EPA approved the change on September 23, 2022.

EPA noted an error in one of the data tables. The `das_flow_dateoff` field in the `filter_pack` table is manually entered from the Site Status Report Form and is no longer verified by double entry since it is not used to generate reported sample measurements. During third quarter, Wood incorporated screening of manually entered fields to flag out-of-range values to prevent recurrence.

Wood submitted the draft of the CASTNET QAPP Revision 10.0 to EPA on November 1, 2022.

EPA requested Wood's CASTNET QA Manager provide additional audits of polyfluorinated alkyl substances (PFAS) data quality for archived cloud water samples and for precipitation sample PFAS data collected as part of the National Atmospheric Deposition Program (NADP) PFAS Wet Deposition Pilot Study from September 2021 through January 2022. The QA Manager requested the data from NADP and completed the data audits during fourth quarter 2022. He used the EPA Office of Research and Development PFAS QAPP and NADP Central Analytical Laboratory standard operating procedures in addition to PFAS laboratory data reports, chains-of-custody, and other reports during the audits.

Wood's acceptance testing of batches of nylon filters from MTL began showing a co-eluting peak with bromide in the chromatogram. Bromide is not an analyte of interest for CASTNET but is used by the laboratory as a surrogate to indicate issues with sample extraction or the injection of samples during instrument analyses. The co-eluting peak cannot be identified with available resources. Wood tested additional batches of nylon filters and noticed the co-eluting peak can be correlated to certain MTL filter washing dates. Wood has contacted MTL for additional information. MTL will replace the filters at no cost if this is a problem resulting from their washing procedures. Wood has surplus filters so there will be no disruption of sampling while Wood and MTL work to resolve this issue.

### **Quarterly/Annual Summary**

Table 1 lists the quarters of data that were validated to Level 3 during 2022 by site calibration group. Table 2 lists the sites in each calibration group along with the calibration schedule. Table 3 presents the measurement criteria for continuous field measurements. These criteria apply to the instrument challenges performed during site calibrations. Table 4 presents the measurement criteria for laboratory filter pack measurements. These criteria apply to the QC samples listed in the following section of this report. Table 5 presents the critical criteria for ozone monitoring. Table 6 presents the critical criteria for trace-level gas monitoring.

### **Laboratory Intercomparison Results Summary**

Wood's CASTNET laboratory regularly participates in the Environment and Climate Change Canada (ECCC) Proficiency Testing (PT) Program for Inorganic Environmental Substances. The results reported by the participating laboratories are evaluated for systematic bias and precision. Systematic bias is assessed using the Youden (1969) non-parametric analysis, while precision is calculated using algorithm A from the ISO standard 13528 (ISO, 2005). Laboratory results are considered systematically biased when individual parameters are ranked by the Youden analysis to be consistently and significantly higher or lower than the assigned value without regard to flagged results. The CASTNET laboratory's proficiency testing plan requires action for individual test results that are greater than three standard deviations from the assigned value, bias 5 percent or higher for a single parameter, three or more biased results of any magnitude in a single study, or a consecutive study result indicating bias of any magnitude for a given parameter.

During January 2022, Wood received results for sample analyses for PT study 118 for Rain and Soft Waters submitted to the Environmental Science and Technology Laboratories Division, a branch of the Water Science and Technology Directorate with ECCC that provides QA services. Analyses of all parameters were rated as "very good" for PT study 118 (ECCC, 2022a).

Wood generally participates in two ECCC PT studies each year. However, as a result of delays and shortages caused by the COVID-19 pandemic during 2021, PT study 118 was delayed. PT study 119, originally scheduled for the summer of 2021, was delayed until winter of 2021. ECCC decided to not run the PT 119 summer study off schedule. The study number 119 was retired in order to preserve the naming convention.

During September 2022, Wood received results from sample analyses for PT study 120 for Rain and Soft Waters. The results showed no indication of systemic bias and no warnings or flags. The laboratory's performance was rated as "Good." Wood's 5-year average was also rated as "good" (ECCC, 2022b).

During 2022, the USGS resumed sending interlaboratory comparison samples for analysis to Wood on a monthly basis. During 2021, USGS was sending samples only every other month.

### **Quality Control Analysis Count**

The QC sample statistics presented in this report are for reference standards (RF) and continuing calibration verification spikes (CCV) used to assess accuracy and for replicate sample analyses (RP) used to assess "in-run" precision. In addition, laboratory method blanks (MB) containing reagents without a filter; laboratory blanks (LB) containing reagents and a new, unexposed filter; and field blanks (FB) containing reagents and an unexposed filter that was loaded into a filter pack assembly and shipped to and from the monitoring site while remaining in sealed packaging are also included. Tables 7 through 10 present the number of analyses in each category that were performed during each quarter of 2022.

### **Sample Receipt Statistics**

Ninety-five percent of field samples from EPA-sponsored sites must be received by the CASTNET laboratory in Gainesville, FL no later than 14 days after removal from the sampling tower. Table 11 presents the relevant sample receipt statistics for each of the four quarters of 2022 together with an annual summary for each category. Shipping labels for CASTNET filter packs being returned to Wood through the U.S. Postal Service (USPS) were transitioned to priority mail during April 2022. Each label provides Wood with a unique tracking number for each filter pack. Comparison of first quarter 2022 filter pack receipt statistics with second through fourth quarter 2022 shows that Wood's receipt of filter packs was significantly improved by the change to custom shipping labels and use of priority mail for return delivery.

### **Data Quality Indicator (DQI) Results**

Figures 1 through 3 present the results of RF, CCV, and RP QC sample analyses for fourth quarter 2022. All results were within the criteria listed in Table 4. Table 12 presents the percent recoveries and standard deviations for RF, CCV, and RP QC sample analyses for 2022. Quarterly averages are all within criteria.

Table 13 presents quarterly co-located filter pack precision results for data validated to Level 3 during the year. Results for ROM406/206, CO were within the criterion for all 11 parameters reported for all four quarters. With the exception of potassium and chloride during first quarter 2021, results for

MCK131/231, KY met the 20 percent MARPD criterion. The average concentration values for these two analytes at MCK131/231 during first quarter 2021 were less than or equal to five times the reporting limit and passed the  $\pm$  reporting limit criterion.

Figure 4 presents completeness statistics for continuous measurements validated to Level 3 during the year. All parameters met the 90 percent criterion.

Table 14 presents summary statistics of critical criteria measurements at ozone sites collected during fourth quarter 2022. The statistics presented contain data validated at Level 2 and Level 3. All data associated with QC checks that failed to meet the criteria listed in Table 5 were or will be invalidated unless the cause of failure has no effect on ambient data collection, and passing results still meet frequency criteria. Results in shaded cells either exceed documented criteria or are otherwise notable. Table 15 presents observations associated with the shaded cell results in Table 14.

Table 16 presents summary statistics of critical criteria measurements at trace-level gas monitoring sites collected during fourth quarter 2022. The statistics presented contain data validated at Level 2 and Level 3. All data associated with QC checks that failed to meet the criteria listed in Table 6 were or will be invalidated unless the cause of failure has no effect on ambient data collection, and passing results still meet frequency criteria. Results in shaded cells either exceed documented criteria or are otherwise notable. Table 17 presents observations associated with the shaded cell results in Table 16.

### Laboratory Control Sample Analysis

The laboratory control sample (LCS) is a reagent blank spiked with the target analytes from the established analytical methods and carried through the same extraction process that field samples must undergo. LCS analyses are performed by the laboratory to monitor for potential sample handling artifacts and provide a means to identify possible analyte loss from extraction to extraction. Figure 5 presents LCS analysis results for fourth quarter 2022. All recovery values were between 88.4 percent and 105.2 percent.

### Blank Results

Figures 6 through 8 present the results of MB, LB, and FB QC sample analyses for fourth quarter 2022. All fourth quarter results were within criteria (two times the reporting limit) listed in Table 4. Table 18 summarizes the record of filter blanks for 2022. All 2022 results were within criteria listed in Table 4 with the exception of one Teflon  $\text{NH}_4^+$  FB and one Teflon  $\text{K}^+$  FB that occurred during first quarter and one nylon  $\text{HNO}_3$  LB during third quarter. All other blank QC checks in their respective batches were within criteria and associated sample concentrations were reasonable.

### Suspect/Invalid Filter Pack Samples

Filter pack samples that were flagged as suspect or invalid during each of the four quarters of 2022 are listed in Table 19. This table also includes associated site identification and a brief description of the reason the sample was flagged. During fourth quarter, seven filter pack samples were invalidated.

## Field Problem Count

Table 20 presents counts of field problems affecting continuous data collection for more than one day for each quarter during 2022. The problem counts are sorted by a 30-, 60-, or 90-day time period to resolution. A category for unresolved problems is also included.

## Field Calibration Results

A summary of field calibration failures by parameter for each quarter of 2022 is listed in Table 21. Calibrations were performed at 20 sites during fourth quarter 2022. During 2022, all sites and parameters were within the criteria listed in Table 3 with the exception of the parameters at the eight sites that are listed in Table 21.

Table 22 presents field accuracy results for 2022 based on instrument challenges performed using independent reference standards during site calibration visits. Each parameter was within its criterion with at least 90 percent frequency. Per CASTNET project protocols, data are flagged but still considered valid if the calibration criterion is not exceeded by more than its magnitude (i.e., if within two times the criterion). All calibration failures reported in 2022 for the indicated parameters were within two times the criterion with the exception of temperature and delta temperature at OXF122, OH in September 2022 and flow rate at SUM156, FL in August 2022. Data associated with the failures at OXF122 and SUM156 were invalidated.

## References

- American Society for Testing and Materials (ASTM). 2008. ASTM E29-08, “Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications.” ASTM International, West Conshohocken, PA, DOI:10.1520/E0029-08. [www.astm.org](http://www.astm.org).
- Environment and Climate Change Canada (ECCC). 2022a. Rain and Soft Waters PT Study 0118 Report. Environmental Science and Technology Laboratories Division, Water Science and Technology Directorate Proficiency Testing Program, Burlington, Ontario, Canada. Prepared for Wood Environment & Infrastructure Solutions, Inc., Newberry FL, USA.
- Environment and Climate Change Canada (ECCC). 2022b. Rain and Soft Waters PT Study 0120 Report. Environmental Science and Technology Laboratories Division, Water Science and Technology Directorate Proficiency Testing Program, Burlington, Ontario, Canada. Prepared for Wood Environment & Infrastructure Solutions, Inc., Gainesville, FL, USA.
- International Organization for Standardization (ISO). 2005. *Statistical Methods for the Use in Proficiency Testing by Interlaboratory Comparisons, Annex C, Robust Analysis, Section C.1: Algorithm A*. Standard 13528. ISO 13528:2005(E).
- U.S. Environmental Protection Agency (EPA). 2020. Title 40 *Code of Federal Regulations* Part 58, “Appendix A to Part 58 – Quality Assurance Requirements for Monitors used in Evaluations of National Ambient Air Quality Standards.”

Wood Environment & Infrastructure Solutions, Inc. (Wood) 2022. *Clean Air Status and Trends Network (CASTNET) Quality Assurance Project Plan (QAPP) Revision 9.5*. Prepared for U.S. Environmental Protection Agency (EPA), Office of Air and Radiation, Clean Air Markets Division, Washington, DC. Contract No. EP-W-16-015. Gainesville, FL.  
<https://java.epa.gov/castnet/documents.do>.

Wood Environment & Infrastructure Solutions, Inc. (Wood) 2021. *Clean Air Status and Trends Network (CASTNET) Quality Assurance Project Plan (QAPP) Revision 9.4*. Prepared for U.S. Environmental Protection Agency (EPA), Office of Air and Radiation, Clean Air Markets Division, Washington, DC. Contract No. EP-W-16-015. Gainesville, FL.  
<https://java.epa.gov/castnet/documents.do>.

Youden, W.J. (Ku, H.H., ed). 1969. *Precision Measurement and Calibration*. NBS Special Publication 300-Volume 1. U.S. Government Printing Office, Washington, DC.

**Table 1** Data Validated to Level 3 through Fourth Quarter 2022

Calibration Group*	Months Available	Number of Months	Complete Quarters	Number of Quarters
SE-4/MW-6 <sup>†</sup>	July 2021 – June 2022	12	Quarter 3 2021 – Quarter 2 2022	4
E-1/SE-5	August 2021 – July 2022	12	Quarter 4 2021 – Quarter 2 2022	3
MW-7/W-9	September 2021 – August 2022	12	Quarter 4 2021 – Quarter 2 2022	3
E-2/MW-8	October 2021 – September 2022	12	Quarter 4 2021 – Quarter 3 2022	4
E-3/W-10 <sup>‡</sup>	May 2021 – April 2022	12	Quarter 3 2021 – Quarter 1 2022	3

**Notes:** \*The sites contained in each calibration group are listed in Table 2.

<sup>†</sup>Contains MCK131/231 co-located pair

<sup>‡</sup>Contains ROM206 of the ROM406/ROM206 co-located pair

**Table 2** Field Calibration Schedule for 2022

Calibration Group	Months Calibrated	Sites Calibrated
<b>Eastern Sites (22 Total)</b>		
E-1 (8 Sites)	February/August	BEL116, MD WSP144, NJ ARE128, PA PED108, VA BWR139, MD CTH110, NY PSU106, PA VPI120, VA
E-2 (9 Sites)	April/October	ABT147, CT WST109, NH HWF187, NY <sup>1</sup> WFM105, NY UND002, VT ASH135, ME CAT175, NY NIC001, NY EGB181, ON
E-3 (5 Sites)	May/November	KEF112, PA LRL117, PA CDR119, WV MKG113, PA PAR107, WV
<b>Southeastern Sites (11 Total)</b>		
SE-4 (6 Sites)	January/July	SND152, AL BFT142, NC COW137, NC GAS153, GA CND125, NC SPD111, TN
SE-5 (5 Sites)	February/August	CAD150, AR SUM156, FL DUK008, NC <sup>3</sup> IRL141, FL CVL151, MS
<b>Midwestern Sites (19 Total)</b>		
MW-6 (6 Sites)	January/July	CDZ171, KY MCK131, KY PNF126, NC <sup>1</sup> CKT136, KY MCK231, KY ESP127, TN
MW-7 (9 Sites)	March/September	ALH157, IL STK138, IL RED004, MN OXF122, OH PRK134, WI BVL130, IL <sup>2</sup> VIN140, IN DCP114, OH QAK172, OH
MW-8 (4 Sites)	April/October	SAL133, IN ANA115, MI HOX148, MI UVL124, MI
<b>Western Sites (12 Total)</b>		
W-9 (5 Sites)	March/September	KNZ184, KS CHE185, OK ALC188, TX KIC003, KS SAN189, NE
W-10 (7 Sites)	May/November	GTH161, CO NPT006, ID UMA009, WA PND165, WY <sup>3</sup> ROM206, CO <sup>3</sup> PAL190, TX CNT169, WY

**Notes:** <sup>1</sup>Trace-level gas calibrations are performed quarterly in January, April, July, and October.

<sup>2</sup>Trace-level gas calibrations are performed quarterly in March, June, September, and December.

<sup>3</sup>Trace-level gas calibrations are performed quarterly in February, May, August, and November.



**Table 3** Data Quality Indicators for CASTNET Continuous Measurements

Measurement		Criteria <sup>1</sup>	
Parameter <sup>2</sup>	Method	Precision	Accuracy
Filter pack flow	Mass flow controller	± 10%	± 5%
Ozone <sup>3</sup>	UV absorbance	All points within ± 2% of full scale of best fit straight line Linearity error < 5%	
Wind speed	Anemometer	± 0.5 m/s	The greater of ± 0.5 m/s for winds < 5 m/s or ± 5% for winds ≥ 5 m/s
Wind direction	Wind vane	± 5°	± 5°
Sigma theta	Wind vane	Undefined	Undefined
Ambient temperature	Platinum RTD	± 1.0°C	± 0.5°C
Delta temperature	Platinum RTD	± 0.5°C	± 0.5°C
Relative humidity	Thin film capacitor	± 10% (of full scale)	± 10%
Precipitation	Tipping bucket rain gauge	± 10% (of reading)	± 0.05 inch <sup>4</sup>
Solar radiation	Pyranometer	± 10% (of reading taken at local noon)	± 10%
Surface wetness	Conductivity bridge	Undefined	Undefined

**Notes:** °C = degrees Celsius  
m/s = meters per second  
RTD = resistance-temperature device  
UV = ultraviolet

<sup>1</sup>Precision criteria apply to co-located instruments, and accuracy criteria apply to calibration of instruments. Co-located precision criteria do not apply to CASTNET sites that are configured and operated in accordance with Part 58 of Title 40 of the *Code of Federal Regulations* (EPA, 2020)

<sup>2</sup>Meteorological parameters are only measured at five of the EPA-sponsored CASTNET sites: IRL141, FL; BVL130, IL; BEL116, MD; CHE185, OK; and PND165, WY.

<sup>3</sup>Ozone is not measured at eight EPA-sponsored CASTNET sites: KIC003, KS; KNZ184, KS; RED004, MN; EGB181, ON; CAT175, NY; NIC001, NY; WFM105, NY; and UND002, VT.

<sup>4</sup>For target value of 0.50 inch

**Table 4** Data Quality Indicators for CASTNET Laboratory Measurements

Analyte	Method	Precision <sup>1</sup> (MARPD)	Accuracy <sup>2</sup> (%)	Nominal Reporting Limits	
				mg/L	µg/Filter
Ammonium (NH <sub>4</sub> <sup>+</sup> )	AC	20	90–110	0.020*	0.5
Sodium (Na <sup>+</sup> )	ICP-OES	20	95–105	0.005	0.125
Potassium (K <sup>+</sup> )	ICP-OES	20	95–105	0.006	0.15
Magnesium (Mg <sup>2+</sup> )	ICP-OES	20	95–105	0.003	0.075
Calcium (Ca <sup>2+</sup> )	ICP-OES	20	95–105	0.006	0.15
Chloride (Cl <sup>-</sup> )	IC	20	95–105	0.020	0.5
Nitrate (NO <sub>3</sub> <sup>-</sup> )	IC	20	95–105	0.008*	0.2
Sulfate (SO <sub>4</sub> <sup>2-</sup> )	IC	20	95–105	0.040	1.0

**Notes:** <sup>1</sup>This column lists precision goals for both network precision calculated from co-located filter samples and laboratory precision based on replicate samples for samples > five times the reporting limit. The criterion is ± the reporting limit if the sample is ≤ five times the reporting limit.

<sup>2</sup>This column lists laboratory accuracy goals based on reference standards and continuing calibration verification spikes. The criterion is 90–110 percent for ICP-OES reference standards.

<sup>3</sup>The reporting limit for sulfate on cellulose filters is 0.080 mg/L (2.0 µg/filter).

AC = automated colorimetry

IC = ion chromatography

ICP-OES = inductively coupled plasma-optical emission spectrometry

MARPD = mean absolute relative percent difference

mg/L = milligrams per liter

µg/Filter = micrograms per filter

\* = as nitrogen

Values are rounded according to American Society for Testing and Materials (ASTM) E29-08, “Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications” (ASTM, 2008).

For more information on analytical methods and associated precision and accuracy criteria, see the CASTNET QAPP, (Wood, 2021; 2022).

**Table 5** Ozone Critical Criteria\*

Type of Check	Analyzer Response
Zero	Less than ± 3.1 parts per billion (ppb)
Span	Less than ± 7.1 percent between supplied and observed concentrations
Single Point QC	Less than ± 7.1 percent between supplied and observed concentrations

**Notes:** \*Applies to CASTNET sites that are configured and operated in accordance with Part 58 of Title 40 of the *Code of Federal Regulations* (EPA, 2020). The minimum frequency for these checks is once every two weeks.

Values are rounded according to ASTM E29-08, “Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications” (ASTM, 2008).

**Table 6** Trace-level Gas Monitoring Critical Criteria\*

Parameter	Analyzer Response	
	Zero Check	Span Check / Single Point QC Check
SO <sub>2</sub>	Less than ± 1.51 ppb	Less than ± 10.1 percent between supplied and observed concentrations
NO <sub>y</sub>	Less than ± 1.51 ppb	
CO	Less than ± 30.1 ppb	

**Notes:** \*Applies to CASTNET sites that are configured and operated in accordance with Part 58 of Title 40 of the *Code of Federal Regulations* (EPA, 2020). The minimum frequency for these checks is once every two weeks.

Values are rounded according to ASTM E29-08, "Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications" (ASTM, 2008).

SO<sub>2</sub> = sulfur dioxide

NO<sub>y</sub> = total reactive oxides of nitrogen

CO = carbon monoxide

ppb = parts per billion

**Table 7** QC Analysis Count for First Quarter 2022

Filter Type	Parameter	RF Sample Count	CCV Sample Count	RP Sample Count	MB Sample Count	LB Sample Count	FB Sample Count
Teflon	SO <sub>4</sub> <sup>2-</sup>	74	211	87	19	24	106
	NO <sub>3</sub> <sup>-</sup>	74	211	87	19	24	106
	NH <sub>4</sub> <sup>+</sup>	38	175	87	19	24	106
	Cl <sup>-</sup>	74	211	87	19	24	106
	Ca <sup>2+</sup>	38	190	86	19	24	106
	Mg <sup>2+</sup>	38	190	86	19	24	106
	Na <sup>+</sup>	38	190	86	19	24	106
	K <sup>+</sup>	38	190	86	19	24	106
Nylon	SO <sub>4</sub> <sup>2-</sup>	45	184	79	14	24	130
	NO <sub>3</sub> <sup>-</sup>	45	184	79	14	24	130
Cellulose	SO <sub>4</sub> <sup>2-</sup>	51	184	85	17	26	136

**Table 8** QC Analysis Count for Second Quarter 2022

Filter Type	Parameter	RF Sample Count	CCV Sample Count	RP Sample Count	MB Sample Count	LB Sample Count	FB Sample Count
Teflon	SO <sub>4</sub> <sup>2-</sup>	59	163	66	14	22	48
	NO <sub>3</sub> <sup>-</sup>	59	163	66	14	22	48
	NH <sub>4</sub> <sup>+</sup>	28	144	66	14	22	48
	Cl <sup>-</sup>	59	163	66	14	22	48
	Ca <sup>2+</sup>	30	147	66	14	22	48
	Mg <sup>2+</sup>	30	147	66	14	22	48
	Na <sup>+</sup>	30	147	66	14	22	48
	K <sup>+</sup>	30	147	66	14	22	48
Nylon	SO <sub>4</sub> <sup>2-</sup>	35	154	73	11	24	49
	NO <sub>3</sub> <sup>-</sup>	35	154	73	11	24	49
Cellulose	SO <sub>4</sub> <sup>2-</sup>	41	151	69	14	24	49

**Table 9** QC Analysis Count for Third Quarter 2022

Filter Type	Parameter	RF Sample Count	CCV Sample Count	RP Sample Count	MB Sample Count	LB Sample Count	FB Sample Count
Teflon	SO <sub>4</sub> <sup>2-</sup>	64	177	77	16	22	71
	NO <sub>3</sub> <sup>-</sup>	64	177	77	16	22	71
	NH <sub>4</sub> <sup>+</sup>	32	161	77	16	22	71
	Cl <sup>-</sup>	64	177	77	16	22	71
	Ca <sup>2+</sup>	38	171	83	18	24	78
	Mg <sup>2+</sup>	38	171	83	18	24	78
	Na <sup>+</sup>	38	171	83	18	24	78
	K <sup>+</sup>	38	171	83	18	24	78
Nylon	SO <sub>4</sub> <sup>2-</sup>	29	140	68	10	22	39
	NO <sub>3</sub> <sup>-</sup>	29	140	68	10	22	39
Cellulose	SO <sub>4</sub> <sup>2-</sup>	46	159	69	14	22	77

**Table 10** QC Analysis Count for Fourth Quarter 2022

Filter Type	Parameter	RF Sample Count	CCV Sample Count	RP Sample Count	MB Sample Count	LB Sample Count	FB Sample Count
Teflon	SO <sub>4</sub> <sup>2-</sup>	56	157	66	14	22	44
	NO <sub>3</sub> <sup>-</sup>	56	157	66	14	22	44
	NH <sub>4</sub> <sup>+</sup>	28	143	66	14	22	44
	Cl <sup>-</sup>	56	157	66	14	22	44
	Ca <sup>2+</sup>	28	146	66	14	22	44
	Mg <sup>2+</sup>	28	146	66	14	22	44
	Na <sup>+</sup>	28	146	66	14	22	44
	K <sup>+</sup>	28	146	66	14	22	44
Nylon	SO <sub>4</sub> <sup>2-</sup>	35	146	72	11	26	47
	NO <sub>3</sub> <sup>-</sup>	35	146	72	11	26	47
Cellulose	SO <sub>4</sub> <sup>2-</sup>	46	158	72	14	26	84

**Table 11** Filter Pack Receipt Summary for 2022

Description	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Annual Summary
Count of samples received more than 14 days after removal from tower:	92	22	14	16	144
Count of all samples received:	697	762	671	655	2785
Fraction of samples received within 14 days:	0.868	0.971	0.979	0.976	0.948
Average interval in days:	9.175	5.963	4.169	4.881	6.047*
First receipt date:	01/03/2022	04/01/2022	07/01/2022	10/01/2022	01/03/2022
Last receipt date:	03/23/2022	06/30/2022	09/15/2022	12/31/2022	12/31/2022

**Note:** Sample shipments for the Egbert, Ontario site (EGB181) are in groups of four. Samples associated with EGB181 are excluded from this statistic.

\*annual average

**Table 12** Filter Pack QC Summary for 2022

Filter Type	Parameter	Reference Sample <sup>1</sup> Recovery (%R)			Continuing Calibration Verification Samples (%R)			In-Run Replicate <sup>2</sup> (RPD)		
		Mean	Std. Dev.	Count <sup>3</sup>	Mean	Std. Dev.	Count <sup>3</sup>	Mean	Std. Dev.	Count <sup>3</sup>
Teflon	SO <sub>4</sub> <sup>2-</sup>	102.18	0.99	265	101.12	1.59	740	1.06	0.88	310
	NO <sub>3</sub> <sup>-</sup>	100.51	1.00	265	99.67	0.83	740	1.33	1.39	310
	NH <sub>4</sub> <sup>+</sup>	100.11	1.51	132	100.06	1.26	652	0.70	0.73	310
	Ca <sup>2+</sup>	102.22	2.93	138	101.02	1.04	673	2.42	3.99	310
	Mg <sup>2+</sup>	97.20	1.50	138	99.90	0.93	673	2.19	2.22	310
	Na <sup>+</sup>	94.08	1.90	138	99.92	0.85	673	1.37	1.64	310
	K <sup>+</sup>	94.89	1.38	138	99.90	0.75	673	2.54	2.85	310
	Cl <sup>-</sup>	99.94	1.10	265	102.12	1.33	740	1.79	2.09	310
Nylon	SO <sub>4</sub> <sup>2-</sup>	102.21	1.40	151	100.99	1.47	648	5.95	4.74	303
	NO <sub>3</sub> <sup>-</sup>	100.35	1.35	151	100.98	1.28	648	2.58	2.61	303
Cellulose	SO <sub>4</sub> <sup>2-</sup>	101.75	1.08	184	100.87	1.49	652	1.45	1.59	295

**Notes:** % R = percent recovery  
RPD = relative percent difference

<sup>1</sup>Results of reference sample analyses provide accuracy estimates

<sup>2</sup>Results of replicate analyses provide precision estimates

<sup>3</sup>Number of QC Samples

**Table 13** Precision Results for Third Quarter 2021 through Second Quarter 2022

Quarter	SO <sub>4</sub> <sup>2-</sup>	NO <sub>3</sub> <sup>-</sup>	NH <sub>4</sub> <sup>+</sup>	Ca <sup>2+</sup>	Mg <sup>2+</sup>	Na <sup>+</sup>	K <sup>+</sup>	Cl <sup>-</sup>	HNO <sub>3</sub>	SO <sub>2</sub>	Total NO <sub>3</sub> <sup>-</sup>
MCK131/231, KY											
2021 Q3	1.57	4.76	1.88	3.76	4.77	8.72	3.79	1.75	3.27	4.94	2.86
2021 Q4	5.03	11.08	4.85	10.90	12.19	10.09	9.77	15.21	7.03	11.41	6.94
2022 Q1	4.48	3.59	5.07	6.17	8.93	10.88	20.73	26.30	4.00	3.66	3.30
2022 Q2	1.34	5.05	1.95	4.78	5.44	2.99	6.40	2.00	2.89	6.57	3.19
Average	3.10	6.12	3.44	6.40	7.83	8.17	10.17	11.32	4.30	6.64	4.07
ROM406/206, CO											
2021 Q3	2.30	8.03	3.35	4.05	5.83	5.71	7.98	7.63	6.81	6.43	5.81
2021 Q4	4.11	12.02	5.56	8.32	11.06	9.46	16.82	9.51	7.36	13.08	7.03
2022 Q1	9.23	14.42	17.42	18.71	18.07	10.28	18.75	6.33	11.12	12.46	10.69
2022 Q2	3.99	9.79	8.01	6.75	13.04	3.34	18.54	3.34	11.62	10.24	5.74
Average	4.91	11.06	8.59	9.46	12.00	7.20	15.52	6.70	9.23	10.55	7.32

**Note:** During first quarter 2022, the MARPD values met the 20 percent criterion except for K<sup>+</sup> and Cl<sup>-</sup> for MCK131/231. The average concentration values were ≤ 5 times the reporting limit and passed the ± reporting limit criterion.

**Table 14** Ozone QC Summary for Fourth Quarter 2022 (1 of 2)

Site ID	% Span Pass <sup>1</sup>	Span  %D  <sup>2</sup>	% Single Point QC Pass <sup>1</sup>	Single Point QC  %D  <sup>2</sup>	% Zero Pass <sup>1</sup>	Zero Average (ppb) <sup>2</sup>
ABT147, CT	100.00	2.33	100.00	2.25	100.00	0.19
ALC188, TX	62.93	49.75	62.93	110.10	87.83	97.36
ALH157, IL	100.00	0.77	100.00	0.77	100.00	0.18
ANA115, MI	100.00	1.70	100.00	1.22	100.00	0.15
ARE128, PA	100.00	0.41	100.00	0.60	100.00	0.29
ASH135, ME	N/A	N/A	N/A	N/A	N/A	N/A
BEL116, MD	100.00	0.64	100.00	0.68	100.00	0.49
BFT142, NC	100.00	3.26	100.00	3.71	100.00	0.20
BVL130, IL	100.00	1.90	97.89	2.11	100.00	0.71
BWR139, MD	100.00	1.40	100.00	1.64	100.00	0.47
CAD150, AR	100.00	1.84	100.00	2.48	100.00	0.35
CDR119, WV	N/A	N/A	N/A	N/A	N/A	N/A
CDZ171, KY	N/A	N/A	N/A	N/A	N/A	N/A
CKT136, KY	100.00	0.47	100.00	0.66	100.00	0.10
CND125, NC	100.00	2.06	100.00	3.02	100.00	0.88
CNT169, WY	100.00	0.67	100.00	1.10	100.00	0.30
COW137, NC	100.00	0.60	100.00	1.21	100.00	0.45
CTH110, NY	100.00	0.84	100.00	1.07	100.00	0.17
CVL151, MS	100.00	0.62	100.00	1.02	100.00	0.21
DCP114, OH	N/A	N/A	N/A	N/A	N/A	N/A
ESP127, TN	98.95	2.49	98.95	1.84	100.00	0.34
GAS153, GA	100.00	0.76	100.00	1.49	100.00	0.45
GTH161, CO	100.00	0.54	100.00	0.58	100.00	0.16
HOX148, MI	100.00	0.84	100.00	0.87	100.00	0.18
HWF187, NY	N/A	N/A	N/A	N/A	N/A	N/A
IRL141, FL	98.91	1.66	98.91	1.67	100.00	0.27
KEF112, PA	100.00	0.92	100.00	0.62	100.00	0.53
LRL117, PA	100.00	0.99	100.00	0.74	100.00	0.34
MCK131, KY	98.94	0.72	100.00	0.71	100.00	0.17
MCK231, KY	100.00	0.72	100.00	0.66	100.00	0.20
MKG113, PA	100.00	0.60	100.00	0.75	100.00	0.28
NPT006, ID	88.78	6.60	88.78	5.23	88.78	0.87
OXF122, OH	100.00	0.94	100.00	0.83	100.00	0.22
PAL190, TX	100.00	1.15	100.00	1.04	100.00	0.18
PAR107, WV	100.00	0.71	100.00	0.87	100.00	0.22
PED108, VA	97.70	2.73	97.70	2.04	97.70	0.87

**Table 14** Ozone QC Summary for Fourth Quarter 2022 (2 of 2)

Site ID	% Span Pass <sup>1</sup>	Span  %D  <sup>2</sup>	% Single Point QC Pass <sup>1</sup>	Single Point QC  %D  <sup>2</sup>	% Zero Pass <sup>1</sup>	Zero Average (ppb) <sup>2</sup>
PND165, WY	100.00	0.72	100.00	1.15	100.00	0.30
PNF126, NC	N/A	N/A	N/A	N/A	N/A	N/A
PRK134, WI	100.00	1.08	100.00	0.91	100.00	0.12
PSU106, PA	100.00	0.45	100.00	0.99	100.00	0.21
QAK172, OH	100.00	1.73	100.00	2.02	98.98	0.45
ROM206, CO	85.85	1352.10	86.54	11.57	96.15	1.47
SAL133, IN	100.00	0.68	100.00	0.53	100.00	0.23
SAN189, NE	100.00	1.34	98.92	1.96	100.00	0.89
SND152, AL	100.00	2.61	100.00	2.96	100.00	0.27
SPD111, TN	100.00	1.06	100.00	1.60	100.00	0.22
STK138, IL	100.00	0.71	100.00	0.91	100.00	0.32
SUM156, FL	98.92	1.73	100.00	0.54	100.00	0.18
UMA009, WA	100.00	0.60	98.95	0.64	100.00	0.43
UVL124, MI	100.00	1.88	100.00	1.04	100.00	0.50
VIN140, IN	100.00	0.38	100.00	0.58	100.00	0.11
VPI120, VA	100.00	0.58	98.96	0.83	97.92	0.28
WSP144, NJ	100.00	0.90	100.00	1.05	100.00	0.20
WST109, NH	N/A	N/A	N/A	N/A	N/A	N/A

**Notes:** <sup>1</sup>Percentage of comparisons that pass the criteria listed in Table 5. Values falling below 90 percent are addressed in Table 15.

<sup>2</sup>Absolute value of the average percent differences between the on-site transfer standard and the site monitor. Values exceeding the criteria listed in Table 5 are addressed in Table 15.

%D = percent difference

ppb = parts per billion

**Table 15** Ozone QC Observations for Fourth Quarter 2022

Site ID	QC Criterion	Comments
ALC188, TX	% Span Pass Span  %D  % Single Point QC Pass Single Point QC  %D  % Zero Pass Zero Average	Several sampling system issues had to be addressed following maintenance and replacement of the analyzer in late October. Associated data were invalidated.
NPT006, ID	% Span Pass % Single Point QC Pass % Zero Pass	Failures resulted from sampling system issues in late October. Associated data were invalidated.
ROM206, CO	% Span Pass Span  %D  % Single Point QC Pass Single Point QC  %D	Failures resulted from malfunctioning analyzer solenoid. Associated data were invalidated.

**Note:** %D = percent difference



**Table 16** Trace-level Gas QC Summary for Fourth Quarter 2022

Parameter	% Span Pass <sup>1</sup>	Span  %D  <sup>2</sup>	% Single Point QC Pass <sup>1</sup>	Single Point QC  %D  <sup>2</sup>	% Zero Pass <sup>1</sup>	Zero Average (ppb) <sup>2</sup>
BVL130, IL						
SO <sub>2</sub>	100.00	1.75	100.00	1.73	100.00	0.34
NO <sub>y</sub>	88.24	6.23	64.71	13.20	64.15	1.73
CO	100.00	2.07	54.76	10.03	86.05	19.13
DUK008, NC						
NO <sub>y</sub>	92.16	5.57	92.16	6.06	100.00	0.18
HWF187, NY						
NO <sub>y</sub>	N/A	N/A	N/A	N/A	N/A	N/A
PND165, WY						
NO <sub>y</sub>	100.00	3.79	96.00	5.73	100.00	0.37
PNF126, NC						
NO <sub>y</sub>	N/A	N/A	N/A	N/A	N/A	N/A
ROM206, CO						
NO <sub>y</sub>	100.00	1.93	100.00	0.65	100.00	0.17

**Notes:** <sup>1</sup>Percentage of comparisons that pass the criteria listed in Table 6. Values falling below 90 percent are addressed in Table 17.

<sup>2</sup>Absolute value of the average percent differences between the supplied and observed concentrations. Values exceeding the criteria listed in Table 6 are addressed in Table 17.

%D = percent difference

ppb = parts per billion

**Table 17** Trace-level Gas QC Observations for Fourth Quarter 2022

Site ID	Parameter	QC Criterion	Comments
BVL130	NO <sub>y</sub>	% Span Pass % Single Point QC Pass Single Point QC  %D  % Zero Pass	The converter and ozone generator malfunctioned beginning in late October. Both were replaced by early December. Associated data were invalidated.
	CO	% Single Point QC Pass Single Point QC  %D  % Zero Pass	The CO system was subject to intermittent analyzer stability issues throughout the quarter.

**Note:** %D = percent difference

**Table 18** Summary of Filter Blanks for 2022 (1 of 2)

Parameter Name	Detection Limit Total $\mu\text{g}$	Total Number	Number > Detection Limit	Average Total $\mu\text{g}$	Average Absolute Deviation	Maximum Total $\mu\text{g}$
<b>FIELD BLANKS</b>						
Teflon- $\text{NH}_4^+\text{-N}$	0.500	322	1	0.503	0.006	1.525
Teflon- $\text{NO}_3^-\text{-N}$	0.200	322	0	0.200	0.000	0.200
Teflon- $\text{SO}_4^{2-}$	1.000	322	0	1.000	0.000	1.000
$\text{Cl}^-$	0.500	322	1	0.501	0.001	0.700
$\text{Ca}^{2+}$	0.150	322	3	0.151	0.001	0.258
$\text{Mg}^{2+}$	0.075	322	0	0.075	0.000	0.075
$\text{Na}^+$	0.125	322	0	0.125	0.000	0.125
$\text{K}^+$	0.150	322	4	0.152	0.003	0.415
Nylon- $\text{NO}_3^-\text{-N}$	0.200	346	2	0.200	0.001	0.295
Nylon - $\text{SO}_4^{2-}$	1.000	346	0	1.000	0.000	1.000
Cellulose - $\text{SO}_4^{2-}$	2.000	352	1	2.001	0.002	2.385
<b>LABORATORY BLANKS</b>						
Teflon- $\text{NH}_4^+\text{-N}$	0.500	102	0	0.500	0.000	0.500
Teflon- $\text{NO}_3^-\text{-N}$	0.200	102	0	0.200	0.000	0.200
Teflon- $\text{SO}_4^{2-}$	1.000	102	0	1.000	0.000	1.000
$\text{Cl}^-$	0.500	102	0	0.500	0.000	0.500
$\text{Ca}^{2+}$	0.150	102	1	0.150	0.000	0.155
$\text{Mg}^{2+}$	0.075	102	0	0.075	0.000	0.075
$\text{Na}^+$	0.125	102	0	0.125	0.000	0.125
$\text{K}^+$	0.150	102	0	0.150	0.000	0.150
Nylon- $\text{NO}_3^-\text{-N}$	0.200	102	2	0.204	0.008	0.475
Nylon - $\text{SO}_4^{2-}$	1.000	102	0	1.000	0.000	1.000
Cellulose - $\text{SO}_4^{2-}$	2.000	104	0	2.000	0.000	2.000

**Table 18** Summary of Filter Blanks for 2022 (2 of 2)

Parameter Name	Detection Limit Total $\mu\text{g}$	Total Number	Number > Detection Limit	Average Total $\mu\text{g}$	Average Absolute Deviation	Maximum Total $\mu\text{g}$
<b>METHOD BLANKS</b>						
Teflon-NH <sub>4</sub> <sup>+</sup> -N	0.500	66	0	0.500	0.000	0.500
Teflon- NO <sub>3</sub> <sup>-</sup> -N	0.200	66	0	0.200	0.000	0.200
Teflon- SO <sub>4</sub> <sup>2-</sup>	1.000	66	0	1.000	0.000	1.000
Cl <sup>-</sup>	0.500	66	0	0.500	0.000	0.500
Ca <sup>2+</sup>	0.150	67	0	0.150	0.000	0.150
Mg <sup>2+</sup>	0.075	67	0	0.075	0.000	0.075
Na <sup>+</sup>	0.125	67	0	0.125	0.000	0.125
K <sup>+</sup>	0.150	67	0	0.150	0.000	0.150
Nylon- NO <sub>3</sub> <sup>-</sup> -N	0.200	48	0	0.200	0.000	0.200
Nylon -SO <sub>4</sub> <sup>2-</sup>	1.000	48	0	1.000	0.000	1.000
Cellulose -SO <sub>4</sub> <sup>2-</sup>	2.000	59	0	2.000	0.000	2.000
<b>ACCEPTANCE TEST VALUES<sup>1</sup></b>						
Teflon-NH <sub>4</sub> <sup>+</sup> -N	0.500	216	0	0.500	0.000	0.500
Teflon- NO <sub>3</sub> <sup>-</sup> -N	0.200	216	0	0.200	0.000	0.200
Teflon- SO <sub>4</sub> <sup>2-</sup>	1.000	216	0	1.000	0.000	1.000
Cl <sup>-</sup>	0.500	216	0	0.500	0.000	0.500
Ca <sup>2+</sup>	0.150	216	0	0.150	0.000	0.150
Mg <sup>2+</sup>	0.075	216	0	0.075	0.000	0.075
Na <sup>+</sup>	0.125	216	0	0.125	0.000	0.125
K <sup>+</sup>	0.150	216	0	0.150	0.000	0.150
Nylon- NO <sub>3</sub> <sup>-</sup> -N	0.200	220	0	0.200	0.000	0.200
Nylon -SO <sub>4</sub> <sup>2-</sup>	1.000	220	0	1.000	0.000	1.000
Cellulose -SO <sub>4</sub> <sup>2-</sup>	2.000	252	0	2.000	0.000	2.000

**Note:** <sup>1</sup>Only filter batches passing QC requirements are used for sampling and analysis.

**Table 19** Filter Packs Flagged as Suspect or Invalid

Site ID	Sample	Reason
<b>First Quarter 2022</b>		
CDR119, WV	2201001-12 2203001-12	A polling issue caused missing data. Additionally, the data logger malfunctioned and was replaced on 1/25/2022.
NPT006, ID	2201004-04	Power failure
RED004, MN	2203004-05	Power failure
SHN418, VA	2201003-20	Power failure
STK138, IL	2204001-49	There was hole in the Teflon filter.
<b>Second Quarter 2022</b>		
ASH135, ME	2216001-05	Power failure
BUF603, WY	2218005-02	The flow channel was offline for three days.
CDR119, WV	2215001-12	A power failure caused the mass flow controller to not communicate with the data logger.
DEN417, AK	2216003-05	There was a leak in the flow system.
FOR605, WY	2217005-03	The flow pump malfunctioned.
JOT403, CA	2217003-12	Flow data were missing after the first four days of the sampling week.
MCK131, KY	2214001-32	A wet Teflon filter upon receipt indicated the filter pack was compromised.
MCK231, KY	2214001-33	A wet Teflon filter upon receipt indicated the filter pack was compromised.
NIC001, NY	2219001-35	Communications issue
ROM206, CO	2219001-45	Communications issue
<b>Third Quarter 2022</b>		
BEL116, MD	2228001-06	Power failure
LAV410, CA	2228003-13	Power failure
PED108, VA	2229001-39	Power failure followed by a mass flow controller malfunction
QAK172, OH	2229001-44	Valid hourly flow < 75%
STK138, IL	2227001-49	Valid hourly flow < 75%
<b>Fourth Quarter 2022</b>		
MKG113, PA	2241001-34 2243001-34	The mass flow controller malfunctioned in mid-October and was replaced on 11/1/2022
SUM156, FL	2240001-50	The mass flow controller malfunctioned in early October and was replaced on 10/18/2022
UVL124, MI	2240001-52 2241001-52 2242001-52 2243001-52	The mass flow controller malfunctioned in early October and was replaced on 11/1/2022

**Table 20** Field Problems Affecting Data Collection

Days to Resolution	Problem Count
First Quarter 2022	
30	242
60	6
90	0
Unresolved by End of Quarter	3
Second Quarter 2022	
30	245
60	18
90	2
Unresolved by End of Quarter	7
Third Quarter 2022	
30	314
60	9
90	1
Unresolved by End of Quarter	10
Fourth Quarter 2022	
30	205
60	15
90	3
Unresolved by Date of Publication	8

**Note:** Field problems affecting data quality during quarters 1 through 3 listed above are resolved as of this publication.

**Table 21** Field Calibration Failures by Parameter for 2022

Site ID	Parameter(s)	Quarter
BEL116, MD	Flow	Q3
CND125, NC	Flow	Q1
GAS153, GA	Flow	Q1
MKG113, PA	Flow	Q4
OXF122, OH	Temperature (zero, ambient)	Q3
RED004, MN	Flow	Q1, Q3
UVL124, MI	Flow	Q4
VPI120, VA	Flow	Q1

**Note:** °C = degrees Celsius

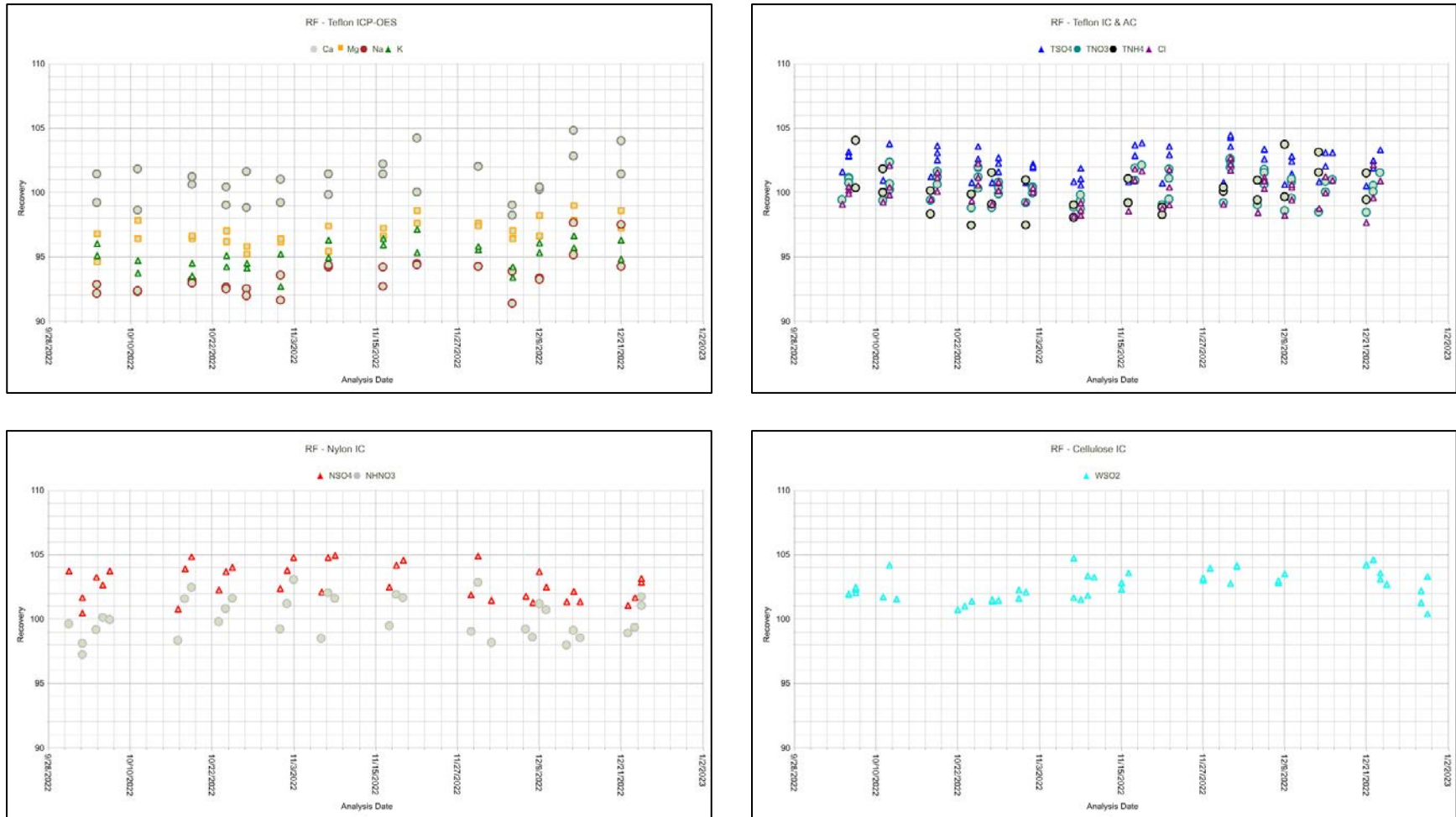
Per CASTNET project protocols, data for all parameters except flow are flagged as “suspect” (S) but still considered valid if the calibration criterion is not exceeded by more than its magnitude (i.e., if within two times the criterion). If flow calibrations fall within two times the criterion, these data are adjusted per approved protocol described in the CASTNET QAPP, (Wood, 2021; 2022). Please refer to Table 15 for documentation of the QC failures affecting the validity of ozone data.

**Table 22** Accuracy Results for 2022 Field Measurements

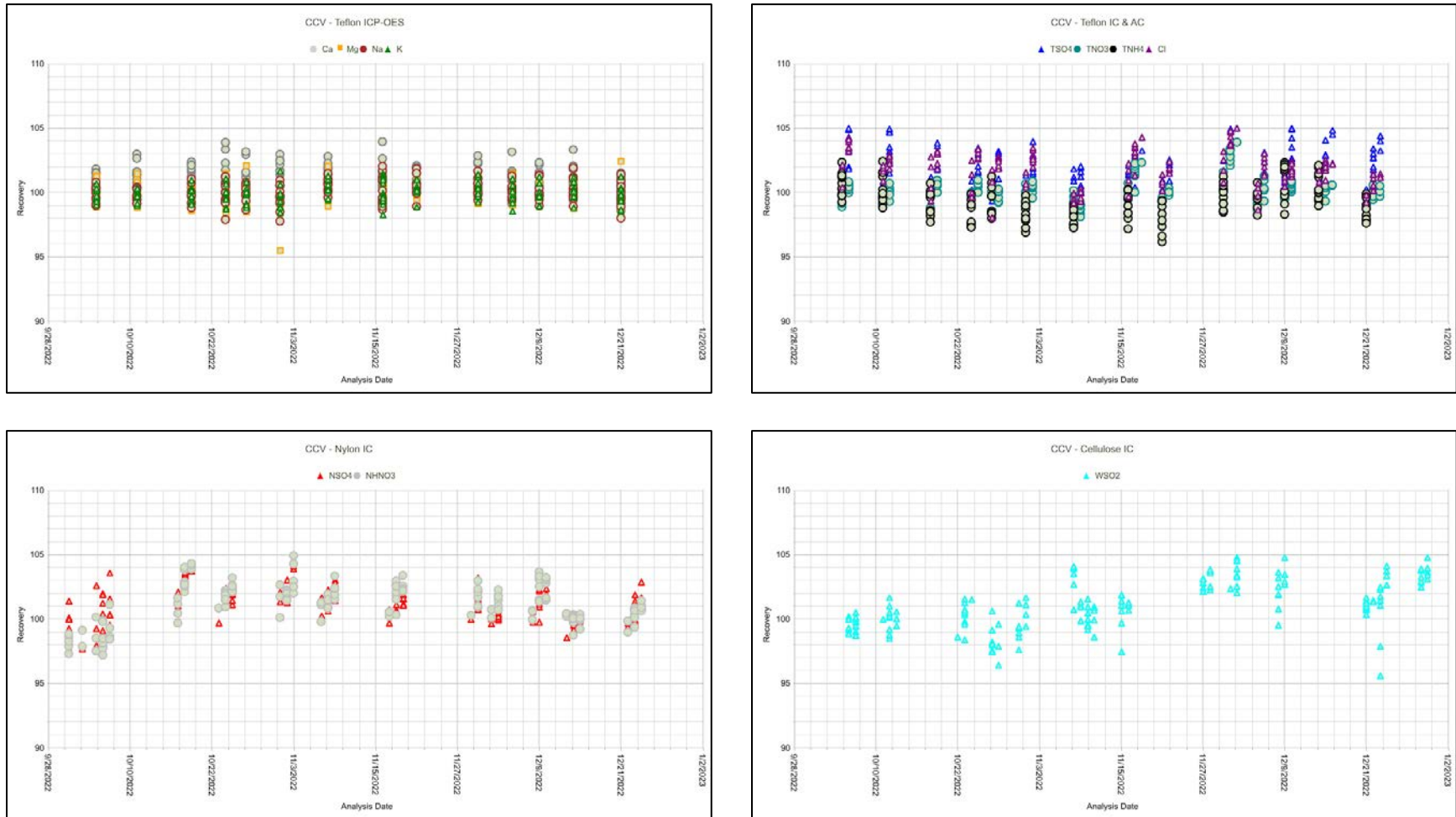
Parameter	Percent Within Criterion
Flow Rate	92.3
Wind Speed < 5 m/s	100.0
Wind Speed $\geq$ 5 m/s	100.0
Wind Direction North	100.0
Wind Direction South	100.0
Temperature (0°C)	100.0
Temperature (ambient)	97.5
Delta Temperature (0°C)	98.3
Delta Temperature (ambient)	100.0
Relative Humidity	100.0
Precipitation	100.0
Solar Radiation	100.0
Wetness (w/in 0.5 volts)	100.0

**Notes:** °C = degrees Celsius  
m/s = meters per second

**Figure 1** Reference Standard Results for Fourth Quarter 2022 (percent recovery)

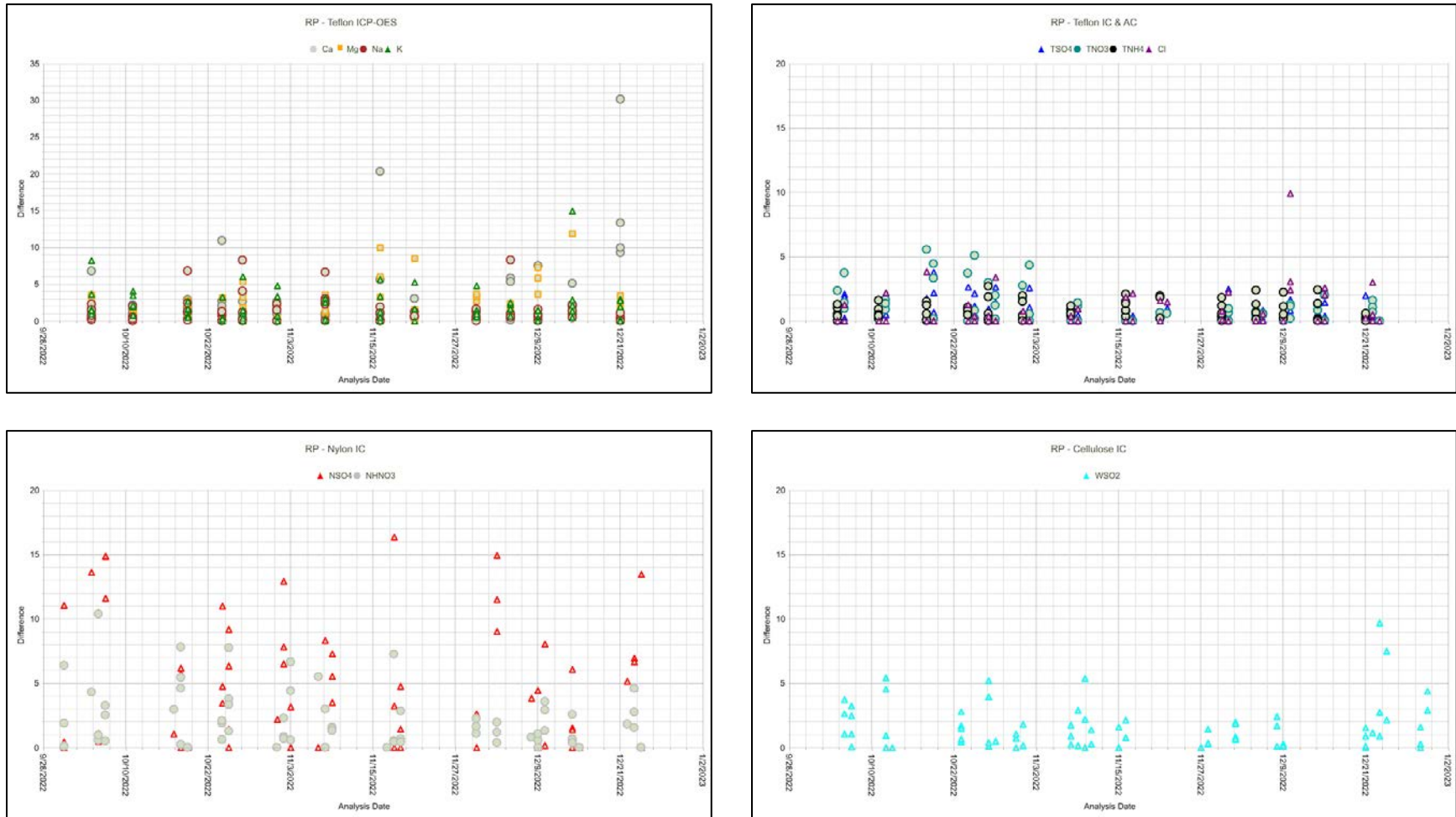


**Figure 2** Continuing Calibration Spike Results for Fourth Quarter 2022 (percent recovery)

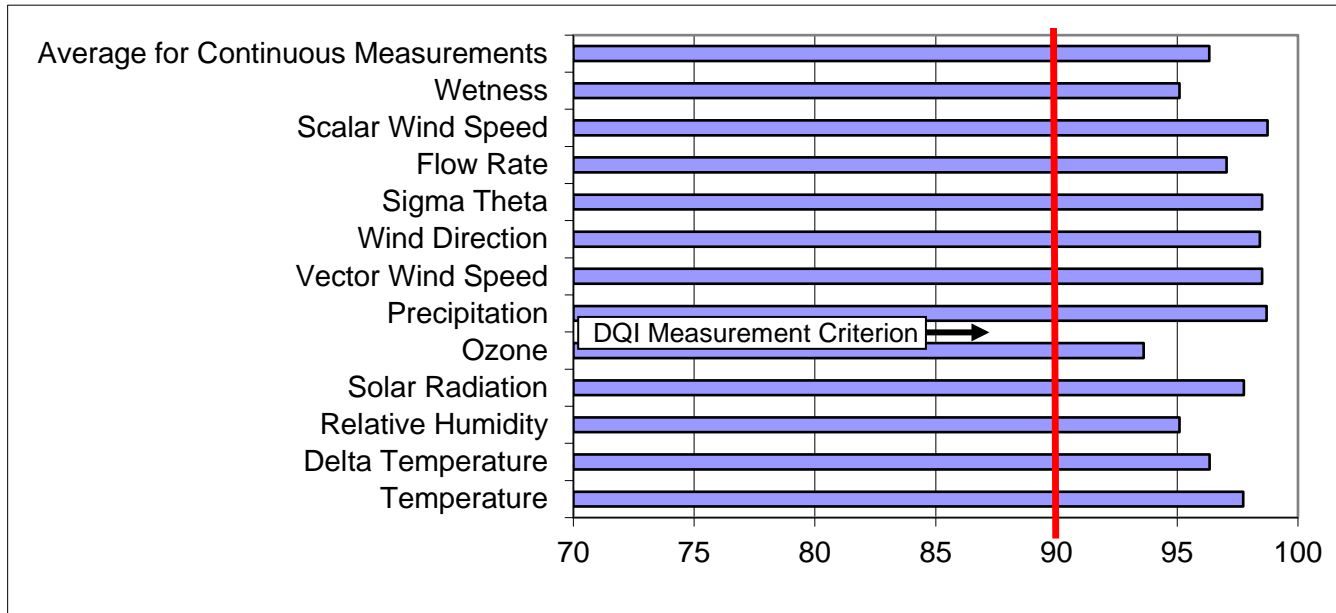




**Figure 3** Replicate Sample Analysis Results for Fourth Quarter 2022 (percent difference)

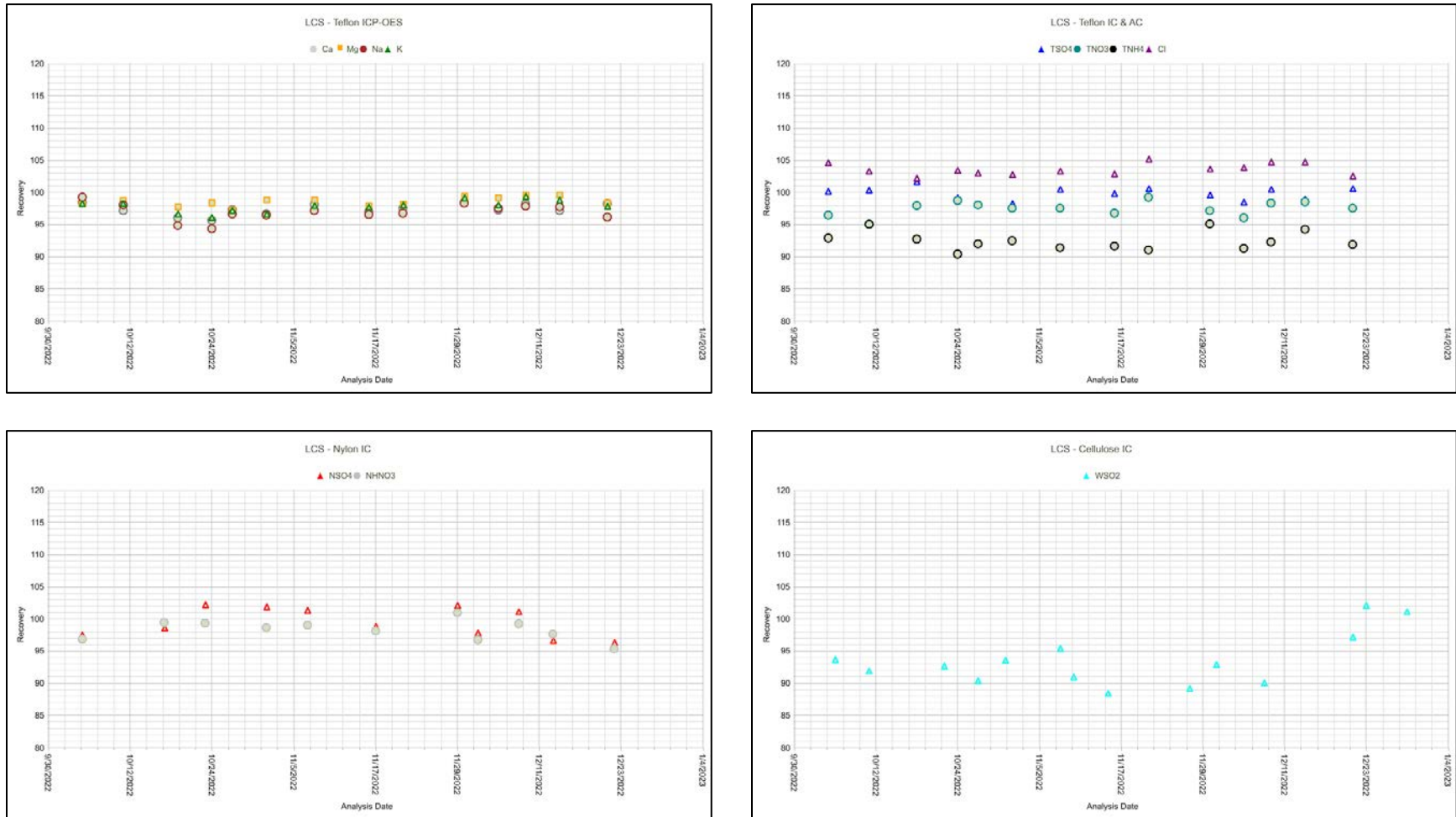


**Figure 4** Percent Completeness of Measurements for Second Quarter 2019 through Third Quarter 2022\*

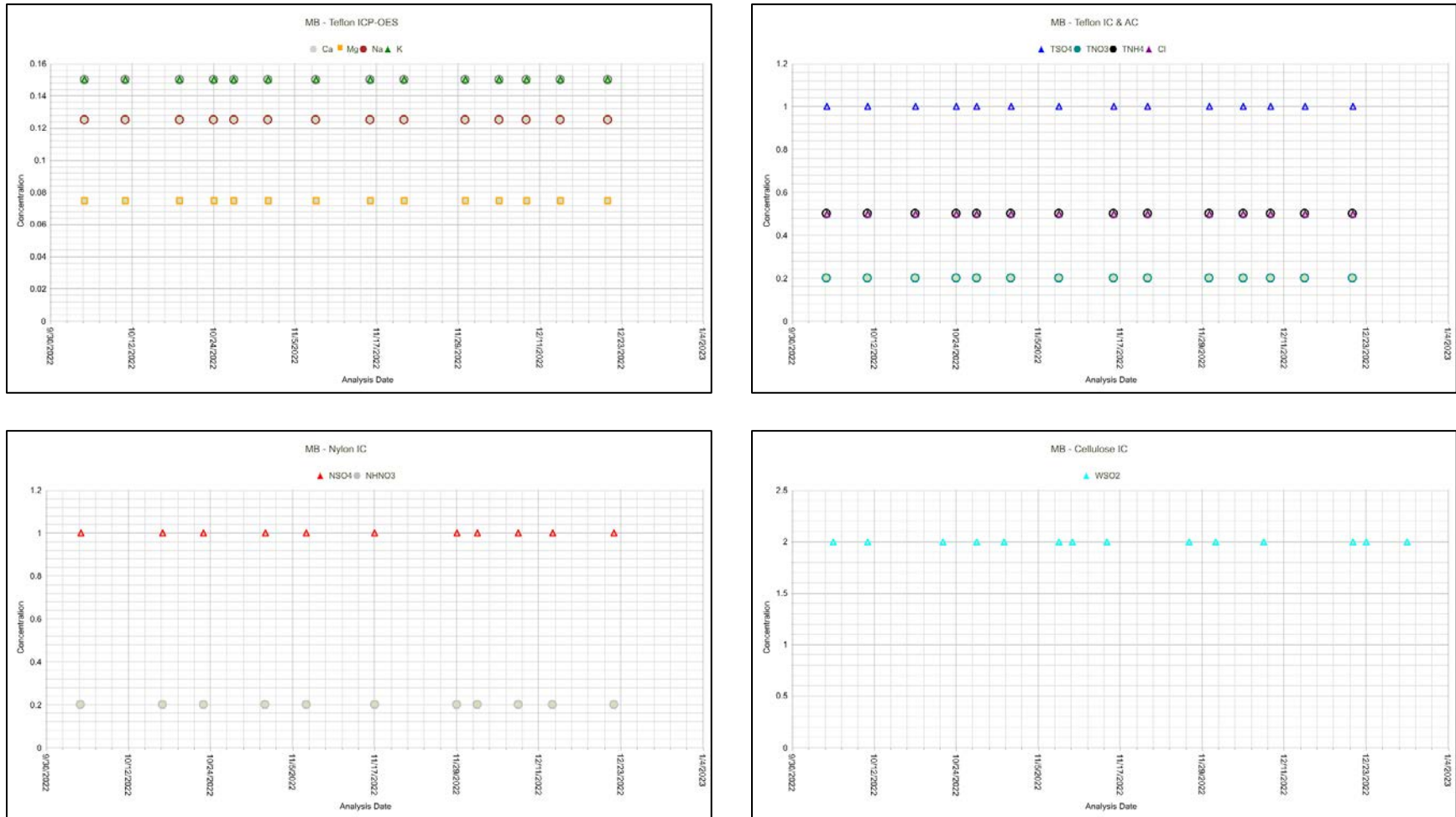


**Note:** \*Presents Level 3 data available during the fourth quarter of 2022

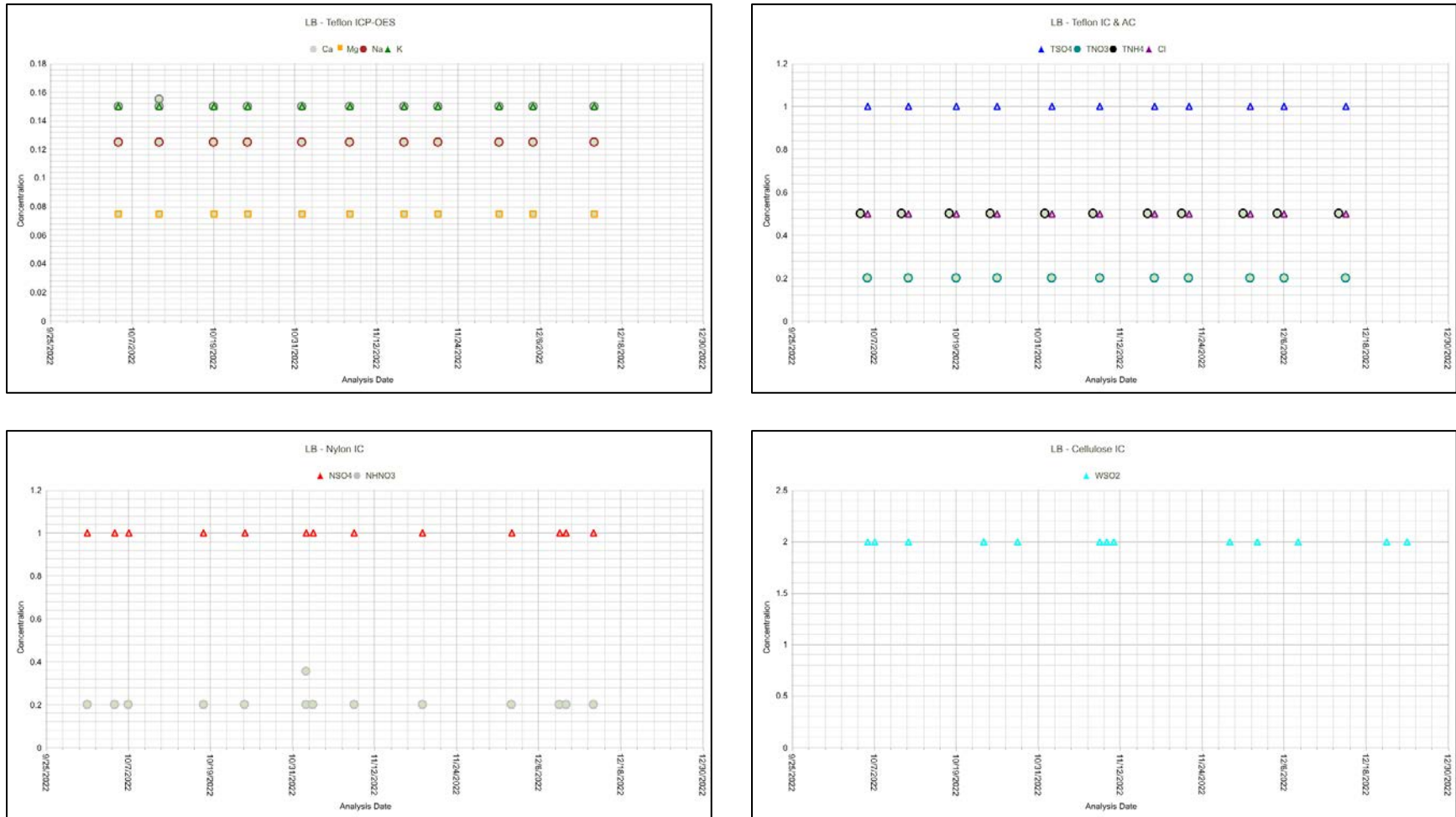
**Figure 5** Laboratory Control Sample Results for Fourth Quarter 2022 (percent recovery)



**Figure 6** Method Blank Analysis Results for Fourth Quarter 2022 (total micrograms)



**Figure 7** Laboratory Blank Analysis Results for Fourth Quarter 2022 (total micrograms)



**Figure 8** Field Blank Analysis Results for Fourth Quarter 2022 (total micrograms)

