

Fourth Quarter 2024 Quality Assurance Report

Summary of Quarterly Operations (October through December) with 2024 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 2024. 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; WSP USA Environment & Infastructure Inc. (WSP), 2024]. 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 2024

Corrective action 0126 (CA_0126) was initiated in first quarter 2024. Problem tickets have customarily been opened in the field problem ticketing system by field or data personnel pursuant to problems with equipment or continuous data collection. In this case, the site operator for the MKG113, PA site broke his foot in December 2023 and was unable to perform his site operator duties through first quarter 2024. This resulted in a significant loss of filter pack concentration data. Fortunately, ozone measurements continued without interruption throughout the quarter. Under CA_0126, a problem ticket will now be opened for any issue adversely affecting the collection of data, including issues that interrupt or compromise filter pack sampling.

Annual review documentation for 2024 was requested by the American Association for Laboratory Accreditation (A2LA) in support of continuation of International Organization for Standardization (ISO)/International Electrotechnical Commission (IEC) 17025:2017 accreditation of WSP's analytical and field laboratories. During first and second quarter 2024, the CASTNET QA Manager worked with the CASTNET Laboratory Operations Manager and CASTNET Field Operations Manager (FOM) to compile the necessary annual review documentation. The annual review documentation provided by WSP was accepted by the A2LA, and the A2LA reaffirmed WSP's ISO/IEC 17025:2017 accreditation until May 31, 2025.

WSP attended EPA's Office of Air Quality Planning and Standards (OAQPS) National Performance Audit Program (NPAP) training during the week of March 4, 2024. The training included a review of regulation changes and the new addition of Nafion dryers. Greg Noah (EPA) credited the work done by the WSP field technicians and CASTNET for the acceptance of Nafion in a regulatory ozone system.

The QA Manager incorporated updates and changes to the draft CASTNET QAPP Revision 10.1, along with comments and recommendations for changes from EPA's Office of Atmospheric Protection, and submitted it to EPA on April 5, 2024. Prior to finalizing, Revision 10.1 was updated with changes in transfer standard protocols as set forth in publication EPA-454/B-22-003, *Transfer Standards for Calibration of Air Monitoring Analyzers for Ozone*, a technical assistance document (TAD) revised by EPA's OAQPS in January 2023 and posted in November 2023 (EPA, 2023b). This

TAD identifies updated procedures to establish and maintain the traceability of ozone measurements within a monitoring network. Air agencies are required to implement these verification protocols by 2025. However, some air agencies are already using these protocols, so the protocols were incorporated in this revision of the CASTNET QAPP. WSP submitted the updated QAPP Revision 10.1 to EPA on June 27, 2024. The QAPP Revision 10.1 was approved by EPA and other CASTNET stakeholders and uploaded to EPA's CASTNET web page (https://www.epa.gov/castnet/documents-reports).

The QA Manager continued working with the EPA Region 3 QA Coordinator regarding the mini technical systems audit (TSA) of the PAR107, WV ozone system on August 21, 2023. During March 2024, the Region 3 QA Coordinator requested additional information for the TSA report. In particular, he asked for the residence time, how often residence time is tested, and the schedule of maintenance procedures such as tubing exchanges. The QA Manager provided the requested information.

During second quarter 2024, the QA Manager performed the annual supplier evaluation for 2023 activities. As per A2LA requirements, suppliers are audited for both the quality of the products provided and their adherence to scheduling. All suppliers met 2023 performance requirements. Of note, Measurement Technology Laboratories (MTL) replaced boxes of contaminated nylon filters with uncontaminated filters. The contaminated filters were not deployed in the field.

The CASTNET QA Manager completed work on the annual managerial review and the related report in support of ISO/IEC 17025:2017 accreditation by the A2LA during second quarter. The annual managerial review report was then distributed to WSP QA and CASTNET management team reviewers. The QA Manager presented the results of the annual managerial review report on August 23, 2024. The presentation was well received by the CASTNET management team, CASTNET QA Supervisor, and WSP's regional corporate management and QA representatives.

The ozone analyzers at sites CNT169, WY; ROM206, CO; and GTH161, CO failed to meet NPAP audit criteria. WSP worked with the auditor to troubleshoot the cause of the problem. The CNT169 NPAP audit was performed on July 25, 2024. This site received its annual performance evaluation by Environmental Engineering & Measurement Services, Inc. (EEMS) two days earlier on July 23, 2024, and it passed at all challenge points. Site ROM206 was audited by the NPAP auditor on July 30, 2024, and then re-audited on August 14, 2024. During the re-audit, the original NPAP auditor was accompanied by his technical supervisor who observed and verified results using his own equipment. After the re-audit, they responded to WSP and noted that the zero air used during the audit was very dry, and the results reflected an audit issue and did not indicate a problem with reported ambient results. The EPA Region 8 auditor performed a NPAP audit of the GTH161 site on September 19, 2024, and the CASTNET FOM met with the auditor at the site to observe audit procedures. The ozone system at the site failed to meet criteria using the auditor's Teledyne API T701 zero air generator. Audit readings for all three photometers, NPAP and CASTNET, matched and were well within criteria using the CASTNET onsite ozone and zero air generation systems. WSP initiated CA_0128 to investigate the audit discrepancies at these sites.

The laboratory detected elevated sulfate concentrations on the laboratory and field cellulose filter blanks. All elevated concentrations were less than two times the reporting limit. No problems were

noted during initial acceptance testing of the filters. In addition, method blanks exhibited no elevation in concentration. Lot numbers for the chemicals used for filter impregnation remained the same across impacted and non-impacted batches of impregnated filters. Since only a few sites are using cellulose filters, analyses are not done as frequently as for other filter media. By the time the potential issue was identified and new non-impacted filters were prepped and tested, approximately 12 weeks (weeks 28-39) of potentially impacted filters had already been shipped out. To avoid this situation in the future, the laboratory plans to analyze cellulose filters at greater frequency using smaller batches.

WSP submitted the review draft of the CASTNET QAPP Revision 10.2 to EPA for review and comment on November 1, 2024.

WSP began preparation of the requested documentation for the 2025 renewal of ISO/IEC 17025:2017 accreditation by the A2LA. The first set of documents was submitted to A2LA on November 29, 2024. A2LA is planning to perform an onsite assessment of the WSP analytical and field laboratories in the spring of 2025. WSP will provide all documents as requested by the assessor during early 2025 prior to the onsite assessment.

EPA's OAQPS is encouraging ozone monitoring organizations to transition to scrubber-free ozone transfer standards. WSP is working with OAQPS to provide information and diagrams on the workings of the CASTNET ozone system. The FOM developed a plumbing diagram and created a schematic showing the flow path and back pressure. This also included removing the knockout bottle and adding an external Nafion dryer. The FOM is evaluating a proposed timeline and estimating costs for transitioning the CASTNET Level 2 and Level 3 ozone transfer standards to be scrubber-free.

During third quarter 2024, WSP began discussing preliminary plans for updating CASTNET ozone transfers to the new ozone absorption cross-section value (Bureau International des Poids et Mesures, 2021; https://www.bipm.org/en/ozone). CASTNET field, data, and management personnel met to discuss the current certification status of CASTNET transfers and the plan to recertify the Level 2 transfers with the new cross-section value. WSP may be limited as to which EPA standard reference photometers are available for recertification with the new cross-section value since some EPA Regions are unwilling to re-certify transfers with scrubbers. Beginning January 1, 2025, data from ozone transfers using the old cross-section value must be flagged as such in EPA's Air Quality System (AQS). WSP anticipates completing the update of the network to the new cross-section value by the end of 2025.

WSP requested that Air Resource Specialists, Inc. perform the Level 4 data review of ozone data from EPA-sponsored CASTNET sites for the period 2021–2023.

During 2024, 25 external audits of CASTNET ozone systems at EPA-sponsored sites were performed by state agencies and NPAP auditors. Table 1 lists the sites audited by quarter during 2024.

Quarterly/Annual Summary

Table 2 lists the quarters of data by site calibration group that were validated to Level 3 during 2024. Table 3 lists the sites in each calibration group along with the calibration schedule. Table 4 presents the measurement criteria for continuous field measurements. These criteria apply to the instrument

challenges performed during site calibrations. Table 5 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 6 presents the critical criteria for ozone monitoring. Table 7 presents the critical criteria for trace-level gas monitoring.

Laboratory Intercomparison Results Summary

WSP'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. The CASTNET laboratory's proficiency testing plan requires action for individual test results that are greater than three standard deviations from the assigned value, a bias of five 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 first quarter 2024, WSP received results for sample analyses for PT study 123 for Rain and Soft Waters that were submitted to the Water Science and Technology Directorate (WSTD), a branch of the Environmental Science and Technology Laboratories Division with ECCC that provides QA services. WSP's results were assessed as "Very Good." However, PT study 123 listed a single magnesium result as "Alarm Low" for WSP. WSTD noted that it was a statistical anomaly and recommended that no action be taken. CA_0127 was opened to document this result and accept WSTD's recommendation. WSP's five-year average was rated as "Good" (ECCC, 2024a).

During September 2024, WSP received results of analyses of samples for PT study 124 for Rain and Soft Waters from the WSTD. WSP's results were assessed as "Good." However, two high ammonia values were flagged indicating potential bias and requiring corrective action (ECCC, 2024b). CA_0129 was opened to investigate the cause of the high ammonia results. WSP is currently troubleshooting what could have caused the high values. There has been no indication of recent bias in CASTNET samples or standards.

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 8 through 11 present the number of analyses in each category that were performed during each quarter of 2024.

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 12 presents the relevant sample receipt statistics for each of the four quarters of 2024 together with an annual summary for each category.

Data Quality Indicator (DQI) Results

Figures 1 through 3 present the results of RF, CCV, and RP QC sample analyses for fourth quarter 2024. All results were within the criteria listed in Table 5. Table 13 presents the percent recoveries and standard deviations for RF, CCV, and RP QC sample analyses for 2024. Quarterly averages are all within criteria. The Teflon calcium result at 20 percent in Figure 3 passes when the established rounding procedure is applied.

Table 14 presents quarterly co-located filter pack precision results for data validated to Level 3 during the year. Results for MCK131/231, KY were within the criterion for all 11 parameters reported. Results for ROM406/206, CO were within the criterion for all quarters except Teflon nitrate in fourth quarter 2023. This high MARPD was caused by low concentrations and large differences during three weeks of the fourth quarter. These differences were likely caused by the different exposure times for the co-located filter packs. The filter packs are changed at different times of the day on Tuesdays based on the schedule of the independent site operators. The time difference between the filter pack changeouts for the sites means that the two sites can collect pollutants during short-term upslope events on different weekly filter packs.

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

Table 15 presents summary statistics of critical criteria measurements at ozone sites collected during fourth quarter 2024. The statistics presented contain data validated at Level 2 and Level 3. All data associated with QC checks that fail to meet the criteria listed in Table 6 were or will be invalidated unless (1) the cause of failure has no effect on ambient data collection and (2) passing results still meet frequency criteria. Results in shaded cells either exceed documented criteria or are otherwise notable. Table 16 presents observations associated with the shaded cell results in Table 15.

Table 17 presents summary statistics of critical criteria measurements at trace-level gas monitoring sites collected during fourth quarter 2024. The statistics presented contain data validated at Level 2 and Level 3. All data associated with QC checks that fail to meet the criteria listed in Table 17 were or will be invalidated unless (1) the cause of failure has no effect on ambient data collection and (2) passing results still meet frequency criteria. Results in shaded cells either exceed documented criteria or are otherwise notable. Table 18 presents observations associated with the shaded cell results in Table 17.

Laboratory Control Sample Analysis

The laboratory control sample (LCS) is a reagent blank spiked with the target analytes from the established analytical methods that is 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 the extraction process. Figure 5 presents LCS analysis results for fourth quarter 2024. All recovery values were between 91 percent and 108 percent.

Blank Results

Figures 6 through 8 present the results of MB, LB, and FB QC sample analyses for fourth quarter 2024. All fourth quarter results were within criteria (two times the reporting limit) listed in Table 5 with the exception of one Teflon FB for calcium and sodium and one cellulose FB for sulfate.

Table 19 summarizes the record of filter blanks for 2024. All 2024 results were within the criteria listed in Table 5 with the exception of the following: one cellulose acceptance test result during first quarter; a total of three cellulose FBs with one in each of first, second, and fourth quarters; one Teflon FB for potassium during third quarter; and one Teflon FB for calcium and sodium during fourth quarter. All other blank QC checks in their respective batches were within criteria. There were no data anomalies associated with the ambient sampling data for these sites on these sampling weeks.

Suspect/Invalid Filter Pack Samples

Filter pack samples that were flagged as suspect or invalid during each of the four quarters of 2024 are listed in Table 20. This table also includes associated site identification and a brief description of the reason the sample was flagged. During fourth quarter, 14 filter pack samples were invalidated.

Field Problem Count

Table 21 presents counts of field problems affecting continuous data collection for more than one day for each quarter during 2024. The problem counts are sorted by a 30-, 60-, or 90-day time period to resolution. A category for unresolved problems is also included. Time to resolution indicates the period taken to implement corrective action.

Field Calibration Results

A summary of field calibration failures by parameter for each quarter of 2024 is listed in Table 22. Calibrations were performed at 24 sites during fourth quarter 2024, and all sites and parameters were within the criteria listed in Table 4 with the exception of the parameters at the two sites listed in Table 22.

Table 23 presents field accuracy results for 2024 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 except wind direction north at 71.4 percent and wind direction south at 71.4 percent. 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 2024 for the indicated parameters were within two times the criterion with the exception of wind direction at BEL116, MD in first and third quarters; flow rate at ROM206 in second quarter; and ambient temperature in fourth quarter at UMA009, WA. Data associated with the failures were invalidated with the exception of wind direction data at BEL116, which were adjusted. The associated vector wind speed data could not be adjusted and were invalidated.

References

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Table 1 NPAP and State Agency Audit of CASTNET Ozone Systems

Site ID	Auditing Agency
	First Quarter
BWR139, MD	Maryland Department of the Environment
	Second Quarter
PAR107, WV	NPAP (EPA Region 3)
CTH110, NY	NPAP (EPA Region 2)
	Third Quarter
OXF122,OH	NPAP (EPA Region 5)
WST109, NH	NPAP (EPA Region 1)
CNT169, WY	NPAP (EPA Region 8)
ROM206, CO	NPAP (EPA Region 8)
KEF112, PA	NPAP (EPA Region 3)
MKG113, PA	NPAP (EPA Region 3)
ANA115, MI	NPAP (EPA Region 5)
BWR139, MD	NPAP (EPA Region 3)
GTH161, CO	NPAP (EPA Region 8)
VIN140, IN	Indiana Department of Environmental Management
LRL117, PA	Pennsylvania Department of Environmental Protection
LPO010, CA	California Air Resources Board
PED108, VA	NPAP (EPA Region 3)
PRK134, WI	NPAP (EPA Region 5)
	Fourth Quarter
ARE128, PA	NPAP (EPA Region 3)
SAL133, IN	Indiana Department of Environmental Management (IDEM)
CVL151, MS	NPAP (EPA Region 4)
BEL116, MD	Maryland Department of the Environment
COW137, NC	North Carolina Department of Environmental Quality
GAS153, GA	Georgia Environmental Protection Division
BWR139, MD	Maryland Department of the Environment
BFT142, NC	North Carolina Department of Environmental Quality
CND125, NC	North Carolina Department of Environmental Quality

Table 2 Data Validated to Level 3 through Fourth Quarter 2024

Calibration Group*	Months Available	Number of Months	Complete Quarters	Number of Quarters
SE-4/MW-6 [†]	July 2023– June 2024	12	Quarter 3 2023– Quarter 2 2024	4
E-1/SE-5	August 2023– July 2024	12	Quarter 4 2023– Quarter 2 2024	3
MW-7/W-9	September 2023– August 2024	12	Quarter 4 2023– Quarter 2 2024	3
E-2/MW-8	October 2023– September 2024	12	Quarter 4 2023– Quarter 3 2024	4
E-3/W-10 [‡]	May 2023– April 2024	12	Quarter 3 2023– Quarter 1 2024	3

Notes: * The sites contained in each calibration group are listed in Table 3.

† Contains MCK131/231 co-located pair

‡ Contains ROM206 of the ROM406/ROM206 co-located pair

Calibration Group	Months Calibrated		Sites	Calibrated*			
	Eastern Sites (22 Total)						
E-1 (8 Sites)	February/August	ARE128, PA PED108, VA	BEL116, MD PSU106, PA	BWR139, MD VPI120, VA	CTH110, NY WSP144, NJ		
E-2 (9 Sites)	April/October	ABT147, CT HWF187, NY WST109, NH	ASH135, ME NIC001, NY	CAT175, NY UND002, VT	EGB181, ON WFM105, NY		
E-3 (5 Sites)	May/November	CDR119, WV PAR107, WV	KEF112, PA	LRL117, PA	MKG113, PA		
	Southeastern Sites (12 Total)						
SE-4 (7 Sites)	January/July	BFT142, NC GAS153, GA	CND125, NC SND152, AL	COW137, NC SPD111, TN	DUK008, NC ¹		
SE-5 (5 Sites)	February/August	CAD150, AR SUM156, FL	CNS011, FL	CVL151, MS	IRL141, FL		
		Midweste	rn Sites (18 Total)				
MW-6 (6 Sites)	January/July	CDZ171, KY MCK231, KY	CKT136, KY PNF126, NC	ESP127, TN	MCK131, KY		
MW-7 (8 Sites)	March/September	BVL130, IL ² QAK172, OH	DCP114, OH RED004, MN	OXF122, OH STK138, IL ²	PRK134, WI VIN140, IN		
MW-8 (4 Sites)	April/October	ANA115, MI	HOX148, MI	SAL133, IN	UVL124, MI		
	Western Sites (12 Total)						
W-9 (4 Sites)	March/September	ALC188, TX	CHE185, OK	KNZ184, KS	SAN192, NE ^{2, 3}		
W-10 (8 Sites)	May/November	CNT169, WY PAL190, TX	GTH161, CO PND165, WY⁴	LPO010, CA ROM206, CO⁴	NPT006, ID UMA009, WA		

Table 3 Field Calibration Schedule for 2024

Notes: Shaded sites did not operate during 2024 ¹ Trace-level gas calibrations are performed quarterly in January, April, July, and October. ² Trace-level gas calibrations are performed quarterly in March, June, September, and December.

³ This site operated as SAN189, NE through April 2024 when it was moved a short distance and renamed SAN192.

⁴ Trace-level gas calibrations are performed quarterly in February, May, August, and November. Trace-level gas monitoring ended at sites PND165 and ROM206 in July 2024.

Table 4 Data Quality Indicators for CASTNET Continuous Measurements

Mea	surements	Crite	ria ¹
Parameter ²	Method	Precision	Accuracy
Filter pack flow	Mass flow controller	± 10%	± 5%
Ozone ³	UV absorbance	All points within ± 2%	of full scale of best fit
		straigh Linearity e	it line rror < 5%
Wind speed	Anemometer	± 0.5 m/s	The greater of ± 0.5 m/s for winds < 5 m/s or ± 5% winds ≥ 5 m/s
Wind direction	Wind vane	± 5°	± 5°
Sigma theta	Wind vane	Undefined	Undefined
Ambient temperature	Platinum RTD	± 1.0°C (of full scale)	± 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 ⁴
Solar radiation	Pyranometer	± 10% (of reading taken at local noon)	± 10%
Surface wetness	Conductivity bridge	Undefined	Undefined

Notes: °C

UV

degrees Celsius

m/s = meters per second RTD = resistance-tempera

resistance-temperature device
 ultraviolet

¹ 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, 2022)

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

³ Ozone is not measured at eight EPA-sponsored CASTNET sites: HAS012, KS; KNZ184, KS; RED004, MN; EGB181, ON; CAT175, NY; NIC001, NY; WFM105, NY; and UND002, VT.

⁴ For target value of 0.50 inch

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

Table 5 Data Quality Indicators for CASTNET Laboratory Measurements

Notes: ¹ 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.

² 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.

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

AC IC ICP-OES MARPD mg/L μg/Filter *		automated colorimetry ion chromatography inductively coupled plasma-optical emission spectrometry mean absolute relative percent difference milligrams per liter micrograms per filter as nitrogen
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Values are rounded according to American Society for Testing and Materials (ASTM) E29-22, "Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications" (ASTM, 2022).

For more information on analytical methods and associated precision and accuracy criteria, see the CASTNET QAPP, (WSP, 2024).

Table 6 Ozone Critical Criteria*

Type Check	Analyzer Response
Zero	Less than ± 3.1 ppb
Span	Less than ± 7.1 percent between supplied and observed concentrations
Single Point QC	Less than ± 7.1 percent between supplied and observed conentrations

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, 2023a). The minimum frequency for these checks is once every two weeks.

ppb = parts per billion

Values are rounded according to ASTM E29-22, "Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications" (ASTM, 2022).

Table 7 Trace-level Gas Monitoring Critical Criteria*

	Analyzer Response				
Parameter	Zero Check	Span Check / Single Point QC Check			
SO ₂	Less than ± 1.51 ppb	Less then 1.40.4 percent between supplied and			
NOy	Less than ± 1.51 ppb	Less than ± 10.1 percent between supplied and observed concentrations			
CO	Less than ± 50 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, 2023). The minimum frequency for these checks is once every two weeks.

Values are rounded according to ASTM E29-22, "Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications" (ASTM, 2022).

SO₂ = sulfur dioxide

 NO_y = total reactive oxides of nitrogen

CO = carbon monoxide

ppb = parts per billion

Table 8 QC Anal	vsis Count for	First Quarter 2024
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Filter Type	Parameter	RF Sample Count	CCV Sample Count	RP Sample Count	MB Sample Count	LB Sample Count	FB Sample Count
Teflon	SO ₄ ²⁻	52	147	62	13	20	57
	NO ₃	52	147	62	13	20	57
	NH_4^+	26	131	58	13	20	57
	Cl	52	147	62	13	20	57
	Ca ²⁺	26	133	61	13	20	57
	Mg ²⁺	26	133	61	13	20	57
	Na [⁺]	26	133	61	13	20	57
	K⁺	26	133	61	13	20	57
Nylon	SO ₄ ²⁻	27	125	61	9	22	57
	NO ₃	27	125	61	9	22	57
Cellulose	SO ₄ ²⁻	35	111	50	11	26	60

Filter Type	Parameter	RF Sample Count	CCV Sample Count	RP Sample Count	MB Sample Count	LB Sample Count	FB Sample Count
Teflon	SO ₄ ²⁻	51	149	63	13	22	43
	NO ₃	51	149	63	13	22	43
	NH_4^+	26	134	63	13	22	43
	Cl ⁻	51	149	63	13	22	43
	Ca ²⁺	26	134	63	13	22	43
	Mg ²⁺	26	134	63	13	22	43
	Na [⁺]	26	134	63	13	22	43
	K⁺	26	134	63	13	22	43
Nylon	SO ₄ ²⁻	36	149	65	12	24	45
	NO ₃	36	149	65	12	24	45
Cellulose	SO ₄ ²⁻	45	125	52	13	24	33

Table 9 QC Ana	lysis Count for	Second Quarte	r 2024
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Table 10 QC Analysis Count for Third Quarter 2024

Filter Type	Parameter	RF Sample Count	CCV Sample Count	RP Sample Count	MB Sample Count	LB Sample Count	FB Sample Count
Teflon	SO ₄ ²⁻	60	169	75	15	24	54
	NO ₃	60	169	75	15	24	54
	NH ⁺ ₄	30	155	70	14	24	52
	Cl	60	169	75	15	24	54
	Ca ²⁺	33	161	75	16	24	52
	Mg ²⁺	33	161	75	16	24	52
	Na [⁺]	33	161	75	16	24	52
	K⁺	33	161	75	16	24	52
Nylon	SO ₄ ²⁻	44	176	73	14	22	45
	NO ₃	44	176	73	14	22	45
Cellulose	SO ₄ ²⁻	20	70	28	8	24	40

Filter Type	Parameter	RF Sample Count	CCV Sample Count	RP Sample Count	MB Sample Count	LB Sample Count	FB Sample Count
Teflon	SO ₄ ²⁻	56	163	69	14	22	44
	NO ₃	56	163	69	14	22	44
	NH_4^+	30	148	65	15	22	44
	Cl	56	163	69	14	22	44
	Ca ²⁺	28	151	67	14	22	44
	Mg ²⁺	28	151	67	14	22	44
	Na [⁺]	28	151	67	14	22	44
	K⁺	28	151	67	14	22	44
Nylon	SO ₄ ²⁻	33	142	60	11	22	44
	NO ₃	33	142	60	11	22	44
Cellulose	SO ₄ ²⁻	11	38	16	4	22	13

Table 11 QC Analysis Count for Fourth Quarter 2024

Table 12 Filter Pack Receipt Summary for 2024

Description	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Annual Summary
Count of samples received more than 14 days after	14	15	22	25	76
Count of all samples received:	692	641	665	709	2707
Fraction of samples received within 14 days:	0.980	0.977	0.967	0.965	0.972*
Average interval in days;	5.980	5.058	4.982	5.841	5.465
First receipt date:	01/02/2024	04/01/2024	07/01/2024	10/01/2024	01/02/2024
Last receipt date:	03/30/2024	06/26/2024	09/30/2024	12/30/2024	12/30/2024

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

		l Sample	Reference	e ry (%R)	Contin Verificati	uing Calik ion Sampl	oration es (%R)	In-R	un Replic (RPD)	ate ²
Filter Type	Parameter	Mean	Std. Dev.	Count ³	Mean	Std. Dev.	Count ³	Mean	Std. Dev.	Count ³
Teflon	SO ₄ ²⁻	101.47	1.03	238	99.77	0.99	684	1.13	1.13	294
	NO ₃	101.65	1.08	238	100.06	1.02	684	1.68	2.05	294
	NH_4^+	96.89	2.48	122	97.99	1.29	619	1.46	2.03	279
	Ca ²⁺	101.94	2.83	123	100.52	1.96	630	1.79	2.42	291
	Mg ²⁺	100.19	2.01	123	100.13	1.23	630	2.00	2.06	291
	Na⁺	95.46	1.66	123	99.77	1.57	630	1.34	1.37	291
	K⁺	98.54	1.89	123	99.99	1.38	630	2.05	2.40	291
	Cl	101.28	1.07	238	100.03	1.40	684	1.90	1.98	294
Nylon	SO ₄ ²⁻	101.94	0.82	147	99.38	1.34	619	6.95	4.74	270
	NO ₃	100.48	0.79	147	99.65	1.17	619	2.59	2.43	270
Cellulose	SO ₄ ²⁻	100.83	2.11	116	100.33	2.47	357	2.87	2.46	152

Table 13 Filter Pack QC Summary for 2024

Notes:

% R = percent recovery RPD = relative percent difference

¹Results of reference sample analyses provide accuracy estimates ²Results of replicate analyses provide precision estimates ³Number of QC Samples

Quarter	SO ²⁻	NO ⁻	NH↓	Ca ²⁺	Ma ²⁺	Na⁺	K⁺	CI	HNO₅	SO	Total NO ₂
MCK131/2	31, KY		4					01		2	
2023 Q3	1.39	10.28	2.46	5.31	4.40	5.05	3.80	0.92	4.09	7.25	4.17
2023 Q4	1.98	5.47	3.40	6.57	6.59	5.90	5.26	1.50	3.81	14.89	3.36
2024 Q1	1.62	5.32	3.77	10.07	8.59	6.80	3.63	4.34	5.27	5.40	2.47
2024 Q2	1.63	5.06	3.13	7.45	7.76	4.17	6.02	1.11	4.08	5.23	3.83
Average	1.65	6.53	3.19	7.35	6.84	5.48	4.68	1.97	4.31	8.19	3.46
ROM406/2	206, CO	=	-								-
2023 Q3	7.21	10.78	13.83	8.77	9.76	11.57	8.68	4.73	7.55		6.72
2023 Q4	6.65	22.11	12.21	8.07	11.19	13.17	4.48	10.44	9.43		11.03
2024 Q1	5.66	18.86	13.26	8.73	9.10	8.88	7.93	9.55	12.46		6.99
2024 Q2	10.34	13.41	7.23	12.94	11.78	15.33	13.21	10.53	12.47		11.39
Average	7.47	16.29	11.63	9.63	10.46	12.24	8.58	8.81	10.48		9.03

Table 14 Precision Results for Third Quarter 2023 through Second Quarter 202
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Notes: 1 of 84 site-quarter-parameters were outside criterion ROM406 does not measure SO₂. Measurements of SO₂ ended at ROM206 in July 2024.

Table 15 Ozone QC Summary for Fourth Quarter 2024 (1 of 2)

			% Single			Zero
011 15	% Span	0 0 010	Point QC	Single Point	% Zero	Average
Site ID	Pass	Span [%D] ²	Pass		Pass	(ppb) ²
ABT147, CT	100.00	0.77	100.00	0.79	100.00	0.16
ALC188, TX	100.00	0.87	100.00	0.92	100.00	0.37
ANA115, MI	100.00	3.07	100.00	3.69	100.00	0.23
ARE128, PA	100.00	0.85	100.00	1.46	100.00	0.64
BEL116, MD	100.00	1.43	100.00	2.81	100.00	0.63
BFT142, NC	100.00	1.02	98.90	1.32	100.00	0.33
BVL130, IL	100.00	1.37	100.00	1.16	100.00	0.12
BWR139, MD	100.00	1.43	100.00	1.23	100.00	0.47
CAD150, AR	100.00	0.63	100.00	0.58	100.00	0.29
CKT136, KY	100.00	0.89	100.00	0.72	100.00	0.14
CND125, NC	98.92	1.12	100.00	1.67	100.00	0.30
CNT169, WY	100.00	0.90	100.00	1.09	100.00	0.25
COW137, NC	100.00	0.95	97.92	1.72	100.00	0.41
CTH110, NY	100.00	0.53	97.85	1.67	100.00	0.31
CVL151, MS	100.00	2.32	100.00	2.28	100.00	0.15
DUK008, NC	95.24	4.97	95.24	4.26	95.24	1.91
ESP127, TN	95.70	1.66	95.70	1.86	100.00	0.46
GAS153, GA	100.00	1.24	98.92	2.23	100.00	0.72
GTH161, CO	100.00	2.75	100.00	2.87	100.00	0.21
HOX148, MI	100.00	0.57	100.00	0.76	100.00	0.15
IRL141, FL	96.39	5.37	97.53	4.15	97.53	1.06
KEF112, PA	100.00	1.83	100.00	1.30	100.00	0.46
LPO010, CA	100.00	0.56	100.00	0.86	100.00	0.21
LRL117, PA	98.98	0.97	100.00	0.79	100.00	0.24
MCK131, KY	100.00	2.23	100.00	2.32	100.00	0.33
MCK231, KY	100.00	1.07	98.94	1.11	100.00	0.27
MKG113, PA	100.00	1.12	100.00	1.41	100.00	0.27
NPT006, ID	98.41	2.87	100.00	1.22	100.00	0.15
OXF122, OH	100.00	2.83	100.00	3.61	100.00	0.19
PAL190, TX	94.44	2.76	96.59	2.08	100.00	0.40
PAR107, WV	100.00	1.10	100.00	0.86	100.00	0.25
PED108, VA	97.59	2.76	97.59	2.63	100.00	0.55
PND165, WY	100.00	1.83	100.00	1.83	100.00	0.32
PRK134, WI	100.00	1.60	100.00	1.70	100.00	0.17
PSU106, PA	86.73	5.70	86.73	7.37	87.76	2.52
QAK172, OH	100.00	0.96	100.00	1.05	100.00	0.26
ROM206, CO	100.00	1.57	100.00	1.26	100.00	0.35
SAL133, IN	100.00	0.52	100.00	0.55	100.00	0.19
SAN192, NE	100.00	1.42	100.00	2.15	100.00	0.59
SND152, AL	100.00	0.94	100.00	1.86	100.00	0.60
SPD111, TN	100.00	1.19	100.00	0.93	100.00	0.26
STK138, IL	100.00	1.16	100.00	0.74	100.00	0.24
SUM156, FL	100.00	2.97	100.00	2.78	100.00	0.20

Table 15 Ozone QC Summary for Fourth Quarter 2024 (2 of 2)

Site ID	% Span Pass¹	Span [%D]²	% Single Point QC Pass ¹	Single Point QC [%D] ²	% Zero Pass¹	Zero Average (ppb)²
UMA009, WA	100.00	1.06	96.00	1.71	99.00	0.50
UVL124, MI	99.01	1.21	100.00	0.96	100.00	0.21
VIN140, IN	100.00	0.92	100.00	1.58	100.00	0.16
VPI120, VA	100.00	1.07	100.00	1.38	100.00	0.17
WSP144, NJ	100.00	1.10	100.00	0.94	100.00	0.42
WST109, NH	100.00	0.43	100.00	0.90	100.00	0.48

Notes: ¹Percentage of comparisons that pass the criteria listed in Table 6. Values falling below 90 percent are addressed in Table 16. ²Absolute value of the average percent differences between the on-site transfer standard and the site monitor. Values exceeding the criteria listed in Table 6 are addressed in Table 16.

%D = percent difference

ppb = parts per billion

Table 16 Ozone QC Observations for Fourth Quarter 2024

PSU106, PA % Span Pass The site analyzer malfunctioned. % Single Point QC Pass Single Point QC %D % Zero Pass He site analyzer malfunctioned.	Site ID	QC Criterion	Comments
	PSU106, PA	% Span Pass % Single Point QC Pass Single Point QC %D % Zero Pass	The site analyzer malfunctioned.

Note: %D = percent difference

Parameter	% Span Pass ¹	Span [%D]²	% Single Point QC Pass ¹	Single Point QC [%D] ²	% Zero Pass¹	Zero Average (ppb)²		
	BVL130, IL							
SO ₂	95.00	3.11	100.00	0.89	100.00	0.34		
NOy	100.00	5.07	100.00	4.23	100.00	0.33		
CO	100.00	1.60	94.87	5.02	92.68	12.86		
			DUK008, NC					
NOy	77.50	14.45	80.00	13.19	100.00	0.37		
	SAN192, NE							
NOy	100.00	2.35	100.00	3.02	100.00	0.28		
	STK138, IL							
NOy	97.78	2.96	97.78	3.32	91.30	0.72		

Table 17 Trace-level Gas QC Summary for Fourth Quarter 2024

Notes: ¹Percentage of comparisons that pass the criteria listed in Table 6. Values falling below 90 percent are addressed in Table 18. ²Absolute value of the average percent differences between the supplied and observed concentrations. Values exceeding the criteria listed in Table 7 are addressed in Table 18.

%D = percent difference

ppb = parts per billion

Table 18 Trace-level Gas QC Observations for Fourth Quarter 2024

Site ID	Parameter	QC Criterion	Comments
DUK008, NC	NOy	% Span Pass Span %D % Single Point QC Pass Single Point QC %D	The pressure sensor board was replaced on 12/11/24. Data are invalid when QC checks are failing.

Note: %D = percent difference

Parameter Name	Detection Limit Total µg	Total Number	Number > Detection Limit	Average Total µg	Average Absolute Deviation	Maximum Total µg
	· · ·	1	FIELD BLANKS		1	
Teflon - NH ⁺ ₄ -N	0.500	297	0	0.500	0.000	0.500
Teflon - NO ₃ ⁻ -N	0.200	297	2	0.201	0.001	0.360
Teflon - SO ₄ ²⁻	1.000	297	0	1.000	0.000	1.000
Cl	0.500	297	1	0.501	0.001	0.665
Ca ²⁺	0.150	297	2	0.151	0.002	0.369
Mg ²⁺	0.075	297	0	0.075	0.000	0.075
Na [⁺]	0.125	297	1	0.126	0.003	0.522
K⁺	0.150	297	2	0.151	0.002	0.379
Nylon - NO ₃ -N	0.200	297	0	0.200	0.000	0.200
Nylon - SO ₄ ²⁻	1.000	297	0	1.000	0.000	1.000
Cellulose - SO ₄ ²⁻	2.000	178	30	2.173	0.294	6.415
LABORATORY BLANKS						
Teflon - NH ⁺ ₄ -N	0.500	100	0	0.500	0.000	0.500
Teflon - NO ₃ ⁻ -N	0.200	100	0	0.200	0.000	0.200
Teflon - SO ₄ ²⁻	1.000	100	0	1.000	0.000	1.000
Cl	0.500	100	0	0.500	0.000	0.500
Ca ²⁺	0.150	100	0	0.150	0.000	0.150
Mg ²⁺	0.075	100	0	0.075	0.000	0.075
Na [⁺]	0.125	100	0	0.125	0.000	0.125
K⁺	0.150	100	0	0.150	0.000	0.150
Nylon - NO ₃ -N	0.200	102	0	0.200	0.000	0.200
Nylon - SO ₄ ²⁻	1.000	102	1	1.001	0.003	1.152
Cellulose - SO ₄ ²⁻	2.000	106	21	2.212	0.344	3.865

Parameter Name	Detection Limit Total µg	Total Number	Number > Detection Limit	Average Total µg	Average Absolute Deviation	Maximum Total µg
		M	IETHOD BLANK	Ś		
Teflon - NH ⁺ ₄ -N	0.500	60	0	0.500	0.000	0.500
Teflon - NO ₃ -N	0.200	60	0	0.200	0.000	0.200
Teflon - SO ₄ ²⁻	1.000	60	0	1.000	0.000	1.000
Cl	0.500	60	0	0.500	0.000	0.500
Ca ²⁺	0.150	61	0	0.150	0.000	0.150
Mg ²⁺	0.075	61	0	0.075	0.000	0.075
Na [⁺]	0.125	61	0	0.125	0.000	0.125
K⁺	0.150	61	0	0.150	0.000	0.150
Nylon - NO ₃ -N	0.200	49	0	0.200	0.000	0.200
Nylon - SO ₄ ²⁻	1.000	49	0	1.000	0.000	1.000
Cellulose - SO ₄ ²⁻	2.000	37	0	2.000	0.000	2.000
ACCEPTANCE TEST VALUES ¹						
Teflon - NH ⁺ ₄ -N	0.500	192	0	0.500	0.000	0.500
Teflon - NO ₃ ⁻ -N	0.200	192	0	0.200	0.000	0.200
Teflon - SO ₄ ²⁻	1.000	192	0	1.000	0.000	1.000
Cl	0.500	192	0	0.500	0.000	0.500
Ca ²⁺	0.150	192	0	0.150	0.000	0.150
Mg ²⁺	0.075	192	0	0.075	0.000	0.075
Na⁺	0.125	192	0	0.125	0.000	0.125
K	0.150	192	0	0.150	0.000	0.150
Nylon - NO ₃ -N	0.200	88	1	0.200	0.000	0.213
Nylon - SO ₄ ²⁻	1.000	88	0	1.000	0.000	1.000
Cellulose - SO ₄ ²⁻	2.000	126	1	2.029	0.058	5.710

Table 19 Summary of Filter Blanks for 2024 (2 of 2)

Note: ¹Only filter batches passing QC requirements are used for sampling and analysis.

Table 20 Filter Packs Flagged as Suspect or Invalid

Site ID	Sample No.	Reason			
First Quarter 2024					
CAT175, NY	2403001-10	Power failure			
CVL151, MS	2402001-18	Flow rate was unknown during this sampling week.			
KEF112, PA	2402001-28	Filter pack failed leak check.			
SHE604, WY	2402005-05	Flow rate was invalidated as suspect.			
	2404005-05	Filter pack was invalidated for suspect data.			
	Second Quarter 2024				
ALB801, AB	2418007-01	Flow data acquisition issue. Data may be recovered by Level 3 review.			
BUF603, WY	2418005-02	Flow data acquisition issue. Data may be recovered by Level 3 review.			
FOR605, WY	2418005-03	Flow data acquisition issue. Data may be recovered by Level 3 review.			
GTH161, CO	2419001-24	The mass flow controller lost communication with the data logger after a site power failure.			
NEC602, WY	2418005-04	Flow data acquisition issue. Data may be recovered by Level 3 review.			
ROM206, CO	2421001-44	Mass flow controller malfunctioned.			
SHN418, VA	2421003-19	Power failure			
VPI120, VA	2421001-53	Power failure			
		Third Quarter 2024			
ALB801, AB	2431007-01	Insufficient flow volume			
BAS601, WY	2429005-01	Power failure			
BBE401, TX	2428003-02	Flow data acquisition issue. Data may be recovered by Level 3 review.			
BUF603, WY	2431005-02	Flow data acquisition issue. Data may be recovered by Level 3 review.			
ESP127, TN	2431001-22	Polling issue			
FOR605, WY	2431005-03	Flow data acquisition issue. Data may be recovered by Level 3 review.			
LAV410, CA	2429003-13	Satellite service was down and caused a communications issue.			
NEC602, WY	2431005-04	Flow data acquisition issue. Data may be recovered by Level 3 review.			
VPI120, VA	2428001-53	Power failure			
WST109, NH	2429001-56	The site laptop malfunctioned on 7/9/24 and was replaced 7/17/24.			
		Fourth Quarter 2024			
ALB801, AB	2444007-01	Flow data from November onward need to be uploaded to the database.			
BUF603, WY	2444005-02	Flow data from November onward need to be uploaded to the database.			
CKT136, KY	2440001-13	The data logger malfunctioned.			
CND125, NC	2442001-14	Flow pump failure			
CTH110, NY	2447001-17	Power failure			
CVL151, MS	2444001-18	The data logger malfunctioned.			
FOR605, WY	2444005-03	Flow data from November onward need to be uploaded to the database.			
LAV410, CA	2444003-13	Flow data from November onward need to be uploaded to the database.			
LPO010, CA	2445004-04	Power failure			
NEC602, WY	2444005-04	Flow data from November onward need to be uploaded to the database.			
PIN414, CA	2446003-16	Flow data from November onward need to be uploaded to the database.			
ROM406, CO	2442003-17	Filter pack was invalidated for suspect data.			
SEK430, CA	2442003-18	Insufficient flow volume			
SHE604, WY	2448005-05	Flow channel was left down.			

Table 21 Field problems Affecting Data Collection

Days to Resolution	Problem Count			
First Quarter 2024				
30	151			
60	5			
90	0			
Unresolved by End of Quarter	9			
Second Quarter 2024				
30	226			
60	6			
90	1			
Unresolved by End of Quarter	5			
Third Quarter 2024				
30	225			
60	7			
90	1			
Unresolved by End of Quarter	4			
Fourth Quarter 2024				
30	205			
60	12			
90	1			
Unresolved by Date of Publication	17			

Table 22 Field Calibration Failures by Parameter for 2024

Site ID	Reason				
First Quarter 2024					
BEL116, MD	Wind Direction				
IRL141, FL	Temperature, Ambient				
Second Quarter 2024					
CAT175, NY	Temperature, Ambient				
EGB181, ON	Flow Rate				
UVL124, MI	Temperature, Ambient				
ROM206, CO	CO Flow Rate				
	Third Quarter 2024				
BEL116, MD Wind Direction					
ALC188, TX	LC188, TX Temperature, Ambient; Temperature, Zero				
STK138, IL	Temperature, Ambient				
Fourth Quarter 2024					
PAR107, WV	R107, WV Temperature, Ambient; Temperature, Zero				
UMA009, WA	, WA Temperature, Ambient				

Note: 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 (WSP, 2024).

Table 23 Accuracy results for 2024 Field Measurements

Parameter	Percent Within Criterion*
Flow rate	98.2
Wind speed < 5 m/s	100.0
Wind speed ≥ 5 m/s	100.0
Wind direction north	71.4
Wind direction south	71.4
Temperature (0°C)	98.2
Temperature (ambient)	93.6
Delta temperature (0°C)	100.0
Delta temperature (ambient)	99.1
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

* = Per CASTNET project protocols, data 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). All calibration failures reported in 2024 for the indicated parameters were within two times the criterion with the exception of wind direction at BEL116, flow rate at ROM206, and ambient temperature at UMA009.

Figure 1 Reference Standard Results for Fourth Quarter 2024 (percent recovery)





Figure 2 Continuing Calibration Spike Results for Fourth Quarter 2024 (percent recovery)





Figure 3 Replicate Sample Analysis Results for Fourth Quarter 2024 (percent difference)



Figure 4 Percent Completeness of Measurements for Second Quarter 2023 through Third Quarter 2024^{*}

Note: *Presents Level 3 data available during the fourth guarter of 2024

Figure 5 Laboratory Control Sample Results for Fourth Quarter 2024 (percent recovery)



Figure 6 Method Blank Analysis Results for Fourth Quarter 2024 (total micrograms)



Figure 7 Laboratory Blank Analysis Results for Fourth Quarter 2024 (total micrograms)



Figure 8 Field Blank Analysis Results for Fourth Quarter 2024 (total micrograms)

