Summary of Quarterly Operations (July through September)

EPA Contract No. EP-W-16-015

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 third quarter 2019. The various QA/QC criteria and policies are documented in the CASTNET Quality Assurance Project Plan (QAPP; Wood, 2019). The QAPP is comprehensive and includes standards and policies for components of project operation from site selection through final data reporting. It is reviewed annually and updated as warranted.

Quarterly Summary

The CASTNET Natural Disaster Preparedness and Response procedure was completed during August 2019. This document provides guidelines for preparing sites for impending severe storms and other natural disasters (e.g., hurricanes, wildfires) and for restoring sites after a natural disaster has occurred. This plan will be included in the next revision of the CASTNET Health and Safety Plan (HASP). The HASP is appendix 5 to the CASTNET QAPP.

Wood finalized plans to use MTL Corp pre-washed nylon filters for CASTNET sampling activities beginning with filter packs deployed on September 3, 2019. Wood updated the preventative action plan summary for transitioning to MTL pre-washed nylon filters and sent it to CASTNET stakeholders. Wood is working with MTL to maintain a year's supply of filters.

During August, the CASTNET Quality Assurance Manager (QAM) audited laboratory personnel on the laboratory method, GLM3180-001. The analyst demonstrated thorough knowledge of the method, instrument operation, and sample handling. A single finding was generated for the laboratory to reconcile a discrepancy between documented procedure and actual performance when volumes of impregnation fluid are added to blank spikes. The QAM routinely audits in support of the QA program.

Sample analyses were submitted for proficiency test study 0114 for Rain and Soft Waters to the National Laboratory of Environmental Testing, a branch of the National Water Research Institute with Environment Canada that provides quality assurance services. The results of the analyses showed a 1 percent high bias for sulfate. No corrective action was needed.

Table 1 lists the quarters of data that were validated to Level 3 during third quarter 2019 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 laboratory filter pack measurements. These criteria apply to the QC samples listed in the following section of this report. Table 4 presents the critical criteria for ozone monitoring. Table 5 presents the critical criteria for trace-level gas monitoring.

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. Table 6 presents the number of analyses in each category that were performed during third quarter 2019.

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 7 presents the relevant sample receipt statistics for third quarter 2019.

Data Quality Indicator (DQI) Results

Figures 1 through 3 present the results of RF, CCV, and RP QC sample analyses for third quarter 2019. All results were within the criteria listed in Table 3.

Table 8 presents summary statistics of critical criteria measurements at ozone sites collected during third quarter 2019. 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 4 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 9 presents observations associated with the shaded cell results in Table 8.

Table 10 presents summary statistics of critical criteria measurements at trace-level gas monitoring sites collected during third quarter 2019. 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 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 11 presents observations associated with the shaded cell results in Table 10.

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. The LCS is not required by the CASTNET QA/QC program. 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 4 presents LCS analysis results for third quarter 2019. All recovery values were between 95 percent and 107 percent. The criterion listed for the LCS in the CASTNET standard operating procedure is 80 to 120 percent.

Blank Results
Figures 5 through 7 present the results of MB, LB, and FB QC sample analyses for third quarter 2019. All third quarter results were within criteria (two times the reporting limit) listed in Table 3.

Suspect/Invalid Filter Pack Samples
Filter pack samples that were flagged as suspect or invalid during third quarter 2019 are listed in Table 12. This table also includes associated site identification and a brief description of the reason the sample was flagged. During third quarter, 16 filter pack samples were invalidated.

Field Problem Count
Table 13 presents counts of field problems affecting continuous data collection for more than one day for third quarter 2019. 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.

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.

U.S. Environmental Protection Agency (EPA). 2017. 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) 2019. *Clean Air Status and Trends Network (CASTNET) Quality Assurance Project Plan* (QAPP) Revision 9.2. 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 during Third Quarter 2019

Calibration Group*	Months Available	Number of Months	Complete Quarters	Number of Quarters
E-3/W-10†	November 2018 – April 2019	6	Quarter 1 2019	1
SE-4/MW-6‡	January 2019 – June 2019	6	Quarter 1 2019 – Quarter 2 2019	2

Notes: * The sites contained in each calibration group are listed in Table 2.
    † Contains ROM206 of the ROM406/ROM206 co-located pair
    ‡ Contains MCK131/231 co-located pair

Table 2 Field Calibration Schedule for 2019

Calibration Group	Months Calibrated	Sites Calibrated				
		Eastern Sites (23 Total)				
E-1 (8 Sites)	February/August	BEL116, MD WSP144, NJ ARE 128, PA PED108, VA BWR139, MD CTH110, NY PSU106, PA VPI120, VA				
E-2 (10 Sites)	April/October	ABT147, CT HOW191, ME[4] CAT175, NY NIC001, NY EGB181, ON ASH135, ME WST109, NH HWF187, NY[2] WFM105, NY UND002, VT				
E-3 (5 Sites)	May/November	KEF112, PA LRL117, PA CDR119, WV MKG113, PA PAR107, WV				
		Southeastern Sites (11 Total)				
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[1] IRL141, FL CVL151, MS				
		Midwestern Sites (19 Total)				
MW-6 (6 Sites)	January/July	CDZ171, KY MCK131, KY PNF126, NC[2] CKT136, KY MCK231, KY ESP127, TN				
MW-7 (9 Sites)	March/September	ALH157, IL STK138, IL RED004, MN OXF122, OH PRK134, WI BVL130, IL[3] VIN140, IN DCP114, OH QAK172, OH				
MW-8 (4 Sites)	April/October	SAL133, IN ANA115, MI HOX148, MI UVL124, MI				
		Western Sites (11 Total)				
W-9 (5 Sites)	March/September	KNZ184, KS CHE185, OK ALC188, TX KIC003, KS SAN189, NE				
W-10 (6 Sites)	May/November	GTH161, CO NPT006, ID PND165, WY[1] ROM206, CO[1] CNT169, WY PAL190, TX				

Notes: [1] Trace-level gas calibrations are performed quarterly in February, May, August, and November.
    [2] Trace-level gas calibrations are performed quarterly in January, April, July, and October.
    [3] Trace-level gas calibrations are performed quarterly in March, June, September, and December.
    [4] The site was decommissioned in March 2019.

Table 3 Data Quality Indicators for CASTNET Laboratory Measurements

Analyte	Method	Precision[1] (MARPD)	Accuracy[2] (%)	Nominal Reporting Limits	
				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

Notes: [1] This column lists precision goals for both network precision calculated from co-located filter samples and laboratory precision based on replicate samples.

[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.

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, 2019).

Table 4 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, 2017). 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 5 Trace-level Gas Monitoring Critical Criteria[*]

Parameter	Analyzer Response	
	Zero Check	Span Check / Single Point QC Check
SO_2	Less than $\pm$ 1.51 ppb	Less than $\pm$ 10.1 percent between supplied and observed concentrations
NO_y	Less than $\pm$ 1.51 ppb	
CO	Less than $\pm$ 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, 2017). 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_2 = sulfur dioxide
NO_y = total reactive oxides of nitrogen
CO = carbon monoxide
ppb = parts per billion

Table 6 QC Analysis Count for Third Quarter 2019

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-}	64	188	80	16	26	93
	NO_3^-	64	188	80	16	26	93
	NH_4^+	32	172	79	16	26	93
	Cl^-	64	188	80	16	26	93
	Ca^{2+}	32	172	79	16	26	93
	Mg^{2+}	32	172	79	16	26	93
	Na^+	32	172	79	16	26	93
	K^+	32	172	79	16	26	93
Nylon	SO_4^{2-}	48	192	78	16	26	93
	NO_3^-	48	192	78	16	26	93
Cellulose	SO_4^{2-}	46	171	78	16	26	93

Table 7 Filter Pack Receipt Summary for Third Quarter 2019

Count of samples received more than 14 days after removal from tower:	14
Count of all samples received:	777
Fraction of samples received within 14 days:	0.982
Average interval in days:	6.060
First receipt date:	07/01/2019
Last receipt date:	09/27/2019

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

Table 8 Ozone QC Summary for Third Quarter 2019 (1 of 2)

Site ID	% Span Pass[1]	Span |%D|[2]	% Single Point QC Pass[1]	Single Point QC |%D|[2]	% Zero Pass[1]	Zero Average (ppb)[2]
ABT147, CT	100.00	1.60	96.84	1.97	100.00	0.28
ALC188, TX	93.15	3.48	94.52	2.71	98.63	0.41
ALH157, IL	97.70	2.46	91.95	3.12	97.70	0.61
ANA115, MI	100.00	1.38	100.00	1.57	100.00	0.18
ARE128, PA	100.00	2.00	100.00	1.63	100.00	0.30
ASH135, ME	100.00	0.71	100.00	0.69	98.91	0.55
BEL116, MD	100.00	0.63	100.00	1.22	100.00	0.72
BFT142, NC	100.00	1.52	100.00	1.66	100.00	0.21
BVL130, IL	100.00	0.67	98.92	0.75	100.00	0.23
BWR139, MD	91.58	7.27	91.58	7.83	96.91	0.45
CAD150, AR	100.00	1.56	100.00	2.11	100.00	0.51
CDR119, WV	100.00	0.62	100.00	1.34	100.00	0.15
CDZ171, KY	100.00	0.56	100.00	0.69	100.00	0.43
CKT136, KY	98.88	1.37	100.00	0.39	100.00	0.15
CND125, NC	100.00	1.30	98.86	1.86	100.00	0.37
CNT169, WY	100.00	0.31	100.00	0.62	100.00	0.17
COW137, NC	100.00	1.35	100.00	1.23	100.00	0.74
CTH110, NY	100.00	0.75	100.00	1.06	100.00	0.21
CVL151, MS	100.00	0.72	98.77	1.63	95.06	0.50
DCP114, OH	100.00	2.79	97.87	2.55	100.00	0.40
DUK008, NC	100.00	2.11	100.00	2.09	100.00	0.23
ESP127, TN	100.00	0.74	100.00	1.60	100.00	0.18
GAS153, GA	94.44	1.36	95.40	1.43	100.00	0.65

Table 8 Ozone QC Summary for Third Quarter 2019 (2 of 2)

Site ID	% Span Pass[1]	Span |%D|[2]	% Single Point QC Pass[1]	Single Point QC |%D|[2]	% Zero Pass[1]	Zero Average (ppb)[2]
GTH161, CO	100.00	1.26	100.00	1.31	100.00	0.13
HOX148, MI	100.00	0.53	100.00	0.84	100.00	0.35
HWF187, NY	100.00	0.95	100.00	1.47	100.00	0.33
IRL141, FL	98.89	1.34	95.74	1.62	98.89	0.69
KEF112, PA	100.00	0.68	100.00	1.29	98.90	0.71
LRL117, PA	100.00	0.77	100.00	0.58	100.00	0.16
MCK131, KY	100.00	0.58	100.00	0.89	100.00	0.18
MCK231, KY	100.00	0.97	100.00	1.16	100.00	0.17
MKG113, PA	100.00	0.92	100.00	0.81	100.00	0.50
NPT006, ID	97.70	3.32	100.00	1.27	100.00	0.28
OXF122, OH	98.97	1.72	94.85	2.64	94.85	0.94
PAL190, TX	100.00	0.72	100.00	1.70	100.00	0.65
PAR107, WV	100.00	1.37	100.00	1.64	100.00	0.22
PED108, VA	100.00	0.82	100.00	0.81	100.00	0.22
PND165, WY	100.00	1.06	100.00	1.73	100.00	0.73
PNF126, NC	100.00	0.28	100.00	0.73	100.00	0.39
PRK134, WI	100.00	2.61	100.00	2.06	98.91	0.47
PSU106, PA	100.00	1.14	100.00	0.62	100.00	0.16
QAK172, OH	100.00	2.97	95.79	3.52	100.00	1.01
ROM206, CO	100.00	3.89	97.89	4.02	100.00	0.19
SAL133, IN	100.00	1.03	100.00	1.09	100.00	0.24
SAN189, NE	100.00	4.63	98.91	4.69	100.00	0.84
SND152, AL	100.00	2.65	100.00	3.27	100.00	0.36
SPD111, TN	100.00	1.48	95.88	1.71	96.91	0.53
STK138, IL	100.00	2.13	100.00	1.40	100.00	0.30
SUM156, FL	100.00	0.49	100.00	0.72	100.00	0.44
UVL124, MI	95.88	3.42	96.88	1.65	98.96	0.49
VIN140, IN	100.00	1.63	97.94	2.97	98.97	1.09
VPI120, VA	98.82	1.07	98.82	1.28	100.00	0.44
WSP144, NJ	100.00	2.21	98.82	2.79	100.00	0.46
WST109, NH	100.00	2.20	96.84	2.11	100.00	0.31

Notes: [1]Percentage of comparisons that pass the criteria listed in Table 4. Values falling below 90 percent are addressed in Table 9.

[2]Absolute value of the average percent differences between the on-site transfer standard and the site monitor. Values exceeding the criteria listed in Table 4 are addressed in Table 9.

%D = percent difference

ppb = parts per billion

Table 9 Ozone QC Observations for Third Quarter 2019

Site ID	QC Criterion	Comments
BWR139, MD	Span |%D| Single Point QC |%D|	The analyzer sample pump failed and was replaced. Associated data were invalidated.

Note: %D = percent difference

Table 10 Trace-level Gas QC Summary for Third Quarter 2019

Parameter	% Span Pass[1]	Span |%D|[2]	% Single Point QC Pass[1]	Single Point QC |%D|[2]	% Zero Pass[1]	Zero Average (ppb)[2]
BVL130, IL						
SO_2	100.00	2.17	100.00	6.79	83.33	1.09
NO_y	100.00	3.62	100.00	4.28	100.00	0.50
CO	70.27	30.10	45.95	31.90	51.35	92.52
DUK008, NC						
NO_y	83.33	7.60	85.71	5.09	100.00	0.51
HWF187, NY						
NO_y	70.27	29.83	70.27	30.49	100.00	0.59
PND165, WY						
NO_y	100.00	2.85	94.87	2.76	97.44	0.64
PNF126, NC						
NO_y	97.78	3.37	100.00	3.37	100.00	0.48
ROM206, CO						
NO_y	100.00	2.08	100.00	2.46	100.00	0.38

Notes: [1]Percentage of comparisons that pass the criteria listed in Table 5. Values falling below 90 percent are addressed in Table 11.

[2]Absolute value of the average percent differences between the supplied and observed concentrations. Values exceeding the criteria listed in Table 5 are addressed in Table 11.

%D = percent difference
ppb = parts per billion

Table 11 Trace-level Gas QC Observations for Third Quarter 2019

Site ID	Parameter	QC Criterion	Comments
BVL130, IL	SO$_2$	% Zero Pass	The analyzer was calibrated in April without the CO analyzer installed. The CO analyzer was reinstalled in July affecting the SO$_2$ analyzer's internal pressure and flows. The SO$_2$ analyzer was not compensating adequately following CO reinstallation. The SO$_2$ pressure transducer was calibrated and the sampling trains were separated in September to address this issue.
	CO	% Span Pass Span |%D| % Single Point QC Pass Single Point QC |%D| % Zero Pass Zero Average	Analyzer reinstalled late July after manufacturer servicing. The reinstalled unit continues to malfunction.
DUK008, NC	NO$_y$	% Span Pass % Single Point QC Pass	Due to analyzer drift. The instrument was recalibrated twice during September.
HWF187, NY	NO$_y$	% Span Pass Span |%D| % Single Point QC Pass Single Point QC |%D|	The analyzer's pre-reactor valve assembly malfunctioned during the quarter. It was replaced in September, and the analyzer was recalibrated.

Notes: %D = percent difference

Table 12 Filter Packs Flagged as Suspect or Invalid during Third Quarter 2019

Site ID	Sample No.	Reason
BBE401, TX	1927003-02 1928003-02 1930003-02	The Teflon filters were perforated. Cause of filter damage was not determined.
BFT142, NC	1929001-07 1930001-07 1931001-07	The mass flow controller malfunctioned as a result of storm damage.
CAN407, UT	1928003-03	The pump was accidentally turned off.
CHA467, AZ	1928003-04	Insufficient flow volume resulted in data missing for two days out of six.
CHE185, OK	1927004-02	A communications issue resulted in missing flow data.
CVL151, MS	1932001-19	The site was down for infrastructure repairs.
FOR605, WY	1928005-03	The mass flow controller malfunctioned as a result of storm damage.
GRB411, NV	1927003-09	A loose ground wire caused invalid flow values.
JOT403, CA	1931003-12	An apparent polling issue caused missing data.
SEK430, CA	1929003-19	The Teflon filter was perforated. Cause of filter damage was not determined but possibly due to acorn woodpecker activity.
UND002, VT	1927001-52 1928001-52	The flow pump malfunctioned.

Table 13 Field Problems Affecting Data Collection

Days to Resolution	Problem Count
30	428
60	13
90	1
Unresolved by End of Quarter	31

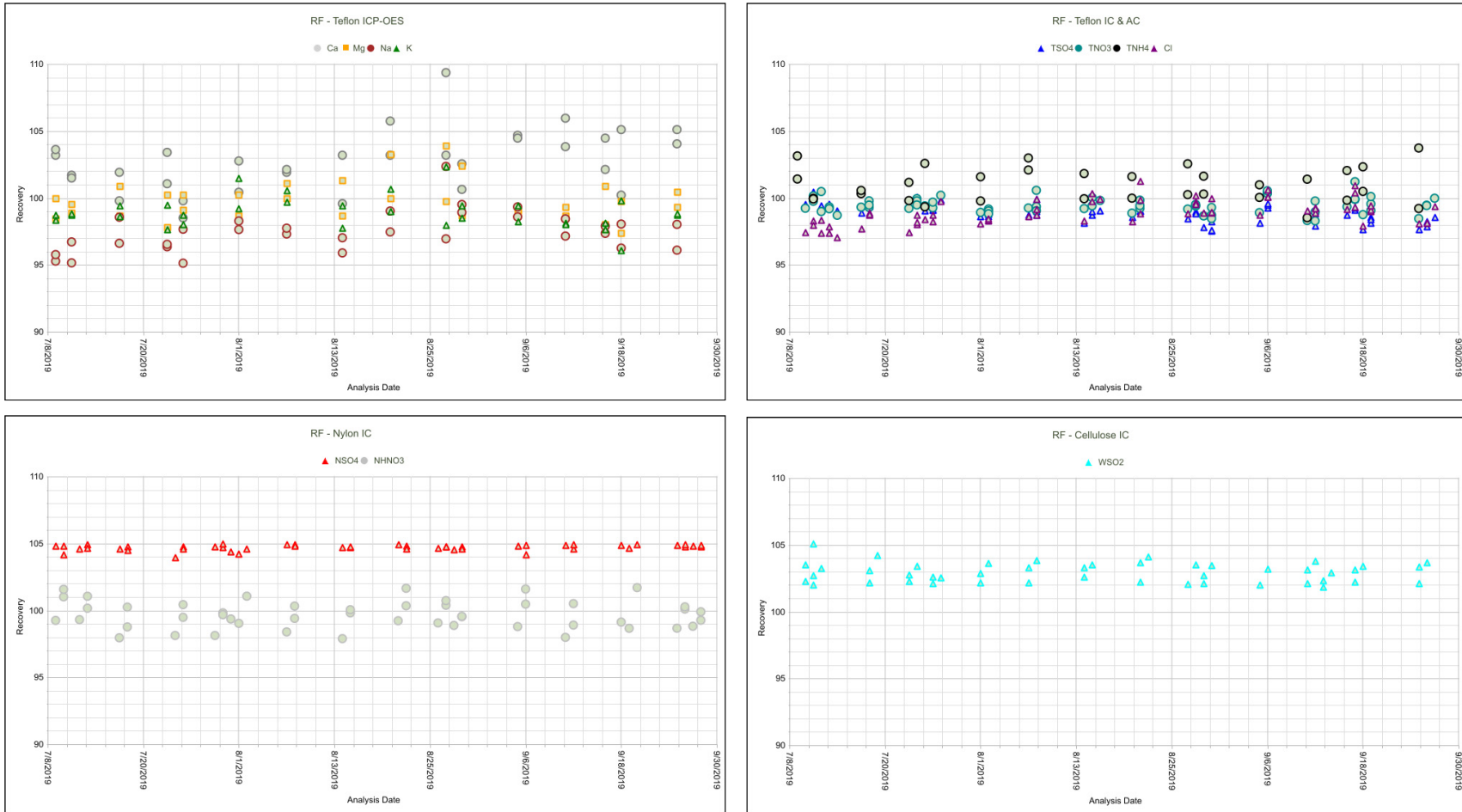**Figure 1** Reference Standard Results for Third Quarter 2019 (percent recovery)

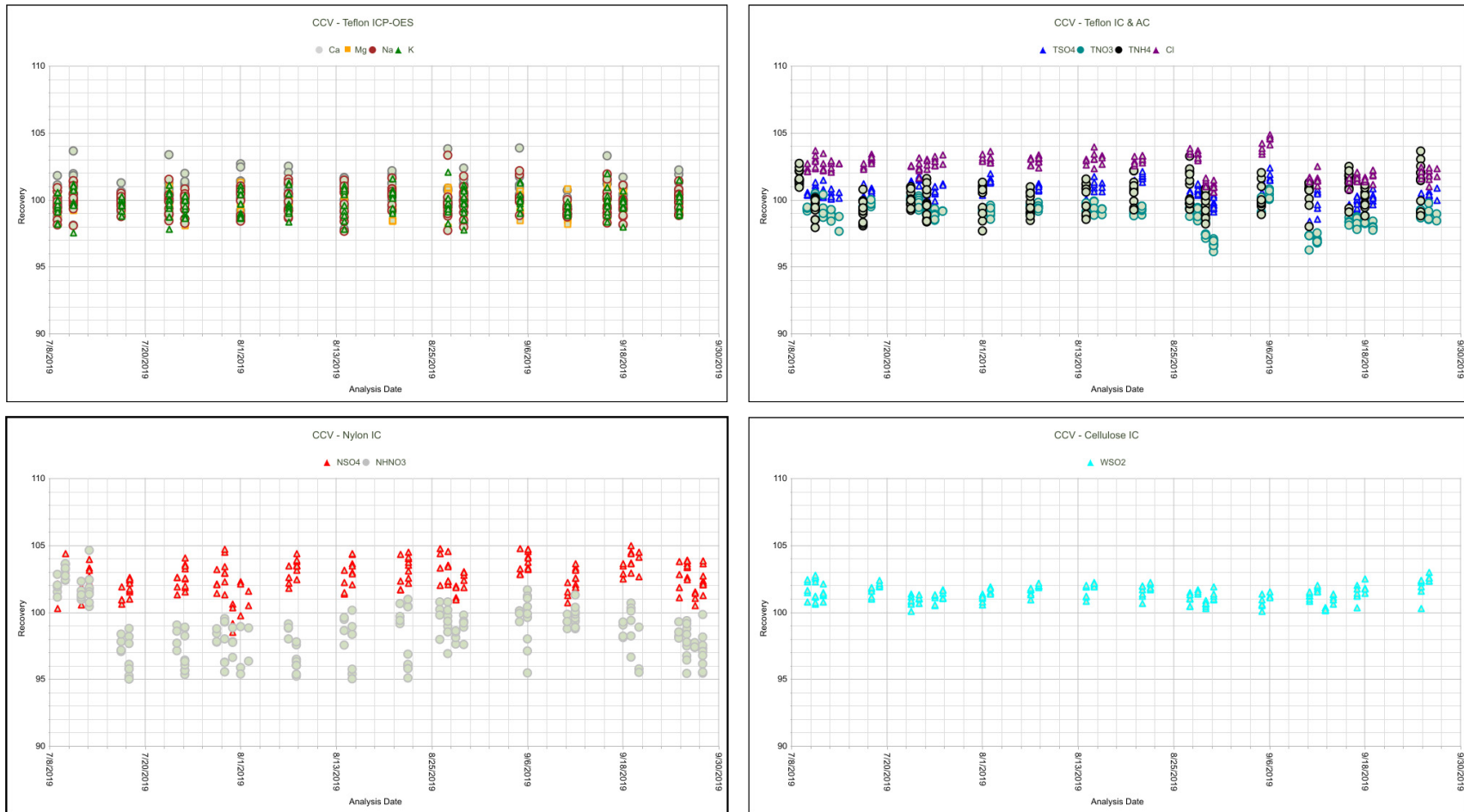**Figure 2** Continuing Calibration Spike Results for Third Quarter 2019 (percent recovery)

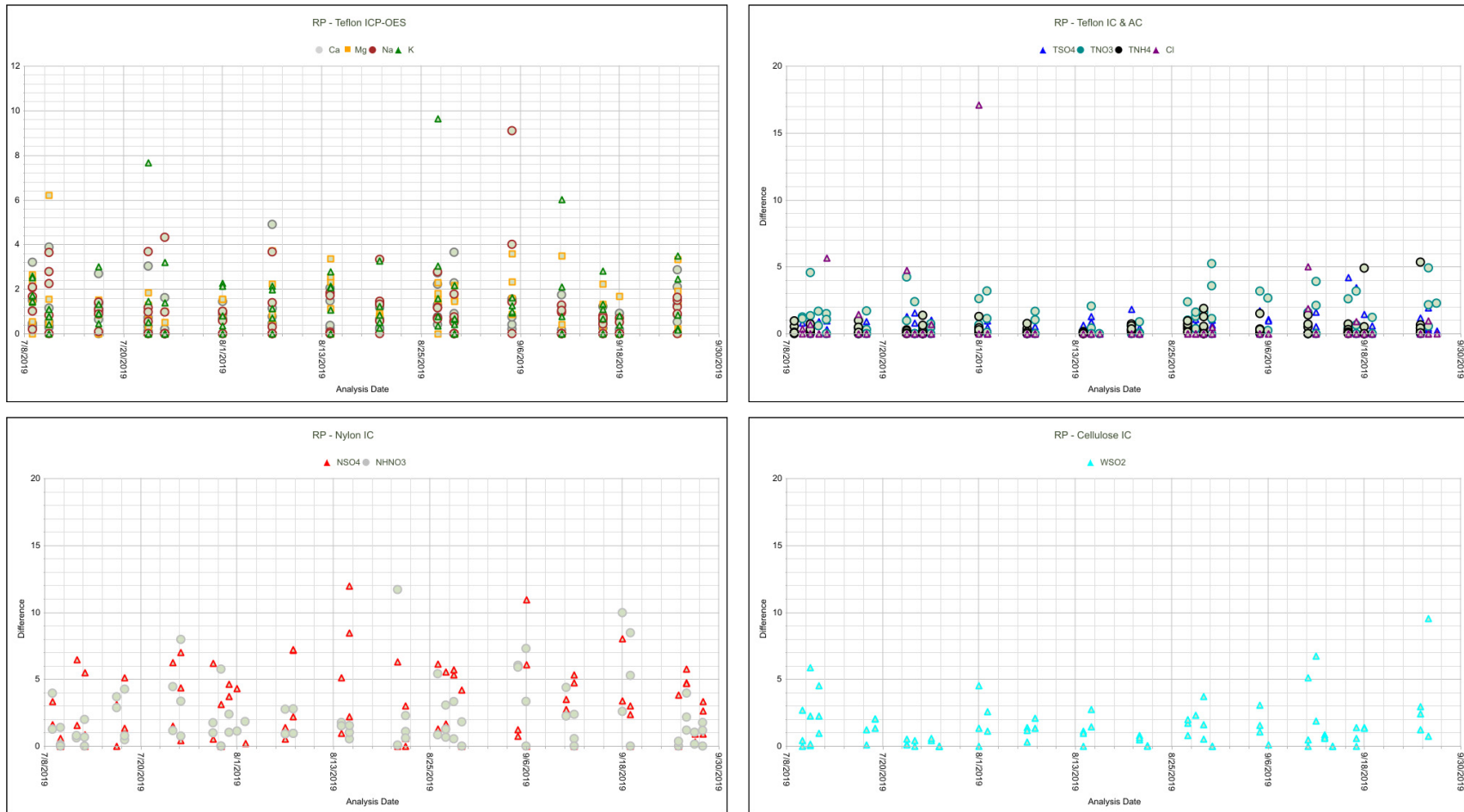**Figure 3** Replicate Sample Analysis Results for Third Quarter 2019 (percent difference)

Figure 4 Laboratory Control Sample Results for Third Quarter 2019 (percent recovery)
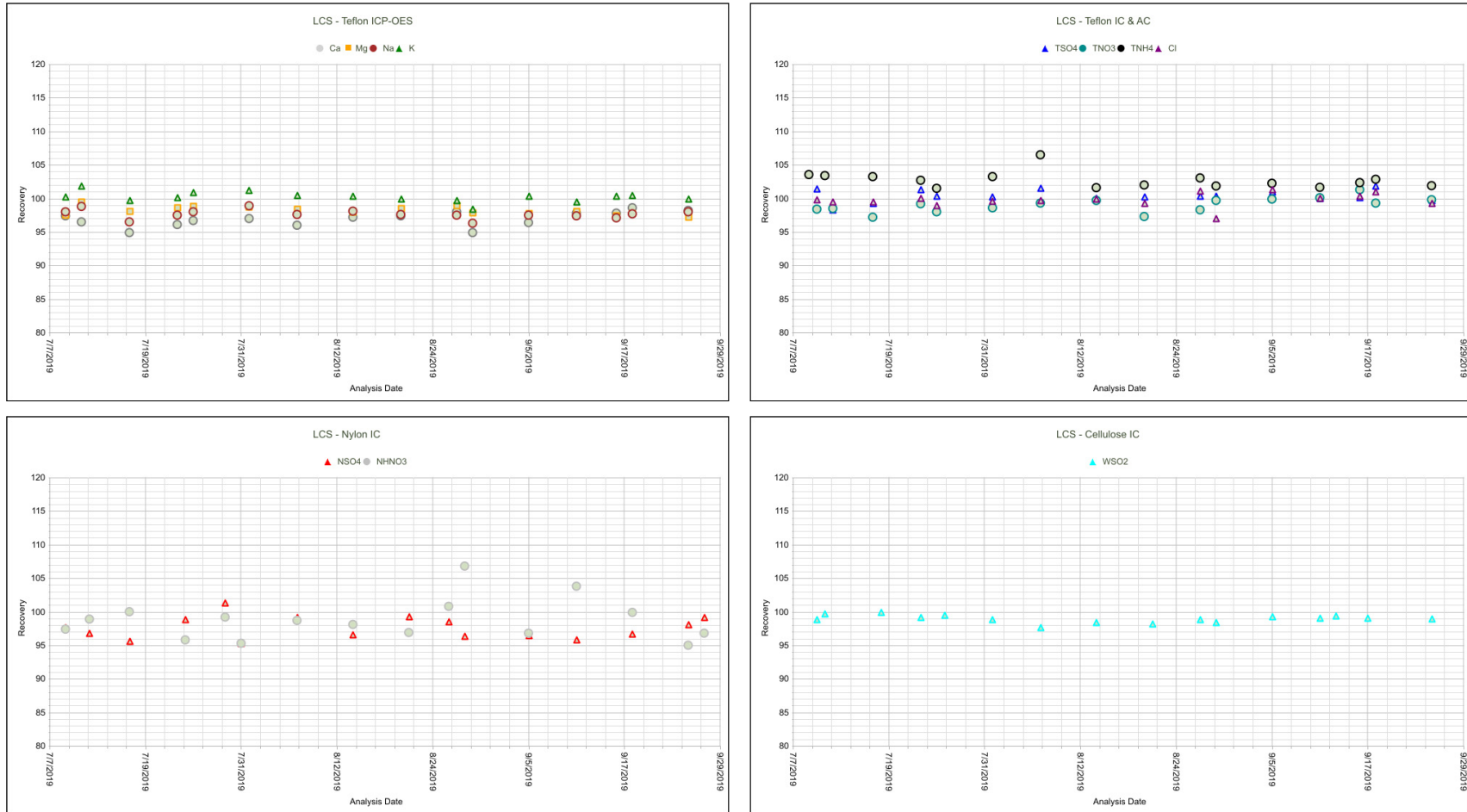
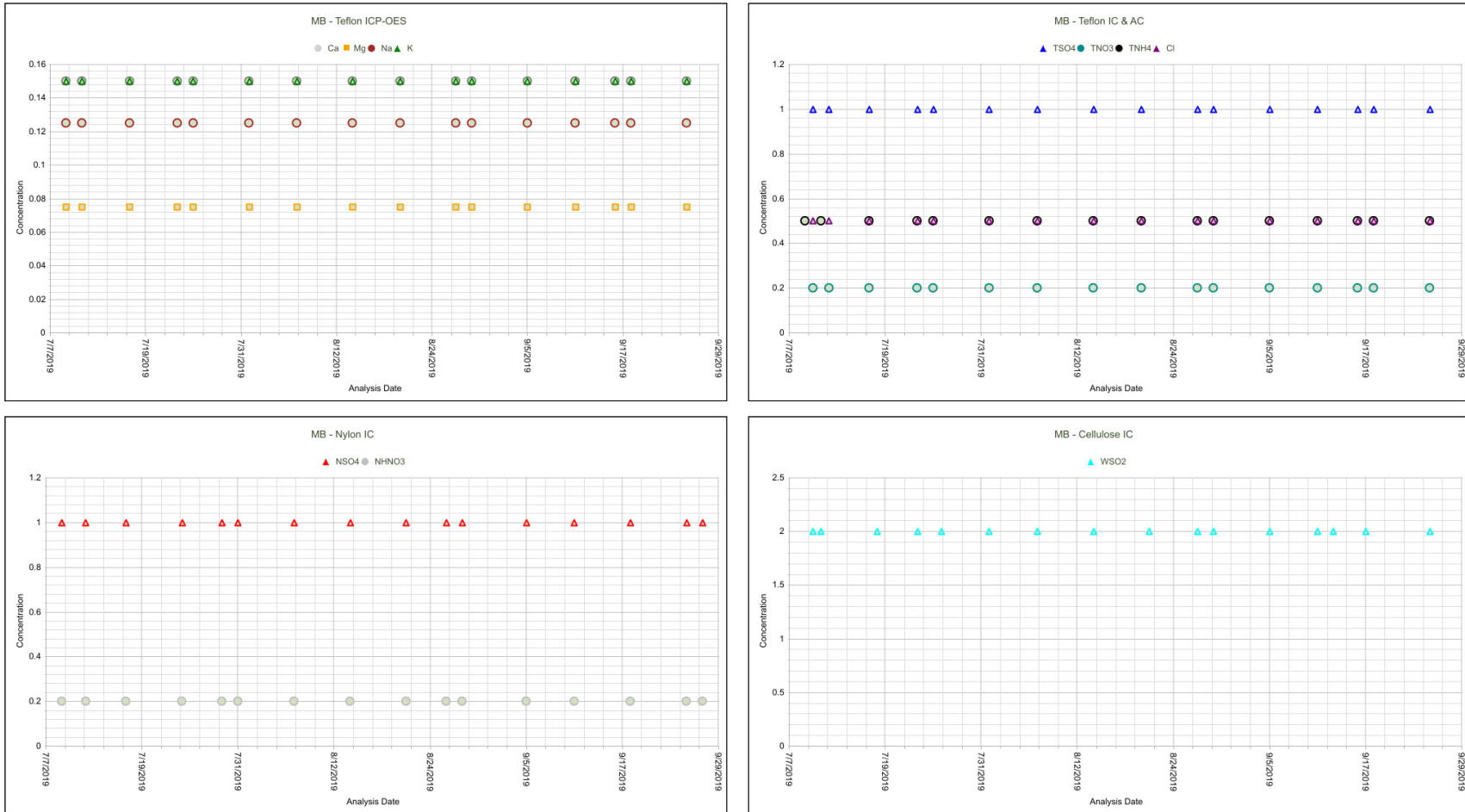**Figure 5** Method Blank Analysis Results for Third Quarter 2019 (total micrograms)

Figure 6 Laboratory Blank Analysis Results for Third Quarter 2019 (total micrograms)
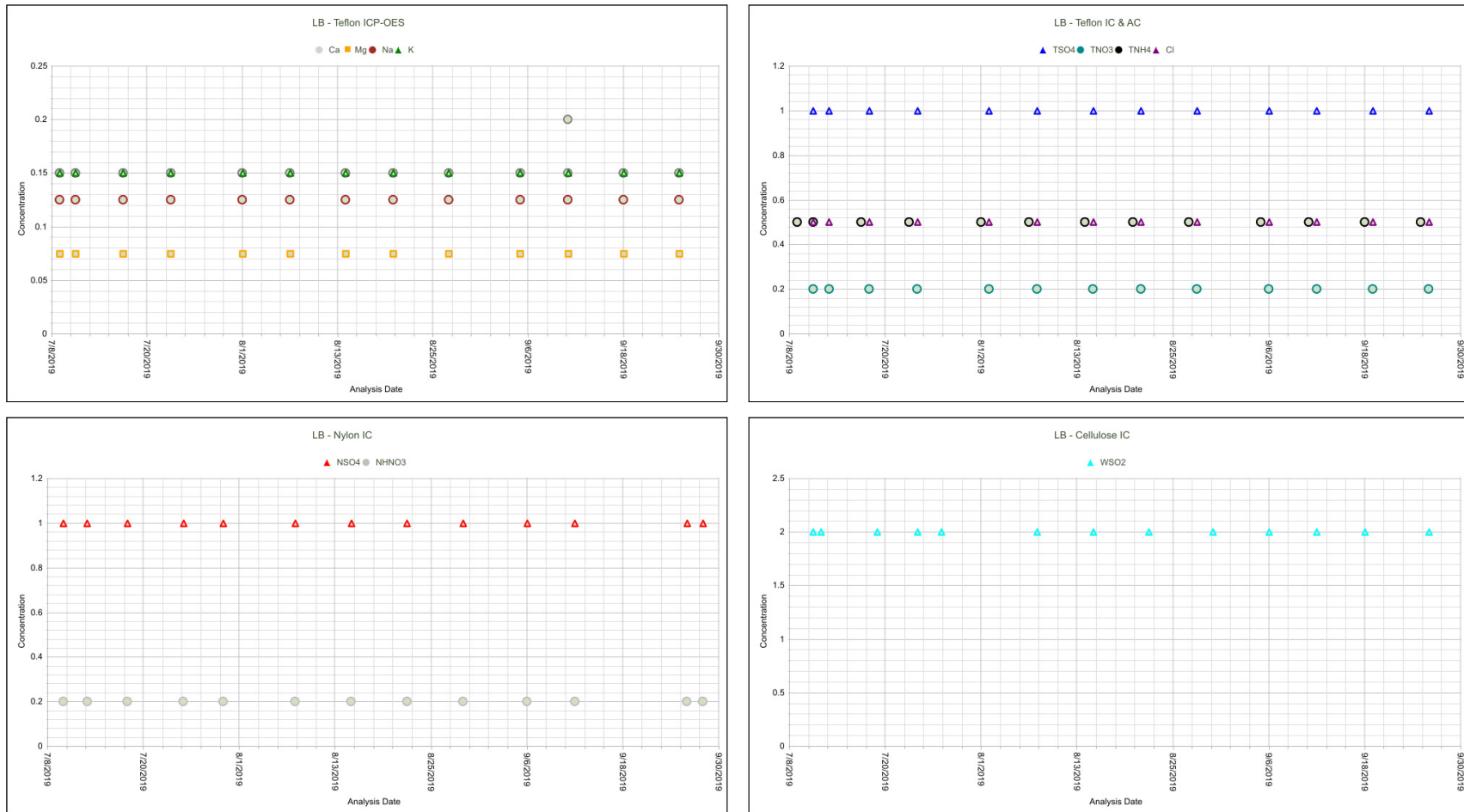
Figure 7 Field Blank Analysis Results for Third Quarter 2019 (total micrograms)