New York State Biomonitoring Program for Trace Elements

Event #1, 2017

Trace Elements in Whole Blood, Urine, and Serum

April, 2017

Wadsworth Center
NEW YORK STATE DEPARTMENT OF HEALTH
Trace Elements Laboratory

Event #1, 2017:
Trace Elements in Whole Blood, Urine, and Serum

4/19/2017

Dear Laboratory Director,

This report summarizes performance for the first biomonitoring proficiency test (PT) event of 2017 for **Trace Elements in Whole Blood, Urine, and Serum**. One of the key goals of this PT program is to achieve harmonization of biomonitoring data for trace elements.

Target Value Assignment and Performance Evaluation

For these PT materials, target values have been assigned for a limited number of trace elements that are gradable under criteria set by the NYS DOH Biomonitoring PT program. See assay-specific narratives for details. Data for additional trace elements are reported and are included here in order to characterize the PT materials more completely. Participant data and descriptive statistics are provided for educational purposes. No target value or acceptable range is implied.

Where the data permit, robust statistics were used to assign target values based on Algorithm A as defined by ISO 13528:2005E *"Statistical methods for use in proficiency testing by inter-laboratory comparisons"* [1]. Acceptable ranges for the "graded elements" are based on consensus criteria and/or those set by the NYS DOH's PT program. For example, some are fixed based on US regulatory guidelines (Pb, Cd) while for other elements the criteria are based on a consensus of the Network of PT scheme organizers for trace elements in occupational and environmental laboratory medicine [2]. Quality specifications are element and matrix specific; full details are provided under each element specific narrative.

A confidential, three-digit code number assigned by PT program staff identifies all laboratory participants.

Samples for the next PT event (Event #2 of 2017) will be shipped July 12, 2017. Comments about this report may be directed to trel@health.ny.gov.

Sincerely,

Patrick J. Parsons, PhD
Chief, Inorganic and Nuclear Chemistry
Division of Environmental Sciences
Wadsworth Center

Aubrey L. Galusha, PhD
Coordinator, Biomonitoring PT Program,
Division of Environmental Sciences
Wadsworth Center

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Event #1, 2017

Trace Elements in Whole Blood

Wadsworth Center
NEW YORK STATE DEPARTMENT OF HEALTH
Trace Elements Laboratory

Event #1, 2017:
Trace Elements in Whole Blood

PT Materials

Human whole blood was purchased from ZenBio, Inc. and preserved with K_2EDTA. The company certifies that this material was "non-reactive" for HBsAg, HBV DNA, HIV-1,2 Ab, HIV-1 RNA, HCV Ab, HCV RNA, and STS. Units of whole blood were filtered into polypropylene containers through cheesecloth to remove particulates and supplemented with arsenic (As), cadmium (Cd), cobalt (Co), chromium (Cr), mercury (Hg), manganese (Mn), lead (Pb), barium (Ba), beryllium (Be), copper (Cu), molybdenum (Mo), nickel (Ni), platinum (Pt), antimony (Sb), selenium (Se), tin (Sn), titanium (Ti), thallium (Tl), uranium (U), vanadium (V), tungsten (W), and zinc (Zn). Whole blood samples were placed on a rocker overnight prior to aliquoting 2-mL into polypropylene vials. PT samples were stored at -80°C until the week of the PT event, when they were thawed at 4°C prior to circulation to laboratories for analysis.

Graded Elements

Seven elements in whole blood are formally graded: As, Cd, Co, Cr, Hg, Mn and Pb. Target values for the graded elements are assigned to these pools based on (a) the robust mean calculated from data reported by all laboratories, or (b) where a robust mean is not possible, the arithmetic mean after outlier deletion.

Additional Elements

An additional 25 elements (beyond the seven graded) were reported by at least one participant: Ag, Al, Ba, Be, Bi, Cs, Cu, I, Li, Mg, Mo, Ni, Pt, Sb, Se, Sn, Sr, Te, Th, Ti, Tl, U, V, W, and Zn. These data are included here to provide a more complete characterization of the PT materials. All results reported by participant laboratories are tabulated and organized by lab code. The PT data are graphed for visual comparison purposes for all elements where at least five laboratories reported a value greater than the LOD. A statistical summary table is provided for samples where at least two comparable values were reported as above the LOD.

The summary statistics for the additional elements are provided for educational purposes only, i.e., no acceptable response is implied. However, it is expected that each laboratory would wish to investigate a potential source of bias if warranted by these data. Future events might result in additional elements becoming graded if a consensus can be reached regarding desired quality specifications.

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Results for Event #1, 2017
Whole Blood Arsenic (As)

Summary Statistics

	Whole Blood As (µg/L)				
	BE17-01	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
Target (Arithmetic Mean ($\bar{x}$))	10.4	23.7	16.1	4.4	41.2
Upper Limit	16.4	29.7	22.1	10.4	49.4
Lower Limit	4.4	17.7	10.1	0	33
Arithmetic SD (s)	1.6	3.4	2.1	0.8	5.8
Arithmetic RSD (%)	15.4	14.3	13.0	18.2	14.1
Number of Sample Measurements (N)	8	8	8	8	8

The acceptable range is based on quality specifications:
±6 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±6 µg/L at concentrations less than or equal to 30 µg/L. These quality specifications were established by New York State Department of Health's Wadsworth Center, the PT Program organizer.

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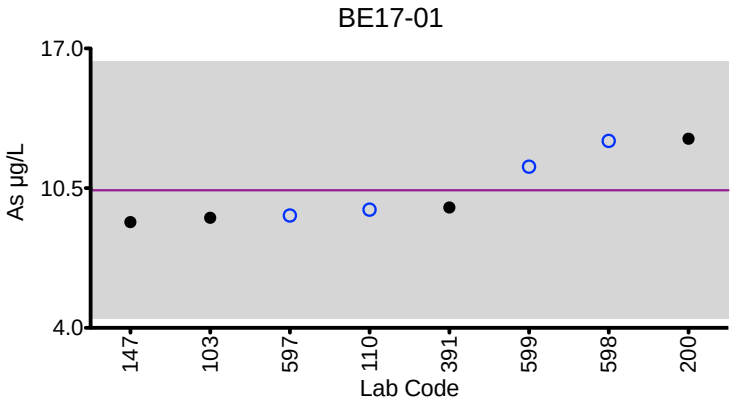
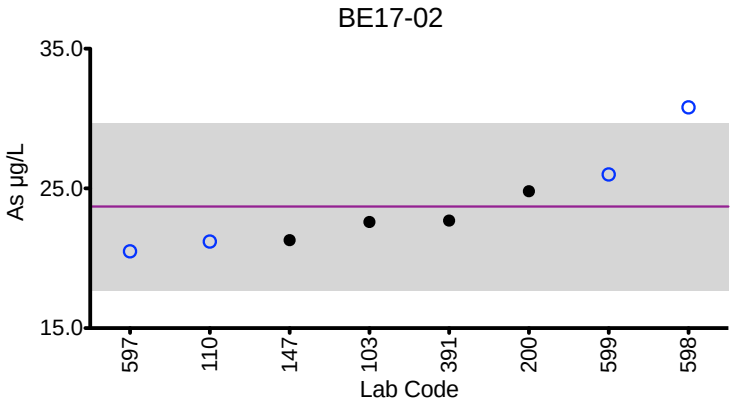
Results for Event #1, 2017
Whole Blood Arsenic (As)
Performance of Participating Laboratories

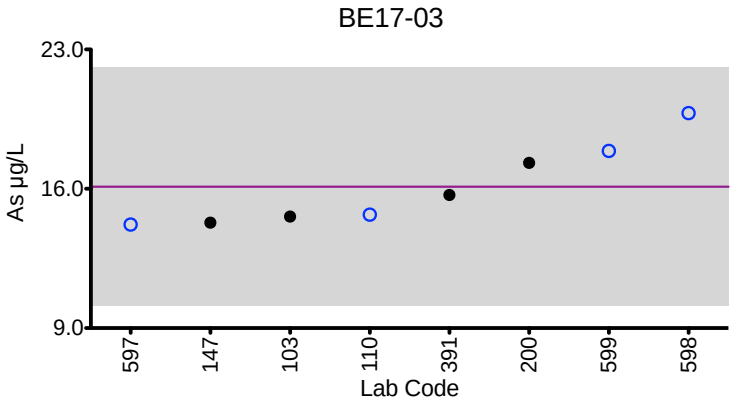
		Whole Blood As (µg/L)				
Lab Code	**Method**	**BE17-01**	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
	Target	**10.4**	**23.7**	**16.1**	**4.4**	**41.2**
103	DRC/CC-ICP-MS	9.12	22.6	14.6	4.00	38.6
110	DRC/CC-ICP-MS	9.5	21.2	14.7	3.9	38.4
147	ICP-MS	8.92	21.3	14.3	3.87	38.1
200	ICP-MS	12.8	24.8	17.3	*0.8	42.0
293	DRC/CC-ICP-MS	9.6	22.6	14.4	3.96	40.1
391	DRC/CC-ICP-MS	9.6	22.7	15.686	3.904	37.21
597	DRC/CC-ICP-MS	9.23	20.5	14.2	3.82	36.7
598	DRC/CC-ICP-MS	12.7	30.8 ↑	19.8	5.71	54.0 ↑
599	DRC/CC-ICP-MS	11.5	26.0	17.9	5.3	44.2

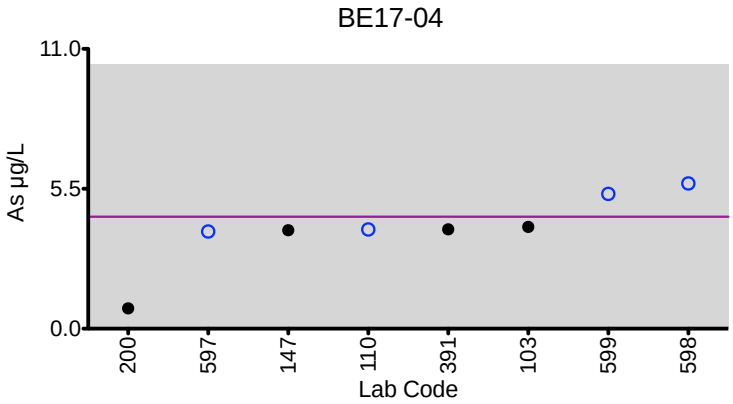
Based on the grading criteria for As in Whole Blood, 96% of results were satisfactory, with 1 of the 9 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

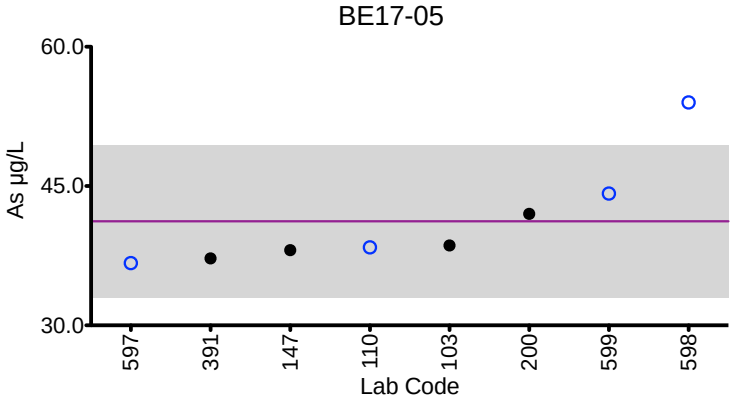
Results for Event #1, 2017: Whole Blood As











Legend:

o CHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the arithmetic mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±6 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±6 µg/L at concentrations less than or equal to 30 µg/L.

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Results for Event #1, 2017
Whole Blood Cadmium (Cd)

Summary Statistics

	Whole Blood Cd (µg/L)				
	BE17-01	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
Target (Robust Mean (x*))	6.6	3.6	1.6	2.3	8.4
Upper Limit	7.6	4.6	2.6	3.3	9.7
Lower Limit	5.6	2.6	0.6	1.3	7.1
Robust SD (s*)	0.3	0.3	0.1	0.2	0.4
Robust RSD (%)	4.3	7.3	6.5	8.4	4.5
Number of Sample Measurements (N)	14	14	14	14	14
Standard Uncertainty (*u*)	0.095	0.087	0.034	0.066	0.125

The acceptable range is based on quality specifications:
±1 µg/L or ±15% around the target value, whichever is greater; thus, it is fixed at ±1 µg/L at concentrations less than or equal to 6.7 µg/L. These quality specifications are based on those used by US OSHA for occupational exposure.

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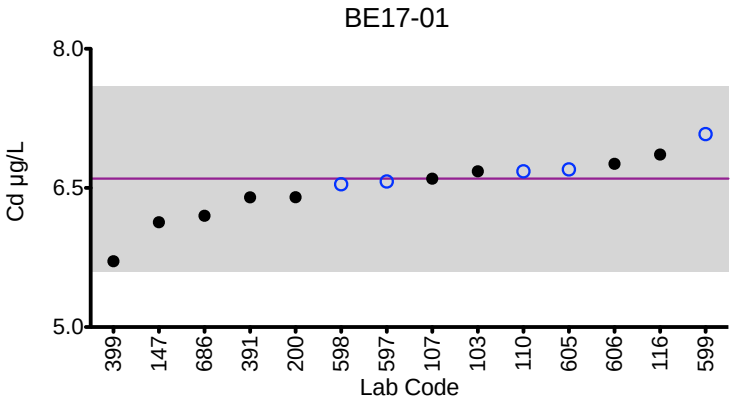
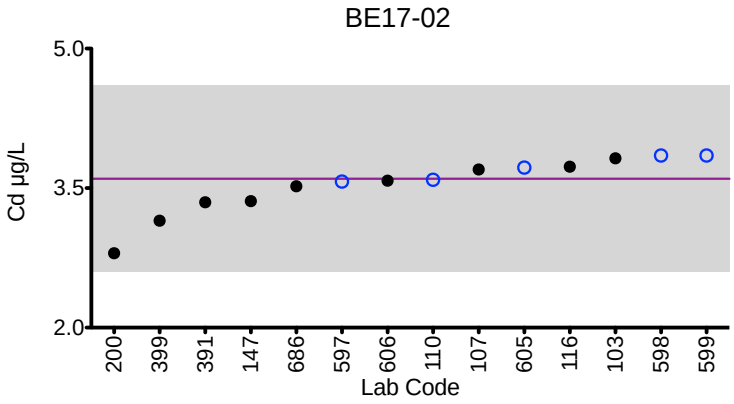
Results for Event #1, 2017
Whole Blood Cadmium (Cd)
Performance of Participating Laboratories

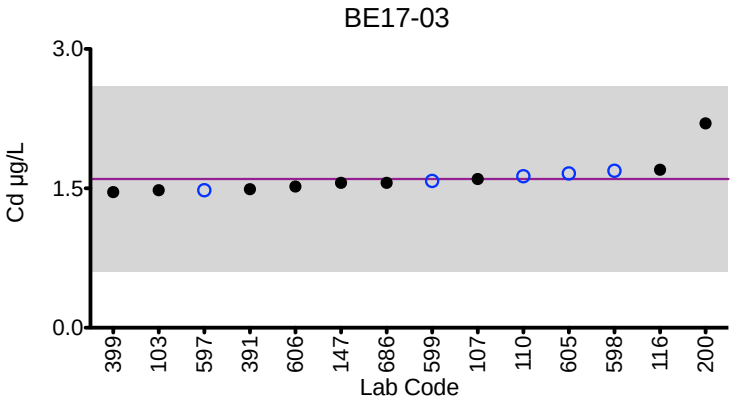
		Whole Blood Cd (µg/L)				
Lab Code	**Method**	**BE17-01**	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
	Target	**6.6**	**3.6**	**1.6**	**2.3**	**8.4**
103	DRC/CC-ICP-MS	6.68	3.82	1.48	2.54	8.33
107	ICP-MS	6.6	3.7	1.6	2.4	8.5
110	ICP-MS	6.68	3.59	1.63	2.41	8.74
116	DRC/CC-ICP-MS	6.86	3.73	1.70	2.47	9.53
147	ICP-MS	6.13	3.36	1.56	2.20	8.00
200	ICP-MS	6.4	2.8	2.2	2.2	8.4
293	DRC/CC-ICP-MS	6.31	3.45	1.53	2.26	8.01
391	DRC/CC-ICP-MS	6.398	3.347	1.491	1.856	7.694
399	DRC/CC-ICP-MS	5.71	3.15	1.46	2.05	7.70
597	DRC/CC-ICP-MS	6.57	3.57	1.48	2.14	8.14
598	DRC/CC-ICP-MS	6.54	3.85	1.69	2.35	8.26
599	DRC/CC-ICP-MS	7.08	3.85	1.58	2.36	8.85
605	ICP-MS	6.7	3.72	1.66	3.62 ↑	8.53
606	ICP-MS	6.76	3.58	1.52	2.42	8.54
686	ICP-MS	6.20	3.52	1.56	2.33	8.49

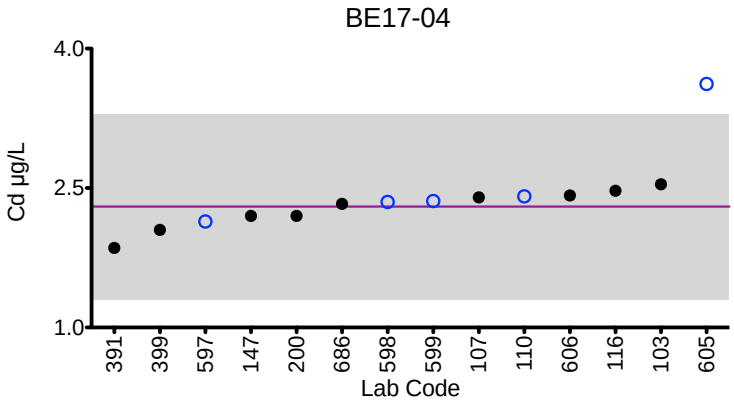
Based on the grading criteria for Cd in Whole Blood, 99% of results were satisfactory, with 0 of the 15 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

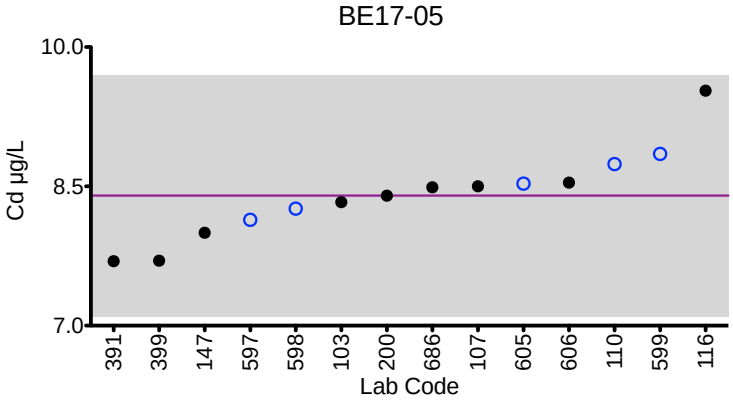
Results for Event #1, 2017: Whole Blood Cd











Legend:

o CHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the robust mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±1 µg/L or ±15% around the target value, whichever is greater; thus, it is fixed at ±1 µg/L at concentrations less than or equal to 6.7 µg/L.

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Results for Event #1, 2017
Whole Blood Cobalt (Co)

Summary Statistics

	Whole Blood Co (µg/L)				
	BE17-01	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
Target (Arithmetic Mean ($\bar{x}$))	6.5	2.0	0.6	12.3	3.7
Upper Limit	8.0	3.5	2.1	14.8	5.2
Lower Limit	5.0	0.5	0.0	9.8	2.2
Arithmetic SD (s)	0.6	0.2	0.1	0.8	0.3
Arithmetic RSD (%)	9.2	10.0	16.7	6.5	8.1
Number of Sample Measurements (N)	7	7	7	7	7

The acceptable range is based on quality specifications:
±1.5 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±1.5 µg/L at concentrations less than or equal to 7.5 µg/L. These quality specifications were established based on discussions with the US FDA, and represent a consensus from a network of Trace Element PT program organizers

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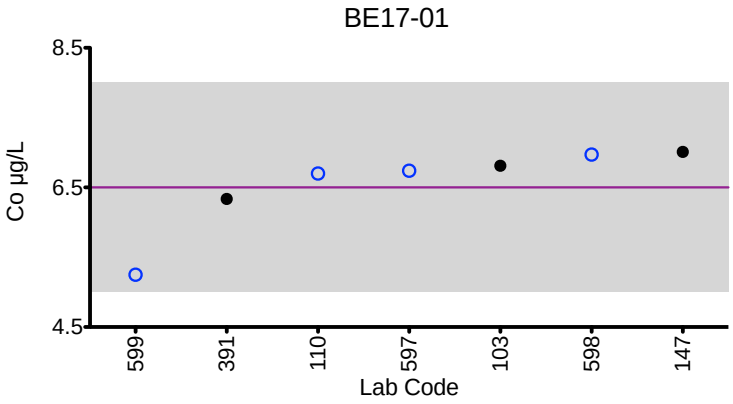
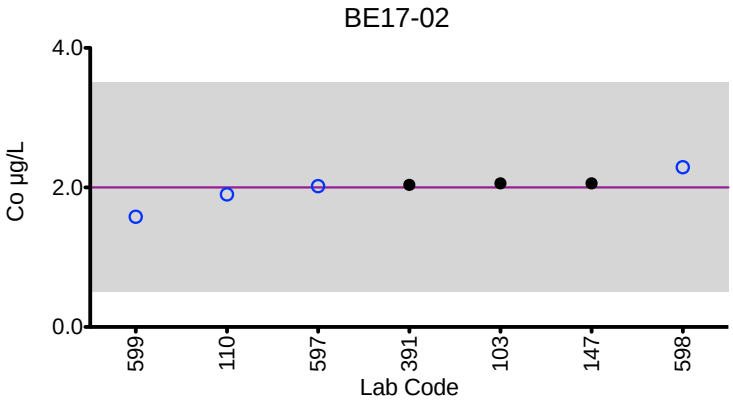
Results for Event #1, 2017
Whole Blood Cobalt (Co)
Performance of Participating Laboratories

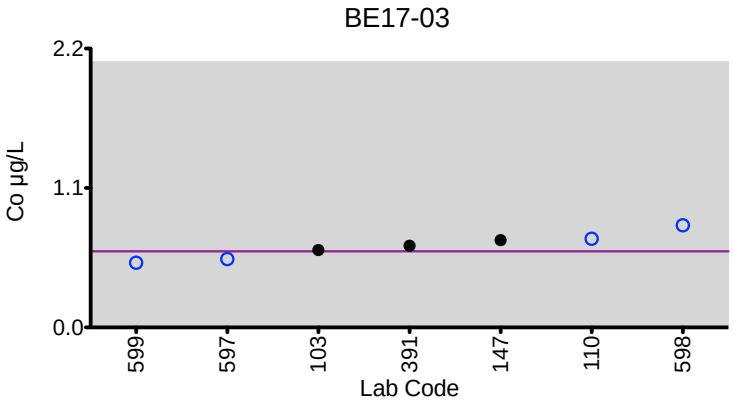
		Whole Blood Co (µg/L)				
Lab Code	**Method**	**BE17-01**	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
	Target	**6.5**	**2.0**	**0.6**	**12.3**	**3.7**
103	DRC/CC-ICP-MS	6.81	2.06	0.611	12.7	3.85
110	ICP-MS	6.7	1.9	0.7	13.1	3.9
147	ICP-MS	7.01	2.06	0.689	13.1	3.98
391	DRC/CC-ICP-MS	6.336	2.037	0.645	12.224	3.575
597	DRC/CC-ICP-MS	6.74	2.02	0.539	12.0	3.55
598	ICP-MS	6.97	2.29	0.806	12.28	3.84
599	DRC/CC-ICP-MS	5.25	1.58	0.51	10.76	3.11

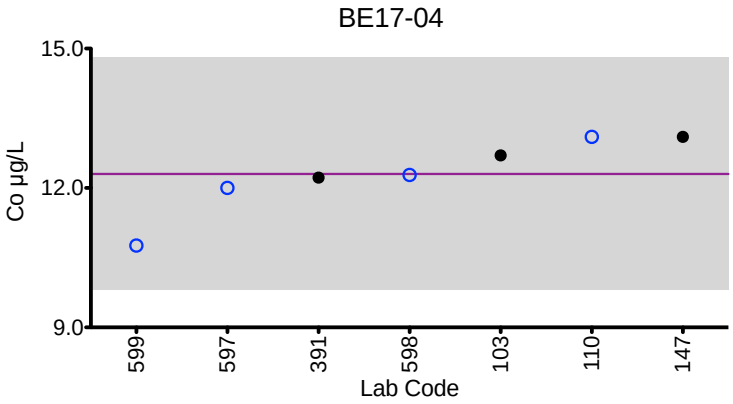
Based on the grading criteria for Co in Whole Blood, 100% of results were satisfactory, with 0 of the 7 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

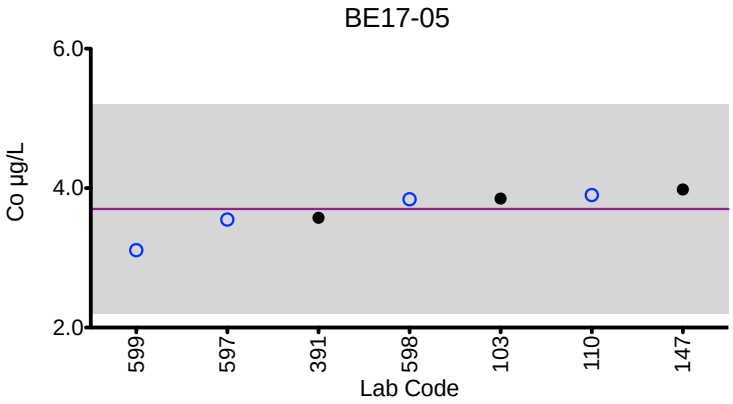
Results for Event #1, 2017: Whole Blood Co











Legend:

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Horizontal purple line = assigned target value based on the arithmetic mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±1.5 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±1.5 µg/L at concentrations less than or equal to 7.5 µg/L.

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Results for Event #1, 2017
Whole Blood Chromium (Cr)

Summary Statistics

	Whole Blood Cr (µg/L)				
	BE17-01	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
Target (Arithmetic Mean ($\bar{x}$))	2.3	7.1	5.1	13.3	NA
Upper Limit	4.3	9.1	7.1	16.0	NA
Lower Limit	0.3	5.1	3.1	10.6	NA
Arithmetic SD (s)	0.3	1.0	1.9	1.2	NA
Arithmetic RSD (%)	13.0	14.1	37.3	9.0	NA
Number of Sample Measurements (N)	6	7	7	7	NA

The acceptable range is based on quality specifications:
±2 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±2 µg/L at concentrations less than or equal to 10 µg/L. These quality specifications were established based on discussions with the US FDA, and represent a consensus from a network of Trace Element PT program organizers

Sample BE17-05 was treated as an educational challenges for the purposes of this event, and is not graded. Statistical data were not calculated due to lack of a consensus value.

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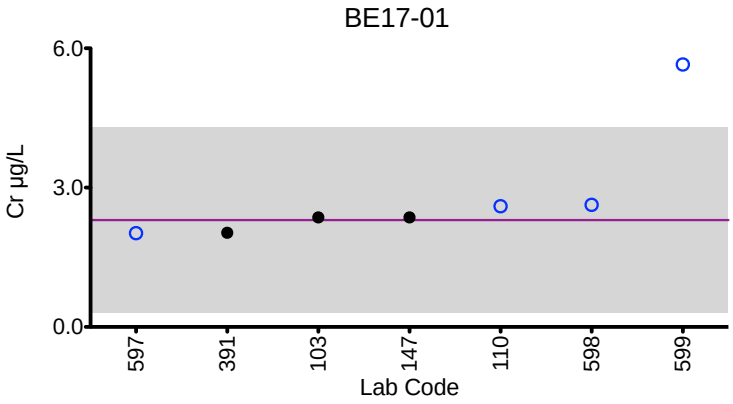
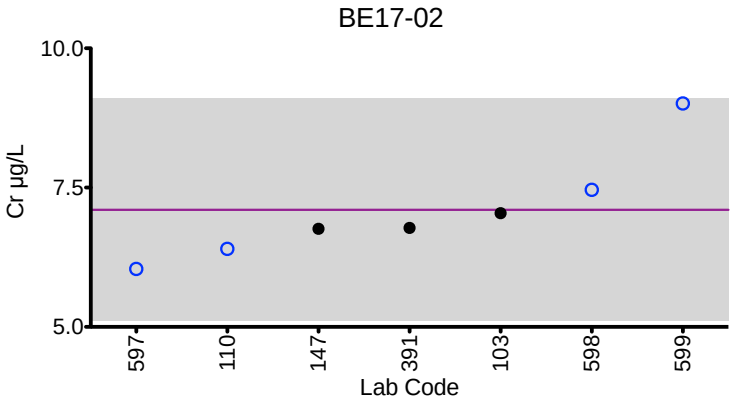
Results for Event #1, 2017
Whole Blood Chromium (Cr)
Performance of Participating Laboratories

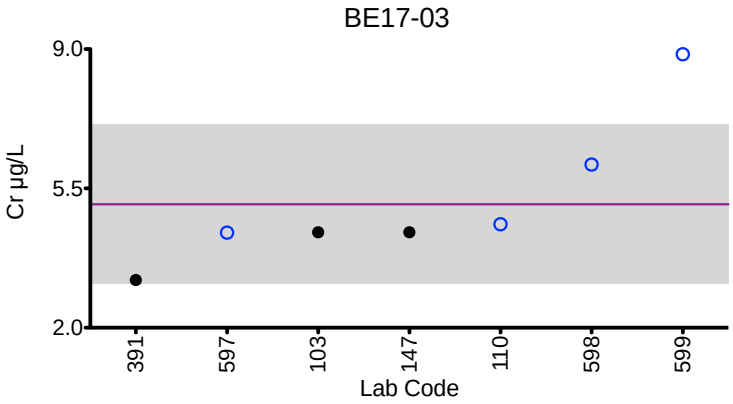
		Whole Blood Cr (µg/L)				
Lab Code	**Method**	**BE17-01**	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
	Target	**2.3**	**7.1**	**5.1**	**13.3**	**NA**
103	DRC/CC-ICP-MS	2.36	7.04	4.40	13.6	< 0.257
110	DRC/CC-ICP-MS	2.6	6.4	4.6	13.6	1.2
147	DRC/CC-ICP-MS	2.36	6.76	4.40	13.3	0.603
391	DRC/CC-ICP-MS	2.028	6.776	3.2	11.172	0.4
597	DRC/CC-ICP-MS	2.02	6.04	4.39	12.9	<0.8
598	DRC/CC-ICP-MS	2.63	7.46	6.10	13.0	1.40
599	DRC/CC-ICP-MS	*5.65 ↑	9.01	8.87 ↑	15.37	3.57

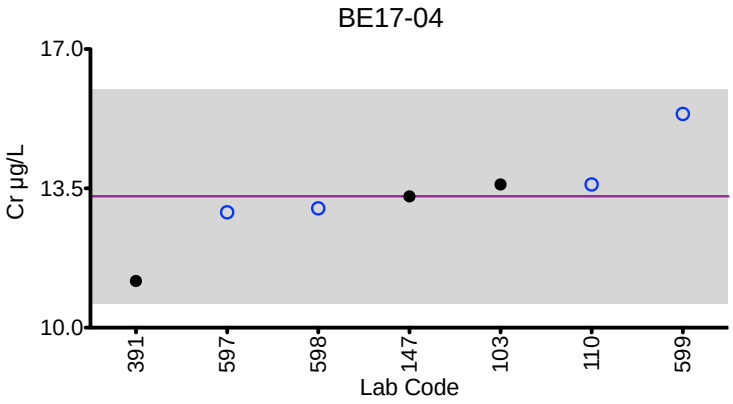
Based on the grading criteria for Cr in Whole Blood, 94% of results were satisfactory, with 1 of the 7 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

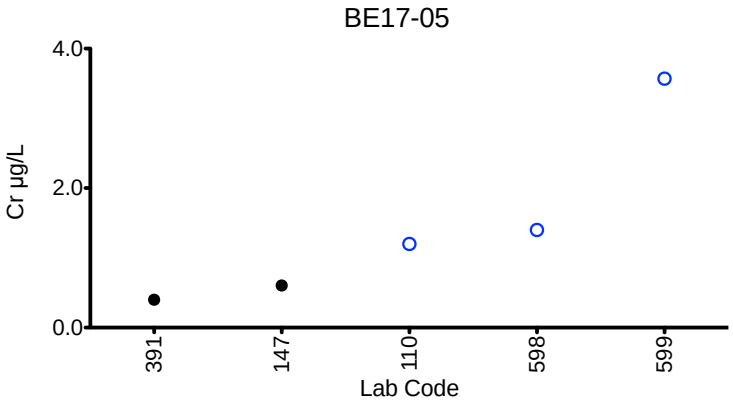
Results for Event #1, 2017: Whole Blood Cr











Legend:

o CHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the arithmetic mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±2 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±2 µg/L at concentrations less than or equal to 10 µg/L.

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Results for Event #1, 2017
Whole Blood Mercury (Hg)

Summary Statistics

	Whole Blood Hg (µg/L)				
	BE17-01	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
Target (Robust Mean (x*))	46.5	22.4	10.3	2.2	5.4
Upper Limit	60.5	29.1	13.4	5.2	8.4
Lower Limit	32.6	15.7	7.2	0.0	2.4
Robust SD (s*)	3.3	1.2	0.4	0.2	0.6
Robust RSD (%)	7.2	5.3	4.3	8.8	11.5
Number of Sample Measurements (N)	12	12	12	12	12
Standard Uncertainty (*u*)	1.21	0.429	0.161	0.070	0.225

The acceptable range is based on quality specifications:
±3 µg/L or ±30% around the target value, whichever is greater; thus, it is fixed at ±3 µg/L at concentrations less than or equal to 10 µg/L. These quality specifications were established by New York State Department of Health's Wadsworth Center, the PT Program organizer.

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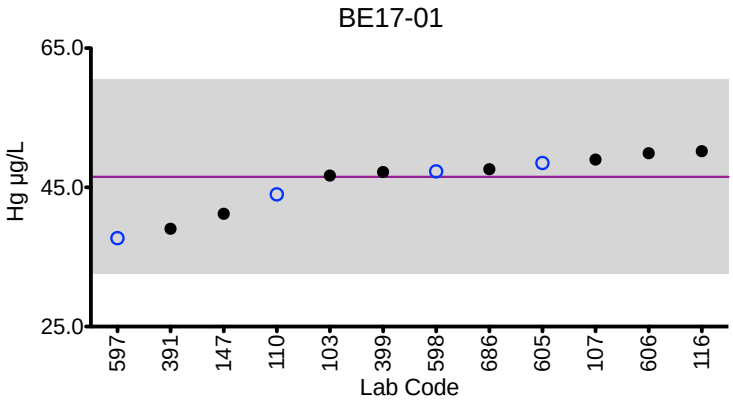
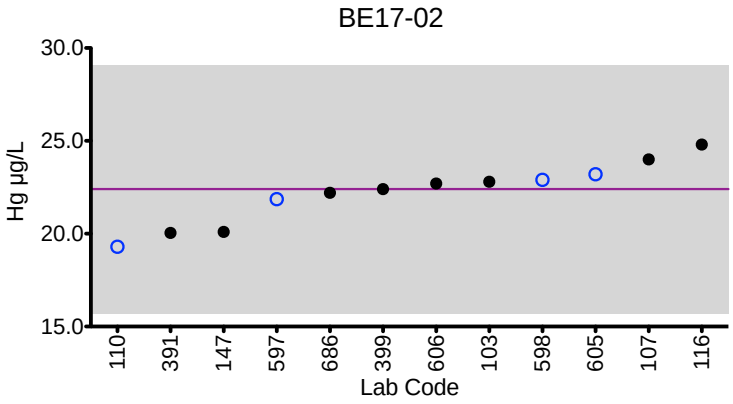
Results for Event #1, 2017
Whole Blood Mercury (Hg)
Performance of Participating Laboratories

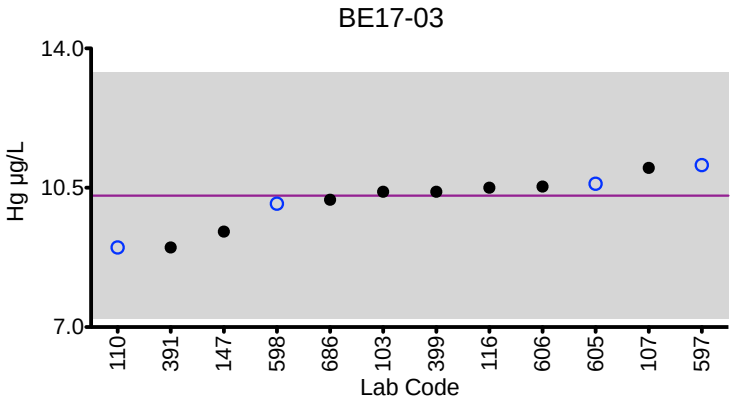
		Whole Blood Hg (µg/L)				
Lab Code	**Method**	**BE17-01**	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
	Target	**46.5**	**22.4**	**10.3**	**2.2**	**5.4**
103	DRC/CC-ICP-MS	46.7	22.8	10.4	2.37	5.19
107	DRC/CC-ICP-MS	49	24	11	2.4	6.7
110	ICP-MS	44.0	19.3	9.00	2.40	5.06
116	DRC/CC-ICP-MS	50.2	24.8	10.5	2.18	6.95
147	ICP-MS	41.2	20.1	9.40	2.20	4.81
293	DRC/CC-ICP-MS	40.18	19.36	9.0	2.26	4.71
391	CV-AAS	39.05	20.04	9.0	1.966	1.635 ↓
399	DRC/CC-ICP-MS	47.2	22.4	10.4	2.21	5.52
597	DMA	37.70	21.86	11.070	1.9	6.05
598	ICP-MS	47.3	22.9	10.1	2.43	5.19
605	ICP-MS	48.5	23.2	10.6	2.22	5.07
606	ICP-MS	49.9	22.7	10.531	2.04	5.81
686	ICP-MS	47.6	22.2	10.2	2.16	5.63

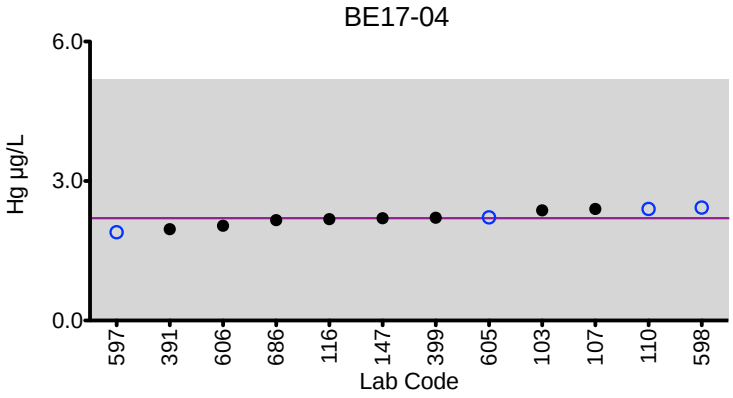
Based on the grading criteria for Hg in Whole Blood, 98% of results were satisfactory, with 0 of the 13 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

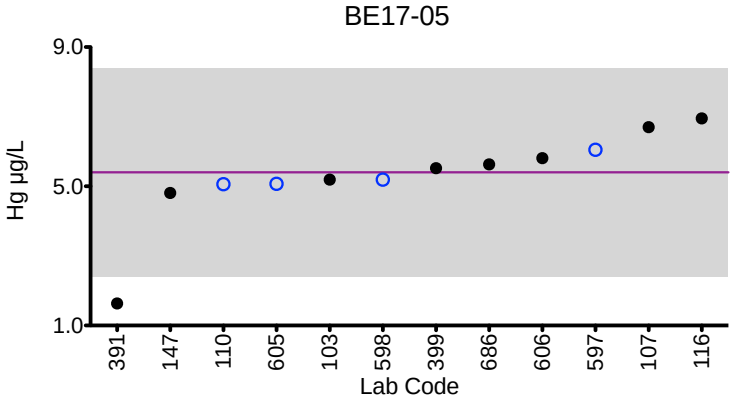
Results for Event #1, 2017: Whole Blood Hg











Legend:

o CHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the robust mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±3 µg/L or ±30% around the target value, whichever is greater; thus, it is fixed at ±3 µg/L at concentrations less than or equal to 10 µg/L.

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Results for Event #1, 2017
Whole Blood Manganese (Mn)

Summary Statistics

	Whole Blood Mn (µg/L)				
	BE17-01	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
Target (Robust Mean (x*))	29.7	22.1	13.5	23.3	20.7
Upper Limit	34.7	25.9	16.5	27.3	24.2
Lower Limit	24.7	18.3	10.5	19.3	17.2
Robust SD (s*)	1.9	2.1	1.2	1.5	1.6
Robust RSD (%)	6.4	9.4	9.0	6.5	7.7
Number of Sample Measurements (N)	10	10	10	10	10
Standard Uncertainty (*u*)	0.747	0.818	0.481	0.598	0.635

The acceptable range is based on quality specifications:
±3 µg/L or ±17% around the target value, whichever is greater; thus, it is fixed at ±3 µg/L at concentrations less than or equal to 17 µg/L. These quality specifications were recently proposed by a network of Trace Element PT program organizers (Praamsma M, et al. An assessment of clinical laboratory performance for the determination of manganese in blood and urine. Clinical Chemistry and Laboratory Medicine. 2016 In press.)

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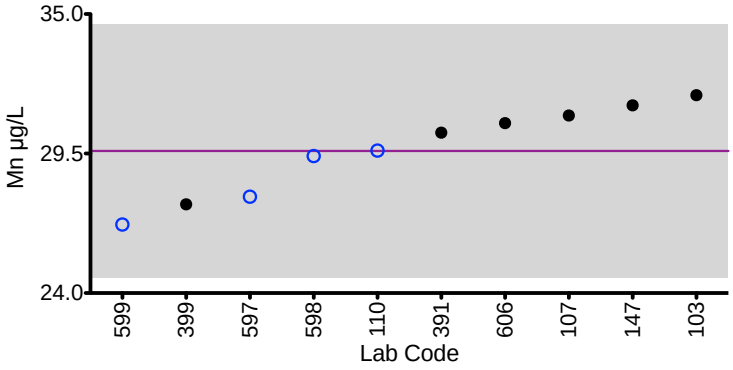
Results for Event #1, 2017
Whole Blood Manganese (Mn)
Performance of Participating Laboratories

		Whole Blood Mn (µg/L)				
Lab Code	**Method**	**BE17-01**	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
	Target	**29.7**	**22.1**	**13.5**	**23.3**	**20.7**
103	DRC/CC-ICP-MS	31.8	24.0	14.4	24.7	22.1
107	DRC/CC-ICP-MS	31	23	14	25	22
110	ICP-MS	29.6	21.6	13.3	23.4	21.0
147	ICP-MS	31.4	22.9	14.3	24.3	21.7
293	DRC/CC-ICP-MS	26.18	18.2 ↓	9.8 ↓	19.1 ↓	17.45
391	DRC/CC-ICP-MS	30.323	25.347	15.7	23.223	22.459
399	DRC/CC-ICP-MS	27.5	19.7	12.2	21.9	19.2
597	DRC/CC-ICP-MS	27.8	18.3 ↓	12.0	19.5	16.9 ↓
598	DRC/CC-ICP-MS	29.4	22.8	13.3	23.1	20.0
599	DRC/CC-ICP-MS	26.7	19.1	12.3	21.8	18.6
606	ICP-MS	30.7	22.2	13.875	24.0	21.3

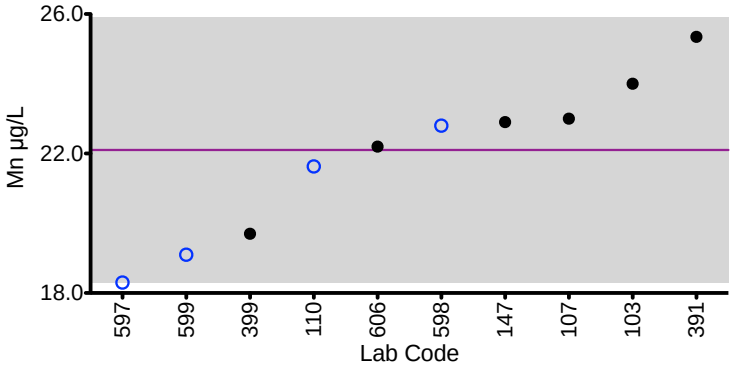
Based on the grading criteria for Mn in Whole Blood, 91% of results were satisfactory, with 2 of the 11 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

Results for Event #1, 2017: Whole Blood Mn

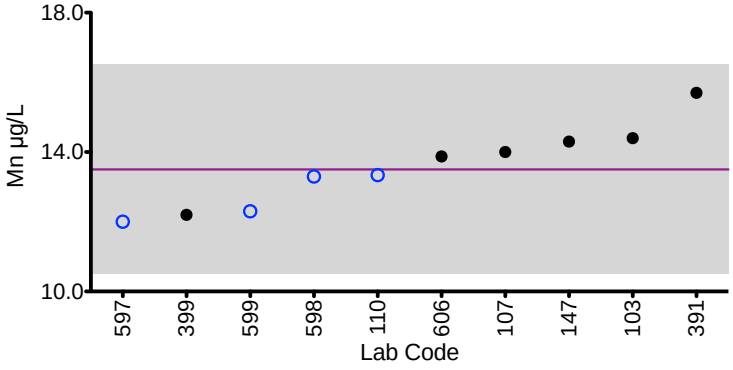
BE17-01



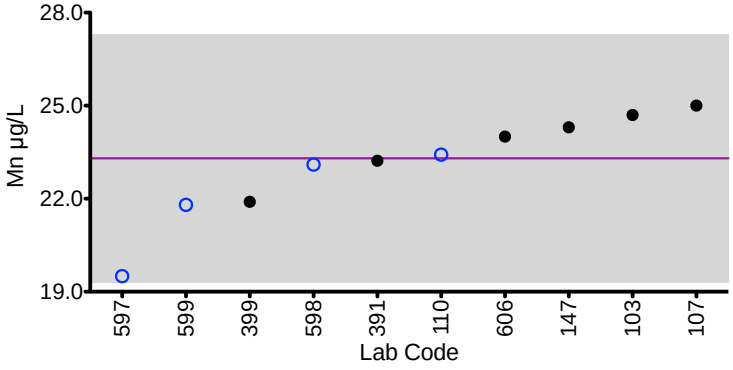
BE17-02



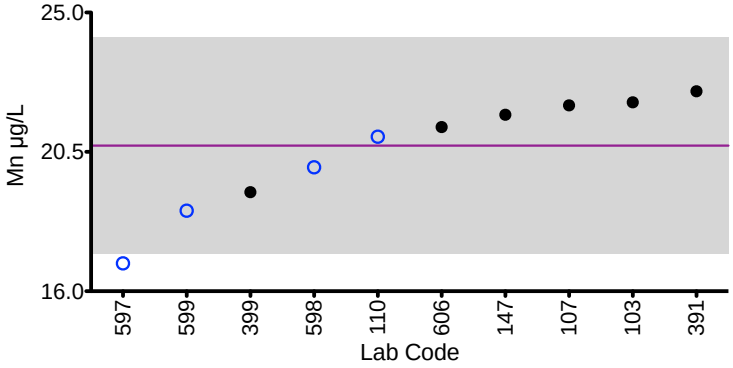
BE17-03



BE17-04



BE17-05



Legend:

o CHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the robust mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±3 µg/L or ±17% around the target value, whichever is greater; thus, it is fixed at ±3 µg/L at concentrations less than or equal to 17 µg/L.

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Results for Event #1, 2017
Whole Blood Lead (Pb)

Summary Statistics

	Whole Blood Pb (µg/dL)				
	BE17-01	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
Target (Robust Mean (x*))	11.1	1.38	32.3	3.25	17.2
Upper Limit	13.1	3.38	35.5	5.25	19.2
Lower Limit	9.1	0.00	29.1	1.25	15.2
Robust SD (s*)	0.5	0.10	1.8	0.22	0.9
Robust RSD (%)	4.8	7.4	5.5	6.9	5.2
Number of Sample Measurements (N)	16	15	16	16	16
Standard Uncertainty (*u*)	0.164	0.033	0.555	0.070	0.277

The acceptable range is based on quality specifications:
±2 µg/dL or ±10% around the target value, whichever is greater; thus, it is fixed at ±2 µg/L at concentrations less than or equal to 20 µg/dL. These quality specifications are recommended by the Clinical Laboratory Standards Institute (CLSI, C40-A2) and have been proposed for use in proficiency testing programs approved under CLIA by the Centers for Medicare and Medicaid Services (CMS) in the USA. (http://shop.clsi.org/C40.html)

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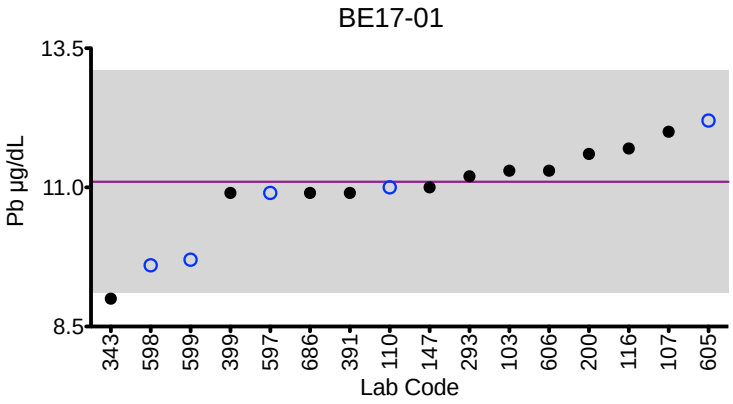
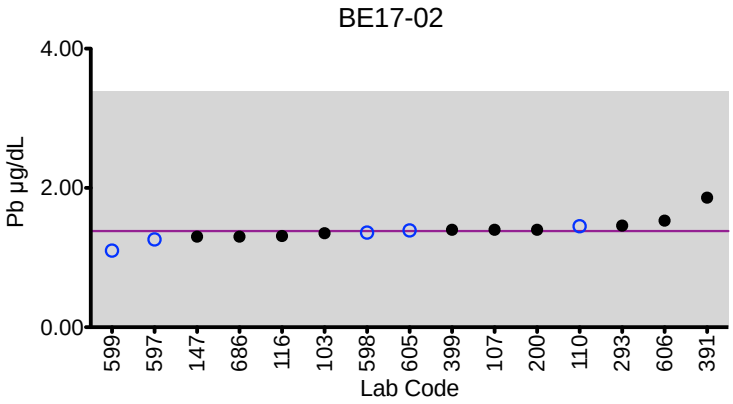
Results for Event #1, 2017
Whole Blood Lead (Pb)
Performance of Participating Laboratories

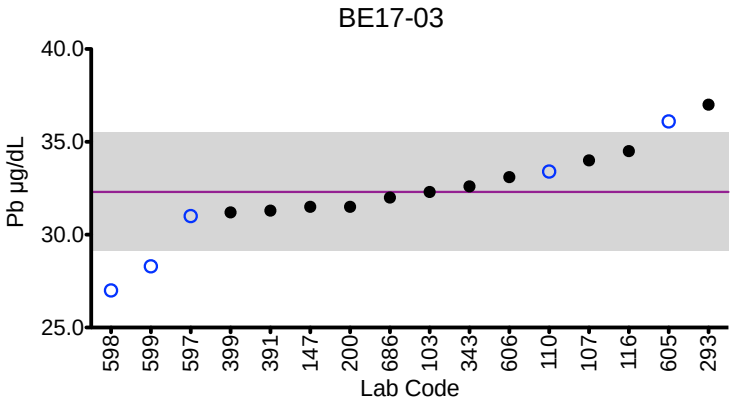
		Whole Blood Pb (µg/dL)				
Lab Code	**Method**	**BE17-01**	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
	Target	**11.1**	**1.38**	**32.3**	**3.25**	**17.2**
103	DRC/CC-ICP-MS	11.3	1.35	32.3	3.27	17.6
107	ICP-MS	12	1.4	34	3.5	18
110	ICP-MS	11.0	1.45	33.4	3.35	17.4
116	DRC/CC-ICP-MS	11.7	1.31	34.5	3.33	18.4
147	ICP-MS	11.0	1.30	31.5	3.17	17.1
200	ICP-MS	11.6	1.4	31.5	3.1	17
293	DRC/CC-ICP-MS	11.2	1.46	37 ↑	3.33	17.9
343	ASV-LeadCare	9.0 ↓	<1.9	32.6	2.2	16.3
391	ETAAS-Z	10.9	1.86	31.3	3.39	16
399	DRC/CC-ICP-MS	10.9	1.40	31.2	3.25	17.5
597	DRC/CC-ICP-MS	10.9	1.26	31.0	3.10	16.6
598	ICP-MS	9.60	1.36	27.0 ↓	2.86	14.5 ↓
599	DRC/CC-ICP-MS	9.67	1.1	28.3 ↓	2.8	14.2 ↓
605	ICP-MS	12.2	1.39	36.1 ↑	3.53	18.1
606	ICP-MS	11.3	1.53	33.1	3.53	17.5
686	ICP-MS	10.9	1.30	32.0	3.27	17.3

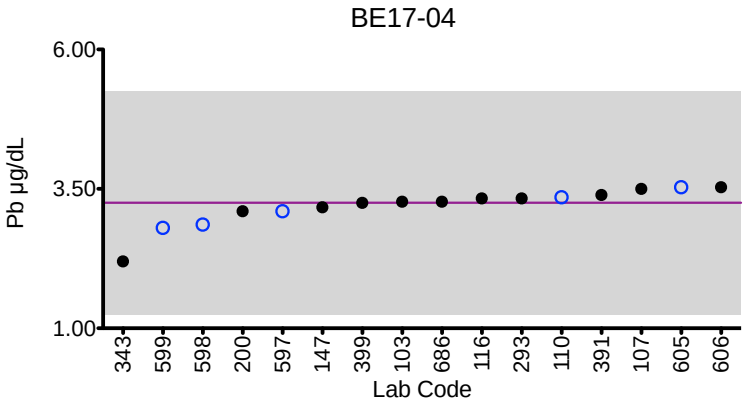
Based on the grading criteria for Pb in Whole Blood, 91% of results were satisfactory, with 2 of the 16 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

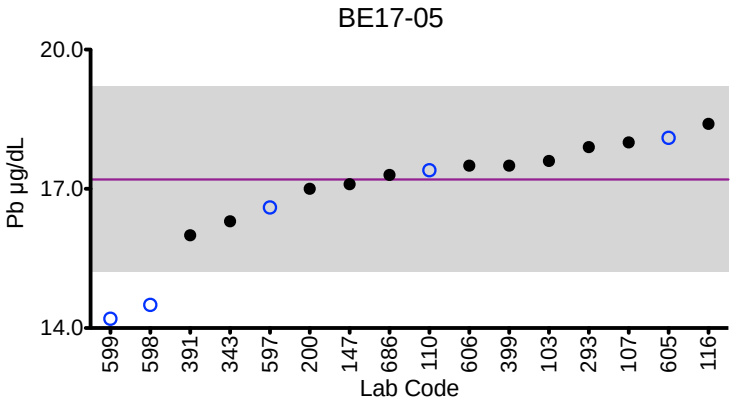
Results for Event #1, 2017: Whole Blood Pb











Legend:

○ CHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the robust mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±2 µg/dL or ±10% around the target value, whichever is greater; thus, it is fixed at ±2 µg/dL at concentrations less than or equal to 20 µg/dL.

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Results for Event #1, 2017
Additional Elements in Whole Blood: Antimony (Sb)

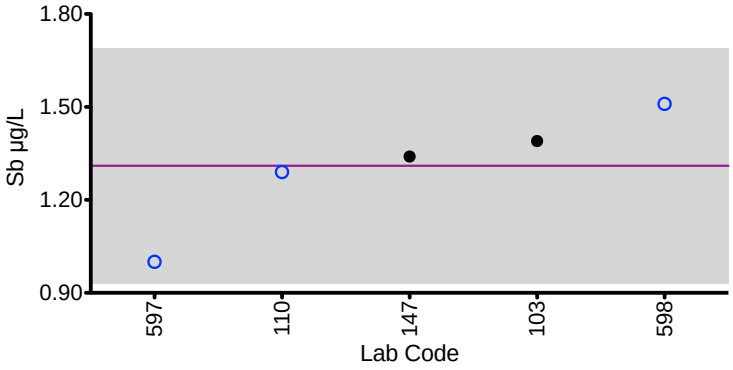
Whole Blood Sb (µg/L)						
Lab Code	**Method**	**BE17-01**	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
103	DRC/CC-ICP-MS	1.39	0.515	7.31	0.637	3.20
110	ICP-MS	1.29	0.56	7.60	0.62	2.76
147	ICP-MS	1.34	0.542	6.95	0.572	2.51
597	DRC/CC-ICP-MS	1.00	<0.3	6.79	0.31	2.39
598	ICP-MS	1.51	1.04	7.85	0.772	2.92

Summary Statistics					
	BE17-01	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
Arithmetic Mean ($\bar{x}$)	1.31	0.66	7.30	0.58	2.76
Arithmetic SD (s)	0.19	0.25	0.44	0.17	0.32
Arithmetic RSD (%)	14.5	37.9	6.0	29.3	11.6
Number of Sample Measurements (N)	5	4	5	5	5

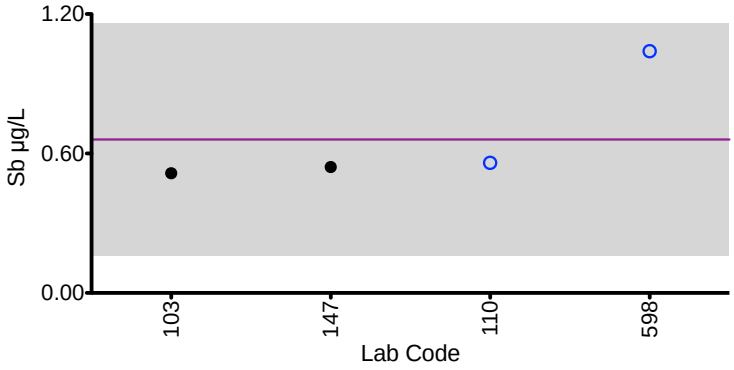
*Denotes a statistical Outlier.

Results for Event #1, 2017:
Whole Blood Sb

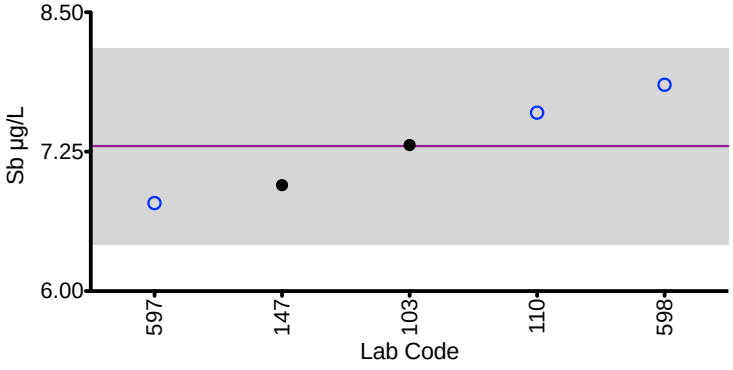
BE17-01



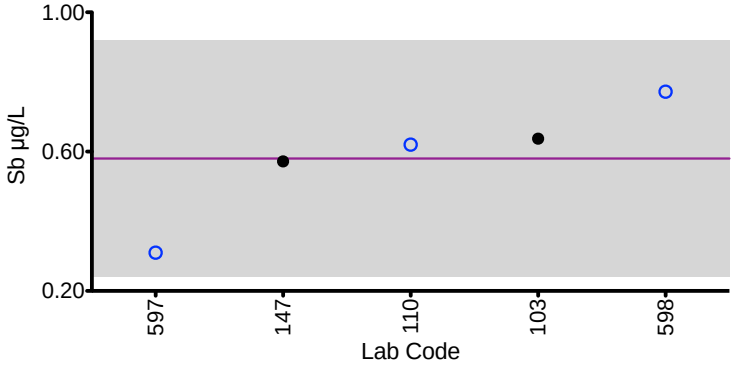
BE17-02



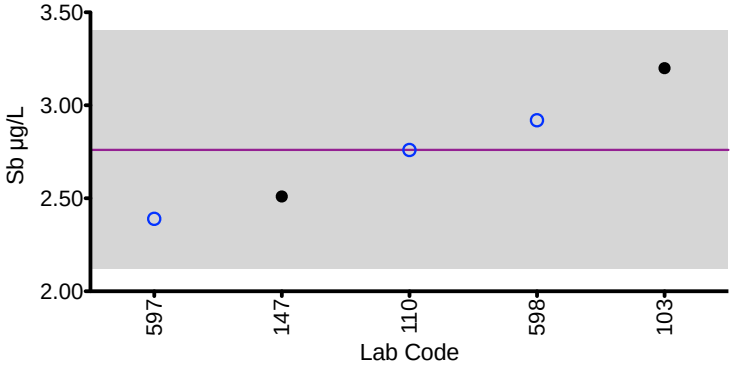
BE17-03



BE17-04



BE17-05



Legend:
○CHEAR Labs ● Other Labs
Horizontal purple line = arithmetic mean of all laboratories.
Gray area = ±2SD of the mean.

The mean and ±2SD of all laboratories are not not intended to be quality specifications and are included for informational purposes only.

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Results for Event #1, 2017
Additional Elements in Whole Blood: Selenium (Se)

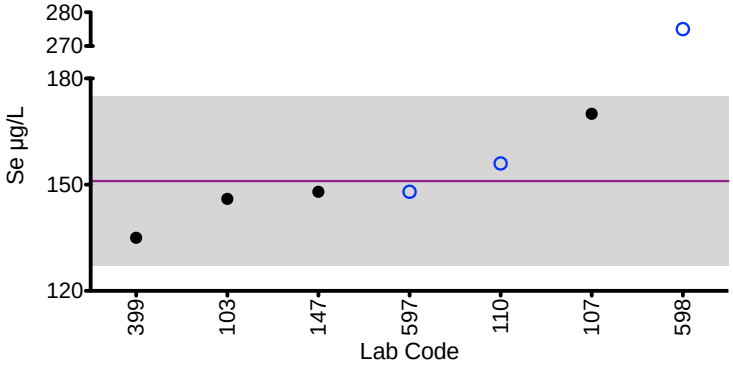
Whole Blood Se (µg/L)						
Lab Code	**Method**	**BE17-01**	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
103	DRC/CC-ICP-MS	146	262	291	177	335
107	DRC/CC-ICP-MS	170	280	320	200	370
110	DRC/CC-ICP-MS	156	237	281	73.0	318
147	ICP-MS	148	246	286	180	344
399	DRC/CC-ICP-MS	135	222	263	161	309
597	DRC/CC-ICP-MS	148	233	270	164	311
598	DRC/CC-ICP-MS	*275	*406	*440	277	*590

Summary Statistics					
	BE17-01	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
Arithmetic Mean ($\bar{x}$)	151	247	285	176	331
Arithmetic SD (s)	12	21	20	60	23
Arithmetic RSD (%)	7.9	8.5	7.0	34.1	6.9
Number of Sample Measurements (N)	6	6	6	7	6

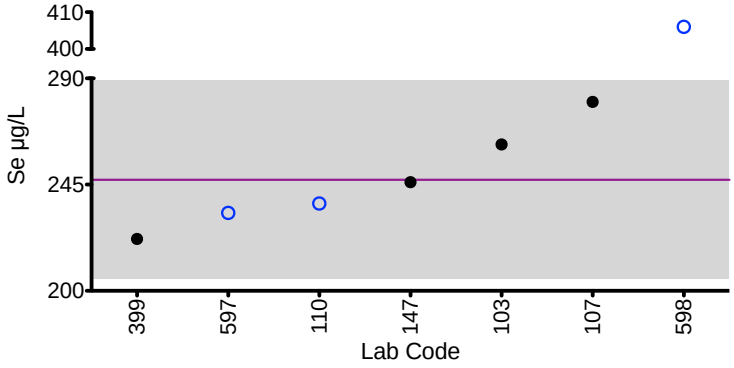
*Denotes a statistical Outlier.

Results for Event #1, 2017:
Whole Blood Se

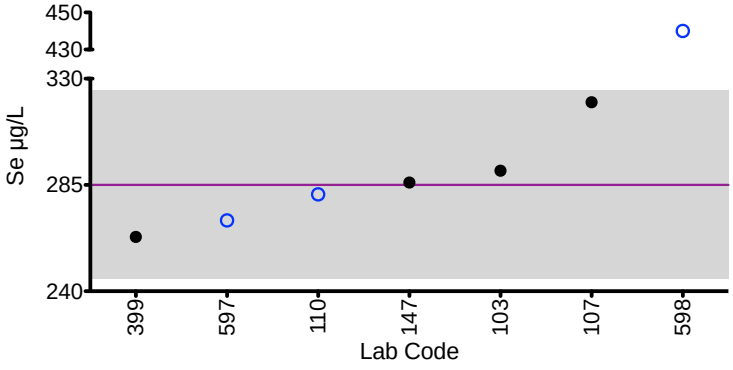
BE17-01



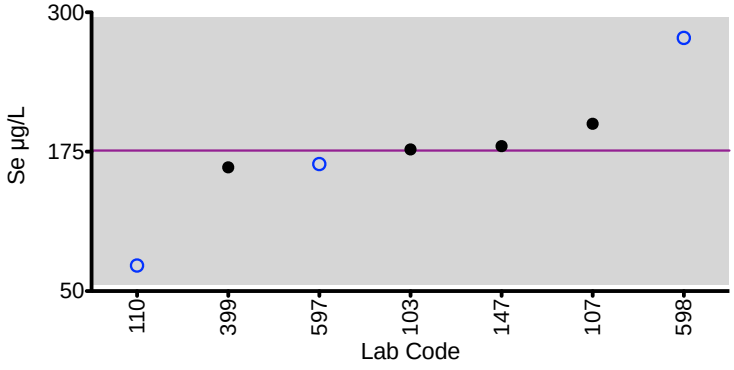
BE17-02



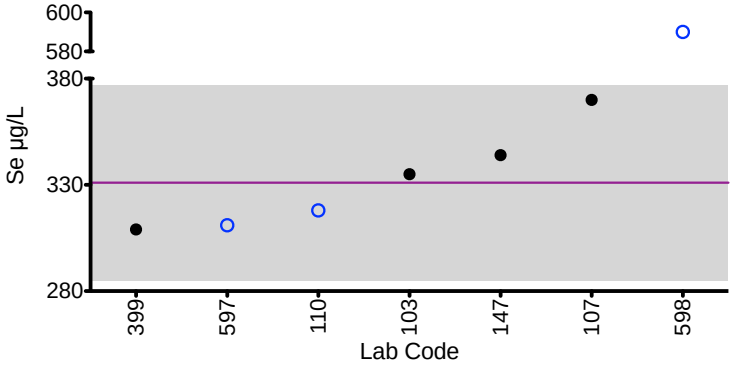
BE17-03



BE17-04



BE17-05



Legend:
○CHEAR Labs ● Other Labs
Horizontal purple line = arithmetic mean of all laboratories.
Gray area = ±2SD of the mean.

The mean and ±2SD of all laboratories are not not intended to be quality specifications and are included for informational purposes only.

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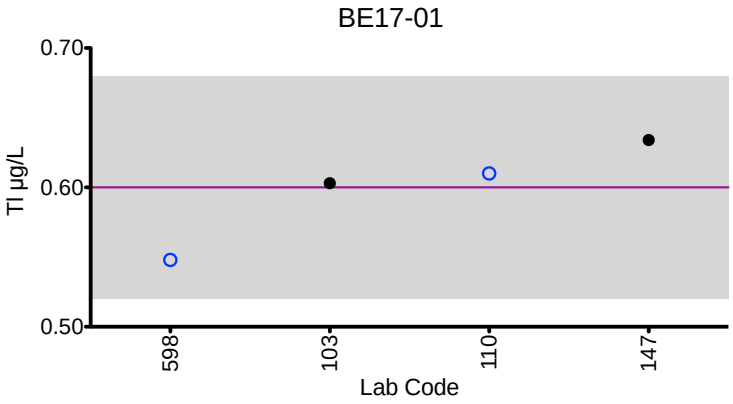
Results for Event #1, 2017
Additional Elements in Whole Blood: Thallium (Tl)

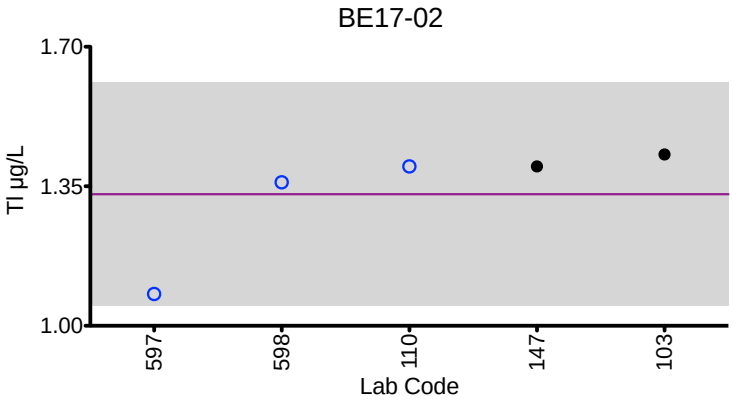
Whole Blood Tl (µg/L)						
Lab Code	**Method**	**BE17-01**	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
103	DRC/CC-ICP-MS	0.603	1.43	0.365	0.0115	1.04
110	ICP-MS	0.61	1.4	0.37	0.02	1.1
147	ICP-MS	0.634	1.40	0.366	< 0.0348	1.03
597	DRC/CC-ICP-MS	<0.4	1.08	<0.4	<0.4	0.73
598	ICP-MS	0.548	1.36	0.385	0.109	0.919

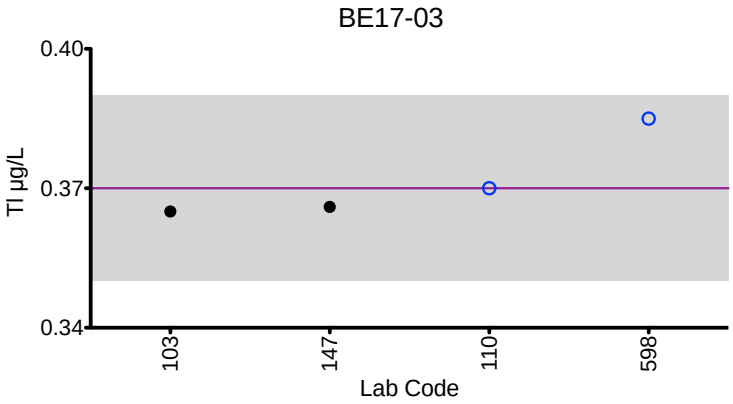
Summary Statistics					
	BE17-01	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
Arithmetic Mean ($\bar{x}$)	0.60	1.33	0.37	0.05	0.96
Arithmetic SD (s)	0.04	0.14	0.01	0.05	0.15
Arithmetic RSD (%)	6.7	10.5	2.7	100	15.6
Number of Sample Measurements (N)	4	5	4	3	5

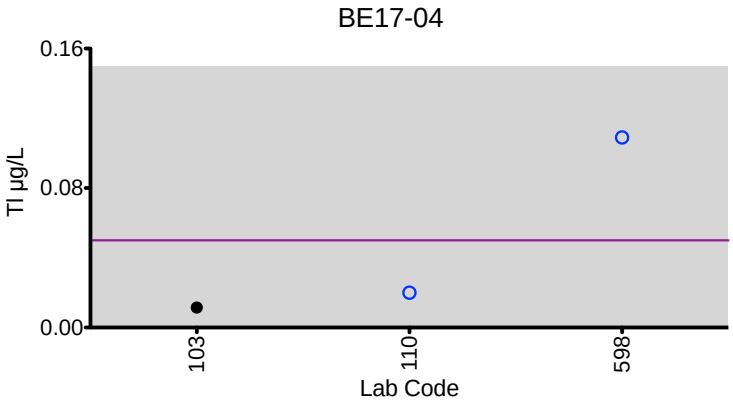
*Denotes a statistical Outlier.

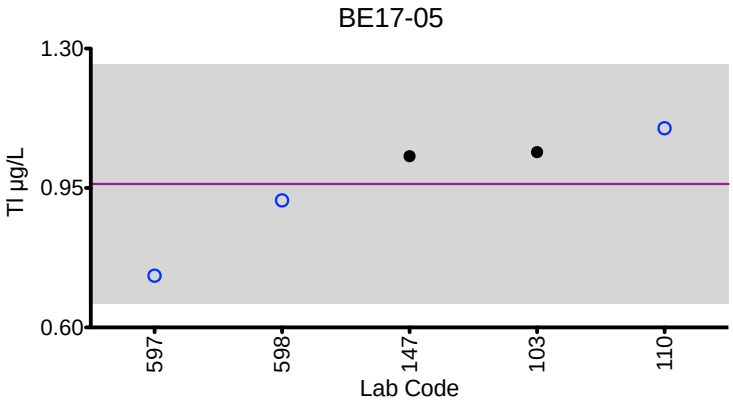
Results for Event #1, 2017:
Whole Blood Tl











Legend:
o CHEAR Labs ● Other Labs
Horizontal purple line = arithmetic mean of all laboratories.
Gray area = ±2SD of the mean.

The mean and ±2SD of all laboratories are not not intended to be quality specifications and are included for informational purposes only.

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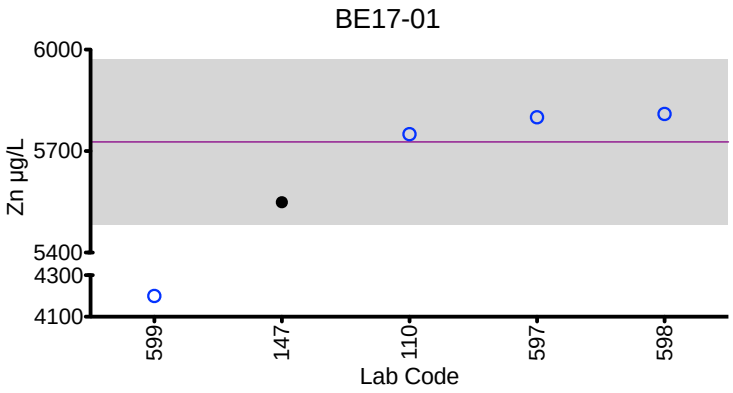
Results for Event #1, 2017
Additional Elements in Whole Blood: Zinc (Zn)

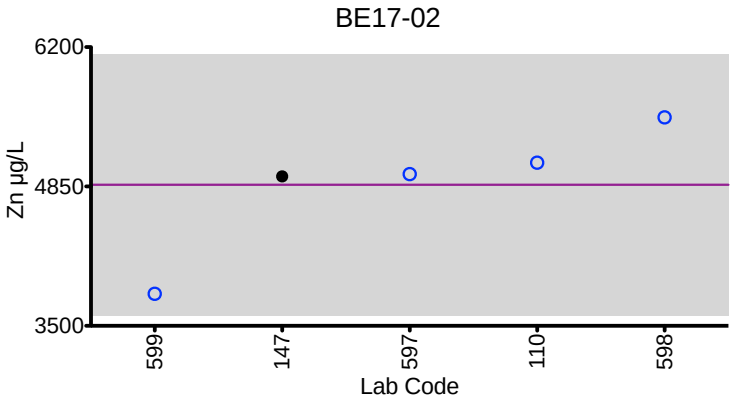
Whole Blood Zn (µg/L)						
Lab Code	**Method**	**BE17-01**	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
110	ICP-MS	5750	5080	4530	9430	7350
147	ICP-MS	5549	4948	4373	8954	7059
597	DRC/CC-ICP-MS	5800	4970	4480	9020	7160
598	ICP-MS	5810	5520	4670	9000	7330
599	DRC/CC-ICP-MS	*4200	3810	*3390	*7410	*5770

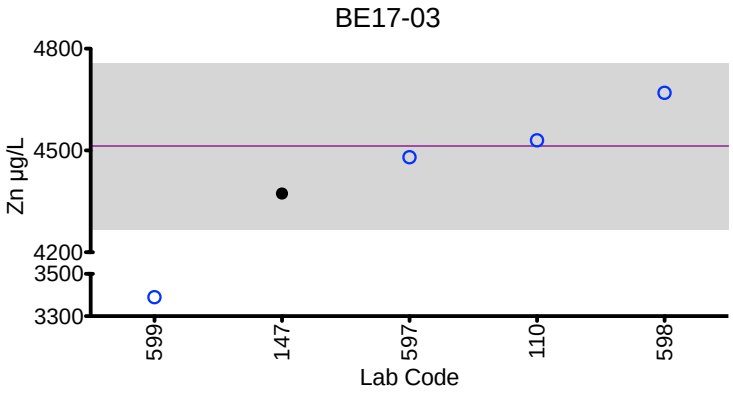
Summary Statistics					
	BE17-01	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
Arithmetic Mean ($\bar{x}$)	5727	4866	4513	9101	7225
Arithmetic SD (s)	122	634	123	221	140
Arithmetic RSD (%)	2.1	13.0	2.7	2.4	1.9
Number of Sample Measurements (N)	4	5	4	4	4

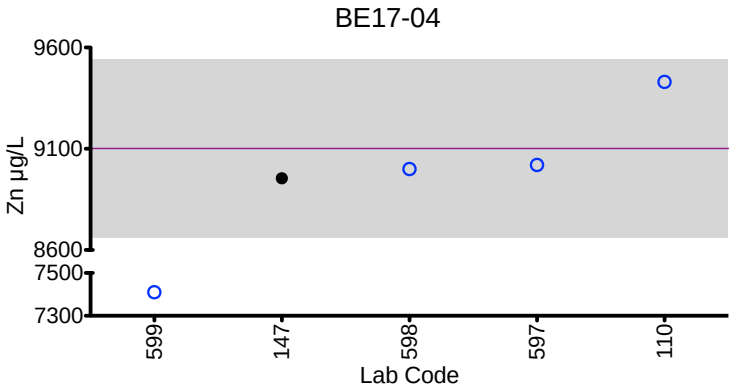
*Denotes a statistical Outlier.

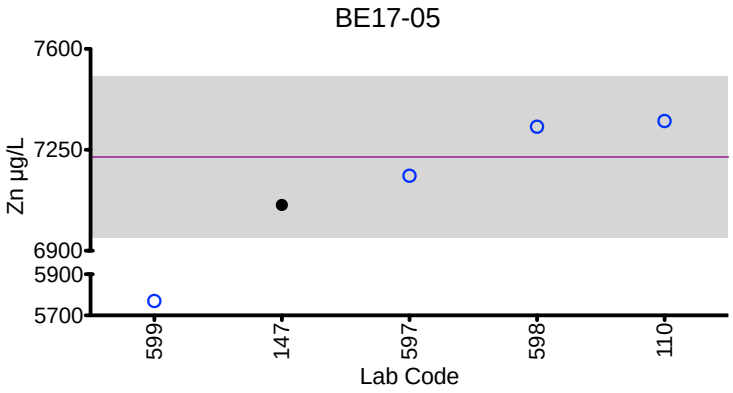
Results for Event #1, 2017: Whole Blood Zn











Legend:
o CHEAR Labs ● Other Labs
Horizontal purple line = arithmetic mean of all laboratories.
Gray area = ±2SD of the mean.

The mean and ±2SD of all laboratories are not not intended to be quality specifications and are included for informational purposes only.

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Results for Event #1, 2017
Additional Elements in Whole Blood: Barium (Ba)

Whole Blood Ba (µg/L)						
Lab Code	**Method**	**BE17-01**	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
110	ICP-MS	3.2	4.9	1.5	2.9	1.8
147	ICP-MS	3.17	4.71	1.46	2.73	1.77
597	DRC/CC-ICP-MS	2.94	4.50	1.63	2.72	1.64
598	ICP-MS	3.76	5.58	2.78	4.22	2.52

Summary Statistics					
	BE17-01	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
Arithmetic Mean ($\bar{x}$)	3.3	4.9	1.8	3.1	1.9
Arithmetic SD (s)	0.3	0.5	0.6	0.7	0.4
Arithmetic RSD (%)	9.1	10.2	33.3	22.6	21.1
Number of Sample Measurements (N)	4	4	4	4	4

*Denotes a statistical Outlier.

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Results for Event #1, 2017
Additional Elements in Whole Blood: Beryllium (Be)

Whole Blood Be (µg/L)						
Lab Code	**Method**	**BE17-01**	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
110	ICP-MS	4.3	2.5	2.1	1.5	0.6
147	ICP-MS	4.35	2.41	2.36	1.77	< 1.17
598	ICP-MS	4.32	2.66	2.17	1.72	0.656
599	DRC/CC-ICP-MS	3.6	1.9	1.7	1.3	0.5

Summary Statistics					
	BE17-01	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
Arithmetic Mean ($\bar{x}$)	4.1	2.4	2.1	1.6	0.6
Arithmetic SD (s)	0.4	0.3	0.3	0.2	0.1
Arithmetic RSD (%)	9.8	12.5	14.3	12.5	16.7
Number of Sample Measurements (N)	4	4	4	4	3

*Denotes a statistical Outlier.

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Results for Event #1, 2017
Additional Elements in Whole Blood: Cesium (Cs)

Whole Blood Cs (µg/L)						
Lab Code	**Method**	**BE17-01**	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
110	ICP-MS	2.5	2.5	2.5	2.2	2.1
597	DRC/CC-ICP-MS	2.24	2.22	2.17	1.71	1.66

Summary Statistics					
	BE17-01	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
Arithmetic Mean ($\bar{x}$)	2.4	2.4	2.4	1.9	1.9
Arithmetic SD (s)	0.2	0.2	0.3	0.3	0.3
Arithmetic RSD (%)	8.3	8.3	12.5	15.8	15.8
Number of Sample Measurements (N)	2	2	2	2	2

*Denotes a statistical Outlier.

Results for Event #1, 2017
Additional Elements in Whole Blood: Copper (Cu)

Whole Blood Cu (µg/L)						
Lab Code	**Method**	**BE17-01**	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
110	ICP-MS	1370	2310	881	1550	1030
147	ICP-MS	1398	2344	902	1576	1067
597	DRC/CC-ICP-MS	1420	2300	890	1520	1040
598	ICP-MS	1410	2430	894	1500	1040

Summary Statistics					
	BE17-01	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
Arithmetic Mean ($\bar{x}$)	1400	2346	892	1537	1044
Arithmetic SD (s)	22	59	9	33	16
Arithmetic RSD (%)	1.6	2.5	1.0	2.1	1.5
Number of Sample Measurements (N)	4	4	4	4	4

*Denotes a statistical Outlier.

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Results for Event #1, 2017
Additional Elements in Whole Blood: Molybdenum (Mo)

Whole Blood Mo (µg/L)						
Lab Code	**Method**	**BE17-01**	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
103	DRC/CC-ICP-MS	6.86	2.14	5.26	12.4	2.09
147	ICP-MS	6.19	2.11	4.95	11.9	2.03
597	DRC/CC-ICP-MS	4.52	<1.3	3.58	9.09	<1.3
598	ICP-MS	8.21	*6.20	*13.2	*26.1	*17.4

Summary Statistics					
	BE17-01	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
Arithmetic Mean ($\bar{x}$)	6.45	2.13	4.60	11.1	2.06
Arithmetic SD (s)	1.53	0.02	0.89	1.8	0.04
Arithmetic RSD (%)	23.7	0.94	19.3	16.2	1.9
Number of Sample Measurements (N)	4	2	3	3	2

*Denotes a statistical Outlier.

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Results for Event #1, 2017
Additional Elements in Whole Blood: Nickel (Ni)

Whole Blood Ni (µg/L)						
Lab Code	**Method**	**BE17-01**	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
110	DRC/CC-ICP-MS	5.4	3.0	9.9	1.9	7.3
147	ICP-MS	5.42	2.77	10.1	1.80	7.22
597	DRC/CC-ICP-MS	4.06	<1.7	9.09	<1.7	6.00
599	DRC/CC-ICP-MS	3.827239	2.094687	8.14464	1.164628	5.251197

Summary Statistics					
	BE17-01	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
Arithmetic Mean ($\bar{x}$)	4.7	2.6	9.3	1.6	6.4
Arithmetic SD (s)	0.9	0.5	0.9	0.4	1.0
Arithmetic RSD (%)	19.1	19.2	9.7	25	15.6
Number of Sample Measurements (N)	4	3	4	3	4

*Denotes a statistical Outlier.

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Results for Event #1, 2017
Additional Elements in Whole Blood: Tin (Sn)

Whole Blood Sn (µg/L)						
Lab Code	**Method**	**BE17-01**	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
110	ICP-MS	5.21	1.29	0.76	3.13	2.5
147	ICP-MS	4.96	1.29	0.679	2.87	2.26
597	DRC/CC-ICP-MS	4.92	0.99	0.35	2.62	2.04
598	ICP-MS	5.89	*3.14	*3.33	*5.48	*8.66

Summary Statistics					
	BE17-01	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
Arithmetic Mean ($\bar{x}$)	5.2	1.2	0.6	2.9	2.3
Arithmetic SD (s)	0.4	0.2	0.2	0.3	0.2
Arithmetic RSD (%)	7.7	16.7	33.3	10.3	8.7
Number of Sample Measurements (N)	4	3	3	3	3

*Denotes a statistical Outlier.

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Results for Event #1, 2017
Additional Elements in Whole Blood: Uranium (U)

Whole Blood U (µg/L)						
Lab Code	**Method**	**BE17-01**	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
103	DRC/CC-ICP-MS	0.109	0.00793	0.0311	0.0570	0.0726
110	ICP-MS	0.096	0.015	0.038	0.065	0.061
147	ICP-MS	0.0976	< 0.0136	0.0324	0.0671	0.0757
598	ICP-MS	0.120	0.04	0.05	0.08	0.07

Summary Statistics					
	BE17-01	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
Arithmetic Mean ($\bar{x}$)	0.106	0.021	0.038	0.067	0.070
Arithmetic SD (s)	0.011	0.017	0.009	0.010	0.006
Arithmetic RSD (%)	10.4	81	23.7	14.9	8.6
Number of Sample Measurements (N)	4	3	4	4	4

*Denotes a statistical Outlier.

Results for Event #1, 2017
Additional Elements in Whole Blood: Vanadium (V)

Whole Blood V (µg/L)						
Lab Code	**Method**	**BE17-01**	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
110	ICP-MS	0.81	1.71	4.24	1.16	0.05
147	DRC/CC-ICP-MS	0.735	1.72	4.12	1.13	0.0607
597	DRC/CC-ICP-MS	0.68	1.48	3.87	1.02	<0.1
598	DRC/CC-ICP-MS	0.801	1.72	3.81	0.988	0.024

Summary Statistics					
	BE17-01	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
Arithmetic Mean ($\bar{x}$)	0.76	1.66	4.01	1.07	0.04
Arithmetic SD (s)	0.06	0.12	0.20	0.08	0.02
Arithmetic RSD (%)	7.9	7.2	5.0	7.5	50
Number of Sample Measurements (N)	4	4	4	4	3

*Denotes a statistical Outlier.

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Results for Event #1, 2017
Additional Elements in Whole Blood: Tungsten (W)

Whole Blood W (µg/L)						
Lab Code	**Method**	**BE17-01**	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
110	ICP-MS	0.11	1.14	1.11	0.75	0.45
200	ICP-MS	0.1	1.3	1.1	0.6	0.4
598	ICP-MS	*1.82	1.33	1.14	0.294	1.30

Summary Statistics					
	BE17-01	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
Arithmetic Mean ($\bar{x}$)	0.11	1.26	1.12	0.55	0.72
Arithmetic SD (s)	0.01	0.10	0.02	0.23	0.51
Arithmetic RSD (%)	9.1	7.9	1.8	41.8	71
Number of Sample Measurements (N)	2	3	3	3	3

*Denotes a statistical Outlier.

Results for Event #1, 2017
Additional Elements in Whole Blood

Whole Blood Ag (µg/L)

Lab Code	Method	BE17-01	BE17-02	BE17-03	BE17-04	BE17-05
147	ICP-MS	< 0.205	< 0.205	< 0.205	< 0.205	< 0.205

Whole Blood Al (µg/L)

Lab Code	Method	BE17-01	BE17-02	BE17-03	BE17-04	BE17-05
147	ICP-MS	< 9.17	< 9.17	< 9.17	< 9.17	< 9.17

Whole Blood Bi (µg/L)

Lab Code	Method	BE17-01	BE17-02	BE17-03	BE17-04	BE17-05
147	ICP-MS	< 0.0836	< 0.0836	< 0.0836	< 0.0836	< 0.0836

Whole Blood I (µg/L)

Lab Code	Method	BE17-01	BE17-02	BE17-03	BE17-04	BE17-05
147	ICP-MS	34.2	31.4	34.8	30.4	30.5

Whole Blood Li (µg/L)

Lab Code	Method	BE17-01	BE17-02	BE17-03	BE17-04	BE17-05
147	ICP-MS	0.436	0.475	0.456	0.812	0.756

Whole Blood Mg (µg/L)

Lab Code	Method	BE17-01	BE17-02	BE17-03	BE17-04	BE17-05
597	DRC/CC-ICP-MS	33400	32400	33000	26800	27200

Whole Blood Pt (µg/L)

Lab Code	Method	BE17-01	BE17-02	BE17-03	BE17-04	BE17-05
110	ICP-MS	6.64	0.61	0.07	1.32	0.40

Whole Blood Sr (µg/L)

Lab Code	Method	BE17-01	BE17-02	BE17-03	BE17-04	BE17-05
103	DRC/CC-ICP-MS	21.3	20.7	19.1	36.4	36.0

Whole Blood Te (µg/L)

Lab Code	Method	BE17-01	BE17-02	BE17-03	BE17-04	BE17-05
147	ICP-MS	< 0.128	< 0.128	< 0.128	< 0.128	< 0.128
598	ICP-MS	<1	<1	<1	<1	<1

Whole Blood Th (µg/L)

Lab Code	Method	BE17-01	BE17-02	BE17-03	BE17-04	BE17-05
147	ICP-MS	< 0.0148	< 0.0148	< 0.0148	< 0.0148	< 0.0148

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Results for Event #1, 2017
Additional Elements in Whole Blood

Whole Blood Ti (µg/L)						
Lab Code	**Method**	**BE17-01**	**BE17-02**	**BE17-03**	**BE17-04**	**BE17-05**
200	DRC/CC-ICP-MS	4.8	1.1	1.8	8.0	3.5

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Event #1, 2017

Trace Elements in Urine

Wadsworth Center
NEW YORK STATE DEPARTMENT OF HEALTH
Trace Elements Laboratory

Event #1, 2017:
Trace Elements in Urine

PT Materials

Urine was collected from volunteer donors into polyethylene containers and stored at 4°C. Following collection, urine was acidified to 1% (v/v) with nitric acid and mixed with a sulfamic acid solution (stock solution contained 200 mg/mL sulfamic acid and 10% (v/v) Triton-X 100) to a final concentration of 1% (v/v) to stabilize Hg. Urine was stored frozen at -80°C pending further preparation. The urine was thawed at room temperature and precipitated salts removed by centrifugation. Urine supernatants were combined and subsequently separated into five pools. Each urine pool was supplemented with arsenic (As), barium (Ba), beryllium (Be), cadmium (Cd), cobalt (Co), chromium (Cr), mercury (Hg), manganese (Mn), lead (Pb), thallium (Tl), uranium (U), aluminum (Al), cesium (Cs), copper (Cu), molybdenum (Mo), nickel (Ni), platinum (Pt), antimony (Sb), selenium (Se), tin (Sn), strontium (Sr), tellurium (Te), vanadium (V), tungsten (W), and zinc (Zn) and stirred overnight to ensure thorough mixing prior to aliquoting 10-mL into polypropylene vials. PT samples were stored at -80°C until the week of the PT event, when they were thawed at 4°C prior to circulation to laboratories for analysis.

Graded Elements

Eleven elements in urine are formally graded: As, Ba, Be, Cd, Co, Cr, Hg, Mn, Pb, Tl, and U. Target values for the graded elements are assigned to these pools based on the robust mean calculated from data reported by all laboratories.

Additional Elements

An additional 23 elements (beyond the eleven graded) were reported by at least one participant: Ag, Al, B, Bi, Cs, Cu, Fe, I, Li, Mg, Mo, Ni, Pt, Sb, Se, Sn, Sr, Te, Th, Ti, V, W, Zn. These data are included here to provide a more complete characterization of the PT materials. All results reported by participant laboratories are tabulated and organized by lab code. The PT data are graphed for visual comparison purposes for all elements where at least five laboratories reported a value greater than the LOD. A statistical summary table is provided for samples where at least two comparable values were reported as above the LOD.

The summary statistics for the additional elements are provided for educational purposes only, i.e., no acceptable response is implied. However, it is expected that each laboratory would wish to investigate a potential source of bias if warranted by these data. Future events might result in additional elements becoming graded if a consensus can be reached regarding desired quality specifications.

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Results for Event #1, 2017
Urine Arsenic (As)

Summary Statistics

	Urine As (µg/L)				
	UE17-01	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
Target (Robust Mean (x*))	12.0	94	25.0	37.3	78.1
Upper Limit	18.0	113	31.0	44.8	93.7
Lower Limit	6.0	75	19.0	29.8	62.5
Robust SD (s*)	0.8	5.7	1.7	2.2	4.6
Robust RSD (%)	7.0	6.0	6.7	5.8	5.9
Number of Sample Measurements (N)	19	19	19	19	19
Standard Uncertainty (*u*)	0.242	1.63	0.481	0.625	1.33

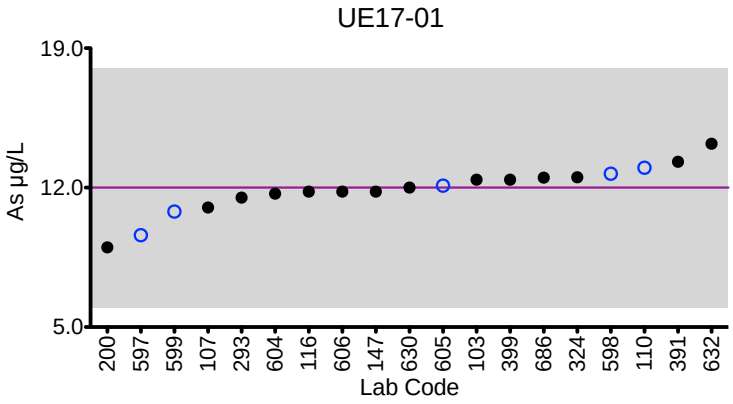
The acceptable range is based on quality specifications:
±6 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±6 µg/L at concentrations less than or equal to 30 µg/L. These quality specifications are based on the same criteria used by the US Centers for Disease Control Prevention (CDC) for public health labs participating in the Laboratory Response Network (LRN) PT program for Toxic Metals.

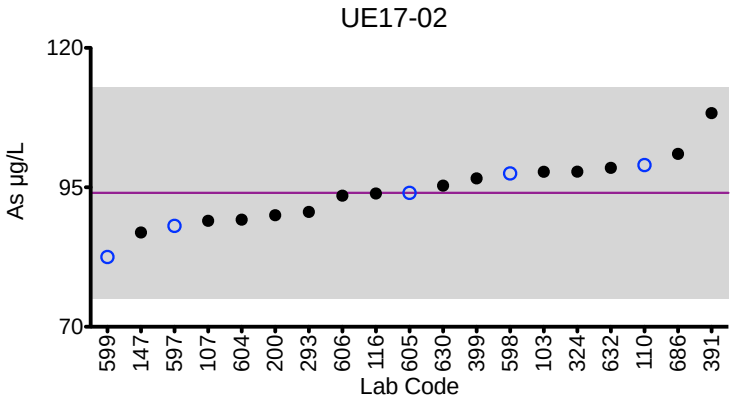
Results for Event #1, 2017
Urine Arsenic (As)
Performance of Participating Laboratories

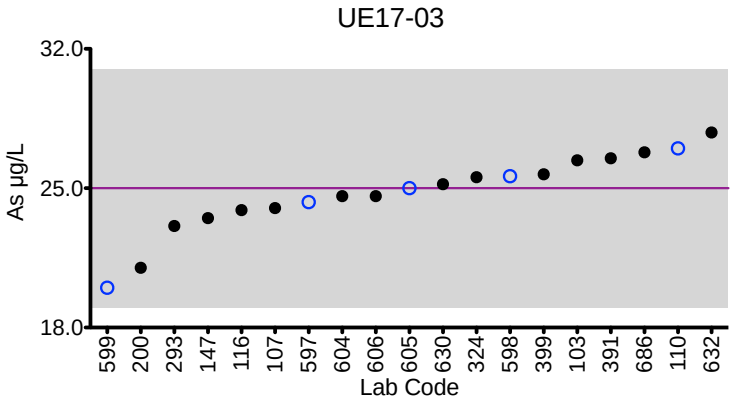
		Urine As (µg/L)				
Lab Code	**Method**	**UE17-01**	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
	Target	**12.0**	**94**	**25.0**	**37.3**	**78.1**
103	DRC/CC-ICP-MS	12.4	97.8	26.4	38.9	80.4
107	ICP-MS	11	89	24	35	73
110	DRC/CC-ICP-MS	13	99	27	40	83
116	DRC/CC-ICP-MS	11.8	93.9	23.9	37.1	76.0
147	ICP-MS	11.8	86.9	23.5	34.5	73.3
200	ICP-MS	9.0	90.0	21.0	33.8	72.0
293	DRC/CC-ICP-MS	11.5	90.6	23.1	36.1	75.4
324	ICP-MS	12.517	97.806	25.551	38.185	81.129
391	DRC/CC-ICP-MS	13.3	108.3	26.5	40.3	84.1
399	DRC/CC-ICP-MS	12.4	96.6	25.7	38.5	81.0
597	DRC/CC-ICP-MS	9.61	88.1	24.3	36.6	74.2
598	ICP-MS	12.7	97.5	25.6	38.7	79.2
599	DRC/CC-ICP-MS	10.8	82.5	20.0	35.3	72.9
604	DRC/CC-ICP-MS	11.7	89.2	24.6	35.2	76.6
605	ICP-MS	12.1	94.0	25.0	37.5	78.2
606	ICP-MS	11.8	93.5	24.6	36.2	76.7
630	ICP-MS	12.0	95.3	25.2	37.6	78.8
632	DRC/CC-ICP-MS	14.2	98.5	27.8	40.0	83.3
686	DRC/CC-ICP-MS	12.5	101	26.8	39.0	84.9

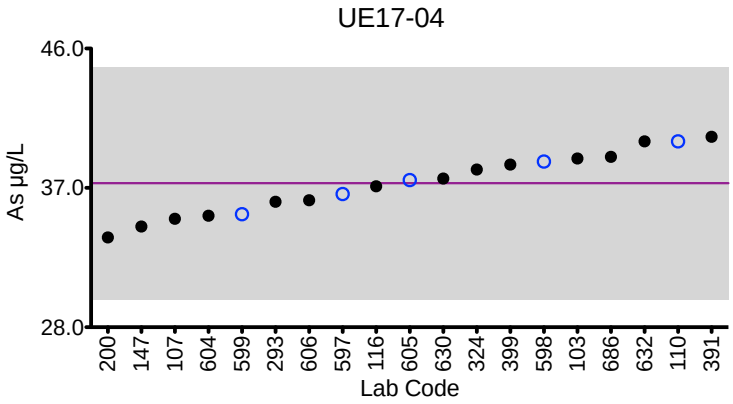
Based on the grading criteria for As in Urine, 100% of results were satisfactory, with 0 of the 19 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

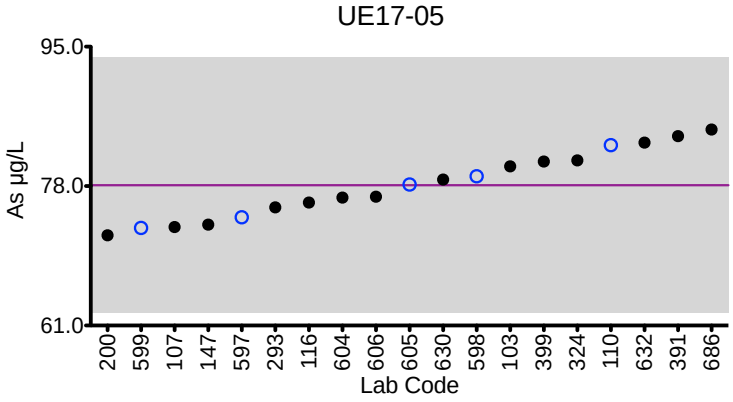
Results for Event #1, 2017: Urine As











Legend:

o CHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the robust mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±6 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±6 µg/L at concentrations less than or equal to 30 µg/L.

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Results for Event #1, 2017
Urine Barium (Ba)

Summary Statistics

	Urine Ba (µg/L)				
	UE17-01	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
Target (Robust Mean (x*))	4.5	1.4	4.6	7.6	0.6
Upper Limit	5.5	2.4	5.6	9.1	1.6
Lower Limit	3.5	0.4	3.6	6.1	0.0
Robust SD (s*)	0.2	0.1	0.2	0.1	0.1
Robust RSD (%)	3.9	6.3	4.2	1.8	13.1
Number of Sample Measurements (N)	13	13	13	13	13
Standard Uncertainty (*u*)	0.060	0.031	0.067	0.048	0.027

The acceptable range is based on quality specifications:
±1 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±1 µg/L at concentrations less than or equal to 5 µg/L. These quality specifications are based on the same criteria used by the US Centers for Disease Control Prevention (CDC) for public health labs participating in the Laboratory Response Network (LRN) PT program for Toxic Metals.

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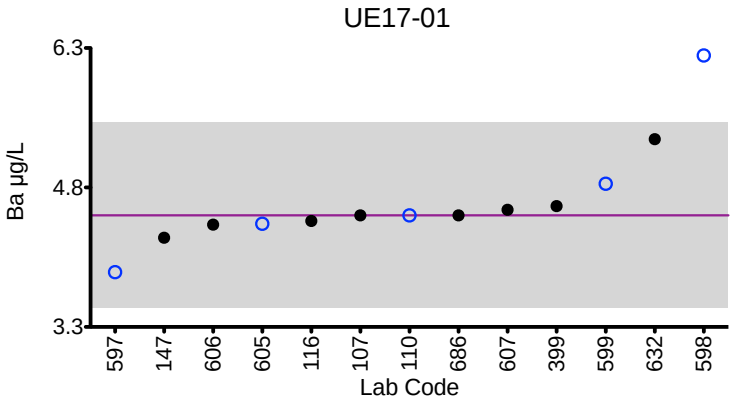
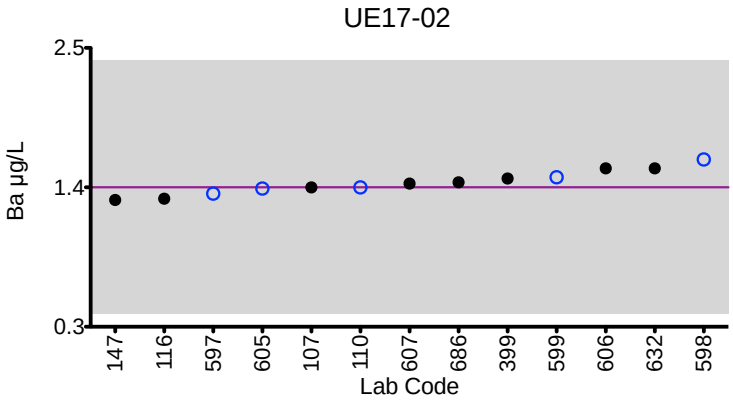
Results for Event #1, 2017
Urine Barium (Ba)
Performance of Participating Laboratories

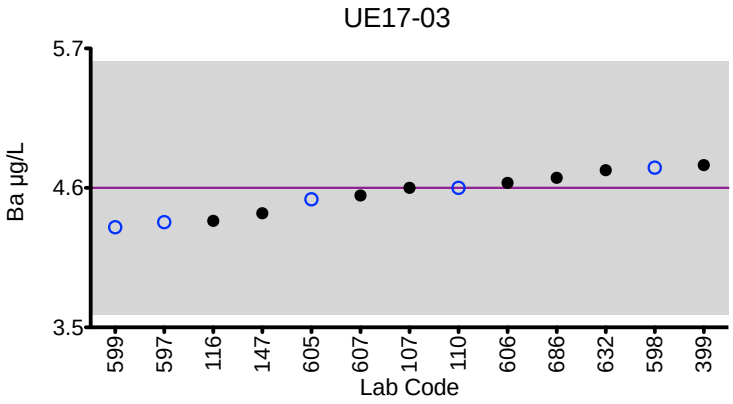
		Urine Ba (µg/L)				
Lab Code	**Method**	**UE17-01**	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
	Target	**4.5**	**1.4**	**4.6**	**7.6**	**0.6**
107	ICP-MS	4.5	1.4	4.6	7.6	0.59
110	ICP-MS	4.5	1.4	4.6	7.4	0.6
116	DRC/CC-ICP-MS	4.44	1.31	4.34	7.62	0.529
147	ICP-MS	4.26	1.30	4.40	7.24	0.504
399	ICP-MS	4.60	1.47	4.78	7.74	0.615
597	DRC/CC-ICP-MS	3.89	1.35	4.33	7.51	0.518
598	ICP-MS	6.22 ↑	1.62	4.76	7.92	0.714
599	DRC/CC-ICP-MS	4.84	1.48	4.29	7.86	0.65
605	ICP-MS	4.41	1.39	4.51	7.53	0.546
606	ICP-MS	4.40	1.55	4.64	7.50	0.966
607	ICP-MS	4.56	1.43	4.54	7.55	0.597
632	ICP-MS	5.32	1.55	4.74	7.58	0.659
686	ICP-MS	4.50	1.44	4.68	7.69	0.637

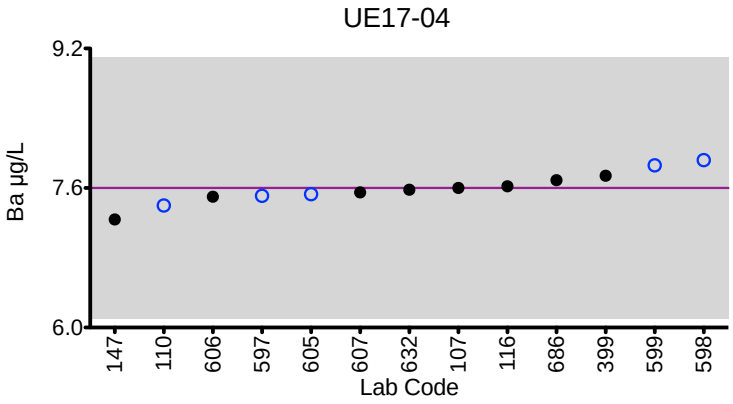
Based on the grading criteria for Ba in Urine, 98% of results were satisfactory, with 0 of the 13 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

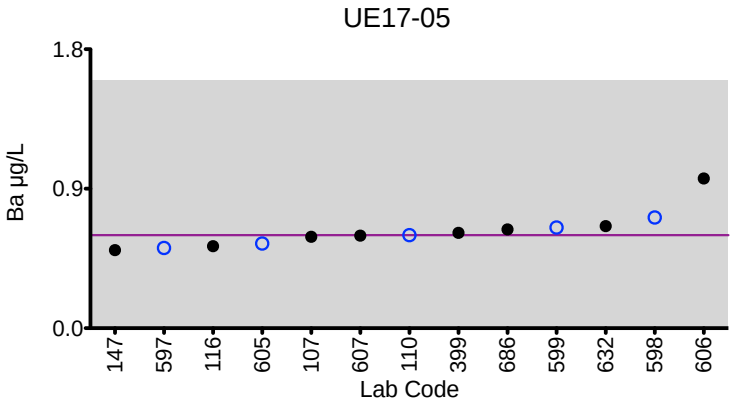
Results for Event #1, 2017:
Urine Ba











Legend:
o CHEAR Labs ● Other Labs
Horizontal purple line = assigned target value based on the robust mean of all laboratories.
Gray area = acceptable range based on quality specifications:
±1 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±1 µg/L at concentrations less than or equal to 5 µg/L.

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Results for Event #1, 2017
Urine Beryllium (Be)

Summary Statistics

	Urine Be (µg/L)				
	UE17-01	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
Target (Robust Mean (x*))	1.3	2.2	4.1	0.45	1.7
Upper Limit	2.3	3.2	5.1	1.45	2.7
Lower Limit	0.3	1.2	3.1	0.00	0.7
Robust SD (s*)	0.1	0.1	0.3	0.03	0.1
Robust RSD (%)	5.8	4.7	7.1	6.5	5.3
Number of Sample Measurements (N)	11	11	11	10	11
Standard Uncertainty (*u*)	0.029	0.039	0.109	0.012	0.034

The acceptable range is based on quality specifications:
±1 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±1 µg/L at concentrations less than or equal to 5 µg/L. These quality specifications are based on the same criteria used by the US Centers for Disease Control Prevention (CDC) for public health labs participating in the Laboratory Response Network (LRN) PT program for Toxic Metals.

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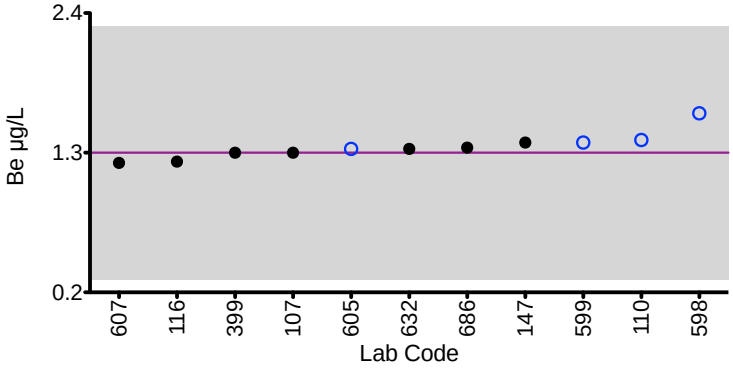
Results for Event #1, 2017
Urine Beryllium (Be)
Performance of Participating Laboratories

		Urine Be (µg/L)				
Lab Code	**Method**	**UE17-01**	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
	Target	**1.3**	**2.2**	**4.1**	**0.45**	**1.7**
107	ICP-MS	1.3	2.2	4.1	0.45	1.7
110	ICP-MS	1.4	2.3	4.4	0.46	1.7
116	ICP-MS	1.23	2.20	3.80	0.370	1.52
147	ICP-MS	1.38	2.35	4.11	< 0.450	1.88
399	ICP-MS	1.30	2.16	4.10	0.465	1.65
598	ICP-MS	1.61	2.17	4.36	0.492	1.74
599	DRC/CC-ICP-MS	1.38	2.37	3.58	0.44	1.84
605	ICP-MS	1.33	2.17	4.14	0.437	1.66
607	ICP-MS	1.22	2.07	3.84	0.418	1.53
632	ICP-MS	1.33	2.37	4.47	0.508	1.75
686	ICP-MS	1.34	2.14	4.03	0.460	1.62

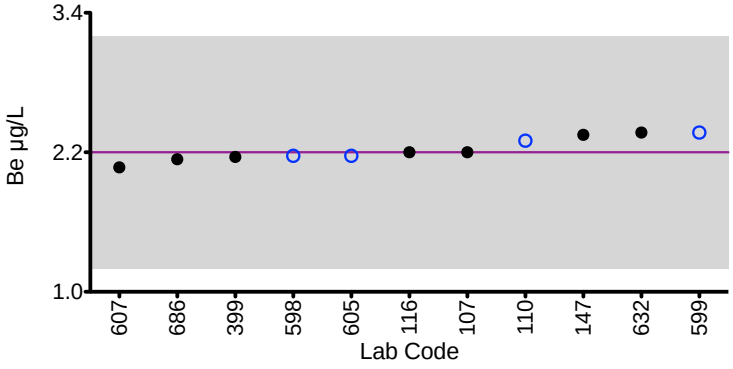
Based on the grading criteria for Be in Urine, 100% of results were satisfactory, with 0 of the 11 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

Results for Event #1, 2017:
Urine Be

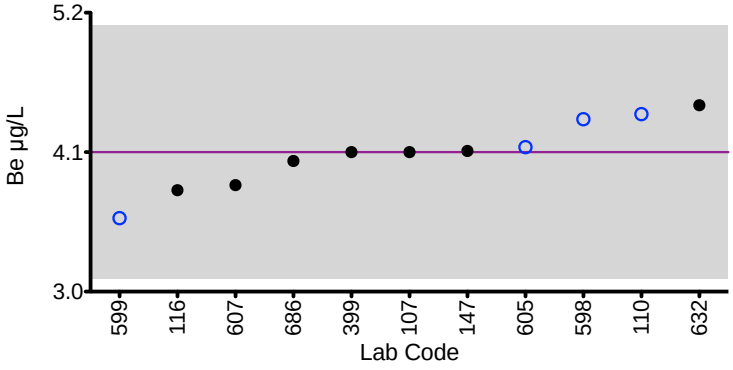
UE17-01



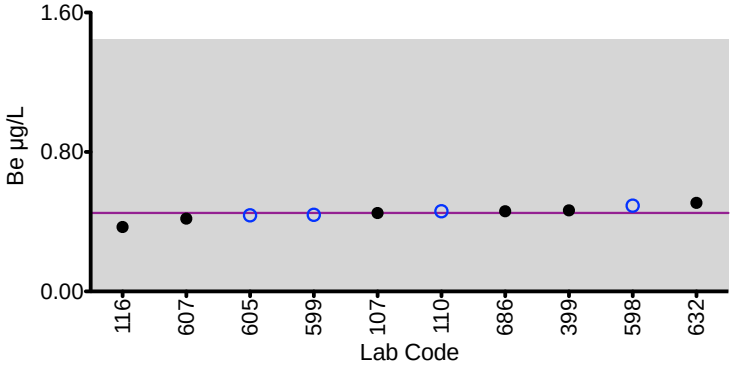
UE17-02



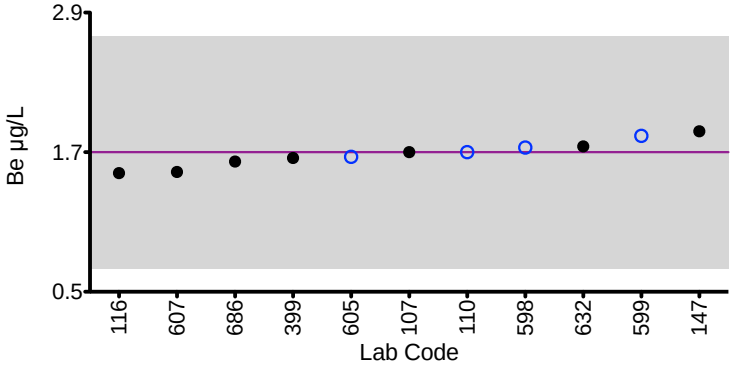
UE17-03



UE17-04



UE17-05



Legend:

o CHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the robust mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±1 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±1 µg/L at concentrations less than or equal to 5 µg/L.

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Results for Event #1, 2017
Urine Cadmium (Cd)

Summary Statistics

	Urine Cd (µg/L)				
	UE17-01	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
Target (Robust Mean (x*))	0.21	0.28	1.03	0.82	3.05
Upper Limit	1.21	1.28	2.03	1.82	4.05
Lower Limit	0.00	0.00	0.03	0.00	2.05
Robust SD (s*)	0.05	0.03	0.07	0.06	0.22
Robust RSD (%)	25.8	9.0	6.4	7.6	7.1
Number of Sample Measurements (N)	17	17	19	18	19
Standard Uncertainty (*u*)	0.016	0.008	0.019	0.018	0.062

The acceptable range is based on quality specifications:
±1 µg/L or ±15% around the target value, whichever is greater; thus, it is fixed at ±1 µg/L at concentrations less than or equal to 6.6 µg/L. These quality specifications are based on the same criteria used by the US Centers for Disease Control Prevention (CDC) for public health labs participating in the Laboratory Response Network (LRN) PT program for Toxic Metals.

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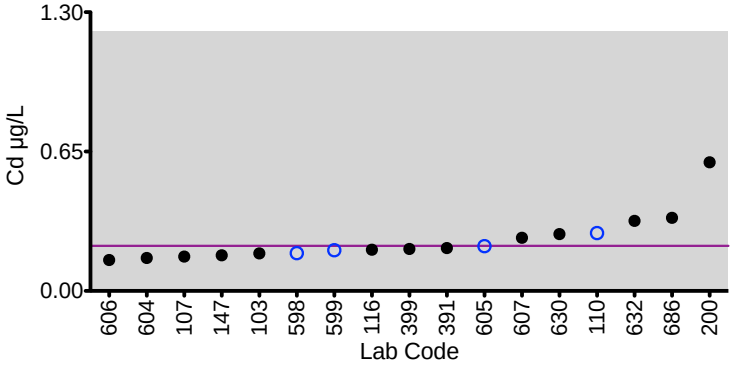
Results for Event #1, 2017
Urine Cadmium (Cd)
Performance of Participating Laboratories

		Urine Cd (µg/L)				
Lab Code	**Method**	**UE17-01**	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
	Target	**0.21**	**0.28**	**1.03**	**0.82**	**3.05**
103	DRC/CC-ICP-MS	0.175	0.293	0.99	0.758	2.97
107	DRC/CC-ICP-MS	0.16	0.31	1.1	0.88	3.4
110	ICP-MS	0.27	0.29	1.08	0.86	3.01
116	DRC/CC-ICP-MS	0.192	0.253	1.03	0.730	2.97
147	ICP-MS	0.166	0.262	1.04	0.815	3.20
200	ICP-MS	0.6	0.3	1.2	1.0	3.4
293	DRC/CC-ICP-MS	0.24	0.30	1.10	0.93	3.42
324	ICP-MS	<1	<1	1.103	<1	3.246
391	DRC/CC-ICP-MS	0.20	0.31	1.05	0.80	2.85
399	DRC/CC-ICP-MS	0.196	0.271	1.05	0.837	3.11
597	DRC/CC-ICP-MS	<0.2	<0.2	0.914	0.667	2.69
598	DRC/CC-ICP-MS	0.176	0.252	0.956	0.759	2.86
599	DRC/CC-ICP-MS	0.19	0.25	0.90	0.78	3.00
604	DRC/CC-ICP-MS	0.154	0.279	1.10	0.854	3.30
605	ICP-MS	0.209	0.297	1.05	0.845	3.13
606	ICP-MS	0.144	0.255	0.981	0.775	2.89
607	ICP-MS	0.248	0.283	1.01	0.829	2.98
630	ICP-MS	0.265	0.277	0.985	0.800	2.75
632	DRC/CC-ICP-MS	0.327	0.390	1.04	0.838	3.00
686	ICP-MS	0.341	0.297	1.07	0.933	3.35

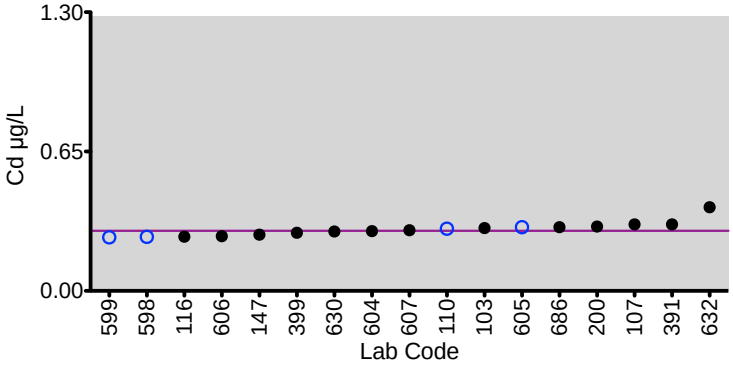
Based on the grading criteria for Cd in Urine, 100% of results were satisfactory, with 0 of the 20 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

Results for Event #1, 2017: Urine Cd

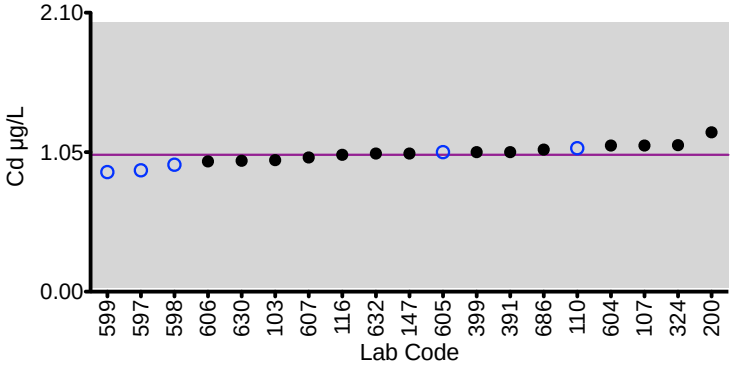
UE17-01



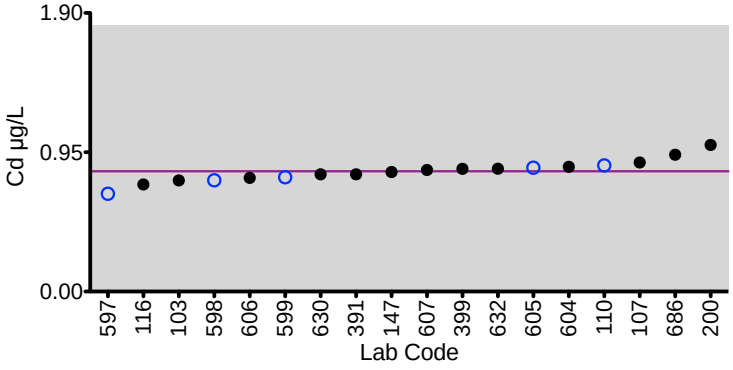
UE17-02



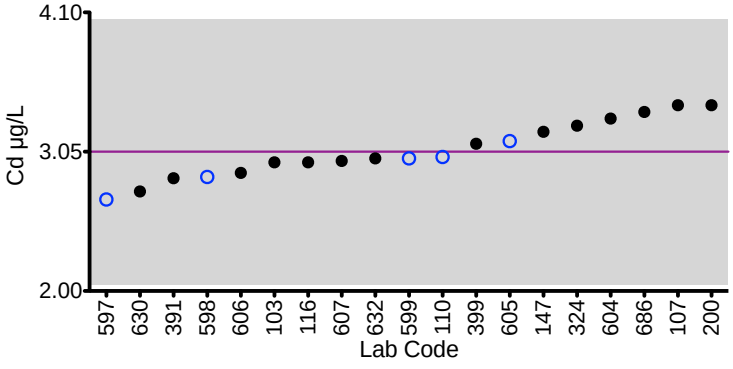
UE17-03



UE17-04



UE17-05



Legend:

o CHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the robust mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±1 µg/L or ±15% around the target value, whichever is greater; thus, it is fixed at ±1 µg/L at concentrations less than or equal to 6.6 µg/L.

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Results for Event #1, 2017
Urine Cobalt (Co)

Summary Statistics

	Urine Co (µg/L)				
	UE17-01	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
Target (Robust Mean (x*))	0.52	2.6	2.3	0.75	1.7
Upper Limit	2.02	4.1	3.8	2.25	3.2
Lower Limit	0.00	1.1	0.8	0.00	0.2
Robust SD (s*)	0.04	0.1	0.1	0.06	0.1
Robust RSD (%)	8.5	3.1	4.5	7.7	5.3
Number of Sample Measurements (N)	13	14	14	13	14
Standard Uncertainty (*u*)	0.015	0.026	0.034	0.020	0.030

The acceptable range is based on quality specifications:
±1.5 µg/L or ±15% around the target value, whichever is greater; thus, it is fixed at ±1.5 µg/L at concentrations less than or equal to 10 µg/L. These quality specifications were established based on discussions with the US FDA, and represent a consensus from a network of Trace Element PT program organizers

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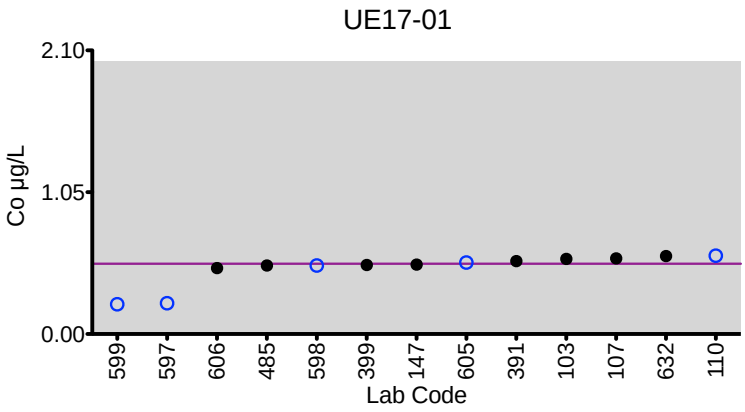
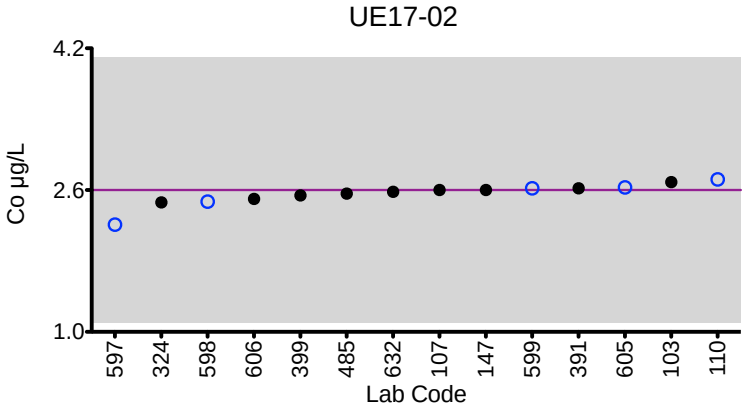
Results for Event #1, 2017
Urine Cobalt (Co)
Performance of Participating Laboratories

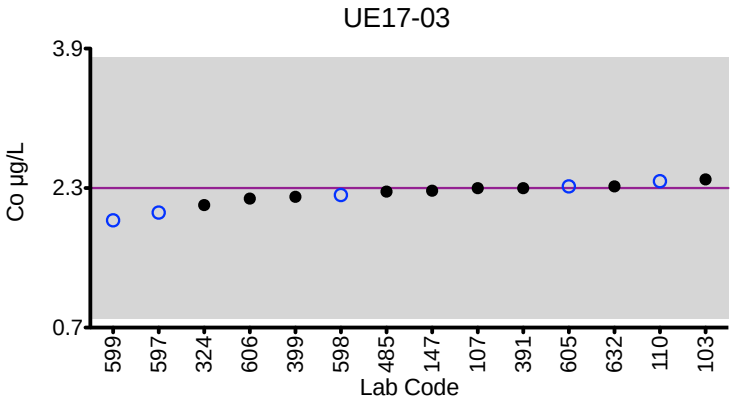
		Urine Co (µg/L)				
Lab Code	**Method**	**UE17-01**	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
	Target	**0.52**	**2.6**	**2.3**	**0.75**	**1.7**
103	DRC/CC-ICP-MS	0.556	2.69	2.40	0.786	1.77
107	ICP-MS	0.56	2.6	2.3	0.8	1.7
110	ICP-MS	0.58	2.72	2.38	0.83	1.79
147	ICP-MS	0.514	2.60	2.27	0.754	1.73
324	ICP-MS	<1	2.460	2.105	<1	1.614
391	DRC/CC-ICP-MS	0.54	2.62	2.3	0.80	1.7
399	DRC/CC-ICP-MS	0.511	2.54	2.20	0.723	1.64
485	HR-ICP-MS	0.507	2.56	2.26	0.783	1.822
597	DRC/CC-ICP-MS	0.228	2.21	2.02	0.501	1.39
598	DRC/CC-ICP-MS	0.507	2.47	2.22	0.718	1.59
599	DRC/CC-ICP-MS	0.22	2.62	1.93	0.51	1.77
605	ICP-MS	0.529	2.63	2.34	0.752	1.75
606	ICP-MS	0.488	2.50	2.18	0.699	1.63
632	ICP-MS	0.577	2.58	2.32	0.788	1.72

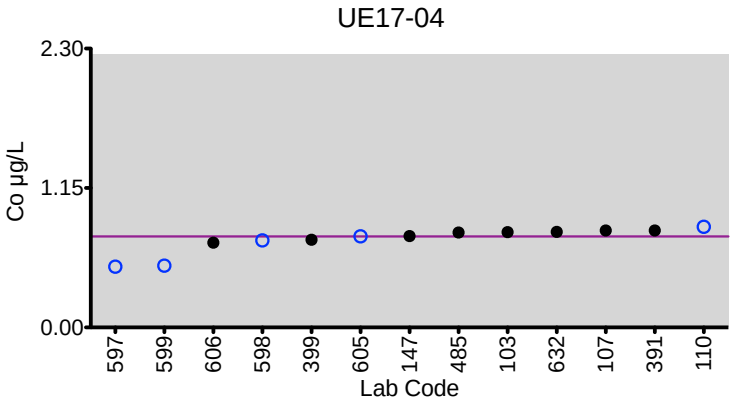
Based on the grading criteria for Co in Urine, 100% of results were satisfactory, with 0 of the 14 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

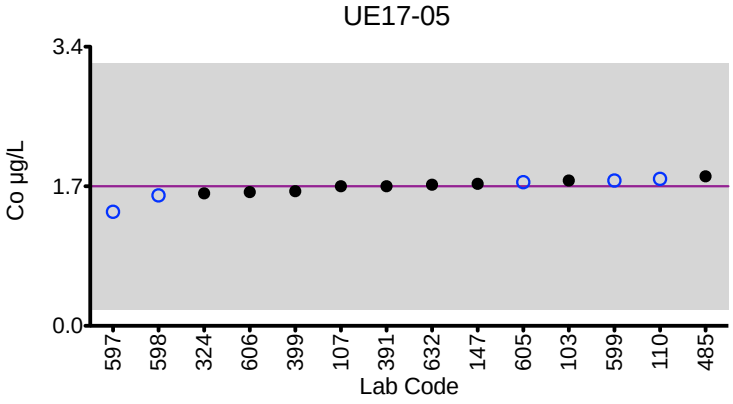
Results for Event #1, 2017: Urine Co











Legend:

o CHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the robust mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±1.5 µg/L or ±15% around the target value, whichever is greater; thus, it is fixed at ±1.5 µg/L at concentrations less than or equal to 10 µg/L.

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Results for Event #1, 2017
Urine Chromium (Cr)

Summary Statistics

	Urine Cr (µg/L)				
	UE17-01	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
Target (Robust Mean (x*))	1.00	7.8	18.0	4.6	1.3
Upper Limit	4.0	10.8	21.6	7.6	4.3
Lower Limit	0.0	4.8	14.4	1.6	0.0
Robust SD (s*)	0.1	0.6	1.2	0.3	0.2
Robust RSD (%)	12.9	8.2	6.4	5.9	13.5
Number of Sample Measurements (N)	11	12	12	12	12
Standard Uncertainty (*u*)	0.049	0.231	0.419	0.098	0.062

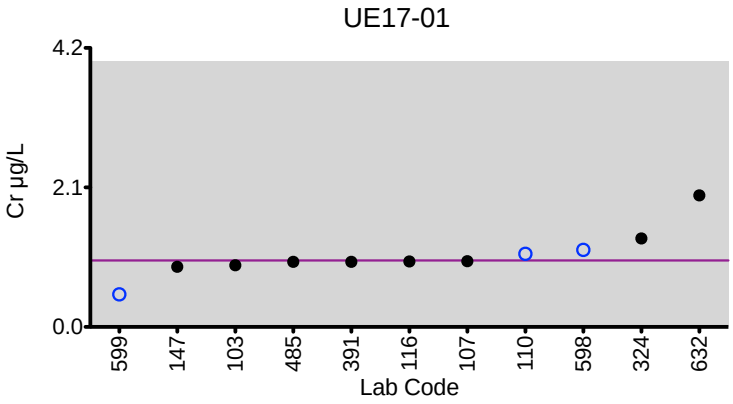
The acceptable range is based on quality specifications:
±3 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±3 µg/L at concentrations less than or equal to 15 µg/L. These quality specifications were established based on discussions with the US FDA, and represent a consensus from a network of Trace Element PT program organizers

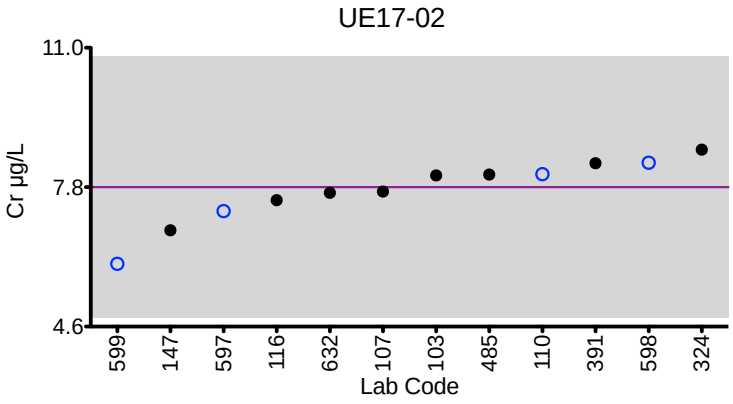
Results for Event #1, 2017
Urine Chromium (Cr)
Performance of Participating Laboratories

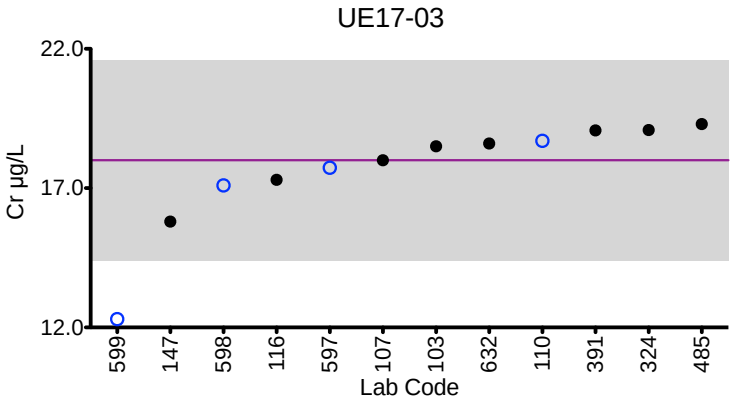
		Urine Cr (µg/L)				
Lab Code	**Method**	**UE17-01**	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
	Target	**1.00**	**7.8**	**18.0**	**4.6**	**1.3**
103	DRC/CC-ICP-MS	0.929	8.07	18.5	4.68	1.24
107	ICP-MS	0.99	7.7	18	5	1.4
110	DRC/CC-ICP-MS	1.1	8.1	18.7	4.8	1.4
116	DRC/CC-ICP-MS	0.985	7.50	17.3	4.59	1.23
147	DRC/CC-ICP-MS	0.905	6.81	15.8	4.03	1.21
324	ICP-MS	1.332	8.660	19.083	5.094	1.693
391	DRC/CC-ICP-MS	0.98	8.35	19.07	4.48	1.31
485	HR-ICP-MS	0.980	8.09	19.3	4.72	1.41
597	DRC/CC-ICP-MS	<0.8	7.25	17.73	4.74	1.11
598	DRC/CC-ICP-MS	1.16	8.36	17.1	4.45	1.32
599	DRC/CC-ICP-MS	0.49	6.04	12.3 ↓	3.54	0.76
632	DRC/CC-ICP-MS	1.98	7.67	18.6	4.52	1.10

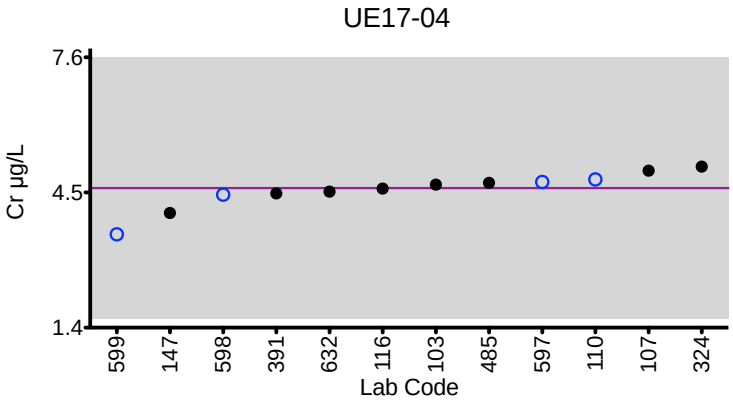
Based on the grading criteria for Cr in Urine, 98% of results were satisfactory, with 0 of the 12 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

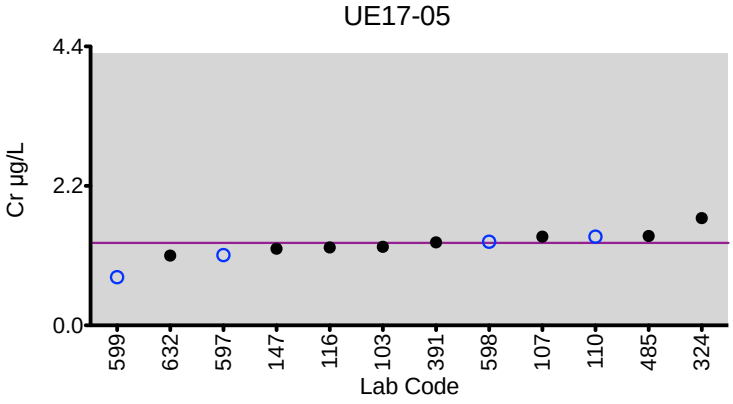
Results for Event #1, 2017:
Urine Cr











Legend:
o CHEAR Labs ● Other Labs
Horizontal purple line = assigned target value based on the robust mean of all laboratories.
Gray area = acceptable range based on quality specifications:
±3 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±3 µg/L at concentrations less than or equal to 15 µg/L.

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Results for Event #1, 2017
Urine Mercury (Hg)

Summary Statistics

	Urine Hg (µg/L)				
	UE17-01	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
Target (Robust Mean (x*))	9.3	14.1	2.8	15.2	23.0
Upper Limit	12.3	18.3	5.8	19.8	29.9
Lower Limit	6.3	9.9	0.0	10.6	16.1
Robust SD (s*)	1.7	1.9	0.3	2.1	3.1
Robust RSD (%)	18.2	13.2	11.9	13.6	13.7
Number of Sample Measurements (N)	11	11	11	11	11
Standard Uncertainty (*u*)	0.643	0.702	0.125	0.777	1.18

The acceptable range is based on quality specifications:
±3 µg/L or ±30% around the target value, whichever is greater; thus, it is fixed at ±3 µg/L at concentrations less than or equal to 10 µg/L. These quality specifications were established by New York State Department of Health's Wadsworth Center, the PT Program organizer.

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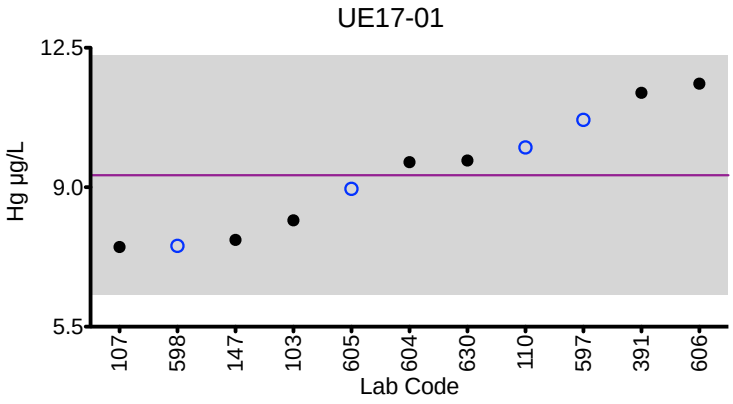
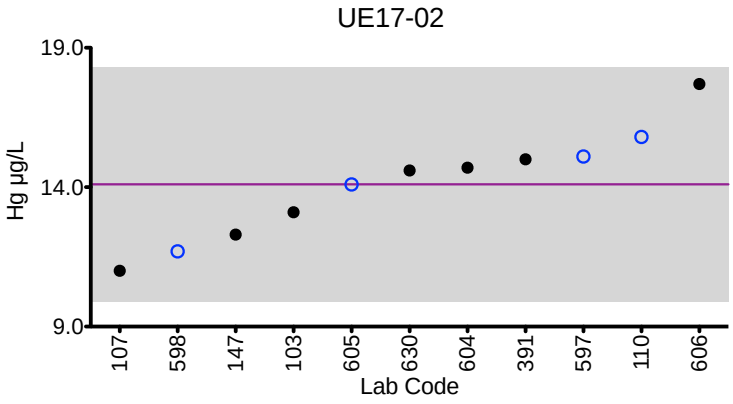
Results for Event #1, 2017
Urine Mercury (Hg)
Performance of Participating Laboratories

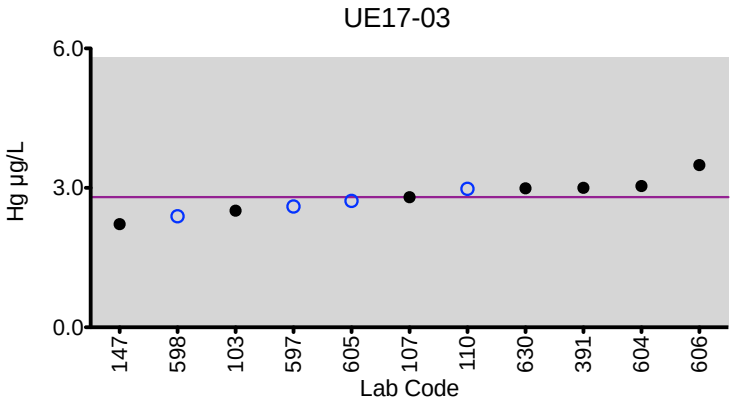
		Urine Hg (µg/L)				
Lab Code	**Method**	**UE17-01**	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
	Target	**9.3**	**14.1**	**2.8**	**15.2**	**23.0**
103	DRC/CC-ICP-MS	8.17	13.1	2.51	14.5	21.1
107	DRC/CC-ICP-MS	7.5	11	2.8	12	26
110	ICP-MS	10	15.8	2.98	17.0	23.5
147	CV-AAS	7.68	12.3	2.22	13.4	20.0
293	DRC/CC-ICP-MS	15.81 ↑	13.63	14.5 ↑	15.85	23.3
391	DRC/CC-ICP-MS	11.37	15.00	3.0	14.27	20.5
597	DMA	10.69	15.1	2.6	16.5	22.3
598	ICP-MS	7.53	11.7	2.39	12.9	17.9
604	DRC/CC-ICP-MS	9.63	14.7	3.04	16.0	26.1
605	ICP-MS	8.96	14.1	2.72	15.6	23.8
606	ICP-MS	11.6	17.7	3.49	19.6	26.5
630	ICP-MS	9.67	14.6	2.99	16.3	24.8

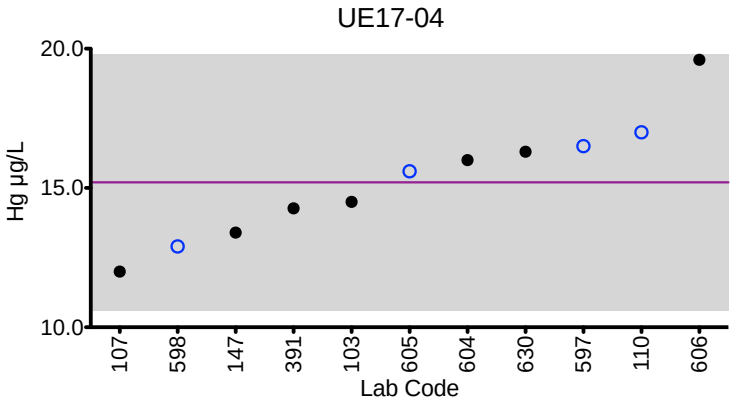
Based on the grading criteria for Hg in Urine, 97% of results were satisfactory, with 1 of the 12 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

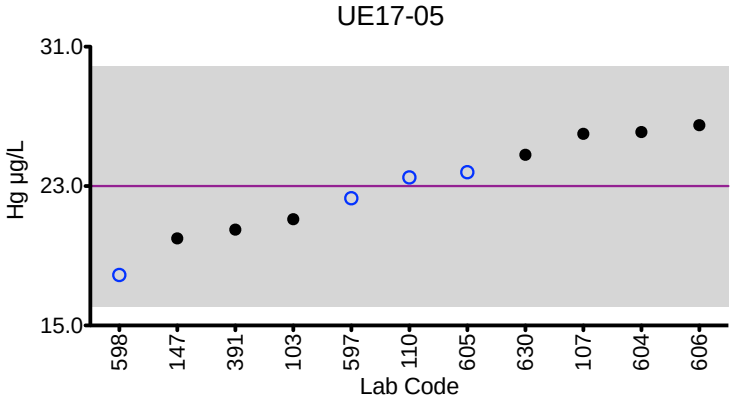
Results for Event #1, 2017:
Urine Hg











Legend:

o CHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the robust mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±3 µg/L or ±30% around the target value, whichever is greater; thus, it is fixed at ±3 µg/L at concentrations less than or equal to 10 µg/L.

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Results for Event #1, 2017
Urine Manganese (Mn)

Summary Statistics

	Urine Mn (µg/L)				
	UE17-01	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
Target (Robust Mean (x*))	1.00	3.1	1.30	2.5	5.0
Upper Limit	1.55	3.9	1.85	3.1	6.3
Lower Limit	0.45	2.3	0.75	1.9	3.8
Robust SD (s*)	0.10	0.2	0.20	0.2	0.3
Robust RSD (%)	12.7	5.9	11.8	8.3	6.1
Number of Sample Measurements (N)	15	16	15	15	16
Standard Uncertainty (*u*)	0.042	0.057	0.050	0.067	0.097

The acceptable range is based on quality specifications:
±0.55 µg/L or ±25% around the target value, whichever is greater; thus, it is fixed at ±0.55 µg/L at concentrations less than or equal to 2.2 µg/L. Quality specifications for Mn are consistent with those used by other External Quality Assessment Schemes for trace elements. (Praamsma M, et al. Clinical Chemistry and Laboratory Medicine.2016; 54(12): 1921-1928)

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Results for Event #1, 2017
Urine Manganese (Mn)
Performance of Participating Laboratories

		Urine Mn (µg/L)				
Lab Code	**Method**	**UE17-01**	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
	Target	**1.00**	**3.1**	**1.30**	**2.5**	**5.0**
103	DRC/CC-ICP-MS	0.996	3.23	1.25	2.46	5.06
107	DRC/CC-ICP-MS	0.98	3.2	1.3	2.5	5.1
110	DRC/CC-ICP-MS	0.98	3.1	1.3	2.4	5.1
116	DRC/CC-ICP-MS	1.01	2.95	1.12	2.48	4.66
147	DRC/CC-ICP-MS	0.802	2.61	1.04	2.07	4.37
324	ICP-MS	1.412	3.604	1.643	2.715	5.4020
391	DRC/CC-ICP-MS	0.84	3.09	1.19	2.49	5.25
399	DRC/CC-ICP-MS	0.923	2.98	1.21	2.30	4.82
597	DRC/CC-ICP-MS	<1.3	1.43 ↓	<1.3	<1.3 ↓	3.06 ↓
598	DRC/CC-ICP-MS	1.02	3.04	1.43	2.69	4.85
599	DRC/CC-ICP-MS	2.42 ↑	4.34 ↑	2.60 ↑	3.80 ↑	6.15
604	DRC/CC-ICP-MS	0.962	3.06	1.29	2.34	5.05
605	ICP-MS	0.969	3.21	1.28	2.53	5.20
606	ICP-MS	1.2	3.00	1.48	2.62	5.33
630	ICP-MS	1.17	3.30	1.42	2.64	5.23
632	DRC/CC-ICP-MS	1.20	3.14	1.26	2.22	4.93

Based on the grading criteria for Mn in Urine, 91% of results were satisfactory, with 2 of the 16 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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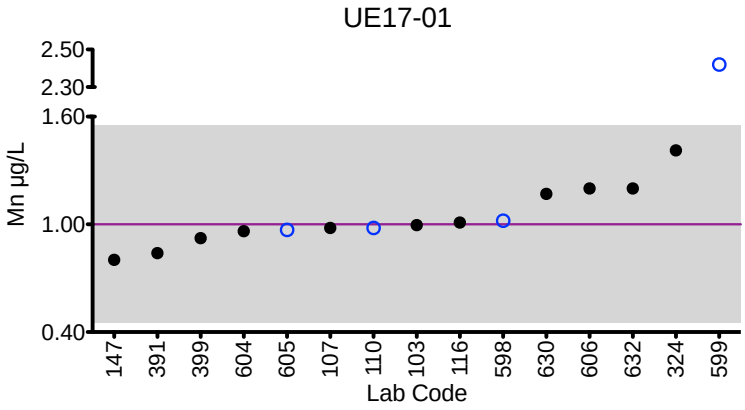
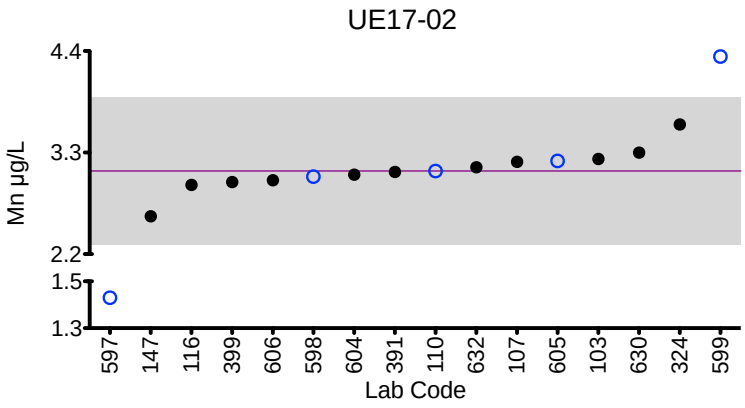
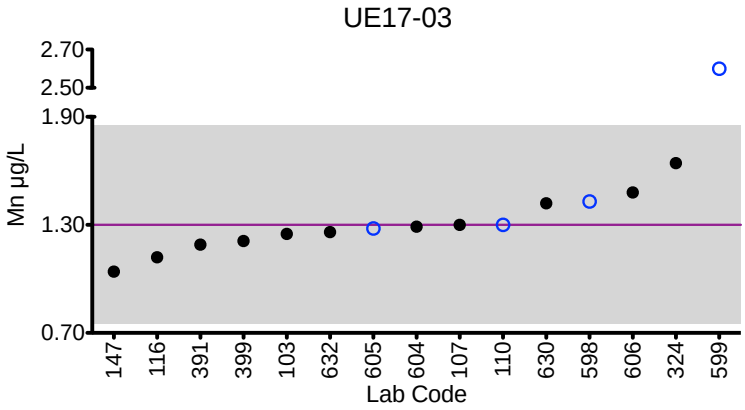
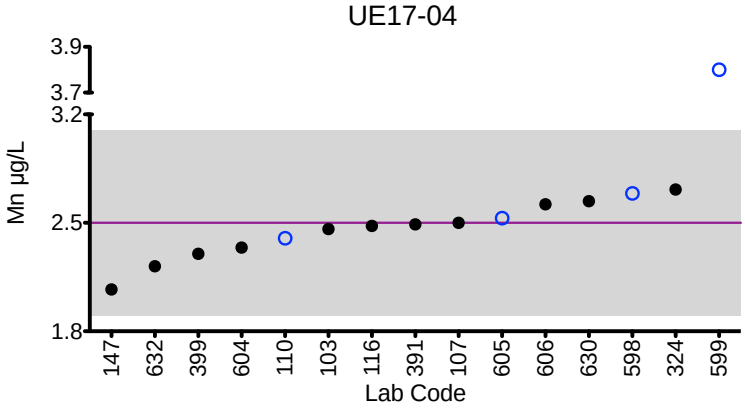
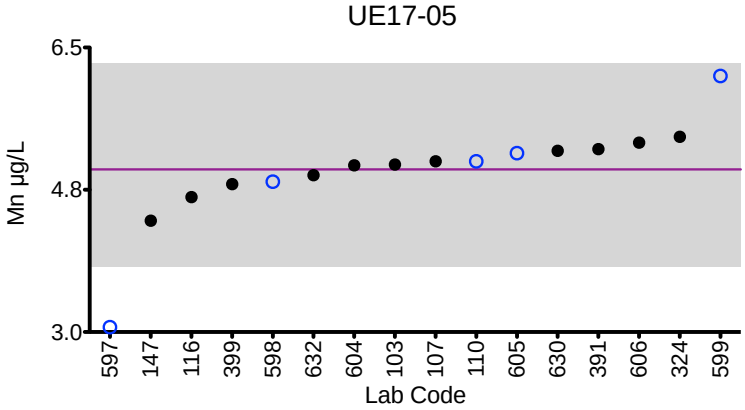
Results for Event #1, 2017: Urine Mn











Legend:

○ CHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the robust mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±0.55 µg/L or ±25% around the target value, whichever is greater; thus, it is fixed at ±0.55 µg/L at concentrations less than or equal to 2.2 µg/L.

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Results for Event #1, 2017
Urine Lead (Pb)

Summary Statistics

	Urine Pb (µg/L)				
	UE17-01	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
Target (Robust Mean (x*))	8.0	4.7	14.3	3.1	1.7
Upper Limit	9.6	5.7	17.2	4.1	2.7
Lower Limit	6.4	3.7	11.4	2.1	0.7
Robust SD (s*)	0.5	0.3	0.7	0.2	0.1
Robust RSD (%)	6.0	5.5	4.8	6.0	8.0
Number of Sample Measurements (N)	17	17	17	17	17
Standard Uncertainty (*u*)	0.145	0.079	0.210	0.056	0.042

The acceptable range is based on quality specifications:
±1 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±1 µg/L at concentrations less than or equal to 5 µg/L. These quality specifications are based on the same criteria used by the US Centers for Disease Control Prevention (CDC) for public health labs participating in the Laboratory Response Network (LRN) PT program for Toxic Metals.

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Results for Event #1, 2017
Urine Lead (Pb)
Performance of Participating Laboratories

		Urine Pb (µg/L)				
Lab Code	**Method**	**UE17-01**	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
	Target	**8.0**	**4.7**	**14.3**	**3.1**	**1.7**
103	DRC/CC-ICP-MS	8.18	4.88	15.0	3.14	1.73
107	ICP-MS	8.1	4.9	15	3.2	1.8
110	ICP-MS	7.9	4.7	14.7	3.1	1.6
116	ICP-MS	7.60	4.52	14.1	2.93	1.59
147	ICP-MS	7.52	4.50	13.9	2.94	1.62
200	ICP-MS	9.3	5.8 ↑	14.7	5.0 ↑	4.6 ↑
293	DRC/CC-ICP-MS	8.7	4.7	15.0	3.1	1.6
324	ICP-MS	7.958	5.010	14.880	3.328	1.913
391	DRC/CC-ICP-MS	7.6	4.9	14.2	3.0	1.7
399	ICP-MS	7.76	4.71	15.0	3.00	1.65
597	DRC/CC-ICP-MS	5.88 ↓	3.97	13.2	2.73	1.34
598	ICP-MS	8.50	4.40	13.7	2.86	1.67
599	DRC/CC-ICP-MS	7.87	4.84	12.5	3.16	1.86
605	ICP-MS	7.99	4.72	14.6	3.08	1.69
606	ICP-MS	7.54	4.56	13.7	2.97	1.87
607	ICP-MS	7.94	5.10	15.1	3.27	1.93
632	ICP-MS	9.92 ↑	4.75	14.1	2.83	1.63
686	ICP-MS	8.45	4.68	14.1	3.01	1.68

Based on the grading criteria for Pb in Urine, 94% of results were satisfactory, with 1 of the 18 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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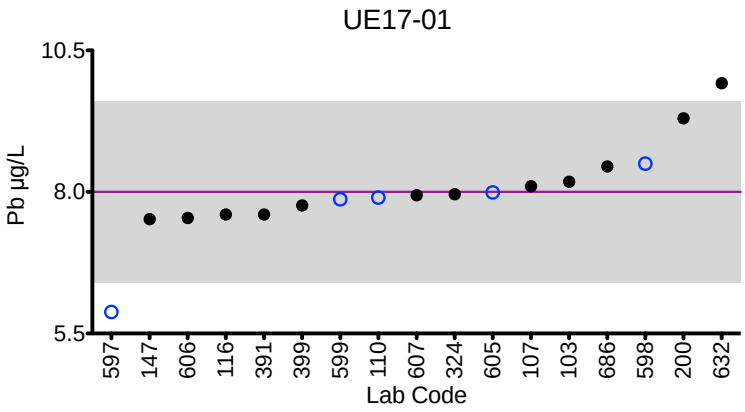
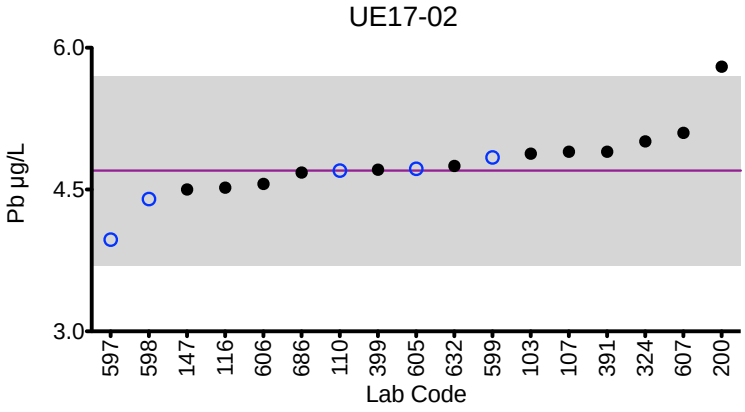
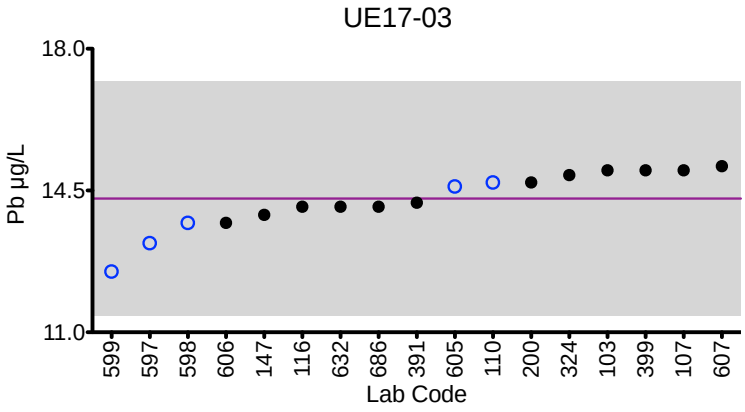
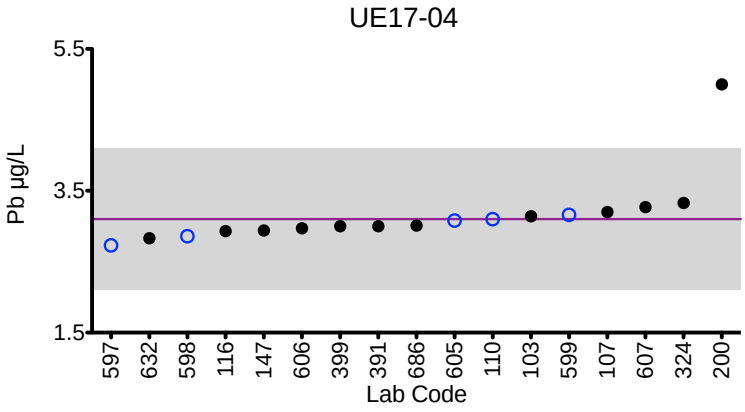
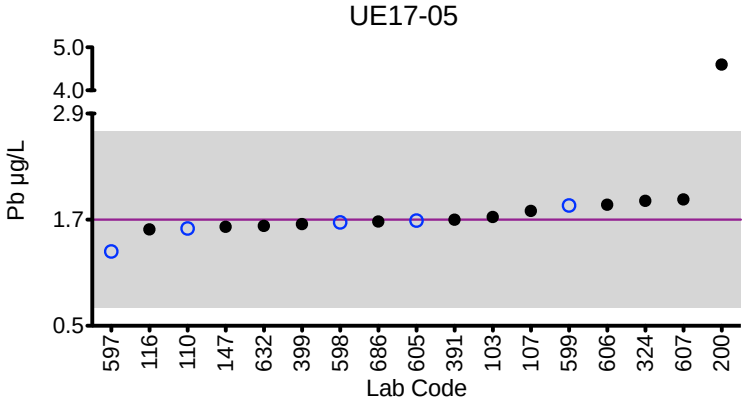
Results for Event #1, 2017: Urine Pb











Legend:

o CHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the robust mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±1 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±1 µg/L at concentrations less than or equal to 5 µg/L.

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Results for Event #1, 2017
Urine Thallium (Tl)

Summary Statistics

	Urine Tl (µg/L)				
	UE17-01	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
Target (Robust Mean (x*))	4.76	0.33	0.42	0.14	1.05
Upper Limit	5.71	0.53	0.62	0.34	1.26
Lower Limit	3.81	0.13	0.22	0.00	0.84
Robust SD (s*)	0.24	0.01	0.01	0.01	0.07
Robust RSD (%)	5.1	4.5	3.3	5.7	6.7
Number of Sample Measurements (N)	14	12	12	12	14
Standard Uncertainty (*u*)	0.08	0.005	0.005	0.003	0.023

The acceptable range is based on quality specifications:
±0.2 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±0.2 µg/L at concentrations less than or equal to 1 µg/L. These quality specifications are based on the same criteria used by the US Centers for Disease Control Prevention (CDC) for public health labs participating in the Laboratory Response Network (LRN) PT program for Toxic Metals.

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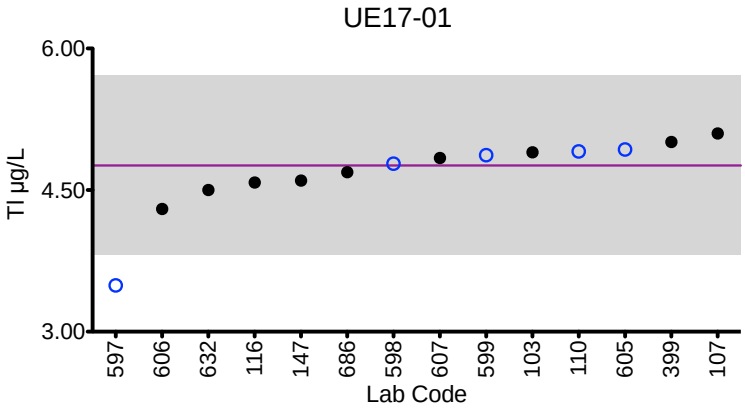
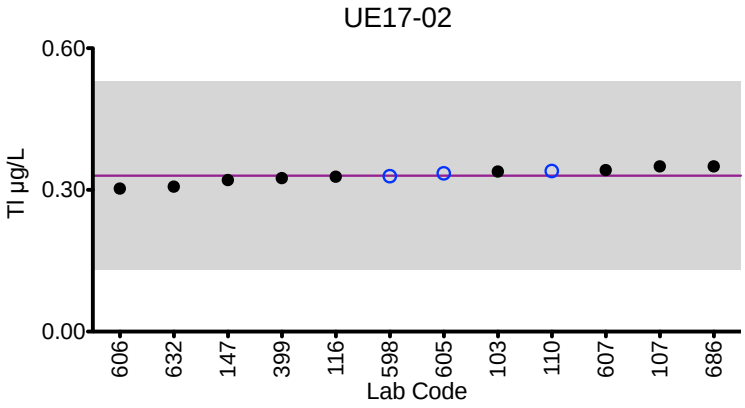
Results for Event #1, 2017
Urine Thallium (Tl)
Performance of Participating Laboratories

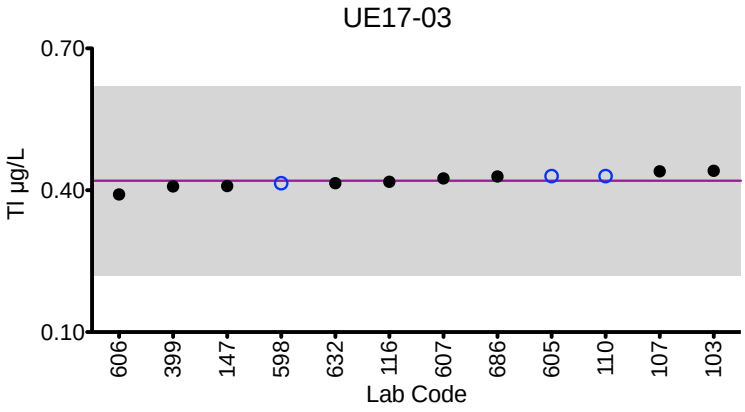
		Urine Tl (µg/L)				
Lab Code	**Method**	**UE17-01**	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
	Target	**4.76**	**0.33**	**0.42**	**0.14**	**1.05**
103	DRC/CC-ICP-MS	4.90	0.339	0.441	0.145	1.13
107	ICP-MS	5.1	0.35	0.44	0.15	1.1
110	ICP-MS	4.91	0.34	0.43	0.15	1.10
116	ICP-MS	4.58	0.328	0.418	0.146	1.06
147	ICP-MS	4.60	0.321	0.409	0.143	1.05
399	ICP-MS	5.01	0.325	0.408	0.138	1.01
597	DRC/CC-ICP-MS	3.49 ↓	<0.4	<0.4	<0.4	0.756 ↓
598	ICP-MS	4.78	0.329	0.415	0.143	1.03
599	DRC/CC-ICP-MS	4.87	<0.1 ↓	<0.1 ↓	<0.1	0.67 ↓
605	ICP-MS	4.93	0.335	0.430	0.149	1.10
606	ICP-MS	4.30	0.303	0.391	0.123	0.980
607	ICP-MS	4.84	0.342	0.425	0.155	1.12
632	ICP-MS	4.50	0.307	0.415	0.137	1.02
686	ICP-MS	4.69	0.350	0.429	0.134	1.12

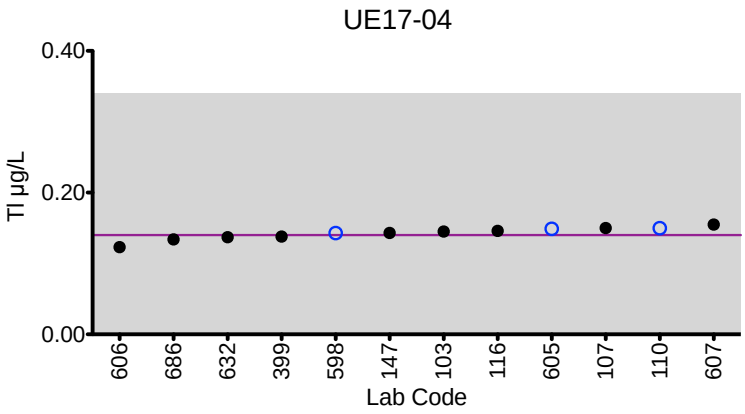
Based on the grading criteria for Tl in Urine, 93% of results were satisfactory, with 2 of the 14 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

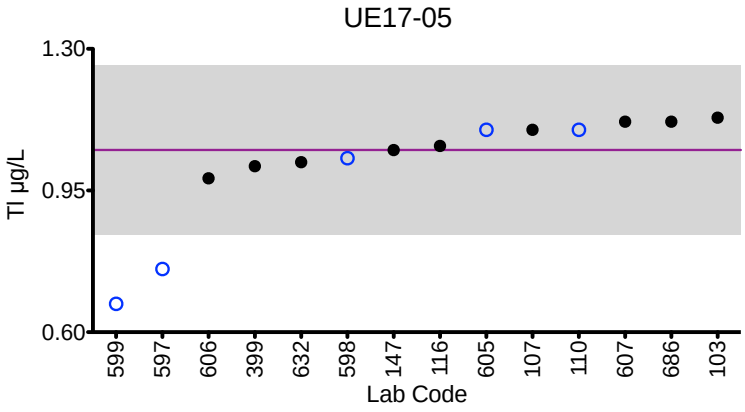
Results for Event #1, 2017:
Urine Tl











Legend:
○ CHEAR Labs ● Other Labs
Horizontal purple line = assigned target value based on the robust mean of all laboratories.
Gray area = acceptable range based on quality specifications:
±0.2 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±0.2 µg/L at concentrations less than or equal to 1 µg/L.

Results for Event #1, 2017
Urine Uranium (U)

Summary Statistics

	Urine U (µg/L)				
	UE17-01	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
Target (Robust Mean (x*))	0.043	0.006	0.079	0.022	0.181
Upper Limit	0.073		0.109	0.052	0.217
Lower Limit	0.013		0.049	0.000	0.145
Robust SD (s*)	0.002	0.002	0.007	0.002	0.011
Robust RSD (%)	5.6	37.5	8.6	11.2	5.9
Number of Sample Measurements (N)	15	7	16	15	16
Standard Uncertainty (*u*)	0.00078		0.002	0.001	0.003

The acceptable range is based on quality specifications:
±0.03 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±0.03 µg/L at concentrations less than or equal to 0.15 µg/L. These quality specifications are based on the same criteria used by the US Centers for Disease Control Prevention (CDC) for public health labs participating in the Laboratory Response Network (LRN) PT program for Toxic Metals.

Sample UE17-02 was treated as an educational challenges for the purposes of this event, and is not graded. However, the statistical data are provided for informational purposes.

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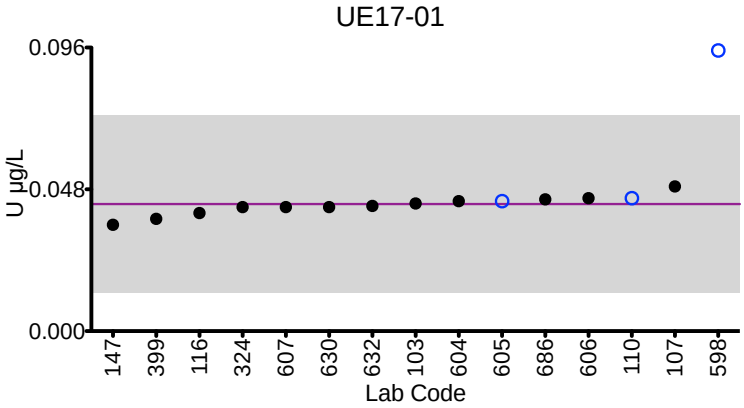
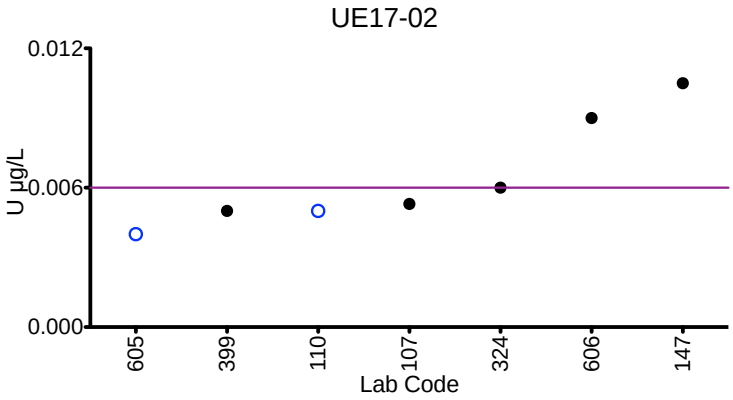
Results for Event #1, 2017
Urine Uranium (U)
Performance of Participating Laboratories

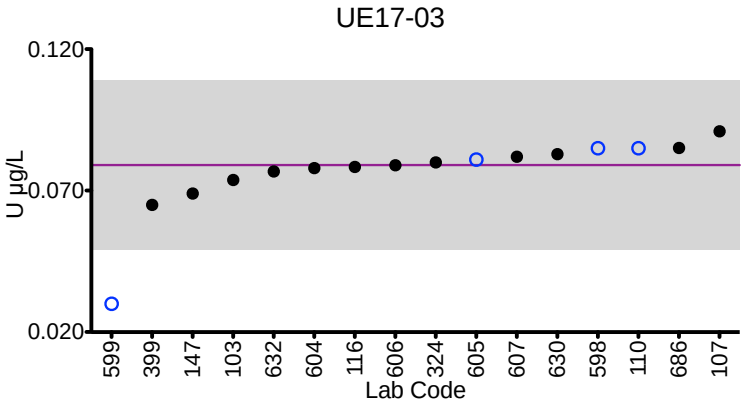
		Urine U (µg/L)				
Lab Code	**Method**	**UE17-01**	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
	Target	**0.043**	**0.006**	**0.079**	**0.022**	**0.181**
103	DRC/CC-ICP-MS	0.0432	< 0.0012	0.0738	0.0148	0.180
107	ICP-MS	0.049	0.0053	0.091	0.024	0.2
110	ICP-MS	0.045	0.005	0.085	0.022	0.191
116	ICP-MS	0.040	< 0.00529	0.0784	0.0208	0.178
147	ICP-MS	0.0360	0.0105	0.0690	0.0197	0.162
324	ICP-MS	0.042	0.006	0.080	0.021	0.179
399	ICP-MS	0.038	0.005	0.065	0.018	0.159
598	ICP-MS	0.095 ↑	<0.01	0.085	0.026	0.183
599	DRC/CC-ICP-MS	<0.1	<0.1	0.03 ↓	<0.1	0.15
604	ICP-MS	0.044	<0.007	0.078	0.023	0.174
605	ICP-MS	0.044	0.004	0.081	0.023	0.187
606	ICP-MS	0.045	0.009	0.079	0.027	0.186
607	ICP-MS	0.042	< 0.008	0.082	0.022	0.184
630	ICP-MS	0.0420	<0.005	0.0829	0.0209	0.185
632	ICP-MS	0.0424	<0.015	0.0768	0.0186	0.172
686	ICP-MS	0.0446	<0.0150	0.0851	0.0234	0.194

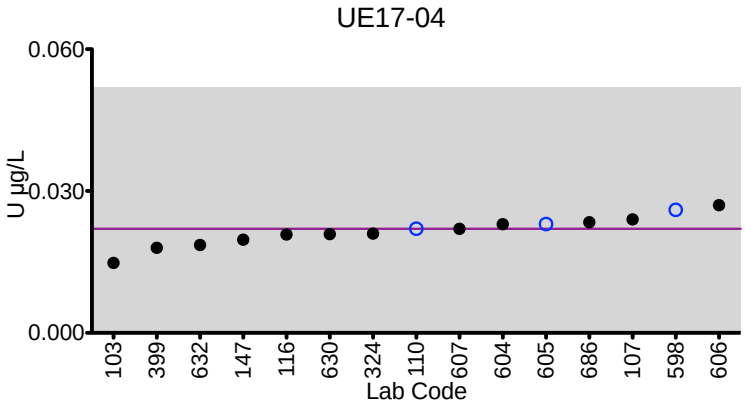
Based on the grading criteria for U in Urine, 98% of results were satisfactory, with 1 of the 16 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

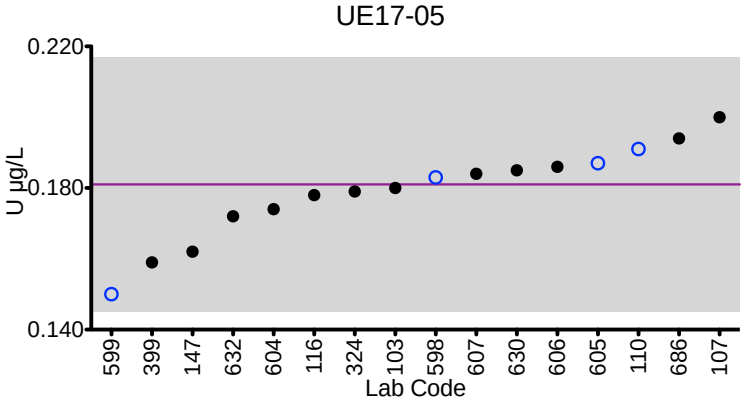
Results for Event #1, 2017: Urine U











Legend:

o CHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the robust mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±0.03 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±0.03 µg/L at concentrations less than or equal to 0.15 µg/L.

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Results for Event #1, 2017
Additional Elements in Urine: Cesium (Cs)

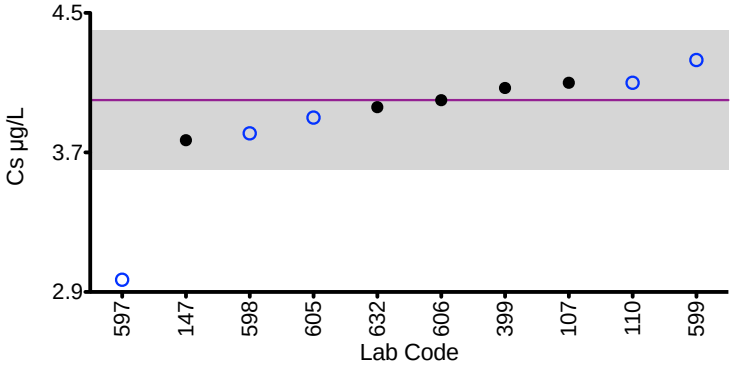
Urine Cs (µg/L)						
Lab Code	**Method**	**UE17-01**	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
107	ICP-MS	4.1	5.5	8.8	1.7	0.21
110	ICP-MS	4.1	5.5	8.7	1.7	0.2
147	ICP-MS	3.77	5.08	8.23	1.56	< 0.292
399	ICP-MS	4.07	5.62	9.00	1.71	0.222
597	DRC/CC-ICP-MS	2.97	4.78	7.97	1.47	<0.4
598	DRC/CC-ICP-MS	3.81	5.28	8.23	1.66	0.172
599	DRC/CC-ICP-MS	4.23	5.69	8.59	1.64	<0.1
605	ICP-MS	3.90	5.29	8.50	1.64	0.212
606	ICP-MS	4.00	5.38	8.64	1.71	0.200
632	ICP-MS	3.96	5.40	8.88	1.67	<0.6

Summary Statistics					
	UE17-01	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
Robust Mean (x*)	4.0	5.4	8.6	1.7	0.20
Robust SD (s*)	0.2	0.2	0.3	0.1	0.02
Robust RSD (%)	4.8	3.7	3.9	3.2	8.5
Number of Sample Measurements (N)	10	10	10	10	6
Standard Uncertainty (*u*)	0.075	0.079	0.134	0.021	NA

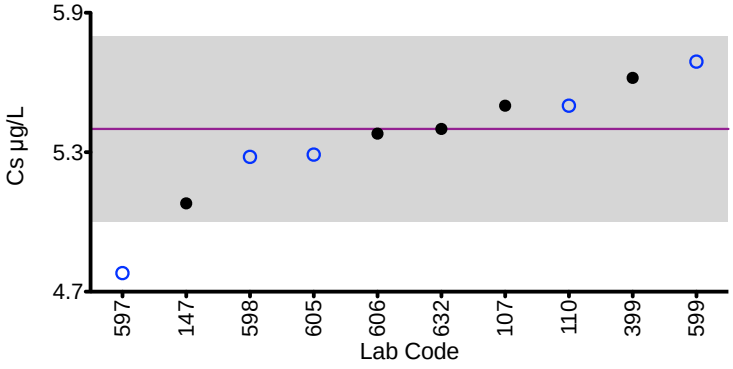
An arithmetic mean, SD, RSD, and n are provided for sample UE17-05.

Results for Event #1, 2017:
Urine Cs

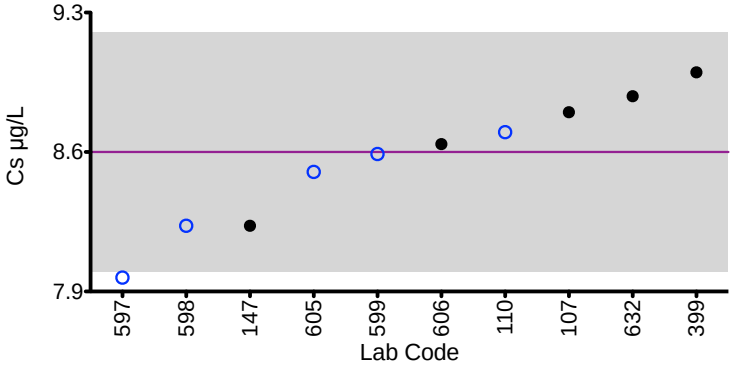
UE17-01



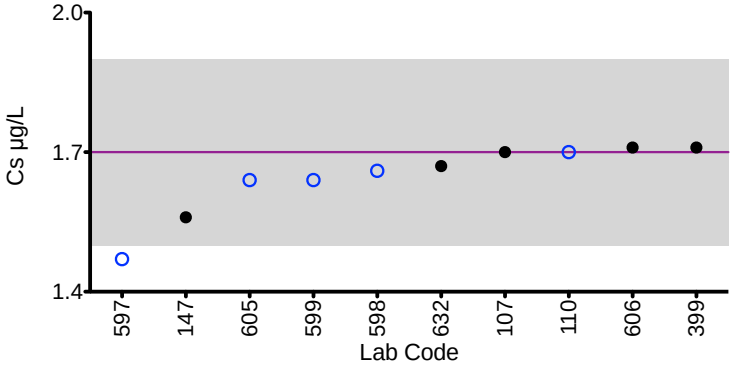
UE17-02



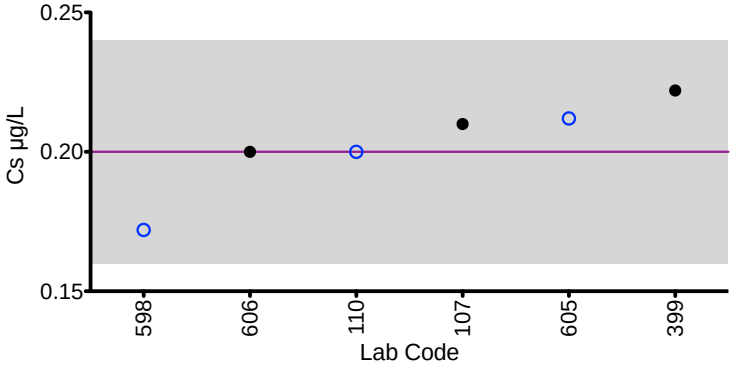
UE17-03



UE17-04



UE17-05



Legend:
o CHEAR Labs ● Other Labs
Horizontal purple line = robust mean of all laboratories.
Gray area = ±2SD of the mean.

The mean and ±2SD of all laboratories are not not intended to be quality specifications and are included for informational purposes only.

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Results for Event #1, 2017
Additional Elements in Urine: Copper (Cu)

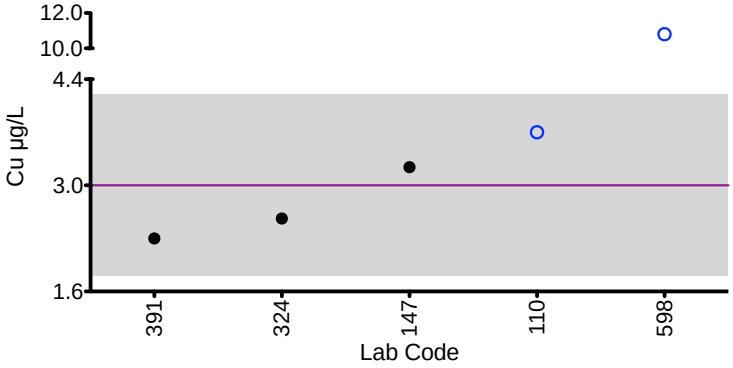
Urine Cu (µg/L)						
Lab Code	**Method**	**UE17-01**	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
110	ICP-MS	3.7	20	48	65	40
116	DRC/CC-ICP-MS	< 4.64	17.1	42.4	57.8	34.5
147	ICP-MS	3.24	20.0	48.6	64.2	38.8
324	ICP-MS	2.562	23.843	46.824	62.167	38.130
391	DRC/CC-ICP-MS	2.3	18.3	44.3	58.7	37.7
597	DRC/CC-ICP-MS	<0.2	15.9	42.84	59.24	32.70
598	ICP-MS	*10.8	17.1	41.0	53.6	33.6

Summary Statistics					
	UE17-01	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
Arithmetic Mean ($\bar{x}$)	3.0	18.9	44.9	60.1	36.5
Arithmetic SD (s)	0.6	2.7	3.0	4.0	2.8
Arithmetic RSD (%)	20.0	14.3	6.7	6.7	7.7
Number of Sample Measurements (N)	4	7	7	7	7

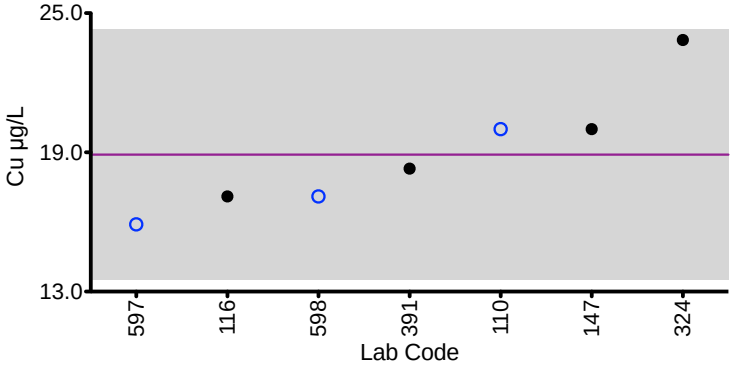
*Denotes a statistical Outlier.

Results for Event #1, 2017:
Urine Cu

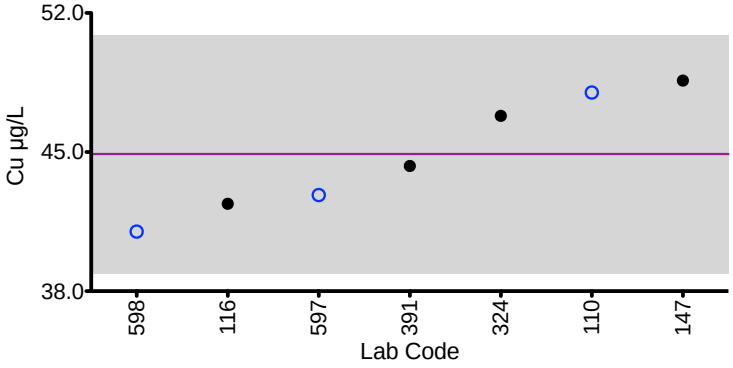
UE17-01



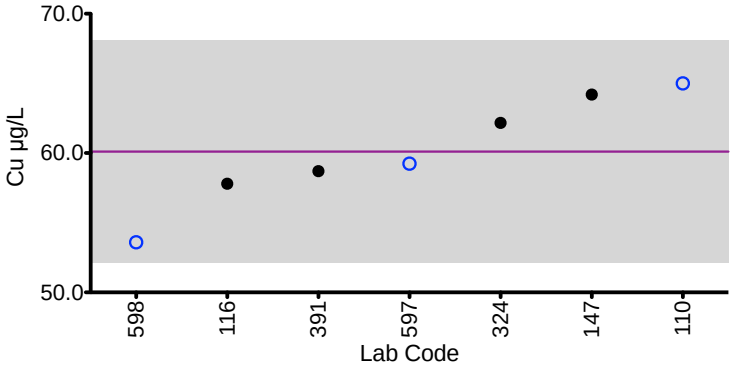
UE17-02



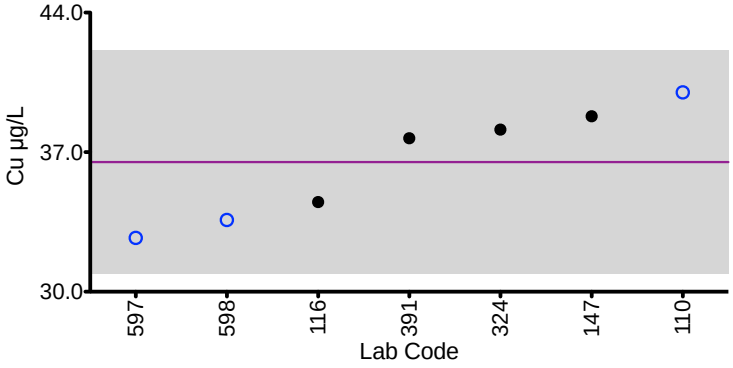
UE17-03



UE17-04



UE17-05



Legend:

o CHEAR Labs ● Other Labs

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Gray area = ±2SD of the mean.

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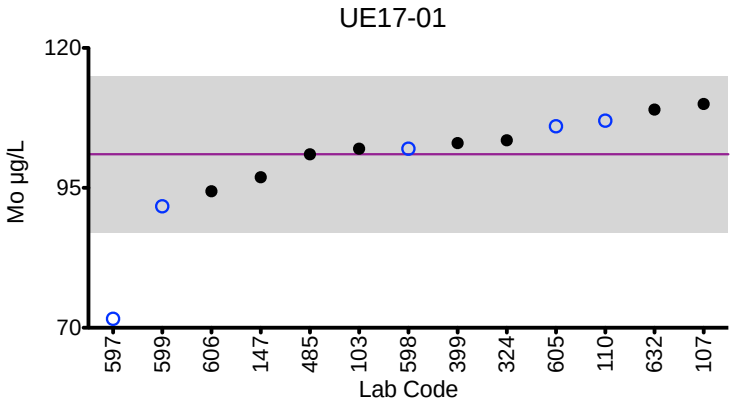
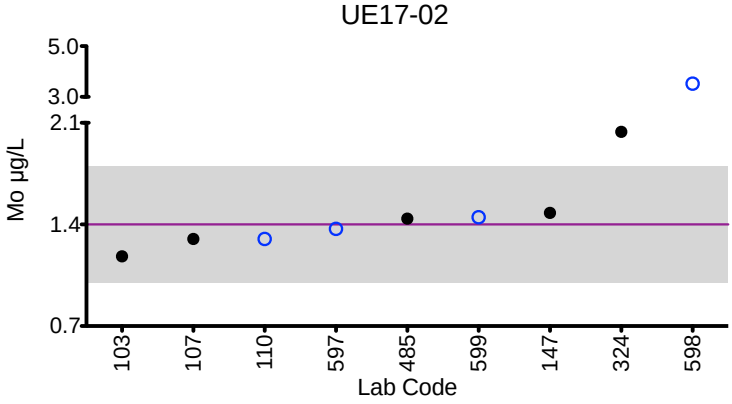
Results for Event #1, 2017
Additional Elements in Urine: Molybdenum (Mo)

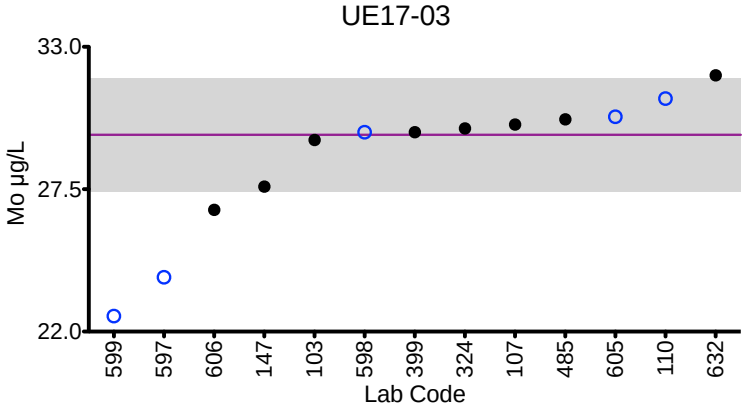
Urine Mo (µg/L)						
Lab Code	**Method**	**UE17-01**	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
103	DRC/CC-ICP-MS	102	1.18	29.4	43.0	55.6
107	ICP-MS	110	1.3	30	44	57
110	ICP-MS	107	1.3	31	45	59
147	ICP-MS	96.9	1.48	27.6	40.2	52.1
324	ICP-MS	103.493	2.038	29.849	43.822	58.184
399	ICP-MS	103	<3.00	29.7	42.8	56.2
485	HR-ICP-MS	101	1.44	30.20	42.89	60.71
597	DRC/CC-ICP-MS	71.6	1.37	24.1	35.9	45.4
598	DRC/CC-ICP-MS	102	3.52	29.7	43.3	56.4
599	DRC/CC-ICP-MS	91.7	1.45	22.6	39.0	52.8
605	ICP-MS	106	<1.896	30.3	44.0	57.8
606	ICP-MS	94.4	<3.00	26.7	39.3	51.8
632	ICP-MS	109	<9	31.9	46.3	60.0

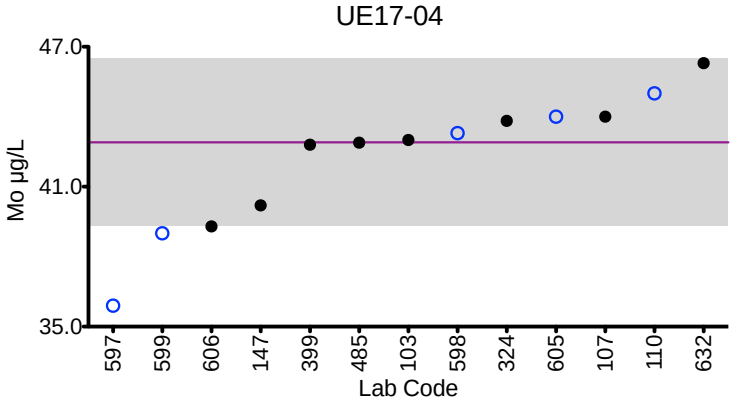
Summary Statistics					
	UE17-01	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
Robust Mean (x*)	101	1.4	29.6	42.9	56.0
Robust SD (s*)	7	0.2	1.1	1.8	3.7
Robust RSD (%)	7.0	15.4	3.7	4.3	6.6
Number of Sample Measurements (N)	13	9	13	13	13
Standard Uncertainty (*u*)	2.45	0.093	0.381	0.635	1.29

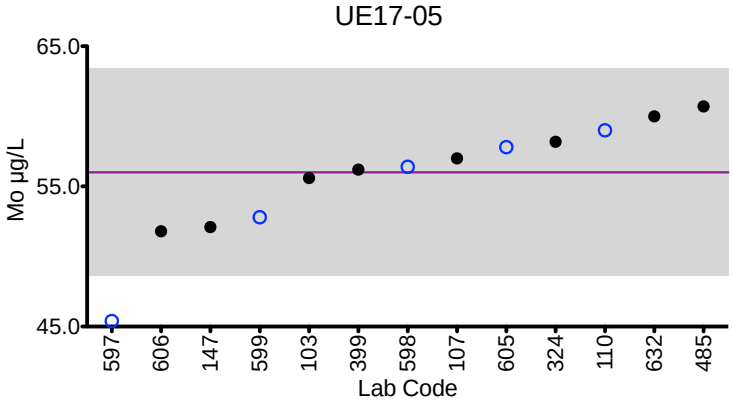
Results for Event #1, 2017: Urine Mo











Legend:
o CHEAR Labs ● Other Labs
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Gray area = ±2SD of the mean.

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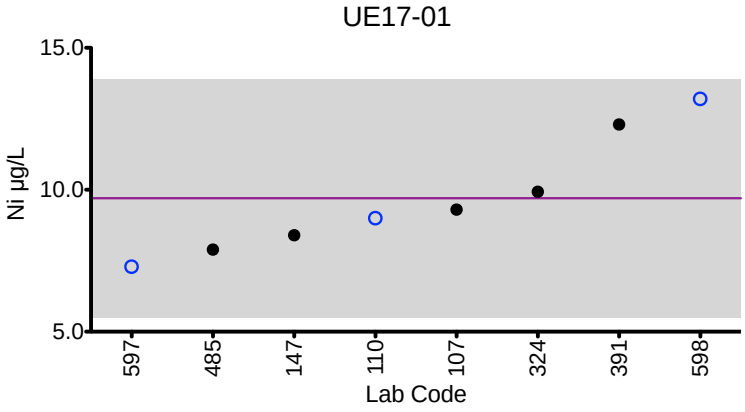
Results for Event #1, 2017
Additional Elements in Urine: Nickel (Ni)

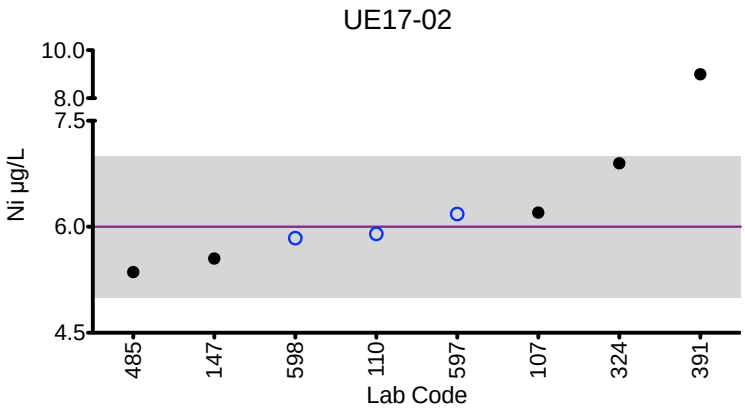
Urine Ni (µg/L)						
Lab Code	**Method**	**UE17-01**	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
107	ICP-MS	9.3	6.2	4.1	3.1	1.8
110	ICP-MS	9.0	5.9	3.7	2.5	<2
147	DRC/CC-ICP-MS	8.40	5.55	3.45	2.24	1.15
324	ICP-MS	9.930	6.899	4.755	3.516	2.059
391	DRC/CC-ICP-MS	12.3	*9	6.7	5.3	*4.4
485	HR-ICP-MS	7.89	5.36	3.44	2.26	1.00
597	DRC/CC-ICP-MS	7.29	6.18	4.61	3.99	<1.7
598	ICP-MS	13.2	5.84	*26.5	3.47	1.54

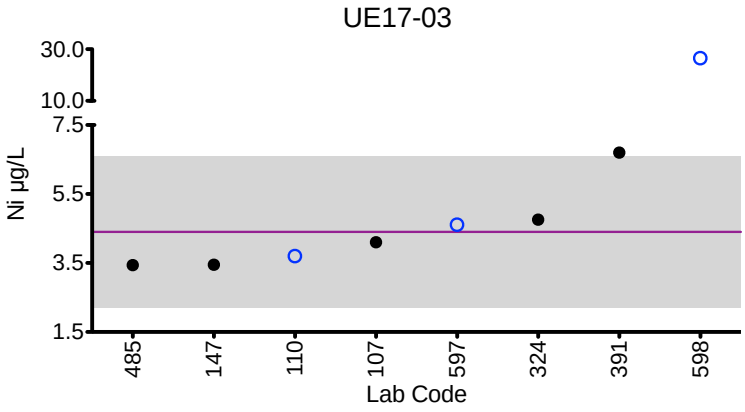
Summary Statistics					
	UE17-01	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
Arithmetic Mean ($\bar{x}$)	9.7	6.0	4.4	3.3	1.5
Arithmetic SD (s)	2.1	0.5	1.1	1.0	0.4
Arithmetic RSD (%)	21.6	8.3	25.0	30.3	26.7
Number of Sample Measurements (N)	8	7	7	8	5

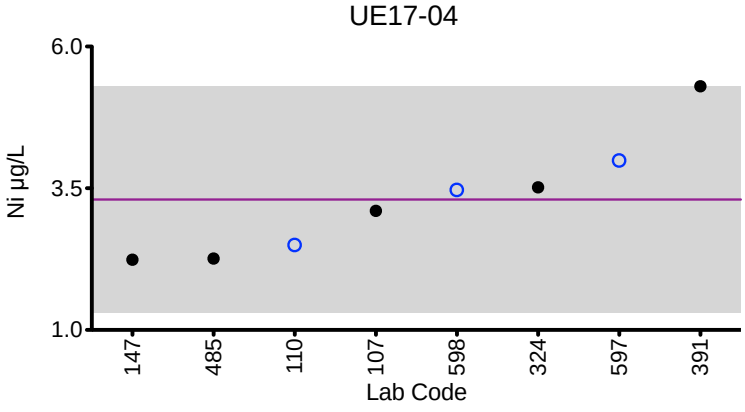
*Denotes a statistical Outlier.

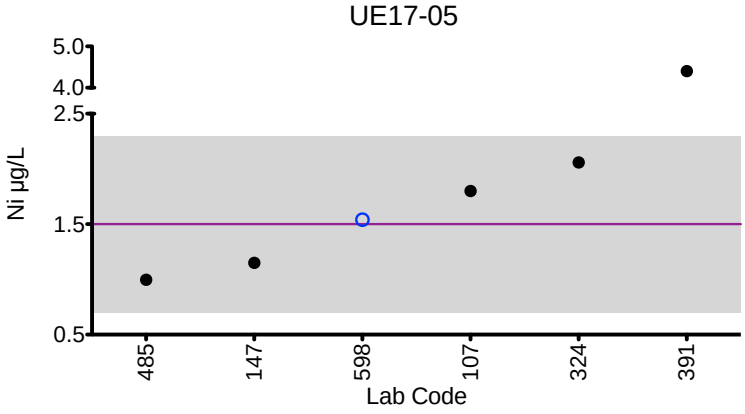
Results for Event #1, 2017:
Urine Ni











Legend:
○CHEAR Labs ● Other Labs
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Gray area = ±2SD of the mean.

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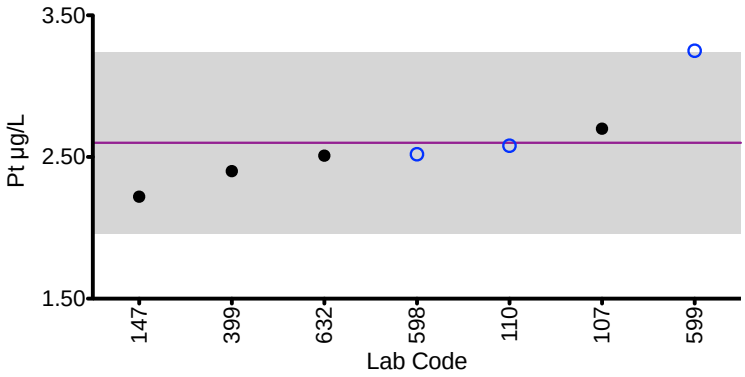
Results for Event #1, 2017
Additional Elements in Urine: Platinum (Pt)

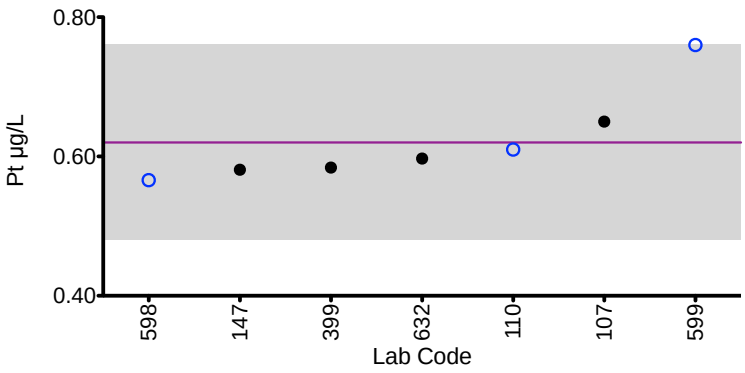
Urine Pt (µg/L)						
Lab Code	**Method**	**UE17-01**	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
107	ICP-MS	2.7	0.65	3.5	0.44	0.12
110	ICP-MS	2.58	0.61	3.47	0.41	0.10
147	ICP-MS	2.22	0.581	2.95	0.440	< 0.127
399	ICP-MS	2.40	0.584	3.40	0.412	0.108
598	ICP-MS	2.52	0.566	3.05	0.384	0.101
599	DRC/CC-ICP-MS	3.25	0.76	3.57	0.55	0.13
632	ICP-MS	2.51	0.597	3.37	0.422	0.110

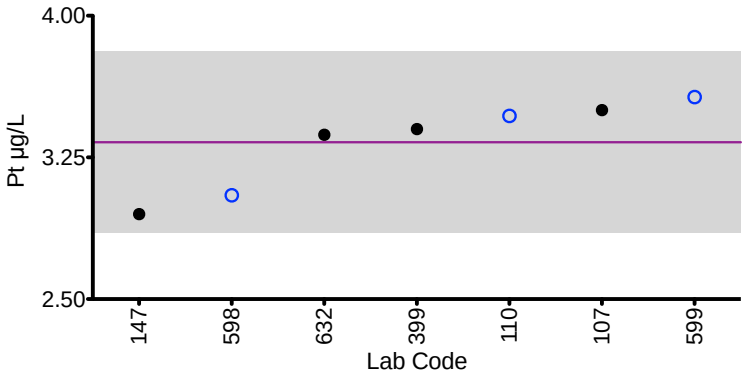
Summary Statistics					
	UE17-01	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
Arithmetic Mean ($\bar{x}$)	2.60	0.62	3.33	0.44	0.11
Arithmetic SD (s)	0.32	0.07	0.24	0.05	0.01
Arithmetic RSD (%)	12.3	11.3	7.2	11.4	9.1
Number of Sample Measurements (N)	7	7	7	7	6

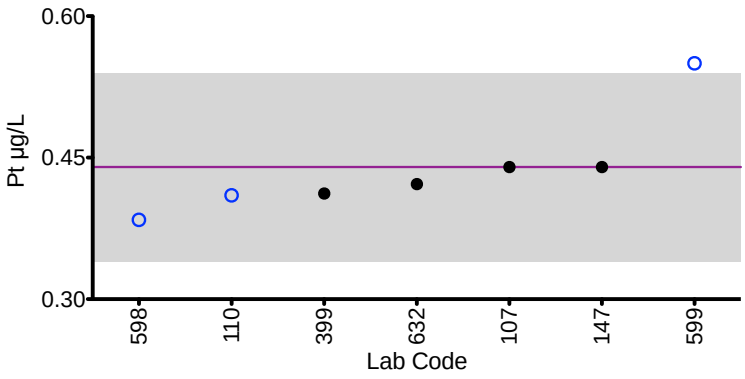
*Denotes a statistical Outlier.

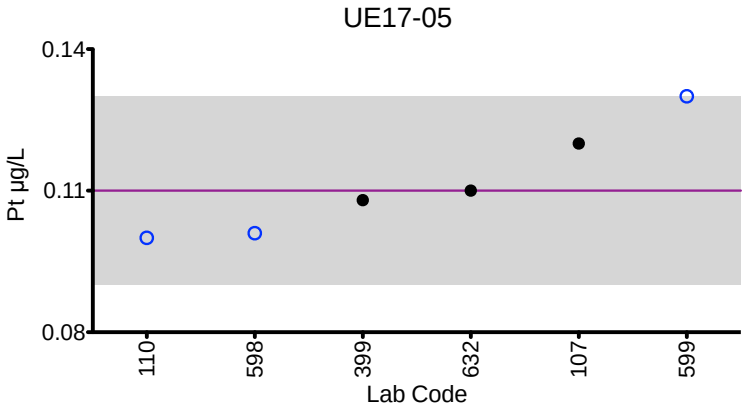
Results for Event #1, 2017:
Urine Pt











Legend:
o CHEAR Labs ● Other Labs
Horizontal purple line = arithmetic mean of all laboratories.
Gray area = ±2SD of the mean.

The mean and ±2SD of all laboratories are not not intended to be quality specifications and are included for informational purposes only.

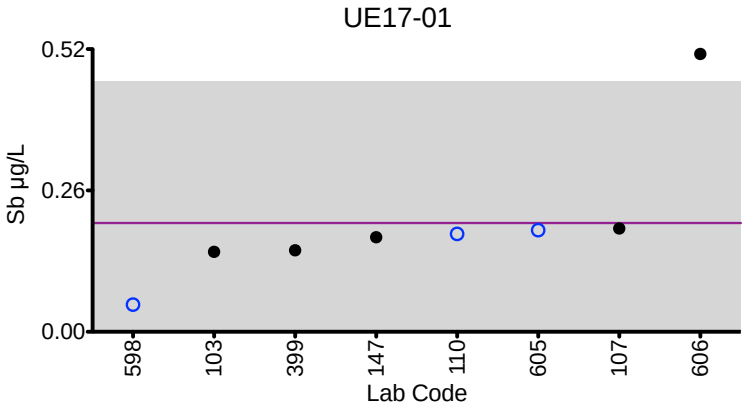
Results for Event #1, 2017
Additional Elements in Urine: Antimony (Sb)

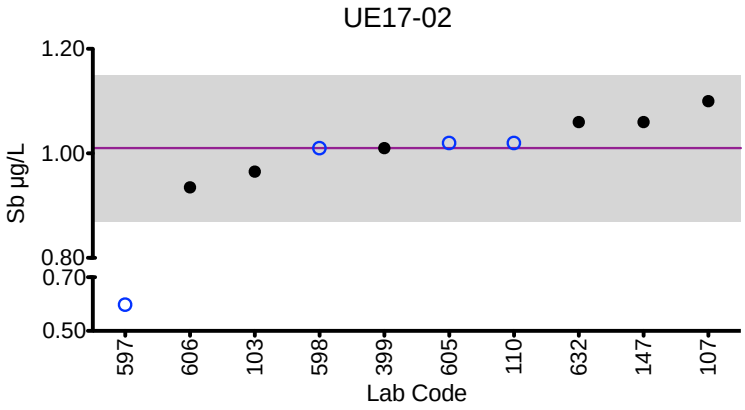
Urine Sb (µg/L)						
Lab Code	**Method**	**UE17-01**	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
103	DRC/CC-ICP-MS	0.147	0.965	0.722	1.09	0.472
107	ICP-MS	0.19	1.1	0.74	1.1	0.53
110	ICP-MS	0.18	1.02	0.73	1.13	0.49
147	ICP-MS	0.174	1.06	0.780	1.16	0.510
399	ICP-MS	0.150	1.01	0.713	1.13	0.491
597	DRC/CC-ICP-MS	<0.3	0.598	0.385	0.818	<0.3
598	DRC/CC-ICP-MS	0.05	1.01	0.63	1.04	0.38
605	ICP-MS	0.187	1.02	0.711	1.13	0.515
606	ICP-MS	0.511	0.935	0.692	1.11	0.514
632	ICP-MS	<0.24	1.06	0.725	1.15	0.520

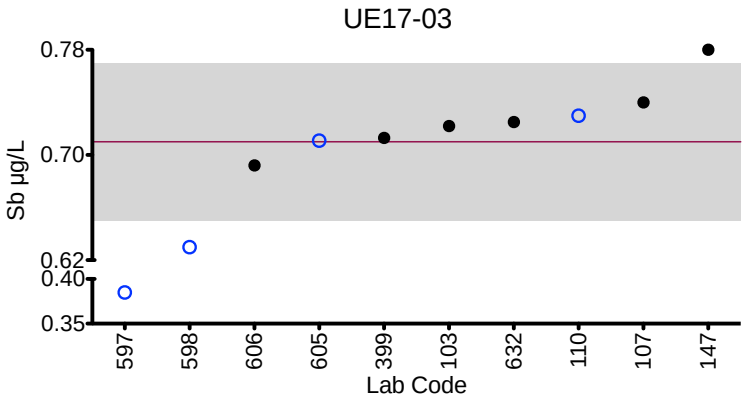
Summary Statistics					
	UE17-01	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
Robust Mean (x*)	0.20	1.01	0.71	1.11	0.49
Robust SD (s*)	0.13	0.07	0.03	0.04	0.05
Robust RSD (%)	68	6.5	4.1	3.4	9.2
Number of Sample Measurements (N)	8	10	10	10	9
Standard Uncertainty (*u*)	NA	0.026	0.011	0.015	NA

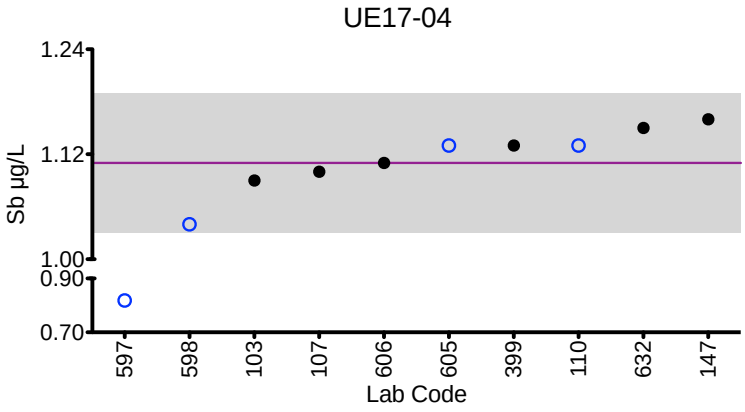
Arithmetic means, SD, RSD, and n are provided for sample UE17-01 and UE17-05.

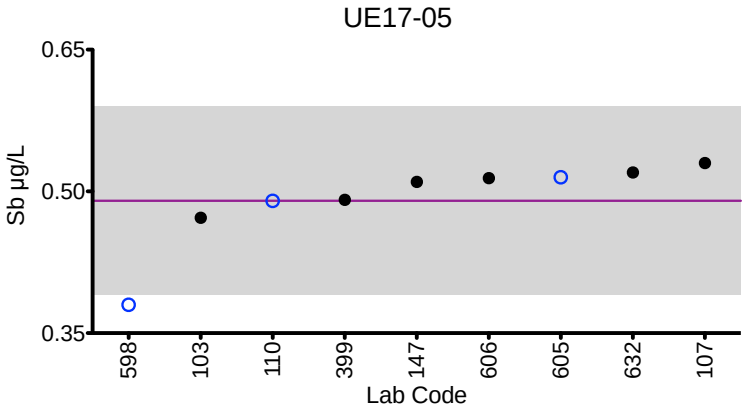
Results for Event #1, 2017:
Urine Sb











Legend:
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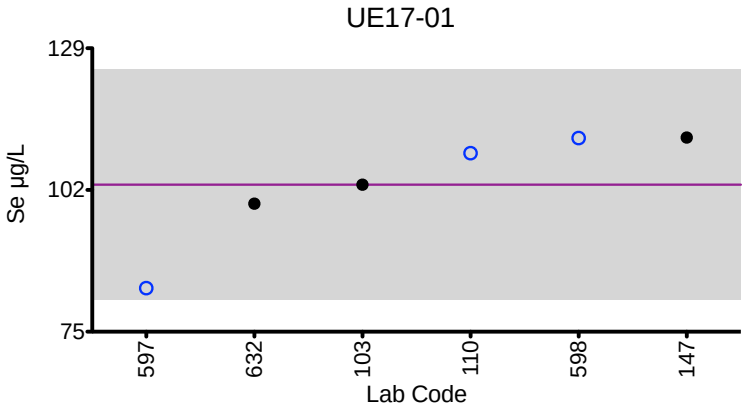
Results for Event #1, 2017
Additional Elements in Urine: Selenium (Se)

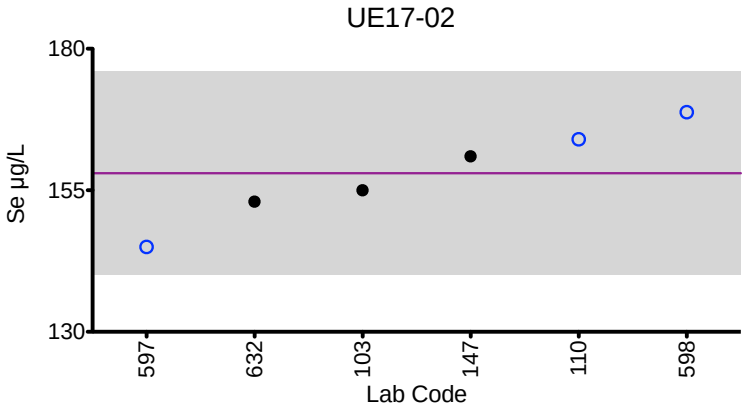
Urine Se (µg/L)						
Lab Code	**Method**	**UE17-01**	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
103	DRC/CC-ICP-MS	103	155	47.0	99.0	12.6
110	DRC/CC-ICP-MS	109	164	49	101	15
147	ICP-MS	112	161	49.9	99.5	14.7
597	DRC/CC-ICP-MS	83.3	145	45.2	96.7	14.4
598	ICP-MS	111.90	168.8	51.96	106.11	17.05
632	DRC/CC-ICP-MS	99.4	153	45.3	92.5	14.4

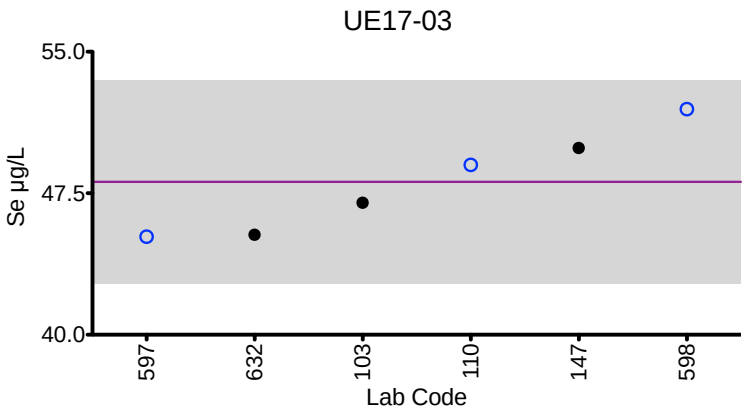
Summary Statistics					
	UE17-01	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
Arithmetic Mean ($\bar{x}$)	103	158	48.1	99	14.7
Arithmetic SD (s)	11	9	2.7	5	1.4
Arithmetic RSD (%)	10.7	5.7	5.6	4.5	9.5
Number of Sample Measurements (N)	6	6	6	6	6

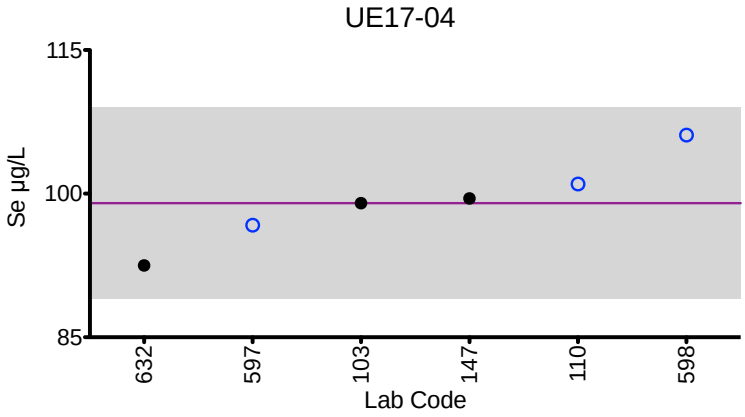
*Denotes a statistical Outlier.

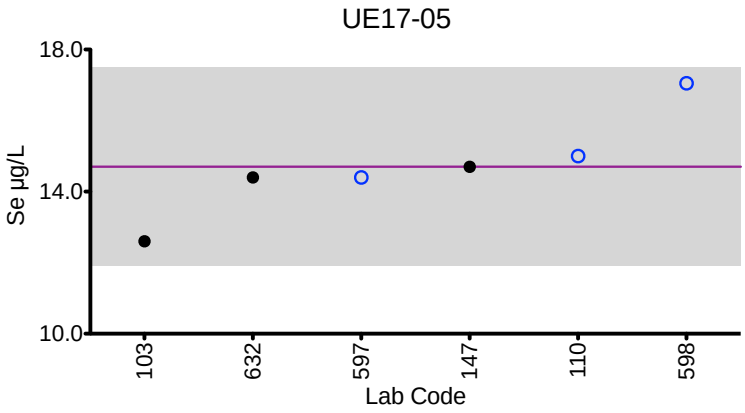
Results for Event #1, 2017:
Urine Se











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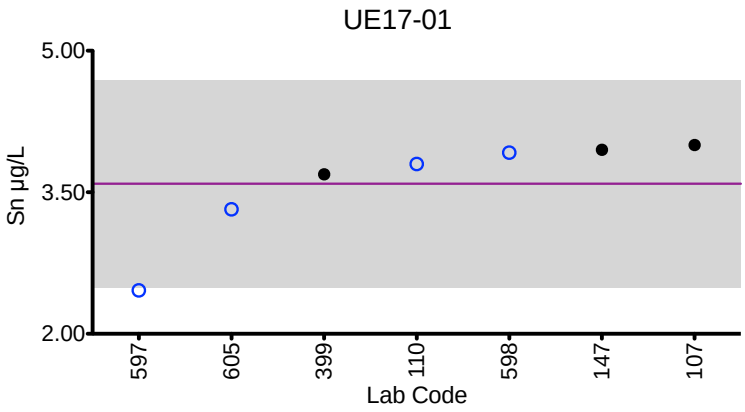
Results for Event #1, 2017
Additional Elements in Urine: Tin (Sn)

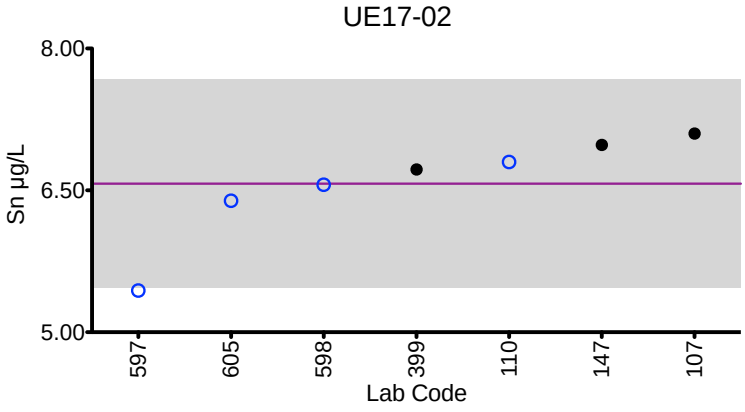
Urine Sn (µg/L)						
Lab Code	**Method**	**UE17-01**	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
107	ICP-MS	4	7.1	2.1	3.4	3.6
110	ICP-MS	3.8	6.8	1.9	3.2	3.3
147	ICP-MS	3.95	6.98	2.04	3.42	3.56
399	ICP-MS	3.69	6.72	1.98	3.20	3.42
597	DRC/CC-ICP-MS	2.46	5.44	1.42	2.71	2.71
598	DRC/CC-ICP-MS	3.92	6.56	1.99	3.28	3.20
605	ICP-MS	3.32	6.39	1.51	2.87	2.97

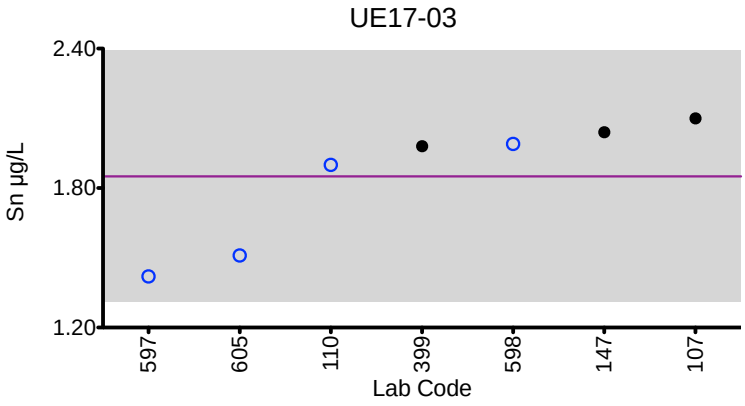
Summary Statistics					
	UE17-01	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
Arithmetic Mean ($\bar{x}$)	3.59	6.57	1.85	3.15	3.25
Arithmetic SD (s)	0.55	0.55	0.27	0.27	0.32
Arithmetic RSD (%)	15.3	8.4	14.6	8.6	9.8
Number of Sample Measurements (N)	7	7	7	7	7

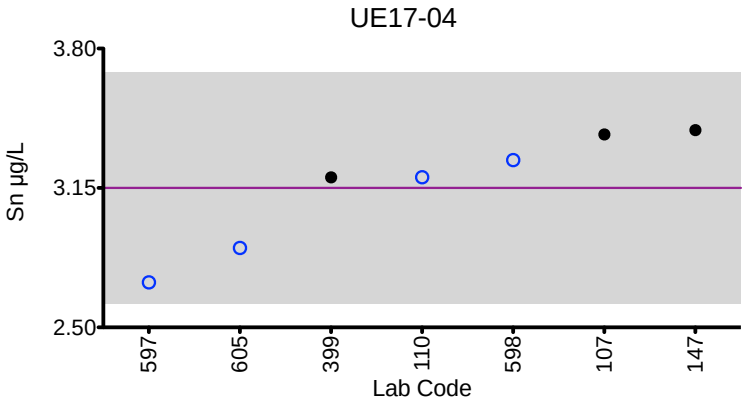
*Denotes a statistical Outlier.

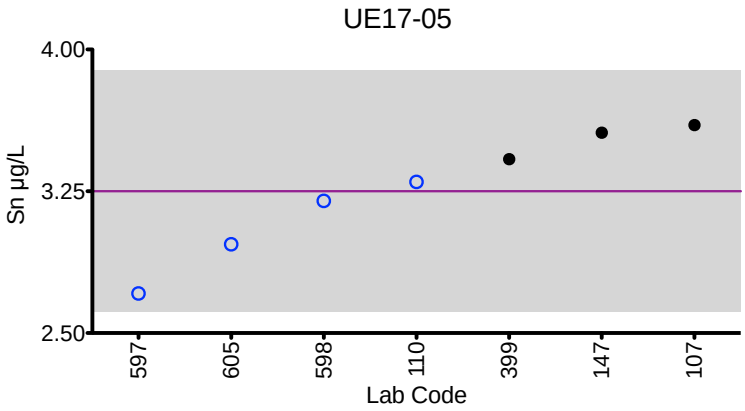
Results for Event #1, 2017:
Urine Sn











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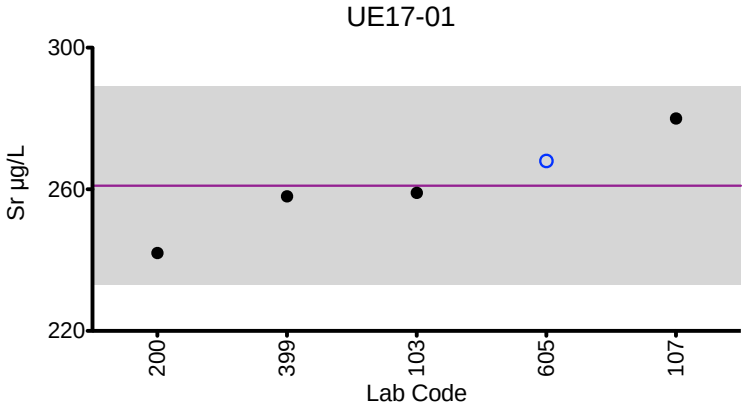
Results for Event #1, 2017
Additional Elements in Urine: Strontium (Sr)

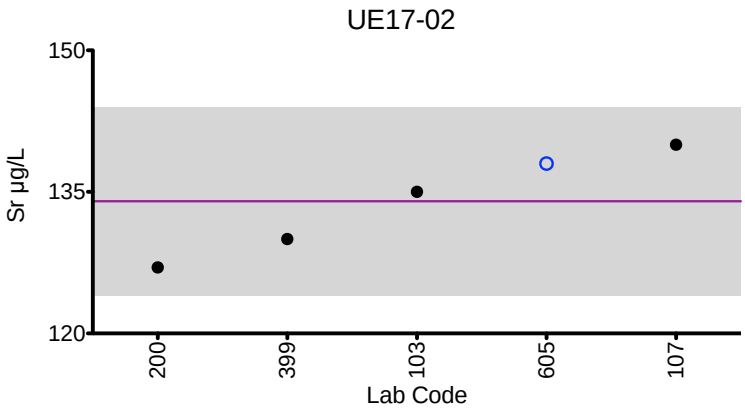
Urine Sr (µg/L)						
Lab Code	**Method**	**UE17-01**	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
103	DRC/CC-ICP-MS	259	135	11.1	72.0	272
107	ICP-MS	280	140	11	73	290
200	ICP-MS	242	127	10.5	66	*525
399	DRC/CC-ICP-MS	258	130	10.8	70.3	271
605	ICP-MS	268	138	11.5	74.5	282

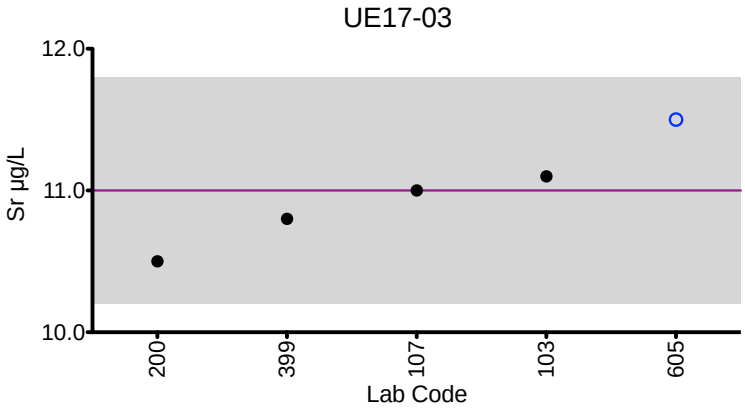
Summary Statistics					
	UE17-01	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
Arithmetic Mean ($\bar{x}$)	261	134	11.0	71.2	279
Arithmetic SD (s)	14	5	0.4	3.3	9
Arithmetic RSD (%)	5.4	3.7	3.6	4.6	3.2
Number of Sample Measurements (N)	5	5	5	5	4

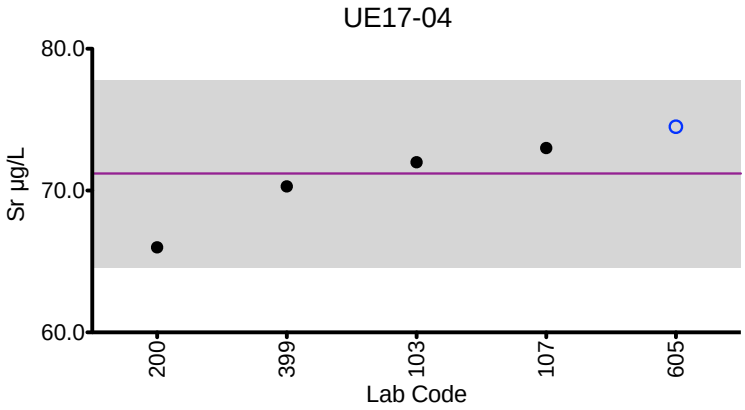
*Denotes a statistical Outlier.

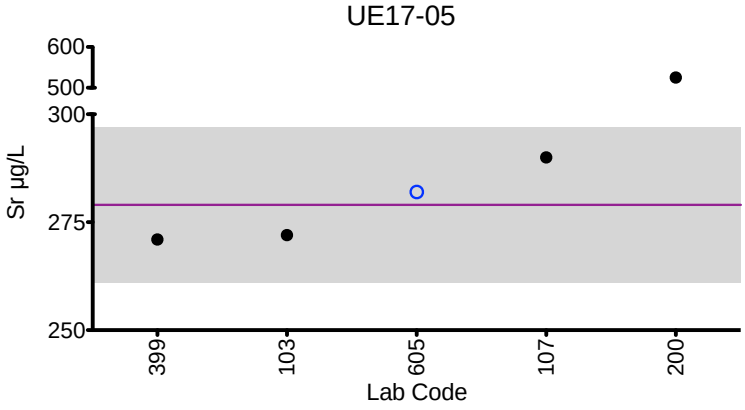
Results for Event #1, 2017:
Urine Sr











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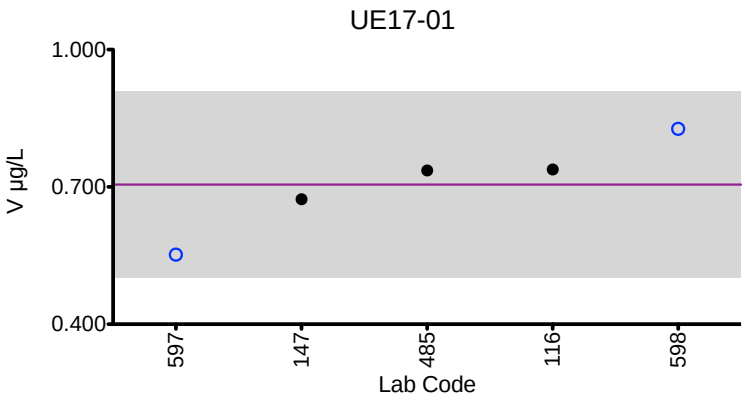
Results for Event #1, 2017
Additional Elements in Urine: Vanadium (V)

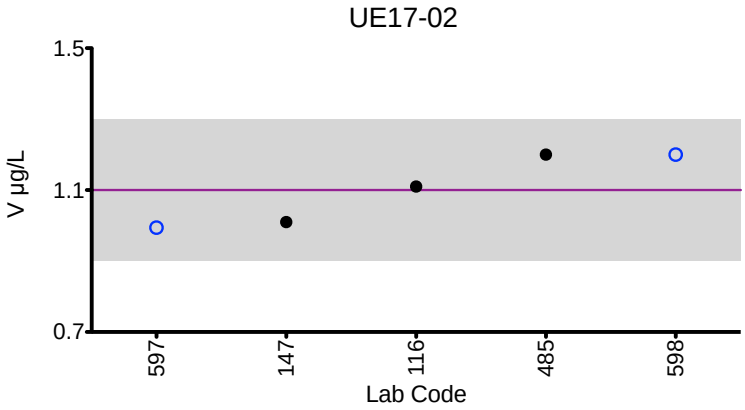
Urine V (µg/L)						
Lab Code	**Method**	**UE17-01**	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
116	DRC/CC-ICP-MS	0.738	1.11	0.354	0.913	0.247
147	DRC/CC-ICP-MS	0.673	1.01	0.357	0.796	0.183
485	HR-ICP-MS	0.736	1.20	0.399	0.975	0.266
597	DRC/CC-ICP-MS	0.552	0.994	0.308	0.844	0.157
598	DRC/CC-ICP-MS	0.827	1.20	0.412	0.935	0.212

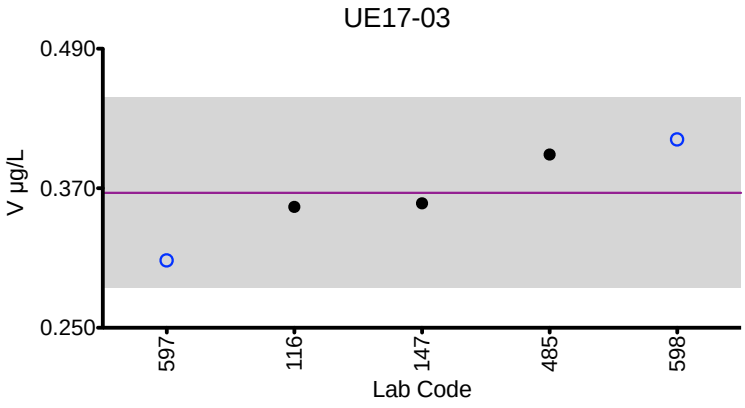
Summary Statistics					
	UE17-01	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
Arithmetic Mean ($\bar{x}$)	0.705	1.1	0.366	0.893	0.213
Arithmetic SD (s)	0.102	0.1	0.041	0.072	0.045
Arithmetic RSD (%)	14.5	9.1	11.2	8.1	21.1
Number of Sample Measurements (N)	5	5	5	5	5

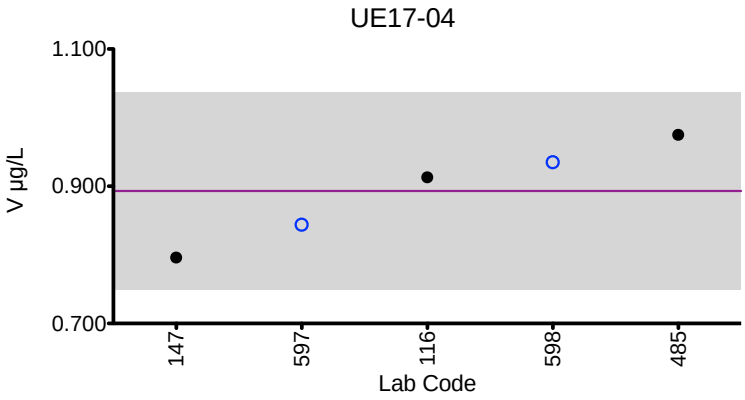
*Denotes a statistical Outlier.

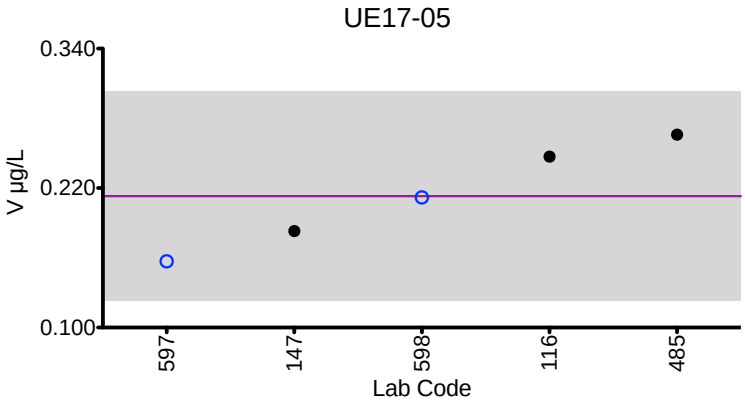
Results for Event #1, 2017:
Urine V











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Results for Event #1, 2017
Additional Elements in Urine: Tungsten (W)

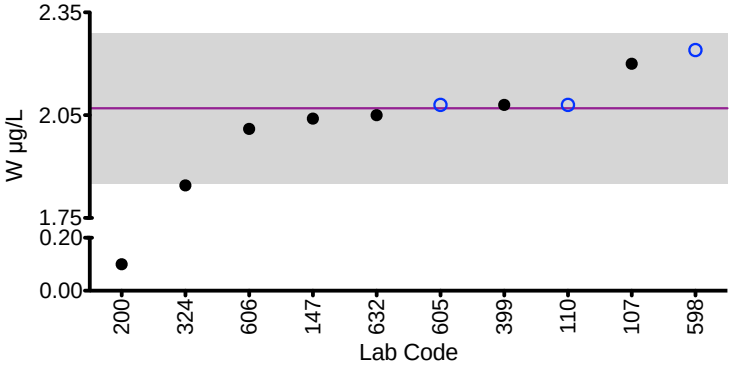
Urine W (µg/L)						
Lab Code	**Method**	**UE17-01**	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
107	ICP-MS	2.2	0.38	0.82	0.59	0.72
110	ICP-MS	2.08	0.37	0.78	0.57	0.68
147	ICP-MS	2.04	0.368	0.758	0.559	0.664
200	ICP-MS	*0.1	0.4	0.8	0.6	0.6
324	ICP-MS	1.845	<1	<1	<1	<1
399	ICP-MS	2.08	0.361	0.793	0.574	0.684
598	ICP-MS	2.24	0.541	0.846	0.704	0.752
605	ICP-MS	2.08	0.356	0.772	0.588	0.668
606	ICP-MS	2.01	0.344	0.797	0.580	0.669
632	ICP-MS	2.05	0.369	0.786	0.569	0.674

Summary Statistics					
	UE17-01	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
Arithmetic Mean ($\bar{x}$)	2.07	0.39	0.79	0.59	0.68
Arithmetic SD (s)	0.11	0.06	0.03	0.04	0.04
Arithmetic RSD (%)	5.3	15.4	3.8	6.8	5.9
Number of Sample Measurements (N)	9	9	9	9	9

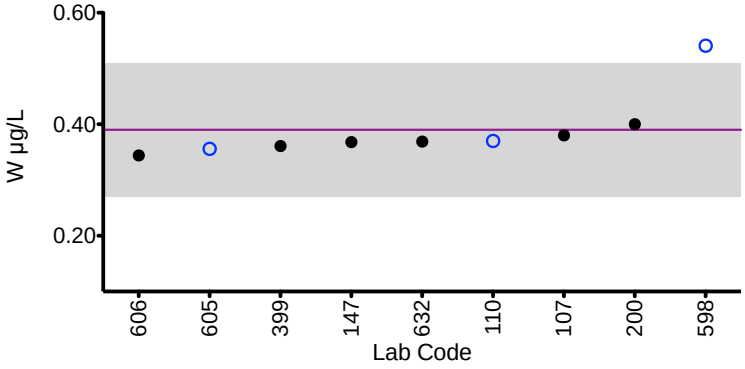
*Denotes a statistical Outlier.

Results for Event #1, 2017:
Urine W

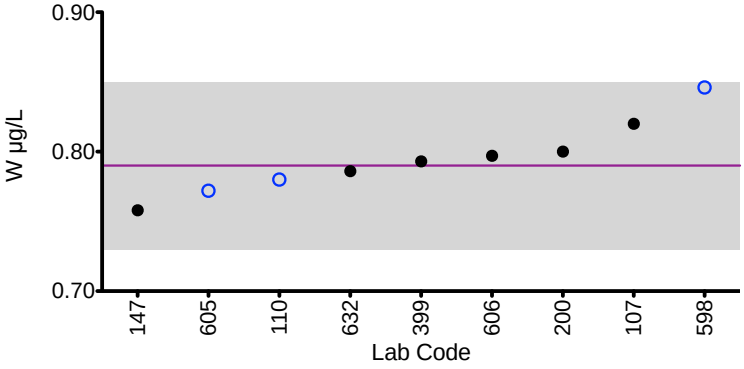
UE17-01



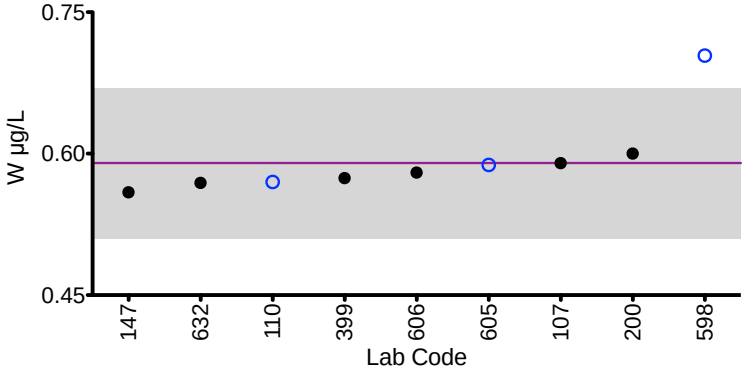
UE17-02



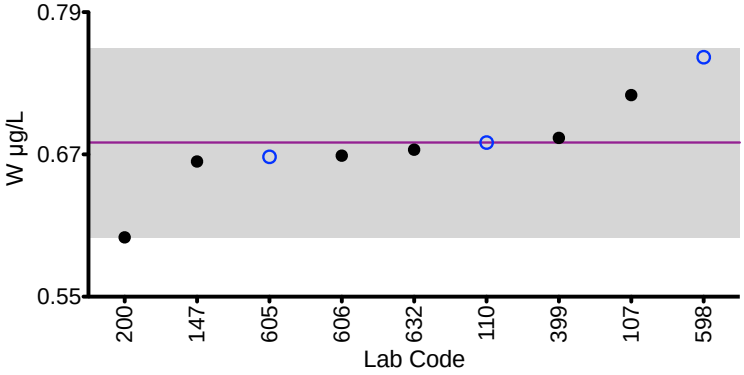
UE17-03



UE17-04



UE17-05



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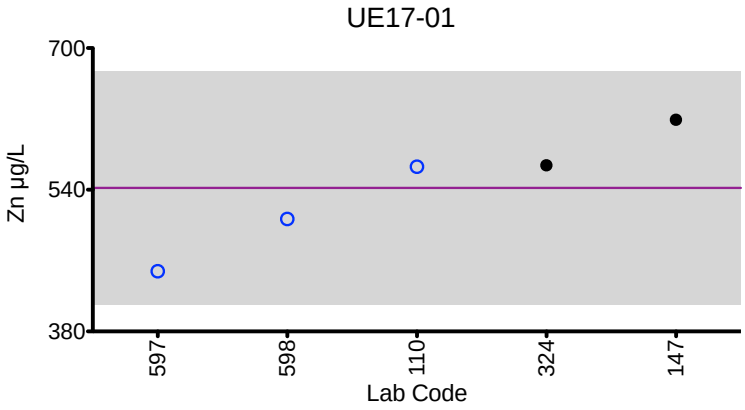
Results for Event #1, 2017
Additional Elements in Urine: Zinc (Zn)

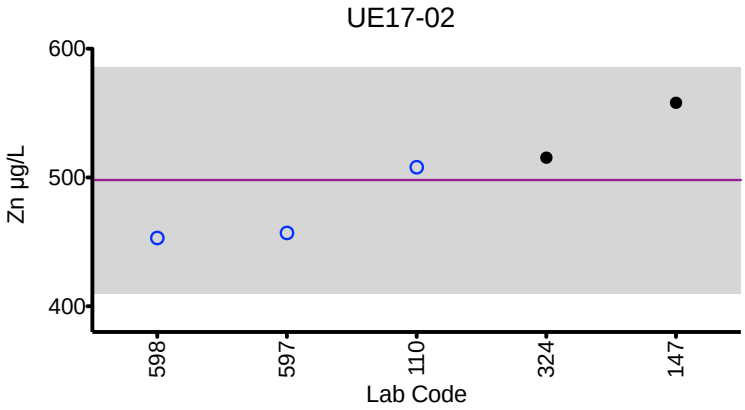
Urine Zn (µg/L)						
Lab Code	**Method**	**UE17-01**	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
110	ICP-MS	566	508	150	372	617
147	ICP-MS	619	558	167	414	693
324	ICP-MS	567.549	515.390	154.261	369.125	617.940
597	DRC/CC-ICP-MS	448	457	141	350	569
598	ICP-MS	507	453	157	381	531

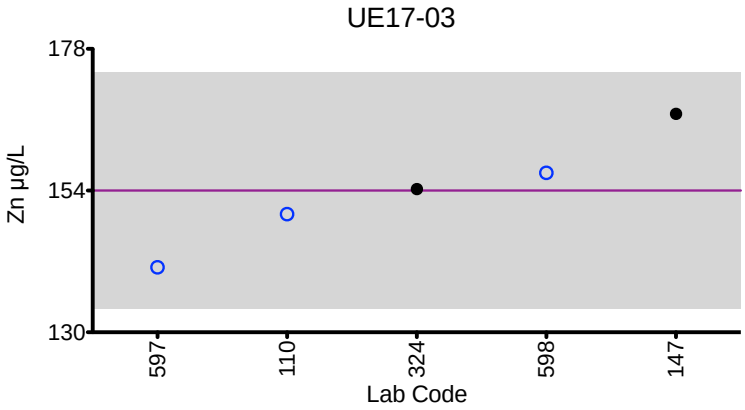
Summary Statistics					
	UE17-01	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
Arithmetic Mean ($\bar{x}$)	542	498	154	377	606
Arithmetic SD (s)	66	44	10	23	61
Arithmetic RSD (%)	12.2	8.8	6.5	6.1	10.1
Number of Sample Measurements (N)	5	5	5	5	5

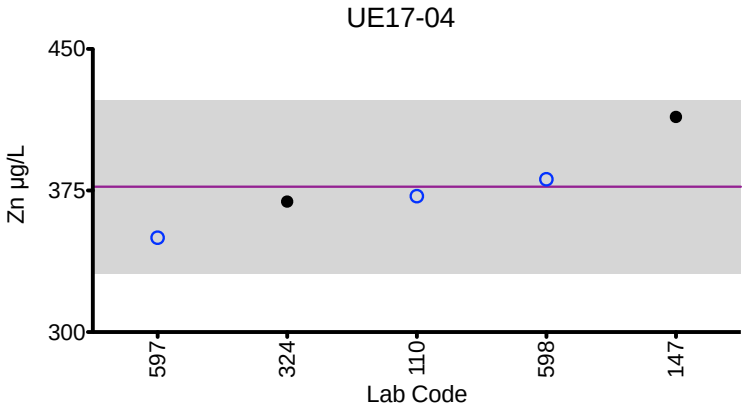
*Denotes a statistical Outlier.

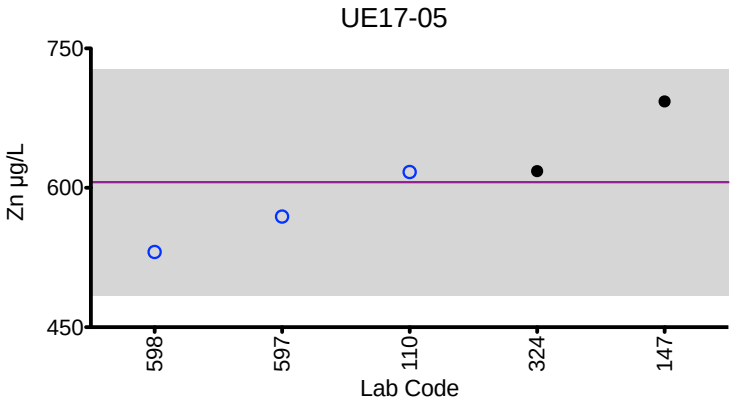
Results for Event #1, 2017:
Urine Zn











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Results for Event #1, 2017
Additional Elements in Urine: Aluminum (Al)

Urine Al (µg/L)						
Lab Code	**Method**	**UE17-01**	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
147	DRC/CC-ICP-MS	< 13.8	< 13.8	< 13.8	< 13.8	< 13.8
324	ICP-MS	15.245	9.375	12.393	10.088	16.225
485	HR-ICP-MS	13.06	4.95	11.5	9.52	17.3
597	DRC/CC-ICP-MS	9.25	<7.9	12.6	8.90	15.4

Summary Statistics					
	UE17-01	**UE17-02**	**UE17-03**	**UE17-04**	**UE17-05**
Arithmetic Mean ($\bar{x}$)	12.5	7.2	12.2	9.5	16.3
Arithmetic SD (s)	3.0	3.1	0.6	0.6	1.0
Arithmetic RSD (%)	24.0	43.1	4.9	6.3	6.1
Number of Sample Measurements (N)	3	2	3	3	3

*Denotes a statistical Outlier.

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Results for Event #1, 2017
Additional Elements in Urine

Urine Ag (µg/L)

Lab Code	Method	UE17-01	UE17-02	UE17-03	UE17-04	UE17-05
147	ICP-MS	< 0.302	< 0.302	< 0.302	0.962	< 0.302

Urine B (µg/L)

Lab Code	Method	UE17-01	UE17-02	UE17-03	UE17-04	UE17-05
200	ICP-MS	126	117	103	103	107

Urine Bi (µg/L)

Lab Code	Method	UE17-01	UE17-02	UE17-03	UE17-04	UE17-05
147	ICP-MS	< 0.230	< 0.230	< 0.230	< 0.230	< 0.230

Urine Fe (µg/L)

Lab Code	Method	UE17-01	UE17-02	UE17-03	UE17-04	UE17-05
324	ICP-MS	6.472	10.331	5.920	5.512	5.000

Urine I (µg/L)

Lab Code	Method	UE17-01	UE17-02	UE17-03	UE17-04	UE17-05
107	ICP-MS	12	9.7	10	11	5.9

Urine Li (µg/L)

Lab Code	Method	UE17-01	UE17-02	UE17-03	UE17-04	UE17-05
147	ICP-MS	2.11	< 2.01	< 2.01	< 2.01	< 2.01

Urine Mg (µg/L)

Lab Code	Method	UE17-01	UE17-02	UE17-03	UE17-04	UE17-05
597	DRC/CC-ICP-MS	8560	7090	8150	8860	3960

Urine Te (µg/L)

Lab Code	Method	UE17-01	UE17-02	UE17-03	UE17-04	UE17-05
110	ICP-MS	0.3	0.7	0.4	<0.3	<0.3
599	DRC/CC-ICP-MS	0.37	0.68	0.35	0.19	0.13

Urine Th (µg/L)

Lab Code	Method	UE17-01	UE17-02	UE17-03	UE17-04	UE17-05
147	ICP-MS	< 0.00557	< 0.00557	< 0.00557	< 0.00557	< 0.00557

Urine Ti (µg/L)

Lab Code	Method	UE17-01	UE17-02	UE17-03	UE17-04	UE17-05
485	HR-ICP-MS	<0.5	<0.5	<0.5	<0.5	<0.5

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Event #1, 2017

Trace Elements in Serum

Wadsworth Center
NEW YORK STATE DEPARTMENT OF HEALTH
Trace Elements Laboratory

Event #1, 2017:
Trace Elements in Serum

PT Materials

Test materials were prepared from human serum obtained from ZenBio, Inc. The company certifies that these materials were tested by FDA approved methods and found to be negative for HIV 1Ž2 and HIV-1 RNA, and non-reactive to HBsAg, HCV3 and STS. Units of serum were filtered into polypropylene containers through cheesecloth to remove particulates and supplemented with aluminum (Al), cobalt (Co), chromium (Cr), copper (Cu), selenium (Se), zinc (Zn), arsenic (As), beryllium (Be), cadmium (Cd), mercury (Hg), manganese (Mn), molybdenum (Mo), nickel (Ni), lead (Pb), platinum (Pt), antimony (Sb), tin (Sn), strontium (Sr), titanium (Ti), thallium (Tl), uranium (U), vanadium (V) and tungsten (W). Serum units were homogenized overnight prior to aliquoting 2-mL into polypropylene vials. PT samples were stored at -80°C until the week of the PT event, when they were thawed at 4°C prior to circulation to laboratories for analysis.

Graded Elements

Six elements in serum are formally graded: Al, Co, Cr, Cu, Se, and Zn. Target values for the graded elements are assigned to these pools based on (a) the robust mean calculated from data reported by all laboratories, or (b) where a robust mean is not possible, the arithmetic mean after outlier deletion.

Additional Elements

An additional 28 elements (beyond the six graded) were reported by at least one participant: Ag, As, B, Ba, Be, Bi, Cd, Cs, Fe, Hg, I, Li, Mg, Mn, Mo, Ni, Pb, Pt, Sb, Sn, Sr, Te, Th, Ti, Tl, U, V, and W. These data are included here to provide a more complete characterization of the PT materials. All results reported by participant laboratories are tabulated and organized by lab code. The PT data are graphed for visual comparison purposes for all elements where at least five laboratories reported a value greater than the LOD. A statistical summary table is provided for samples where at least two comparable values were reported as above the LOD.

The summary statistics for the additional elements are provided for educational purposes only, i.e., no acceptable response is implied. However, it is expected that each laboratory would wish to investigate a potential source of bias if warranted by these data. Future events might result in additional elements becoming graded if a consensus can be reached regarding desired quality specifications.

Results for Event #1, 2017
Serum Aluminum (Al)

Summary Statistics

	Serum Al (µg/L)				
	SE17-01	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
Target (Arithmetic Mean ($\bar{x}$))	162	44.0	105	15.6	64.6
Upper Limit	194	52.8	126	20.6	77.5
Lower Limit	130	35.2	84	10.6	51.7
Arithmetic SD (s)	23	7.3	19	4.6	13.2
Arithmetic RSD (%)	14.2	16.6	18.1	29.5	20.4
Number of Sample Measurements (N)	6	6	7	6	6

The acceptable range is based on quality specifications:
±5 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±5 µg/L at concentrations less than or equal to 25 µg/L. These quality specifications were established by New York State Department of Health's Wadsworth Center, the PT Program organizer.

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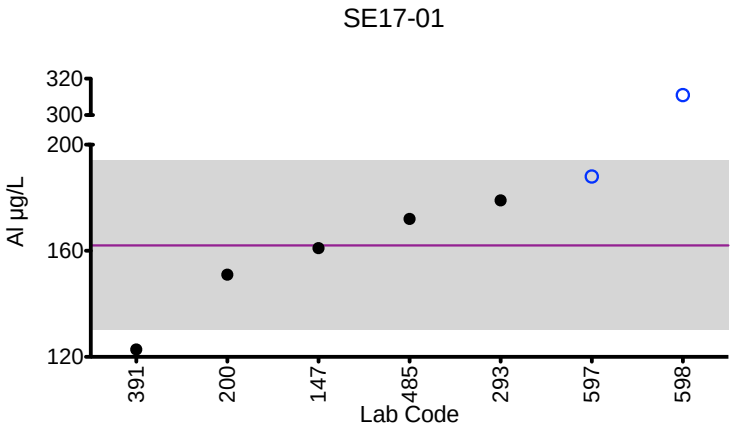
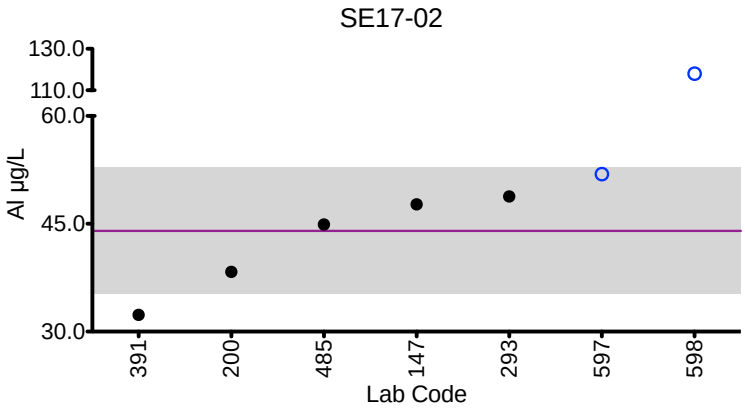
Results for Event #1, 2017
Serum Aluminum (Al)
Performance of Participating Laboratories

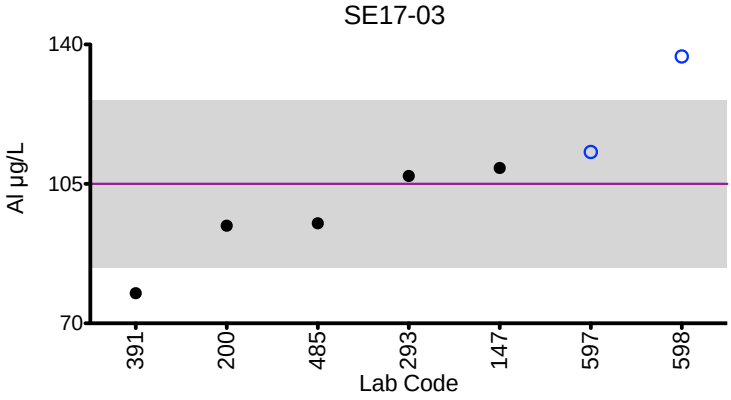
		Serum Al (µg/L)				
Lab Code	**Method**	**SE17-01**	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
	Target	**162**	**44.0**	**105**	**15.6**	**64.6**
147	ETAAS-Z	161	47.7	109	18.8	75.2
200	DRC/CC-ICP-MS	151	38.3	94.5	15.5	58.3
293	DRC/CC-ICP-MS	179	48.8	107	20	71.2
391	ETAAS-Z	122.80 ↓	32.33 ↓	77.56 ↓	7.01 ↓	40.48 ↓
485	HR-ICP-MS	172	44.9	95.1	15.01	68.9
597	DRC/CC-ICP-MS	188	51.9	113	17.3	73.5
598	ICP-MS	*311 ↑	*118 ↑	137 ↑	*52.8 ↑	*271 ↑

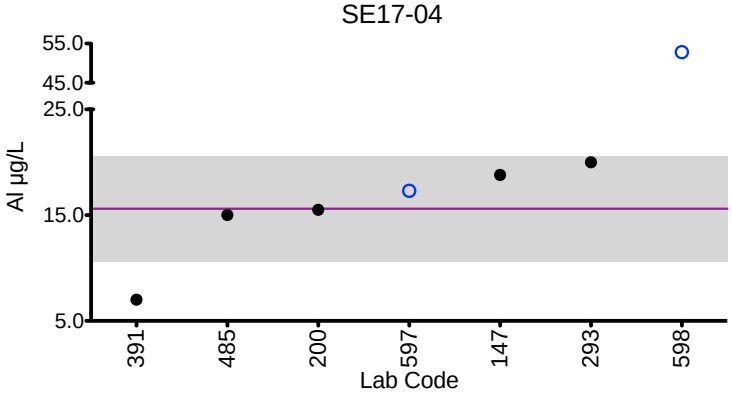
Based on the grading criteria for Al in Serum, 71% of results were satisfactory, with 2 of the 7 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

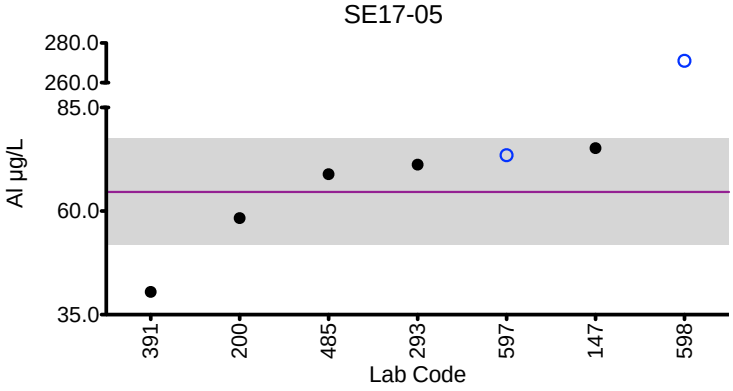
Results for Event #1, 2017: Serum Al











Legend:

o CHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the arithmetic mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±5 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±5 µg/L at concentrations less than or equal to 25 µg/L.

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Results for Event #1, 2017
Serum Cobalt (Co)

Summary Statistics

	Serum Co (µg/L)				
	SE17-01	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
Target (Arithmetic Mean ($\bar{x}$))	2.2	1.1	4.5	7.5	1.5
Upper Limit	3.7	2.6	6.0	9.0	3.0
Lower Limit	0.7	0.0	3.0	6.0	0.0
Arithmetic SD (s)	0.2	0.1	0.3	0.4	0.2
Arithmetic RSD (%)	9.1	9.1	6.7	5.3	13.3
Number of Sample Measurements (N)	7	7	7	7	7

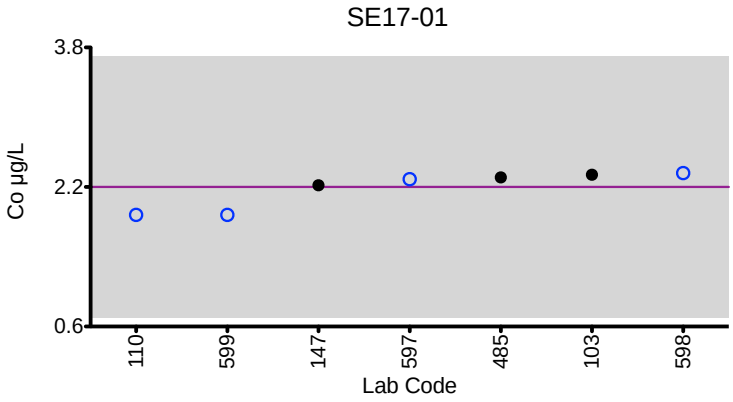
The acceptable range is based on quality specifications:
±1.5 µg/L or ±15% around the target value, whichever is greater; thus, it is fixed at ±1.5 µg/L at concentrations less than or equal to 10 µg/L. These quality specifications were established based on discussions with the US FDA, and represent a consensus from a network of Trace Element PT program organizers

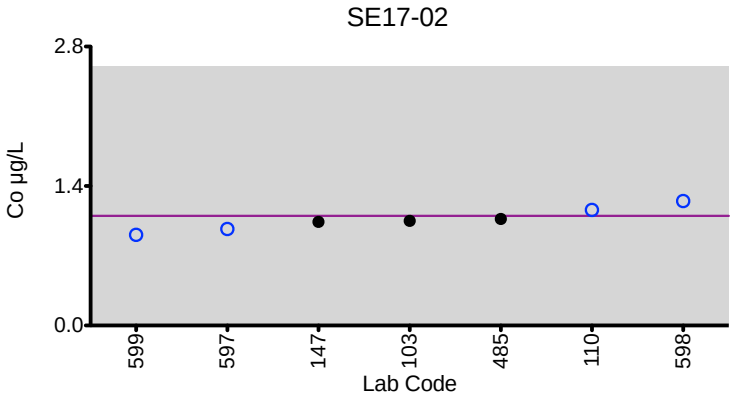
Results for Event #1, 2017
Serum Cobalt (Co)
Performance of Participating Laboratories

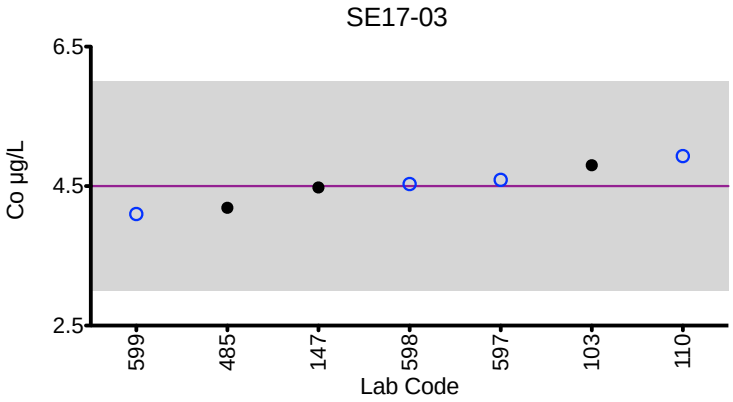
		Serum Co (µg/L)				
Lab Code	**Method**	**SE17-01**	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
	Target	**2.2**	**1.1**	**4.5**	**7.5**	**1.5**
103	DRC/CC-ICP-MS	2.34	1.05	4.8	7.70	1.51
110	ICP-MS	1.88	1.16	4.93	7.84	1.62
147	ICP-MS	2.22	1.04	4.48	7.96	1.43
485	HR-ICP-MS	2.31	1.07	4.19	7.52	1.58
597	DRC/CC-ICP-MS	2.29	0.969	4.59	7.25	1.28
598	ICP-MS	2.36	1.25	4.53	7.19	2.00
599	DRC/CC-ICP-MS	1.88	0.91	4.10	6.73	1.37

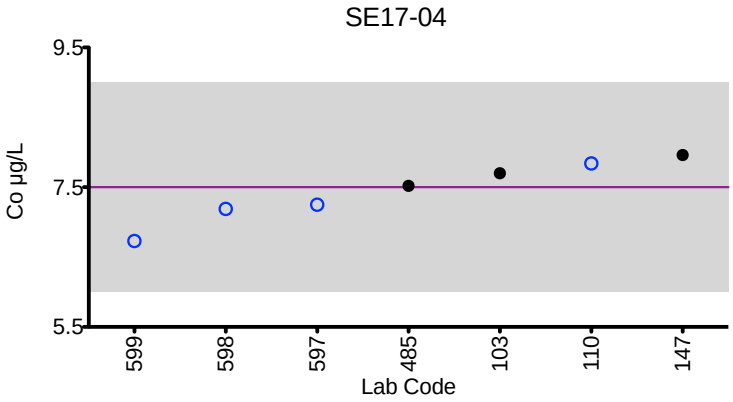
Based on the grading criteria for Co in Serum, 100% of results were satisfactory, with 0 of the 7 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

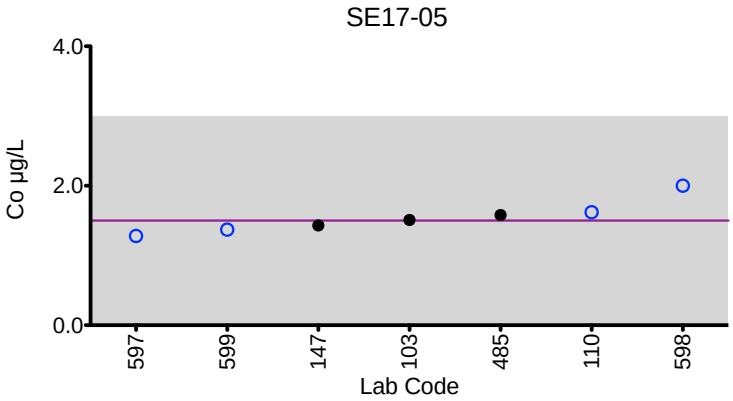
Results for Event #1, 2017: Serum Co











Legend:

o CHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the arithmetic mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±1.5 µg/L or ±15% around the target value, whichever is greater; thus, it is fixed at ±1.5 µg/L at concentrations less than or equal to 10 µg/L.

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Results for Event #1, 2017
Serum Chromium (Cr)

Summary Statistics

	Serum Cr (µg/L)				
	SE17-01	SE17-02	SE17-03	SE17-04	SE17-05
Target (Arithmetic Mean ($\bar{x}$))	2.0	3.9	0.68	4.3	8.7
Upper Limit	4.0	5.9	2.68	6.3	10.7
Lower Limit	0.0	1.9	0.00	2.3	6.7
Arithmetic SD (s)	0.4	0.9	0.08	0.8	0.7
Arithmetic RSD (%)	20.0	23.1	11.8	18.6	8.0
Number of Sample Measurements (N)	6	7	4	7	7

The acceptable range is based on quality specifications:
±2 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±2 µg/L at concentrations less than or equal to 10 µg/L. These quality specifications were established based on discussions with the US FDA, and represent a consensus from a network of Trace Element PT program organizers

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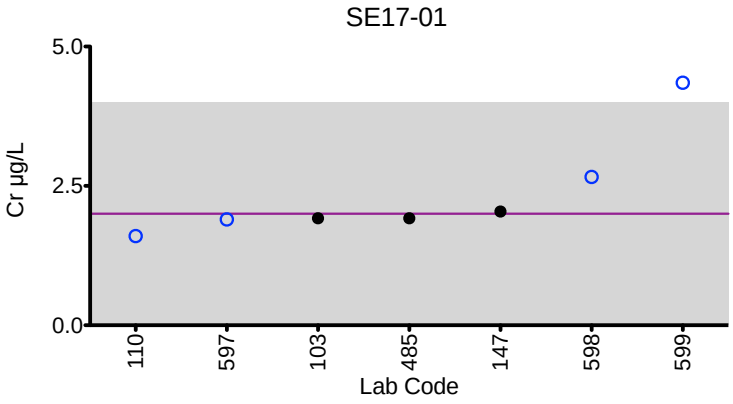
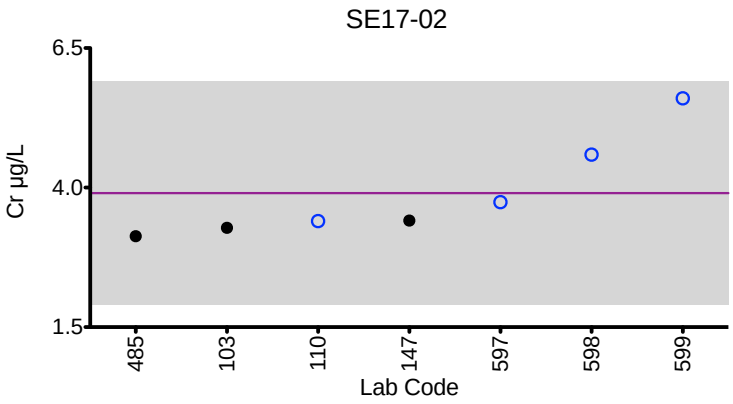
Results for Event #1, 2017
Serum Chromium (Cr)
Performance of Participating Laboratories

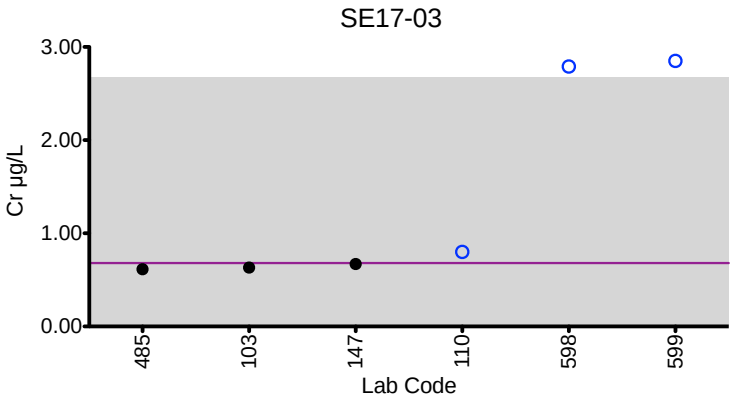
		Serum Cr (µg/L)				
Lab Code	**Method**	**SE17-01**	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
	Target	**2.0**	**3.9**	**0.68**	**4.3**	**8.7**
103	DRC/CC-ICP-MS	1.92	3.28	0.632	3.82	8.52
110	DRC/CC-ICP-MS	1.6	3.4	0.8	4.1	8.1
147	DRC/CC-ICP-MS	2.04	3.41	0.671	4.07	8.27
485	HR-ICP-MS	1.92	3.13	0.615	3.65	8.21
597	DRC/CC-ICP-MS	1.90	3.74	<0.8	3.53	8.59
598	ETAAS-Other	2.66	4.59	*2.79 ↑	4.91	9.26
599	DRC/CC-ICP-MS	*4.35 ↑	5.60	*2.85 ↑	5.70	9.97

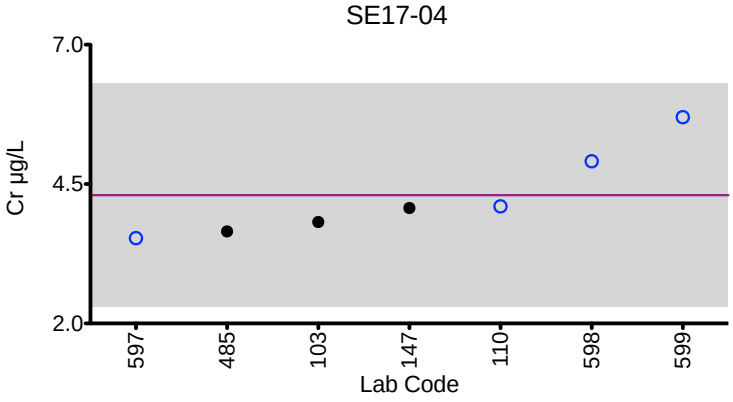
Based on the grading criteria for Cr in Serum, 91% of results were satisfactory, with 1 of the 7 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

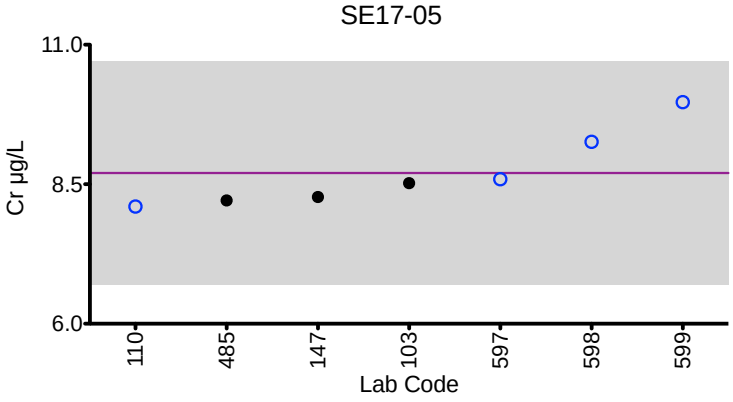
Results for Event #1, 2017: Serum Cr











Legend:

o CHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the arithmetic mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±2 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±2 µg/L at concentrations less than or equal to 10 µg/L.

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Results for Event #1, 2017
Serum Copper (Cu)

Summary Statistics

	Serum Cu (µg/L)				
	SE17-01	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
Target (Robust Mean (x*))	1042	1338	949	2588	1810
Upper Limit	1198	1539	1091	2976	2082
Lower Limit	886	1137	807	2200	1539
Robust SD (s*)	135	156	70	54	115
Robust RSD (%)	13.0	11.7	7.3	2.1	6.4
Number of Sample Measurements (N)	10	10	10	10	10
Standard Uncertainty (*u*)	53.5	61.8	27.5	21.2	45.5

The acceptable range is based on quality specifications:
±95 µg/L or ±15% around the target value, whichever is greater; thus, it is fixed at ±95 µg/L at concentrations less than or equal to 635 µg/L. These quality specifications were established by New York State Department of Health's Wadsworth Center, the PT Program organizer.

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Results for Event #1, 2017
Serum Copper (Cu)
Performance of Participating Laboratories

		Serum Cu (µg/L)				
Lab Code	**Method**	**SE17-01**	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
	Target	**1042**	**1338**	**949**	**2588**	**1810**
107	DRC/CC-ICP-MS	1100	1400	980	2600	1900
110	ICP-MS	863 ↓	1450	1000	2620	1900
147	ICP-MS	1029	1296	921	2618	1773
200	ICP-MS	1175	1461	1029	2616	1899
293	DRC/CC-ICP-MS	1030	1310	914	2500	1740
457	ICP-AES/OES	1128	1430	922	2622	1764
483	DRC/CC-ICP-MS	1110	1100 ↓	992	2660	1920
597	DRC/CC-ICP-MS	1190	1530	1010	2540	1880
598	ICP-MS	917	1220	872	2220	1650
599	DRC/CC-ICP-MS	865 ↓	1150	796 ↓	2210	1590

Based on the grading criteria for Cu in Serum, 92% of results were satisfactory, with 1 of the 10 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

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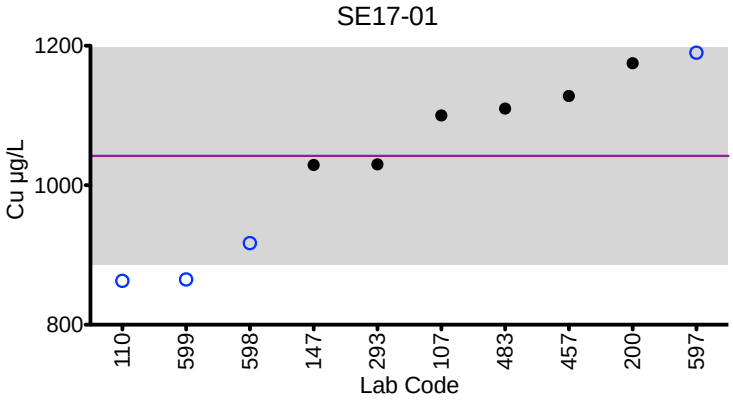
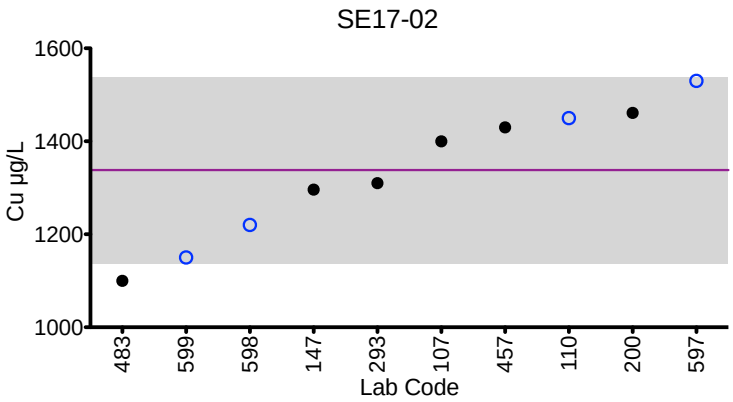
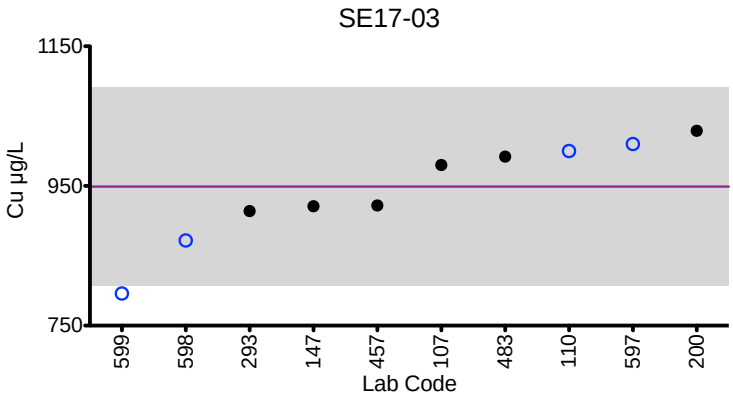
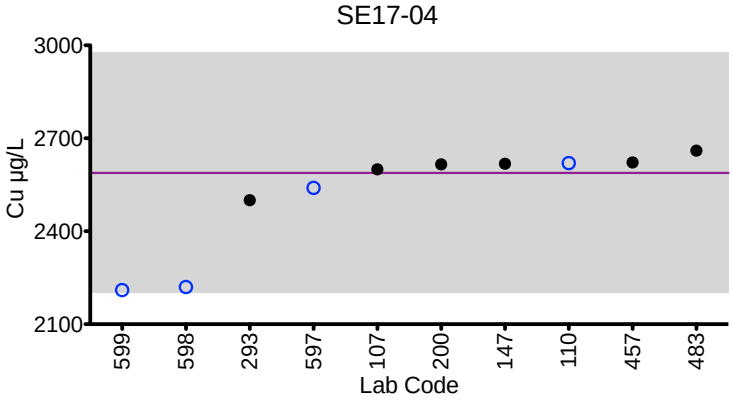
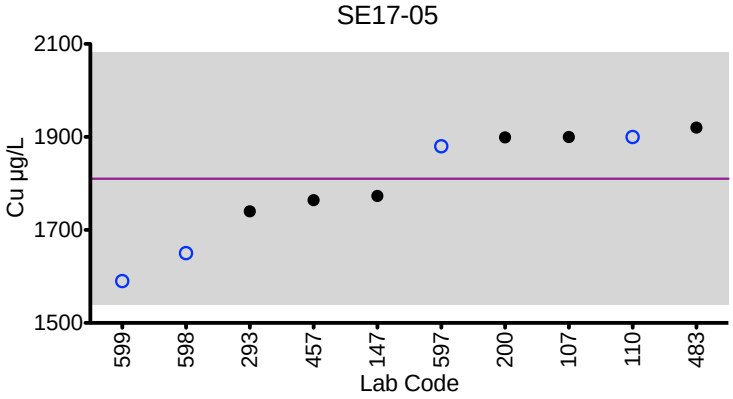
Results for Event #1, 2017: Serum Cu











Legend:

o CHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the robust mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±95 µg/L or ±15% around the target value, whichever is greater; thus, it is fixed at ±95 µg/L at concentrations less than or equal to 635 µg/L.

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Results for Event #1, 2017
Serum Selenium (Se)

Summary Statistics

	Serum Se (µg/L)				
	SE17-01	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
Target (Robust Mean (x*))	213	153	100	281	103
Upper Limit	256	184	120	337	124
Lower Limit	170	122	80	225	82
Robust SD (s*)	20	8	6	11	5
Robust RSD (%)	9.6	5.3	6.0	3.9	4.6
Number of Sample Measurements (N)	10	10	10	10	10
Standard Uncertainty (*u*)	8.08	3.24	2.36	4.35	1.87

The acceptable range is based on quality specifications:
±2 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±2 µg/L at concentrations less than or equal to 10 µg/L. These quality specifications were established by New York State Department of Health's Wadsworth Center, the PT Program organizer.

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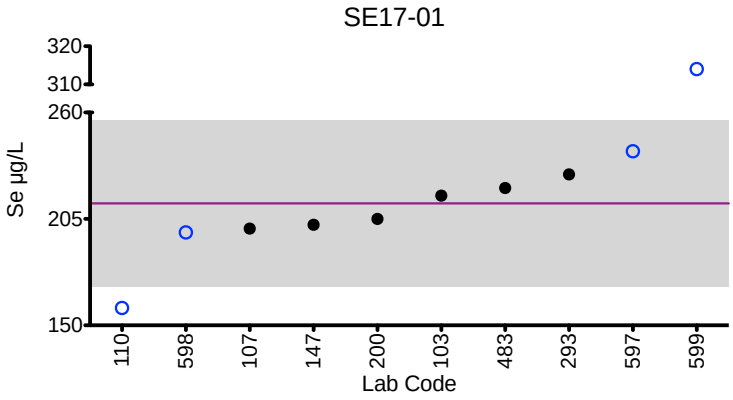
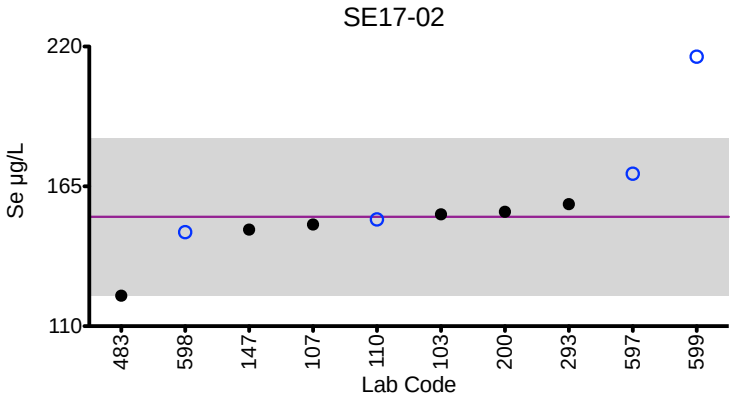
Results for Event #1, 2017
Serum Selenium (Se)
Performance of Participating Laboratories

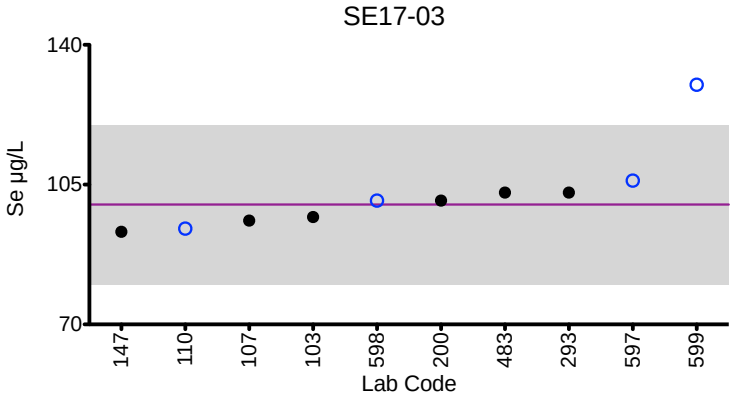
		Serum Se (µg/L)				
Lab Code	**Method**	**SE17-01**	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
	Target	**213**	**153**	**100**	**281**	**103**
103	DRC/CC-ICP-MS	217	154	96.9	284	105
107	DRC/CC-ICP-MS	200	150	96	270	98
110	DRC/CC-ICP-MS	159 ↓	152	94	268	97
147	ICP-MS	202	148	93.2	279	103
200	ETAAS-Other	205	155	101	281	103
293	DRC/CC-ICP-MS	228	158	103	295	101
483	DRC/CC-ICP-MS	221	122	103	286	108
597	DRC/CC-ICP-MS	240	170	106	272	106
598	ICP-MS	198	147	101	281	100
599	DRC/CC-ICP-MS	314 ↑	216 ↑	130 ↑	380 ↑	145 ↑

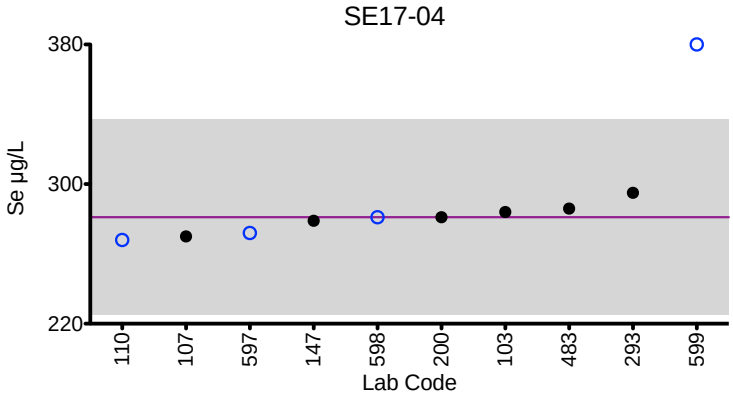
Based on the grading criteria for Se in Serum, 88% of results were satisfactory, with 1 of the 10 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

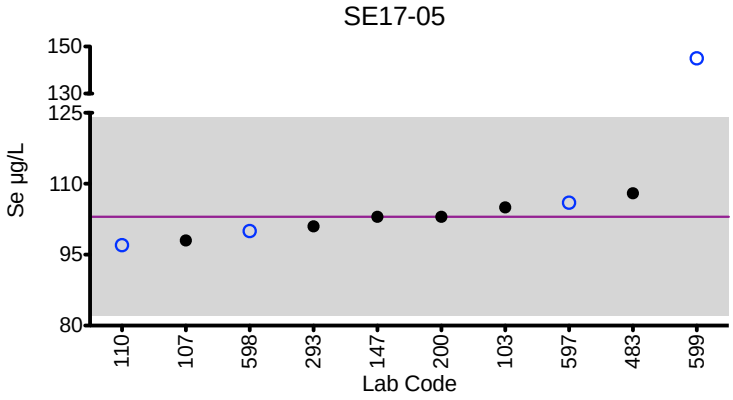
Results for Event #1, 2017: Serum Se











Legend:

o CHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the robust mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±2 µg/L or ±20% around the target value, whichever is greater; thus, it is fixed at ±2 µg/L at concentrations less than or equal to 10 µg/L.

Results for Event #1, 2017
Serum Zinc (Zn)

Summary Statistics

Serum Zn (µg/L)	SE17-01	SE17-02	SE17-03	SE17-04	SE17-05
Target (Robust Mean (x*))	1415	696	1132	532	1635
Upper Limit	1627	800	1302	612	1880
Lower Limit	1203	592	962	452	1390
Robust SD (s*)	154	92	90	38	137
Robust RSD (%)	10.9	13.3	8.0	7.1	8.4
Number of Sample Measurements (N)	9	10	10	10	10
Standard Uncertainty (*u*)	64.1	36.5	35.7	14.9	54.0

The acceptable range is based on quality specifications:
±15 µg/L or ±15% around the target value, whichever is greater; thus, it is fixed at ±15 µg/L at concentrations less than or equal to 100 µg/L. These quality specifications were established by New York State Department of Health's Wadsworth Center, the PT Program organizer.

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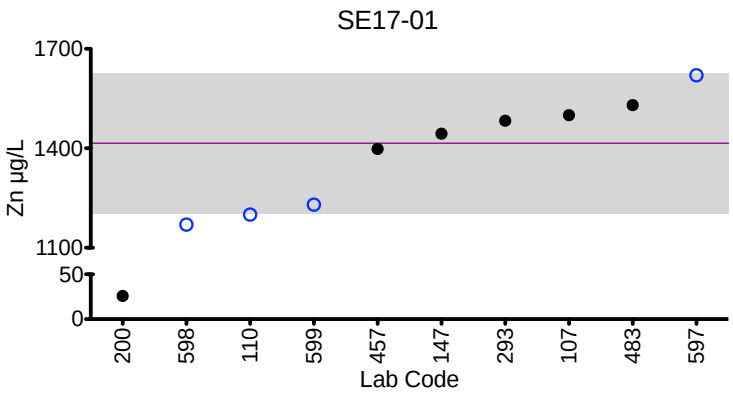
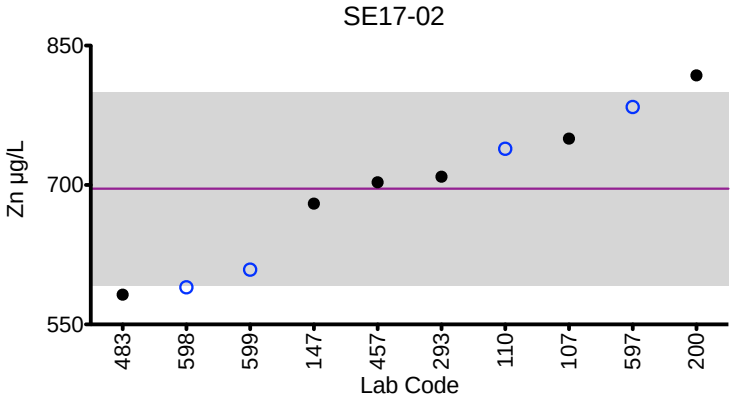
Results for Event #1, 2017
Serum Zinc (Zn)
Performance of Participating Laboratories

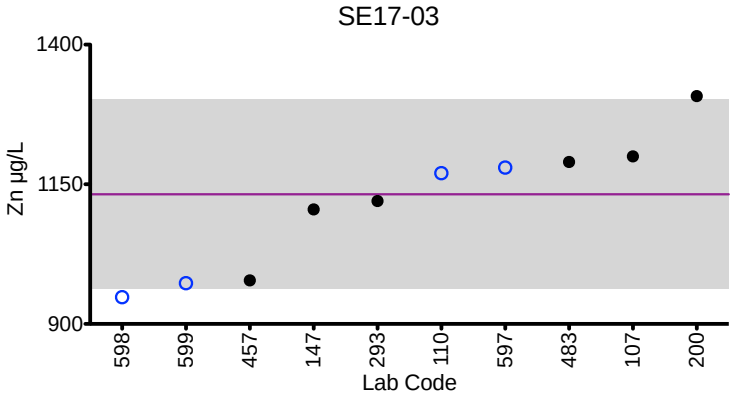
		Serum Zn (µg/L)				
Lab Code	**Method**	**SE17-01**	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
	Target	**1415**	**696**	**1132**	**532**	**1635**
107	DRC/CC-ICP-MS	1500	750	1200	560	1700
110	ICP-MS	1200 ↓	739	1170	546	1690
147	ICP-MS	1444	680	1105	548	1654
200	ICP-MS	*25.8 ↓	818 ↑	1308 ↑	602	1838
293	DRC/CC-ICP-MS	1483	709	1120	515	1588
457	ICP-AES/OES	1398	703	978	523	1500
483	DRC/CC-ICP-MS	1530	582 ↓	1190	560	1750
597	DRC/CC-ICP-MS	1620	784	1180	516	1670
598	ICP-MS	1170 ↓	590 ↓	948 ↓	444 ↓	1370 ↓
599	DRC/CC-ICP-MS	1230	609	973	454	1450

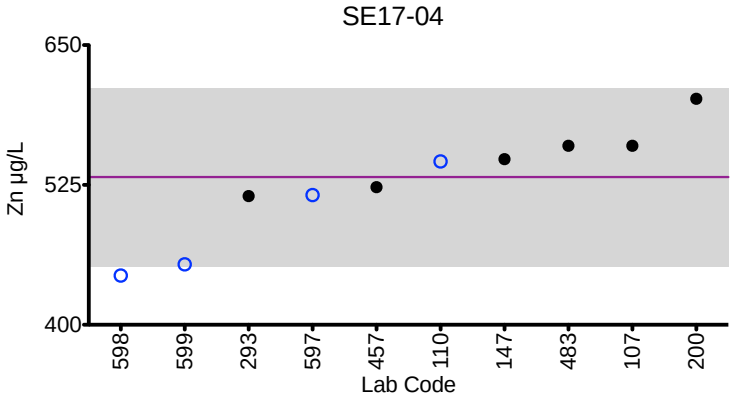
Based on the grading criteria for Zn in Serum, 80% of results were satisfactory, with 2 of the 10 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

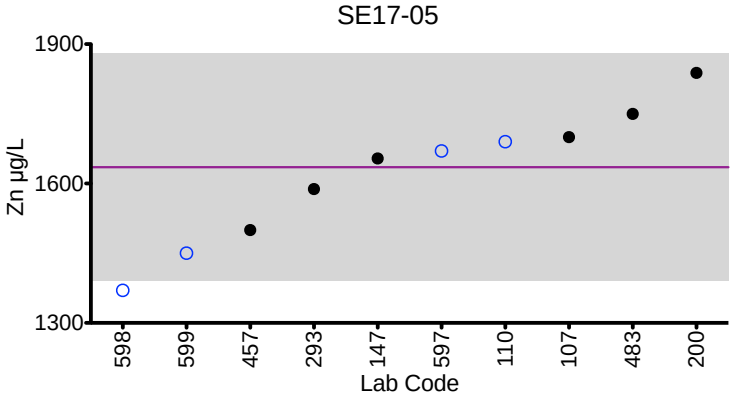
Results for Event #1, 2017: Serum Zn











Legend:

o CHEAR Labs ● Other Labs

Horizontal purple line = assigned target value based on the robust mean of all laboratories.

Gray area = acceptable range based on quality specifications:

±15 µg/L or ±15% around the target value, whichever is greater; thus, it is fixed at ±15 µg/L at concentrations less than or equal to 100 µg/L.

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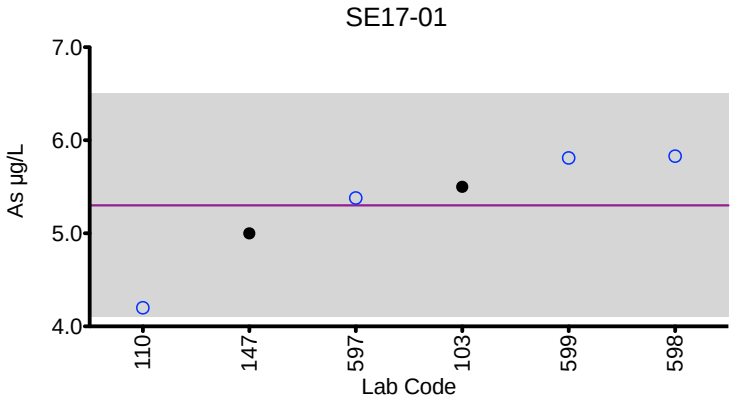
Results for Event #1, 2017
Additional Elements in Serum: Arsenic (As)

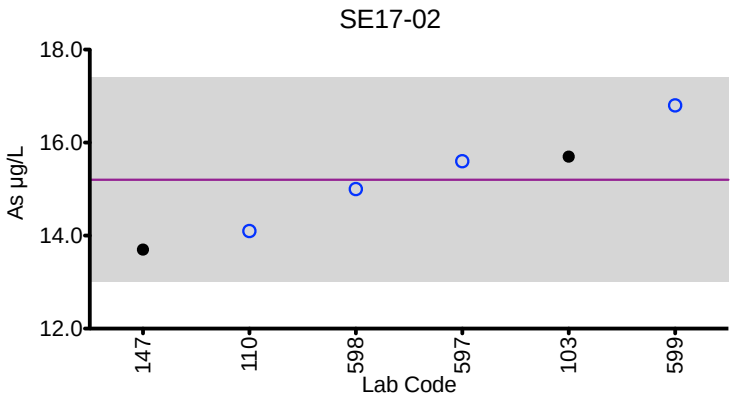
Serum As (µg/L)						
Lab Code	**Method**	**SE17-01**	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
103	DRC/CC-ICP-MS	5.50	15.7	12.9	8.43	3.19
110	DRC/CC-ICP-MS	4.2	14.1	11.6	7.8	3.3
147	ICP-MS	5.00	13.7	11.2	7.45	2.72
597	DRC/CC-ICP-MS	5.38	15.6	11.9	7.61	2.83
598	ICP-MS	5.83	15.0	13.8	9.34	3.96
599	DRC/CC-ICP-MS	5.81	16.8	13.2	8.92	3.36

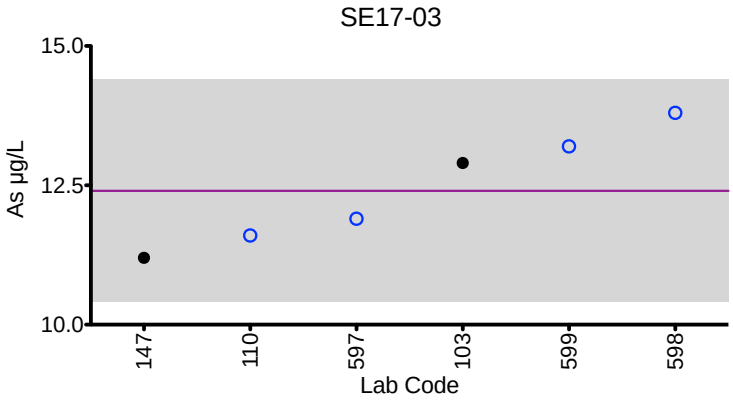
Summary Statistics					
	SE17-01	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
Arithmetic Mean ($\bar{x}$)	5.3	15.2	12.4	8.3	3.2
Arithmetic SD (s)	0.6	1.1	1.0	0.8	0.4
Arithmetic RSD (%)	11.3	7.2	8.1	9.6	12.5
Number of Sample Measurements (N)	6	6	6	6	6

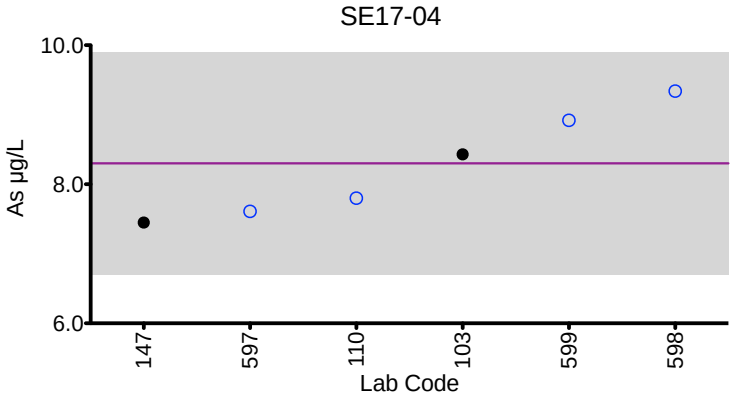
*Denotes a statistical Outlier.

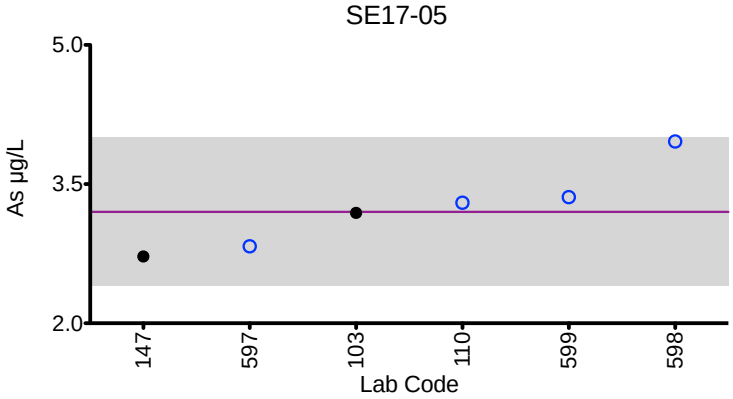
Results for Event #1, 2017: Serum As











Legend:
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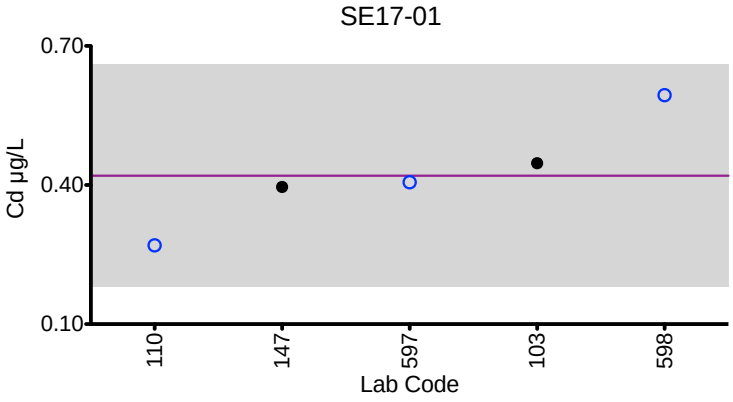
Results for Event #1, 2017
Additional Elements in Serum: Cadmium (Cd)

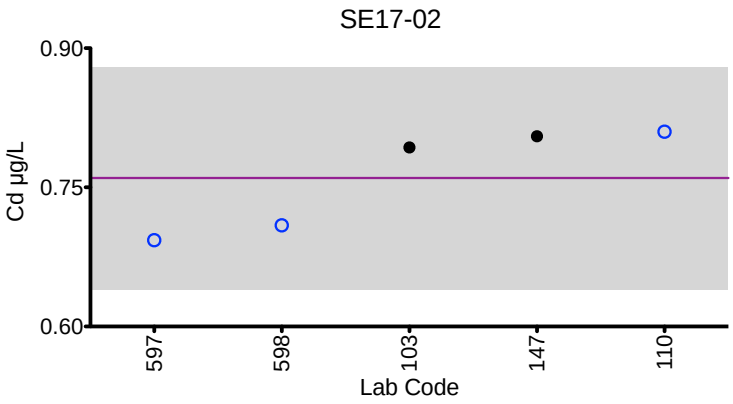
Serum Cd (µg/L)						
Lab Code	**Method**	**SE17-01**	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
103	DRC/CC-ICP-MS	0.447	0.793	2.44	5.96	2.95
110	ICP-MS	0.27	0.81	2.50	6.05	2.95
147	ICP-MS	0.396	0.805	2.50	6.58	2.88
597	DRC/CC-ICP-MS	0.406	0.693	2.44	6.05	2.84
598	ICP-MS	0.594	0.709	2.44	5.97	2.90

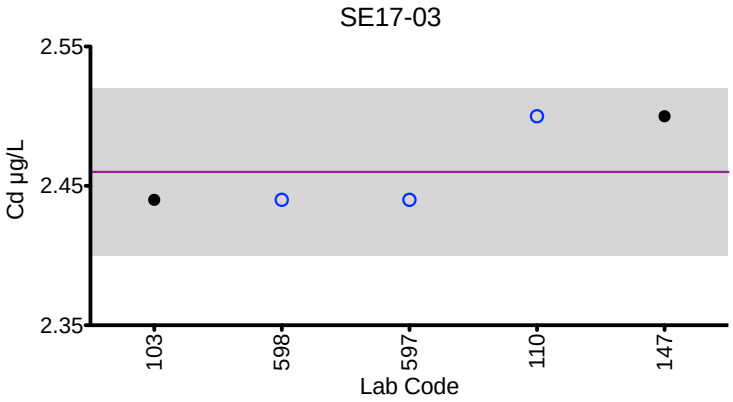
Summary Statistics					
	SE17-01	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
Arithmetic Mean ($\bar{x}$)	0.42	0.76	2.46	6.1	2.90
Arithmetic SD (s)	0.12	0.06	0.03	0.3	0.05
Arithmetic RSD (%)	28.6	7.9	1.3	4.9	1.6
Number of Sample Measurements (N)	5	5	5	5	5

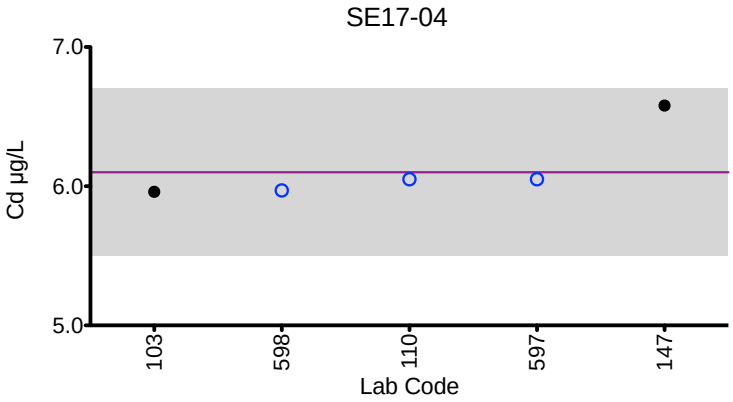
*Denotes a statistical Outlier.

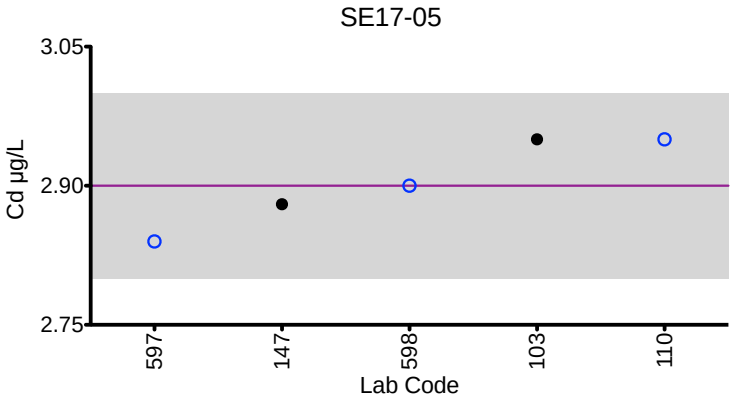
Results for Event #1, 2017: Serum Cd











Legend:
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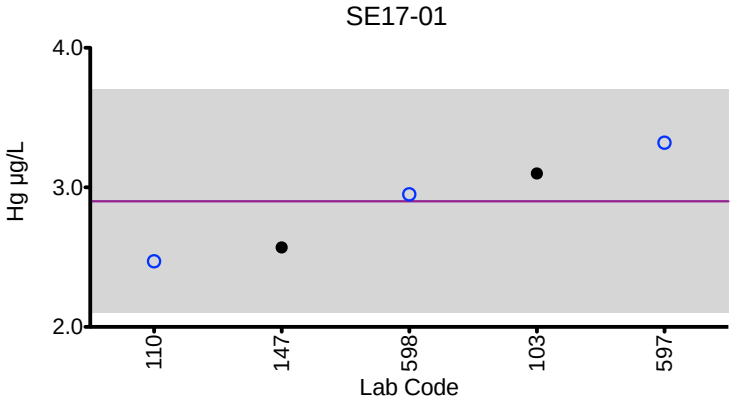
Results for Event #1, 2017
Additional Elements in Serum: Mercury (Hg)

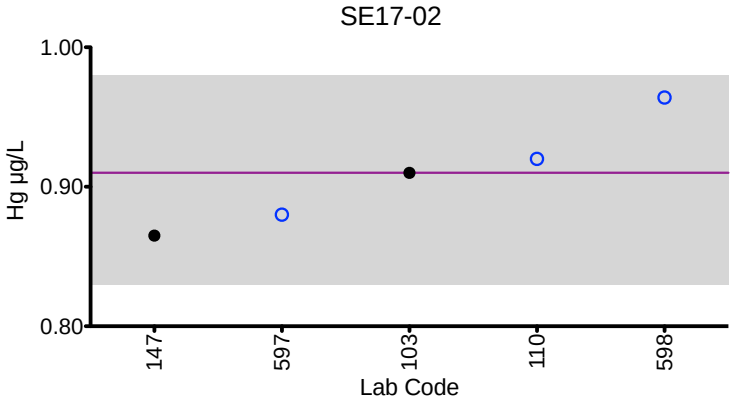
Serum Hg (µg/L)						
Lab Code	**Method**	**SE17-01**	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
103	DRC/CC-ICP-MS	3.10	0.910	4.93	1.01	5.98
110	ICP-MS	2.47	0.92	4.85	0.92	5.85
147	ICP-MS	2.57	0.865	4.31	0.782	5.18
597	DMA	3.32	0.88	5.10	0.750	6.13
598	ICP-MS	2.95	0.964	5.06	1.16	6.00

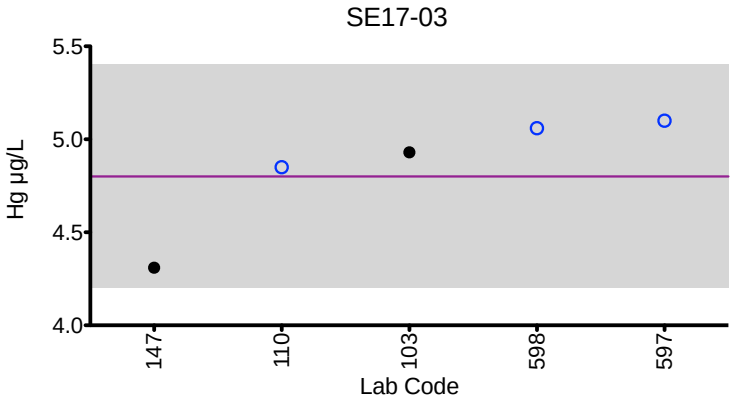
Summary Statistics					
	SE17-01	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
Arithmetic Mean ($\bar{x}$)	2.9	0.91	4.8	0.9	5.8
Arithmetic SD (s)	0.4	0.04	0.3	0.2	0.4
Arithmetic RSD (%)	13.8	4.2	6.3	22.2	6.9
Number of Sample Measurements (N)	5	5	5	5	5

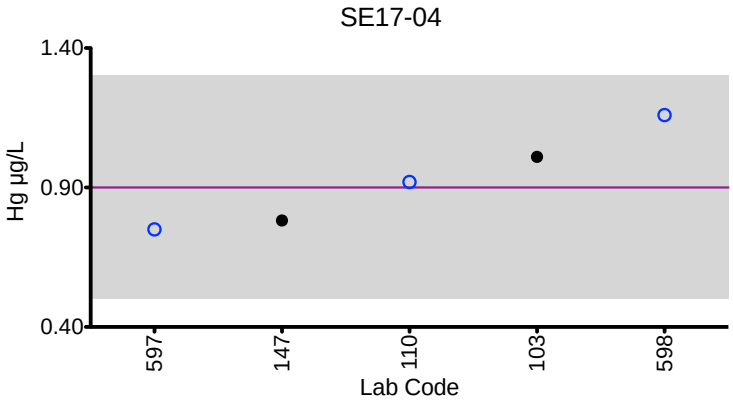
*Denotes a statistical Outlier.

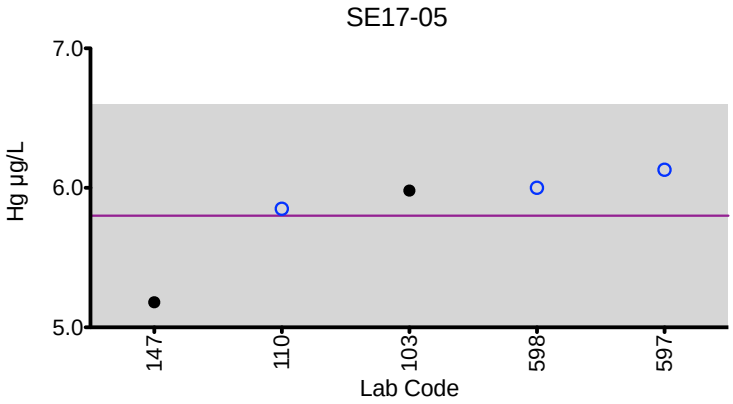
Results for Event #1, 2017:
Serum Hg











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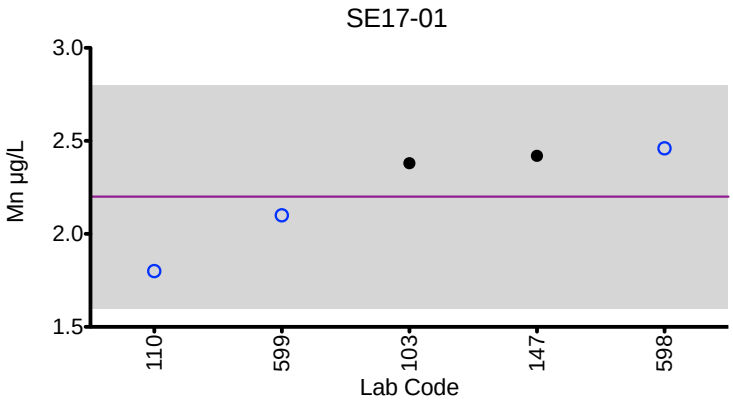
Results for Event #1, 2017
Additional Elements in Serum: Manganese (Mn)

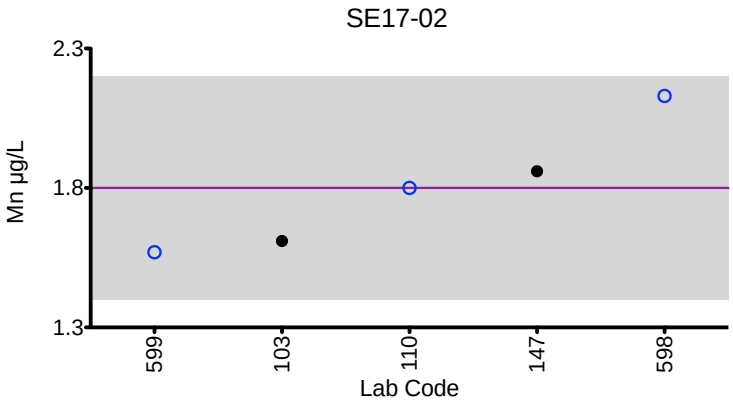
Serum Mn (µg/L)						
Lab Code	**Method**	**SE17-01**	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
103	DRC/CC-ICP-MS	2.38	1.61	5.48	12.8	4.31
110	ICP-MS	1.8	1.8	5.5	12.7	4.0
147	ICP-MS	2.42	1.86	5.14	13.1	4.03
597	DRC/CC-ICP-MS	<1.3	<1.3	3.85	10.7	2.41
598	ICP-MS	2.46	2.13	5.28	11.2	6.35
599	DRC/CC-ICP-MS	2.10	1.57	4.97	11.8	3.85

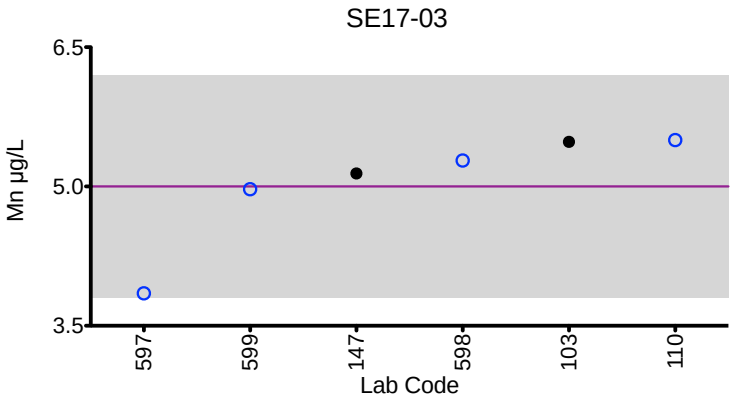
Summary Statistics					
	SE17-01	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
Arithmetic Mean ($\bar{x}$)	2.2	1.8	5.0	12.1	4.2
Arithmetic SD (s)	0.3	0.2	0.6	1.0	1.3
Arithmetic RSD (%)	13.6	11.1	12.0	8.3	31.0
Number of Sample Measurements (N)	5	5	6	6	6

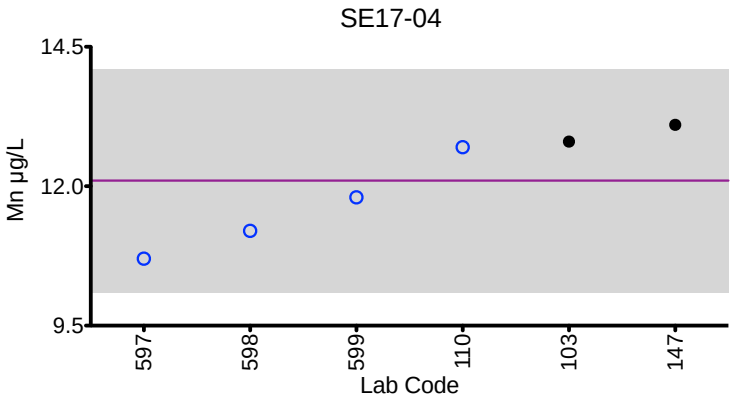
*Denotes a statistical Outlier.

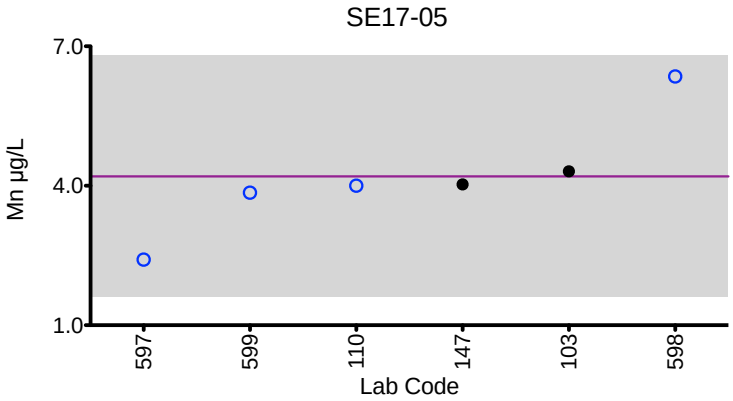
Results for Event #1, 2017: Serum Mn











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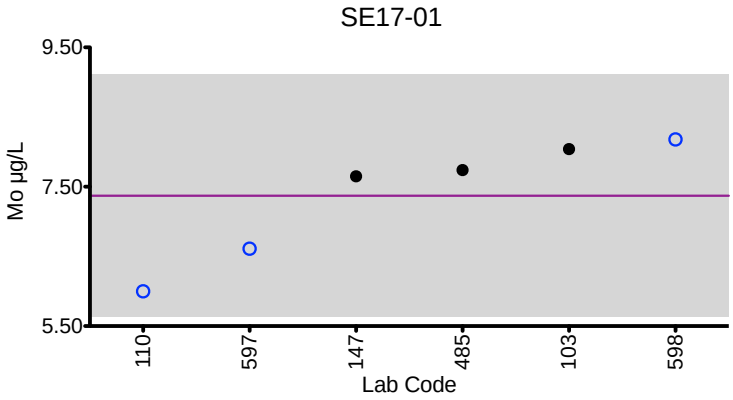
Results for Event #1, 2017
Additional Elements in Serum: Molybdenum (Mo)

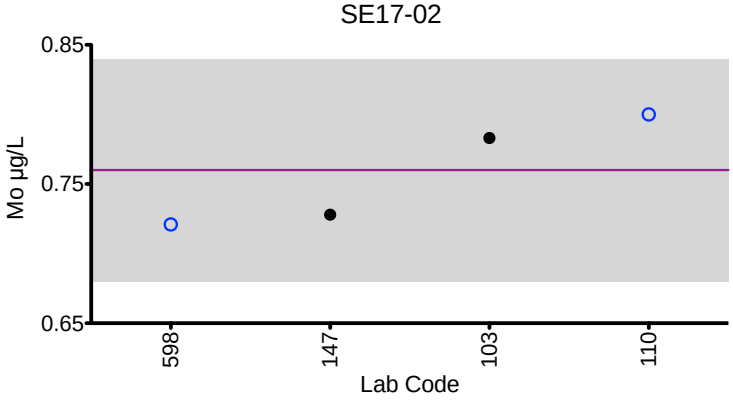
Serum Mo (µg/L)						
Lab Code	**Method**	**SE17-01**	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
103	DRC/CC-ICP-MS	8.04	0.783	4.04	4.87	2.51
110	ICP-MS	6.0	0.8	4.0	5.1	2.6
147	ICP-MS	7.65	0.728	3.64	4.97	2.34
485	HR-ICP-MS	7.74	<1	3.37	4.71	2.54
597	DRC/CC-ICP-MS	6.61	<1.3	2.62	3.22	1.44
598	ICP-MS	8.18	0.721	3.79	4.68	2.56

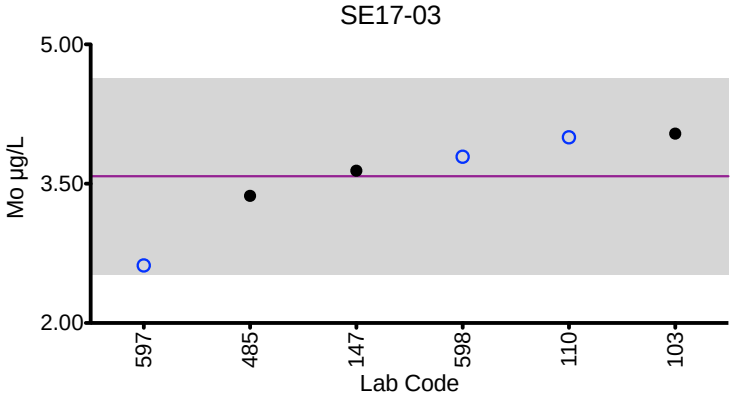
Summary Statistics					
	SE17-01	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
Arithmetic Mean ($\bar{x}$)	7.37	0.76	3.58	4.59	2.33
Arithmetic SD (s)	0.87	0.04	0.53	0.69	0.45
Arithmetic RSD (%)	11.8	5.3	14.8	15.0	19.3
Number of Sample Measurements (N)	6	4	6	6	6

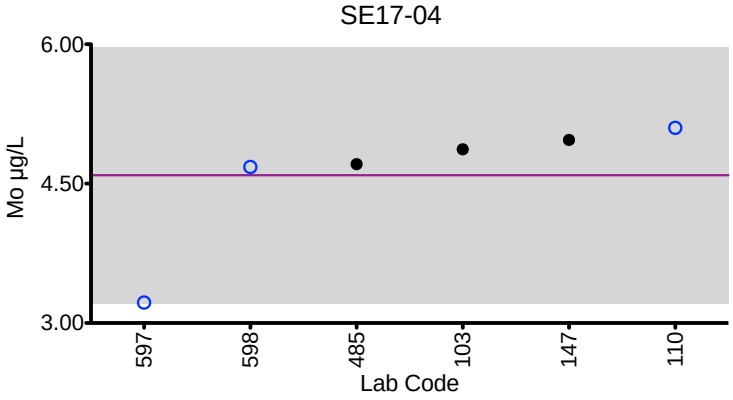
*Denotes a statistical Outlier.

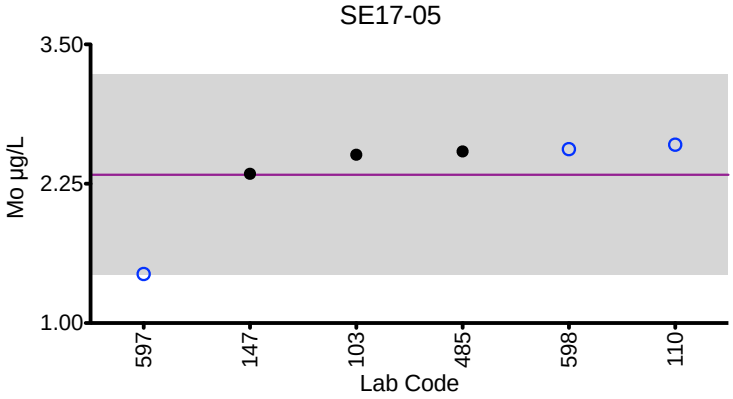
Results for Event #1, 2017:
Serum Mo











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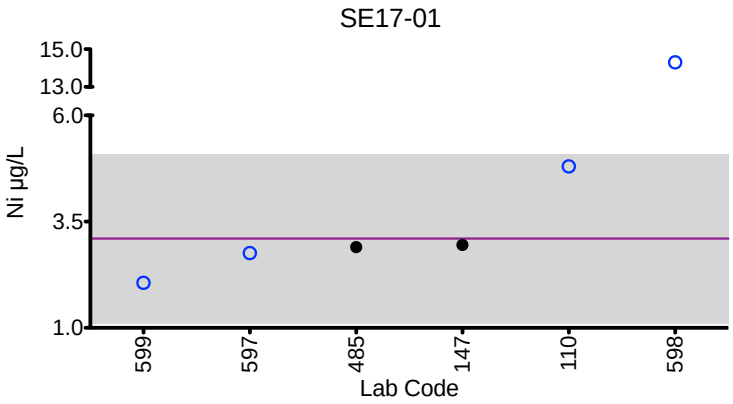
Results for Event #1, 2017
Additional Elements in Serum: Nickel (Ni)

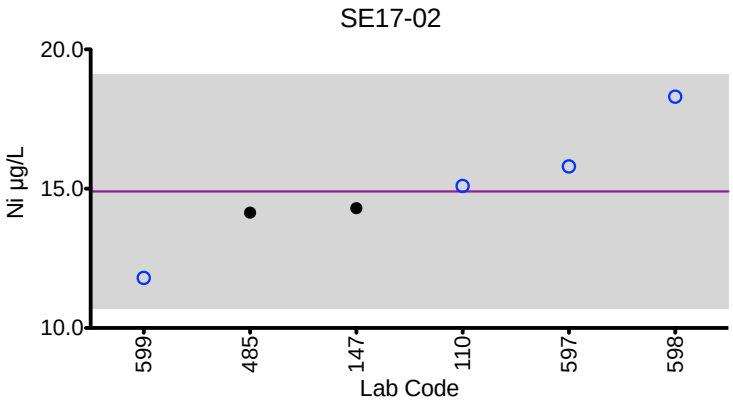
Serum Ni (µg/L)						
Lab Code	**Method**	**SE17-01**	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
110	DRC/CC-ICP-MS	4.8	15.1	9.5	2.1	5.1
147	ICP-MS	2.95	14.3	8.28	1.90	5.30
485	HR-ICP-MS	2.90	14.14	7.77	1.54	4.94
597	DRC/CC-ICP-MS	2.76	15.8	8.04	<1.7	4.66
598	ICP-MS	*14.3	18.3	11.7	*7.95	*49.3
599	DRC/CC-ICP-MS	2.06	11.8	6.97	1.21	4.67

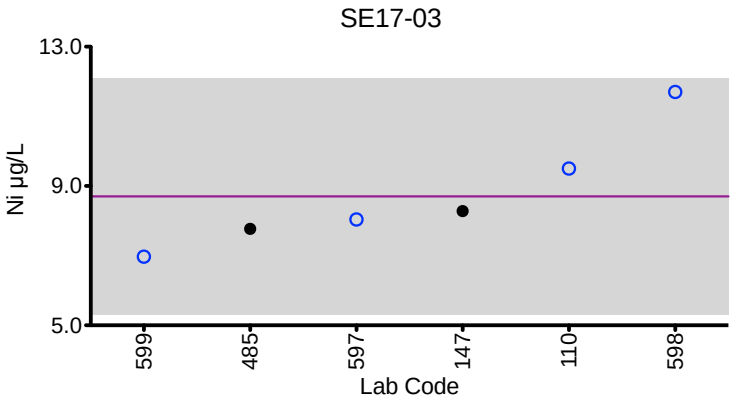
Summary Statistics					
	SE17-01	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
Arithmetic Mean ($\bar{x}$)	3.1	14.9	8.7	1.7	4.9
Arithmetic SD (s)	1.0	2.1	1.7	0.4	0.3
Arithmetic RSD (%)	32.3	14.1	19.5	23.5	6.1
Number of Sample Measurements (N)	5	6	6	4	5

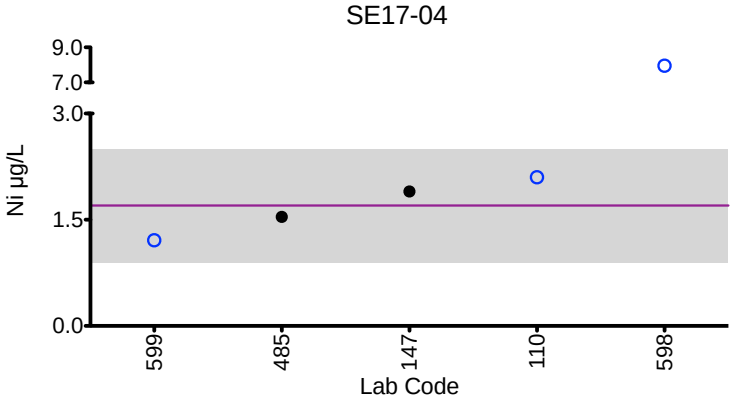
*Denotes a statistical Outlier.

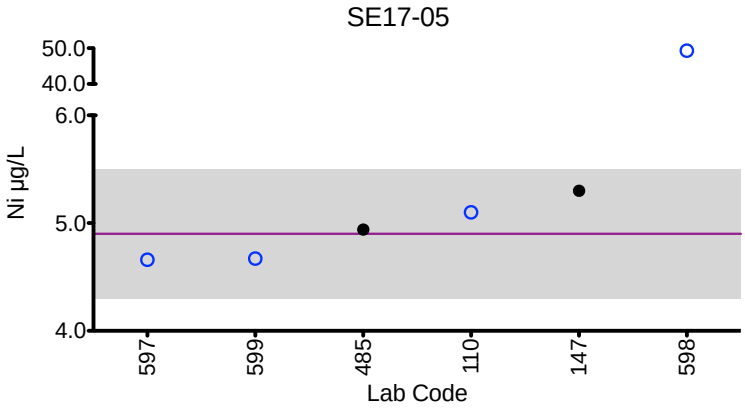
Results for Event #1, 2017: Serum Ni











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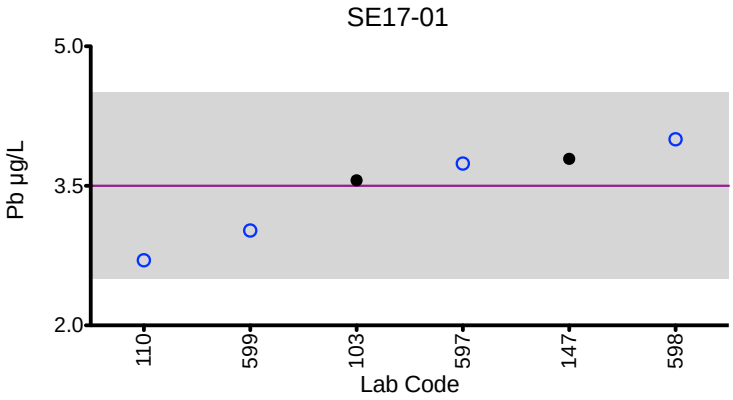
Results for Event #1, 2017
Additional Elements in Serum: Lead (Pb)

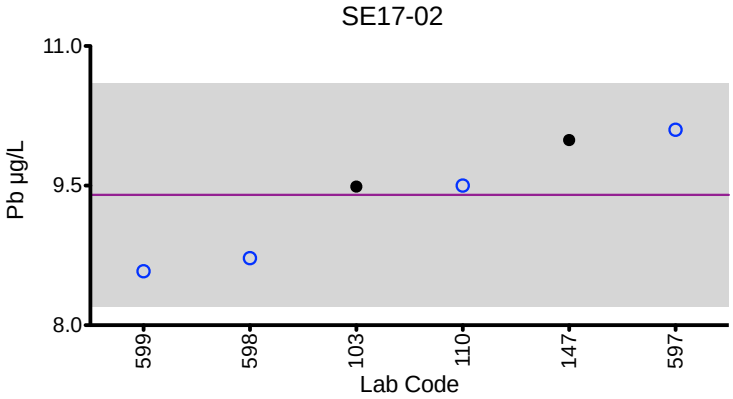
Serum Pb (µg/L)						
Lab Code	**Method**	**SE17-01**	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
103	DRC/CC-ICP-MS	3.56	9.49	5.32	4.57	7.44
110	ICP-MS	2.7	9.5	5.3	4.6	7.2
147	ICP-MS	3.79	9.99	5.37	5.01	7.60
597	DRC/CC-ICP-MS	3.74	10.1	5.07	4.27	7.07
598	ICP-MS	4.00	8.72	4.77	5.85	6.75
599	DRC/CC-ICP-MS	3.02	8.58	4.58	3.95	6.54

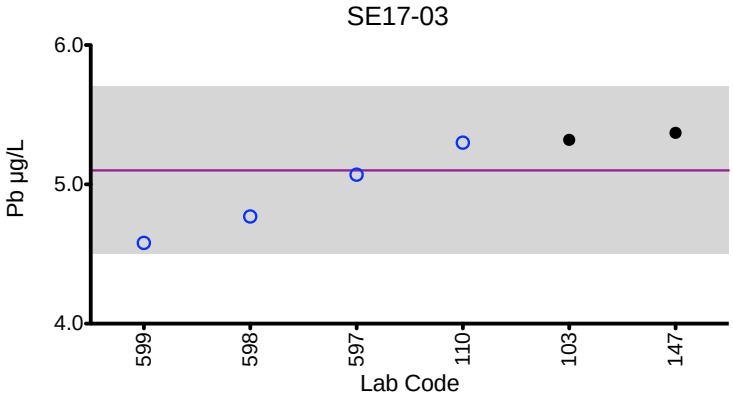
Summary Statistics					
	SE17-01	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
Arithmetic Mean ($\bar{x}$)	3.5	9.4	5.1	4.7	7.1
Arithmetic SD (s)	0.5	0.6	0.3	0.7	0.4
Arithmetic RSD (%)	14.3	6.4	5.9	14.9	5.6
Number of Sample Measurements (N)	6	6	6	6	6

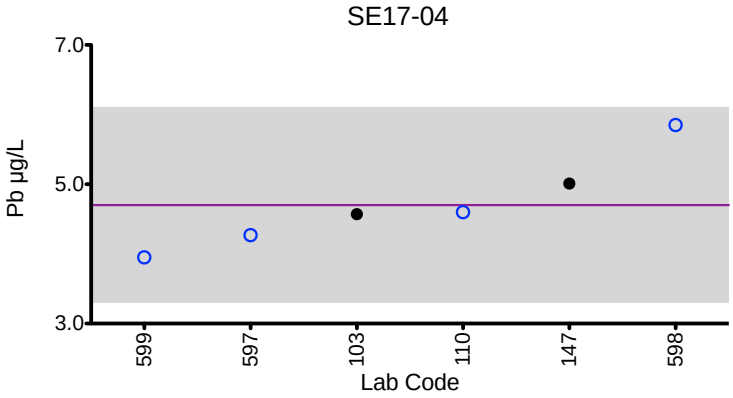
*Denotes a statistical Outlier.

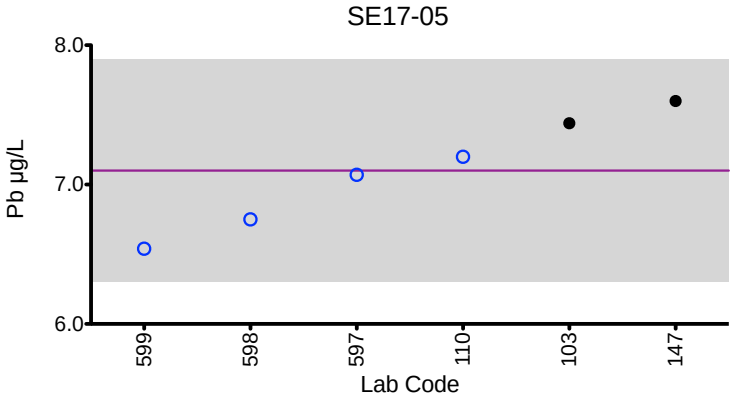
Results for Event #1, 2017: Serum Pb











Legend:
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Horizontal purple line = arithmetic mean of all laboratories.
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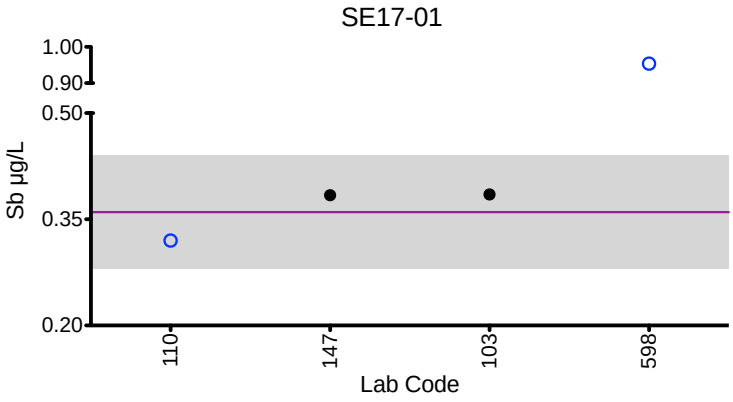
Results for Event #1, 2017
Additional Elements in Serum: Antimony (Sb)

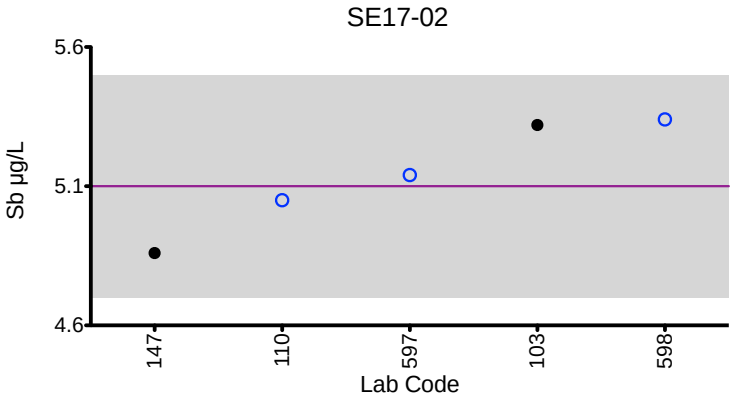
Serum Sb (µg/L)						
Lab Code	**Method**	**SE17-01**	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
103	DRC/CC-ICP-MS	0.385	5.32	1.06	4.21	2.16
110	ICP-MS	0.32	5.05	1.00	4.24	1.96
147	ICP-MS	0.384	4.86	0.984	4.21	1.98
597	DRC/CC-ICP-MS	<0.3	5.14	0.637	3.78	1.74
598	ICP-MS	*0.954	5.34	1.07	4.62	2.23

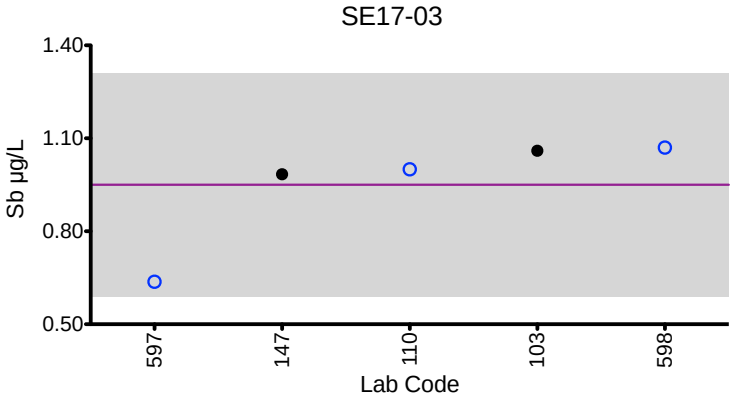
Summary Statistics					
	SE17-01	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
Arithmetic Mean ($\bar{x}$)	0.36	5.1	0.95	4.2	2.0
Arithmetic SD (s)	0.04	0.2	0.18	0.3	0.2
Arithmetic RSD (%)	11.1	3.9	18.9	7.1	10.0
Number of Sample Measurements (N)	3	5	5	5	5

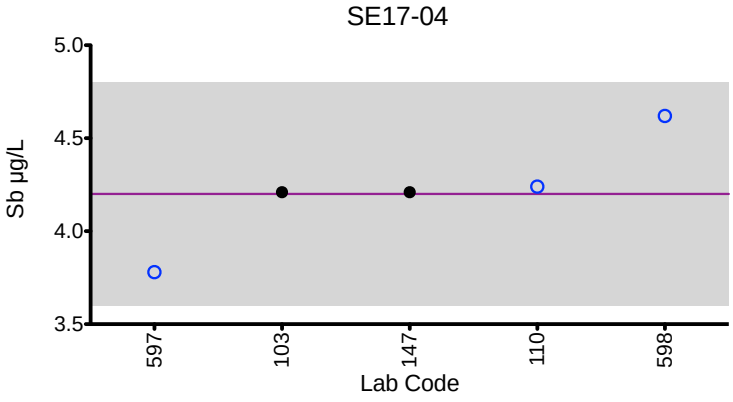
*Denotes a statistical Outlier.

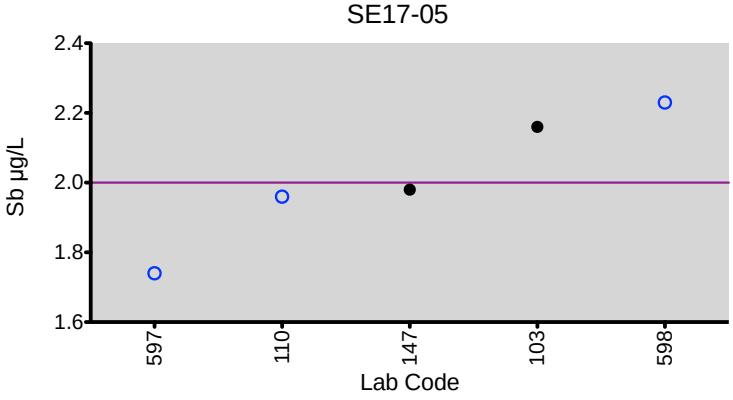
Results for Event #1, 2017: Serum Sb











Legend:
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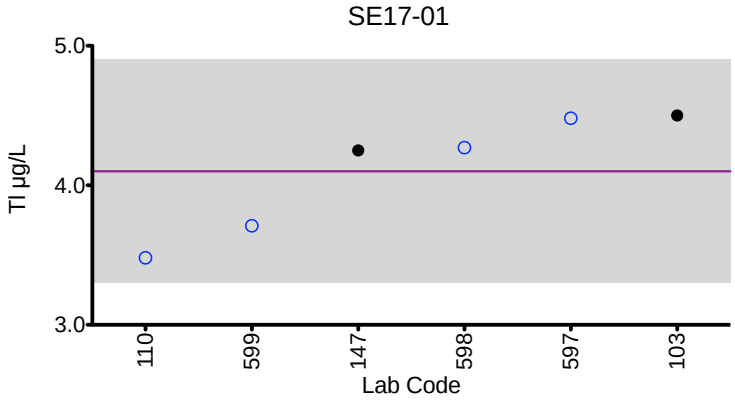
Results for Event #1, 2017
Additional Elements in Serum: Thallium (Tl)

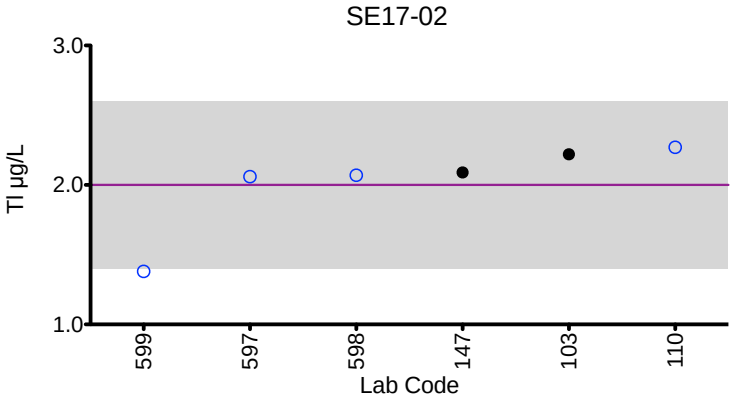
Serum Tl (µg/L)						
Lab Code	**Method**	**SE17-01**	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
103	DRC/CC-ICP-MS	4.50	2.22	3.11	1.05	3.32
110	ICP-MS	3.48	2.27	3.1	1.03	3.29
147	ICP-MS	4.25	2.09	2.92	1.04	3.03
597	DRC/CC-ICP-MS	4.48	2.06	2.80	0.709	2.85
598	ICP-MS	4.27	2.07	2.96	1.02	3.04
599	DRC/CC-ICP-MS	3.71	1.38	2.25	<0.1	2.46

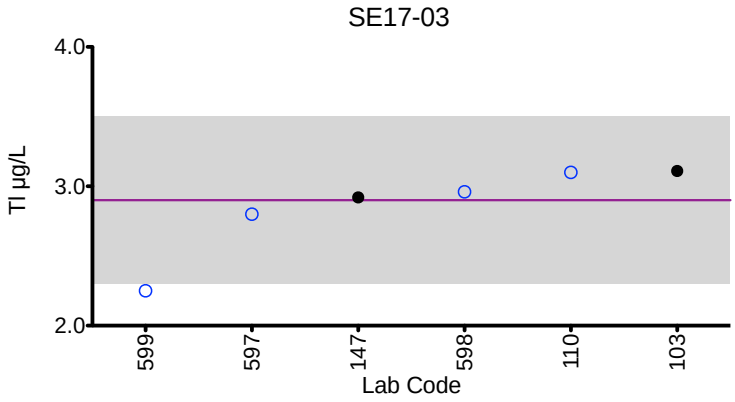
Summary Statistics					
	SE17-01	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
Arithmetic Mean ($\bar{x}$)	4.1	2.0	2.9	0.97	3.0
Arithmetic SD (s)	0.4	0.3	0.3	0.15	0.3
Arithmetic RSD (%)	9.8	15.0	10.3	15.5	10.0
Number of Sample Measurements (N)	6	6	6	5	6

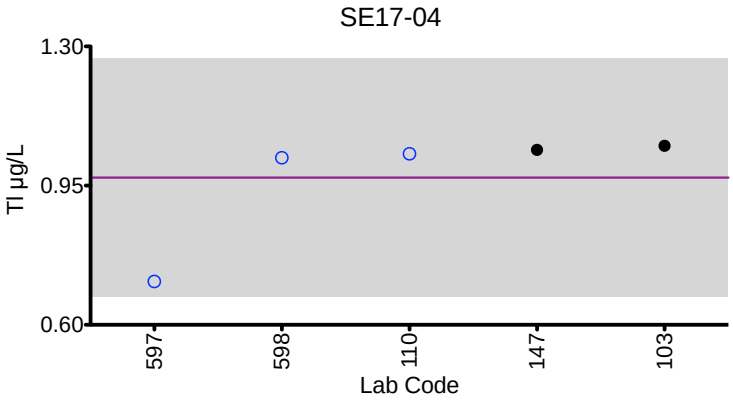
*Denotes a statistical Outlier.

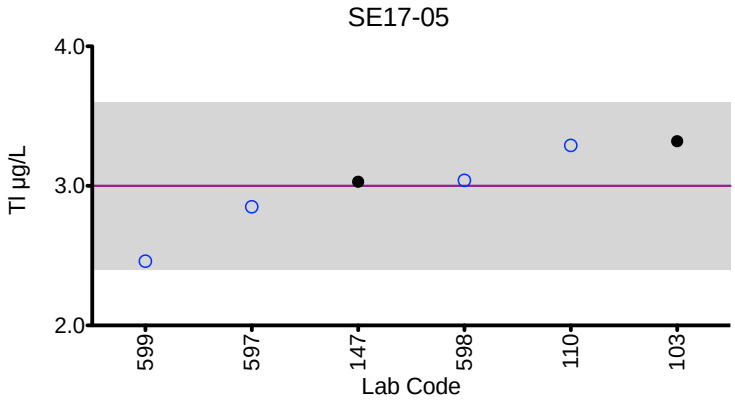
Results for Event #1, 2017: Serum Tl











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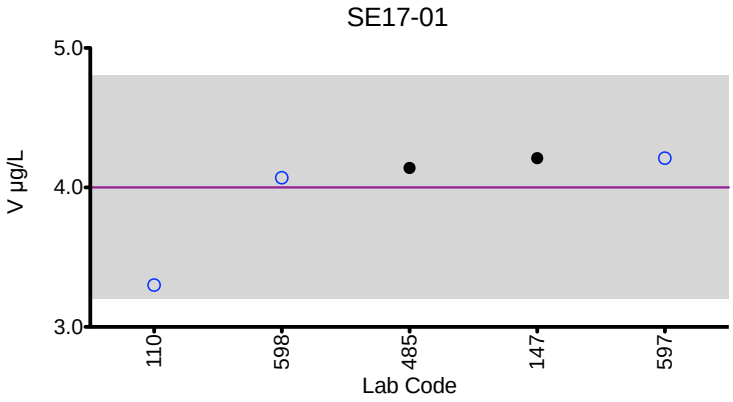
Results for Event #1, 2017
Additional Elements in Serum: Vanadium (V)

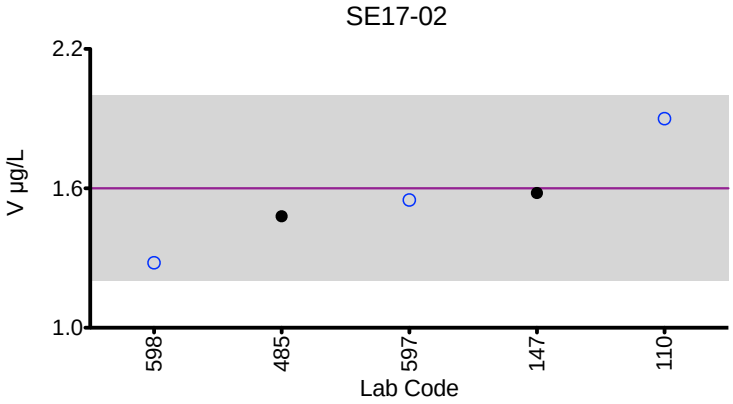
Serum V (µg/L)						
Lab Code	**Method**	**SE17-01**	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
110	DRC/CC-ICP-MS	3.3	1.9	3.0	2.3	9.7
147	DRC/CC-ICP-MS	4.21	1.58	2.66	2.35	9.39
485	HR-ICP-MS	4.14	1.48	2.42	2.20	8.99
597	DRC/CC-ICP-MS	4.21	1.55	2.57	1.99	8.94
598	DRC/CC-ICP-MS	4.07	1.28	2.41	1.89	9.42

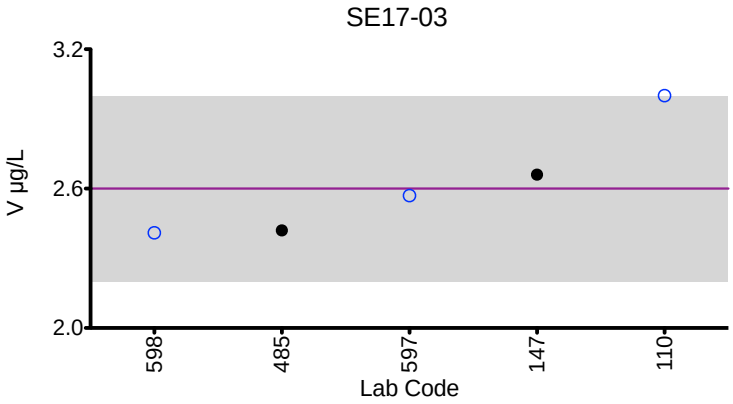
Summary Statistics					
	SE17-01	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
Arithmetic Mean ($\bar{x}$)	4.0	1.6	2.6	2.1	9.3
Arithmetic SD (s)	0.4	0.2	0.2	0.2	0.3
Arithmetic RSD (%)	10.0	12.5	7.7	9.5	3.2
Number of Sample Measurements (N)	5	5	5	5	5

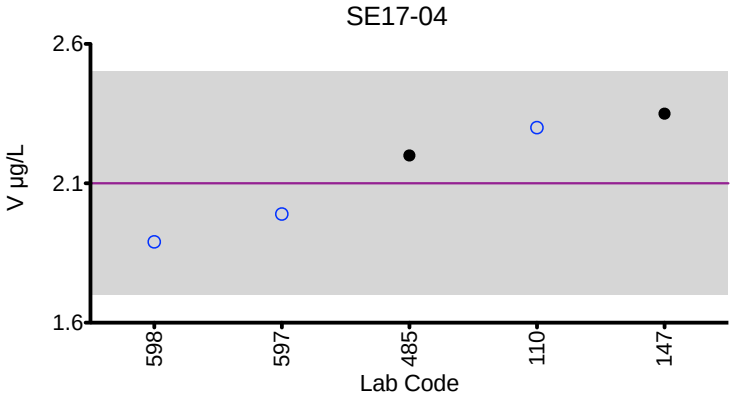
*Denotes a statistical Outlier.

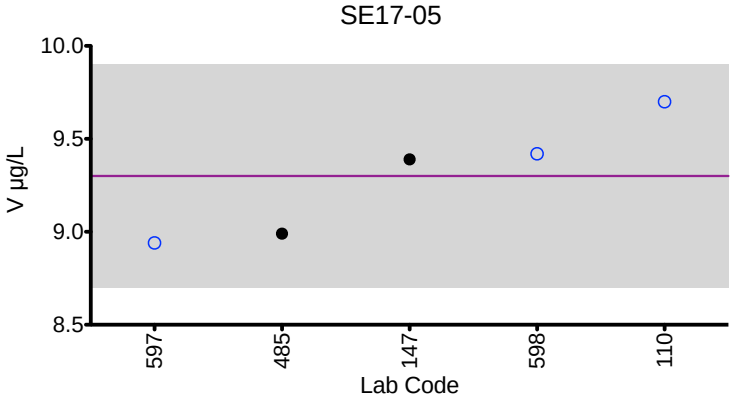
Results for Event #1, 2017: Serum V











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Results for Event #1, 2017
Additional Elements in Serum: Barium (Ba)

Serum Ba (µg/L)						
Lab Code	**Method**	**SE17-01**	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
110	ICP-MS	0.5	0.5	0.6	0.5	0.6
147	ICP-MS	0.577	0.636	0.438	0.462	0.566
597	DRC/CC-ICP-MS	0.819	0.622	<0.4	<0.4	0.509
598	ICP-MS	1.16	0.824	0.469	1.76	0.766

Summary Statistics					
	SE17-01	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
Arithmetic Mean ($\bar{x}$)	0.76	0.65	0.50	0.91	0.61
Arithmetic SD (s)	0.30	0.13	0.09	0.74	0.11
Arithmetic RSD (%)	39.5	20.0	18.0	81	18.0
Number of Sample Measurements (N)	4	4	3	3	4

*Denotes a statistical Outlier.

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Results for Event #1, 2017
Additional Elements in Serum: Beryllium (Be)

Serum Be (µg/L)						
Lab Code	**Method**	**SE17-01**	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
110	ICP-MS	2.08	1.78	6.00	0.19	4.00
147	ICP-MS	2.86	1.90	6.41	< 0.441	4.43
598	ICP-MS	2.38	1.70	6.07	0.112	4.37
599	DRC/CC-ICP-MS	2.19	1.64	5.03	0.20	3.51

Summary Statistics					
	SE17-01	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
Arithmetic Mean ($\bar{x}$)	2.4	1.8	5.9	0.17	4.1
Arithmetic SD (s)	0.3	0.1	0.6	0.05	0.4
Arithmetic RSD (%)	12.5	5.6	10.2	29.4	9.8
Number of Sample Measurements (N)	4	4	4	3	4

*Denotes a statistical Outlier.

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Results for Event #1, 2017
Additional Elements in Serum: Cesium (Cs)

Serum Cs (µg/L)						
Lab Code	**Method**	**SE17-01**	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
110	ICP-MS	0.63	0.79	0.51	0.49	0.76
597	DRC/CC-ICP-MS	0.714	0.684	<0.4	<0.4	0.587
598	ICP-MS	0.783	0.748	0.471	0.498	0.754

Summary Statistics					
	SE17-01	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
Arithmetic Mean ($\bar{x}$)	0.7	0.7	0.5	0.5	0.7
Arithmetic SD (s)	0.1	0.1	0.0	0.0	0.1
Arithmetic RSD (%)	14.3	14.3	0.00	0.00	14.3
Number of Sample Measurements (N)	3	3	2	2	3

*Denotes a statistical Outlier.

Results for Event #1, 2017
Additional Elements in Serum: Iron (Fe)

Serum Fe (µg/L)						
Lab Code	**Method**	**SE17-01**	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
457	ICP-AES/OES	327.0	322	433	476	290
483	DRC/CC-ICP-MS	380	283	543	560	363

Summary Statistics					
	SE17-01	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
Arithmetic Mean ($\bar{x}$)	354	303	488	518	327
Arithmetic SD (s)	37	28	78	59	52
Arithmetic RSD (%)	10.5	9.2	16.0	11.4	15.9
Number of Sample Measurements (N)	2	2	2	2	2

*Denotes a statistical Outlier.

Results for Event #1, 2017
Additional Elements in Serum: Platinum (Pt)

Serum Pt (µg/L)						
Lab Code	**Method**	**SE17-01**	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
110	ICP-MS	0.06	0.09	1.68	0.77	0.10
598	ICP-MS	0.090	0.063	1.571	0.683	0.099

Summary Statistics					
	SE17-01	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
Arithmetic Mean ($\bar{x}$)	0.075	0.075	1.63	0.727	0.100
Arithmetic SD (s)	0.021	0.019	0.08	0.061	0.000
Arithmetic RSD (%)	28.0	25.3	4.9	8.4	0.00
Number of Sample Measurements (N)	2	2	2	2	2

*Denotes a statistical Outlier.

Results for Event #1, 2017
Additional Elements in Serum: Tin (Sn)

Serum Sn (µg/L)						
Lab Code	**Method**	**SE17-01**	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
110	ICP-MS	5.01	1.14	1.13	9.04	3.98
147	ICP-MS	6.27	1.01	1.03	9.35	3.82
597	DRC/CC-ICP-MS	6.63	0.798	0.710	8.08	3.50
598	ICP-MS	7.05	1.46	1.02	9.04	3.78

Summary Statistics					
	SE17-01	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
Arithmetic Mean ($\bar{x}$)	6.2	1.1	1.0	8.9	3.8
Arithmetic SD (s)	0.9	0.3	0.2	0.6	0.2
Arithmetic RSD (%)	14.5	27.3	20.0	6.7	5.3
Number of Sample Measurements (N)	4	4	4	4	4

*Denotes a statistical Outlier.

Results for Event #1, 2017
Additional Elements in Serum: Strontium (Sr)

Serum Sr (µg/L)						
Lab Code	**Method**	**SE17-01**	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
103	DRC/CC-ICP-MS	34.6	78.8	24.8	84.2	57.9
200	ICP-MS	31.5	68.3	23.7	76.2	52.6

Summary Statistics					
	SE17-01	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
Arithmetic Mean ($\bar{x}$)	33.0	73.6	24.3	80.2	55.3
Arithmetic SD (s)	2.2	7.4	0.8	5.7	3.7
Arithmetic RSD (%)	6.7	10.1	3.3	7.1	6.7
Number of Sample Measurements (N)	2	2	2	2	2

*Denotes a statistical Outlier.

Results for Event #1, 2017
Additional Elements in Serum: Titanium (Ti)

Serum Ti (µg/L)						
Lab Code	**Method**	**SE17-01**	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
200	DRC/CC-ICP-MS	3.0	1.7	7.9	5.6	6.9
485	HR-ICP-MS	2.75	1.86	8.35	5.10	8.29

Summary Statistics					
	SE17-01	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
Arithmetic Mean ($\bar{x}$)	2.9	1.8	8.1	5.4	7.6
Arithmetic SD (s)	0.2	0.1	0.3	0.4	1.0
Arithmetic RSD (%)	6.9	5.6	3.7	7.4	13.2
Number of Sample Measurements (N)	2	2	2	2	2

*Denotes a statistical Outlier.

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Results for Event #1, 2017
Additional Elements in Serum: Uranium (U)

Serum U (µg/L)						
Lab Code	**Method**	**SE17-01**	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
103	DRC/CC-ICP-MS	0.00143	0.0842	0.0319	0.209	0.0584
110	ICP-MS	0.008	0.088	0.04	0.207	0.055
147	ICP-MS	< 0.0145	0.0774	0.0343	0.212	0.0540
598	ICP-MS	0.013	0.075	0.026	0.211	0.053

Summary Statistics					
	SE17-01	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
Arithmetic Mean ($\bar{x}$)	0.007	0.081	0.033	0.210	0.055
Arithmetic SD (s)	0.006	0.006	0.006	0.002	0.002
Arithmetic RSD (%)	86	7.4	18.2	0.95	3.6
Number of Sample Measurements (N)	3	4	4	4	4

*Denotes a statistical Outlier.

Results for Event #1, 2017
Additional Elements in Serum: Tungsten (W)

Serum W (µg/L)						
Lab Code	**Method**	**SE17-01**	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
110	ICP-MS	0.45	1.65	3.14	3.92	0.91
147	ICP-MS	0.607	1.17	2.56	3.57	0.506
200	ICP-MS	0.6	1.5	3	3.8	0.8
598	ICP-MS	0.678	1.64	3.12	3.90	0.875

Summary Statistics					
	SE17-01	**SE17-02**	**SE17-03**	**SE17-04**	**SE17-05**
Arithmetic Mean ($\bar{x}$)	0.6	1.5	3.0	3.8	0.8
Arithmetic SD (s)	0.1	0.2	0.3	0.2	0.2
Arithmetic RSD (%)	16.7	13.3	10.0	5.3	25.0
Number of Sample Measurements (N)	4	4	4	4	4

*Denotes a statistical Outlier.

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Results for Event #1, 2017
Additional Elements in Serum

Serum Ag (µg/L)

Lab Code	Method	SE17-01	SE17-02	SE17-03	SE17-04	SE17-05
147	ICP-MS	< 0.248	< 0.248	< 0.248	< 0.248	< 0.248

Serum B (µg/L)

Lab Code	Method	SE17-01	SE17-02	SE17-03	SE17-04	SE17-05
200	ICP-MS	2.9	2.6	1.8	1.8	2.2

Serum Bi (µg/L)

Lab Code	Method	SE17-01	SE17-02	SE17-03	SE17-04	SE17-05
147	ICP-MS	< 0.200	< 0.200	< 0.200	< 0.200	< 0.200

Serum I (µg/L)

Lab Code	Method	SE17-01	SE17-02	SE17-03	SE17-04	SE17-05
147	ICP-MS	56.1	56.7	27.5	27.1	54.6

Serum Li (µg/L)

Lab Code	Method	SE17-01	SE17-02	SE17-03	SE17-04	SE17-05
147	ICP-MS	0.586	0.483	0.494	0.482	0.509

Serum Mg (µg/L)

Lab Code	Method	SE17-01	SE17-02	SE17-03	SE17-04	SE17-05
597	DRC/CC-ICP-MS	20200	19900	17900	16700	18500

Serum Te (µg/L)

Lab Code	Method	SE17-01	SE17-02	SE17-03	SE17-04	SE17-05
147	ICP-MS	< 0.0880	< 0.0880	< 0.0880	< 0.0880	< 0.0880

Serum Th (µg/L)

Lab Code	Method	SE17-01	SE17-02	SE17-03	SE17-04	SE17-05
147	ICP-MS	< 0.00789	< 0.00789	< 0.00789	< 0.00789	< 0.00789

References

1. ISO/FDIS-13528 (2005) Statistical methods for use in proficiency testing by interlaboratory comparisons. International Organization for Standardization, Geneva.

2. Taylor A, Angerer J, Arnaud J, Claeys F, Jones RL, Mazarrasa O, Mairiaux E, Menditto A, Parsons PJ, Patriarca M, Pineau A, Valkonen S, Weber J-P, Weykamp C. Occupational and environmental laboratory medicine: A network of EQAS organisers. Accreditation and Quality Assurance. 2006;11(8-9):435-9. PubMed PMID: 086NJ-0011.