New York State Biomonitoring Program for Trace Elements

Event #3, 2022

Trace Elements in Whole Blood, Urine, and Serum

November, 2022

Wadsworth Center
NEW YORK STATE DEPARTMENT OF HEALTH
Trace Elements Laboratory

11/3/2022

Dear Laboratory Director,

This report summarizes performance for the third biomonitoring proficiency test (PT) event of 2022 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 #1, 2023) will be shipped February 1, 2023. Comments about this report may be directed to trel@health.ny.gov. If you have not yet enrolled for next year, please contact PT program staff at trel@health.ny.gov.

Sincerely,

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

Kayla Mehigan
Coordinator, Biomonitoring PT Program,
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Event #3, 2022

Trace Elements in Whole Blood

Wadsworth Center
NEW YORK STATE DEPARTMENT OF HEALTH
Trace Elements Laboratory

Event #3, 2022:
Trace Elements in Whole Blood

PT Materials

Human whole blood was purchased from Zen-Bio, 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 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

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) if a robust mean is not possible, the arithmetic mean after outlier deletion.

Additional Elements

An additional 25 elements 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.

Results for Event #3, 2022:
Summary Statistics

Whole Blood As (µg/L)					
	BE22-11	**BE22-12**	**BE22-13**	**BE22-14**	**BE22-15**
Target (Arithmetic Mean ($\bar{x}$))	34.8	16.6	2.06	10.1	6.1
Upper Limit	41.8	22.6	8.06	16.1	12.1
Lower Limit	27.8	10.6	0.00	4.1	0.1
Arithmetic SD (s)	2.1	1.5	0.22	1.8	0.4
Arithmetic RSD (%)	6.0	8.9	11	18	5.8
Number of Sample Measurements (N)	7	8	7	8	7

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.

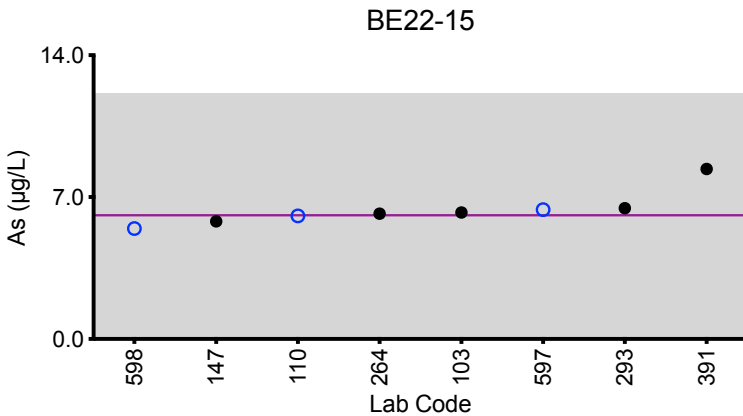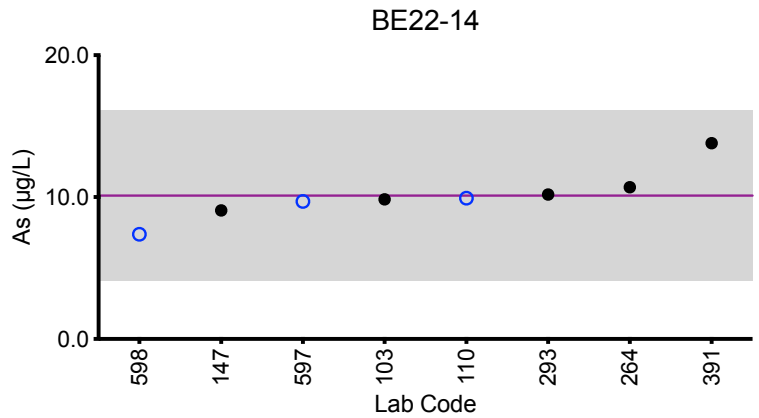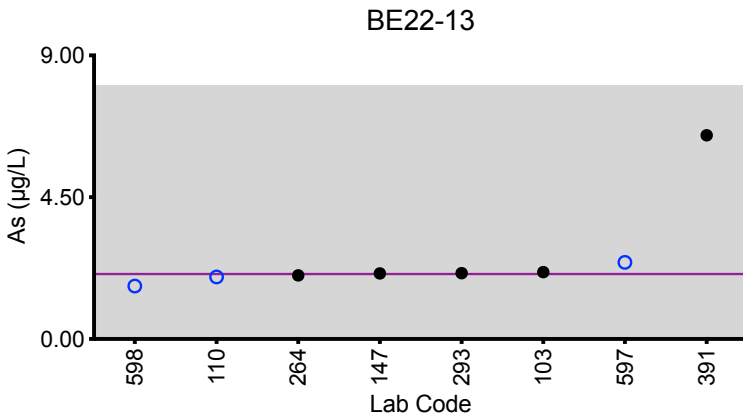# Results for Event #3, 2022:
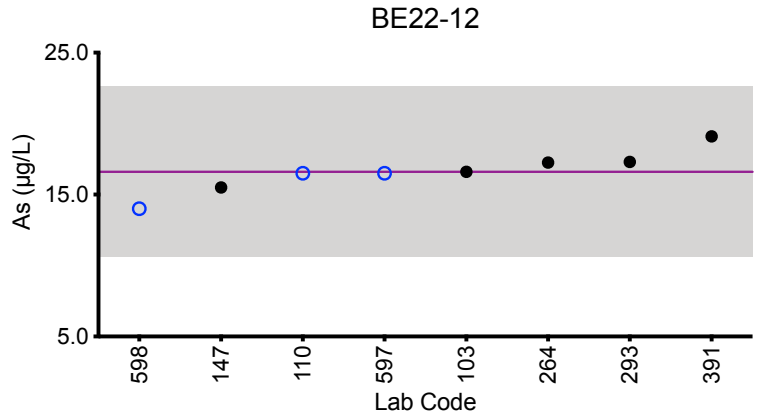## Performance of Participating Laboratories

		Whole Blood As (µg/L)				
Lab Code	Method	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
	Target	**34.8**	**16.6**	**2.06**	**10.1**	**6.1**
103	ICP-MS/MS	34.7	16.6	2.12	9.84	6.24
110	ICP-MS/MS	35.6	16.5	1.97	9.92	6.07
147	ICP-MS	33.3	15.5	2.08	9.06	5.80
264	ICP-MS	35.12	17.25	2.02	10.69	6.18
293	DRC/CC-ICP-MS	35.10	17.3	2.09	10.18	6.45
391	ICP-MS	38.4	19.1	*6.47	13.8	*8.39
597	ICP-MS/MS	31.6	16.5	2.43	9.69	6.38
598	DRC/CC-ICP-MS	*2.93 ↓	14.0	1.68	7.38	5.45

Based on the grading criteria for As in Whole Blood, 98% of results were satisfactory, with 0 of the 8 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

Results for Event #3, 2022:
Summary Figures

Whole Blood As

BE22-11

As (µg/L) vs Lab Code: 598, 597, 147, 103, 293, 264, 110, 391

BE22-12

As (µg/L) vs Lab Code: 598, 147, 110, 597, 103, 264, 293, 391

BE22-13

As (µg/L) vs Lab Code: 598, 110, 264, 147, 293, 103, 597, 391

BE22-14

As (µg/L) vs Lab Code: 598, 147, 597, 103, 110, 293, 264, 391

BE22-15

As (µg/L) vs Lab Code: 598, 147, 110, 264, 103, 597, 293, 391

Legend:
○ C/HHEAR 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.

Results for Event #3, 2022:
Summary Statistics

Whole Blood Cd (µg/L)					
	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
Target (Robust Mean (x^*))	0.88	7.2	12.9	1.36	3.64
Upper Limit	1.88	8.3	14.8	2.36	4.64
Lower Limit	0.00	6.1	11.0	0.36	2.64
Robust SD (s^*)	0.10	0.3	0.8	0.08	0.16
Robust RSD (%)	11	4.1	6.2	5.9	4.4
Number of Sample Measurements (N)	11	13	13	12	13
Standard Uncertainty (u)	0.04	0.1	0.3	0.03	0.06

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.

Results for Event #3, 2022:
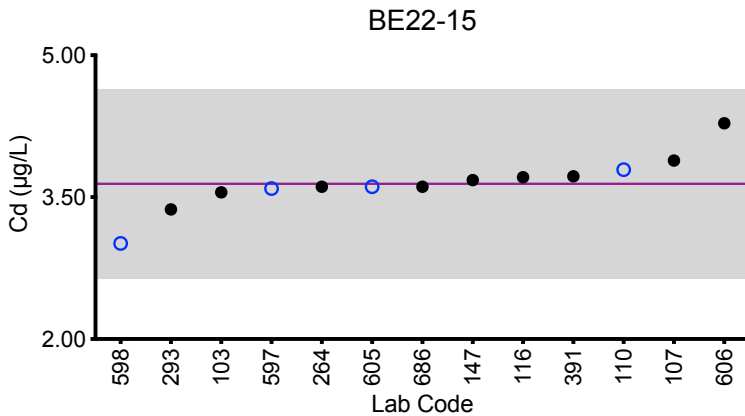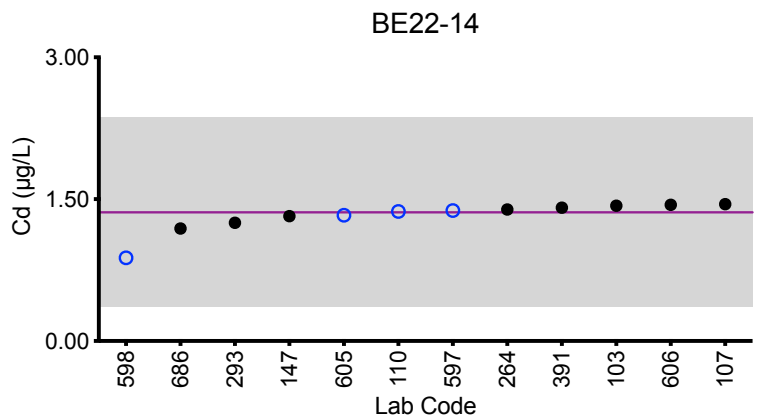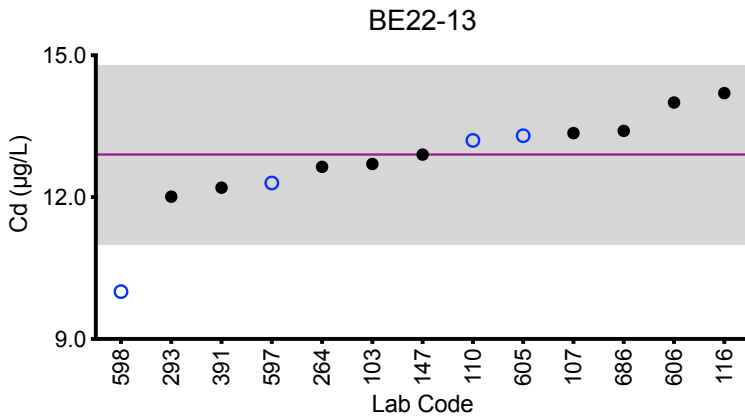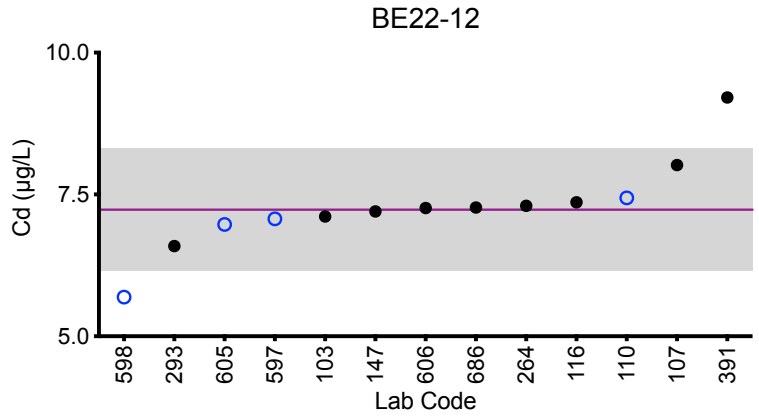## Performance of Participating Laboratories

Lab Code	Method	BE22-11	BE22-12		BE22-13		BE22-14	BE22-15
		Whole Blood Cd (µg/L)						
	Target	**0.88**	**7.2**		**12.9**		**1.36**	**3.64**
103	ICP-MS/MS	0.897	7.11		12.7		1.43	3.55
107	ICP-MS/MS	0.932	8.017		13.354		1.447	3.886
110	ICP-MS	0.91	7.44		13.2		1.37	3.79
116	ICP-MS/MS	<1.50	7.36		14.2		<1.50	3.71
147	ICP-MS	0.877	7.20		12.9		1.32	3.68
264	ICP-MS	0.95	7.30		12.64		1.39	3.61
293	DRC/CC-ICP-MS	0.75	6.59		12.010		1.25	3.37
391	ICP-MS	0.742	9.21	↑	12.2		1.41	3.72
597	ICP-MS/MS	0.839	7.07		12.3		1.38	3.59
598	DRC/CC-ICP-MS	<0.2	5.69	↓	10.0	↓	0.880	3.01
605	ICP-MS	0.995	6.97		13.3		1.33	3.61
606	ICP-MS/MS	1.03	7.26		14.0		1.44	4.28
686	ICP-MS	0.705	7.27		13.4		1.19	3.61

Based on the grading criteria for Cd in Whole Blood, 95% of results were satisfactory, with 1 of the 13 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

Results for Event #3, 2022:
Summary Figures

Whole Blood Cd

Legend:
o C/HHEAR 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.

Results for Event #3, 2022:
Summary Statistics

Whole Blood Co (µg/L)					
	BE22-11	**BE22-12**	**BE22-13**	**BE22-14**	**BE22-15**
Target (Arithmetic Mean ($\bar{x}$))	11.0	7.3	7.1	17.3	1.84
Upper Limit	13.2	8.8	8.6	20.8	3.34
Lower Limit	8.8	5.8	5.6	13.8	0.34
Arithmetic SD (s)	0.6	1.1	0.3	0.7	0.16
Arithmetic RSD (%)	5.5	15	3.9	4.2	8.7
Number of Sample Measurements (N)	8	9	8	8	9

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

Results for Event #3, 2022:
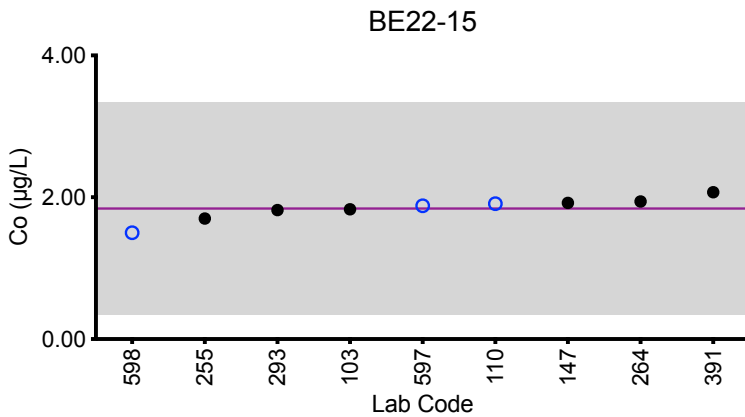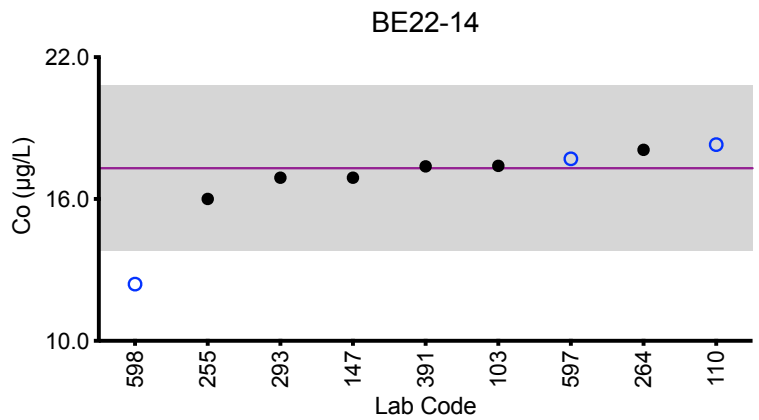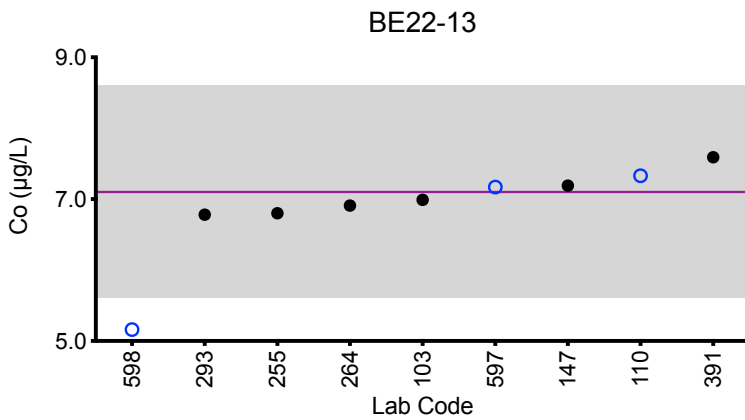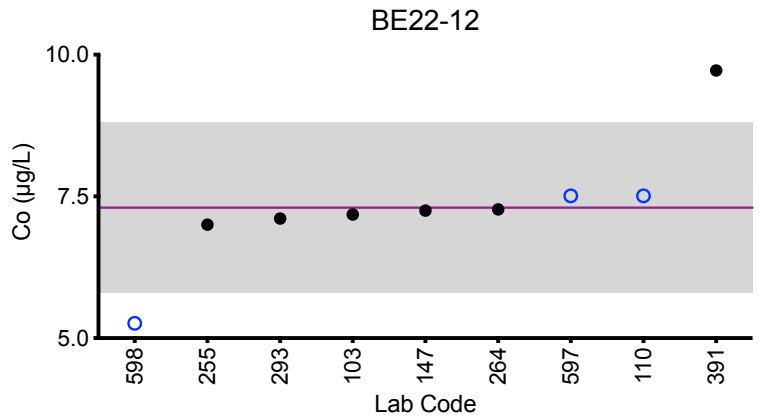## Performance of Participating Laboratories

		Whole Blood Co (µg/L)				
Lab Code	Method	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
	Target	11.0	7.3	7.1	17.3	1.84
103	ICP-MS/MS	11.3	7.18	6.99	17.4	1.83
110	ICP-MS/MS	11.7	7.51	7.33	18.3	1.91
147	ICP-MS	11.3	7.25	7.19	16.9	1.92
255	ICP-MS	10	7	6.8	16	1.7
264	ICP-MS	11.86	7.27	6.91	18.08	1.94
293	DRC/CC-ICP-MS	10.97	7.11	6.78	16.90	1.82
391	ICP-MS	10.4	9.72 ↑	7.59	17.38	2.07
597	ICP-MS/MS	10.8	7.51	7.17	17.7	1.88
598	ICP-MS	*1.19 ↓	5.26 ↓	*5.16 ↓	*12.4 ↓	1.50

Based on the grading criteria for Co in Whole Blood, 89% 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 #3, 2022:
Summary Figures

Whole Blood Co

BE22-11

BE22-12

BE22-13

BE22-14

BE22-15

Legend:
○ C/HHEAR 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 ±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.

Results for Event #3, 2022:
Summary Statistics

Whole Blood Cr (µg/L)					
	BE22-11	**BE22-12**	**BE22-13**	**BE22-14**	**BE22-15**
Target (Arithmetic Mean ($\bar{x}$))	14.1	10.1	1.0	2.6	5.0
Upper Limit	16.9	12.1	3.0	4.6	7.0
Lower Limit	11.3	8.1	0.0	0.6	3.0
Arithmetic SD (s)	1.4	1.3	0.3	0.4	0.4
Arithmetic RSD (%)	9.9	13	34	15	8.4
Number of Sample Measurements (N)	8	9	6	8	8

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

Results for Event #3, 2022:
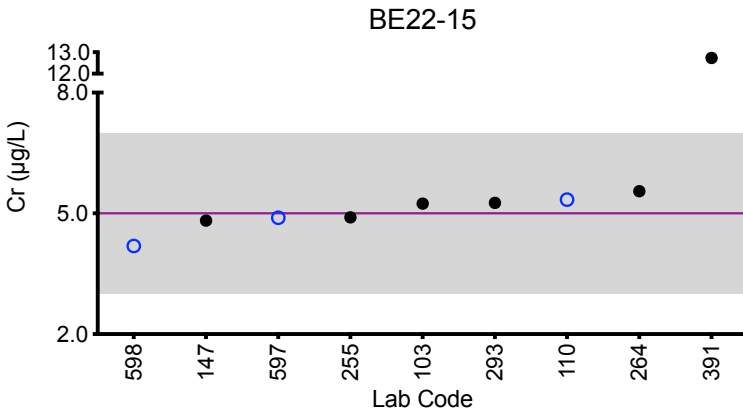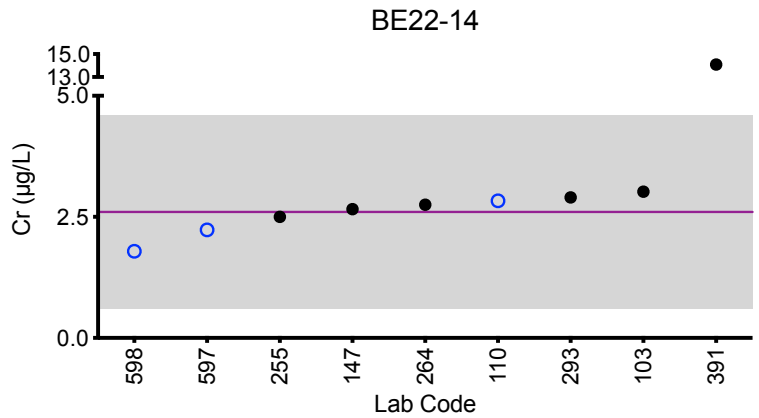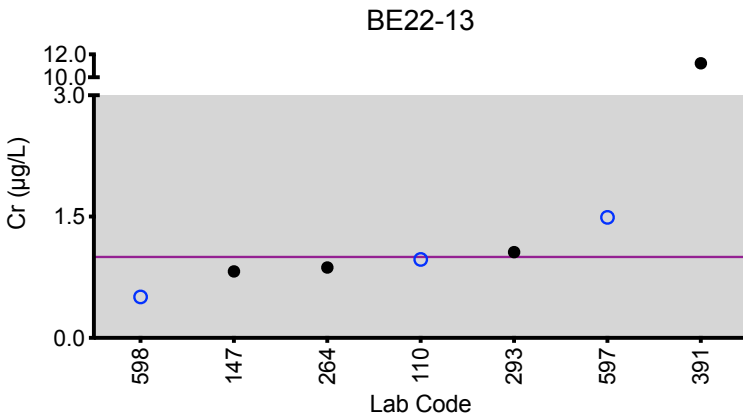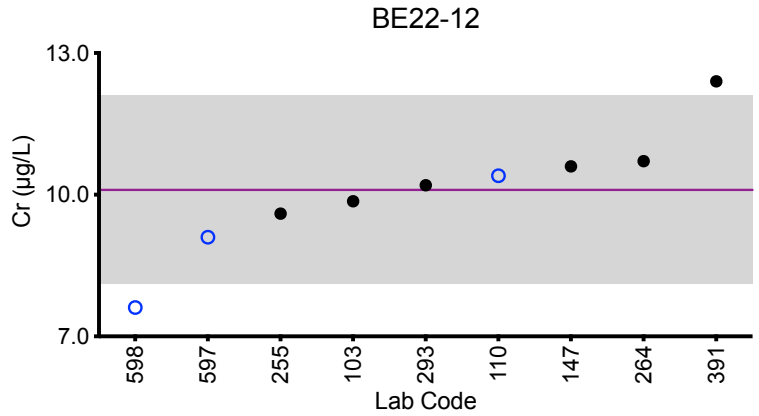## Performance of Participating Laboratories

		Whole Blood Cr (µg/L)				
Lab Code	**Method**	**BE22-11**	**BE22-12**	**BE22-13**	**BE22-14**	**BE22-15**
	Target	**14.1**	**10.1**	**1.0**	**2.6**	**5.0**
103	ICP-MS/MS	13.7	9.86	<1.50	3.02	5.24
110	ICP-MS/MS	14.1	10.4	0.97	2.83	5.34
147	DRC/CC-ICP-MS	14.8	10.6	0.822	2.66	4.82
255	ICP-MS	13	9.6	<1.0	2.5	4.9
264	ICP-MS	13.51	10.71	0.87	2.75	5.55
293	DRC/CC-ICP-MS	13.60	10.20	1.06	2.90	5.26
391	ICP-MS	17.3 ↑	12.4 ↑	*11.2 ↑	*14.1 ↑	*12.7 ↑
597	ICP-MS/MS	13.0	9.10	1.49	2.23	4.89
598	DRC/CC-ICP-MS	*1.18 ↓	7.61 ↓	0.506	1.79	4.19

Based on the grading criteria for Cr in Whole Blood, 84% of results were satisfactory, with 2 of the 9 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

Results for Event #3, 2022:
Summary Figures

Whole Blood Cr

BE22-11

BE22-12

BE22-13

BE22-14

BE22-15

Legend:
○ C/HHEAR 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.

Results for Event #3, 2022:
Summary Statistics

Whole Blood Hg (µg/L)					
	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
Target (Robust Mean (x^*))	1.10	13.8	2.38	4.6	9.4
Upper Limit	4.10	17.9	5.38	7.6	12.4
Lower Limit	0.00	9.7	0.00	1.6	6.4
Robust SD (s^*)	0.10	1.2	0.24	0.5	0.9
Robust RSD (%)	9.4	8.7	10	11	9.6
Number of Sample Measurements (N)	12	14	14	14	14
Standard Uncertainty (u)	0.04	0.4	0.08	0.2	0.3

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.

Results for Event #3, 2022:
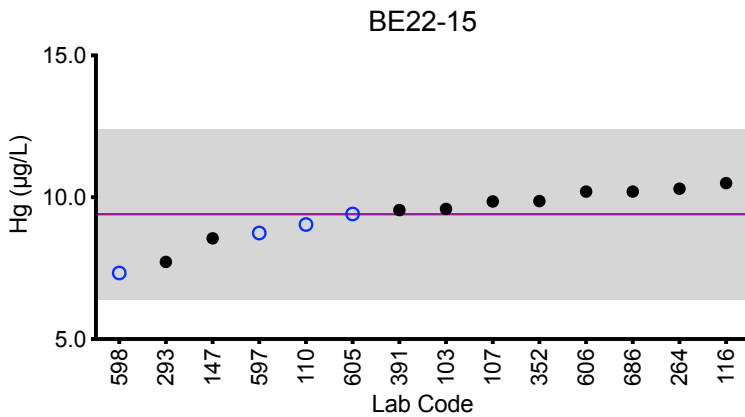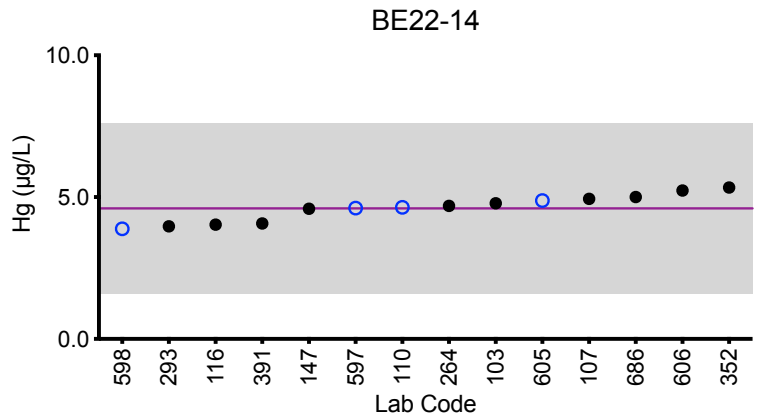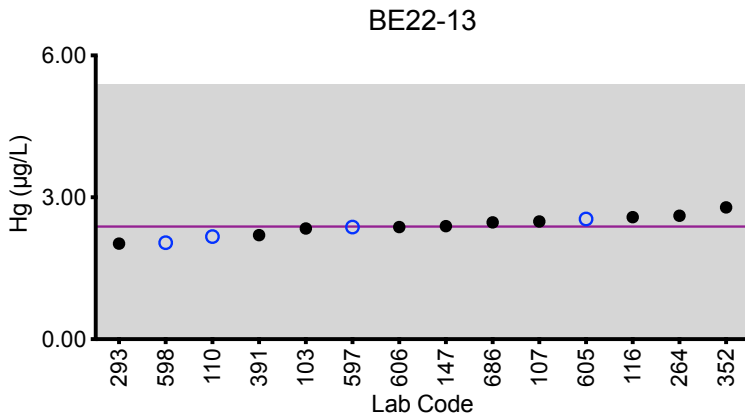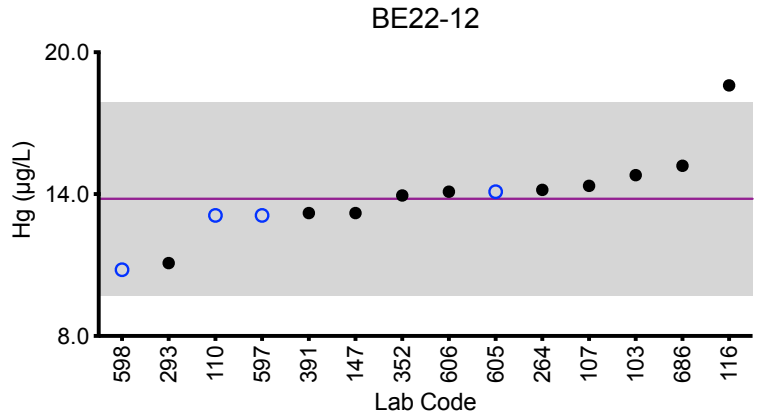# Performance of Participating Laboratories

		Whole Blood Hg (µg/L)				
Lab Code	Method	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
	Target	1.10	13.8	2.38	4.6	9.4
103	ICP-MS/MS	1.10	14.8	2.34	4.78	9.59
107	ICP-MS/MS	1.04	14.35	2.49	4.94	9.85
110	ICP-MS	1.25	13.1	2.17	4.64	9.04
116	ICP-MS/MS	<1.50	18.6 ↑	2.58	4.03	10.5
147	ICP-MS	1.04	13.2	2.39	4.59	8.55
264	ICP-MS	0.90	14.18	2.61	4.69	10.30
293	DRC/CC-ICP-MS	1.12	11.08	2.02	3.97	7.72
352	ETAAS-Z	1.426	13.94	2.787	5.337	9.865
391	CV-AAS	0.47	13.2	2.20	4.07	9.55
597	ICP-MS/MS	1.13	13.1	2.37	4.61	8.74
598	ICP-MS	<0.2	10.8	2.04	3.88	7.33
605	ICP-MS	1.10	14.1	2.54	4.88	9.41
606	ICP-MS/MS	1.21	14.1	2.37	5.23	10.2
686	ICP-MS	1.10	15.2	2.47	5.00	10.2

Based on the grading criteria for Hg in Whole Blood, 99% 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 #3, 2022:
Summary Figures

Whole Blood Hg

BE22-11

BE22-12

BE22-13

BE22-14

BE22-15

Legend:
o C/HHEAR 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.

Results for Event #3, 2022:
Summary Statistics

			Whole Blood Mn (µg/L)		
	BE22-11	**BE22-12**	**BE22-13**	**BE22-14**	**BE22-15**
Target (Robust Mean (x*))	14.3	28.2	15.6	16.1	17.2
Upper Limit	17.3	33.0	18.6	19.1	20.2
Lower Limit	11.3	23.4	12.6	13.1	14.2
Robust SD (s*)	2.6	3.0	1.0	1.2	1.2
Robust RSD (%)	18	11	6.4	7.5	7.0
Number of Sample Measurements (N)	10	10	10	10	10
Standard Uncertainty (u)	0.1	0.1	0.4	0.5	0.5

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 17.7 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 Laboratory Medicine 2016; 54(12): 1921-1928).

Results for Event #3, 2022:
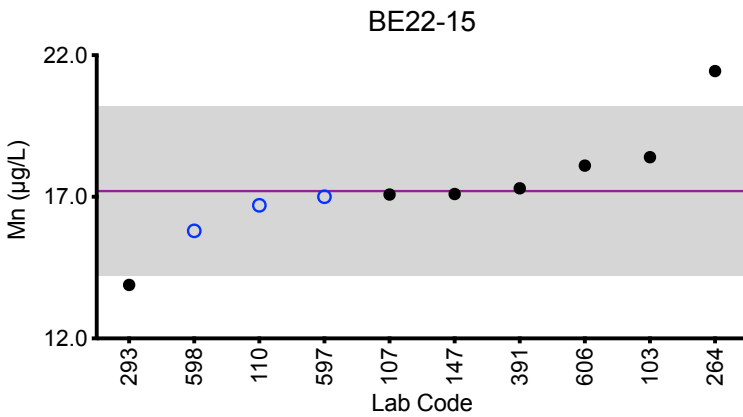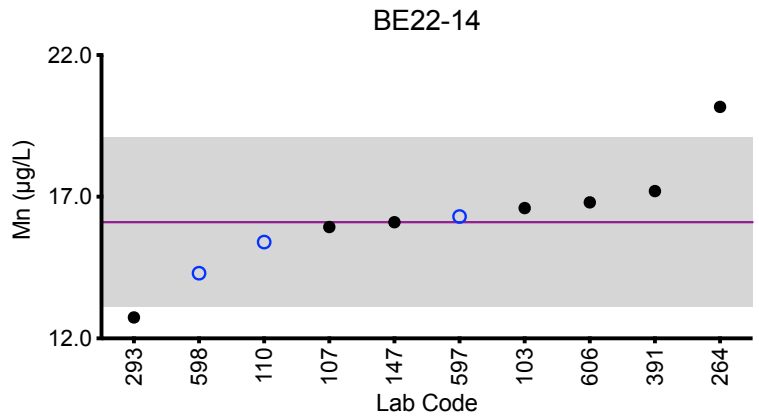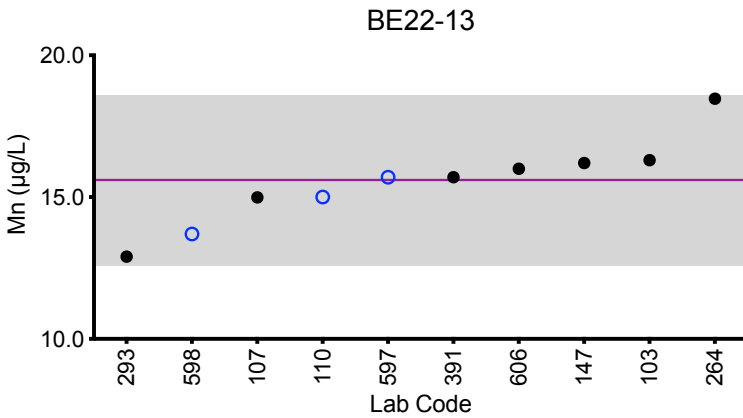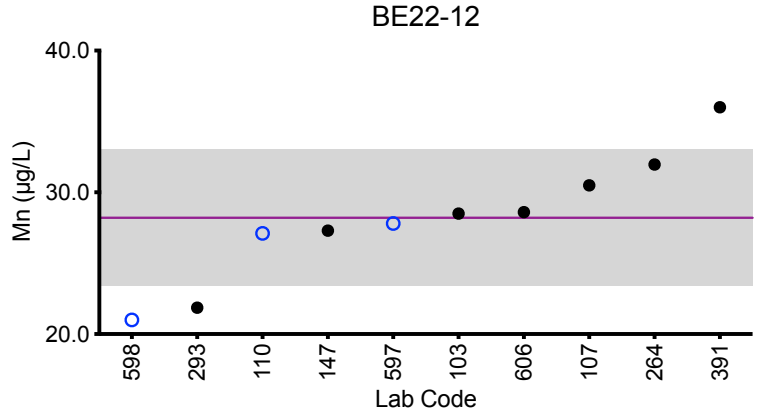## Performance of Participating Laboratories

		Whole Blood Mn (µg/L)				
Lab Code	**Method**	**BE22-11**	**BE22-12**	**BE22-13**	**BE22-14**	**BE22-15**
	Target	**14.3**	**28.2**	**15.6**	**16.1**	**17.2**
103	ICP-MS/MS	16.6	28.5	16.3	16.6	18.4
107	ICP-MS/MS	14.77	30.49	14.99	15.93	17.08
110	ICP-MS	13.0	27.1	15.0	15.4	16.7
147	ICP-MS	16.2	27.3	16.2	16.1	17.1
264	ICP-MS	17.28	31.96	18.47	20.17 ↑	21.44 ↑
293	DRC/CC-ICP-MS	9.45 ↓	21.86 ↓	12.90	12.74 ↓	13.89 ↓
391	ICP-MS	14.2	36.0 ↑	15.7	17.2	17.3
597	ICP-MS/MS	13.6	27.8	15.7	16.3	17.0
598	ICP-MS	1.37 ↓	21.0 ↓	13.7	14.3	15.8
606	ICP-MS/MS	16.1	28.6	16.0	16.8	18.1

Based on the grading criteria for Mn in Whole Blood, 82% of results were satisfactory, with 3 of the 10 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

Results for Event #3, 2022:
Summary Figures

Whole Blood Mn

BE22-11

BE22-12

BE22-13

BE22-14

BE22-15

Legend:
o C/HHEAR 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 17.7 µg/L.

Results for Event #3, 2022: Summary Statistics

Whole Blood Pb (µg/dL)					
	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
Target (Robust Mean (x*))	9.2	1.13	3.04	6.0	14.2
Upper Limit	11.2	3.13	5.04	8.0	16.2
Lower Limit	7.2	0.00	1.04	4.0	12.2
Robust SD (s*)	0.4	0.08	0.24	0.3	0.8
Robust RSD (%)	4.7	7.1	7.9	5.3	5.6
Number of Sample Measurements (N)	14	12	12	14	14
Standard Uncertainty (u)	0.1	0.03	0.08	0.1	0.3

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/dL 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. (https://clsi.org/standards/products/clinical-chemistry-and-toxicology/documents/c40/)

Results for Event #3, 2022:
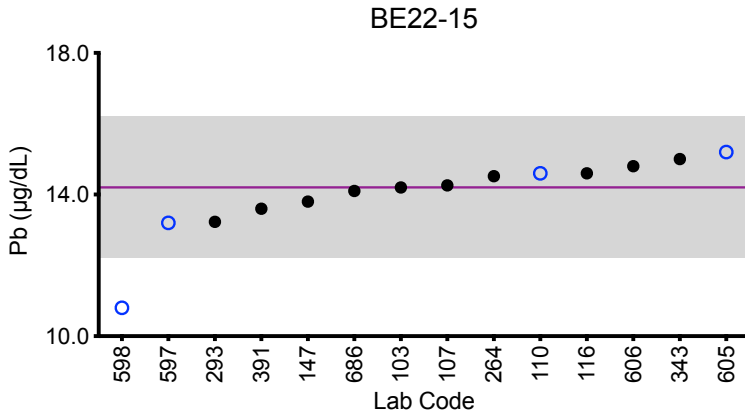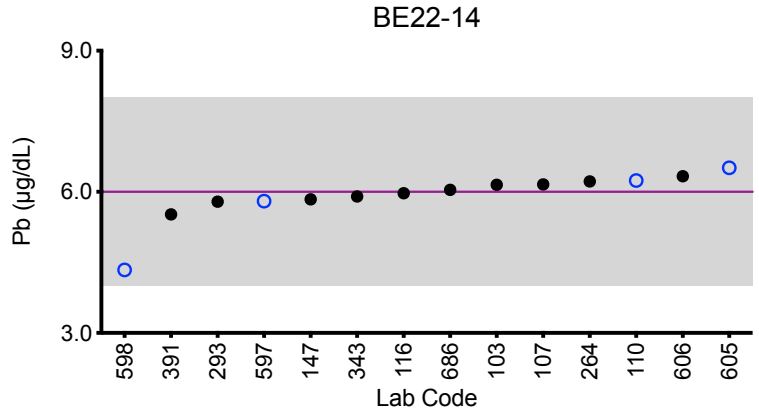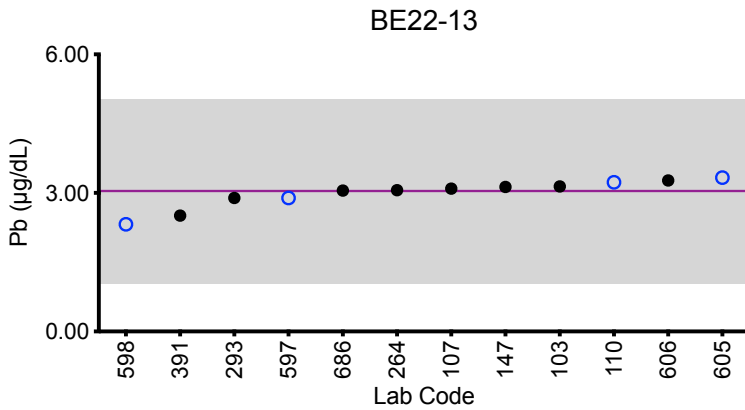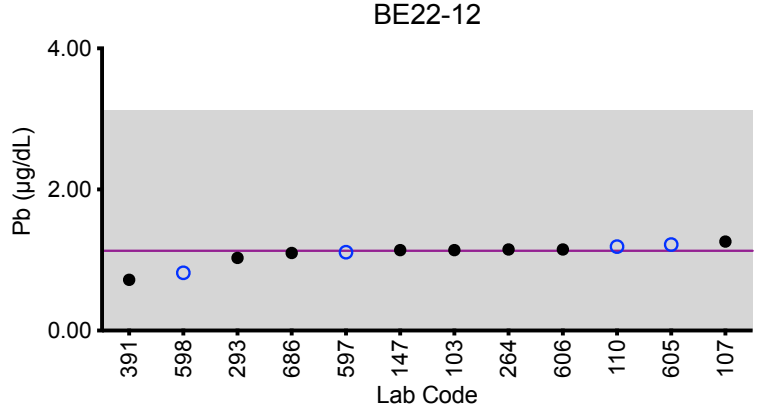# Performance of Participating Laboratories

		Whole Blood Pb (µg/dL)				
Lab Code	Method	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
	Target	9.2	1.13	3.04	6.0	14.2
103	ICP-MS/MS	9.20	1.14	3.14	6.15	14.2
107	ICP-MS/MS	9.518	1.261	3.092	6.156	14.258
110	ICP-MS	9.34	1.19	3.23	6.24	14.6
116	ICP-MS/MS	9.43	<3.00	<3.00	5.97	14.6
147	ICP-MS	9.01	1.14	3.13	5.84	13.8
264	ICP-MS	9.26	1.15	3.06	6.22	14.52
293	DRC/CC-ICP-MS	8.89	1.03	2.89	5.79	13.23
343	ASV-LeadCare	9.1	<3.3	<3.3	5.9	15.0
391	ETAAS-Z	7.33	0.72	2.51	5.52	13.6
597	ICP-MS/MS	8.48	1.11	2.89	5.80	13.2
598	ICP-MS	0.940 ↓	0.818	2.32	4.34	10.8 ↓
605	ICP-MS	9.570	1.22	3.33	6.51	15.2
606	ICP-MS/MS	10.0	1.15	3.27	6.33	14.8
686	ICP-MS	9.20	1.10	3.05	6.04	14.1

Based on the grading criteria for Pb in Whole Blood, 97% of results were satisfactory, with 1 of the 14 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

Results for Event #3, 2022:
Summary Figures

Whole Blood Pb

Legend:
○ C/HHEAR 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.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Whole Blood Mo (µg/L)

Lab Code	Method	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
103	ICP-MS/MS	6.78	1.69	11.4	4.95	3.23
147	ICP-MS	6.94	1.64	11.4	4.49	3.15
264	ICP-MS	11.26	<0.10	12.80	3.96	1.75
442	DRC/CC-ICP-MS	6.55	1.49	10.8	4.5	2.95
597	ICP-MS/MS	6.39	1.66	10.9	4.43	3.11
598	DRC/CC-ICP-MS	*0.542	1.35	8.12	3.42	2.45

Summary Statistics

	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
Arithmetic Mean ($\bar{x}$)	7.6	1.57	10.9	4.3	2.8
Arithmetic SD (s)	2.1	0.14	1.5	0.5	0.6
Arithmetic RSD (%)	28	8.9	14	12	21
Number of Sample Measurements (N)	5	5	6	6	6

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Summary Figures

Whole Blood Mo

Legend:
○ C/HHEAR 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 intended to be quality specifications and are included for informational purposes only.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Whole Blood Sb (µg/L)

Lab Code	Method	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
103	ICP-MS/MS	2.55	<0.150	1.02	<0.150	1.21
110	ICP-MS/MS	3.16	0.00	0.99	0.01	1.44
147	ICP-MS	3.21	<0.244	1.03	<0.244	1.42
264	ICP-MS	3.44	<0.10	1.08	<0.10	1.65
293	DRC/CC-ICP-MS	2.890	0.14	0.97	0.09	1.42
442	DRC/CC-ICP-MS	3.18	<1	<1	<1	1.25
597	ICP-MS/MS	3.10	0.116	1.10	0.0918	1.52
598	ICP-MS	*0.328	<0.2	0.801	<0.2	1.23

Summary Statistics

	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
Arithmetic Mean ($\bar{x}$)	3.1	NA	1.00	NA	1.39
Arithmetic SD (s)	0.3	NA	0.10	NA	0.15
Arithmetic RSD (%)	9.1	NA	10	NA	11
Number of Sample Measurements (N)	7	NA	7	NA	8

*Denotes a statistical Outlier.

Statistical data was not calculated for BE22-12 and BE22-14 based on a lack of consensus among participating labs.

Results for Event #3, 2022:
Summary Figures

Whole Blood Sb

BE22-11

BE22-12

BE22-13

BE22-14

BE22-15

Legend:
o C/HHEAR 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 intended to be quality specifications and are included for informational purposes only.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

		Whole Blood Se (µg/L)				
Lab Code	Method	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
103	ICP-MS/MS	149	134	253	305	381
107	ICP-MS/MS	163.9	149.3	268.7	326.9	408.0
110	ICP-MS/MS	153	131	235	296	372
147	ICP-MS	152	130	253	280	361
264	ICP-MS	162.12	140.87	255.53	320.46	399.02
293	DRC/CC-ICP-MS	126	127	240	284	375
597	ICP-MS/MS	143	130	239	290	368
598	DRC/CC-ICP-MS	149	133	239	308	362

Summary Statistics					
	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
Arithmetic Mean ($\overline{x}$)	150	134	248	301	378
Arithmetic SD (s)	12	7	12	17	17
Arithmetic RSD (%)	7.9	5.2	4.8	5.6	4.5
Number of Sample Measurements (N)	8	8	8	8	8

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Summary Figures

Whole Blood Se

BE22-11

BE22-12

BE22-13

BE22-14

BE22-15

Legend:
○ C/HHEAR 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 intended to be quality specifications and are included for informational purposes only.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Whole Blood Tl (µg/L)

Lab Code	Method	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
103	ICP-MS/MS	2.62	1.17	0.262	1.99	0.787
110	ICP-MS/MS	2.62	1.16	0.25	1.99	0.81
147	ICP-MS	2.58	1.13	0.243	1.87	0.799
264	ICP-MS	2.61	1.13	0.24	2.04	0.82
293	DRC/CC-ICP-MS	2.56	1.13	0.24	1.96	0.76
391	ICP-MS	2.61	*1.52	0.229	1.94	0.748
597	ICP-MS/MS	2.45	1.15	0.248	1.90	0.777
598	ICP-MS	*0.305	1.13	0.233	*1.47	0.696

Summary Statistics

	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
Arithmetic Mean ($\bar{x}$)	2.58	1.143	0.243	1.96	0.78
Arithmetic SD (s)	0.06	0.017	0.010	0.06	0.04
Arithmetic RSD (%)	2.3	1.5	4.1	3.1	5.2
Number of Sample Measurements (N)	7	7	8	7	8

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Summary Figures

Whole Blood Tl

BE22-11

BE22-12

BE22-13

BE22-14

BE22-15

Legend:
○ C/HHEAR 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 intended to be quality specifications and are included for informational purposes only.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Whole Blood U (µg/L)

Lab Code	Method	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
103	ICP-MS/MS	0.216	0.0786	0.208	<0.0500	0.142
110	ICP-MS/MS	0.231	0.0842	0.207	0.0488	0.144
147	ICP-MS	0.216	0.0748	0.208	0.0450	0.135
391	ICP-MS	0.238	0.106	0.246	0.039	0.160
597	ICP-MS/MS	0.215	0.0745	0.191	0.0447	0.138
598	ICP-MS	<0.2	0.107	0.179	<0.2	0.134

Summary Statistics

	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
Arithmetic Mean ($\bar{x}$)	0.223	0.088	0.206	0.044	0.142
Arithmetic SD (s)	0.011	0.015	0.023	0.004	0.010
Arithmetic RSD (%)	4.9	17	11	9.1	6.7
Number of Sample Measurements (N)	5	6	6	4	6

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Summary Figures

Whole Blood U

BE22-11

BE22-12

BE22-13

BE22-14

BE22-15

Legend:
○ C/HHEAR 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 intended to be quality specifications and are included for informational purposes only.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Whole Blood Ba (µg/L)						
Lab Code	Method	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
110	ICP-MS/MS	10.1	1.73	5.84	6.23	11.9
147	ICP-MS	10.6	1.68	4.44	5.65	11.1
597	ICP-MS/MS	9.01	2.11	4.66	5.73	11.5
598	ICP-MS	*0.991	1.98	3.64	4.94	9.75
Summary Statistics						
		BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
Arithmetic Mean ($\bar{x}$)		9.9	1.9	4.6	5.6	11.1
Arithmetic SD (s)		0.8	0.2	0.9	0.5	0.9
Arithmetic RSD (%)		8.1	11	20	8.9	8.1
Number of Sample Measurements (N)		3	4	4	4	4

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

		Whole Blood Be (µg/L)				
Lab Code	**Method**	**BE22-11**	**BE22-12**	**BE22-13**	**BE22-14**	**BE22-15**
110	ICP-MS/MS	2.20	4.16	6.22	0.97	3.31
147	ICP-MS	1.94	3.63	5.28	<0.991	2.75
597	ICP-MS/MS	1.98	4.03	5.79	0.967	2.97
598	ICP-MS	*0.180	2.08	4.62	0.676	2.52
	Summary Statistics					
		BE22-11	**BE22-12**	**BE22-13**	**BE22-14**	**BE22-15**
Arithmetic Mean ($\bar{x}$)		2.04	3.5	5.5	0.87	2.9
Arithmetic SD (s)		0.14	1.0	0.7	0.15	0.3
Arithmetic RSD (%)		6.9	29	13	17	10
Number of Sample Measurements (N)		3	4	4	4	4

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Whole Blood Bi (µg/L)

Lab Code	Method	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
147	ICP-MS	0.0974	<0.0334	<0.0334	<0.0334	<0.0334
597	ICP-MS/MS	0.0694	<0.0374	<0.0374	<0.0374	<0.0374

Summary Statistics

	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
Arithmetic Mean ($\bar{x}$)	0.08	NA	NA	NA	NA
Arithmetic SD (s)	0.02	NA	NA	NA	NA
Arithmetic RSD (%)	24	NA	NA	NA	NA
Number of Sample Measurements (N)	2	NA	NA	NA	NA

*Denotes a statistical Outlier.

Statistical data was not calculated for BE22-12, BE22-13, BE22-14, and BE22-15 based on a lack of consensus among participating labs.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Whole Blood Cs (µg/L)						
Lab Code	Method	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
110	ICP-MS/MS	2.70	1.69	1.65	2.39	2.24
147	ICP-MS	2.74	1.59	1.59	2.29	2.17
597	ICP-MS/MS	2.49	1.61	1.56	2.35	2.18
598	ICP-MS	*0.289	1.23	1.27	1.70	1.78
Summary Statistics						
		BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
Arithmetic Mean ($\bar{x}$)		2.64	1.5	1.52	2.2	2.1
Arithmetic SD (s)		0.13	0.2	0.17	0.3	0.2
Arithmetic RSD (%)		4.9	13	11	14	10
Number of Sample Measurements (N)		3	4	4	4	4

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Whole Blood Cu (µg/L)

Lab Code	Method	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
110	ICP-MS/MS	1200	946	2480	1810	771
147	ICP-MS	1213	953	2440	1722	769
597	ICP-MS/MS	1200	992	2430	1790	784
598	DRC/CC-ICP-MS	1260	1020	2540	1770	761

Summary Statistics

	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
Arithmetic Mean ($\overline{x}$)	1218	980	2470	1770	771
Arithmetic SD (s)	29	30	50	40	10
Arithmetic RSD (%)	2.4	3.1	2.0	2.3	1.3
Number of Sample Measurements (N)	4	4	4	4	4

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Whole Blood Ni (µg/L)					
Lab Code	**Method**	**BE22-11**	**BE22-12**	**BE22-13**	**BE22-14**	**BE22-15**
110	ICP-MS/MS	2.2	12.2	5.2	10.2	12.7
147	ICP-MS	2.72	11.6	5.14	9.69	11.9
597	ICP-MS/MS	1.73	11.7	4.88	9.66	12.0
598	DRC/CC-ICP-MS	<2.0	9.43	3.65	6.70	8.57

Summary Statistics					
	BE22-11	**BE22-12**	**BE22-13**	**BE22-14**	**BE22-15**
Arithmetic Mean ($\overline{x}$)	2.2	11.2	4.7	9.1	11.3
Arithmetic SD (s)	0.5	1.2	0.7	1.6	1.8
Arithmetic RSD (%)	23	11	15	18	16
Number of Sample Measurements (N)	3	4	4	4	4

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Whole Blood Pt (μg/L)						
Lab Code	**Method**	**BE22-11**	**BE22-12**	**BE22-13**	**BE22-14**	**BE22-15**
110	ICP-MS/MS	1.25		0.229	2.17	0.484
293	DRC/CC-ICP-MS	1.010	0.140	0.21	1.85	0.16
598	ICP-MS	*0.151	0.160	0.216	1.62	0.263
Summary Statistics						
		BE22-11	**BE22-12**	**BE22-13**	**BE22-14**	**BE22-15**
Arithmetic Mean (x̄)		1.1	0.15	0.218	1.9	NA
Arithmetic SD (s)		0.2	0.01	0.010	0.3	NA
Arithmetic RSD (%)		15	9.3	4.6	16	NA
Number of Sample Measurements (N)		2	2	3	3	NA

*Denotes a statistical Outlier.

Statistical data was not calculated for BE22-15 based on a lack of consensus among participating labs.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Whole Blood Sn (µg/L)						
Lab Code	Method	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
110	ICP-MS/MS	5.4	7.8	0.5	2.6	1.0
147	ICP-MS	5.31	7.57	0.382	2.42	0.867
597	ICP-MS/MS	5.04	7.67	0.389	2.43	0.898
598	ICP-MS	*0.507	6.03	0.302	1.86	0.662
Summary Statistics						
		BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
Arithmetic Mean ($\bar{x}$)		5.3	7.3	0.39	2.3	0.86
Arithmetic SD (s)		0.2	0.8	0.08	0.3	0.14
Arithmetic RSD (%)		3.6	11	21	13	16
Number of Sample Measurements (N)		3	4	4	4	4

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Whole Blood Sr (µg/L)

Lab Code	Method	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
103	ICP-MS/MS	13.0	26.6	27.8	28.3	31.0
147	ICP-MS	12.7	24.7	26.6	26.2	28.7
597	ICP-MS/MS	13.0	25.5	26.8	27.3	29.5

Summary Statistics

	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
Arithmetic Mean ($\bar{x}$)	12.9	25.6	27.1	27.3	29.7
Arithmetic SD (s)	0.2	1.0	0.6	1.1	1.2
Arithmetic RSD (%)	1.3	3.9	2.2	3.9	3.9
Number of Sample Measurements (N)	3	3	3	3	3

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

		Whole Blood Ti (µg/L)				
Lab Code	**Method**	**BE22-11**	**BE22-12**	**BE22-13**	**BE22-14**	**BE22-15**
200	DRC/CC-ICP-MS	5.7	4.3	4.6	9.2	11.6
597	ICP-MS/MS	5.01	3.69	2.68	8.73	11.8
		Summary Statistics				
		BE22-11	**BE22-12**	**BE22-13**	**BE22-14**	**BE22-15**
Arithmetic Mean ($\bar{x}$)		5.4	4.0	NA	9.0	11.7
Arithmetic SD (s)		0.5	0.4	NA	0.3	0.1
Arithmetic RSD (%)		9.3	10	NA	3.3	1.2
Number of Sample Measurements (N)		2	2	NA	2	2

*Denotes a statistical Outlier.

Statistical data was not calculated for BE22-13 based on a lack of consensus among participating labs.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Whole Blood V (µg/L)

Lab Code	Method	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
110	ICP-MS/MS	6.45	0.82	2.60	3.78	1.51
147	DRC/CC-ICP-MS	6.38	0.786	2.57	3.58	1.44
597	ICP-MS/MS	6.00	0.834	2.52	3.63	1.49
598	DRC/CC-ICP-MS	*0.532	0.638	2.25	2.63	1.25

Summary Statistics

	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
Arithmetic Mean ($\bar{x}$)	6.3	0.77	2.48	3.4	1.42
Arithmetic SD (s)	0.2	0.09	0.16	0.5	0.12
Arithmetic RSD (%)	3.8	12	6.5	15	8.5
Number of Sample Measurements (N)	3	4	4	4	4

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Whole Blood W (µg/L)

Lab Code	Method	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
110	ICP-MS/MS	0.60	0.17	0.88	0.78	1.17
597	ICP-MS/MS	0.487	0.170	0.851	0.711	1.09
598	ICP-MS	<0.2	<0.2	0.694	0.551	0.851

Summary Statistics

	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
Arithmetic Mean ($\overline{x}$)	0.54	0.17	0.81	0.68	1.0
Arithmetic SD (s)	0.08	0.00	0.10	0.12	0.2
Arithmetic RSD (%)	15	0.0	12	18	16
Number of Sample Measurements (N)	2	2	3	3	3

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

		Whole Blood Zn (µg/L)				
Lab Code	Method	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
110	ICP-MS/MS	6990	5920	5110	5580	5020
147	ICP-MS	6667	5614	4980	5059	4758
597	ICP-MS/MS	6610	5850	5000	5360	4880
598	DRC/CC-ICP-MS	7240	6380	5400	5680	4960
	Summary Statistics					
		BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
Arithmetic Mean (x̄)		6880	5900	5120	5420	4900
Arithmetic SD (s)		290	300	190	280	110
Arithmetic RSD (%)		4.2	5.1	3.7	5.2	2.2
Number of Sample Measurements (N)		4	4	4	4	4

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Additional Elements in Whole Blood

Whole Blood Ag (µg/L)

Lab Code	Method	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
147	ICP-MS	<0.151	0.272	<0.151	<0.151	<0.151

Whole Blood Al (µg/L)

Lab Code	Method	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
147	ICP-MS	<4.86	<4.86	<4.86	<4.86	<4.86
597	ICP-MS/MS	<7.16	<7.16	<7.16	<7.16	<7.16

Whole Blood I (µg/L)

Lab Code	Method	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
147	ICP-MS	25.7	25.9	28.9	35.2	38.7

Whole Blood Li (µg/L)

Lab Code	Method	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
147	ICP-MS	1.06	1.09	1.92	1.27	1.43

Whole Blood Mg (µg/L)

Lab Code	Method	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
597	ICP-MS/MS	33800	30600	28500	32800	30800

Whole Blood Te (µg/L)

Lab Code	Method	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
147	ICP-MS	<0.0561	<0.0561	<0.0561	<0.0561	<0.0561

Whole Blood Th (µg/L)

Lab Code	Method	BE22-11	BE22-12	BE22-13	BE22-14	BE22-15
147	ICP-MS	<0.0255	<0.0255	<0.0255	<0.0255	<0.0255
597	ICP-MS/MS	0.0107	<0.0105	<0.0105	<0.0105	<0.0105

Event #3, 2022

Trace Elements in Urine

New York State Department of Health | Wadsworth Center

Event #3, 2022:
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 into five separate 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), titanium (Ti), vanadium (V), tungsten (W), and zinc (Zn). 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 (a) the robust mean calculated from data reported by all laboratories, or (b) if a robust mean is not possible, the arithmetic mean after outlier deletion.

Additional Elements

An additional 22 elements were reported by at least one participant: Ag, Al, Bi, Cs, Cu, Fe, I, Li, Mg, Mo, Ni, Pt, Sb, Se, Sn, Sr, Te, Th, Ti, 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.

Results for Event #3, 2022:
Summary Statistics

Urine As (µg/L)					
	UE22-11	**UE22-12**	**UE22-13**	**UE22-14**	**UE22-15**
Target (Robust Mean (x*))	101.7	2.13	37.7	17.6	84.6
Upper Limit	122.0	8.13	45.2	23.6	101.5
Lower Limit	81.4	0.00	30.2	11.6	67.7
Robust SD (s*)	3.5	0.25	0.7	0.6	3.0
Robust RSD (%)	3.4	12	1.9	3.4	3.5
Number of Sample Measurements (N)	17	14	17	17	17
Standard Uncertainty (u)	0.1	0.08	0.2	0.2	0.9

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 #3, 2022:
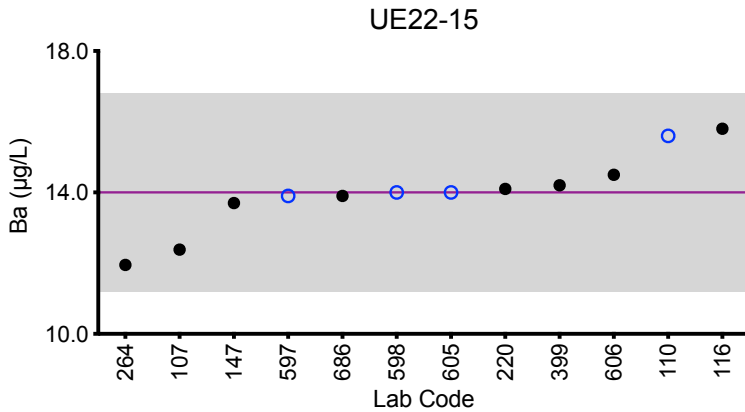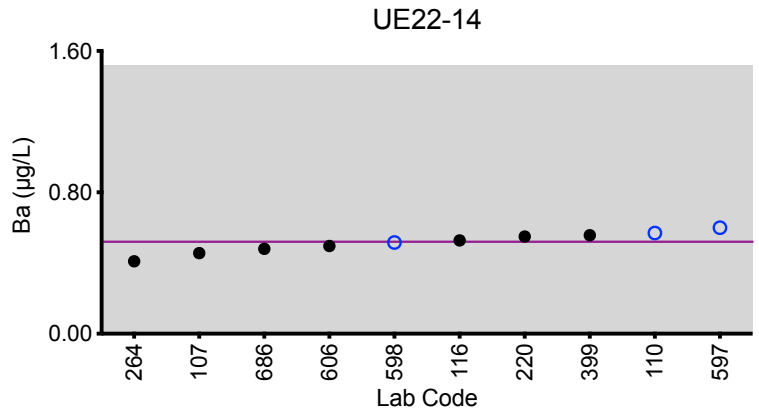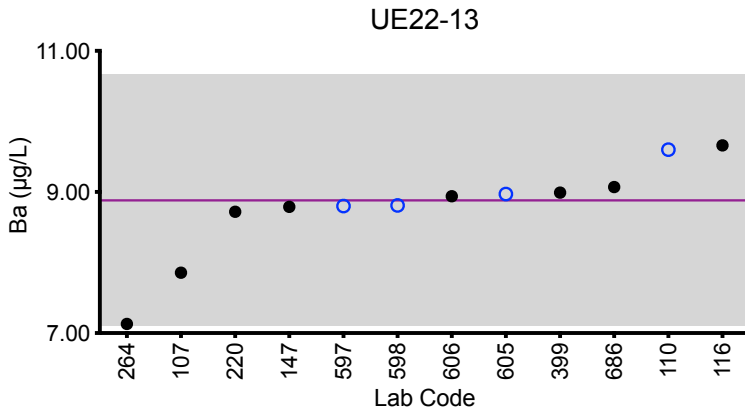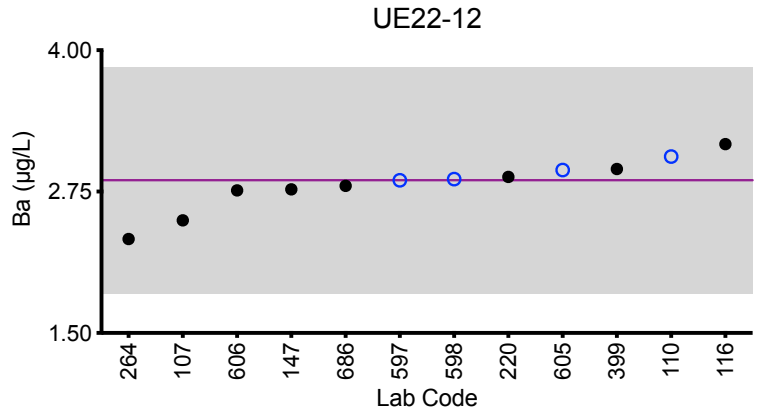# Performance of Participating Laboratories

		Urine As (µg/L)				
Lab Code	Method	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
	Target	101.7	2.13	37.7	17.6	84.6
103	ICP-MS/MS	103	2.05	37.4	17.3	85.2
107	DRC/CC-ICP-MS	99.92	1.81	33.87	16.61	79.04
110	DRC/CC-ICP-MS	108	2.10	39.4	18.3	91.2
116	ICP-MS/MS	103	<5.00	38.4	16.9	84.2
147	ICP-MS	105	1.61	37.2	17.5	86.1
220	DRC/CC-ICP-MS	103	2.27	38.3	18.3	86.2
264	ICP-MS	109.47	2.09	41.61	19.04	94.53
293	DRC/CC-ICP-MS	97.64	3.56	37.49	17.29	80.46
324	ICP-MS	102.180	2.093	37.492	17.777	86.116
391	ICP-MS	93.4	6.16	38.6	21.3	80.6
399	DRC/CC-ICP-MS	102	2.01	37.2	17.5	83.5
442	ICP-MS/MS	103	1.98	37.9	17.6	84.4
597	ICP-MS/MS	101	2.36	37.3	17.5	84.4
598	DRC/CC-ICP-MS	97.8	2.70	38.0	18.1	87.1
605	ICP-MS	103	2.01	37.6	17.6	84.4
606	ICP-MS/MS	99.8	<2.00	37.4	17.6	87.1
686	DRC/CC-ICP-MS	81.1 ↓	<6.00	34.6	16.0	81.8

Based on the grading criteria for As in Urine, 99% of results were satisfactory, with 0 of the 17 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

Results for Event #3, 2022:
Summary Figures

Urine As

Results for Event #3, 2022:
Summary Statistics

	Urine Ba (µg/L)				
	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
Target (Robust Mean (x*))	4.69	2.85	8.88	0.52	14.0
Upper Limit	5.69	3.85	10.66	1.52	16.8
Lower Limit	3.69	1.85	7.10	0.00	11.2
Robust SD (s*)	0.16	0.15	0.23	0.06	0.4
Robust RSD (%)	3.4	5.3	2.6	12	2.9
Number of Sample Measurements (N)	12	12	12	10	12
Standard Uncertainty (u)	0.06	0.05	0.08	0.02	0.2

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.

		Urine Ba (µg/L)				
Lab Code	**Method**	**UE22-11**	**UE22-12**	**UE22-13**	**UE22-14**	**UE22-15**
	Target	**4.69**	**2.85**	**8.88**	**0.52**	**14.0**
107	ICP-MS	4.346	2.496	7.856	0.456	12.382
110	ICP-MS	4.95	3.06	9.60	0.57	15.6
116	ICP-MS/MS	5.17	3.17	9.66	0.528	15.8
147	ICP-MS	4.71	2.77	8.79	<0.659	13.7
220	ICP-MS	4.63	2.88	8.72	0.55	14.1
264	ICP-MS	3.74	2.33	7.13	0.41	11.95
399	ICP-MS/MS	4.70	2.95	8.99	0.557	14.2
597	ICP-MS/MS	4.81	2.85	8.80	0.600	13.9
598	ICP-MS	4.68	2.86	8.81	0.516	14.0
605	ICP-MS	4.79	2.94	8.97	<0.600	14.0
606	ICP-MS/MS	4.60	2.76	8.94	0.496	14.5
686	ICP-MS	4.62	2.80	9.07	0.480	13.9

Based on the grading criteria for Ba in Urine, 100% 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 #3, 2022:
Summary Figures

Urine Ba

UE22-11

UE22-12

UE22-13

UE22-14

UE22-15

Legend:
o C/HHEAR 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.

Results for Event #3, 2022: Summary Statistics

	Urine Be (µg/L)				
	UE22-11	**UE22-12**	**UE22-13**	**UE22-14**	**UE22-15**
Target (Robust Mean (x*))	5.46	3.47	4.00	2.35	6.8
Upper Limit	6.55	4.47	5.00	3.35	8.1
Lower Limit	4.37	2.47	3.00	1.35	5.4
Robust SD (s*)	0.14	0.25	0.22	0.14	0.3
Robust RSD (%)	2.6	7.2	5.5	6.0	4.7
Number of Sample Measurements (N)	12	12	12	12	12
Standard Uncertainty (u)	0.05	0.09	0.08	0.05	0.1

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.

Results for Event #3, 2022:
Performance of Participating Laboratories

		Urine Be (µg/L)				
Lab Code	Method	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
	Target	5.46	3.47	4.00	2.35	6.8
107	ICP-MS	5.386	3.217	3.755	2.261	6.516
110	ICP-MS	5.46	3.57	4.01	2.36	6.79
116	ICP-MS/MS	4.88	3.21	3.64	2.08	6.05
147	ICP-MS	6.15	3.82	4.35	2.49	7.27
220	ICP-MS	5.44	3.48	3.96	2.33	6.73
264	ICP-MS	4.75	3.07	3.51	2.11	6.51
293	ICP-MS	5.52	3.43	3.95	2.38	6.7
399	ICP-MS/MS	5.37	3.53	4.04	2.33	6.78
597	ICP-MS/MS	5.50	3.69	4.16	2.42	6.78
598	ICP-MS	5.72	3.36	4.26	2.49	7.50
605	ICP-MS	5.96	3.74	4.11	2.53	7.00
686	ICP-MS	5.40	3.50	4.00	2.26	6.58

Based on the grading criteria for Be in Urine, 100% 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 #3, 2022:
Summary Figures

Urine Be

UE22-11

UE22-12

UE22-13

UE22-14

UE22-15

Legend:
○ C/HHEAR 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.

Results for Event #3, 2022:
Summary Statistics

Urine Cd (µg/L)					
	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
Target (Robust Mean (x^*))	1.80	1.43	3.23	0.71	0.48
Upper Limit	2.80	2.43	4.23	1.71	1.48
Lower Limit	0.80	0.43	2.23	0.00	0.00
Robust SD (s^*)	0.08	0.06	0.11	0.04	0.04
Robust RSD (%)	4.4	4.2	3.4	6.0	8.8
Number of Sample Measurements (N)	17	17	17	16	15
Standard Uncertainty (u)	0.02	0.02	0.03	0.01	0.01

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.

Results for Event #3, 2022:
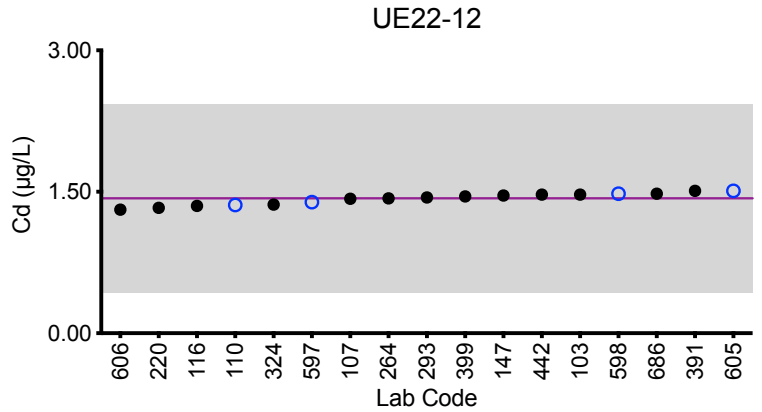## Performance of Participating Laboratories

		Urine Cd (µg/L)				
Lab Code	Method	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
	Target	1.80	1.43	3.23	0.71	0.48
103	ICP-MS/MS	1.79	1.47	3.28	0.747	0.484
107	DRC/CC-ICP-MS	1.782	1.426	3.357	0.680	0.437
110	ICP-MS	1.70	1.36	3.13	0.717	0.465
116	ICP-MS/MS	1.76	1.35	3.08	0.655	0.355
147	ICP-MS	1.82	1.46	3.29	0.705	0.434
220	ICP-MS	1.77	1.33	3.00	0.69	0.51
264	ICP-MS	1.85	1.43	3.37	0.74	0.50
293	DRC/CC-ICP-MS	1.75	1.44	3.23	0.73	0.48
324	ICP-MS	1.885	1.364	3.166	<1	<1
391	ICP-MS	2.16	1.51	3.26	0.66	0.49
399	DRC/CC-ICP-MS	1.78	1.45	3.25	0.703	0.454
442	ICP-MS/MS	1.96	1.47	3.24	0.816	0.54
597	ICP-MS/MS	1.75	1.39	3.20	0.691	0.483
598	DRC/CC-ICP-MS	1.73	1.48	3.17	0.668	0.543
605	ICP-MS	1.87	1.51	3.26	0.748	0.464
606	ICP-MS/MS	1.64	1.31	2.99	0.703	0.421
686	ICP-MS	1.89	1.48	3.37	0.786	<0.600

Based on the grading criteria for Cd in Urine, 100% of results were satisfactory, with 0 of the 17 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

Results for Event #3, 2022:
Summary Figures

Urine Cd

UE22-11

UE22-12

UE22-13

UE22-14

UE22-15

Legend:
○ C/HHEAR 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.

Results for Event #3, 2022:
Summary Statistics

	Urine Co (µg/L)				
	UE22-11	**UE22-12**	**UE22-13**	**UE22-14**	**UE22-15**
Target (Robust Mean (x*))	6.88	0.755	3.65	88.9	27.3
Upper Limit	8.38	2.255	5.15	102.2	31.4
Lower Limit	5.38	0.000	2.15	75.6	23.2
Robust SD (s*)	0.16	0.022	0.14	2.1	0.6
Robust RSD (%)	2.3	2.9	3.8	2.4	2.2
Number of Sample Measurements (N)	14	13	14	14	14
Standard Uncertainty (u)	0.05	0.007	0.05	0.7	0.2

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

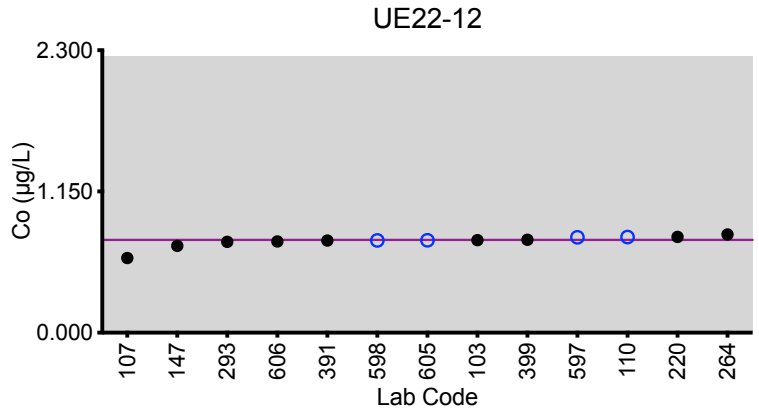# Results for Event #3, 2022:
Performance of Participating Laboratories

Lab Code	Method	Urine Co (µg/L)				
		UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
	Target	**6.88**	**0.755**	**3.65**	**88.9**	**27.3**
103	ICP-MS/MS	6.97	0.754	3.67	89.9	27.6
107	ICP-MS	6.308	0.608	3.119	79.974	26.283
110	ICP-MS	7.00	0.779	3.76	91.6	28.3
147	ICP-MS	6.72	0.707	3.52	75.8	27.2
220	ICP-MS	6.89	0.78	3.71	89.2	27.7
264	ICP-MS	7.52	0.80	3.94	95.80	30.14
293	DRC/CC-ICP-MS	6.83	0.74	3.52	87.44	28.34
324	ICP-MS	6.752	<1	3.584	89.329	26.943
391	ICP-MS	6.84	0.75	3.49	86.6	25.8
399	DRC/CC-ICP-MS	7.08	0.757	3.69	87.9	27.3
597	ICP-MS/MS	6.97	0.777	3.86	90.6	27.1
598	ICP-MS	6.89	0.751	3.70	88.1	27.4
605	ICP-MS	6.93	0.752	3.62	89.6	27.1
606	ICP-MS/MS	6.66	0.743	3.65	89.4	27.3

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 #3, 2022:
Summary Figures

Urine Co

UE22-11

UE22-12

UE22-13

UE22-14

UE22-15

Legend:
○ C/HHEAR 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.

Results for Event #3, 2022:
Summary Statistics

	Urine Cr (µg/L)				
	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
Target (Robust Mean (x*))	12.7	8.3	2.02	0.45	5.8
Upper Limit	15.7	11.3	5.02	3.45	8.8
Lower Limit	9.7	5.3	0.00	0.00	2.8
Robust SD (s*)	0.3	0.4	0.26	0.07	0.4
Robust RSD (%)	2.7	4.8	13	16	6.9
Number of Sample Measurements (N)	12	12	12	8	12
Standard Uncertainty (u)	0.1	0.2	0.09	NA	0.1

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

An arithmetic mean, SD, RSD and n are provided for sample UE22-14.

Results for Event #3, 2022:
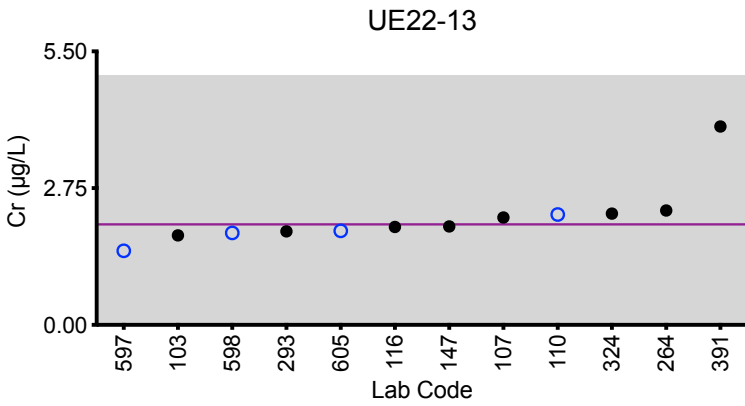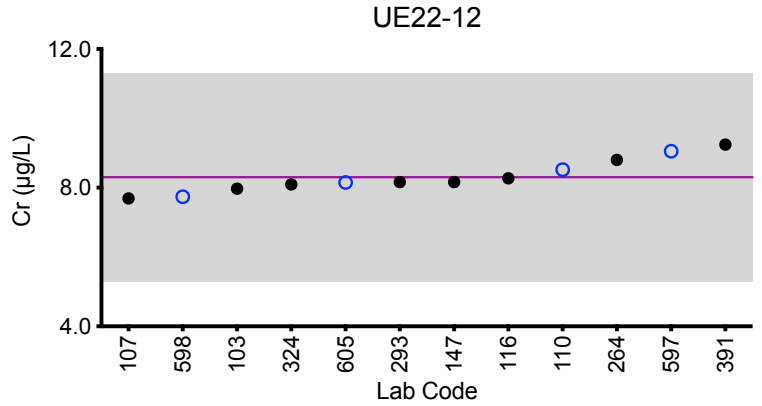# Performance of Participating Laboratories

		Urine Cr (µg/L)				
Lab Code	**Method**	**UE22-11**	**UE22-12**	**UE22-13**	**UE22-14**	**UE22-15**
	Target	**12.7**	**8.3**	**2.02**	**0.45**	**5.8**
103	ICP-MS/MS	12.2	7.97	1.80	<0.600	4.79
107	DRC/CC-ICP-MS	12.51	7.69	2.16	0.46	5.47
110	DRC/CC-ICP-MS	12.8	8.52	2.22	0.55	6.19
116	ICP-MS/MS	12.5	8.27	1.97	0.362	5.69
147	DRC/CC-ICP-MS	12.9	8.16	1.98	0.471	5.56
264	ICP-MS	13.51	8.80	2.30	0.56	6.51
293	DRC/CC-ICP-MS	12.57	8.16	1.88	0.42	6.03
324	ICP-MS	12.784	8.094	2.237	<1	6.037
391	ICP-MS	13.1	9.24	3.99	*1.79	6.80
597	ICP-MS/MS	12.8	9.05	1.49	<1.25	5.68
598	DRC/CC-ICP-MS	11.8	7.74	1.85	0.407	5.62
605	ICP-MS	12.4	8.15	1.89	0.403	5.66

Based on the grading criteria for Cr in Urine, 100% of results were satisfactory, with 0 of the 12 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

Urine Cr

Legend:
o C/HHEAR 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.

Results for Event #3, 2022: Summary Statistics

	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
Urine Hg (µg/L)					
Target (Robust Mean (x^*))	56	5.1	21.5	1.49	9.3
Upper Limit	73	8.1	28.0	4.49	12.3
Lower Limit	39	2.1	15.1	0.00	6.3
Robust SD (s^*)	7	0.4	2.5	0.16	1.2
Robust RSD (%)	13	8.2	12	11	13
Number of Sample Measurements (N)	13	14	14	14	14
Standard Uncertainty (u)	2	0.1	0.8	0.05	0.4

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.

Results for Event #3, 2022:
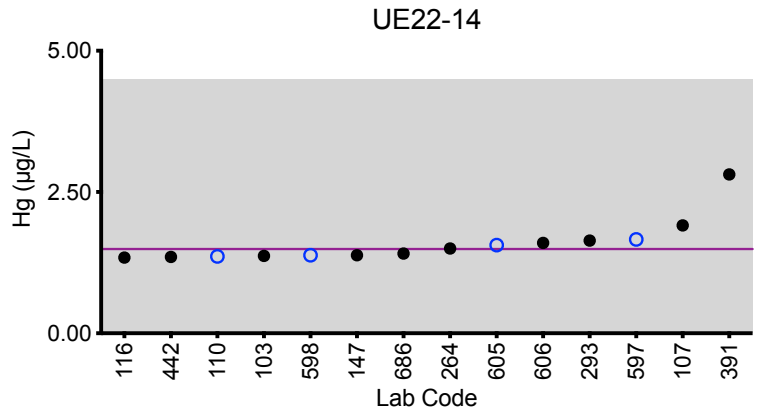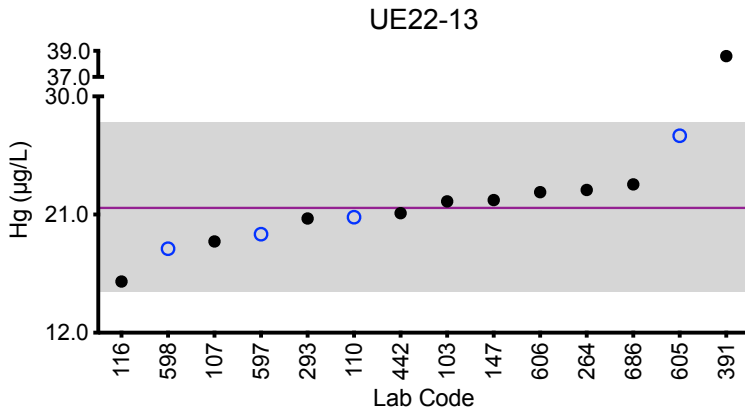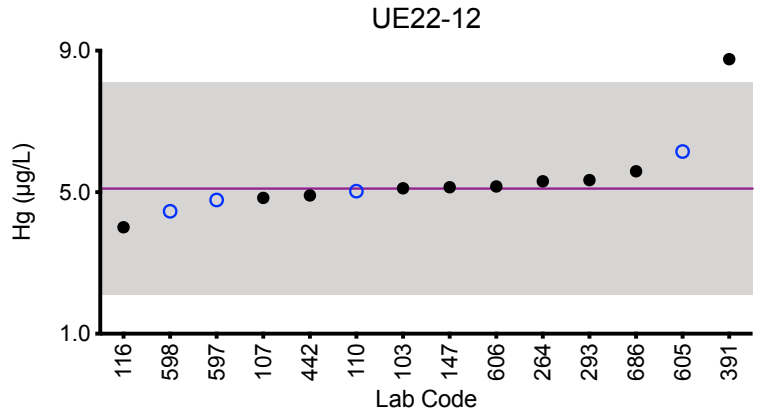## Performance of Participating Laboratories

Lab Code	Method	Urine Hg (µg/L)				
		UE22-11	**UE22-12**	**UE22-13**	**UE22-14**	**UE22-15**
	Target	**56**	**5.1**	**21.5**	**1.49**	**9.3**
103	ICP-MS/MS	58.0	5.11	22.0	1.37	9.28
107	DRC/CC-ICP-MS	61.29	4.84	18.95	1.91	11.04
110	ICP-MS	56.0	5.03	20.8	1.36	9.09
116	ICP-MS/MS	44.6	4.01	15.9	1.34	7.01
147	ICP-MS	48.7	5.14	22.1	1.38	8.71
264	ICP-MS	57.32	5.31	22.87	1.50	9.85
293	DRC/CC-ICP-MS	59.89	5.34	20.7	1.64	9.31
391	ICP-MS	108 ↑	8.76 ↑	38.6 ↑	2.81	15.9 ↑
442	ICP-MS/MS	54.3	4.91	21.1	1.35	9
597	ICP-MS/MS	46.5	4.78	19.5	1.66	8.33
598	ICP-MS	38.6 ↓	4.46	18.4	1.38	8.00
605	ICP-MS	61.2	6.15	27.0	1.56	10.8
606	ICP-MS/MS	>50.0	5.16	22.7	1.60	9.02
686	ICP-MS	61.6	5.59	23.3	1.41	10.2

Based on the grading criteria for Hg in Urine, 93% of results were satisfactory, with 1 of the 14 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

Results for Event #3, 2022:
Summary Figures

Urine Hg

UE22-11

UE22-12

UE22-13

UE22-14

UE22-15

Legend:
○ C/HHEAR 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.

Results for Event #3, 2022:
Summary Statistics

	Urine Mn (µg/L)				
	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
Target (Robust Mean (x*))	8.8	1.54	7.6	5.22	2.62
Upper Limit	11.0	2.09	9.5	6.53	3.28
Lower Limit	6.6	0.99	5.7	3.92	1.97
Robust SD (s*)	0.5	0.10	0.4	0.27	0.21
Robust RSD (%)	5.7	6.5	5.8	5.2	8.0
Number of Sample Measurements (N)	14	14	14	14	14
Standard Uncertainty (u)	0.2	0.03	0.1	0.09	0.07

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. An assessment of clinical laboratory performance for the determination of manganese in blood and urine. Clinical Chemistry and Laboratory Medicine.2016; 54(12): 1921-1928).

Results for Event #3, 2022:
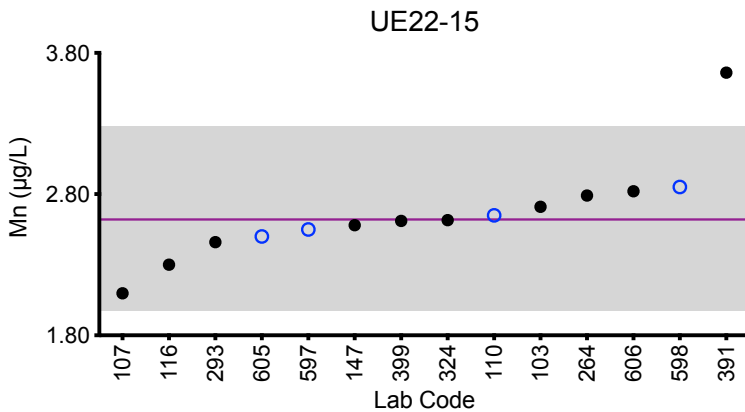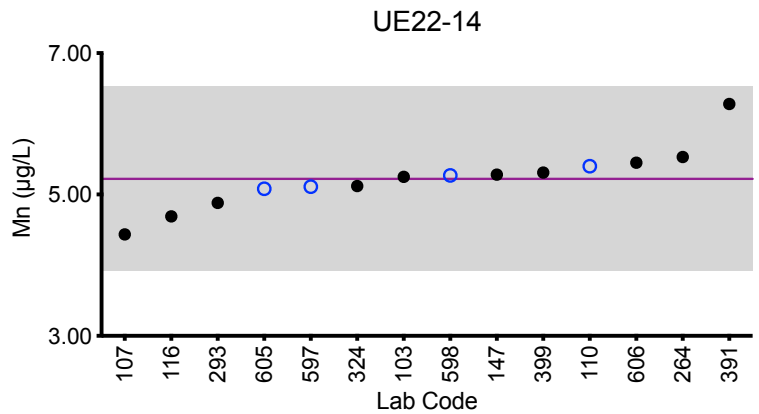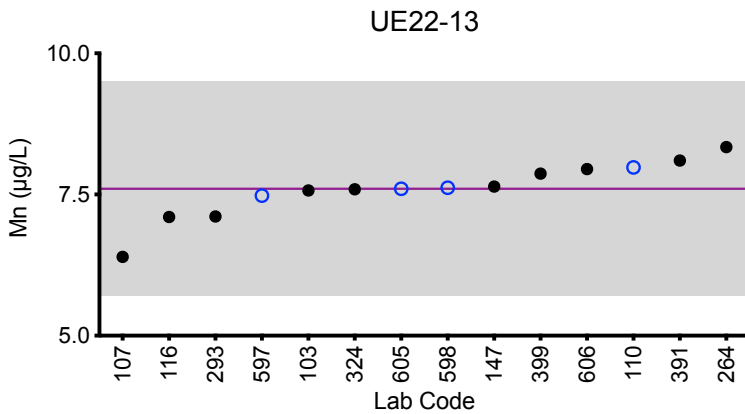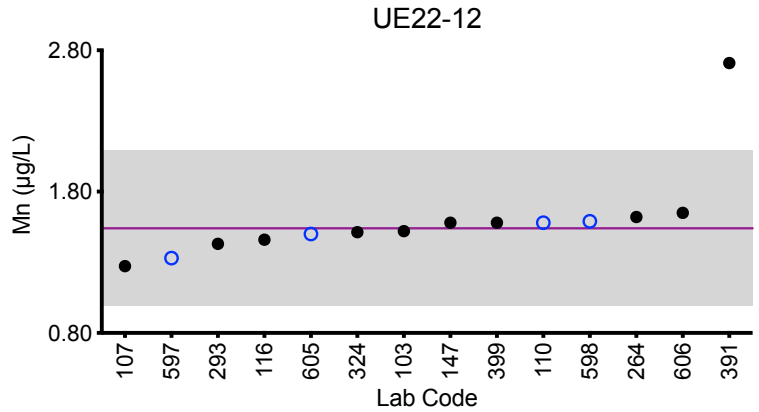## Performance of Participating Laboratories

		Urine Mn (µg/L)				
Lab Code	**Method**	**UE22-11**	**UE22-12**	**UE22-13**	**UE22-14**	**UE22-15**
	Target	**8.8**	**1.54**	**7.6**	**5.22**	**2.62**
103	ICP-MS/MS	8.99	1.52	7.57	5.25	2.71
107	DRC/CC-ICP-MS	7.840	1.273	6.394	4.436	2.098
110	DRC/CC-ICP-MS	9.25	1.58	7.98	5.40	2.65
116	ICP-MS/MS	8.15	1.46	7.10	4.69	2.30
147	DRC/CC-ICP-MS	8.96	1.58	7.64	5.28	2.58
264	ICP-MS	9.56	1.62	8.34	5.53	2.79
293	DRC/CC-ICP-MS	8.36	1.43	7.11	4.88	2.46
324	ICP-MS	8.720	1.513	7.591	5.120	2.616
391	ICP-MS	9.32	2.71 ↑	8.10	6.28	3.66 ↑
399	DRC/CC-ICP-MS	8.92	1.58	7.87	5.31	2.61
597	ICP-MS/MS	8.36	1.33	7.48	5.11	2.55
598	ICP-MS	8.81	1.59	7.62	5.27	2.85
605	ICP-MS	8.51	1.50	7.60	5.08	2.50
606	ICP-MS/MS	8.82	1.65	7.95	5.45	2.82

Based on the grading criteria for Mn in Urine, 97% of results were satisfactory, with 1 of the 14 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

Results for Event #3, 2022:
Summary Figures

Urine Mn

UE22-11

UE22-12

UE22-13

UE22-14

UE22-15

Legend:
○ C/HHEAR 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.

Results for Event #3, 2022:
Summary Statistics

Urine Pb (µg/L)					
	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
Target (Robust Mean (x*))	5.01	8.65	14.4	1.49	0.63
Upper Limit	6.01	10.38	17.3	2.49	1.63
Lower Limit	4.01	6.92	11.5	0.49	0.00
Robust SD (s*)	0.15	0.27	0.4	0.07	0.04
Robust RSD (%)	3.0	3.1	2.5	4.7	5.9
Number of Sample Measurements (N)	17	17	17	17	16
Standard Uncertainty (u)	0.05	0.08	0.1	0.02	0.01

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.

Results for Event #3, 2022:
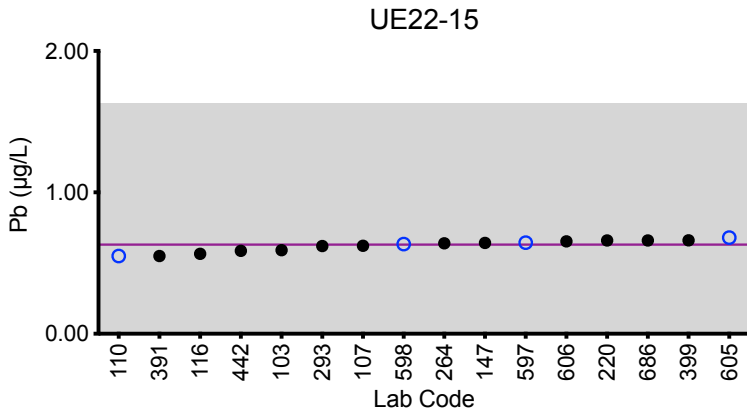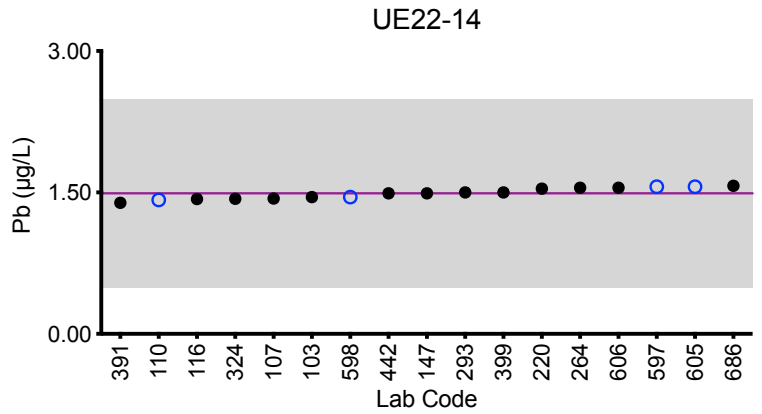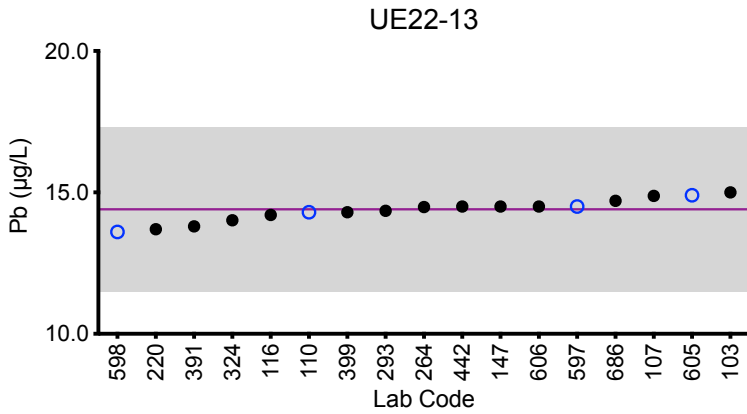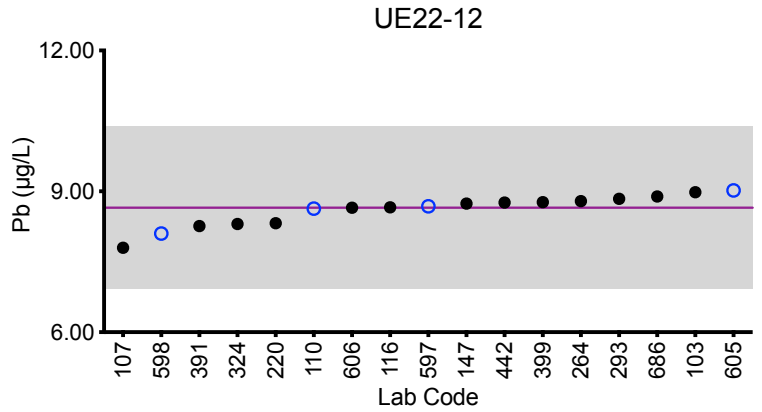## Performance of Participating Laboratories

Lab Code	Method	Urine Pb (µg/L)				
		UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
	Target	5.01	8.65	14.4	1.49	0.63
103	ICP-MS/MS	5.14	8.98	15.0	1.45	0.591
107	ICP-MS	4.882	7.797	14.876	1.435	0.622
110	ICP-MS	5.02	8.63	14.3	1.42	0.55
116	ICP-MS/MS	4.97	8.66	14.2	1.43	0.565
147	ICP-MS	4.87	8.74	14.5	1.49	0.642
220	ICP-MS	4.90	8.32	13.7	1.54	0.66
264	ICP-MS	5.10	8.79	14.48	1.55	0.64
293	DRC/CC-ICP-MS	5.18	8.84	14.35	1.5	0.62
324	ICP-MS	4.789	8.305	14.015	1.432	<1
391	ICP-MS	5.04	8.26	13.8	1.39	0.55
399	ICP-MS/MS	4.99	8.77	14.3	1.50	0.661
442	ICP-MS/MS	5.02	8.76	14.5	1.49	0.586
597	ICP-MS/MS	5.10	8.68	14.5	1.56	0.644
598	ICP-MS	4.77	8.10	13.6	1.45	0.634
605	ICP-MS	5.30	9.02	14.9	1.56	0.680
606	ICP-MS/MS	4.99	8.65	14.5	1.55	0.653
686	ICP-MS	5.16	8.89	14.7	1.57	0.660

Based on the grading criteria for Pb in Urine, 100% of results were satisfactory, with 0 of the 17 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

Results for Event #3, 2022:
Summary Figures

Urine Pb

UE22-11

UE22-12

UE22-13

UE22-14

UE22-15

Legend:
○ C/HHEAR 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.

Results for Event #3, 2022:
Summary Statistics

	Urine Tl (µg/L)				
	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
Target (Robust Mean (x*))	1.69	2.89	0.226	0.52	4.74
Upper Limit	2.03	3.47	0.426	0.72	5.69
Lower Limit	1.35	2.31	0.026	0.32	3.79
Robust SD (s*)	0.06	0.13	0.017	0.03	0.07
Robust RSD (%)	3.6	4.5	7.5	6.0	1.5
Number of Sample Measurements (N)	15	15	14	14	15
Standard Uncertainty (u)	0.02	0.04	0.006	0.01	0.02

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.

Results for Event #3, 2022:
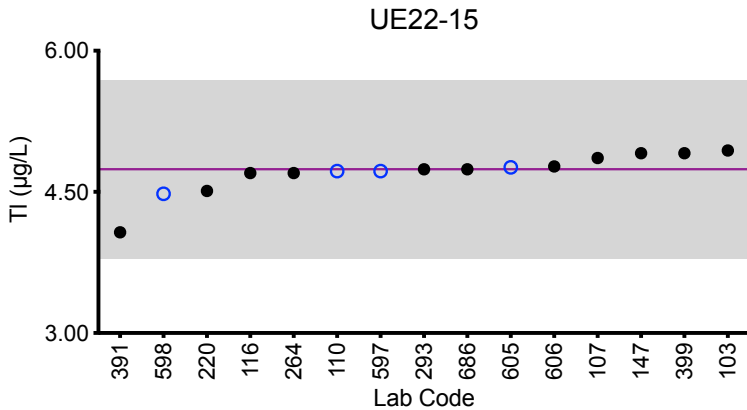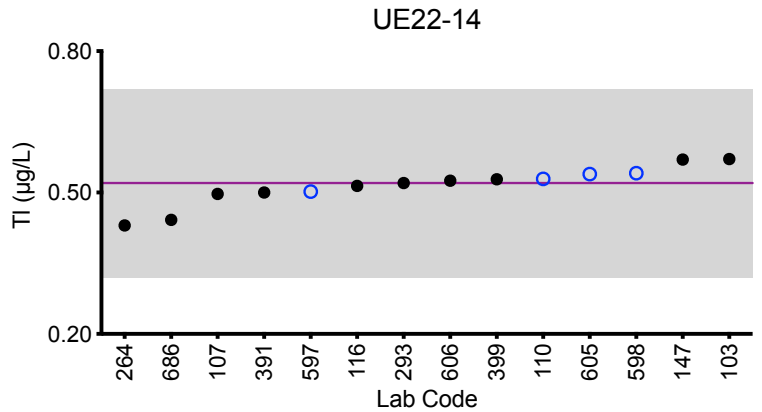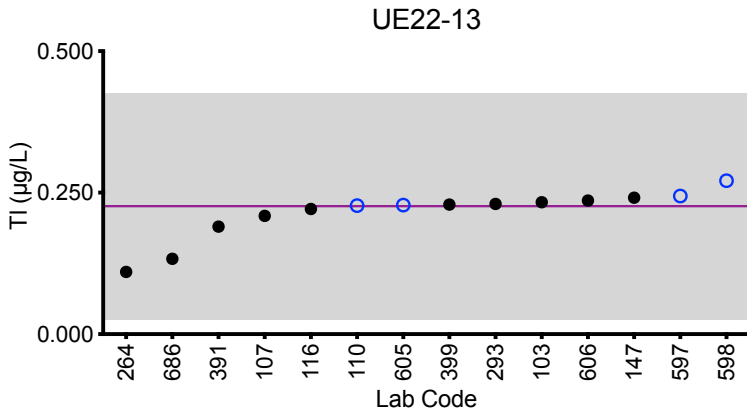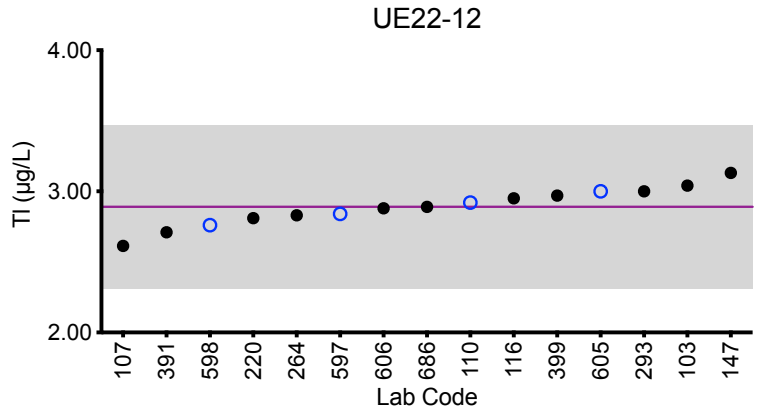## Performance of Participating Laboratories

		Urine Tl (µg/L)				
Lab Code	Method	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
	Target	1.69	2.89	0.226	0.52	4.74
103	ICP-MS/MS	1.73	3.04	0.233	0.571	4.94
107	ICP-MS	1.654	2.613	0.209	0.497	4.860
110	ICP-MS	1.86	2.92	0.227	0.529	4.72
116	ICP-MS/MS	1.69	2.95	0.221	0.514	4.70
147	ICP-MS	1.83	3.13	0.241	0.570	4.91
220	ICP-MS	1.63	2.81	<0.9	<0.9	4.51
264	ICP-MS	1.63	2.83	0.11	0.43	4.70
293	DRC/CC-ICP-MS	1.73	3	0.23	0.52	4.74
391	ICP-MS	1.69	2.71	0.19	0.50	4.07
399	ICP-MS/MS	1.68	2.97	0.229	0.528	4.91
597	ICP-MS/MS	1.68	2.84	0.244	0.502	4.72
598	ICP-MS	1.73	2.76	0.271	0.541	4.48
605	ICP-MS	1.77	3.00	0.228	0.539	4.76
606	ICP-MS/MS	1.64	2.88	0.236	0.525	4.77
686	ICP-MS	1.61	2.89	0.133	0.442	4.74

Based on the grading criteria for Tl in Urine, 100% 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 #3, 2022:
Summary Figures

Urine Tl

UE22-11

UE22-12

UE22-13

UE22-14

UE22-15

Legend:
○ C/HHEAR 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 #3, 2022:
Summary Statistics

Urine U (µg/L)					
	UE22-11	**UE22-12**	**UE22-13**	**UE22-14**	**UE22-15**
Target (Robust Mean (x*))	0.111	0.0374	0.0139	0.0922	0.218
Upper Limit	0.141	0.0674	0.0439	0.1222	0.262
Lower Limit	0.081	0.0074	0.0000	0.0622	0.174
Robust SD (s*)	0.006	0.0025	0.0018	0.0022	0.009
Robust RSD (%)	5.4	6.7	13	2.4	4.1
Number of Sample Measurements (N)	15	15	12	15	15
Standard Uncertainty (*u*)	0.002	0.0008	0.0007	0.0007	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.

Results for Event #3, 2022:
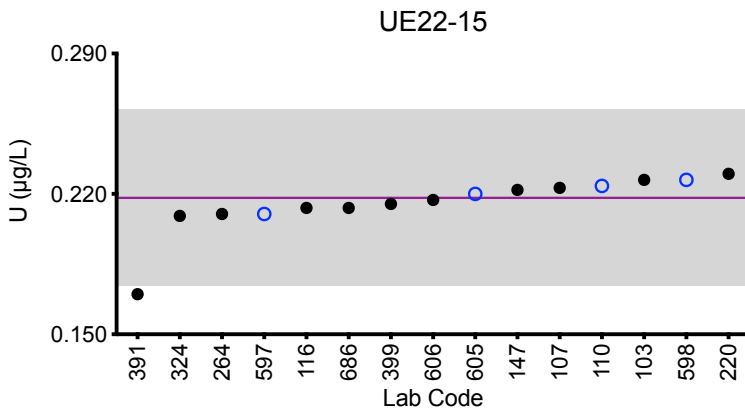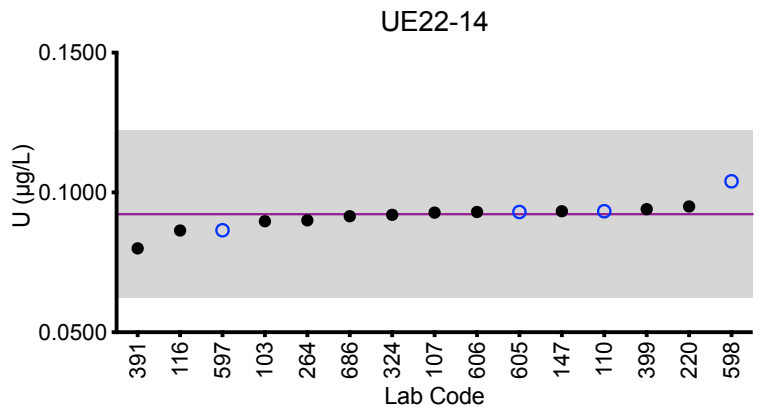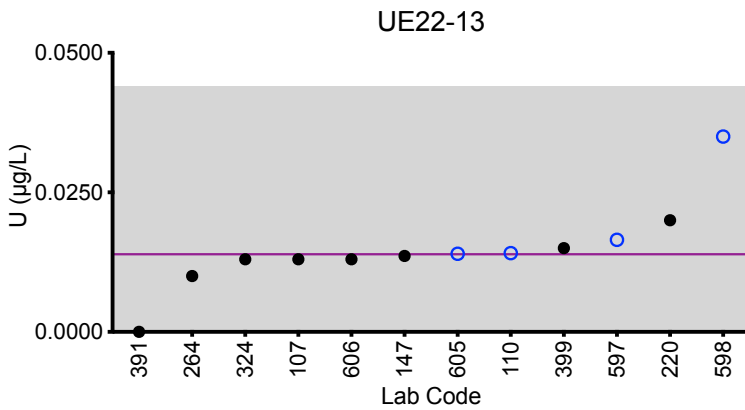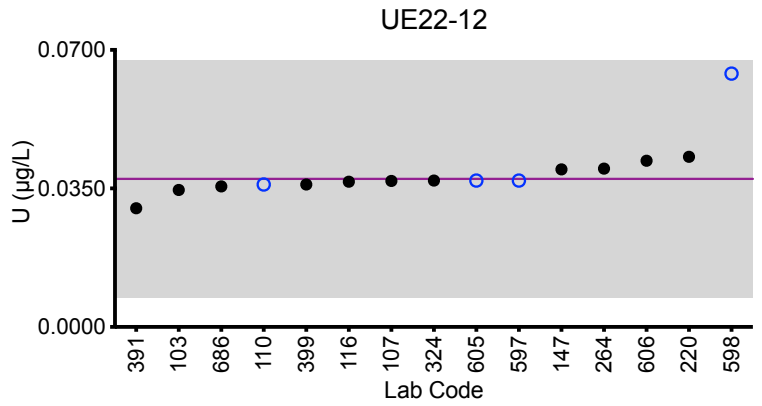## Performance of Participating Laboratories

		Urine U (µg/L)				
Lab Code	**Method**	**UE22-11**	**UE22-12**	**UE22-13**	**UE22-14**	**UE22-15**
	Target	**0.111**	**0.0374**	**0.0139**	**0.0922**	**0.218**
103	ICP-MS/MS	0.110	0.0346	<0.0200	0.0897	0.227
107	ICP-MS	0.1087	0.0369	0.0130	0.0928	0.2230
110	ICP-MS	0.109	0.0360	0.0141	0.0933	0.224
116	ICP-MS/MS	0.106	0.0367	<0.0150	0.0864	0.213
147	ICP-MS	0.115	0.0398	0.0136	0.0933	0.222
220	ICP-MS	0.12	0.043	0.020	0.095	0.23
264	ICP-MS	0.10	0.04	0.01	0.09	0.21
324	ICP-MS	0.114	0.037	0.013	0.092	0.209
391	ICP-MS	0.09	0.03	0.00	0.08	0.17 ↓
399	ICP-MS/MS	0.107	0.0360	0.0150	0.0940	0.215
597	ICP-MS/MS	0.110	0.0370	0.0165	0.0865	0.210
598	ICP-MS	0.139	0.0640	0.0350	0.104	0.227
605	ICP-MS	0.114	0.037	0.014	0.093	0.220
606	ICP-MS/MS	0.118	0.042	0.013	0.093	0.217
686	ICP-MS	0.113	0.0355	<0.0150	0.0915	0.213

Based on the grading criteria for U in Urine, 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 #3, 2022:
Summary Figures

Urine U

UE22-11

UE22-12

UE22-13

UE22-14

UE22-15

Legend:
○ C/HHEAR 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.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Urine Al (µg/L)

Lab Code	Method	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
147	ICP-MS	<13.8	20.9	30.5	<13.8	18.8
264	ICP-MS	13.73	23.86	32.02	10.13	18.46
293	DRC/CC-ICP-MS	13.22	22.93	26.98	9.98	16.73
324	ICP-MS	11.728	17.781	24.068	11.569	20.081
391	ICP-MS	14.7	19.9	30.8	11.5	19.4
597	ICP-MS/MS	16.5	23.5	26.7	7.49	*25.9

Summary Statistics

	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
Arithmetic Mean ($\bar{x}$)	14.0	21.5	28.5	10.1	18.7
Arithmetic SD (s)	1.8	2.4	3.1	1.7	1.3
Arithmetic RSD (%)	13	11	11	17	6.7
Number of Sample Measurements (N)	5	6	6	5	5

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Summary Figures

Urine Al

UE22-11

UE22-12

UE22-13

UE22-14

UE22-15

Legend:
○ C/HHEAR 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 intended to be quality specifications and are included for informational purposes only.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Urine Cs (µg/L)

Lab Code	Method	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
107	ICP-MS	2.55	7.10	1.67	0.65	10.65
110	ICP-MS	2.92	8.79	2.00	0.78	13.0
147	ICP-MS	2.64	7.97	1.79	0.688	11.5
220	ICP-MS	2.66	8.09	1.82	0.73	11.7
264	ICP-MS	2.14	6.56	1.46	0.59	9.99
399	ICP-MS/MS	2.72	8.39	1.88	0.734	11.8
597	ICP-MS/MS	2.66	7.92	1.79	0.752	11.5
598	ICP-MS	2.72	7.39	1.74	0.691	11.1
605	ICP-MS	2.74	8.22	1.84	0.727	11.7
606	ICP-MS/MS	2.72	8.20	1.87	0.719	12.0

Summary Statistics

	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
Robust Mean (x^*)	2.68	8.0	1.80	0.71	11.5
Robust SD (s^*)	0.07	0.5	0.10	0.05	0.5
Robust RSD (%)	2.6	6.3	5.6	6.4	4.3
Number of Sample Measurements (N)	10	10	10	10	10
Standard Uncertainty (u)	0.03	0.2	0.04	0.02	0.2

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Summary Figures

Urine Cs

UE22-11

UE22-12

UE22-13

UE22-14

UE22-15

Legend:
○ C/HHEAR 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 intended to be quality specifications and are included for informational purposes only.

Results for Event #3, 2022:
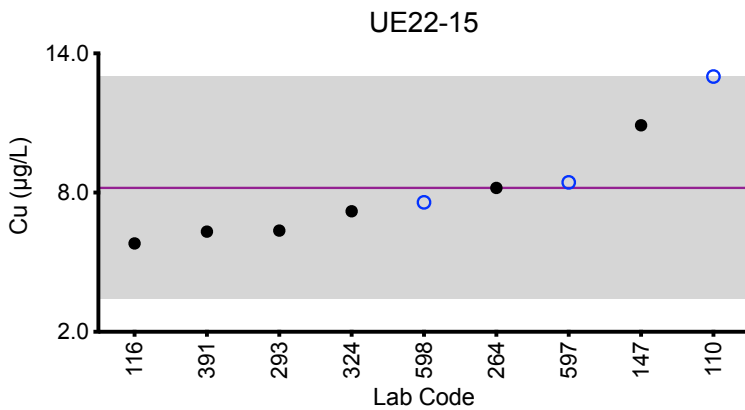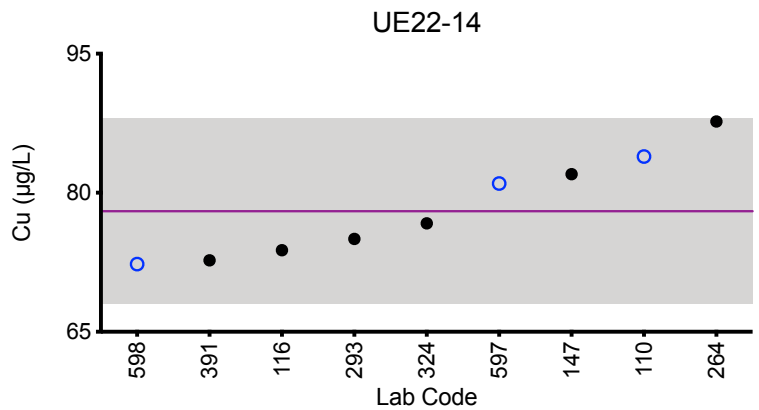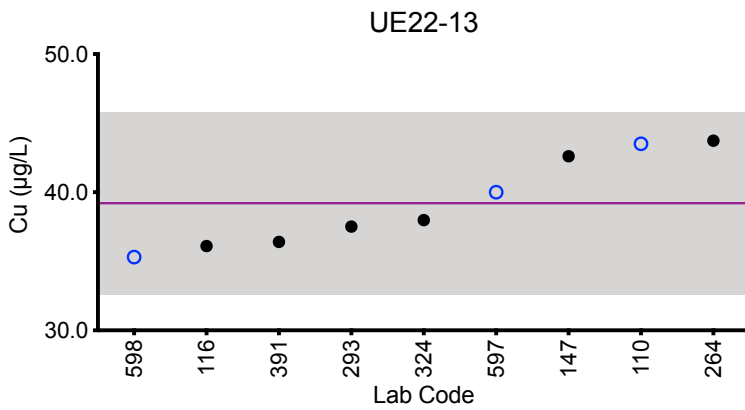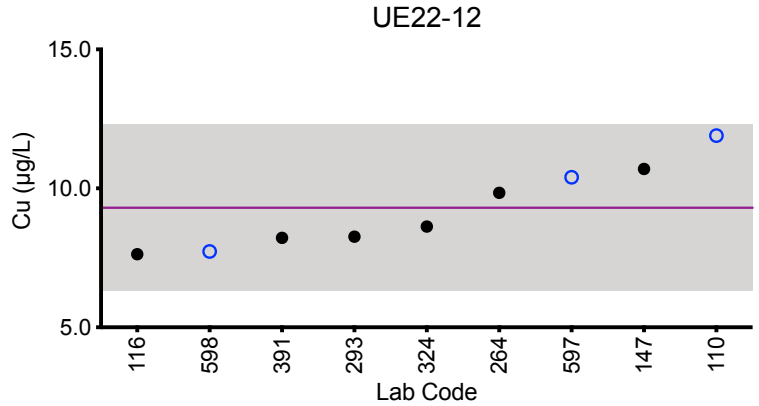## Laboratory Data and Summary Statistics

Urine Cu (µg/L)

Lab Code	Method	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
110	ICP-MS	71.8	11.9	43.5	83.9	13.0
116	ICP-MS/MS	57.2	7.63	36.1	73.8	5.81
147	ICP-MS	63.3	10.7	42.6	82.0	10.9
264	ICP-MS	69.01	9.84	43.73	87.68	8.20
293	DRC/CC-ICP-MS	59.12	8.26	37.51	75.02	6.36
324	ICP-MS	59.918	8.625	37.980	76.697	7.193
391	ICP-MS	57.2	8.22	36.4	72.7	6.32
597	ICP-MS/MS	63.0	10.4	40.0	81.0	8.44
598	ICP-MS	57.2	7.73	35.3	72.3	7.58

Summary Statistics

	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
Arithmetic Mean ($\bar{x}$)	62	9.3	39.2	78	8.2
Arithmetic SD (s)	5	1.5	3.3	5	2.4
Arithmetic RSD (%)	8.1	16	8.4	6.4	29
Number of Sample Measurements (N)	9	9	9	9	9

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Summary Figures

Urine Cu

UE22-11

UE22-12

UE22-13

UE22-14

UE22-15

Legend:
○ C/HHEAR 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 intended to be quality specifications and are included for informational purposes only.

Results for Event #3, 2022:
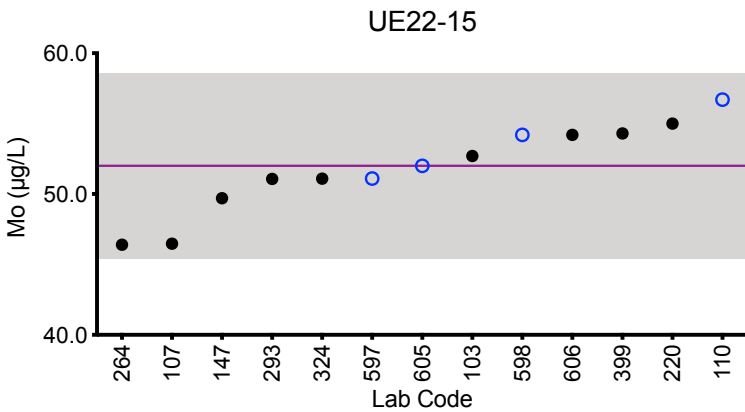## Laboratory Data and Summary Statistics

Urine Mo (µg/L)

Lab Code	Method	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
103	ICP-MS/MS	81.1	9.46	71.2	11.8	52.7
107	ICP-MS	73.39	7.95	62.57	10.70	46.47
110	ICP-MS	85.5	9.72	75.5	12.9	56.7
147	ICP-MS	78.2	8.92	67.9	11.6	49.7
220	ICP-MS	83.3	9.76	73.5	12.6	55.0
264	ICP-MS	64.48	8.67	60.95	10.10	46.40
293	DRC/CC-ICP-MS	82.78	11.15	69.2	13.75	51.07
324	ICP-MS	81.163	9.171	68.468	11.705	51.090
399	ICP-MS/MS	83.6	9.79	73.4	12.5	54.3
597	ICP-MS/MS	78.6	8.98	68.9	11.8	51.1
598	DRC/CC-ICP-MS	79.7	9.81	72.3	11.8	54.2
605	ICP-MS	80.9	9.28	71.4	11.9	52.0
606	ICP-MS/MS	81.4	9.32	71.7	12.2	54.2

Summary Statistics

	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
Robust Mean (x*)	80.7	9.4	70.4	11.9	52.0
Robust SD (s*)	3.2	0.6	3.3	0.7	3.3
Robust RSD (%)	4.0	6.4	4.7	5.9	6.3
Number of Sample Measurements (N)	13	13	13	13	13
Standard Uncertainty (u)	0.1	0.2	0.1	0.2	0.1

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Summary Figures

Urine Mo

Legend:
○ C/HHEAR 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 intended to be quality specifications and are included for informational purposes only.

Results for Event #3, 2022:
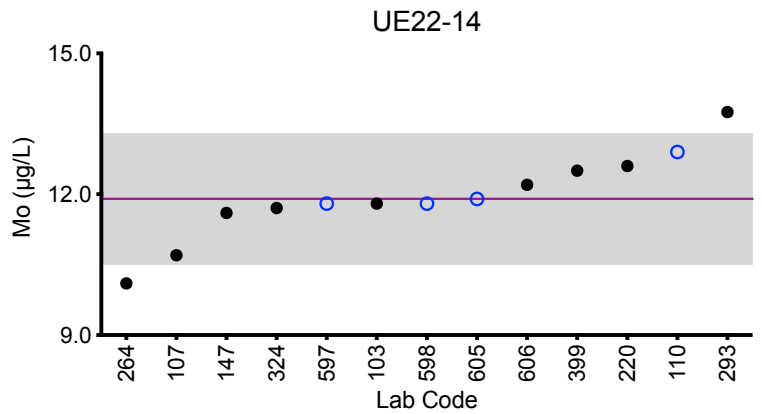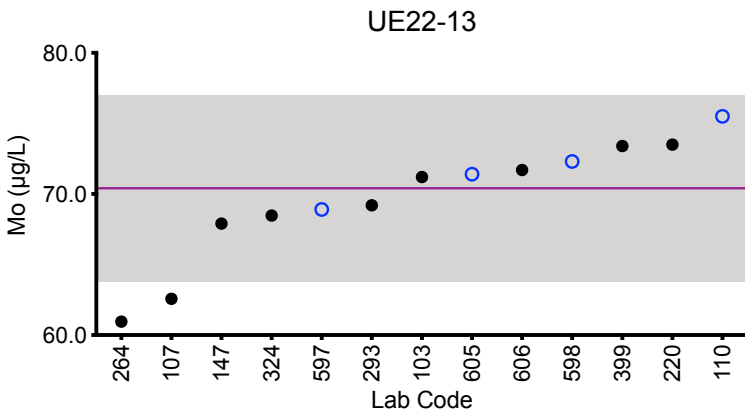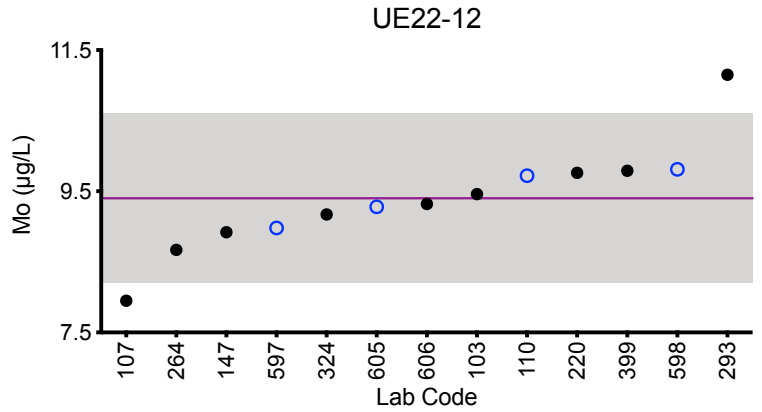## Laboratory Data and Summary Statistics

Urine Ni (µg/L)

Lab Code	Method	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
107	DRC/CC-ICP-MS	0.32	5.09	2.80	34.88	13.67
110	ICP-MS	*1.20	5.96	4.01	37.7	15.5
147	ICP-MS	<0.558	5.27	3.03	37.6	14.7
264	ICP-MS	0.80	6.24	4.01	41.32	16.94
293	DRC/CC-ICP-MS	0.63	5.3	3.29	36.98	14.6
324	ICP-MS	<1	4.973	3.181	32.812	13.223
391	ICP-MS	0.660	4.96	3.42	35.2	14.0
442	DRC/CC-ICP-MS	0.54	5.44	3.16	38.2	15.1
597	ICP-MS/MS	*0.224	5.15	2.94	35.6	14.4
598	ICP-MS	0.674	5.14	3.54	34.7	14.5
605	ICP-MS	0.512	5.49	3.09	37.5	14.3

Summary Statistics

	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
Robust Mean (x*)	0.6	5.3	3.3	36.5	14.5
Robust SD (s*)	0.2	0.3	0.3	2.0	0.8
Robust RSD (%)	26	5.5	11	5.5	5.5
Number of Sample Measurements (N)	7	11	11	11	11
Standard Uncertainty (u)	NA	0.1	0.1	0.8	0.3

*Denotes a statistical Outlier.

An arithmetic mean, SD, RSD and n are provided for sample UE22-11.

Results for Event #3, 2022:
Summary Figures

Urine Ni

UE22-11

UE22-12

UE22-13

UE22-14

UE22-15

Legend:
○ C/HHEAR 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 intended to be quality specifications and are included for informational purposes only.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Urine Pt (µg/L)

Lab Code	Method	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
107	ICP-MS	3.0072	0.9456	0.1552	0.3007	0.7086
110	ICP-MS	3.03	1.09	0.169	0.329	0.801
220	ICP-MS	2.94	1.02	0.18	0.30	0.76
264	ICP-MS	3.10	1.05	0.19	0.30	0.73
293	DRC/CC-ICP-MS	2.92	1.02	0.2	0.3	0.67
399	ICP-MS/MS	3.05	1.07	0.172	0.329	0.768
598	ICP-MS	3.20	1.06	*0.256	0.343	0.783
605	ICP-MS	3.08	1.05	0.168	0.302	0.729

Summary Statistics

	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
Arithmetic Mean ($\bar{x}$)	3.04	1.04	0.176	0.313	0.74
Arithmetic SD (s)	0.09	0.04	0.015	0.018	0.04
Arithmetic RSD (%)	3.0	3.8	8.5	5.8	5.4
Number of Sample Measurements (N)	8	8	7	8	8

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Summary Figures

Urine Pt

UE22-11

UE22-12

UE22-13

UE22-14

UE22-15

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

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Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Urine Sb (µg/L)

Lab Code	Method	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
103	ICP-MS/MS	2.35	1.32	0.808	0.340	0.520
107	ICP-MS	2.646	1.407	0.870	0.437	0.533
110	ICP-MS	2.57	1.49	0.909	0.378	0.555
147	ICP-MS	2.80	1.57	0.944	0.408	0.573
220	ICP-MS	2.72	1.52	0.92	0.38	0.58
264	ICP-MS	1.76	1.04	0.59	0.20	0.35
293	DRC/CC-ICP-MS	2.99	1.53	0.87	0.43	0.53
324	ICP-MS	2.668	1.481	<1	<1	<1
399	ICP-MS/MS	2.79	1.57	0.919	0.413	0.564
597	ICP-MS/MS	2.71	1.53	0.954	0.442	0.596
598	ICP-MS	2.50	1.39	0.915	0.360	0.495
605	ICP-MS	2.81	1.55	0.926	<0.800	<0.800
606	ICP-MS/MS	2.68	1.51	0.947	0.421	0.523

Summary Statistics

	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
Robust Mean (x^*)	2.67	1.50	0.91	0.40	0.54
Robust SD (s^*)	0.17	0.07	0.04	0.04	0.04
Robust RSD (%)	6.4	4.7	4.5	10	7.4
Number of Sample Measurements (N)	13	13	12	11	11
Standard Uncertainty (u)	0.06	0.02	0.01	0.02	0.02

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Summary Figures

Urine Sb

UE22-11
UE22-12
UE22-13
UE22-14
UE22-15

Legend:
○ C/HHEAR Labs   ● Other Labs
Horizontal purple line = robust mean of all laboratories.
Gray area = ±2SD of the mean.

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Results for Event #3, 2022:
Laboratory Data and Summary Statistics

		Urine Se (µg/L)				
Lab Code	Method	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
103	ICP-MS/MS	107	80.9	17.0	221	31.5
110	DRC/CC-ICP-MS	101	80.6	18.1	222	35.5
147	ICP-MS	101	80.6	17.0	220	33.2
293	DRC/CC-ICP-MS	97.16	73.46	15.8	206.95	30.02
391	ICP-MS	94.1	77.3	16.5	196	29.8
597	ICP-MS/MS	97.2	76.4	18.0	209	33.0
598	DRC/CC-ICP-MS	97.0	73.5	14.5	207	29.4

	Summary Statistics				
	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
Arithmetic Mean ($\bar{x}$)	99	77.5	16.7	212	31.8
Arithmetic SD (s)	4	3.3	1.3	10	2.2
Arithmetic RSD (%)	4.2	4.3	7.8	4.7	6.9
Number of Sample Measurements (N)	7	7	7	7	7

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Summary Figures

Urine Se

UE22-11

UE22-12

UE22-13

UE22-14

UE22-15

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

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Results for Event #3, 2022:
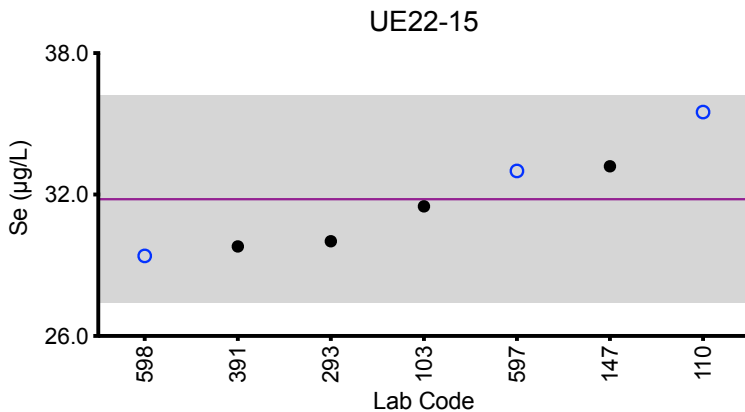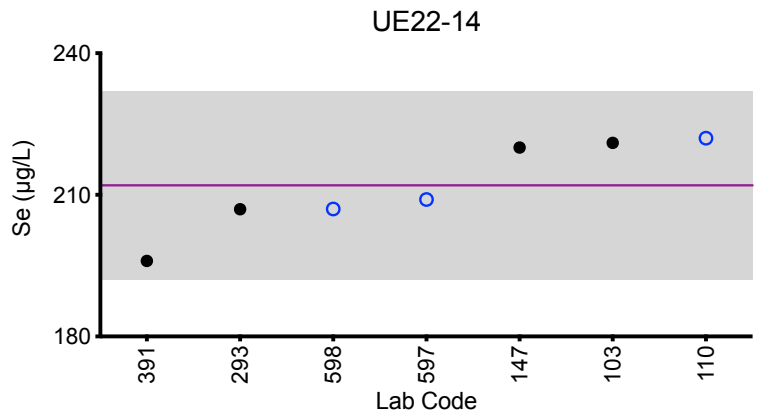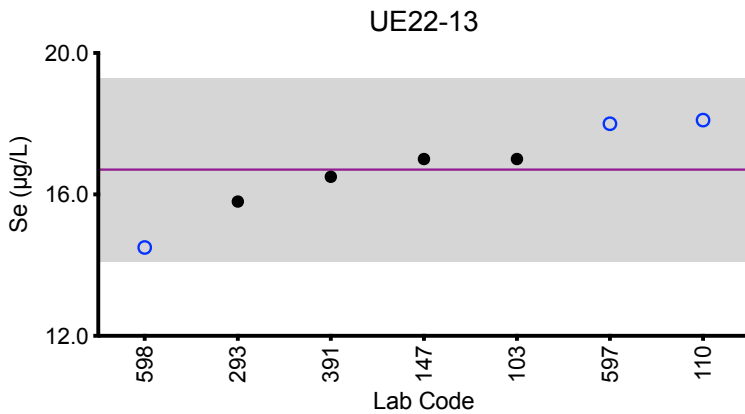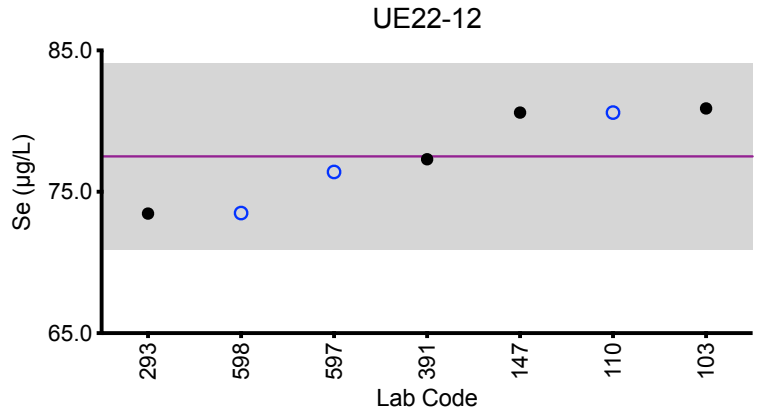## Laboratory Data and Summary Statistics

Urine Sn (µg/L)

Lab Code	Method	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
107	ICP-MS	0.25	1.07	4.58	4.05	1.14
110	ICP-MS	0.28	1.18	5.34	3.93	1.18
147	ICP-MS	0.296	1.24	5.17	4.25	1.20
220	ICP-MS	<0.4	1.20	4.99	4.12	1.27
264	ICP-MS	0.11	0.74	3.14	2.75	0.88
324	ICP-MS	<1	1.127	4.878	3.928	1.148
399	ICP-MS/MS	0.258	1.21	5.24	4.14	1.21
597	ICP-MS/MS	0.303	1.15	4.75	3.83	1.15
598	ICP-MS	0.204	1.04	4.24	3.67	1.08
605	ICP-MS	<0.900	1.18	4.95	3.89	1.17

Summary Statistics

	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
Robust Mean (x*)	0.24	1.15	4.8	3.94	1.16
Robust SD (s*)	0.07	0.07	0.4	0.24	0.05
Robust RSD (%)	28	6.1	8.3	6.1	4.3
Number of Sample Measurements (N)	7	10	10	10	10
Standard Uncertainty (u)	NA	0.03	0.2	0.09	0.02

*Denotes a statistical Outlier.

An arithmetic mean, SD, RSD and n are provided for sample UE22-11.

Urine Sn

UE22-11

UE22-12

UE22-13

UE22-14

UE22-15

Legend:
○ C/HHEAR Labs   ● Other Labs
Horizontal purple line = robust mean of all laboratories.
Gray area = ±2SD of the mean.

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Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Urine Sr (µg/L)

Lab Code	Method	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
103	ICP-MS/MS	71.1	166	325	70.0	405
107	ICP-MS	66.7	144.7	297.2	65.0	373.1
220	ICP-MS	73.7	170	331	74.2	421
264	ICP-MS	*54.01	127.12	273.34	55.80	371.19
399	DRC/CC-ICP-MS	73.0	170	338	72.8	426
597	ICP-MS/MS	69.1	156	316	68.5	402
605	ICP-MS	73.6	169	334	72.7	412

Summary Statistics

	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
Arithmetic Mean ($\bar{x}$)	71.2	158	316	68	401
Arithmetic SD (s)	2.8	16	23	6	22
Arithmetic RSD (%)	3.9	10	7.3	8.8	5.5
Number of Sample Measurements (N)	6	7	7	7	7

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Summary Figures

Urine Sr

UE22-11

UE22-12

UE22-13

UE22-14

UE22-15

Legend:
○ C/HHEAR 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 intended to be quality specifications and are included for informational purposes only.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Urine V (µg/L)

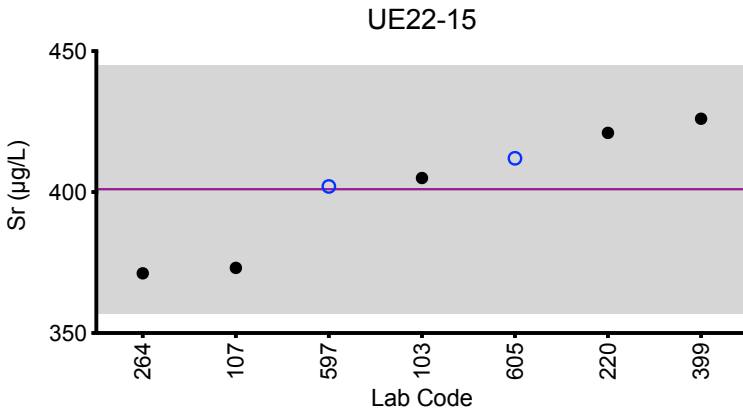| Lab Code	Method	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
116	ICP-MS/MS	5.32	2.83	0.646	1.64	0.405
147	DRC/CC-ICP-MS	5.77	2.89	0.689	1.79	0.452
293	DRC/CC-ICP-MS	5.59	2.78	0.74	1.77	0.54
597	ICP-MS/MS	5.44	2.75	0.613	1.69	0.401
598	DRC/CC-ICP-MS	5.48	2.99	0.750	1.81	0.550
605	ICP-MS	5.42	2.88	0.779	1.74	0.592

Summary Statistics

	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
Arithmetic Mean ($\bar{x}$)	5.50	2.85	0.70	1.74	0.49
Arithmetic SD (s)	0.16	0.09	0.06	0.06	0.08
Arithmetic RSD (%)	2.9	3.2	8.6	3.4	16
Number of Sample Measurements (N)	6	6	6	6	6

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Summary Figures

Urine V

UE22-11

UE22-12

UE22-13

UE22-14

UE22-15

Legend:
○ C/HHEAR 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 intended to be quality specifications and are included for informational purposes only.

Results for Event #3, 2022:
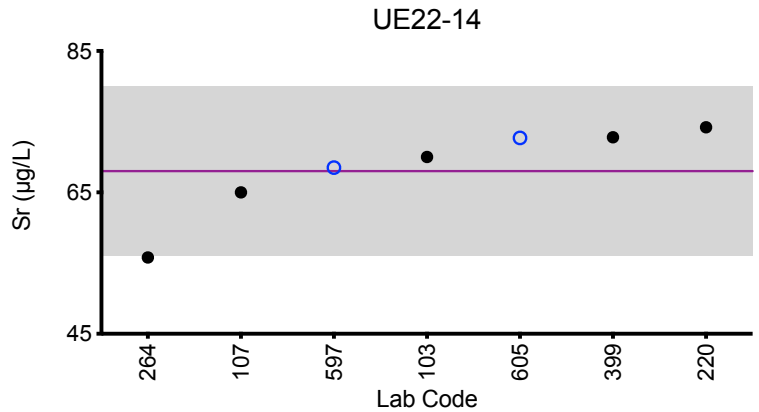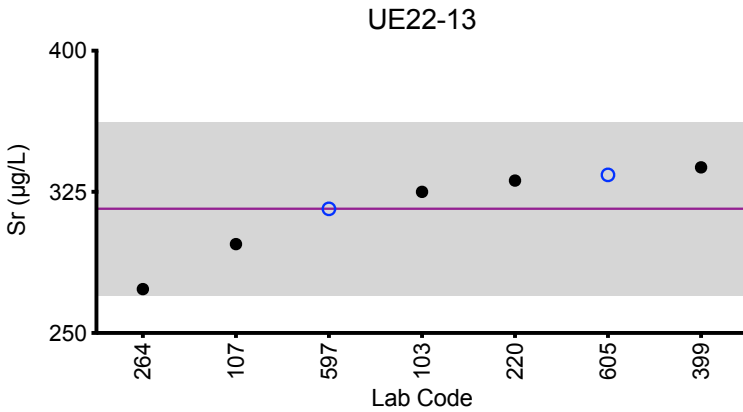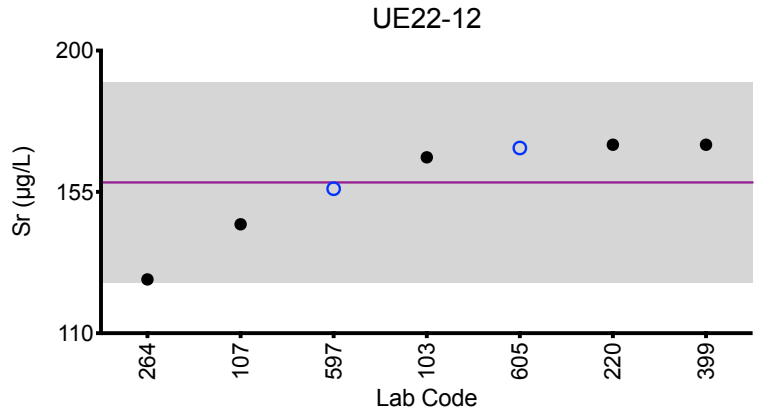## Laboratory Data and Summary Statistics

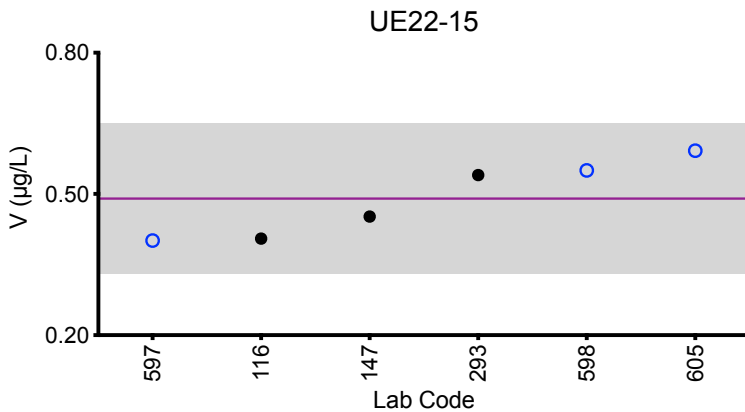### Urine W (µg/L)

Lab Code	Method	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
107	ICP-MS	0.782	0.309	0.693	0.492	1.297
110	ICP-MS	0.877	0.433	0.805	0.572	1.51
147	ICP-MS	0.840	0.382	0.782	0.522	1.47
220	ICP-MS	0.85	0.36	0.74	0.54	1.48
264	ICP-MS	0.78	0.37	0.71	0.47	1.40
324	ICP-MS	<1	<1	<1	<1	1.392
399	ICP-MS/MS	0.893	0.380	0.785	0.519	1.52
597	ICP-MS/MS	0.821	0.393	0.752	0.507	1.43
598	ICP-MS	0.897	0.496	0.802	0.573	1.53
605	ICP-MS	0.849	0.422	0.780	0.529	1.48
606	ICP-MS/MS	0.805	0.357	0.734	0.516	1.51

Summary Statistics

	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
Robust Mean (x^*)	0.84	0.39	0.76	0.52	1.46
Robust SD (s^*)	0.05	0.04	0.04	0.03	0.06
Robust RSD (%)	5.7	10	5.3	5.4	4.1
Number of Sample Measurements (N)	10	10	10	10	11
Standard Uncertainty (u)	0.02	0.02	0.02	0.01	0.02

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Summary Figures

Urine W

UE22-11

UE22-12

UE22-13

UE22-14

UE22-15

Legend:
○ C/HHEAR 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 intended to be quality specifications and are included for informational purposes only.

Results for Event #3, 2022:
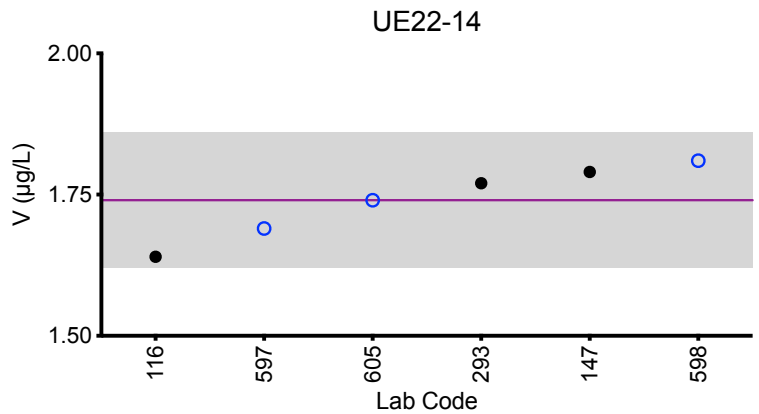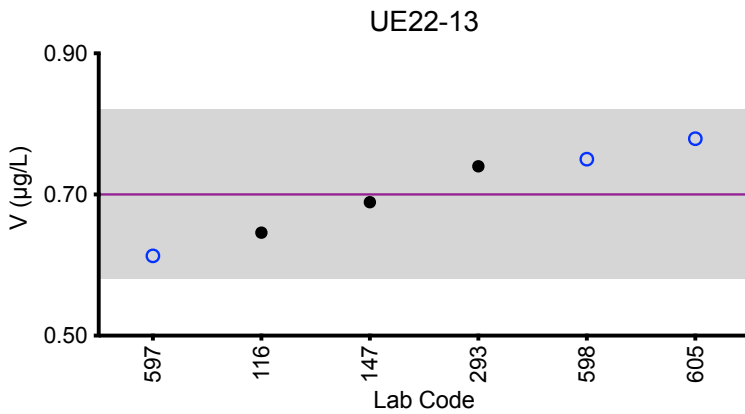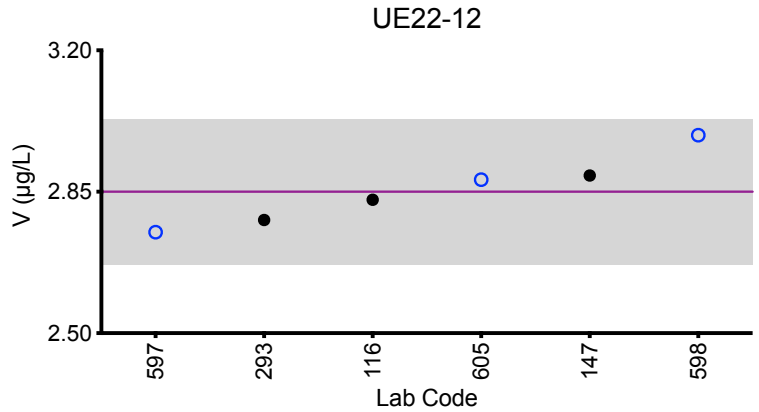## Laboratory Data and Summary Statistics

Urine Zn (µg/L)

Lab Code	Method	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
110	ICP-MS	77.9	157	248	156	173
147	ICP-MS	52.4	158	250	159	175
264	ICP-MS	65.04	170.50	269.56	168.10	185.38
293	DRC/CC-ICP-MS	78.43	169.93	250.98	153.59	168.63
324	ICP-MS	56.961	150.924	238.347	149.578	163.958
391	ICP-MS	50.6	173	*192	*112	*123
597	ICP-MS/MS	55.4	150	241	148	162
598	ICP-MS	53.8	141	231	146	163

Summary Statistics

	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
Arithmetic Mean ($\bar{x}$)	61	159	247	154	170
Arithmetic SD (s)	11	11	12	8	8
Arithmetic RSD (%)	18	6.9	4.9	5.2	4.7
Number of Sample Measurements (N)	8	8	7	7	7

*Denotes a statistical Outlier.

Urine Zn

Legend:
○ C/HHEAR 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 intended to be quality specifications and are included for informational purposes only.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Urine Fe (µg/L)						
Lab Code	**Method**	**UE22-11**	**UE22-12**	**UE22-13**	**UE22-14**	**UE22-15**
324	ICP-MS	3.747	6.093	8.614	14.971	15.919
391	ICP-MS	5.13	8.19	12.38	13.3	15.8
Summary Statistics						
		UE22-11	**UE22-12**	**UE22-13**	**UE22-14**	**UE22-15**
Arithmetic Mean (x̄)		4.4	7.1	10	14.1	15.86
Arithmetic SD (s)		1.0	1.5	3	1.2	0.08
Arithmetic RSD (%)		23	21	30	8.5	0.53
Number of Sample Measurements (N)		2	2	2	2	2

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

		Urine Te (µg/L)				
Lab Code	**Method**	**UE22-11**	**UE22-12**	**UE22-13**	**UE22-14**	**UE22-15**
110	ICP-MS	1.27	0.441	1.88	0.312	0.733
147	ICP-MS	1.24	0.434	1.79	0.313	0.628
		Summary Statistics				
		UE22-11	**UE22-12**	**UE22-13**	**UE22-14**	**UE22-15**
Arithmetic Mean ($\bar{x}$)		1.26	0.438	1.84	0.3125	0.68
Arithmetic SD (s)		0.02	0.005	0.06	0.0007	0.07
Arithmetic RSD (%)		1.7	1.1	3.3	0.22	10
Number of Sample Measurements (N)		2	2	2	2	2

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Additional Elements in Urine

Urine Ag (µg/L)

Lab Code	Method	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
147	ICP-MS	<0.151	<0.151	<0.151	<0.151	<0.151

Urine Bi (µg/L)

Lab Code	Method	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
147	ICP-MS	<0.0794	<0.0794	<0.0794	<0.0794	<0.0794
264	ICP-MS	<0.10	<0.10	<0.10	<0.10	<0.10
597	ICP-MS/MS	<0.0394	<0.0394	<0.0394	<0.0394	<0.0394

Urine I (µg/L)

Lab Code	Method	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
147	ICP-MS	74.9	144	220	122	209

Urine Li (µg/L)

Lab Code	Method	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
147	ICP-MS	3.67	4.91	8.54	6.60	13.4

Urine Mg (µg/L)

Lab Code	Method	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
597	ICP-MS/MS	9440	18100	31600	14300	29200

Urine Th (µg/L)

Lab Code	Method	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
147	ICP-MS	<0.102	<0.102	<0.102	<0.102	<0.102
597	ICP-MS/MS	0.0138	0.0109	0.0142	0.0126	0.0454

Urine Ti (µg/L)

Lab Code	Method	UE22-11	UE22-12	UE22-13	UE22-14	UE22-15
597	ICP-MS/MS	<2.75	11.0	8.19	4.58	9.46

Event #3, 2022

Trace Elements in Serum

Wadsworth Center
NEW YORK STATE DEPARTMENT OF HEALTH
Trace Elements Laboratory

Event #3, 2022:
Trace Elements in Serum

PT Materials

Test materials were prepared from human serum obtained from Zen-Bio, 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). 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) if a robust mean is not possible, the arithmetic mean after outlier deletion.

Additional Elements

An additional 25 were reported by at least one participant: As, Ba, Be, Bi, Cd, Cs, Fe, Hg, I, Li, Mg, Mn, Mo, Ni, Pb, Pt, Sb, Sn, Sr, 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 #3, 2022:
Summary Statistics

	Serum Al (µg/L)				
	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
Target (Arithmetic Mean ($\bar{x}$))	86	71	28.4	64.3	49
Upper Limit	103	85	34.1	77.2	59
Lower Limit	69	57	22.7	51.4	39
Arithmetic SD (s)	4	5	3.2	3.5	4
Arithmetic RSD (%)	4.7	7.0	11	5.4	8.2
Number of Sample Measurements (N)	6	6	6	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.

Results for Event #3, 2022:
Performance of Participating Laboratories

		Serum Al (µg/L)				
Lab Code	Method	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
	Target	86	71	28.4	64.3	49
147	ETAAS-Z	82.0	69.4	29.1	62.9	47.5
264	ICP-MS	83.89	66.11	26.07	61.29	42.71
293	DRC/CC-ICP-MS	85.75	72.85	28.49	63.44	48.39
391	ETAAS-Other	92.7	80.0	34.2 ↑	71.1	52.8
485	HR-ICP-MS	85.9	72.6	27.9	64.8	50.9
597	ICP-MS/MS	84.4	66.2	24.9	62.3	53.1

Based on the grading criteria for Al in Serum, 97% of results were satisfactory, with 0 of the 6 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

Results for Event #3, 2022:
Summary Figures

Serum Al

SE22-11

SE22-12

SE22-13

SE22-14

SE22-15

Legend:
○ C/HHEAR 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.

Results for Event #3, 2022:
Summary Statistics

Serum Co (µg/L)					
	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
Target (Arithmetic Mean (x̄))	18.2	2.57	1.07	4.93	4.36
Upper Limit	20.9	4.07	2.57	6.43	5.86
Lower Limit	15.4	1.07	0.00	3.43	2.86
Arithmetic SD (s)	0.3	0.12	0.04	0.15	0.13
Arithmetic RSD (%)	1.6	4.7	3.5	3.0	2.9
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 #3, 2022:
Performance of Participating Laboratories

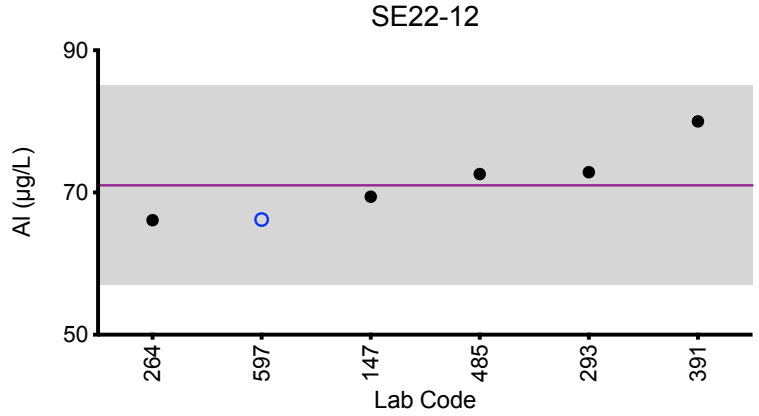| Serum Co (µg/L)						
Lab Code	Method	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
	Target	18.2	2.57	1.07	4.93	4.36
103	ICP-MS/MS	17.9	2.65	1.06	4.91	4.38
110	ICP-MS/MS	18.4	2.68	1.12	5.12	4.39
147	DRC/CC-ICP-MS	18.0	2.32	1.01	4.67	4.41
264	ICP-MS	18.43	2.58	1.05	4.97	4.18
293	DRC/CC-ICP-MS	17.8	2.57	1.05	4.83	4.18
485	HR-ICP-MS	18.0	2.55	1.10	4.98	4.49
597	ICP-MS/MS	18.5	2.66	1.09	5.056	4.47

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 #3, 2022:
Summary Figures

Serum Co

SE22-11

SE22-12

SE22-13

SE22-14

SE22-15

Legend:
○ C/HHEAR 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.

Results for Event #3, 2022:
Summary Statistics

	Serum Cr (µg/L)				
	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
Target (Arithmetic Mean ($\bar{x}$))	1.53	0.85	2.7	5.32	2.17
Upper Limit	3.53	2.85	4.7	7.32	4.17
Lower Limit	0.00	0.00	0.7	3.32	0.17
Arithmetic SD (s)	0.20	0.24	0.4	0.28	0.04
Arithmetic RSD (%)	13	28	15	5.3	1.8
Number of Sample Measurements (N)	6	7	7	7	6

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

Results for Event #3, 2022:
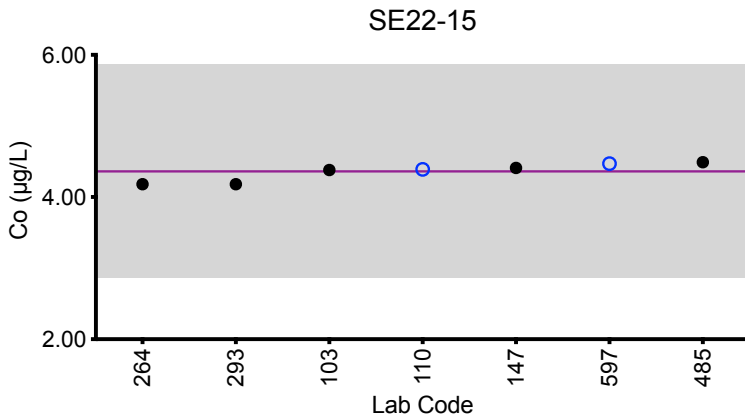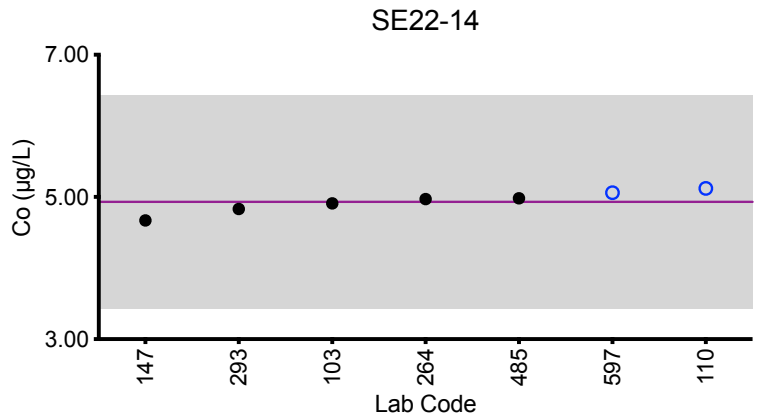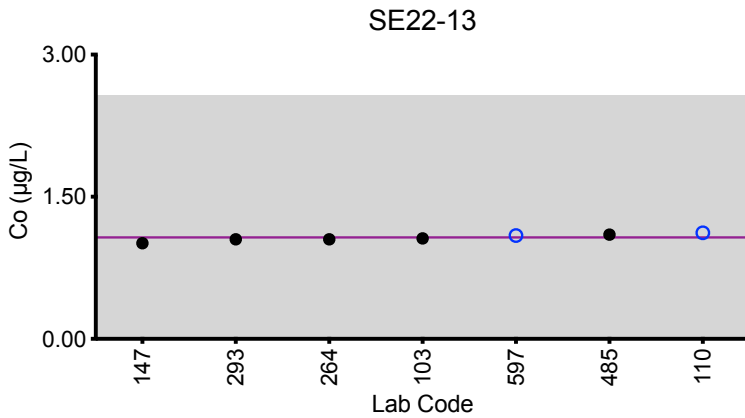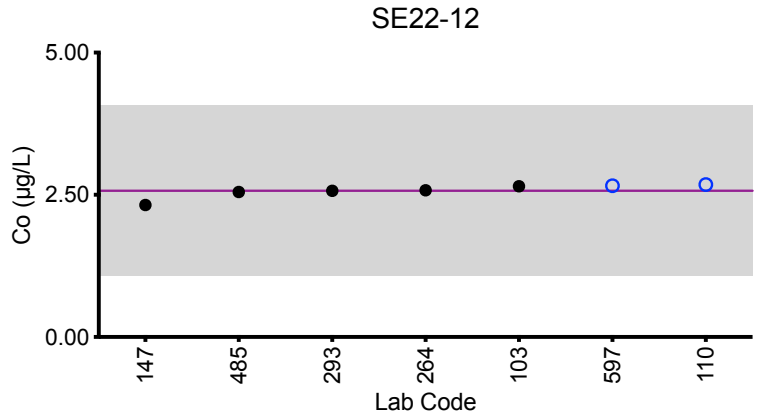## Performance of Participating Laboratories

Lab Code	Method	Serum Cr (µg/L)				
		SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
	Target	**1.53**	**0.85**	**2.7**	**5.32**	**2.17**
103	ICP-MS/MS	1.31	0.641	2.25	4.95	2.16
110	ICP-MS/MS	1.56	0.69	3.15	5.22	2.19
147	DRC/CC-ICP-MS	1.33	0.707	2.35	5.10	2.14
264	ICP-MS	1.86	0.94	2.63	5.60	2.12
293	DRC/CC-ICP-MS	1.57	0.90	2.59	5.37	2.22
485	HR-ICP-MS	1.58	0.720	2.52	5.27	2.19
597	ICP-MS/MS	<1.30	1.33	3.49	5.76	*3.03

Based on the grading criteria for Cr 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 #3, 2022:
Summary Figures

Serum Cr

SE22-11

SE22-12

SE22-13

SE22-14

SE22-15

Legend:
○ C/HHEAR 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.

Results for Event #3, 2022:
Summary Statistics

Serum Cu (µg/L)					
	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
Target (Arithmetic Mean ($\bar{x}$))	1092	1470	894	768	1310
Upper Limit	1256	1690	1028	883	1510
Lower Limit	928	1250	760	653	1110
Arithmetic SD (s)	40	60	39	24	40
Arithmetic RSD (%)	3.7	4.1	4.4	3.1	3.1
Number of Sample Measurements (N)	7	7	7	7	7

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.

Results for Event #3, 2022:
Performance of Participating Laboratories

		Serum Cu (µg/L)				
Lab Code	Method	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
	Target	1092	1470	894	768	1310
107	DRC/CC-ICP-MS	1148	1542	945	808	1330
110	ICP-MS/MS	1080	1440	877	744	1270
147	DRC/CC-ICP-MS	1023	1366	896	743	1366
264	ICP-MS	1119.1	1507.7	903.4	774.7	1281.3
293	DRC/CC-ICP-MS	1081	1462	877	757	1278
436	FAAS	1080	1461	826	762	1270
597	ICP-MS/MS	1110	1540	932	789	1350

Based on the grading criteria for Cu 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 #3, 2022:
Summary Figures

Serum Cu

SE22-11

SE22-12

SE22-13

SE22-14

SE22-15

Legend:
○ C/HHEAR 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:
±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.

Results for Event #3, 2022:
Summary Statistics

	Serum Se (µg/L)				
	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
Target (Arithmetic Mean ($\bar{x}$))	277	114.5	132.5	149	188
Upper Limit	332	137.4	159.0	179	226
Lower Limit	222	91.6	106.0	119	150
Arithmetic SD (s)	12	3.7	3.9	5	5
Arithmetic RSD (%)	4.3	3.2	2.9	3.4	2.7
Number of Sample Measurements (N)	7	7	7	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 by New York State Department of Health's Wadsworth Center, the PT Program organizer.

Results for Event #3, 2022:
Performance of Participating Laboratories

		Serum Se (µg/L)				
Lab Code	Method	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
	Target	277	114.5	132.5	149	188
103	ICP-MS/MS	291	119	140	157	196
107	DRC/CC-ICP-MS	274.1	114.5	128.9	150.5	186.8
110	ICP-MS/MS	275	112	131	146	186
147	DRC/CC-ICP-MS	254	108	130	141	190
264	ICP-MS	276.38	117.20	132.78	151.55	181.60
293	DRC/CC-ICP-MS	280	114	130	149	186
597	ICP-MS/MS	286	117	135	150	190

Based on the grading criteria for Se 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 #3, 2022:
Summary Figures

SE22-11

SE22-12

SE22-13

SE22-14

SE22-15

Legend:
○ C/HHEAR 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.

Results for Event #3, 2022:
Summary Statistics

Serum Zn (μg/L)					
	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
Target (Arithmetic Mean ($\bar{x}$))	896	677	890	866	574
Upper Limit	1030	779	1020	996	660
Lower Limit	762	575	760	736	488
Arithmetic SD (s)	25	24	60	23	33
Arithmetic RSD (%)	2.8	3.5	6.7	2.7	5.7
Number of Sample Measurements (N)	5	5	6	5	6

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.

Results for Event #3, 2022:
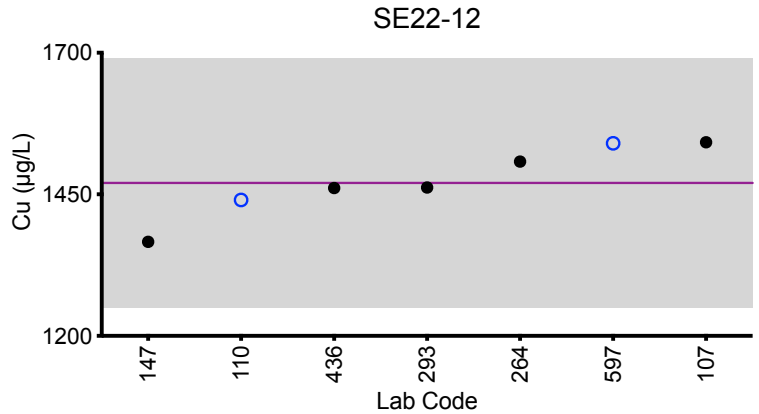## Performance of Participating Laboratories

		|			Serum Zn (µg/L)				
Lab Code	Method		SE22-11		SE22-12		SE22-13	SE22-14	SE22-15
	Target		**896**		**677**		**890**	**866**	**574**
107	DRC/CC-ICP-MS		918		698		933	881	595
110	ICP-MS/MS		918		691		921	872	604
147	DRC/CC-ICP-MS		*712 ↓		*539 ↓		771	*732 ↓	524
264	ICP-MS		862.5		648.2		875.1	841.7	548.6
293	DRC/CC-ICP-MS		876		654		895	843	569
597	ICP-MS/MS		905		696		949	894	602

Based on the grading criteria for Zn in Serum, 90% of results were satisfactory, with 1 of the 6 laboratories reporting 2 or more of the 5 results outside of the acceptable ranges.

Results for Event #3, 2022:
Summary Figures

Serum Zn

SE22-11

SE22-12

SE22-13

SE22-14

SE22-15

Legend:
○ C/HHEAR 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:
±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.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Serum Mn (µg/L)

Lab Code	Method	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
103	ICP-MS/MS	8.09	11.8	2.92	1.83	5.73
110	ICP-MS/MS	8.6	11.8	3.1	1.9	5.7
147	DRC/CC-ICP-MS	7.860	11.50	2.98	1.88	6.04
264	ICP-MS	9.50	13.31	3.64	2.71	6.62
293	DRC/CC-ICP-MS	7.98	11.15	2.83	1.77	5.44
597	ICP-MS/MS	8.41	12.3	3.16	2.24	6.05

Summary Statistics

	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
Arithmetic Mean ($\bar{x}$)	8.4	12.0	3.1	2.1	5.9
Arithmetic SD (s)	0.6	0.8	0.3	0.4	0.4
Arithmetic RSD (%)	7.1	6.7	9.3	17	6.8
Number of Sample Measurements (N)	6	6	6	6	6

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Summary Figures

Serum Mn

SE22-11
Mn (µg/L) vs Lab Code (147, 293, 103, 597, 110, 264)

SE22-12
Mn (µg/L) vs Lab Code (293, 147, 103, 110, 597, 264)

SE22-13
Mn (µg/L) vs Lab Code (293, 103, 147, 110, 597, 264)

SE22-14
Mn (µg/L) vs Lab Code (293, 103, 147, 110, 597, 264)

SE22-15
Mn (µg/L) vs Lab Code (293, 110, 103, 147, 597, 264)

Legend:
o C/HHEAR 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 intended to be quality specifications and are included for informational purposes only.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Serum Mo (µg/L)

Lab Code	Method	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
103	ICP-MS/MS	7.48	4.79	1.02	2.84	3.85
110	ICP-MS/MS	7.71	4.92	1.15	2.93	4.07
147	DRC/CC-ICP-MS	6.99	4.7	1.13	2.79	4.09
293	DRC/CC-ICP-MS	7.12	4.85	1.26	2.84	4.62
485	HR-ICP-MS	7.42	4.75	1.13	2.83	3.93
597	ICP-MS/MS	7.23	4.76	1.12	2.69	3.86

Summary Statistics

	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
Arithmetic Mean ($\bar{x}$)	7.3	4.79	1.14	2.82	4.07
Arithmetic SD (s)	0.3	0.08	0.08	0.08	0.29
Arithmetic RSD (%)	3.5	1.7	6.8	2.8	7.1
Number of Sample Measurements (N)	6	6	6	6	6

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Summary Figures

Serum Mo

SE22-11

SE22-12

SE22-13

SE22-14

SE22-15

Legend:
○ C/HHEAR 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 intended to be quality specifications and are included for informational purposes only.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Serum Ni (µg/L)

Lab Code	Method	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
110	ICP-MS/MS	12.0	4.7	1.9	3.6	6.5
147	DRC/CC-ICP-MS	10.90	*8.57	1.85	3.58	6.81
293	DRC/CC-ICP-MS	12.11	5.12	1.83	3.66	6.51
442	DRC/CC-ICP-MS	11.8	4.81	1.52	3.66	6.71
485	HR-ICP-MS	11.5	4.74	1.46	3.57	6.59
597	ICP-MS/MS	11.8	4.79	1.29	3.49	7.07

Summary Statistics

	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
Arithmetic Mean ($\bar{x}$)	11.7	4.83	1.6	3.59	6.70
Arithmetic SD (s)	0.4	0.17	0.3	0.06	0.22
Arithmetic RSD (%)	3.4	3.5	15	1.7	3.3
Number of Sample Measurements (N)	6	5	6	6	6

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Summary Figures

Serum Ni

SE22-11

SE22-12

SE22-13

SE22-14

SE22-15

Legend:
o C/HHEAR 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 intended to be quality specifications and are included for informational purposes only.
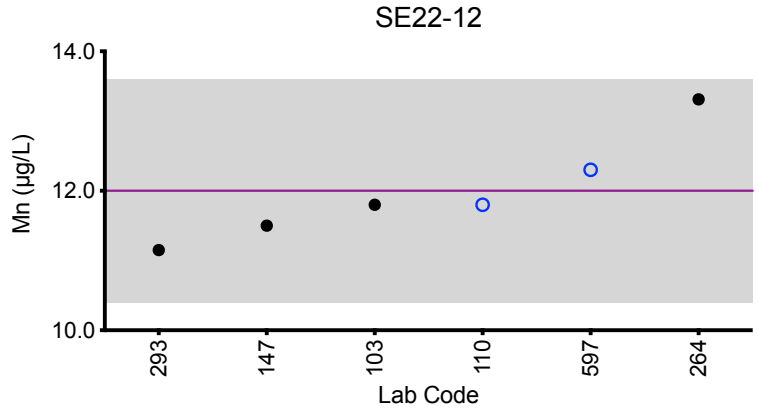
Results for Event #3, 2022:
Laboratory Data and Summary Statistics

	Serum V (µg/L)				
Lab Code	**Method**	**SE22-11**	**SE22-12**	**SE22-13**	**SE22-14**	**SE22-15**
110	ICP-MS/MS	2.51	3.29	0.87	3.81	1.28
147	DRC/CC-ICP-MS	2.22	2.990	0.73	3.630	1.230
293	DRC/CC-ICP-MS	2.62	3.42	1.06	3.83	1.46
485	HR-ICP-MS	2.42	3.12	0.809	3.56	1.25
597	ICP-MS/MS	2.41	3.13	0.819	3.76	1.31
Summary Statistics					
		SE22-11	**SE22-12**	**SE22-13**	**SE22-14**	**SE22-15**
Arithmetic Mean ($\bar{x}$)		2.44	3.19	0.86	3.72	1.31
Arithmetic SD (s)		0.15	0.17	0.12	0.12	0.09
Arithmetic RSD (%)		6.1	5.3	14	3.2	6.9
Number of Sample Measurements (N)		5	5	5	5	5

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Summary Figures

Serum V

SE22-11

SE22-12

SE22-13

SE22-14

SE22-15

Legend:
○ C/HHEAR 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 intended to be quality specifications and are included for informational purposes only.

Results for Event #3, 2022:
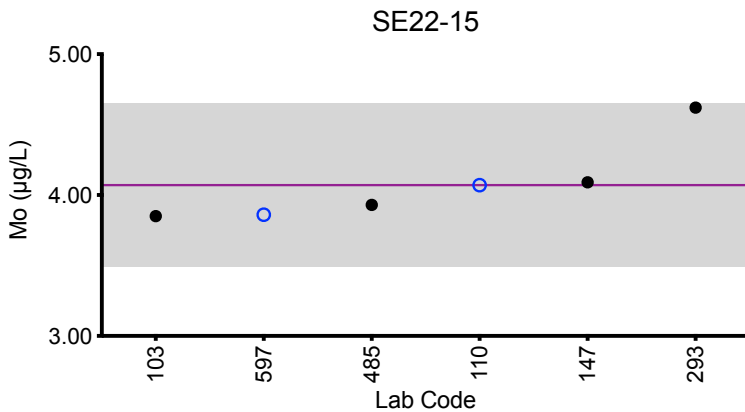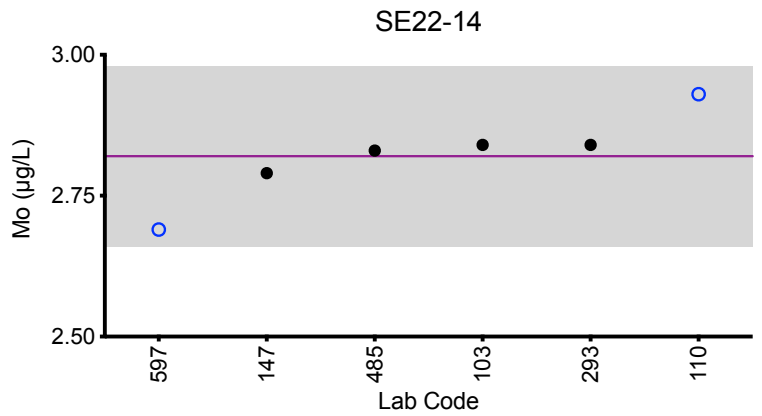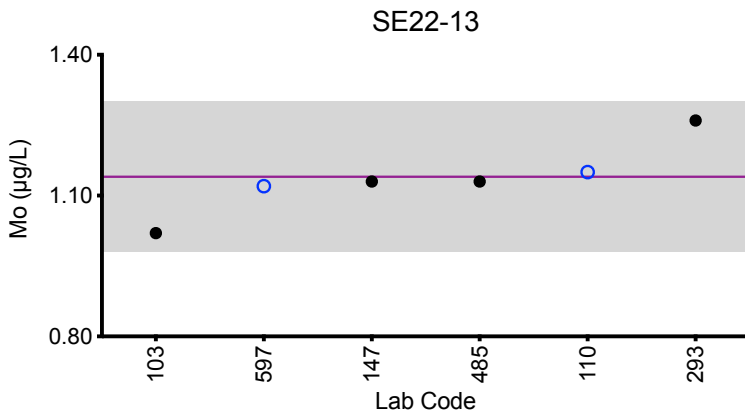## Laboratory Data and Summary Statistics

Serum As (µg/L)						
Lab Code	Method	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
103	ICP-MS/MS	2.50	12.5	3.47	7.07	1.08
110	ICP-MS/MS	2.38	11.4	3.36	6.91	1.02
147	DRC/CC-ICP-MS	2.37	11.5	3.46	6.96	1.19
597	ICP-MS/MS	2.23	12.3	3.52	7.25	1.00
Summary Statistics						
		SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
Arithmetic Mean ($\bar{x}$)		2.37	11.9	3.45	7.05	1.07
Arithmetic SD (s)		0.11	0.6	0.07	0.15	0.09
Arithmetic RSD (%)		4.6	5.0	2.0	2.1	8.4
Number of Sample Measurements (N)		4	4	4	4	4

*Denotes a statistical Outlier.

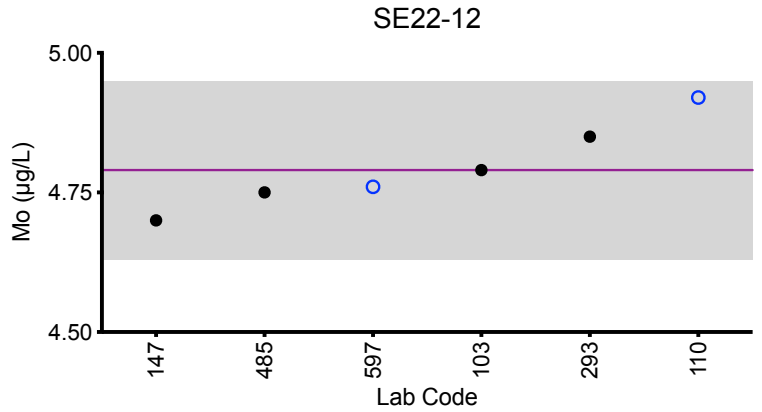# Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Serum Ba (µg/L)

Lab Code	Method	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
110	ICP-MS/MS	2.30	1.79	1.27	1.55	1.30
147	ICP-MS	1.85	1.51	1.17	1.40	1.18
597	ICP-MS/MS	1.84	2.15	1.27	1.59	1.33

Summary Statistics

	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
Arithmetic Mean ($\bar{x}$)	2.0	1.8	1.24	1.51	1.27
Arithmetic SD (s)	0.3	0.3	0.06	0.10	0.08
Arithmetic RSD (%)	15	17	4.8	6.6	6.3
Number of Sample Measurements (N)	3	3	3	3	3

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Serum Be (µg/L)						
Lab Code	Method	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
110	ICP-MS/MS	4.97	0.69	0.98	3.53	0.47
147	ICP-MS	3.68	0.651	0.841	2.93	0.437
293	ICP-MS	4.570	0.73	0.94	3.60	0.430
597	ICP-MS/MS	4.97	0.749	1.12	3.76	0.383
Summary Statistics						
		SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
Arithmetic Mean ($\overline{x}$)		4.5	0.71	0.97	3.5	0.43
Arithmetic SD (s)		0.6	0.04	0.12	0.4	0.04
Arithmetic RSD (%)		13	5.7	12	11	9.3
Number of Sample Measurements (N)		4	4	4	4	4

*Denotes a statistical Outlier.

Results for Event #3, 2022:
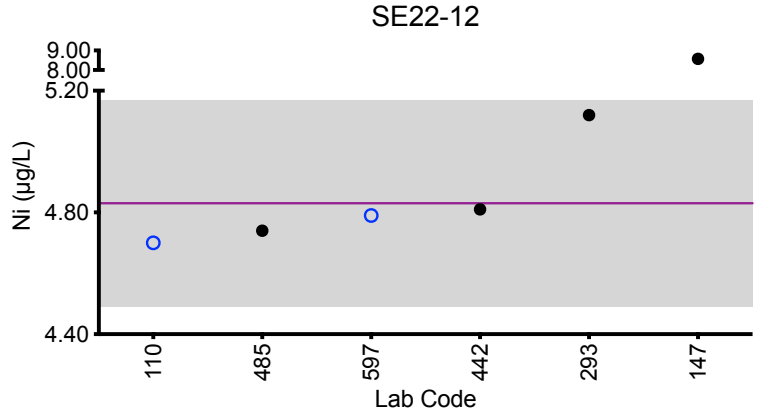## Laboratory Data and Summary Statistics

Serum Cd (µg/L)						
Lab Code	**Method**	**SE22-11**	**SE22-12**	**SE22-13**	**SE22-14**	**SE22-15**
103	ICP-MS/MS	2.50	6.67	0.498	0.889	1.45
110	ICP-MS/MS	2.53	6.66	0.53	0.86	1.42
147	ICP-MS	2.560	7.09	0.524	0.99	1.66
597	ICP-MS/MS	2.40	6.69	0.561	0.886	1.41
Summary Statistics						
		SE22-11	**SE22-12**	**SE22-13**	**SE22-14**	**SE22-15**
Arithmetic Mean ($\overline{x}$)		2.50	6.78	0.53	0.91	1.49
Arithmetic SD (s)		0.07	0.21	0.03	0.06	0.12
Arithmetic RSD (%)		2.8	3.1	4.9	6.6	8.1
Number of Sample Measurements (N)		4	4	4	4	4

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Serum Cs (µg/L)					
Lab Code	Method	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
110	ICP-MS/MS	0.73	0.67	0.53	0.64	0.39
597	ICP-MS/MS	0.674	0.655	0.536	0.641	0.395

Summary Statistics					
	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
Arithmetic Mean ($\bar{x}$)	0.70	0.662	0.533	0.6405	0.393
Arithmetic SD (s)	0.04	0.011	0.004	0.0007	0.004
Arithmetic RSD (%)	5.7	1.7	0.75	0.11	0.90
Number of Sample Measurements (N)	2	2	2	2	2

*Denotes a statistical Outlier.

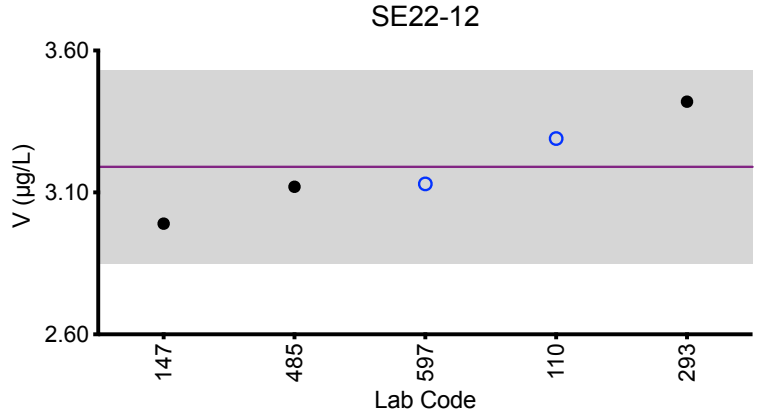# Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Serum Hg (µg/L)						
Lab Code	Method	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
103	ICP-MS/MS	3.11	0.427	0.538	1.58	2.05
110	ICP-MS/MS	3.31	0.34	0.39	1.25	1.78
597	ICP-MS/MS	2.98	0.433	0.531	1.51	2.04
Summary Statistics						
		SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
Arithmetic Mean ($\bar{x}$)		3.13	0.40	0.49	1.45	1.96
Arithmetic SD (s)		0.17	0.05	0.08	0.17	0.15
Arithmetic RSD (%)		5.4	13	16	12	7.7
Number of Sample Measurements (N)		3	3	3	3	3

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Serum I (µg/L)						
Lab Code	Method	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
147	ICP-MS	50.80	63.20	58.500	67.500	67.30
442	ICP-MS	55.3	68.6	61.6	73.4	66.9
Summary Statistics						
		SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
Arithmetic Mean (x̄)		53	66	60	70	67.1
Arithmetic SD (s)		3	4	2	4	0.3
Arithmetic RSD (%)		5.7	6.1	3.3	5.7	0.45
Number of Sample Measurements (N)		2	2	2	2	2

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Serum Mg (µg/L)					
Lab Code	**Method**	**SE22-11**	**SE22-12**	**SE22-13**	**SE22-14**	**SE22-15**
264	ICP-MS	19332.7	15661.3	16427.7	20623.3	17545.7
597	ICP-MS/MS	20100	16300	17100	20900	18200

Summary Statistics					
	SE22-11	**SE22-12**	**SE22-13**	**SE22-14**	**SE22-15**
Arithmetic Mean ($\bar{x}$)	19700	16000	16800	20760	17900
Arithmetic SD (s)	500	500	500	200	500
Arithmetic RSD (%)	2.5	3.1	2.8	0.96	2.8
Number of Sample Measurements (N)	2	2	2	2	2

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Serum Pb (µg/L)						
Lab Code	**Method**	**SE22-11**	**SE22-12**	**SE22-13**	**SE22-14**	**SE22-15**
103	ICP-MS/MS	4.99	7.01	1.22	2.82	1.48
110	ICP-MS/MS	5.54	6.92	1.29	2.91	1.04
597	ICP-MS/MS	4.81	7.14	1.29	3.01	1.05

Summary Statistics					
	SE22-11	**SE22-12**	**SE22-13**	**SE22-14**	**SE22-15**
Arithmetic Mean ($\bar{x}$)	5.1	7.02	1.27	2.91	1.2
Arithmetic SD (s)	0.4	0.11	0.04	0.10	0.3
Arithmetic RSD (%)	7.8	1.6	3.1	3.4	21
Number of Sample Measurements (N)	3	3	3	3	3

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

		Serum Pt (µg/L)				
Lab Code	**Method**	**SE22-11**	**SE22-12**	**SE22-13**	**SE22-14**	**SE22-15**
110	ICP-MS/MS	0.211	1.25	0.639	0.658	
264	ICP-MS	*0.78	1.34	0.66	0.64	1.99
293	DRC/CC-ICP-MS	0.20	1.23	0.63	0.63	1.79
Summary Statistics						
		SE22-11	**SE22-12**	**SE22-13**	**SE22-14**	**SE22-15**
Arithmetic Mean ($\overline{x}$)		0.205	1.27	0.643	0.643	1.89
Arithmetic SD (s)		0.008	0.06	0.015	0.014	0.14
Arithmetic RSD (%)		3.9	4.7	2.3	2.2	7.4
Number of Sample Measurements (N)		2	3	3	3	2

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Serum Sb (µg/L)						
Lab Code	Method	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
103	ICP-MS/MS	1.29	0.685	2.93	0.874	1.20
110	ICP-MS/MS	1.50	0.82	3.49	1.03	1.37
147	ICP-MS	1.4	0.754	3.35	1.00	1.39
597	ICP-MS/MS	1.51	0.899	3.53	1.04	1.52
Summary Statistics						
		SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
Arithmetic Mean ($\bar{x}$)		1.43	0.79	3.33	0.99	1.37
Arithmetic SD (s)		0.10	0.09	0.27	0.08	0.13
Arithmetic RSD (%)		7.2	11	8.1	8.1	9.5
Number of Sample Measurements (N)		4	4	4	4	4

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Serum Sn (µg/L)						
Lab Code	Method	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
110	ICP-MS/MS	3.44	6.47	4.91	1.39	0.41
597	ICP-MS/MS	3.24	6.27	4.85	1.31	0.712
Summary Statistics						
		SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
Arithmetic Mean ($\bar{x}$)		3.34	6.37	4.88	1.35	0.6
Arithmetic SD (s)		0.14	0.14	0.04	0.06	0.2
Arithmetic RSD (%)		4.2	2.2	0.82	4.4	33
Number of Sample Measurements (N)		2	2	2	2	2

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Serum Sr (µg/L)						
Lab Code	Method	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
103	ICP-MS/MS	78.9	107	53.8	91.3	64.1
597	ICP-MS/MS	77.0	108	56.4	94.9	65.3
Summary Statistics						
		SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
Arithmetic Mean ($\bar{x}$)		78.0	107.5	55.1	93	64.7
Arithmetic SD (s)		1.3	0.7	1.8	3	0.8
Arithmetic RSD (%)		1.7	0.65	3.3	3.2	1.2
Number of Sample Measurements (N)		2	2	2	2	2

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Serum Ti (µg/L)						
Lab Code	**Method**	**SE22-11**	**SE22-12**	**SE22-13**	**SE22-14**	**SE22-15**
200	DRC/CC-ICP-MS	6.80	4.40	2.00	2.20	3.00
442	ICP-MS/MS	6.79	4.44	2.7	2.03	3.47
485	HR-ICP-MS	6.22	3.74	2.49	1.64	2.93
597	ICP-MS/MS	7.17	5.33	3.43	2.81	5.38
Summary Statistics						
		SE22-11	**SE22-12**	**SE22-13**	**SE22-14**	**SE22-15**
Arithmetic Mean ($\bar{x}$)		6.7	4.5	2.7	2.2	3.7
Arithmetic SD (s)		0.4	0.7	0.6	0.5	1.1
Arithmetic RSD (%)		5.8	16	22	23	30
Number of Sample Measurements (N)		4	4	4	4	4

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Serum Tl (µg/L)						
Lab Code	Method	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
103	ICP-MS/MS	1.28	0.432	2.10	0.893	0.228
110	ICP-MS/MS	1.33	0.46	2.16	0.92	0.23
147	ICP-MS	1.21	0.448	1.92	0.893	0.22
597	ICP-MS/MS	1.32	0.469	2.17	0.923	0.229
Summary Statistics						
		SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
Arithmetic Mean ($\bar{x}$)		1.28	0.452	2.09	0.907	0.227
Arithmetic SD (s)		0.05	0.016	0.12	0.017	0.005
Arithmetic RSD (%)		3.9	3.5	5.7	1.9	2.2
Number of Sample Measurements (N)		4	4	4	4	4

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Serum U (µg/L)					
Lab Code	**Method**	**SE22-11**	**SE22-12**	**SE22-13**	**SE22-14**	**SE22-15**
103	ICP-MS/MS	0.125	0.119	0.156	0.0940	0.201
110	ICP-MS/MS	0.138	0.1228	0.173	0.104	0.211
597	ICP-MS/MS	0.125	0.126	0.155	0.102	0.195

Summary Statistics					
	SE22-11	**SE22-12**	**SE22-13**	**SE22-14**	**SE22-15**
Arithmetic Mean ($\bar{x}$)	0.129	0.123	0.161	0.100	0.202
Arithmetic SD (s)	0.007	0.004	0.010	0.005	0.008
Arithmetic RSD (%)	5.4	3.3	6.2	5.3	4.0
Number of Sample Measurements (N)	3	3	3	3	3

*Denotes a statistical Outlier.

Results for Event #3, 2022:
Laboratory Data and Summary Statistics

Serum W (µg/L)						
Lab Code	**Method**	**SE22-11**	**SE22-12**	**SE22-13**	**SE22-14**	**SE22-15**
110	ICP-MS/MS	0.72	1.76	1.34	0.30	0.58
597	ICP-MS/MS	0.722	1.76	1.24	0.308	0.575
Summary Statistics						
		SE22-11	**SE22-12**	**SE22-13**	**SE22-14**	**SE22-15**
Arithmetic Mean ($\bar{x}$)		0.721	1.76	1.29	0.304	0.578
Arithmetic SD (s)		0.001	0.00	0.07	0.006	0.004
Arithmetic RSD (%)		0.19	0.00	5.4	1.9	0.69
Number of Sample Measurements (N)		2	2	2	2	2

*Denotes a statistical Outlier.

Results for Event #3, 2022: Additional Elements in Serum

		Serum Bi (µg/L)				
Lab Code	Method	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
597	ICP-MS/MS	<0.0277	<0.0277	<0.0277	<0.0277	<0.0277

		Serum Fe (µg/L)				
Lab Code	Method	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
264	ICP-MS	1785.4	1092.5	1221.3	790.0	804.4

		Serum Li (µg/L)				
Lab Code	Method	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
147	ICP-MS	1.0	1.5	1.2	1.6	2.4

		Serum Th (µg/L)				
Lab Code	Method	SE22-11	SE22-12	SE22-13	SE22-14	SE22-15
597	ICP-MS/MS	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100

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.