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Institute

Proficiency Test Final Report AQA 25-13 Trace Elements and Solids in Sea and River Water

February 2026

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Accredited for compliance with ISO/IEC 17043

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Summary

This report presents the results of the proficiency testing study AQA 25-13 Trace Elements and Solids in Sea and River Water. The study focused on the measurement of dissolved Ag, Al, As, Be, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Sb, Se, Tl, U, V and Zn in river water and of dissolved Ag, Al, As, Be, Cd, Cr, Cu, Fe, Hg, Mn, Ni, P, Pb, Sb, Se, Sn, Tl, U, V and Zn in seawater. Participant were also asked to report total dissolved solids (TDS), total suspended solids (TSS), total solids (TS) and turbidity in river water.

The sample set consisted of one seawater sample and two river water samples.

Twenty-two laboratories registered to participate, and all submitted results.

The assigned values were the robust averages of participants' results. The associated uncertainties were evaluated from the robust standard deviation of participants' results.

The outcomes of the study were evaluated against the aims as follows, to:

- i. assess laboratory capabilities in measuring trace elements and solids in sea and river water;*

Laboratory performance was assessed using both z-scores and E_n -scores.

Of 599 scored results, 555 (93%) returned an acceptable score of $|z| \leq 2.0$.

Of 599 scored results, 513 (86%) returned an acceptable score of $|E_n| < 1.0$.

No laboratories returned results for all 43 tests scored in this proficiency testing study.

Laboratories 7 and 16 returned the highest number of acceptable z-scores, with 41 out of the 41 reported.

Laboratory 7 also had the highest number of acceptable E_n -scores, 40 out of 41 reported.

- ii. evaluate the laboratories' methods used in the determination of inorganic analytes in sea and river water;*

Rounding of results and reporting results with an insufficient number of significant figures was the main cause of unacceptable results. According to Eurachem/CITAC Guide, "The reported result has to provide enough information in case a decision has to be made (e.g. when the result is close to the accepted guideline)."

Caution should be exercised when ICP-OES is used for measurement of analytes at parts-per-billion (ppb) level in seawater samples. Laboratories using this technique should consider reviewing their method detection limit and increasing the reporting level accordingly.

Participants employed a wide range of instrumental techniques for the measurement of Se in the seawater sample: ICP-MS/MS, ICP-MS in reaction mode, ICP-MS with high energy helium or ICP-MS in reaction mode with H_2 or NH_3 . All laboratories using these approaches produced acceptable results, with the exception of one. One laboratory who reported using ICP-OES also performed acceptable.

As in previous studies, P in seawater was the test that most challenged participants' analytical techniques. Of the 10 participants who measured P in the seawater sample, only 7 reported numeric results. No assigned value could be calculated because the results were too variable.

- iii. compare the performance of participant laboratories with their past performance;*

AQA 25-13 is the 36th NMIA proficiency study of metals in water. Over the last 10 years, the average proportion of acceptable scores was 93% for z-scores and 85% for E_n -scores.

- iv. *develop the practical application of measurement uncertainty and provide participants with information that will be useful in assessing their uncertainty evaluations;*

605 out of 606 numerical results were reported with an expanded measurement uncertainty. The magnitude of these expanded uncertainties was within the range 0.004% to 500% of the reported value.

An example of evaluating measurement uncertainty using only the proficiency testing data is given in Appendix 3.

- v. *produce materials that can be used in method validation and as control samples.*

Surplus test samples from the present study are available for sale.

A certified reference material for metals in seawater (MX014) with reference values traceable to SI is also available for sale from NMIA (<https://www.industry.gov.au/national-measurement-institute/nmi-services/chemical-and-biological-measurement-services/chemical-reference-materials/matrix-reference-materials>).

1 INTRODUCTION

1.1 NMIA Proficiency Testing Program

The National Measurement Institute Australia (NMIA) is responsible for Australia's national measurement infrastructure, providing a range of services including a chemical proficiency testing program.

Proficiency testing (PT) is the 'evaluation of participant performance against pre-established criteria by means of interlaboratory comparisons'.¹ NMIA PT studies target chemical testing in areas of high public significance such as trade, environment, law enforcement and food safety. NMIA offers studies in:

- per- and polyfluoroalkyl substances in soil, biosolids, water, biota, food, and consumer goods;
- hydrocarbons, phenols and other organic compounds in soil and water;
- pesticide residues in soil, water, fruit, vegetables, and herbs;
- metals in soil, water, food, filters, and paint;
- nutrients, anions and physical tests in water and soil;
- chlorophyll a in water; and
- controlled drug assay, drugs in wipes, and clandestine laboratory.

AQA 25-13 is the 36th NMIA proficiency study of metals in water.

1.2 Study Aims

The aims of the study were to:

- assess laboratory capabilities in measuring trace elements and solids in sea and river water;
- evaluate the laboratories' methods used in the determination of inorganic analytes in sea and river water;
- compare the performance of participant laboratories with their past performance;
- develop the practical application of measurement uncertainty and provide participants with information that will be useful in assessing their uncertainty evaluations; and
- produce materials that can be used in method validation and as control samples.

1.3 Study Conduct

The conduct of NMIA proficiency tests is described in the NMIA Chemical Proficiency Testing Study Protocol.² The statistical methods used are described in the NMIA Chemical Proficiency Statistical Manual.³ These documents have been prepared with reference to ISO Standard 17043¹ and The International Harmonized Protocol for Proficiency Testing of (Chemical) Analytical Laboratories.⁴

NMIA is accredited by National Association of Testing Authorities, Australia (NATA) to ISO/IEC 17043:2023 as a provider of proficiency testing schemes. This proficiency test is within the scope of NMIA's accreditation.

The choice of the test method was left to the participating laboratories.

2 STUDY INFORMATION

2.1 Selection of Matrices and Inorganic Analytes

The 44 tests in this study were selected from those for which an investigation level is published in Australian and New Zealand Guidelines for Fresh and Marine Water Quality⁵ and are commonly measured by water testing laboratories.

2.2 Participation

Twenty-two laboratories participated and all submitted results.

The timeline of the study was:

Invitation issued:	1 September 2025
Samples dispatched:	29 September 2025
Results due:	24 October 2025
Interim report issued	28 October 2025
Preliminary report issued:	31 October 2025

2.3 Test Material Specification

Three samples were provided for analysis:

Sample S1 was 100 mL of filtered, acidified and fortified river water;

Sample S2 was 100 mL of filtered, acidified and fortified seawater; and

Sample S3 was 750 mL of unfiltered and fortified river water.

2.4 Laboratory Code

All participant laboratories were assigned a confidential code number.

2.5 Sample Preparation, Analysis and Homogeneity Testing

The same validated preparation procedure was followed as in previous studies.² Test samples from previous studies were demonstrated to be sufficiently homogeneous for the evaluation of participants' performance. However, a partial homogeneity test was conducted for all tests in the study. The results of the partial homogeneity tests are reported as the homogeneity values.

The preparation and analysis are described in Appendix 1.

2.6 Stability of Analytes

No stability study was carried out for Samples S1 and S2. Stability studies conducted for similar previous studies of metals in river and seawater found no significant changes. NMIA also produced a Certified Reference Material MX014 for metals in seawater for which long term stability (over 10 years) has been demonstrated.

2.7 Sample Storage, Dispatch and Receipt

Samples S1 and S2 were refrigerated before dispatch, while Sample S3 was stored at room temperature.

The samples were dispatched by courier on 29 September 2025.

A description of the test samples, instructions for participants, and a form for participants to confirm the receipt of the test samples, were sent with the samples.

An Excel spreadsheet for the electronic reporting of results was emailed to participants.

2.8 Instructions to Participants

Participants were instructed as follows:

- Quantitatively analyse the samples using your normal test method.
- If analyses cannot be commenced on the day of receipt, please store samples S1 and S2 chilled, S3 is to be stored at room temperature
- Participants are asked to report results in units of $\mu\text{g/L}$ for Samples S1 and S2, and in mg/L for Sample S3 except turbidity (NTU) for:

SAMPLE S1 River water		SAMPLE S2 Seawater		SAMPLE S3 River water	
Test DISSOLVED	Estimated Value* $\mu\text{g/L}$	Test DISSOLVED	Estimated Value* $\mu\text{g/L}$	Test	Estimated Value* mg/L
Ag	0.5-20	Ag	0.5-20	TDS**	50-2000
Al	5-200	Al	5-200	TSS**	5-200
As	0.5-20	As	0.5-20	TS**	50-2000
Be	0.5-20	Be	0.5-20	Turbidity (NTU)	1-400
Cd	0.5-20	Cd	0.5-20		
Co	0.5-20	Cr	0.5-20		
Cr	0.5-20	Cu	0.5-20		
Cu	0.5-20	Fe	5-200		
Fe	50-20000	Hg	0.30		
Hg	0.05-2	Mn	0.5-20		
Mn	5-200	Ni	0.5-20		
Mo	0.5-20	P	5-200		
Ni	0.5-20	Pb	0.5-20		
Pb	0.5-20	Sb	0.5-20		
Sb	0.5-20	Se	0.5-20		
Se	0.5-20	Sn	0.5-20		
Tl	0.5-20	Tl	0.5-20		
U	0.5-20	U	0.5-20		
V	0.5-20	V	0.5-20		
Zn	5-200	Zn	5-200		

*Please note these are natural samples and the analytes' concentration range is just an estimate. **Dried at 103-105°C.

- Report results using the electronic results sheet emailed to you.
- Report results as you would report to a client. For each analyte in each sample, report the expanded measurement uncertainty associated with your analytical result (e.g. $5.23 \pm 0.51 \mu\text{g/L}$).
- Please send us the requested details regarding the test method and the basis of your uncertainty evaluation.
- Please return the completed results sheet by 17 October 2025.

The due date was extended to 24 October 2025 in response to staff shortages reported by some participants.

2.9 Interim Report and Preliminary Report

An interim report was emailed to participants on 28 October 2025.

A preliminary report was issued on 31 October 2025. This report included: a summary of the results reported by laboratories, assigned values, performance coefficient of variations, z-scores and En-scores for each analyte tested by participants.

There were no changes from the Preliminary Report in this Final Report.

3 PARTICIPANT LABORATORY INFORMATION

3.1 Test Method Summaries

Summaries of test methods for dissolved elements are transcribed in Table 1, and the instrumental techniques reported by participants are presented in Appendix 5. Summaries of test methods for solids and turbidity are transcribed in Table 2. The information received from participants has been adjusted where relevant to remove identifying data.

Table 1 Methodology for Dissolved Elements

Lab. Code	Method Reference	Sample Mass (mL)	Temp. (°C)	Time (min)	HNO ₃ (mL)	HCl (mL)	Other (mL)
1	APHA 3125, USEPA SW846-6020						
2	APHA 3125, EPA 200.8	5	90	120	2	1	
3	APHA 3125 B and US EPA Method 245.7						
6	USEPA 6020						
7*	APHA 3125; USEPA SW846 - 6020	10	98	120	0.5		
8	US EPA6020 and APHA3112	10	95	120	0.25		0.5 (H ₂ SO ₄)
9	6020B						
10	USEPA SW846 and in house	10	95	120	0.5		
11	Inhouse with reference to USEPA 6010 and 6020	14	95	90	0.28	0.42	
13	EPA 200.7	50	85	120	10 (1:1)	4 (1:1)	
14	APHA Standard Methods for the Examination of Water and Wastewater, current edition, 3030B	50			1		
15	USEPA 1638 and APHA 3125B	100	95	240	1		
16	APHA 3125; USEPA SW846 - 6020						
17	APHA 3120B						
18	In house methods referencing APHA 3125						
19	USEPA 6010, 6020, 200.7, 200.8, 200.2 APHA3010 and 3030	30	95-100	90	2		
21*	EPA 200.7	50					

*Additional Information in Table 3.

Table 2 Method References for Solids and Turbidity

Lab. Code	TDS Method Reference	TSS Method Reference	TS Method Reference	Turbidity Method Reference
1	APHA 2540C	APHA 2540D	APHA 2540B	APHA 2130B
2		APHA 2540		APHA 2130-Turbidity
4	APHA 2540C	APHA 2540D	APHA 2540B	APHA 2130 A&B
5*	APHA 2540C (EA015&H)	APHA, 2540D (EA025&H)	APHA 2540B (EA030&H)	APHA 2130 – Turbidity A and B (EA045-3)
7*	APHA 2540C	APHA 2540D	APHA 2540B	APHA 2130- Turbidity
9	AS 3580-10-1-2026	AS 3580-10-1-2026	AS 3580-10-1-2026	APHA 2130B
10*	APHA 2540C	APHA 2540D	APHA 2540B	APHA 2130B
12	Inhouse Method	Inhouse Method		Inhouse Method
14	APHA Standard Methods for the Examination of Water and Wastewater. 23st Edition. 2540 C Total Dissolved Solids dried at 180°C	APHA, Standard Methods for the Examination of Water and Wastewater, Method 2540D and 2540E.	APHA Standard Methods for the Examination of Water and Wastewater. 2540 B Total Solids dried at 103-105°C	APHA Standard Methods for the Examination of Water and Wastewater. 2130B Nephelometric Method

Lab. Code	TDS Method Reference	TSS Method Reference	TS Method Reference	Turbidity Method Reference
15	APHA	APHA		APHA
16*	APHA 2540C	APHA 2540D	APHA 2540B	APHA 2130B
17	APHA 2540C	APHA 2540D	APHA 2540 B	
18	APHA 2540C	GFC equiv. filter - APHA 2540-D		APHA 2130
19*	APHA	APHA	APHA	APHA

*Additional Information in Table 3

3.2 Additional Information

Participants had the option to report additional information for each sample analysed. These are transcribed in Table 3.

Table 3 Additional information

Lab Code	Additional Information
5	S3 Methodology: Total Dissolved Solids dried at 180 +/- 5 °C (not 103-105 °C). Total Suspended Solids and Total Solids dried at 104 +/- 2 °C.
7	Dissolved Elements Methodology: Sample analysed as received S3 Methodology: TDS result has been determined @180 ± 5°C.
10	S3 Methodology: TDS performed at 180C, Total Solids at 104C
16	S3 Methodology: TDS: drying temperature 180 degrees
19	S3 Methodology: TDS was calculated as the difference between TS and TSS
21	Dissolved Elements Methodology: Direct injected, no digestion was performed

3.3 Basis of Participants' Measurement Uncertainty Evaluations

Participants were requested to provide information about the basis of their uncertainty evaluations (Table 4).

Table 4 Basis of Uncertainty Evaluation

Lab. Code	Approach to Evaluating MU	Information Sources for MU Evaluation ^a		Guide Document for Evaluating MU
		Precision	Method Bias	
1	Top Down - precision and estimates of the method and laboratory bias k = 2	Control Samples - CRM Duplicate Analysis Instrument Calibration	CRM Instrument Calibration	Eurachem/CITAC Guide
2	Top Down - precision and estimates of the method and laboratory bias k = 2	Control Samples - CRM Duplicate Analysis Instrument Calibration	CRM Instrument Calibration Recoveries of SS	Eurachem/CITAC Guide
3	Standard deviation of replicate analyses multiplied by 2 or 3 Coverage factor not reported	Control Samples - SS Duplicate Analysis	Instrument Calibration Recoveries of SS	Eurachem/CITAC Guide
4	Top Down - precision and estimates of the method and laboratory bias k = 2	Control Samples - CRM Duplicate Analysis Instrument Calibration	CRM Instrument Calibration	Eurachem/CITAC Guide
5	Bottom Up (ISO/GUM, fish bone/ cause and effect diagram) k = 2	Control Samples - CRM Duplicate Analysis Instrument Calibration	CRM Instrument Calibration Laboratory Bias from PT Studies Recoveries of SS	Eurachem 2000 / ISO1993A
6	Top Down - precision and estimates of the method and laboratory bias k = 2	Control Samples - CRM Duplicate Analysis	CRM Instrument Calibration Recoveries of SS	ASTM E2554-13
7	Top Down - precision and estimates of the method and laboratory bias Coverage factor not reported	Control Samples - CRM Duplicate Analysis Instrument Calibration		Eurachem/CITAC Guide
8	Professional judgment k = 2	Control Samples Duplicate Analysis Instrument Calibration	Recoveries of SS	ISO/GUM
9	Standard deviation of replicate analyses multiplied by 2 or 3 k = 2	Standard deviation from PT studies only		ISO/GUM
			Recoveries of SS	
10	Top Down - precision and estimates of the method and laboratory bias Coverage factor not reported	Control Samples - CRM Duplicate Analysis	CRM Recoveries of SS	Eurachem/CITAC Guide
11	Bottom Up (ISO/GUM, fish bone/ cause and effect diagram) Coverage factor not reported	Duplicate Analysis Instrument Calibration	Instrument Calibration Recoveries of SS	Eurachem/CITAC Guide
12	Standard deviation of replicate analyses multiplied by 2 or 3 Coverage factor not reported	Control Samples - SS Duplicate Analysis		
13	Standard deviation of replicate analyses multiplied by 2 or 3 k = 2	Control Samples - RM / Ex PT Sample Duplicate Analysis Instrument Calibration	CRM Instrument Calibration Recoveries of SS Standard Purity	Eurachem/CITAC Guide
14	Top Down - precision and estimates of the method and laboratory bias Coverage factor not reported	Control Samples Duplicate Analysis	Laboratory Bias from PT Studies	ISO/GUM

Lab. Code	Approach to Evaluating MU	Information Sources for MU Evaluation ^a		Guide Document for Evaluating MU
		Precision	Method Bias	
15	Top Down - precision and estimates of the method and laboratory bias k = 2	Control Samples - CRM Duplicate Analysis	CRM Instrument Calibration Recoveries of SS	ISO/GUM
16	Bottom Up (ISO/GUM, fish bone/ cause and effect diagram) Coverage factor not reported	Control Samples Duplicate Analysis	CRM Instrument Calibration Recoveries of SS	Eurachem/CITAC Guide
17	Top Down - precision and estimates of the method and laboratory bias Coverage factor not reported	Duplicate Analysis Instrument Calibration	CRM Instrument Calibration Recoveries of SS	NMI Uncertainty Course
18	Top Down - precision and estimates of the method and laboratory bias Coverage factor not reported	Control Samples - CRM Duplicate Analysis	CRM	Nordtest Report TR537
19	Top Down - precision and estimates of the method and laboratory bias k = 2	Control Samples - CRM Duplicate Analysis		Nordtest Report TR537
20	Coverage factor not reported	Duplicate Analysis Instrument Calibration	CRM Instrument Calibration Laboratory Bias from PT Studies	
21	Bottom Up (ISO/GUM, fish bone/ cause and effect diagram) k = 2	Control Samples - SS	CRM Recoveries of SS	Eurachem/CITAC Guide
22	Top Down - precision and estimates of the method and laboratory bias k = 2	Control Samples - SS Duplicate Analysis	CRM Standard Purity	Nordtest Report TR537

^aCRM = Certified Reference Material, SS = Spiked samples, RM = Reference Material.

3.4 Participant Comments on this PT Study or Suggestions for Future Studies

The study co-ordinator welcomes comments or suggestions from participants about this study or possible future studies. Such feedback is useful in improving future studies.

In this study, no participants provided any comments.

4 PRESENTATION OF RESULTS AND STATISTICAL ANALYSIS

4.1 Results Summary

Participant results are listed in Tables 5 to 48 with results summary statistics, along with other estimates of analyte concentration. Bar charts of results and performance scores are presented in Figures 2 to 45. An example chart with an interpretation guide is shown in Figure 1.

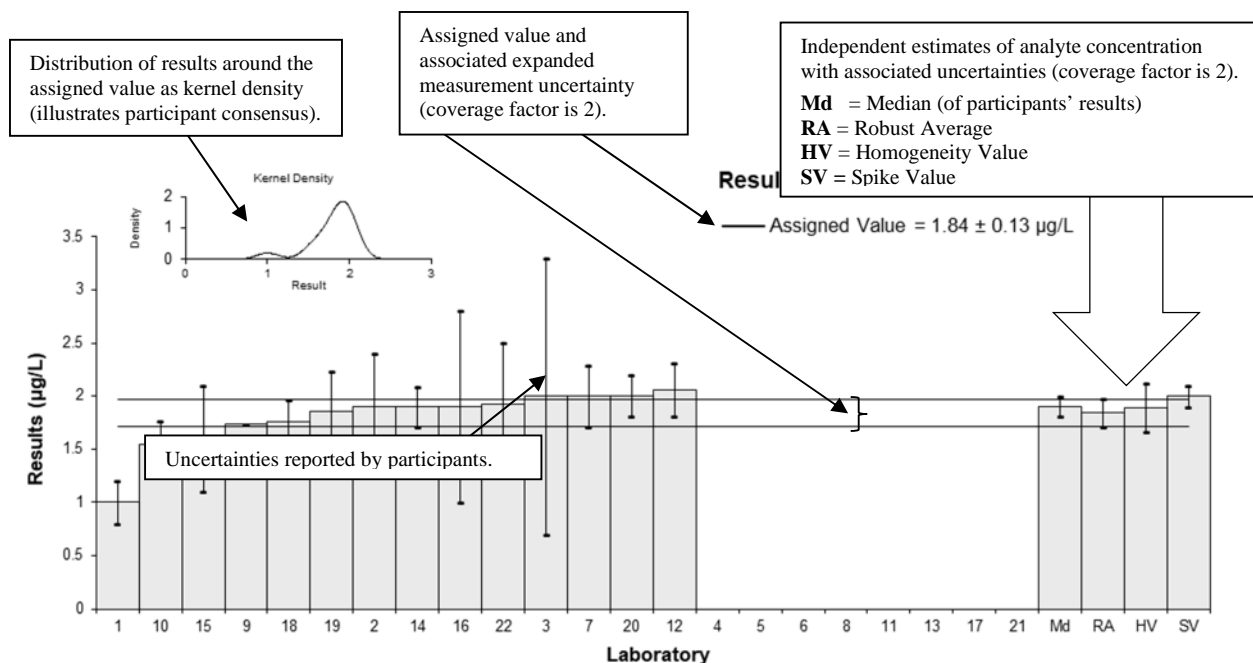


Figure 1 Guide to Presentation of Results

4.2 Outliers and Extreme Outliers

Outliers were results less than 50% and greater than 150% of the robust average and were removed before assigned value calculation. Extreme outliers (gross errors) were obvious blunders, such as those with incorrect units, decimal errors, or results from a different proficiency test item and were removed for calculation of summary statistics.^{3,4,6}

4.3 Assigned Value

An example of the assigned value calculation using data from the present study is given in Appendix 3. The assigned value is defined as: 'the value attributed to a particular property of a proficiency test item.'¹ In this study, the property is the mass fraction of analyte. Assigned values were the robust average of participants' results, outliers removed; the expanded uncertainties were evaluated from the associated robust standard deviations.^{4,6}

4.4 Robust Average and Robust Between-Laboratory Coefficient of Variation

The robust averages and associated expanded uncertainties, and robust CVs (a measure of the variability of participants' results) were calculated as described in ISO 13528.⁶

Robust CV as presented in the Section 5 (Statistics table) is the robust between-laboratory CV including outliers but excluding extreme outliers. Everywhere else in the report, the robust between-laboratory CV refers to the robust CV calculated with both outliers and extreme outliers removed.

4.5 Standard Deviation for Proficiency Assessment

The standard deviation for proficiency assessment (SDPA, σ) is the product of the assigned value (X) and the performance coefficient of variation (PCV). This value is used for

calculation of the participants' z-scores and provides scaling for laboratory deviation from the assigned value.

$$\sigma = X * PCV \quad \text{Equation 1}$$

It is important to note that the PCV is a fixed value and is not the standard deviation of participants' results. The fixed value set for PCV is based on the existing regulation, the acceptance criteria indicated by the methods, the matrix, the concentration level of analyte and on experience from previous studies. It is backed up by mathematical models such as Thompson-Horwitz equation.⁷

4.6 z-Score

An example of z-score calculation using data from the present study is given in Appendix 2. For each participants' result, a z-score is calculated according to Equation 2 below:

$$z = \frac{(\chi - X)}{\sigma} \quad \text{Equation 2}$$

where:

- z is z-score;
- χ is a participants' result;
- X is the assigned value;
- σ is the standard deviation for proficiency assessment.

A z-score with absolute value ($|z|$): $|z| \leq 2.0$ is acceptable; $2.0 < |z| < 3.0$ is questionable; $|z| \geq 3.0$ is unacceptable.

4.7 E_n-Score

An example of E_n-score calculation using data from the present study is given in Appendix 2. The E_n-score is complementary to the z-score in assessment of laboratory performance. E_n-score includes measurement uncertainty and is calculated according to Equation 3 below:

$$E_n = \frac{(\chi - X)}{\sqrt{U_\chi^2 + U_X^2}} \quad \text{Equation 3}$$

where:

- E_n is E_n-score;
- χ is a participants' result;
- X is the assigned value;
- U_χ is the expanded uncertainty of the participants' result;
- U_X is the expanded uncertainty of the assigned value.

An E_n-score with absolute value ($|E_n|$): $|E_n| < 1.0$ is acceptable; $|E_n| \geq 1.0$ is unacceptable.

4.8 Traceability and Measurement Uncertainty

Laboratories accredited to AS ISO/IEC Standard 17025:2018⁸ must establish and demonstrate the traceability and measurement uncertainty associated with their test results. Guidelines for quantifying uncertainty in analytical measurement are described in the Eurachem/CITAC Guide.⁹

5 TABLES AND FIGURES

Table 5

Sample Details

Sample No.	S1
Matrix	River Water
Analyte	Ag
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	1	0.2	-4.57	-3.52
2	1.9	0.5	0.33	0.12
3	2.0	1.3	0.87	0.12
4	NT	NT		
5	NT	NT		
6	NT	NT		
7	2	0.29	0.87	0.50
8	NT	NT		
9	1.73	0.002	-0.60	-0.85
10	1.54	0.22	-1.63	-1.17
11	NR	NR		
12	2.06	0.25	1.20	0.78
13	NT	NT		
14	1.9	0.19	0.33	0.26
15	1.6	0.5	-1.30	-0.46
16	1.9	0.9	0.33	0.07
17	NT	NT		
18	1.76	0.2	-0.43	-0.34
19	1.86	0.37	0.11	0.05
20	2.0	0.2	0.87	0.67
21	<3	NR		
22	1.9278	0.57834	0.48	0.15

Statistics

Assigned Value	1.84	0.13
Spike Value	2.00	0.10
Homogeneity Value	1.89	0.23
Robust Average	1.84	0.13
Median	1.90	0.10
Mean	1.80	
N	14	
Max	2.06	
Min	1	
Robust SD	0.2	
Robust CV	11%	

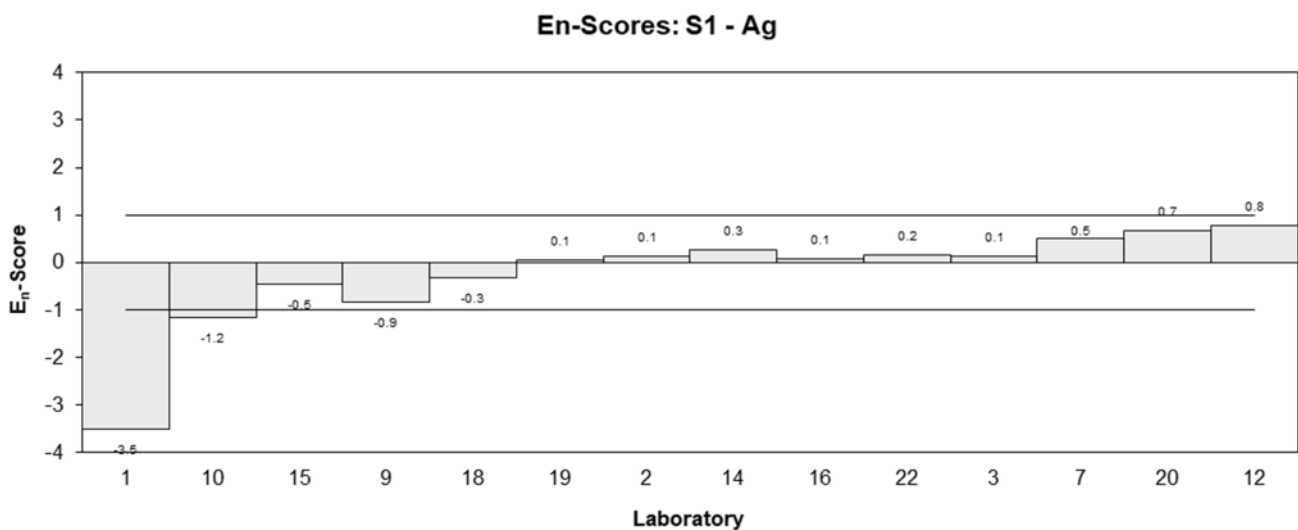
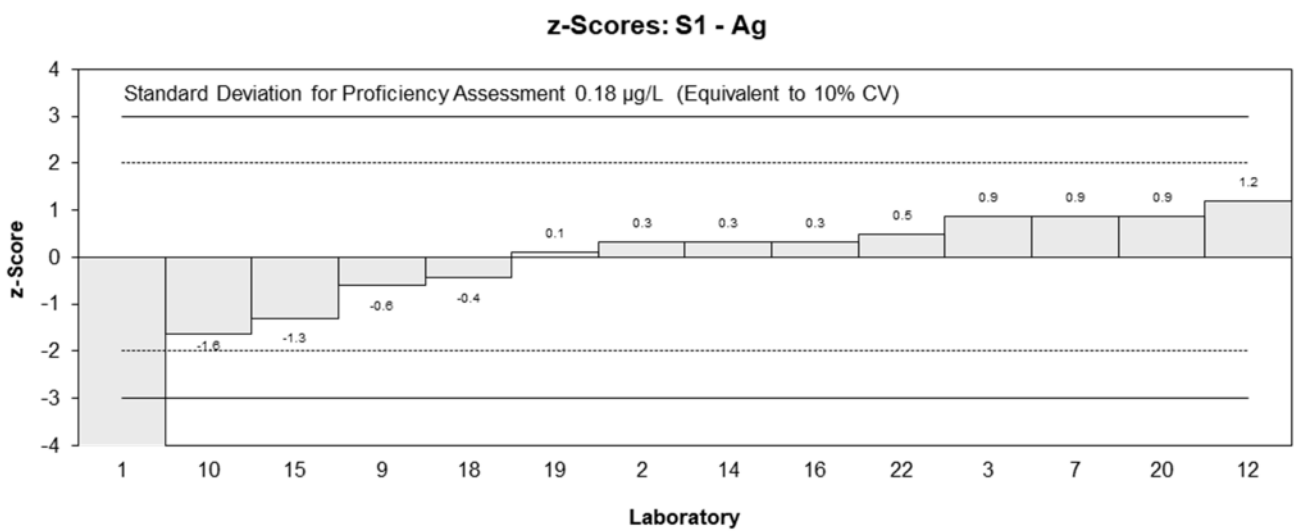
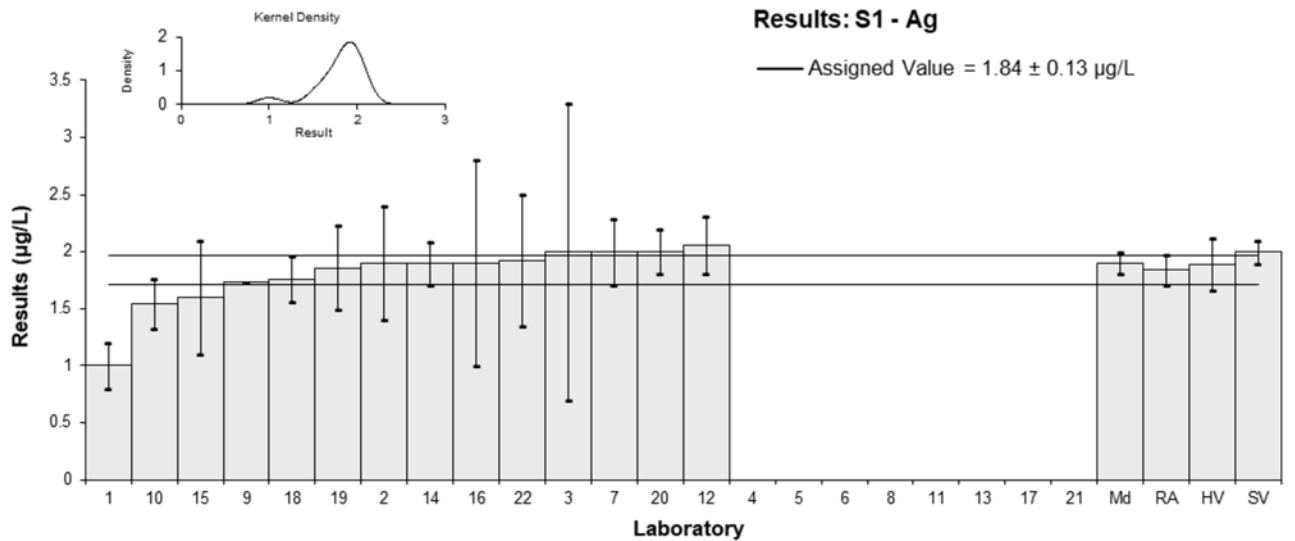


Figure 2

Table 6

Sample Details

Sample No.	S1
Matrix	River Water
Analyte	Al
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	30	3	-0.91	-0.88
2	32	9	-0.30	-0.11
3	33.6	3.4	0.18	0.16
4	NT	NT		
5	NT	NT		
6	NT	NT		
7	32	5.85	-0.30	-0.16
8	NT	NT		
9	30.20	0.047	-0.85	-1.75
10	33.61	2.33	0.18	0.22
11	33.5	7.0	0.15	0.07
12	35.3	6.7	0.70	0.33
13	NT	NT		
14	35	3.5	0.61	0.52
15	30	6	-0.91	-0.48
16	36	3.9	0.91	0.71
17	NT	NT		
18	29.8	3.0	-0.97	-0.94
19	31.7	6.3	-0.39	-0.20
20	33	3.3	0.00	0.00
21	37	3	1.21	1.18
22	34.6992	10.40976	0.51	0.16

Statistics

Assigned Value	33.0	1.6
Spike Value	34.8	2.5
Homogeneity Value	33.9	4.1
Robust Average	33.0	1.6
Median	33.3	1.5
Mean	33.0	
N	16	
Max	37	
Min	29.8	
Robust SD	2.6	
Robust CV	7.8%	

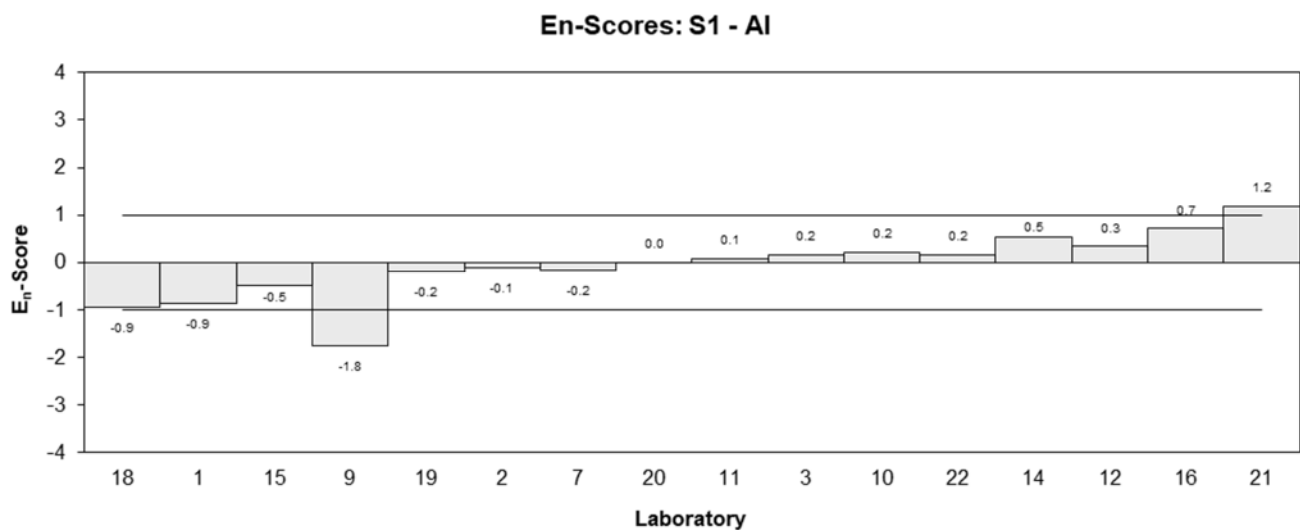
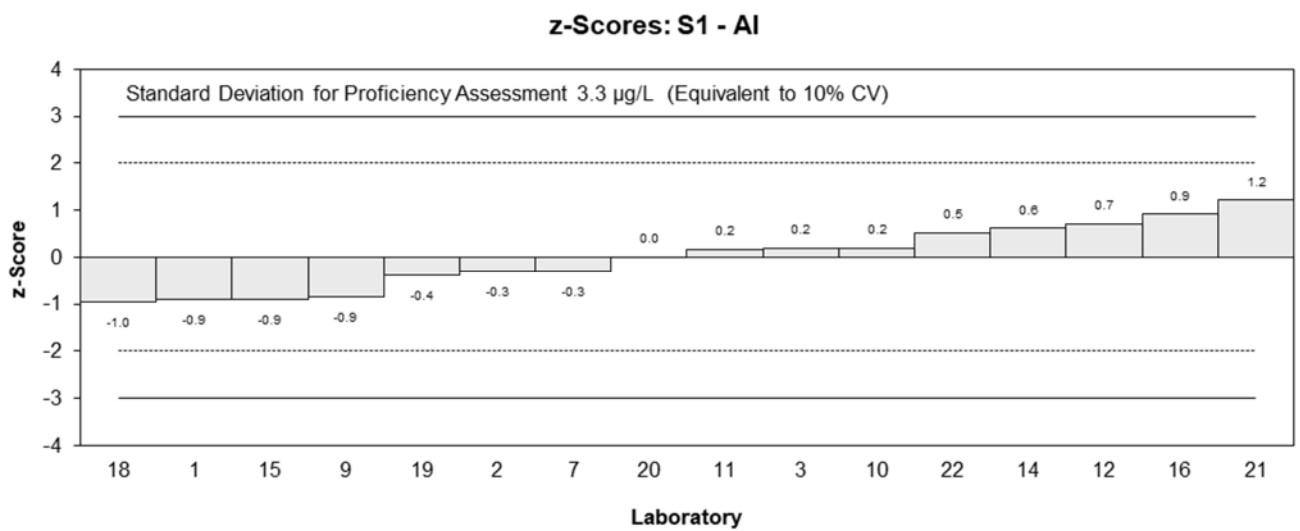
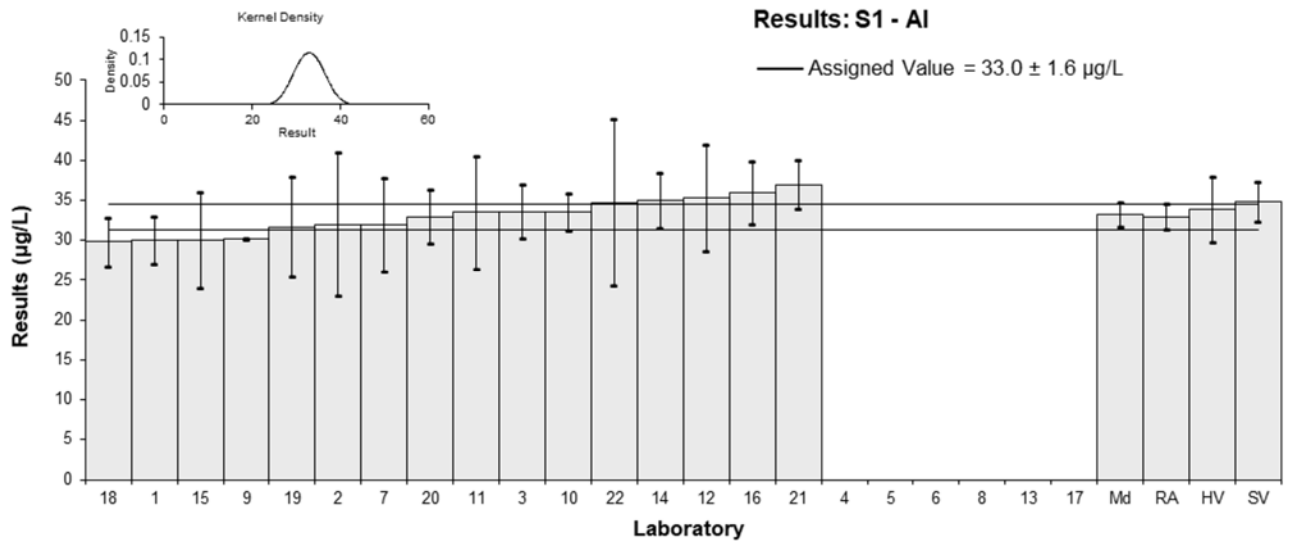


Figure 3

Table 7

Sample Details

Sample No.	S1
Matrix	River Water
Analyte	As
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	1	0.2	-0.20	-0.10
2	1	5	-0.20	0.00
3	1.07	0.67	0.49	0.07
4	NT	NT		
5	NT	NT		
6	NT	NT		
7	1	0.14	-0.20	-0.14
8	NT	NT		
9	0.99	0.002	-0.29	-0.75
10	1.00	0.076	-0.20	-0.23
11	0.94	0.21	-0.78	-0.37
12	1.06	0.17	0.39	0.23
13	NT	NT		
14	0.92	0.092	-0.98	-1.00
15	<1	NR		
16	1.1	0.1	0.78	0.74
17	NT	NT		
18	1.10	0.2	0.78	0.39
19	<1	NR		
20	1.04	0.10	0.20	0.19
21	<20	NR		
22	1.0806	0.32418	0.59	0.19

Statistics

Assigned Value	1.02	0.04
Spike Value	1.05	0.05
Homogeneity Value	1.09	0.13
Robust Average	1.02	0.04
Median	1.00	0.06
Mean	1.02	
N	13	
Max	1.1	
Min	0.92	
Robust SD	0.064	
Robust CV	6.3%	

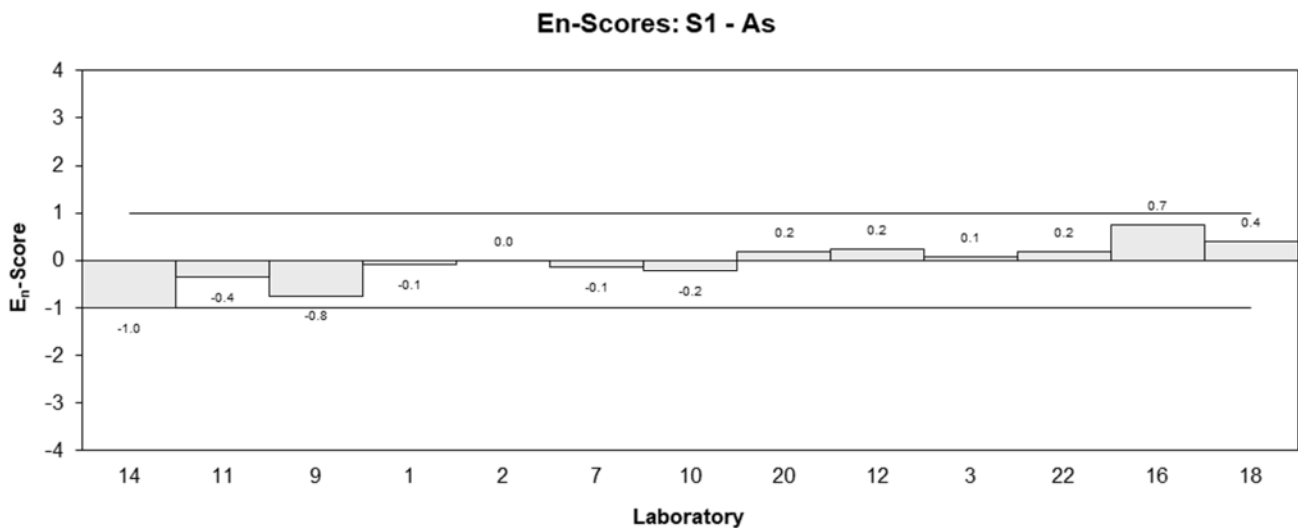
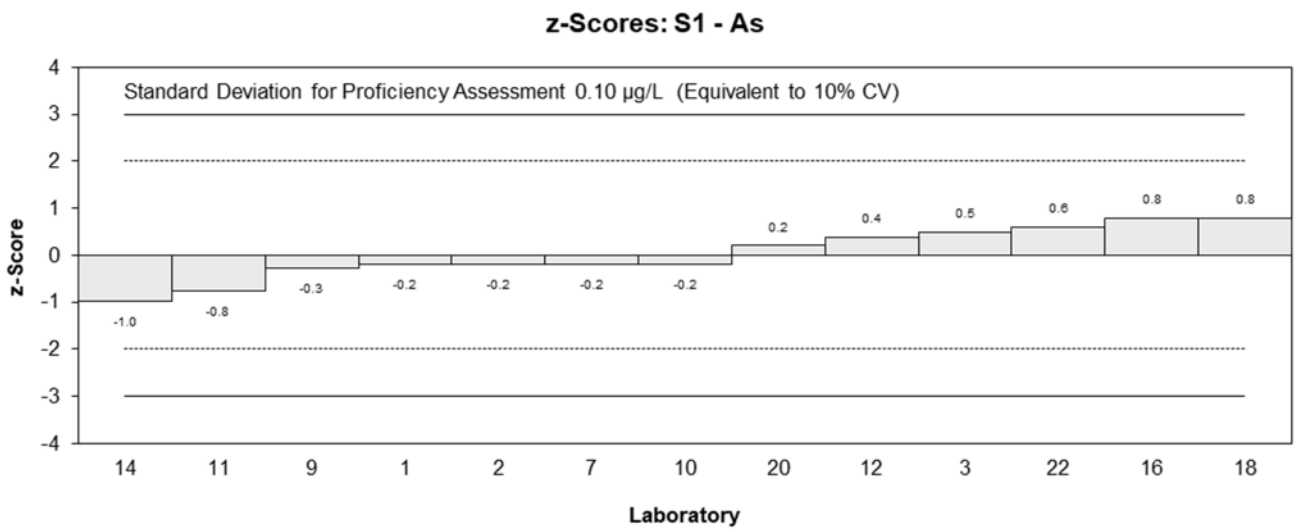
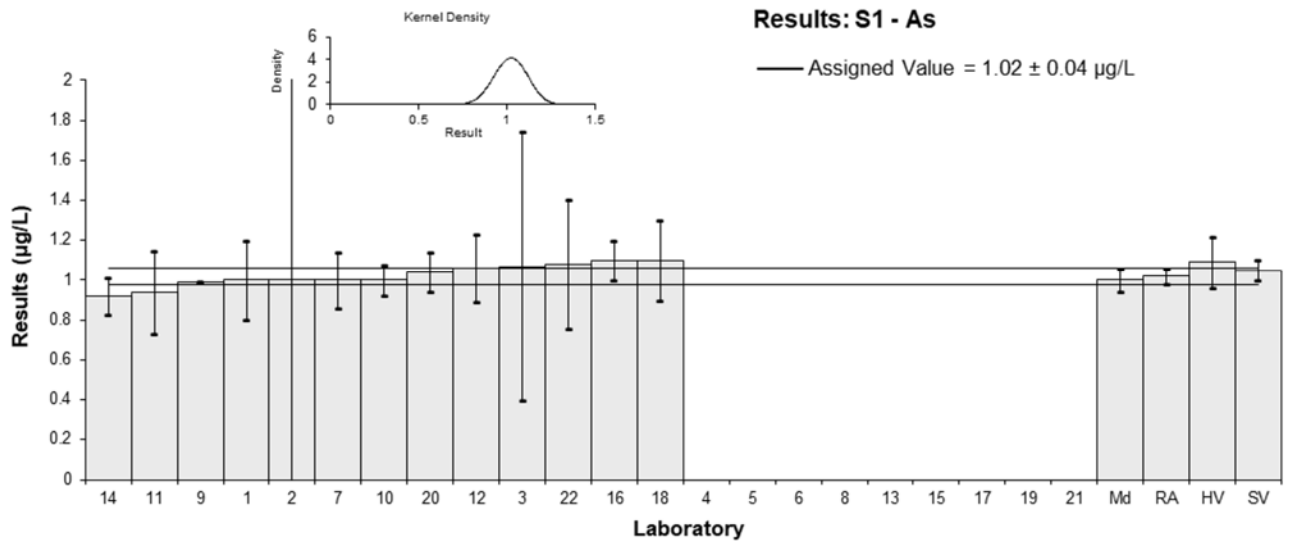


Figure 4

Table 8

Sample Details

Sample No.	S1
Matrix	River Water
Analyte	Be
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	1	0.1	-0.57	-0.56
2	<1	2		
3	1.07	0.11	0.09	0.09
4	NT	NT		
5	NT	NT		
6	NT	NT		
7	1	0.21	-0.57	-0.28
8	NT	NT		
9	1.08	0.001	0.19	0.50
10	1.07	0.11	0.09	0.09
11	1.04	0.33	-0.19	-0.06
12	NT	NT		
13	NT	NT		
14	1.1	0.11	0.38	0.34
15	1.1	0.2	0.38	0.20
16	1.1	0.3	0.38	0.13
17	NT	NT		
18	0.95	0.2	-1.04	-0.54
19	1.11	0.22	0.47	0.22
20	1.09	0.11	0.28	0.26
21	<2	NR		
22	<0.5	NR		

Statistics

Assigned Value	1.06	0.04
Spike Value	1.02	0.05
Homogeneity Value	1.02	0.12
Robust Average	1.06	0.04
Median	1.08	0.03
Mean	1.06	
N	12	
Max	1.11	
Min	0.95	
Robust SD	0.05	
Robust CV	4.7%	

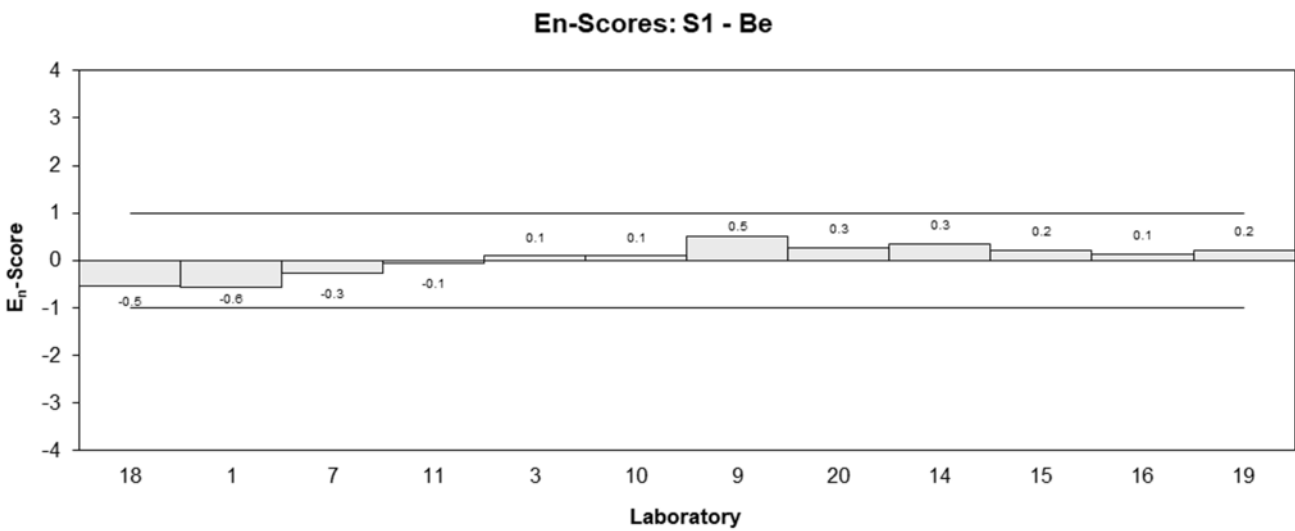
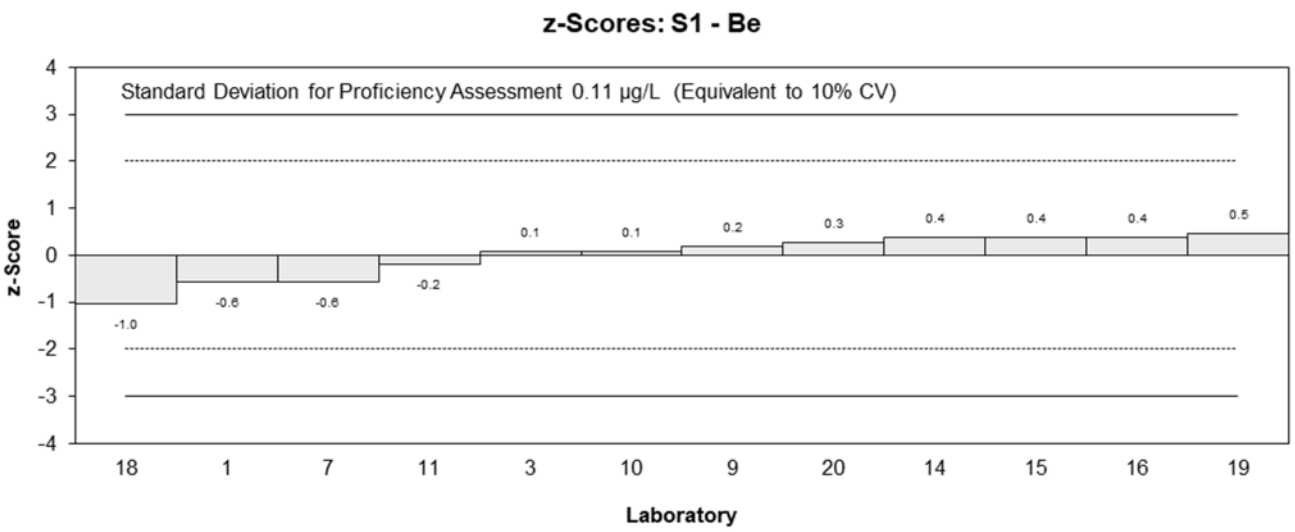
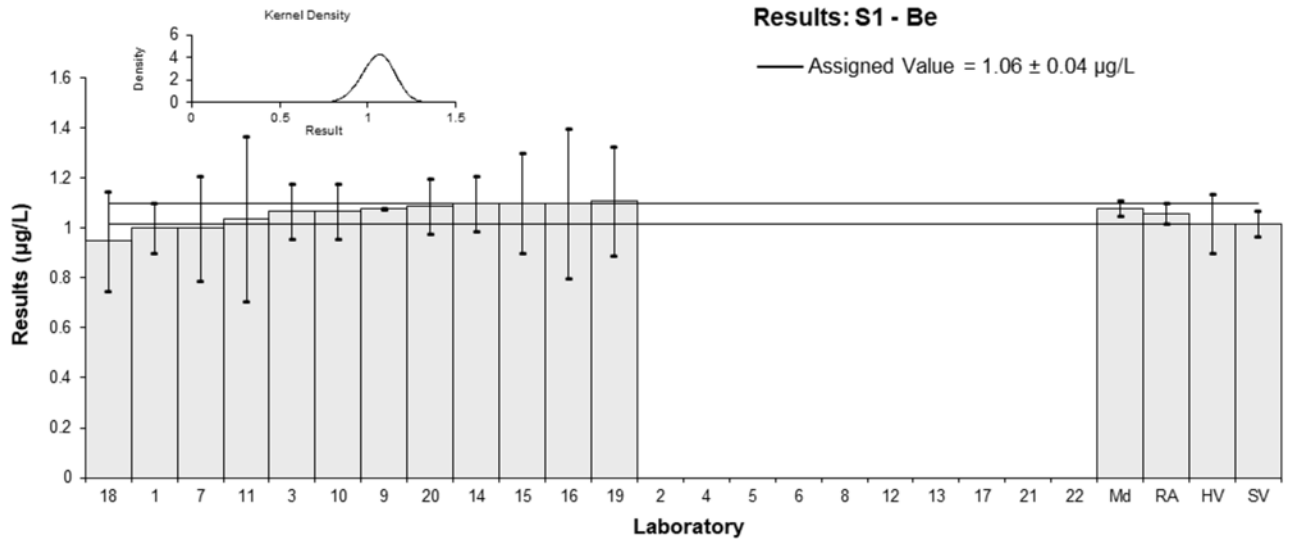


Figure 5

Table 9

Sample Details

Sample No.	S1
Matrix	River Water
Analyte	Cd
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.8	0.05	-0.16	-0.20
2	0.8	0.8	-0.16	-0.02
3	0.82	0.13	0.09	0.05
4	NT	NT		
5	NT	NT		
6	NT	NT		
7	0.81	0.06	-0.04	-0.04
8	NT	NT		
9	0.86	0.001	0.58	1.17
10	0.75	0.072	-0.77	-0.76
11	0.74	0.17	-0.90	-0.42
12	0.886	0.195	0.90	0.37
13	NT	NT		
14	0.78	0.078	-0.41	-0.38
15	<1	NR		
16	0.88	0.8	0.82	0.08
17	NT	NT		
18	0.74	0.1	-0.90	-0.68
19	0.766	0.453	-0.58	-0.10
20	0.79	0.08	-0.28	-0.26
21	1	0.2	2.30	0.92
22	0.861	0.2583	0.59	0.18

Statistics

Assigned Value	0.813	0.040
Spike Value	0.811	0.041
Homogeneity Value	0.823	0.099
Robust Average	0.813	0.040
Median	0.800	0.048
Mean	0.819	
N	15	
Max	1	
Min	0.74	
Robust SD	0.062	
Robust CV	7.6%	

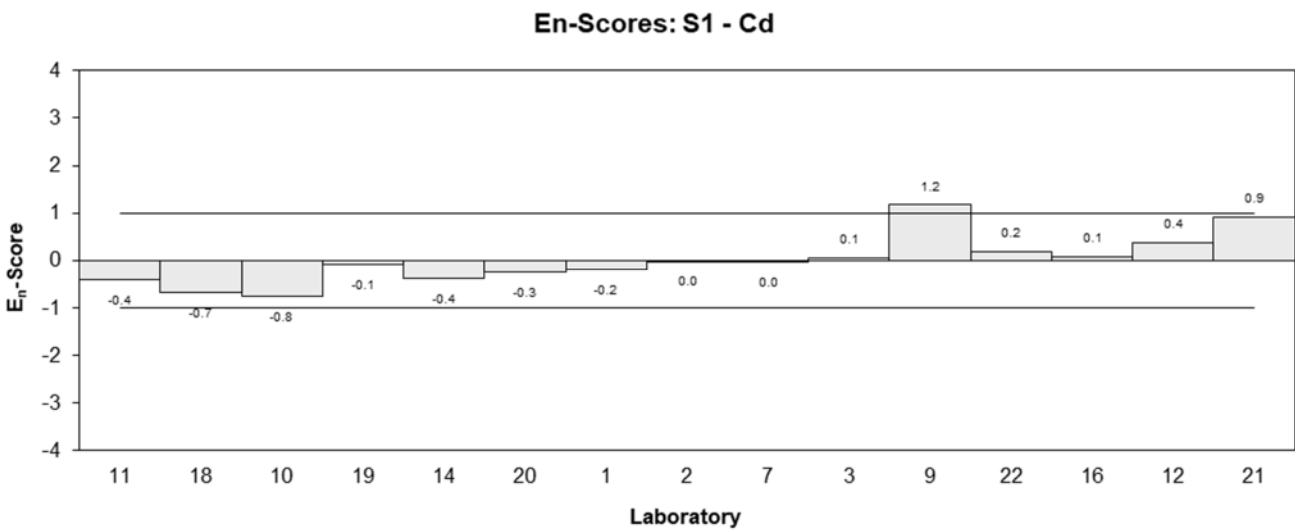
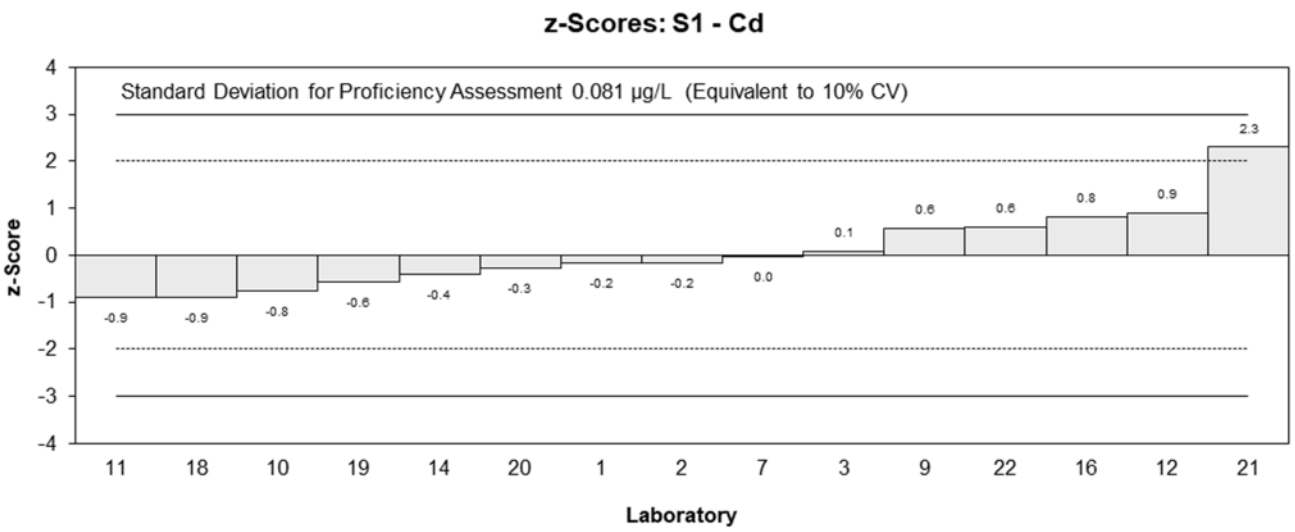
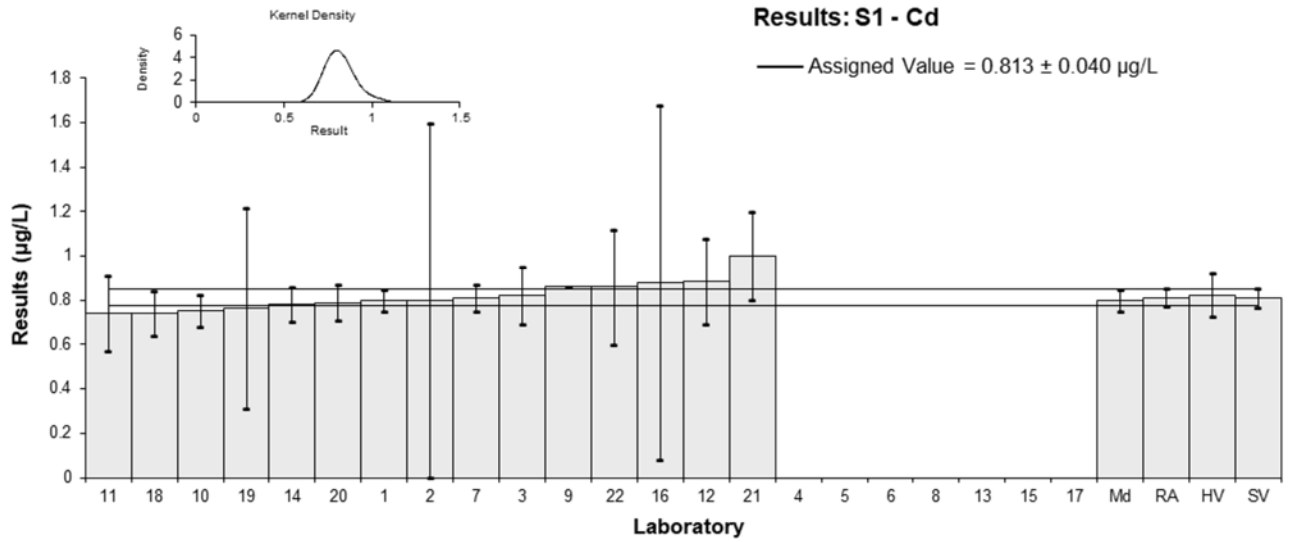


Figure 6

Table 10

Sample Details

Sample No.	S1
Matrix	River Water
Analyte	Co
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	2	0.1	2.11	3.07
2	1	1	-2.28	-0.52
3	1.64	0.15	0.53	0.62
4	NT	NT		
5	NT	NT		
6	NT	NT		
7	1.6	0.18	0.35	0.37
8	NT	NT		
9	1.27	0.001	-1.10	-2.08
10	1.51	0.12	-0.04	-0.06
11	1.47	0.36	-0.22	-0.13
12	1.67	0.35	0.66	0.41
13	NT	NT		
14	1.1	0.11	-1.84	-2.58
15	1.5	0.2	-0.09	-0.09
16	1.6	0.3	0.35	0.25
17	NT	NT		
18	1.51	0.2	-0.04	-0.04
19	1.56	0.31	0.18	0.12
20	1.66	0.17	0.61	0.67
21	<3	NR		
22	1.5407	0.46221	0.09	0.04

Statistics

Assigned Value	1.52	0.12
Spike Value	1.52	0.08
Homogeneity Value	1.63	0.20
Robust Average	1.52	0.12
Median	1.54	0.07
Mean	1.51	
N	15	
Max	2	
Min	1	
Robust SD	0.18	
Robust CV	12%	

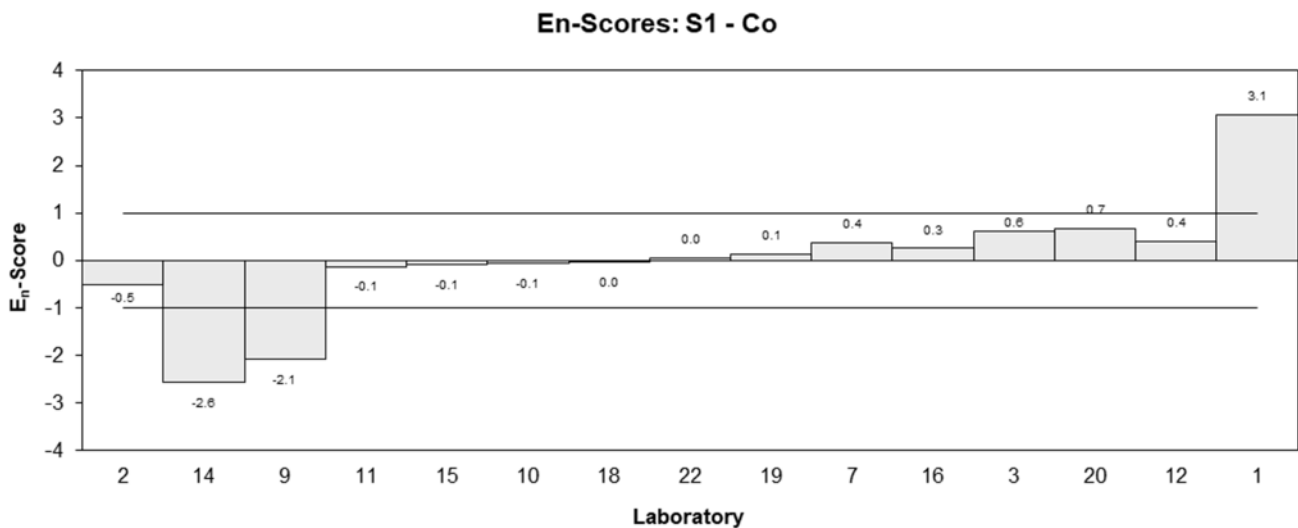
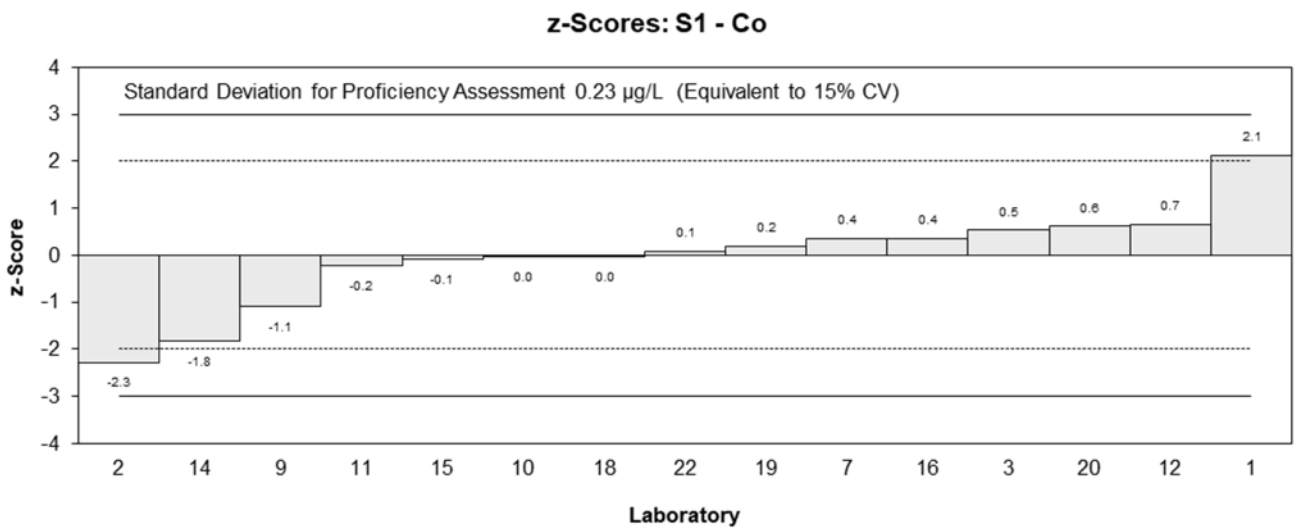
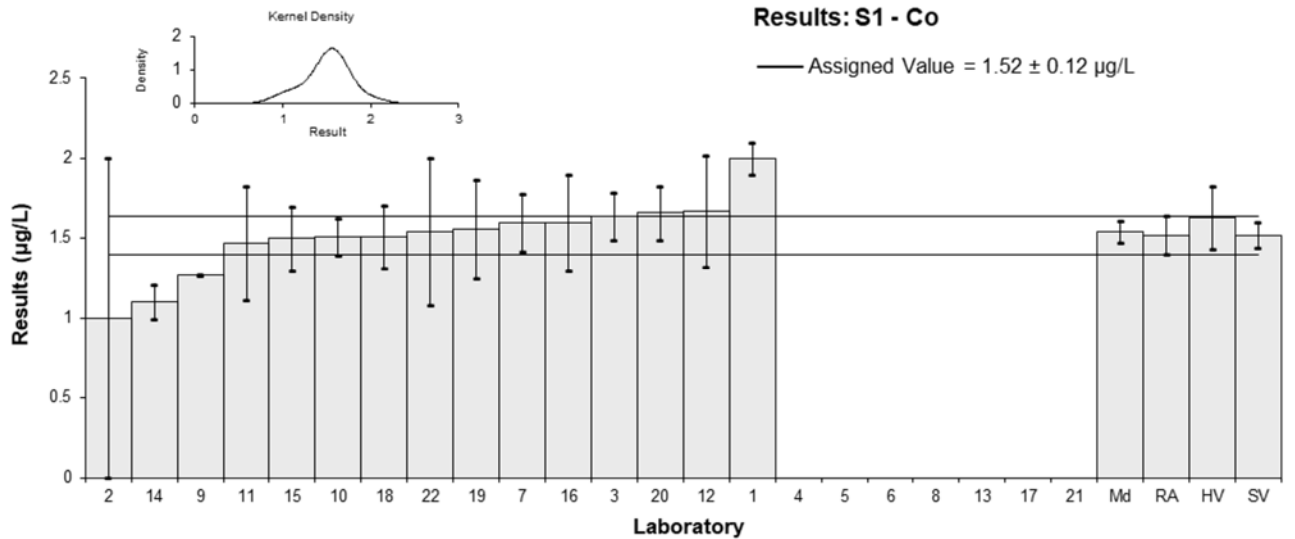


Figure 7

Table 11

Sample Details

Sample No.	S1
Matrix	River Water
Analyte	Cr
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	2	0.2	2.86	2.46
2	1.3	1.2	-0.48	-0.08
3	1.45	0.35	0.24	0.13
4	NT	NT		
5	NT	NT		
6	NT	NT		
7	1.4	0.24	0.00	0.00
8	NT	NT		
9	0.96	0.002	-2.10	-3.14
10	1.58	0.12	0.86	0.98
11	1.40	0.38	0.00	0.00
12	1.27	0.19	-0.62	-0.55
13	NT	NT		
14	1.1	0.11	-1.43	-1.68
15	1.5	0.2	0.48	0.41
16	1.6	0.3	0.95	0.60
17	NT	NT		
18	1.32	0.2	-0.38	-0.33
19	1.46	0.29	0.29	0.19
20	1.58	0.16	0.86	0.85
21	<3	NR		
22	1.2044	0.36132	-0.93	-0.50

Statistics

Assigned Value	1.40	0.14
Spike Value	1.45	0.07
Homogeneity Value	1.43	0.17
Robust Average	1.40	0.14
Median	1.40	0.12
Mean	1.41	
N	15	
Max	2	
Min	0.96	
Robust SD	0.21	
Robust CV	15%	

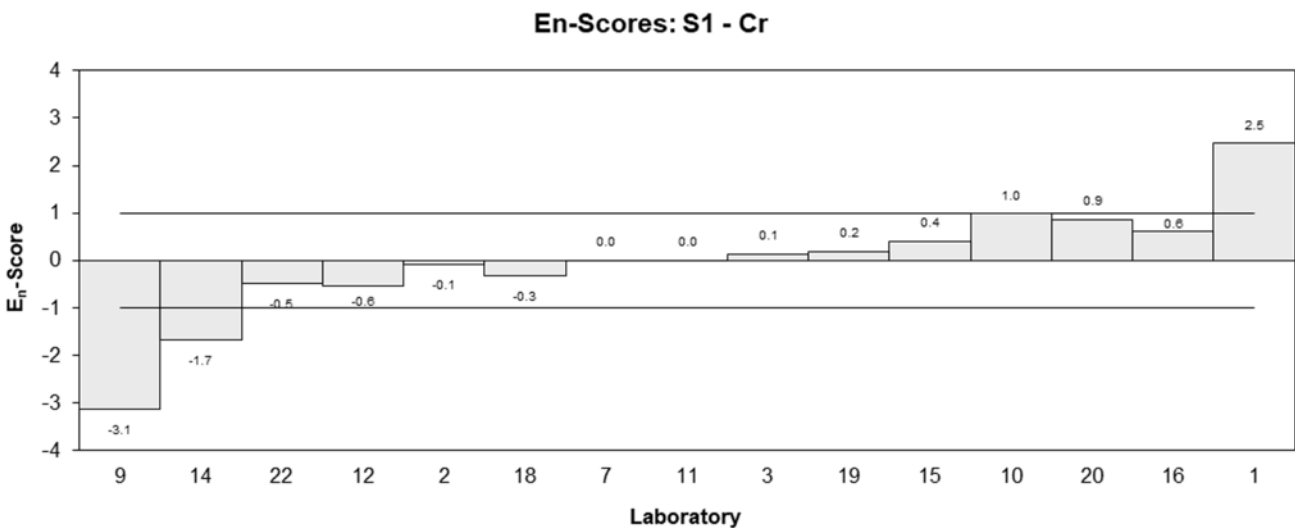
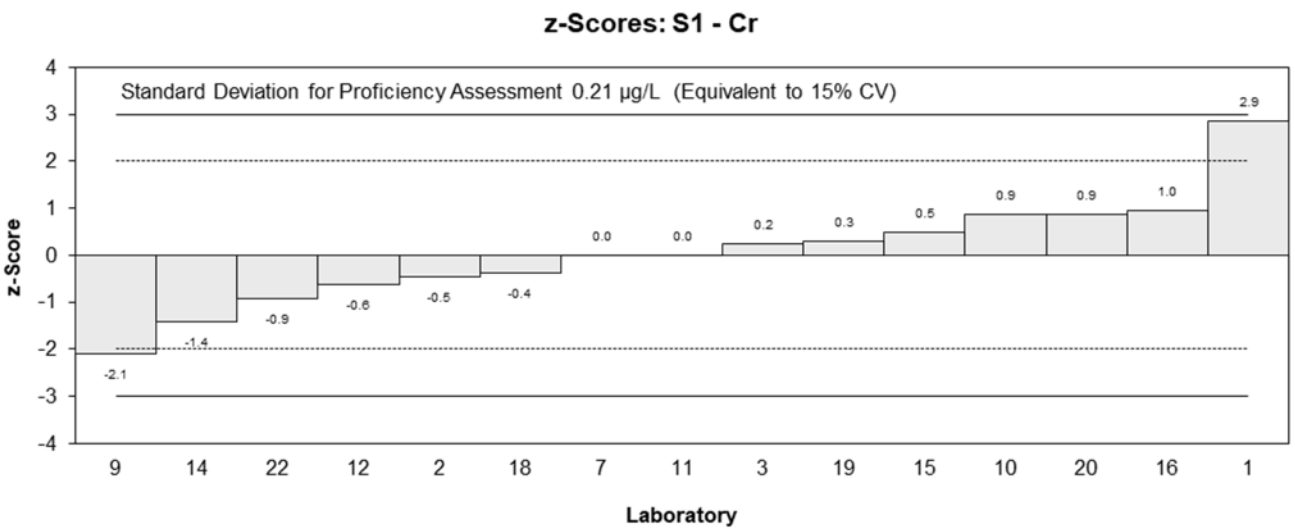
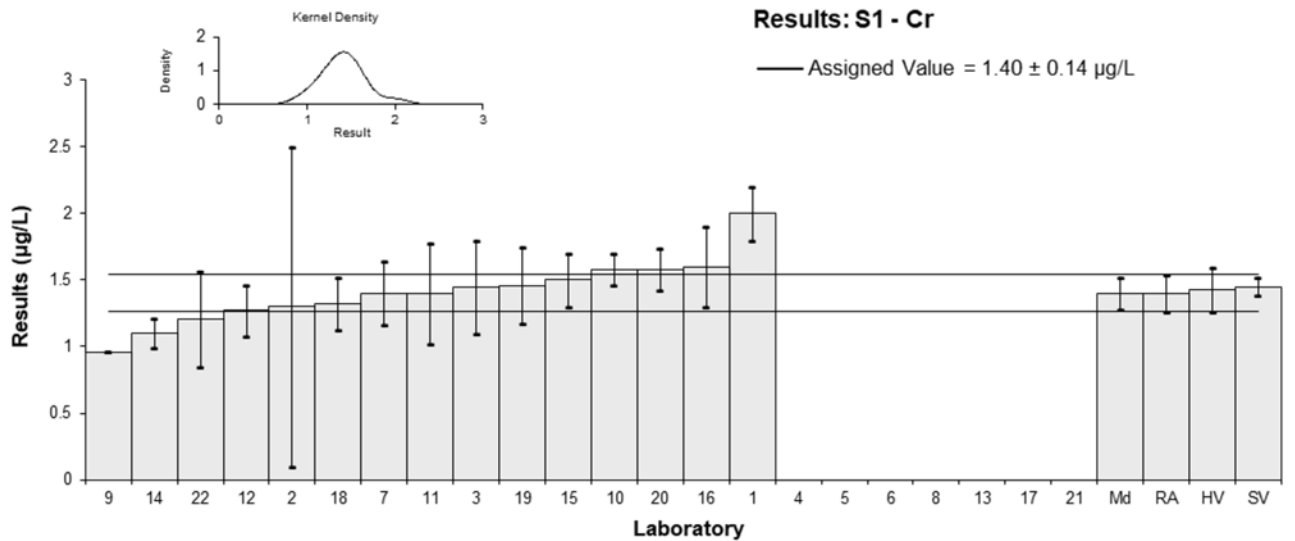


Figure 8

Table 12

Sample Details

Sample No.	S1
Matrix	River Water
Analyte	Cu
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	15	2	0.20	0.15
2	14	2	-0.48	-0.34
3	15.1	1.5	0.27	0.25
4	NT	NT		
5	NT	NT		
6	NT	NT		
7	15.3	1.58	0.41	0.36
8	NT	NT		
9	14.84	0.002	0.10	0.28
10	15.26	1.21	0.38	0.43
11	14.5	3.4	-0.14	-0.06
12	15.6	2.6	0.61	0.34
13	NT	NT		
14	14	1.5	-0.48	-0.44
15	14	2	-0.48	-0.34
16	15.7	3	0.68	0.33
17	NT	NT		
18	14.4	1.5	-0.20	-0.19
19	14.6	2.9	-0.07	-0.03
20	15.48	1.55	0.53	0.48
21	14	1	-0.48	-0.63
22	11.7072	3.51216	-2.04	-0.84

Statistics

Assigned Value	14.7	0.5
Spike Value	14.7	1.2
Homogeneity Value	14.7	1.8
Robust Average	14.7	0.5
Median	14.7	0.6
Mean	14.6	
N	16	
Max	15.7	
Min	11.7072	
Robust SD	0.76	
Robust CV	5.2%	

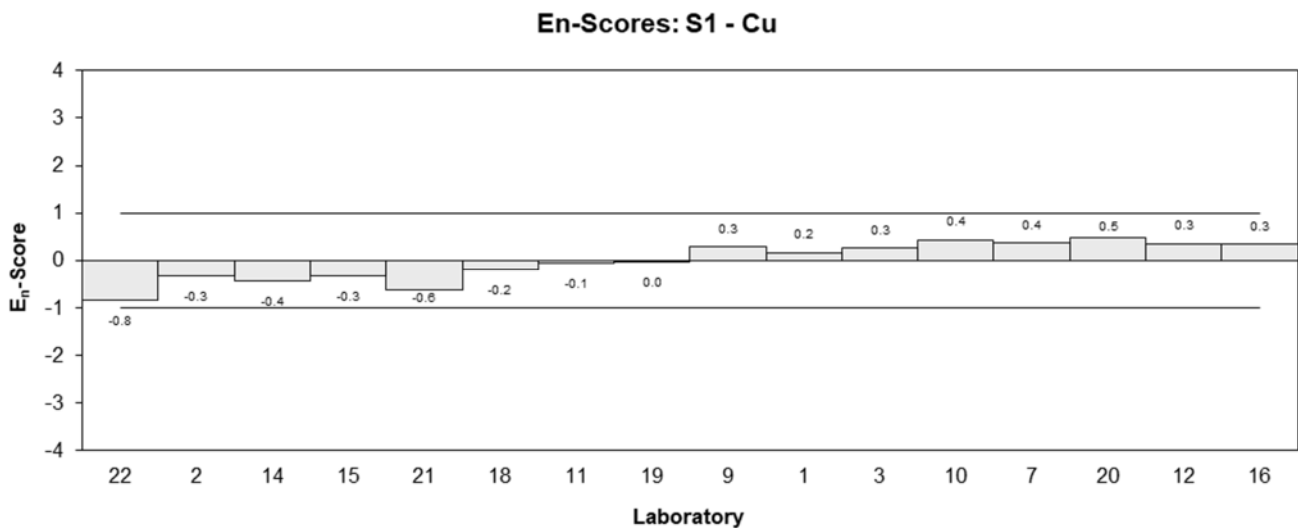
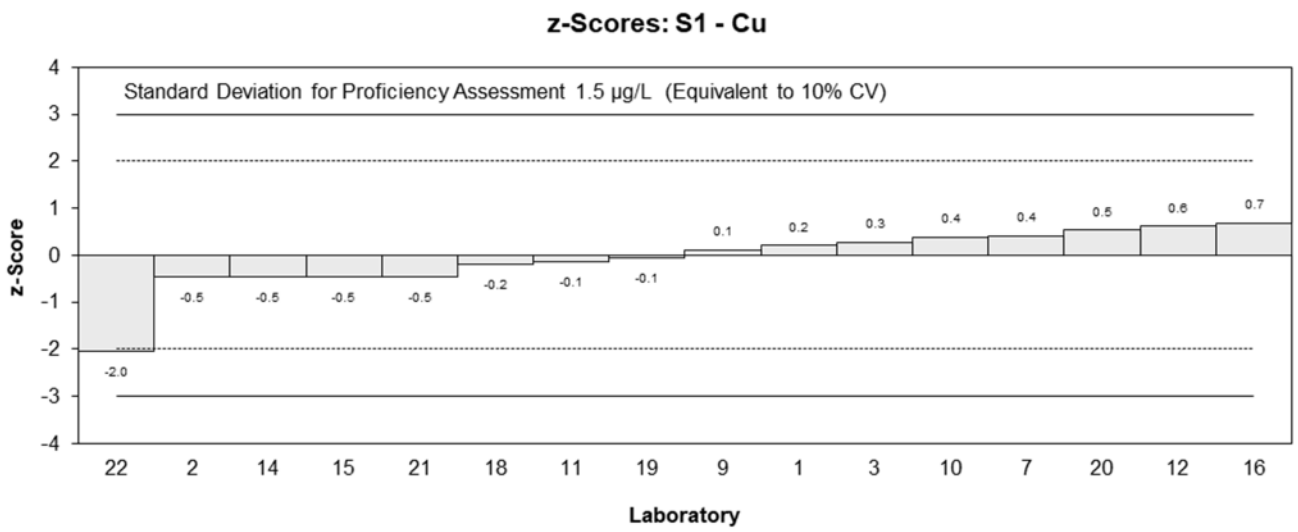
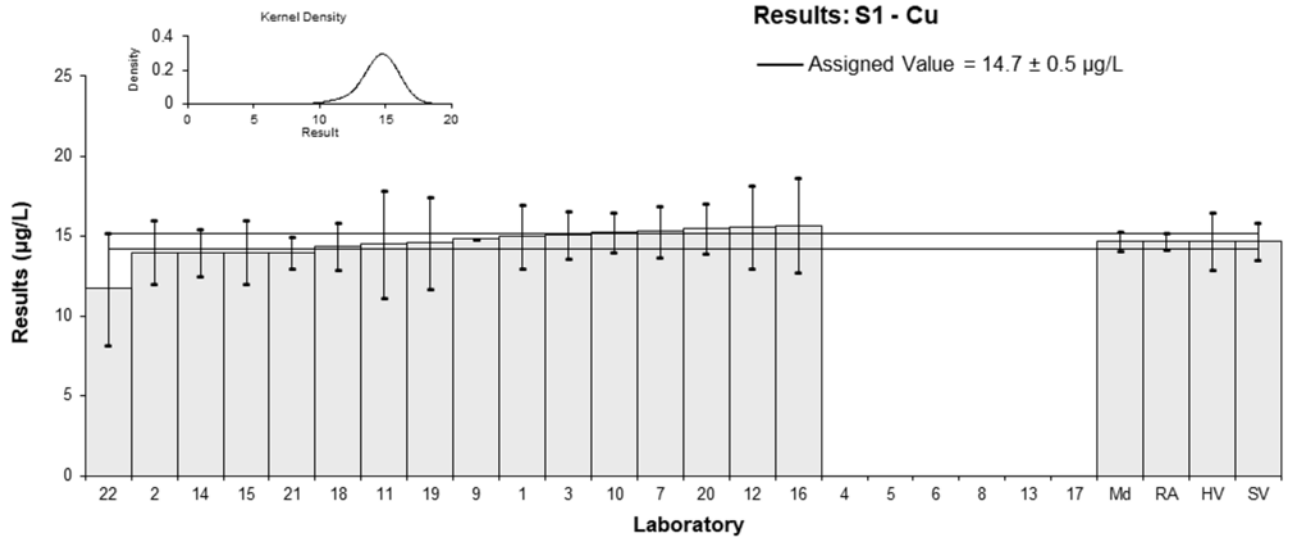


Figure 9

Table 13

Sample Details

Sample No.	S1
Matrix	River Water
Analyte	Fe
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	180	17	0.40	0.38
2	162	16.2	-0.64	-0.62
3	180	19	0.40	0.35
4	NT	NT		
5	NT	NT		
6	NT	NT		
7	168	22.0	-0.29	-0.22
8	NT	NT		
9	173.74	0.011	0.04	0.11
10	179.72	12.69	0.39	0.46
11	187	45	0.81	0.31
12	161	21	-0.69	-0.54
13	NT	NT		
14	160	1.5	-0.75	-1.82
15	160	29	-0.75	-0.44
16	176	35.2	0.17	0.08
17	NT	NT		
18	155	16	-1.04	-1.03
19	185	37	0.69	0.32
20	182	18.2	0.52	0.46
21	170	10	-0.17	-0.25
22	184.3423	55.30269	0.66	0.20

Statistics

Assigned Value	173	7
Spike Value	Not Spiked	
Homogeneity Value	183	22
Robust Average	173	7
Median	175	8
Mean	173	
N	16	
Max	187	
Min	155	
Robust SD	12	
Robust CV	6.9%	

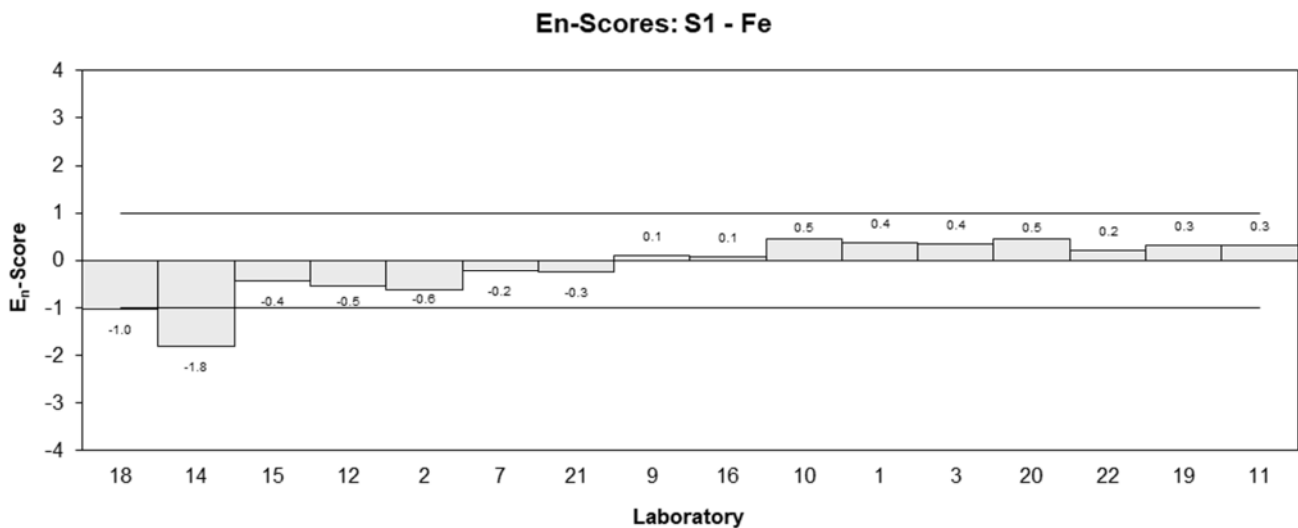
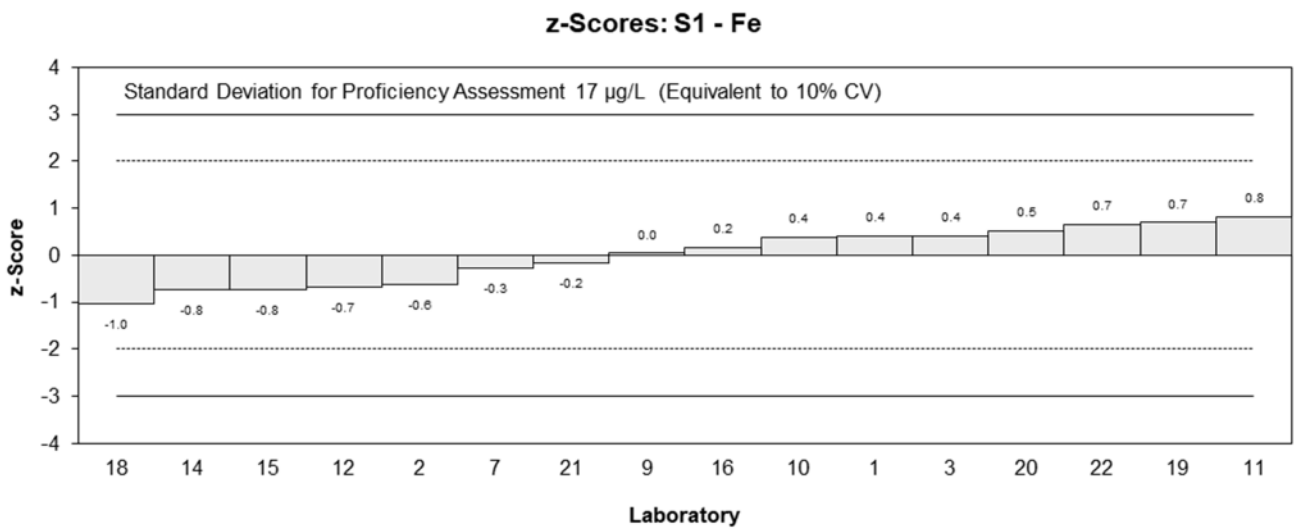
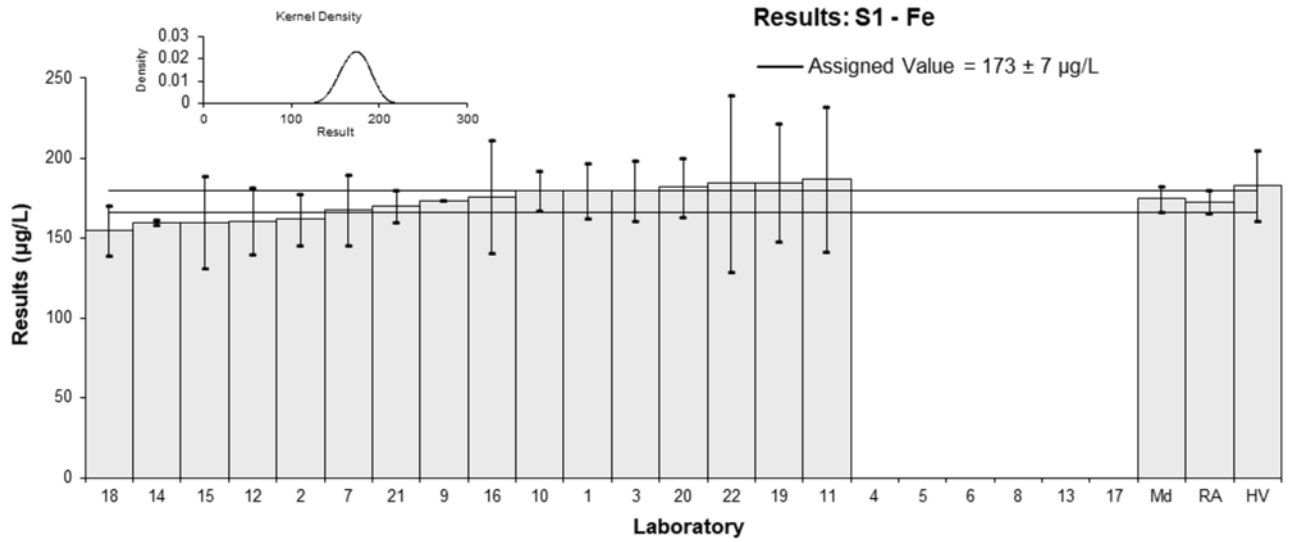


Figure 10

Table 14

Sample Details

Sample No.	S1
Matrix	River Water
Analyte	Hg
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	0.2	0.08	-2.00	-1.01
2	0.28	0.08	-0.14	-0.07
3	0.29	NR	0.09	0.14
4	NT	NT		
5	NT	NT		
6	NT	NT		
7	0.26	0.026	-0.61	-0.67
8	NT	NT		
9	0.29	0.0001	0.09	0.14
10	0.311	0.053	0.58	0.41
11	0.22	0.02	-1.54	-1.87
12	0.307	0.071	0.49	0.27
13	NT	NT		
14	0.26	0.026	-0.61	-0.67
15	0.32	0.06	0.79	0.51
16	0.28	0.03	-0.14	-0.14
17	NT	NT		
18	0.25	0.1	-0.84	-0.35
19	0.345	0.069	1.38	0.79
20	0.30	0.03	0.33	0.34
21	<5	NR		
22	0.3622	0.10866	1.78	0.68

Statistics

Assigned Value	0.286	0.029
Spike Value	0.302	0.015
Homogeneity Value	0.319	0.038
Robust Average	0.286	0.029
Median	0.290	0.029
Mean	0.285	
N	15	
Max	0.3622	
Min	0.2	
Robust SD	0.044	
Robust CV	16%	

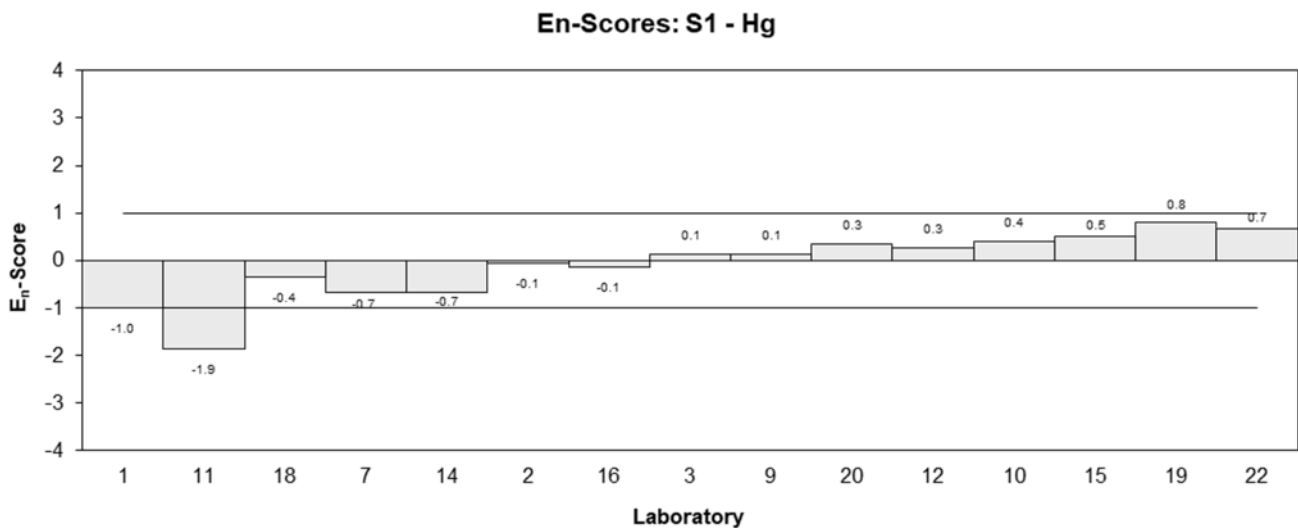
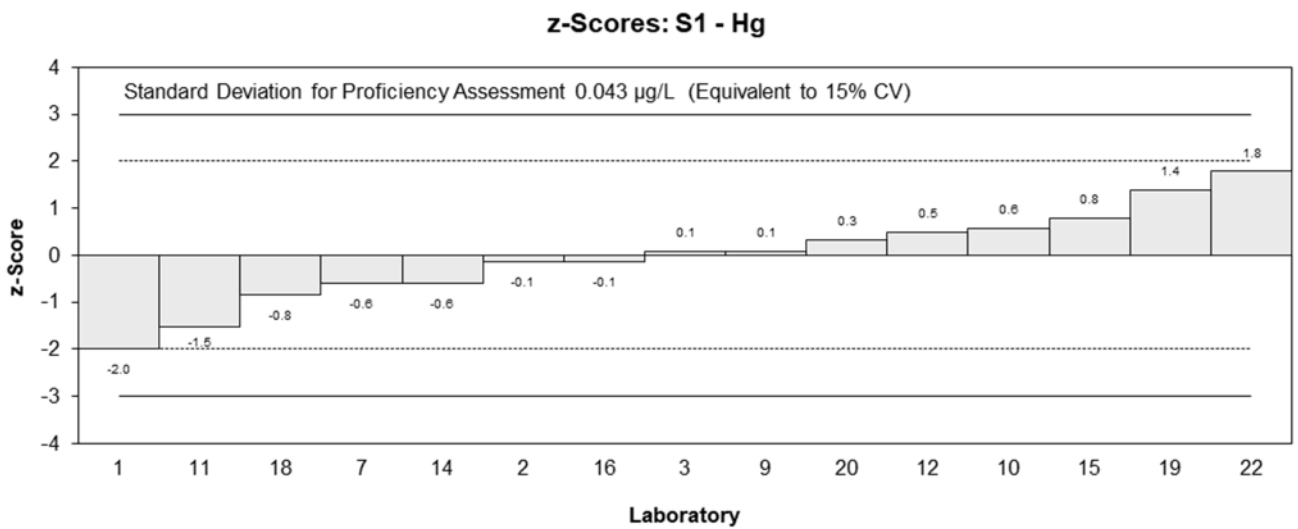
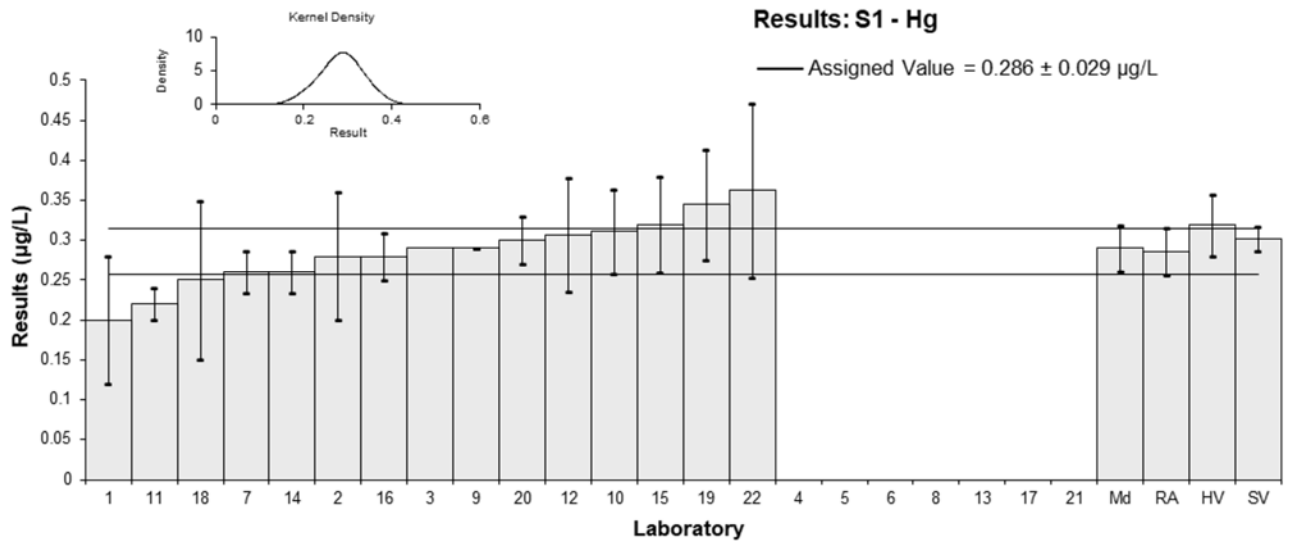


Figure 11

Table 15

Sample Details

Sample No.	S1
Matrix	River Water
Analyte	Mn
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	<1	NR		
2	<0.5	2		
3	0.59	0.34	1.31	0.28
4	NT	NT		
5	NT	NT		
6	NT	NT		
7	<0.5	NR		
8	NT	NT		
9	0.49	0.0001	-0.04	-0.04
10	<1	NR		
11	0.48	0.13	-0.18	-0.08
12	0.505	0.106	0.16	0.09
13	NT	NT		
14	NT	NT		
15	<1	NR		
16	<0.5	0.08		
17	NT	NT		
18	0.37	0.1	-1.66	-0.96
19	<1	NR		
20	0.52	0.05	0.37	0.28
21	<2	NR		
22	<0.5	NR		

Statistics

Assigned Value	0.493	0.081
Spike Value	Not Spiked	
Homogeneity Value	0.532	0.064
Robust Average	0.493	0.081
Median	0.498	0.030
Mean	0.493	
N	6	
Max	0.59	
Min	0.37	
Robust SD	0.08	
Robust CV	16%	

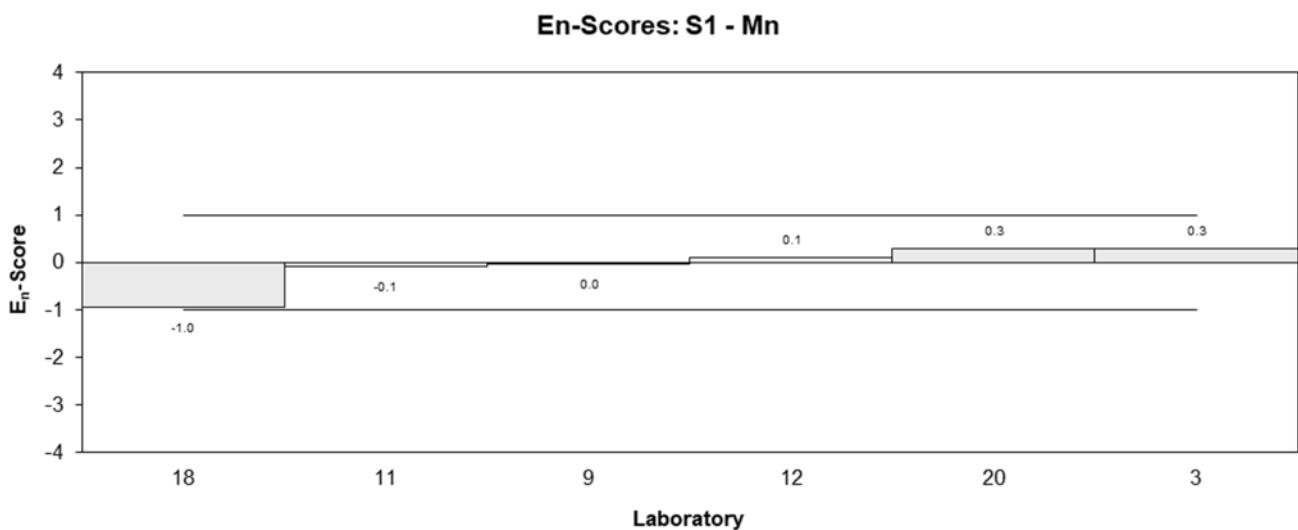
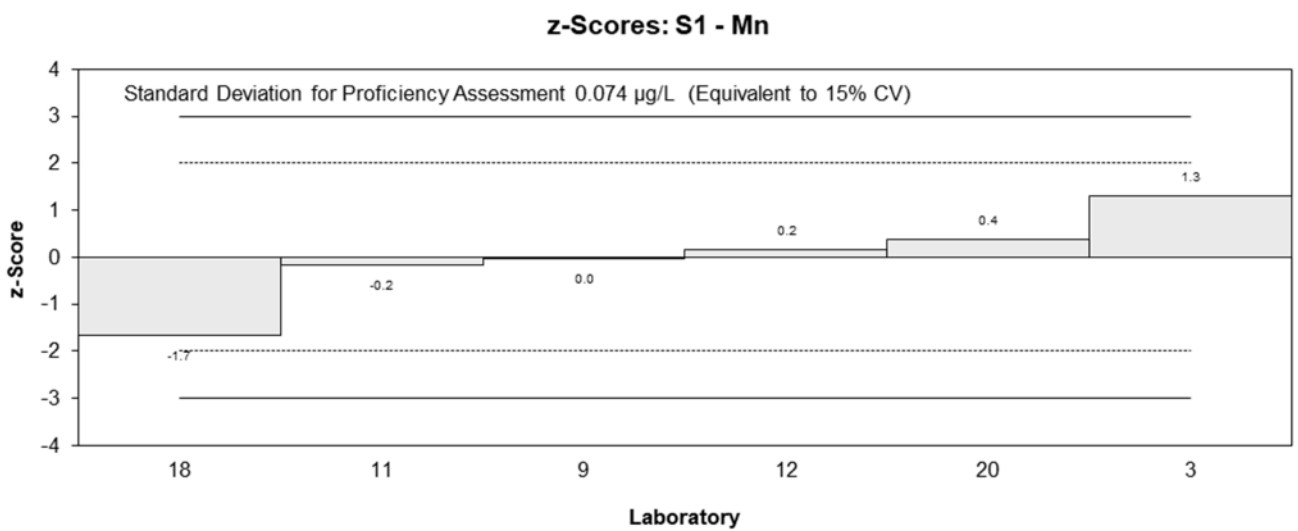
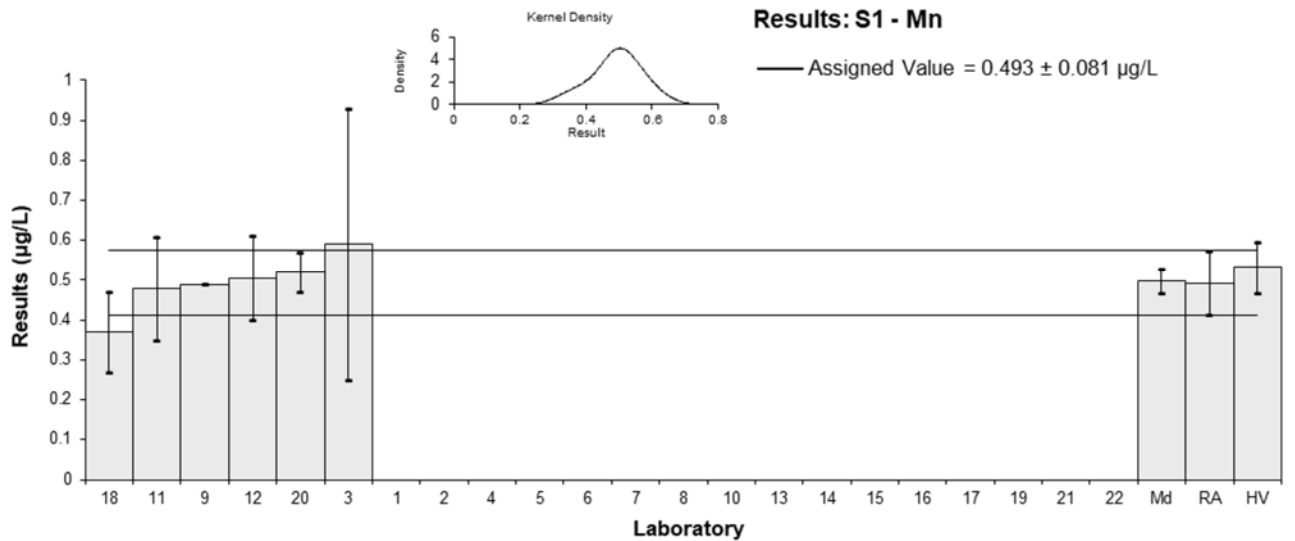


Figure 12

Table 16

Sample Details

Sample No.	S1
Matrix	River Water
Analyte	Mo
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	6	0.5	1.36	1.21
2	4.8	6	-0.91	-0.08
3	5.39	0.88	0.21	0.12
4	NT	NT		
5	NT	NT		
6	NT	NT		
7	5.4	0.6	0.23	0.18
8	NT	NT		
9	5.21	0.001	-0.13	-0.22
10	4.62	0.36	-1.25	-1.37
11	4.95	1.13	-0.63	-0.28
12	4.66	0.75	-1.17	-0.76
13	NT	NT		
14	5.3	0.53	0.04	0.03
15	4.7	0.9	-1.10	-0.61
16	5.4	0.5	0.23	0.20
17	NT	NT		
18	6.35	0.7	2.03	1.39
19	5.76	1.15	0.91	0.40
20	5.53	0.55	0.47	0.39
21	5.5	0.3	0.42	0.50
22	5.2233	1.56699	-0.11	-0.04

Statistics

Assigned Value	5.28	0.32
Spike Value	5.29	0.25
Homogeneity Value	5.35	0.64
Robust Average	5.28	0.32
Median	5.35	0.27
Mean	5.30	
N	16	
Max	6.35	
Min	4.62	
Robust SD	0.51	
Robust CV	9.6%	

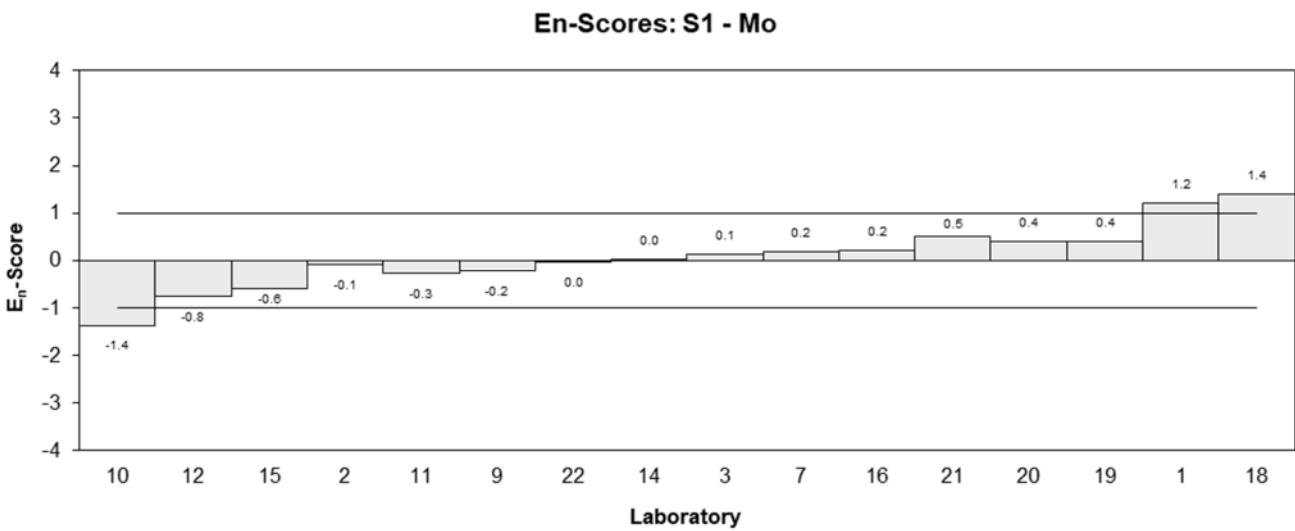
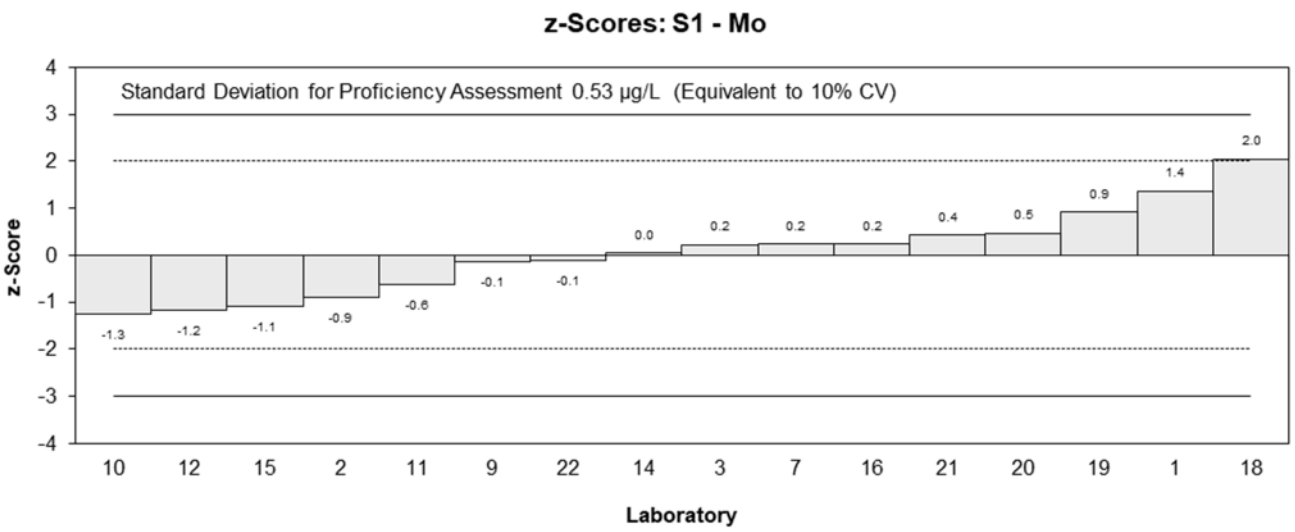
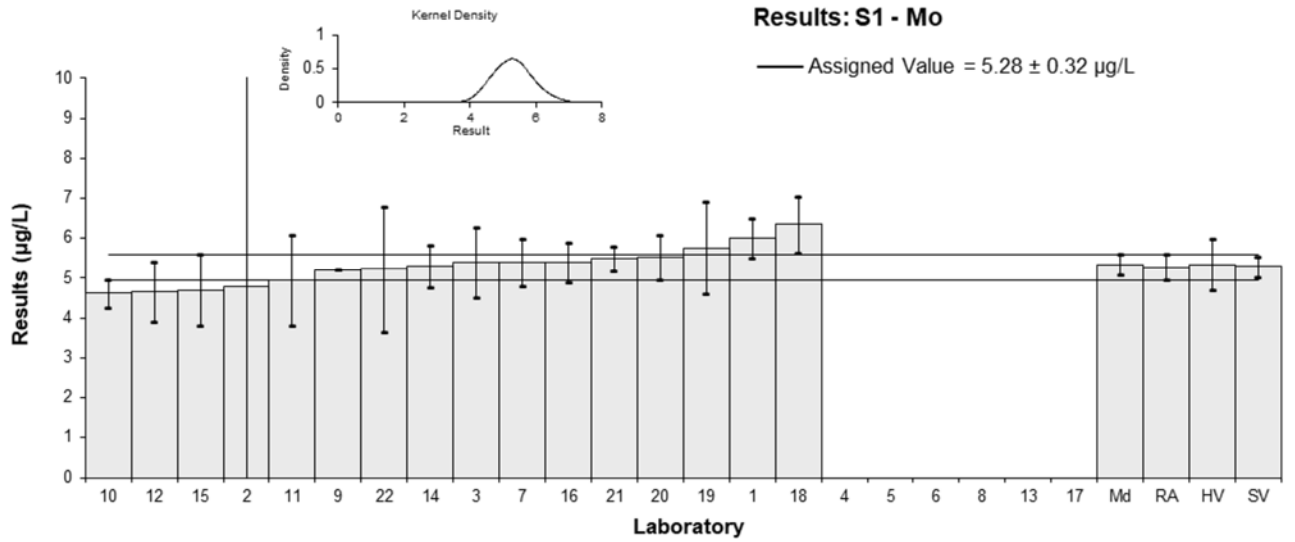


Figure 13

Table 17

Sample Details

Sample No.	S1
Matrix	River Water
Analyte	Ni
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	3	0.3	0.60	0.53
2	3	3	0.60	0.06
3	3.01	0.35	0.64	0.49
4	NT	NT		
5	NT	NT		
6	NT	NT		
7	2.8	0.4	-0.11	-0.07
8	NT	NT		
9	2.57	0.0001	-0.92	-2.36
10	2.85	0.25	0.07	0.07
11	2.65	0.59	-0.64	-0.30
12	3.00	0.42	0.60	0.39
13	NT	NT		
14	3	3.5	0.60	0.05
15	2.7	0.4	-0.46	-0.31
16	2.9	0.3	0.25	0.22
17	NT	NT		
18	2.68	0.3	-0.53	-0.47
19	2.72	0.54	-0.39	-0.20
20	2.91	0.29	0.28	0.26
21	<4	NR		
22	2.6831	0.80493	-0.52	-0.18

Statistics

Assigned Value	2.83	0.11
Spike Value	2.86	0.14
Homogeneity Value	2.66	0.32
Robust Average	2.83	0.11
Median	2.85	0.14
Mean	2.83	
N	15	
Max	3.01	
Min	2.57	
Robust SD	0.18	
Robust CV	6.2%	

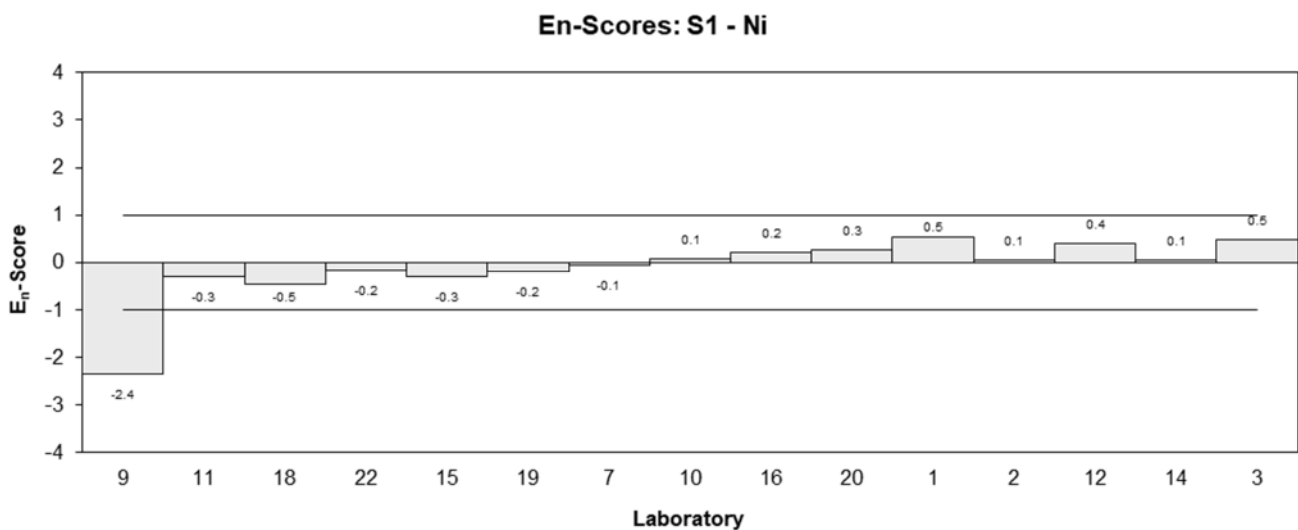
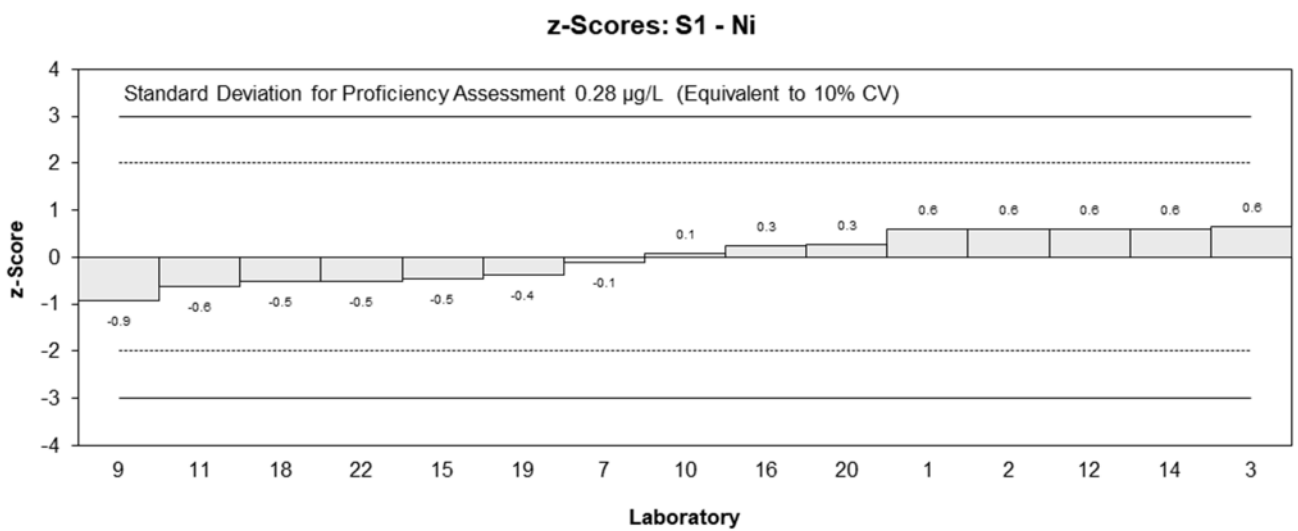
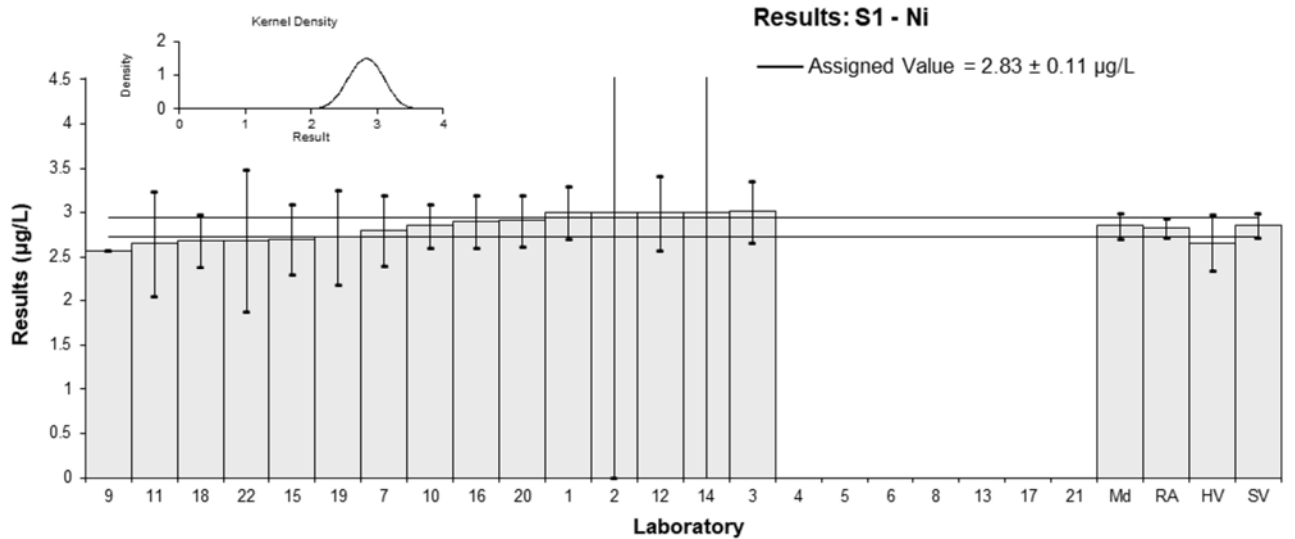


Figure 14

Table 18

Sample Details

Sample No.	S1
Matrix	River Water
Analyte	Pb
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	2	0.1	2.66	3.28
2	1	3	-3.67	-0.19
3	1.62	0.13	0.25	0.26
4	NT	NT		
5	NT	NT		
6	NT	NT		
7	1.6	0.18	0.13	0.10
8	NT	NT		
9	1.55	0.0001	-0.19	-0.37
10	1.70	0.13	0.76	0.79
11	1.61	0.36	0.19	0.08
12	1.68	0.34	0.63	0.29
13	NT	NT		
14	1.4	0.14	-1.14	-1.12
15	1.4	0.2	-1.14	-0.84
16	1.6	0.3	0.13	0.06
17	NT	NT		
18	1.52	0.2	-0.38	-0.28
19	1.53	0.31	-0.32	-0.16
20	1.64	0.16	0.38	0.34
21	<7	NR		
22	1.6261	0.48783	0.29	0.09

Statistics

Assigned Value	1.58	0.08
Spike Value	1.62	0.08
Homogeneity Value	1.58	0.19
Robust Average	1.58	0.08
Median	1.60	0.07
Mean	1.57	
N	15	
Max	2	
Min	1	
Robust SD	0.13	
Robust CV	8.1%	

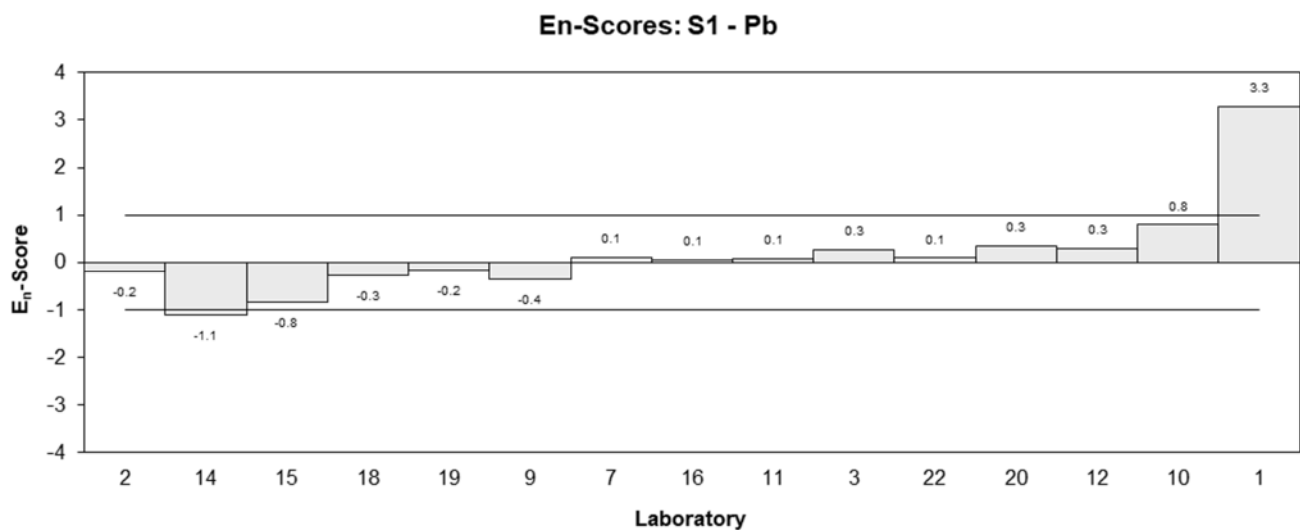
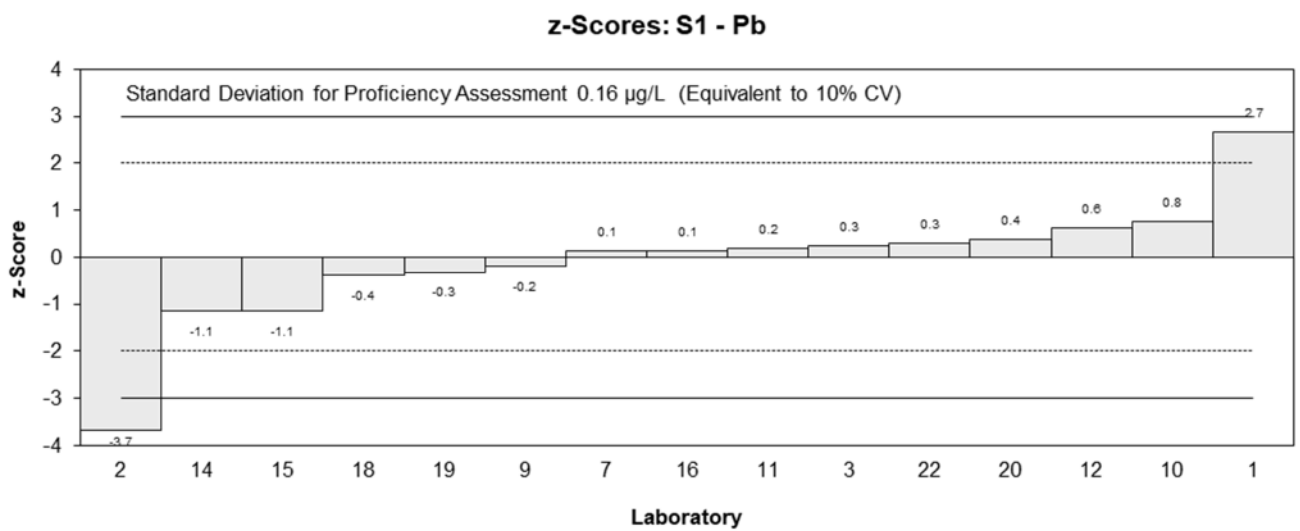
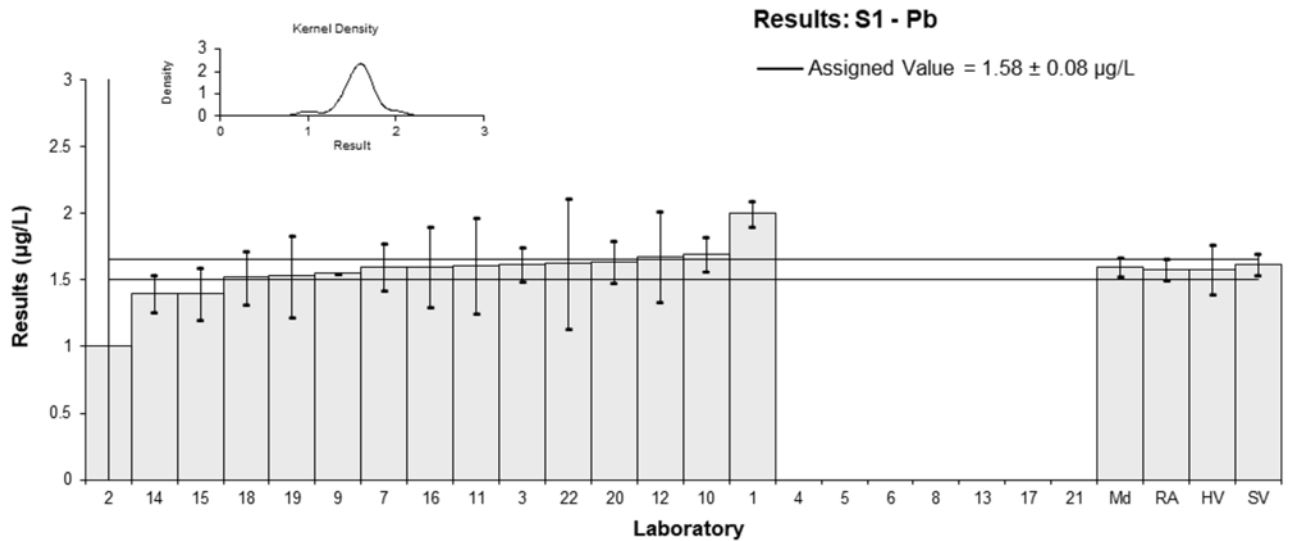


Figure 15

Table 19

Sample Details

Sample No.	S1
Matrix	River Water
Analyte	Sb
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	3	0.6	0.60	0.27
2	2.5	0.8	-1.17	-0.40
3	2.80	0.43	-0.11	-0.06
4	NT	NT		
5	NT	NT		
6	NT	NT		
7	3.2	0.74	1.31	0.48
8	NT	NT		
9	2.68	0.001	-0.53	-0.75
10	2.78	0.30	-0.18	-0.14
11	2.47	0.55	-1.27	-0.62
12	3.09	0.68	0.92	0.37
13	NT	NT		
14	2.8	0.28	-0.11	-0.09
15	2	0.3	-2.93	-2.30
16	3.1	2.4	0.95	0.11
17	NT	NT		
18	2.94	0.4	0.39	0.25
19	2.62	0.52	-0.74	-0.38
20	2.87	0.29	0.14	0.11
21	<10	NR		
22	3.2455	0.97365	1.47	0.42

Statistics

Assigned Value	2.83	0.20
Spike Value	2.73	0.13
Homogeneity Value	2.75	0.33
Robust Average	2.83	0.20
Median	2.80	0.19
Mean	2.81	
N	15	
Max	3.2455	
Min	2	
Robust SD	0.3	
Robust CV	11%	

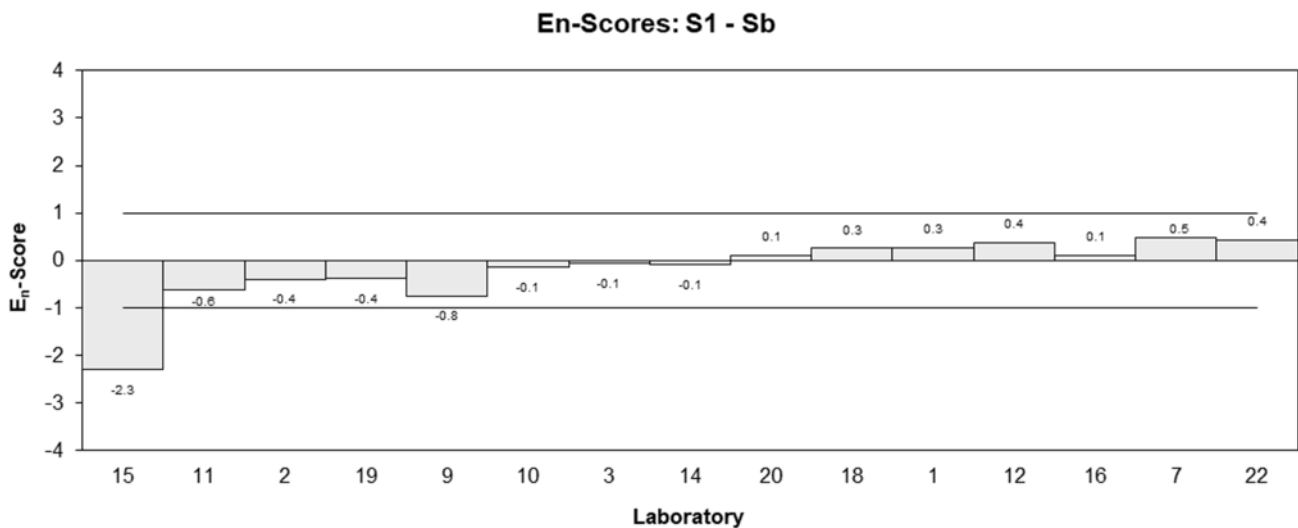
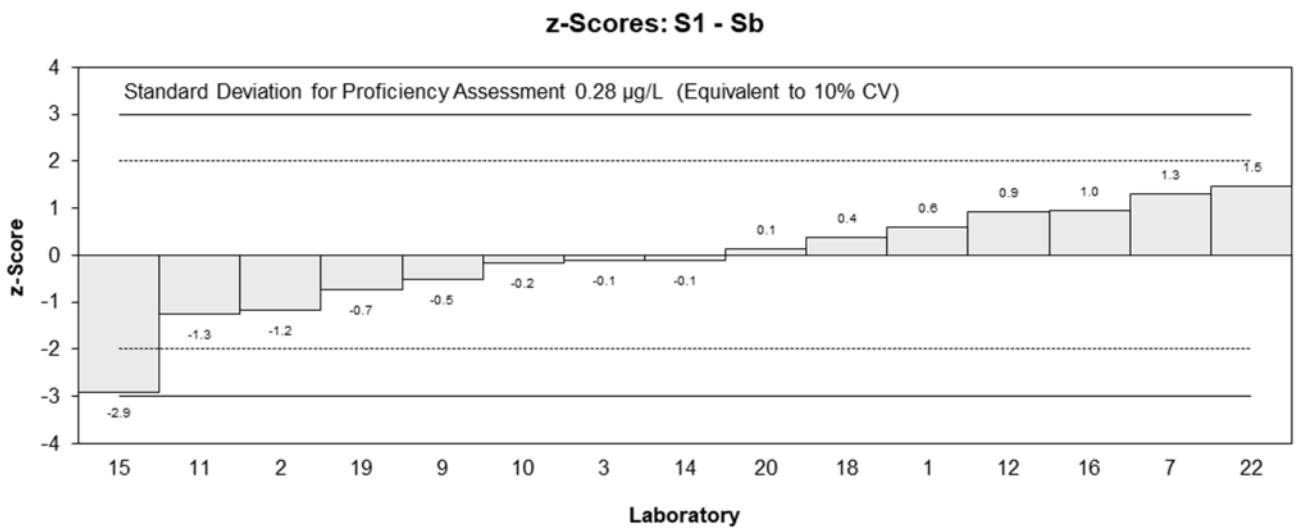
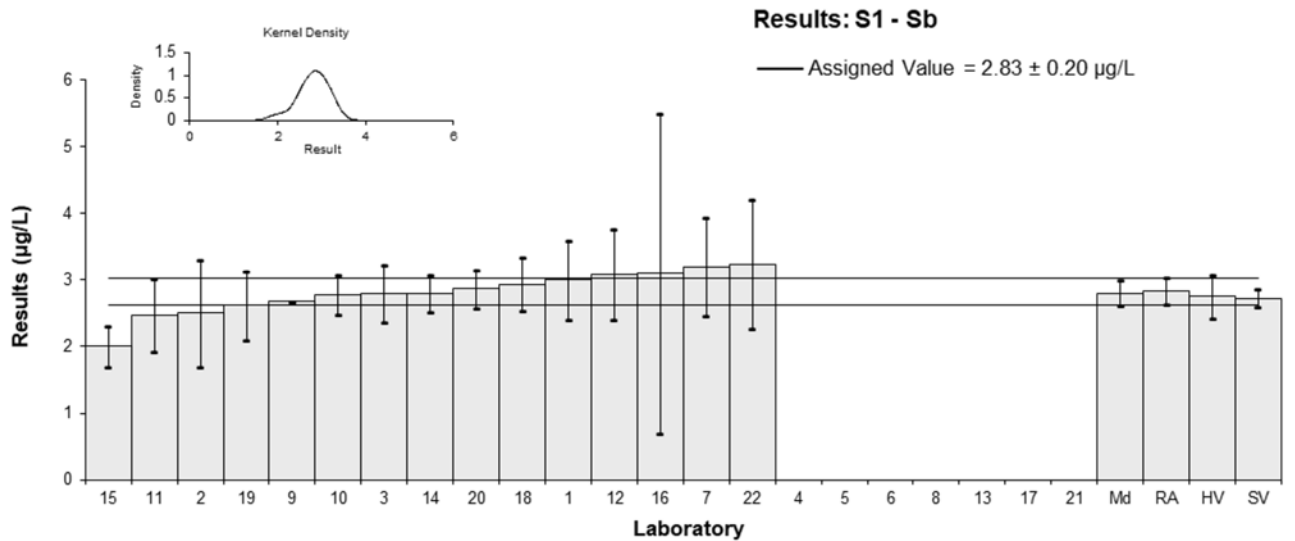


Figure 16

Table 20

Sample Details

Sample No.	S1
Matrix	River Water
Analyte	Se
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	<10	NR		
2	2	3	1.43	0.08
3	1.78	0.68	0.17	0.04
4	NT	NT		
5	NT	NT		
6	NT	NT		
7	1.8	0.29	0.29	0.16
8	NT	NT		
9	1.82	0.0013	0.40	0.54
10	<10	NR		
11	1.66	0.41	-0.51	-0.21
12	1.59	0.43	-0.91	-0.36
13	NT	NT		
14	1.7	0.17	-0.29	-0.23
15	1.5	0.3	-1.43	-0.76
16	2.0	0.4	1.43	0.59
17	NT	NT		
18	1.52	0.2	-1.31	-0.96
19	1.70	0.34	-0.29	-0.14
20	1.78	0.18	0.17	0.14
21	<20	NR		
22	1.8731	0.56193	0.70	0.21

Statistics

Assigned Value	1.75	0.13
Spike Value	1.80	0.08
Homogeneity Value	1.63	0.20
Robust Average	1.75	0.13
Median	1.78	0.10
Mean	1.75	
N	13	
Max	2	
Min	1.5	
Robust SD	0.18	
Robust CV	10%	

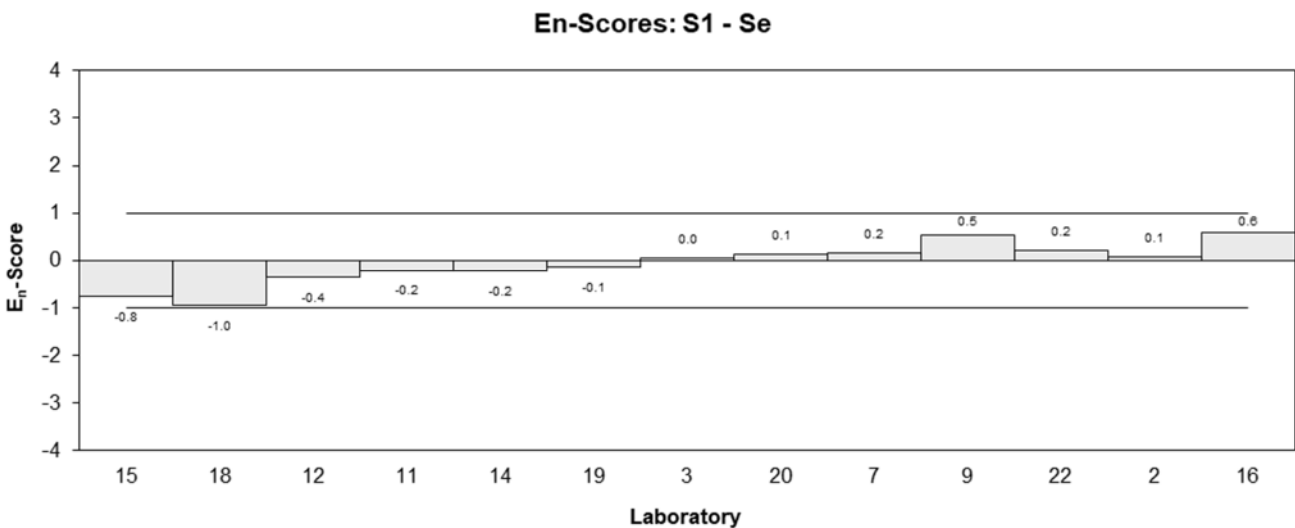
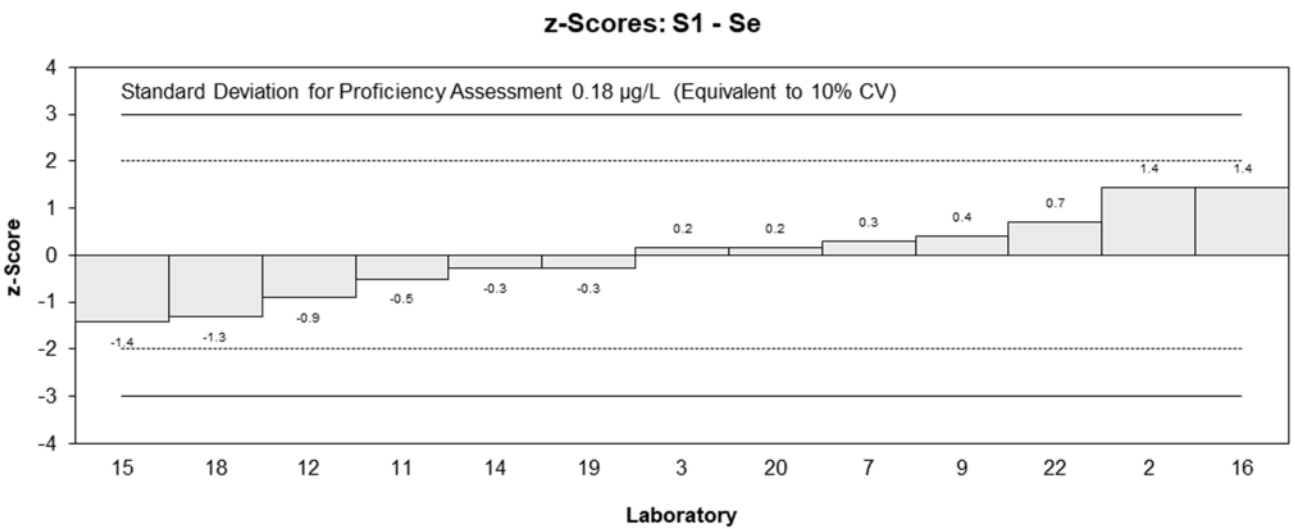
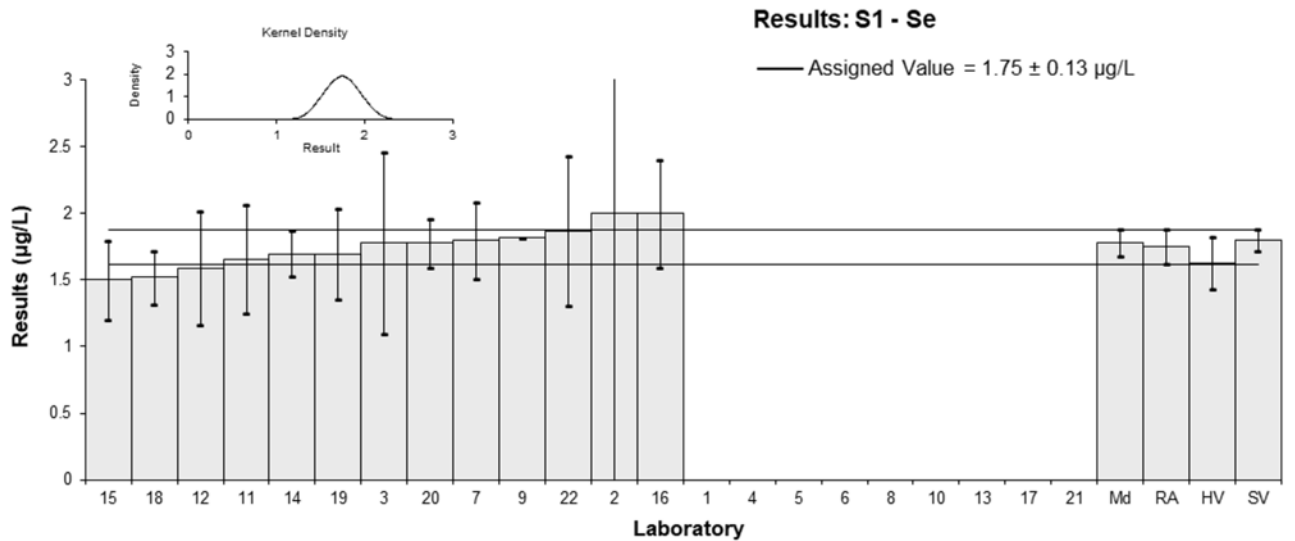


Figure 17

Table 21

Sample Details

Sample No.	S1
Matrix	River Water
Analyte	TI
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	NT	NT		
2	1.1	1	-0.68	-0.08
3	1.196	0.063	0.14	0.20
4	NT	NT		
5	NT	NT		
6	NT	NT		
7	1.21	0.17	0.25	0.17
8	NT	NT		
9	1.20	0.0001	0.17	0.40
10	1.22	0.09	0.34	0.39
11	1.11	0.26	-0.59	-0.26
12	1.30	0.21	1.02	0.56
13	NT	NT		
14	1.2	0.12	0.17	0.15
15	NT	NT		
16	1.22	0.3	0.34	0.13
17	NT	NT		
18	1.09	0.2	-0.76	-0.44
19	1.11	0.22	-0.59	-0.31
20	1.24	0.12	0.51	0.46
21	<50	NR		
22	NT	NT		

Statistics

Assigned Value	1.18	0.05
Spike Value	1.20	0.06
Homogeneity Value	1.11	0.13
Robust Average	1.18	0.05
Median	1.20	0.03
Mean	1.18	
N	12	
Max	1.3	
Min	1.09	
Robust SD	0.073	
Robust CV	6.2%	

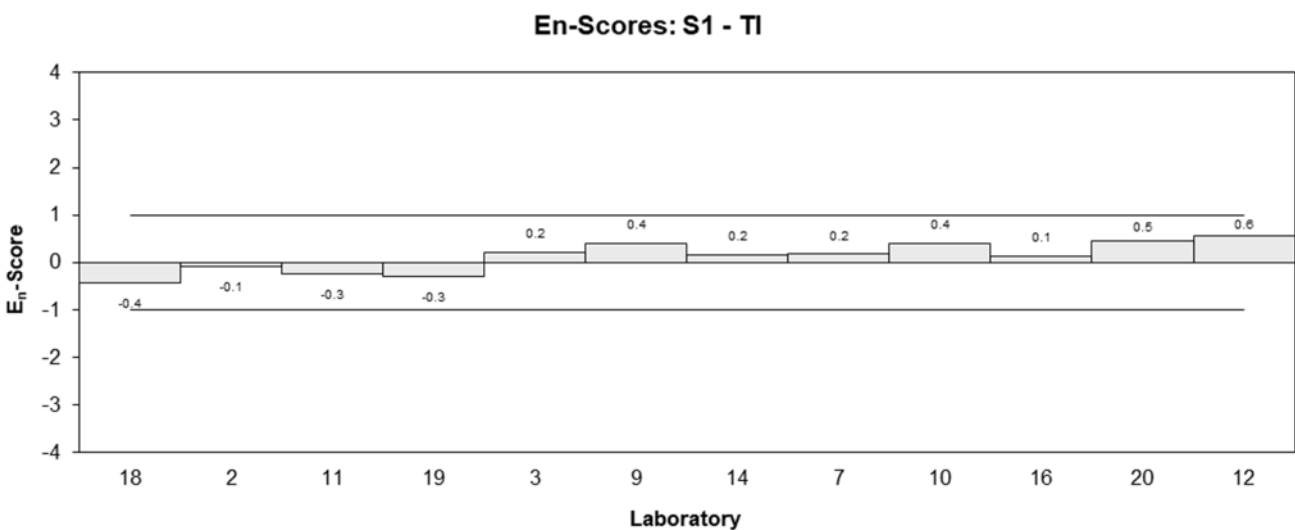
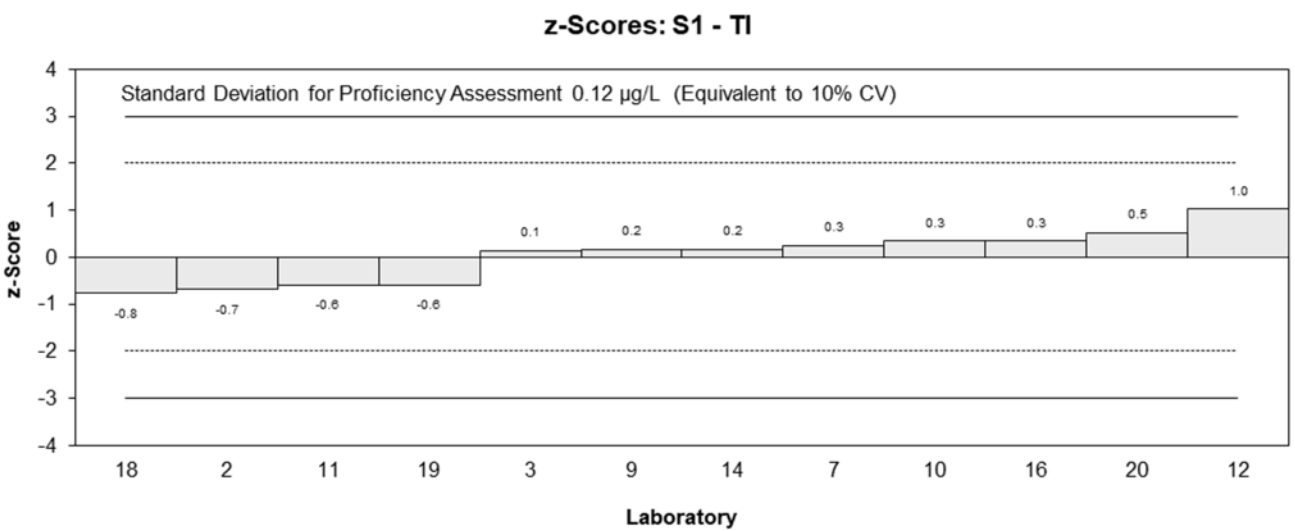
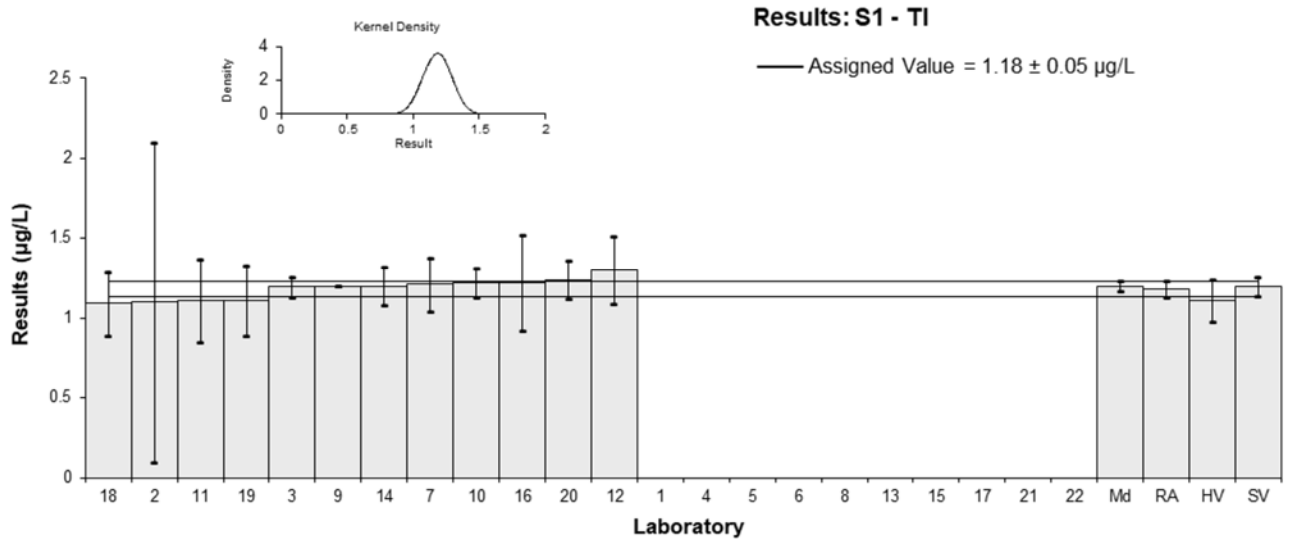


Figure 18

Table 22

Sample Details

Sample No.	S1
Matrix	River Water
Analyte	U
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	2	0.2	0.05	0.05
2	2	1	0.05	0.01
3	2.14	0.24	0.75	0.61
4	NT	NT		
5	NT	NT		
6	NT	NT		
7	2.11	0.31	0.60	0.38
8	NT	NT		
9	1.93	0.0003	-0.30	-1.00
10	2.05	0.13	0.30	0.42
11	1.92	0.43	-0.35	-0.16
12	2.07	0.29	0.40	0.27
13	NT	NT		
14	1.9	0.19	-0.45	-0.45
15	1.7	0.3	-1.46	-0.95
16	1.99	0.07	0.00	0.00
17	NT	NT		
18	1.95	0.2	-0.20	-0.19
19	1.94	0.39	-0.25	-0.13
20	2.06	0.21	0.35	0.32
21	<40	NR		
22	NT	NT		

Statistics

Assigned Value	1.99	0.06
Spike Value	2.00	0.10
Homogeneity Value	2.02	0.24
Robust Average	1.99	0.06
Median	2.00	0.06
Mean	1.98	
N	14	
Max	2.14	
Min	1.7	
Robust SD	0.095	
Robust CV	4.7%	

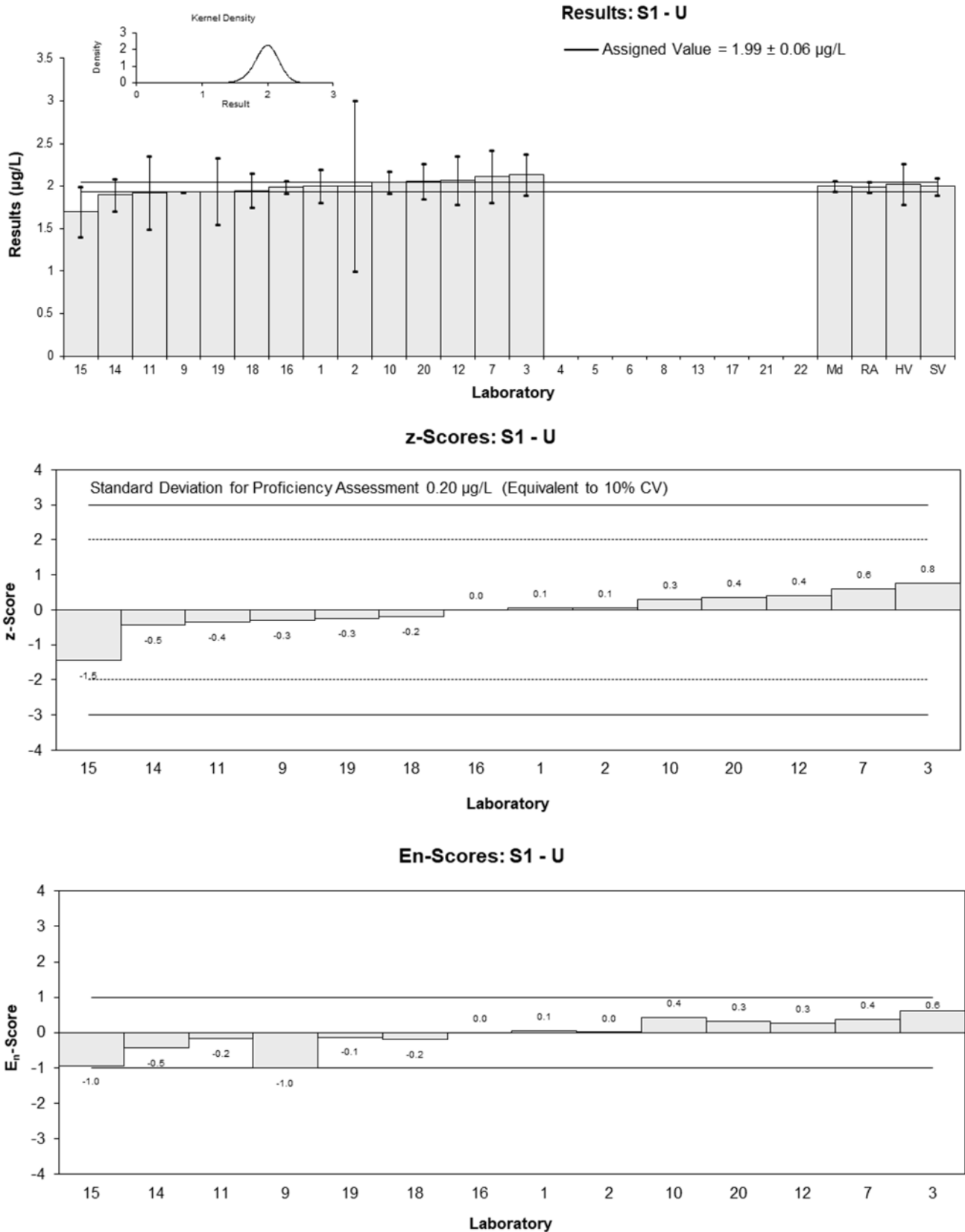


Figure 19

Table 23

Sample Details

Sample No.	S1
Matrix	River Water
Analyte	V
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	<10	NR		
2	1	2	-2.81	-0.19
3	1.40	0.68	0.07	0.01
4	NT	NT		
5	NT	NT		
6	NT	NT		
7	1.4	0.15	0.07	0.05
8	NT	NT		
9	1.28	0.0002	-0.79	-0.92
10	<10	NR		
11	1.44	0.41	0.36	0.12
12	1.85	0.35	3.31	1.24
13	NT	NT		
14	1.4	0.14	0.07	0.05
15	1.4	0.2	0.07	0.04
16	1.6	0.18	1.51	0.97
17	NT	NT		
18	1.17	0.2	-1.58	-0.94
19	1.47	0.29	0.58	0.25
20	1.50	0.15	0.79	0.57
21	<3	NR		
22	1.2792	0.38376	-0.80	-0.28

Statistics

Assigned Value	1.39	0.12
Spike Value	1.47	0.07
Homogeneity Value	1.46	0.18
Robust Average	1.39	0.12
Median	1.40	0.10
Mean	1.40	
N	13	
Max	1.85	
Min	1	
Robust SD	0.17	
Robust CV	12%	

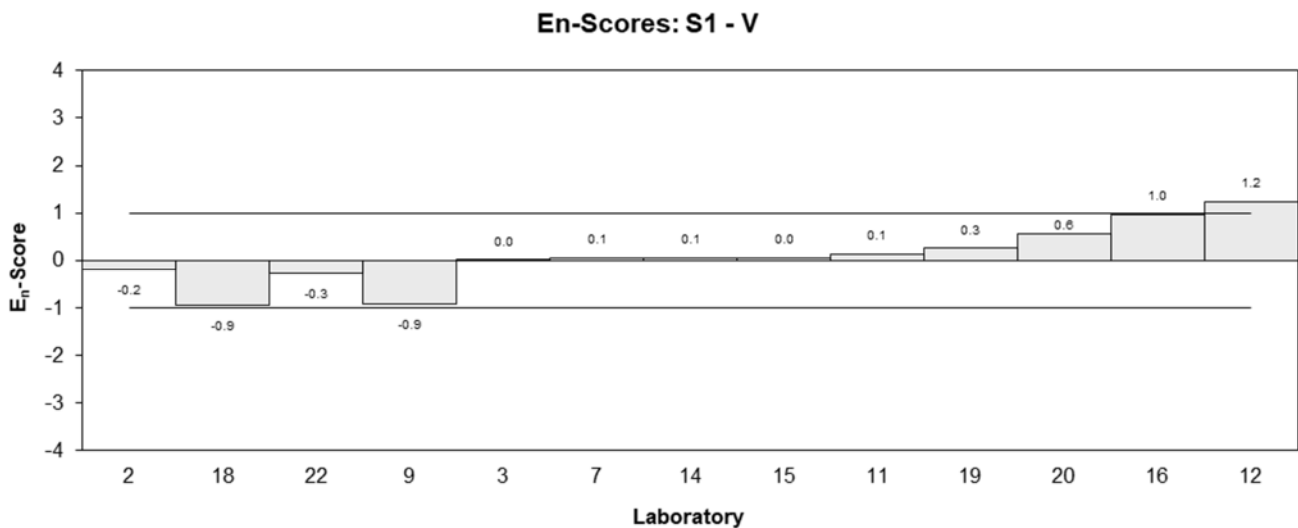
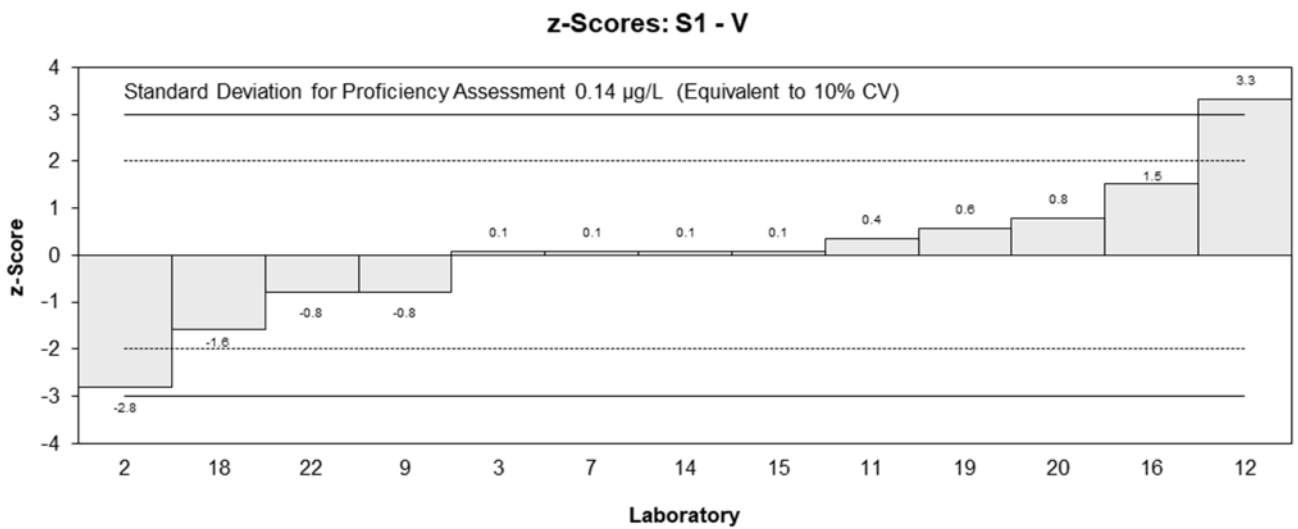
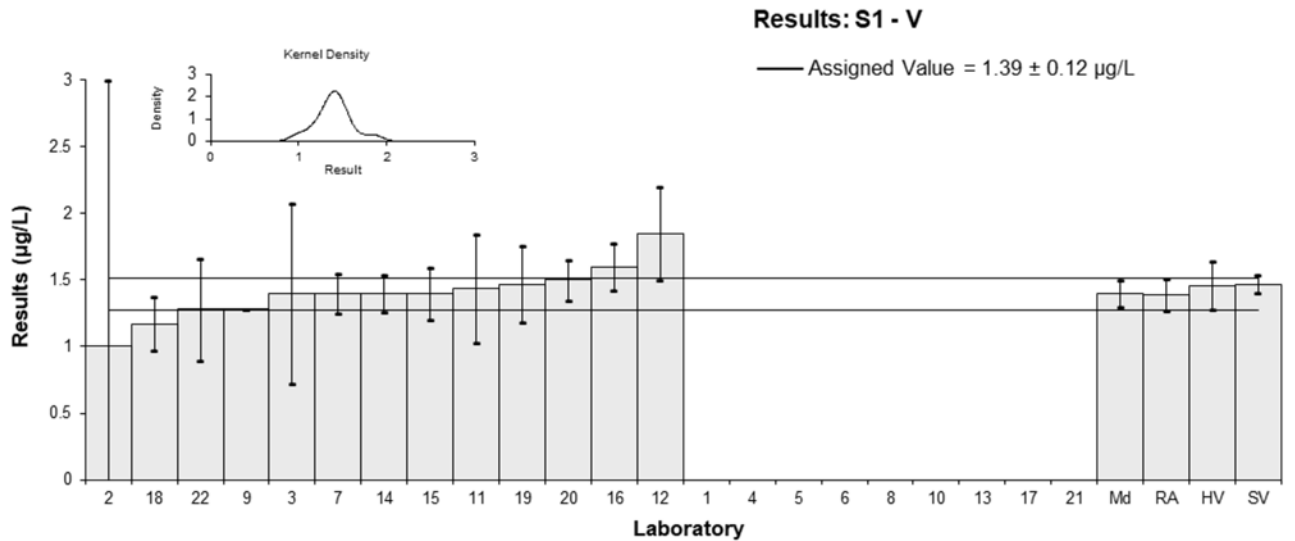


Figure 20

Table 24

Sample Details

Sample No.	S1
Matrix	River Water
Analyte	Zn
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	21	2	0.29	0.26
2	18	5	-1.18	-0.47
3	21.2	2.1	0.39	0.34
4	NT	NT		
5	NT	NT		
6	NT	NT		
7	19	3.34	-0.69	-0.40
8	NT	NT		
9	18.05	0.0016	-1.15	-2.14
10	18.88	1.46	-0.75	-0.83
11	19.5	4.7	-0.44	-0.19
12	21.0	4.4	0.29	0.13
13	NT	NT		
14	23	2.5	1.27	0.95
15	21	5	0.29	0.12
16	22	2.55	0.78	0.58
17	NT	NT		
18	20.4	2.1	0.00	0.00
19	19.4	3.9	-0.49	-0.25
20	21.95	2.20	0.76	0.63
21	22	2	0.78	0.70
22	20.787	6.2361	0.19	0.06

Statistics

Assigned Value	20.4	1.1
Spike Value	20.2	1.0
Homogeneity Value	20.0	2.4
Robust Average	20.4	1.1
Median	20.9	1.0
Mean	20.4	
N	16	
Max	23	
Min	18	
Robust SD	1.7	
Robust CV	8.3%	

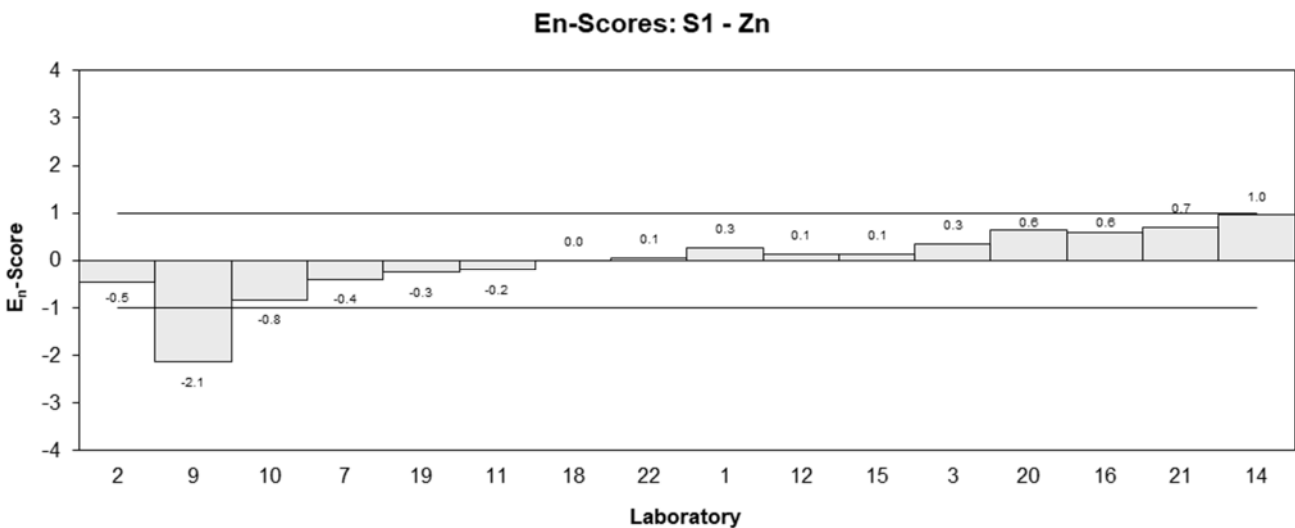
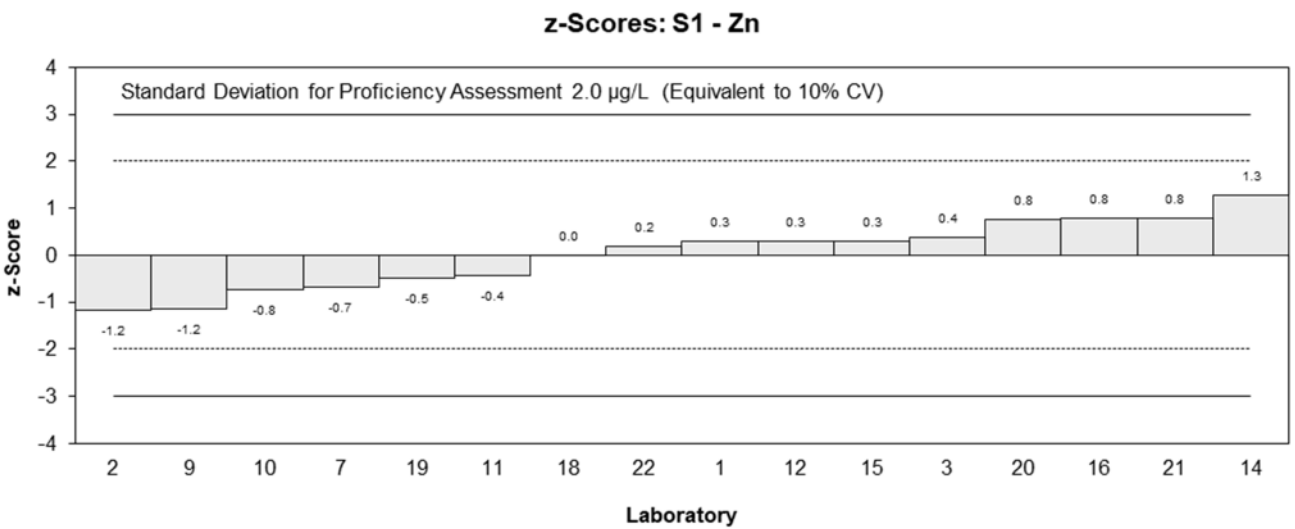
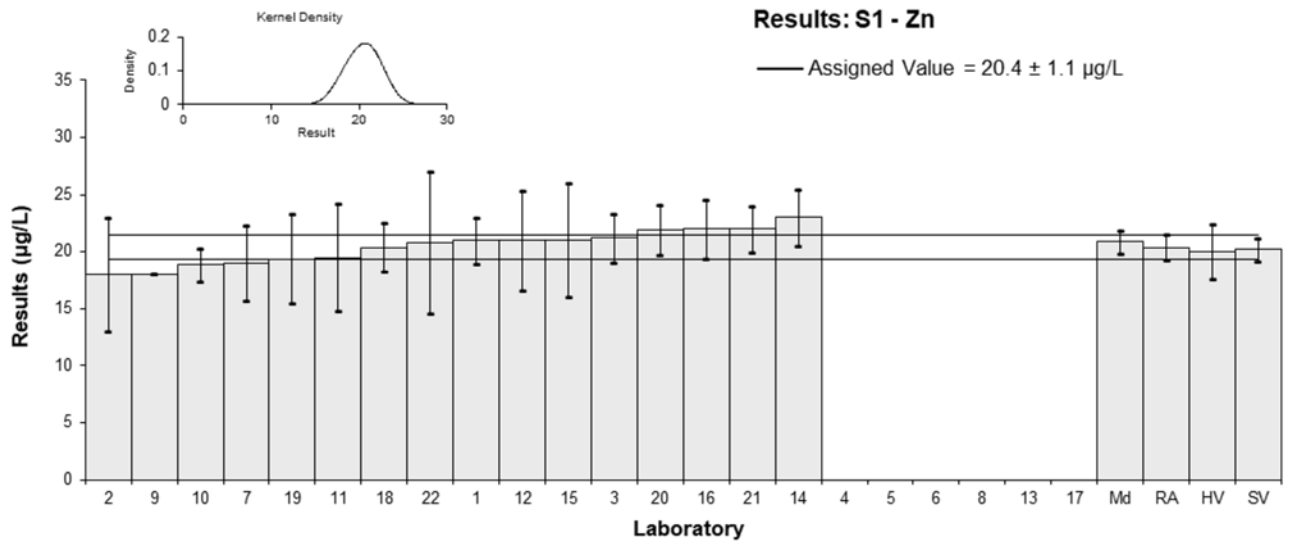


Figure 21

Table 25

Sample Details

Sample No.	S2
Matrix	Seawater
Analyte	Ag
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	1.3	0.3	-0.81	-0.58
2	1.4	0.5	-0.36	-0.16
3	1.49	0.35	0.05	0.03
4	NT	NT		
5	NT	NT		
6	< 5	NR		
7	1.4	0.24	-0.36	-0.32
8*	2.4	0.3	4.14	2.96
9	NT	NT		
10*	5.17	0.74	16.62	4.96
11	NR	NR		
12	1.52	0.20	0.18	0.19
13	2	0.38	2.34	1.34
14	1.7	0.17	0.99	1.17
15	<1	NR		
16	1.5	0.23	0.09	0.08
17	1.4	0.1	-0.36	-0.62
18	1.48	0.3	0.00	0.00
19	1.50	0.3	0.09	0.06
20	1.5	0.15	0.09	0.12
21	NT	NT		
22	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	1.48	0.08
Spike Value	1.51	0.08
Homogeneity Value	1.49	0.18
Robust Average	1.58	0.17
Median	1.50	0.10
Mean	1.84	
N	14	
Max	5.17	
Min	1.3	
Robust SD	0.26	
Robust CV	16%	

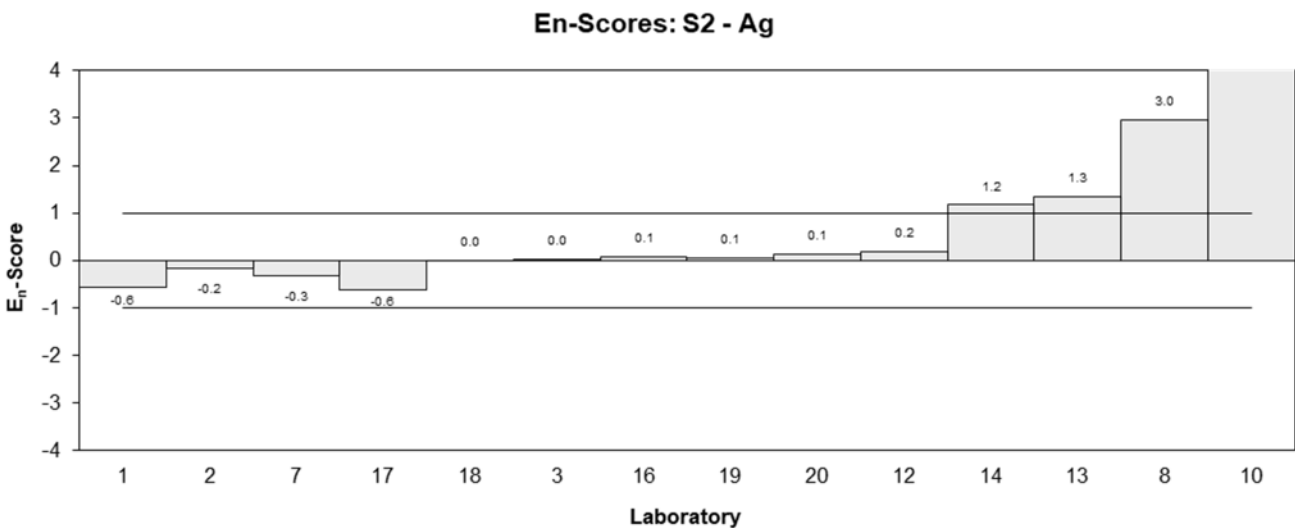
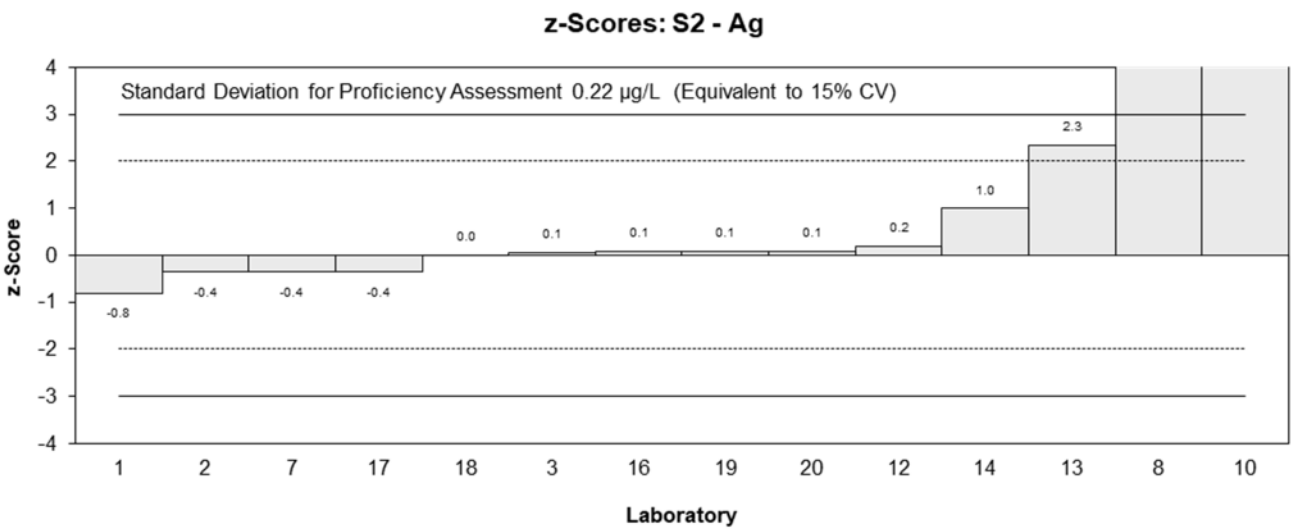
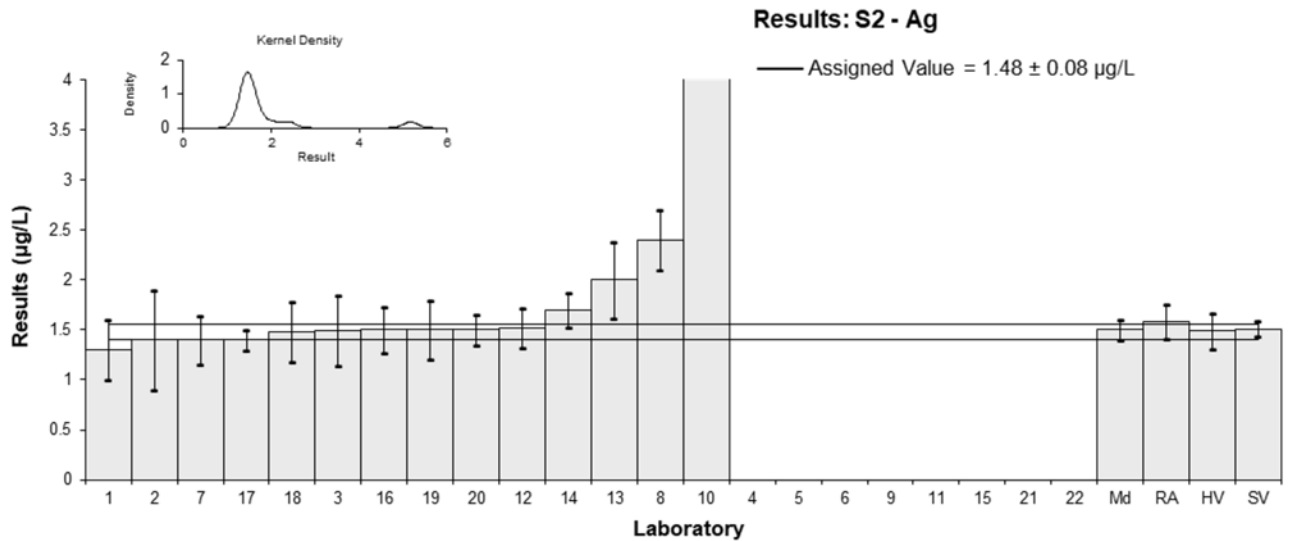


Figure 22

Table 26

Sample Details

Sample No.	S2
Matrix	Seawater
Analyte	Al
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	16	8	-0.36	-0.11
2	15	9	-0.75	-0.20
3	< 40	27		
4	NT	NT		
5	NT	NT		
6	< 50	NR		
7	18	4.3	0.43	0.23
8	12	6	-1.93	-0.76
9	NT	NT		
10	<50	NR		
11	18.6	3.9	0.67	0.38
12	18.7	4.1	0.71	0.38
13	25	2.55	3.20	2.36
14	NT	NT		
15	16	3	-0.36	-0.24
16	18	3.1	0.43	0.28
17	NR	NR		
18	18.6	2.0	0.67	0.56
19*	26.9	5.4	3.94	1.70
20	13.3	1.3	-1.42	-1.36
21	NT	NT		
22	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	16.9	2.3
Spike Value	15.0	0.8
Homogeneity Value	18.0	2.2
Robust Average	17.6	2.9
Median	18.0	2.1
Mean	18.0	
N	12	
Max	26.9	
Min	12	
Robust SD	4.0	
Robust CV	23%	

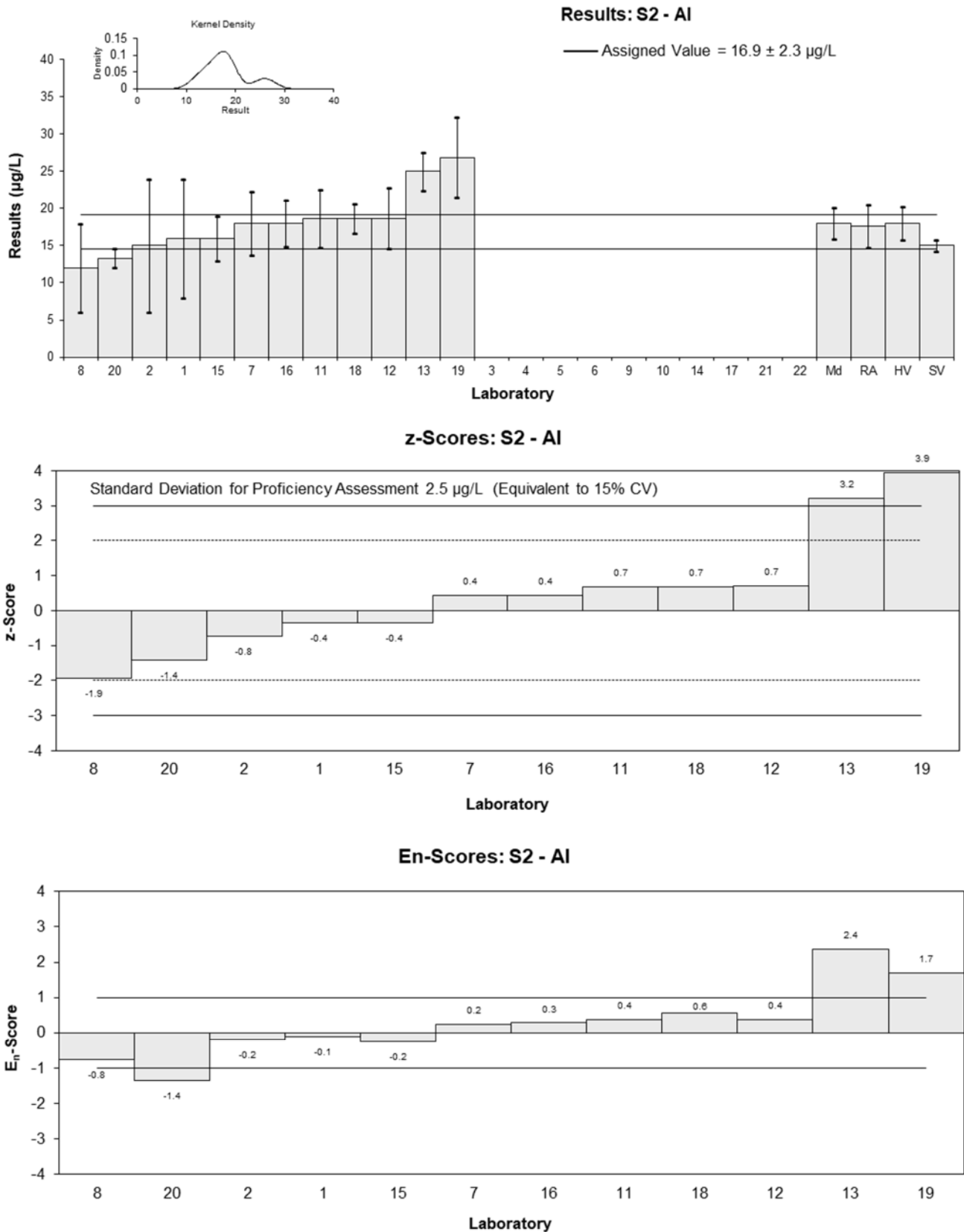


Figure 23

Table 27

Sample Details

Sample No.	S2
Matrix	Seawater
Analyte	As
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	4.6	0.3	-0.75	-0.88
2	6.6	5	1.83	0.28
3	4.8	2.7	-0.49	-0.14
4	NT	NT		
5	NT	NT		
6	6.2	1.86	1.31	0.52
7	4.4	0.54	-1.00	-0.98
8	6.2	1.6	1.31	0.60
9	NT	NT		
10	6.34	0.48	1.49	1.53
11	4.13	0.92	-1.35	-0.96
12	5.11	0.66	-0.09	-0.08
13*	10	1.1	6.20	3.86
14	5	0.5	-0.23	-0.23
15	6.1	1.2	1.18	0.69
16	4.8	0.77	-0.49	-0.39
17	5.3	1.0	0.15	0.10
18	4.04	0.5	-1.47	-1.47
19	4.60	0.92	-0.75	-0.53
20	4.71	0.47	-0.60	-0.62
21	NT	NT		
22	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	5.18	0.59
Spike Value	4.66	0.25
Homogeneity Value	4.64	0.56
Robust Average	5.28	0.62
Median	5.00	0.54
Mean	5.47	
N	17	
Max	10	
Min	4.04	
Robust SD	1.0	
Robust CV	19%	

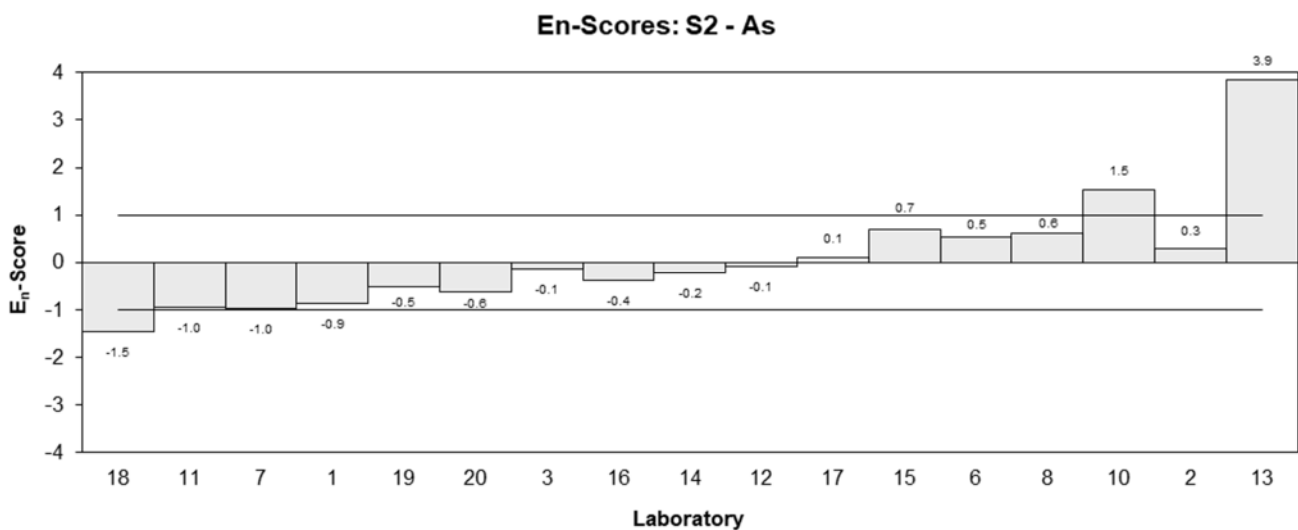
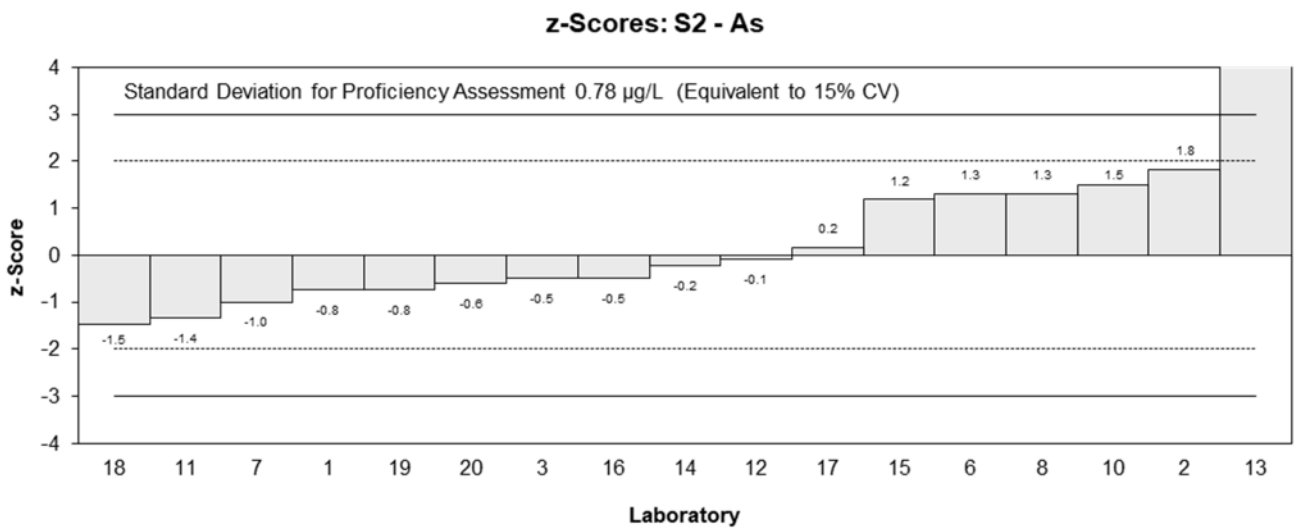
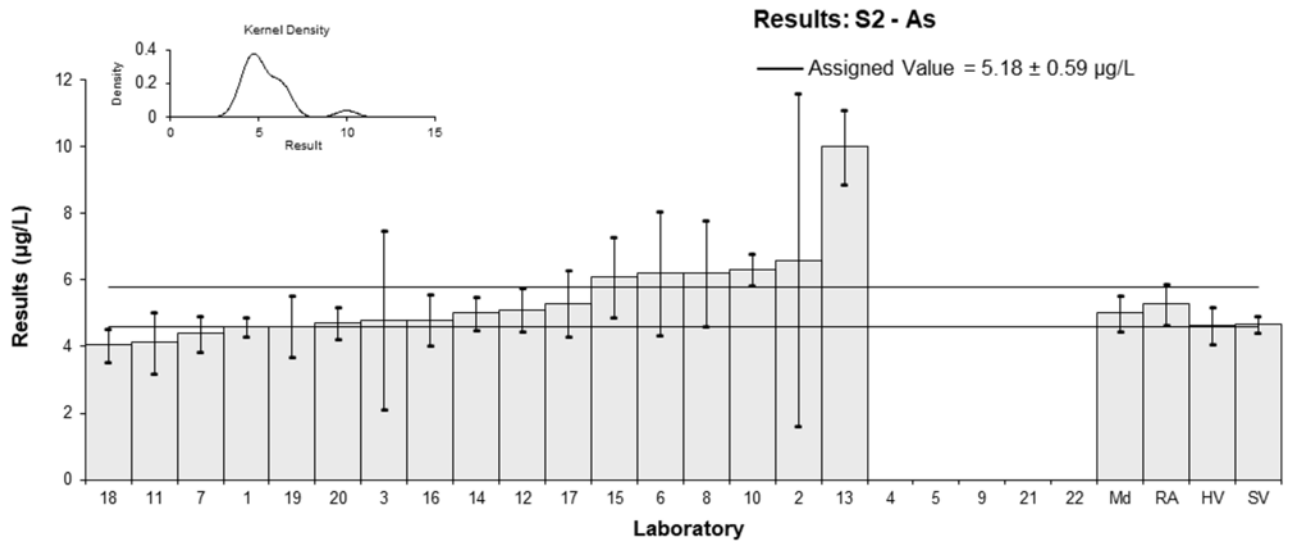


Figure 24

Table 28

Sample Details

Sample No.	S2
Matrix	Seawater
Analyte	Be
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	1.6	0.1	0.13	0.23
2	<1	2		
3	NT	NT		
4	NT	NT		
5	NT	NT		
6	< 5	NR		
7	1.6	0.33	0.13	0.09
8	2.2	0.3	2.68	2.03
9	NT	NT		
10	<5	NR		
11	1.53	0.48	-0.17	-0.08
12	NT	NT		
13	2	0.17	1.83	2.29
14	1.5	0.15	-0.30	-0.41
15	<1	NR		
16	1.5	0.5	-0.30	-0.14
17	1.6	0.1	0.13	0.23
18	1.45	0.3	-0.51	-0.39
19	1.50	0.3	-0.30	-0.23
20	1.54	0.15	-0.13	-0.18
21	NT	NT		
22	NT	NT		

Statistics

Assigned Value	1.57	0.08
Spike Value	1.51	0.08
Homogeneity Value	1.62	0.19
Robust Average	1.57	0.08
Median	1.54	0.07
Mean	1.64	
N	11	
Max	2.2	
Min	1.45	
Robust SD	0.1	
Robust CV	6.4%	

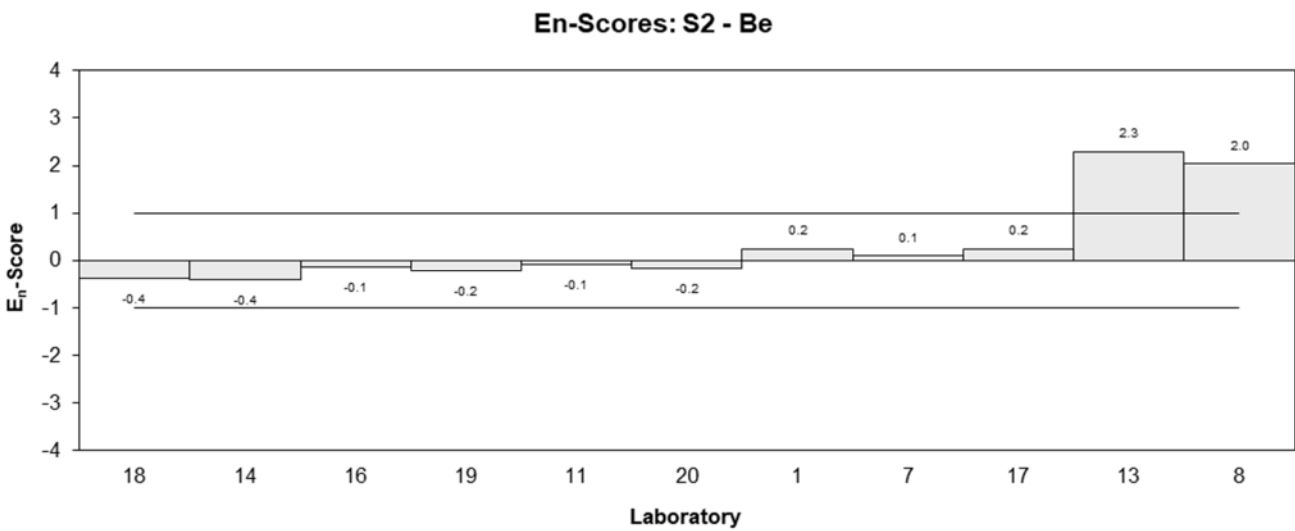
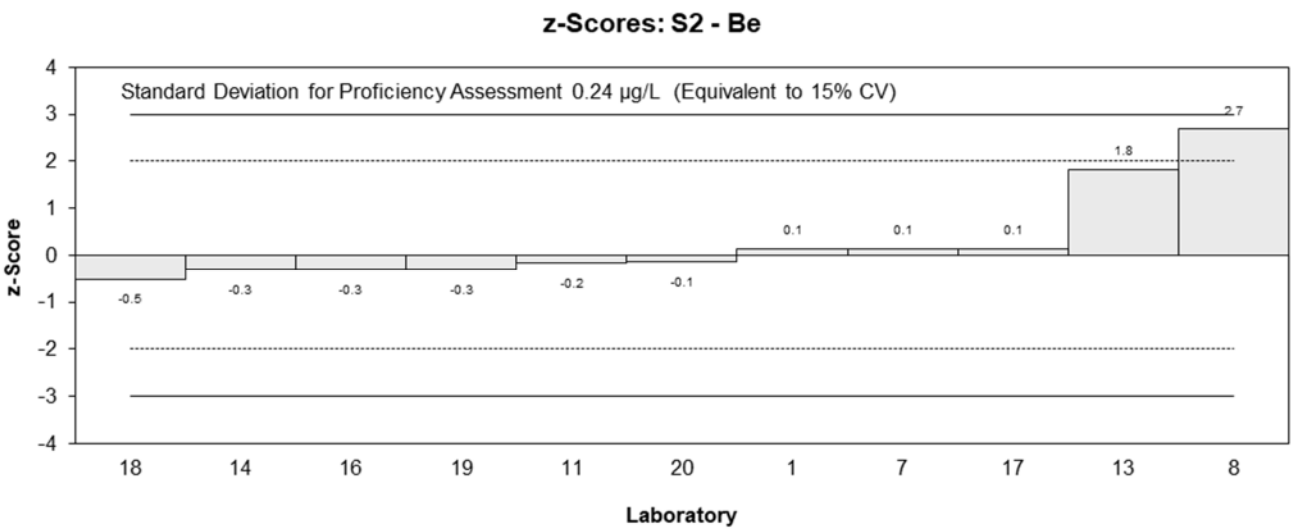
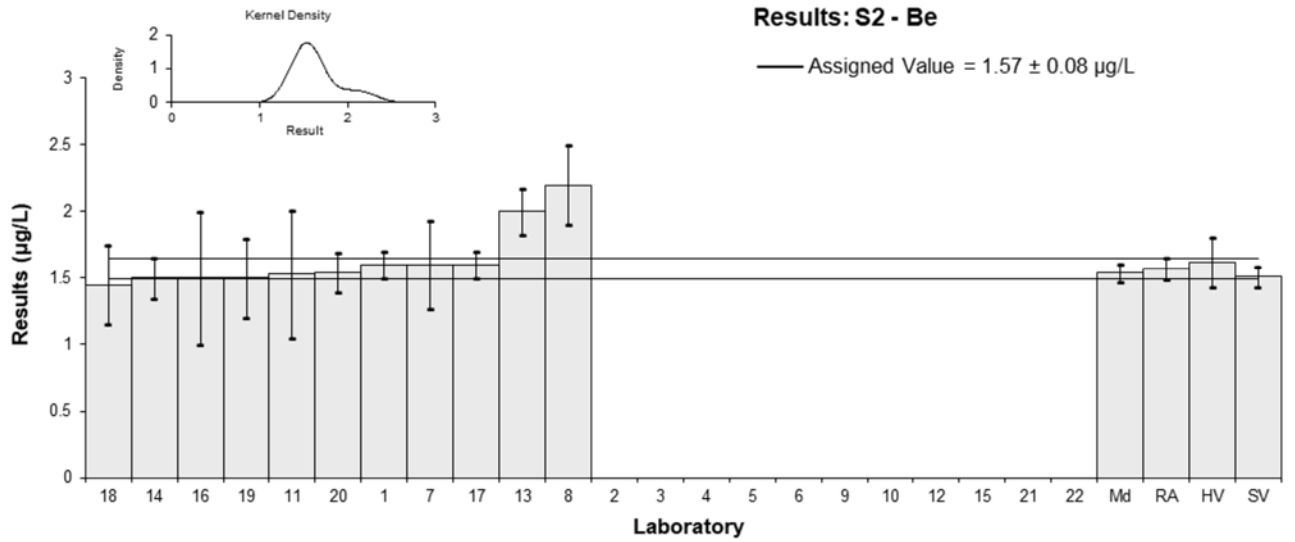


Figure 25

Table 29

Sample Details

Sample No.	S2
Matrix	Seawater
Analyte	Cd
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.8	0.1	-0.77	-0.91
2	0.9	0.7	-0.04	-0.01
3	0.95	0.25	0.33	0.18
4	NT	NT		
5	NT	NT		
6	0.78	0.234	-0.92	-0.52
7	0.8	0.1	-0.77	-0.91
8	0.92	1	0.11	0.01
9	NT	NT		
10	0.927	0.089	0.16	0.21
11	0.76	0.18	-1.07	-0.77
12	0.987	0.217	0.60	0.37
13	1	0.08	0.70	0.97
14	0.96	0.096	0.41	0.49
15	<1	NR		
16	0.9	0.15	-0.04	-0.03
17	0.9	0.1	-0.04	-0.04
18	1.04	0.2	0.99	0.65
19	0.934	0.187	0.21	0.15
20	0.91	0.9	0.04	0.01
21	NT	NT		
22	NT	NT		

Statistics

Assigned Value	0.905	0.057
Spike Value	0.902	0.045
Homogeneity Value	0.96	0.11
Robust Average	0.905	0.057
Median	0.915	0.037
Mean	0.904	
N	16	
Max	1.04	
Min	0.76	
Robust SD	0.091	
Robust CV	10%	

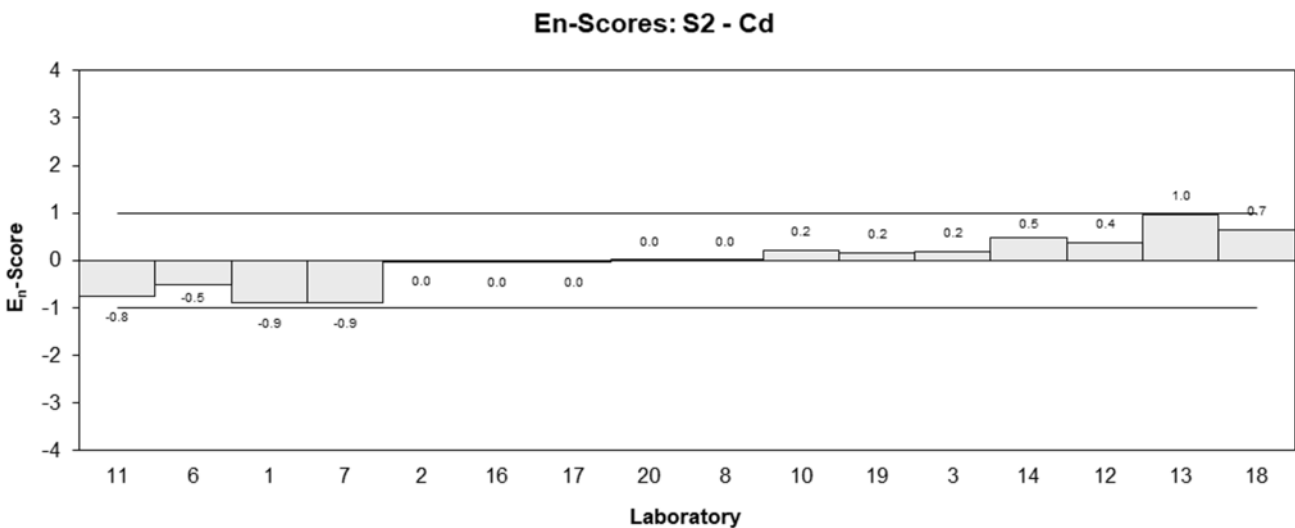
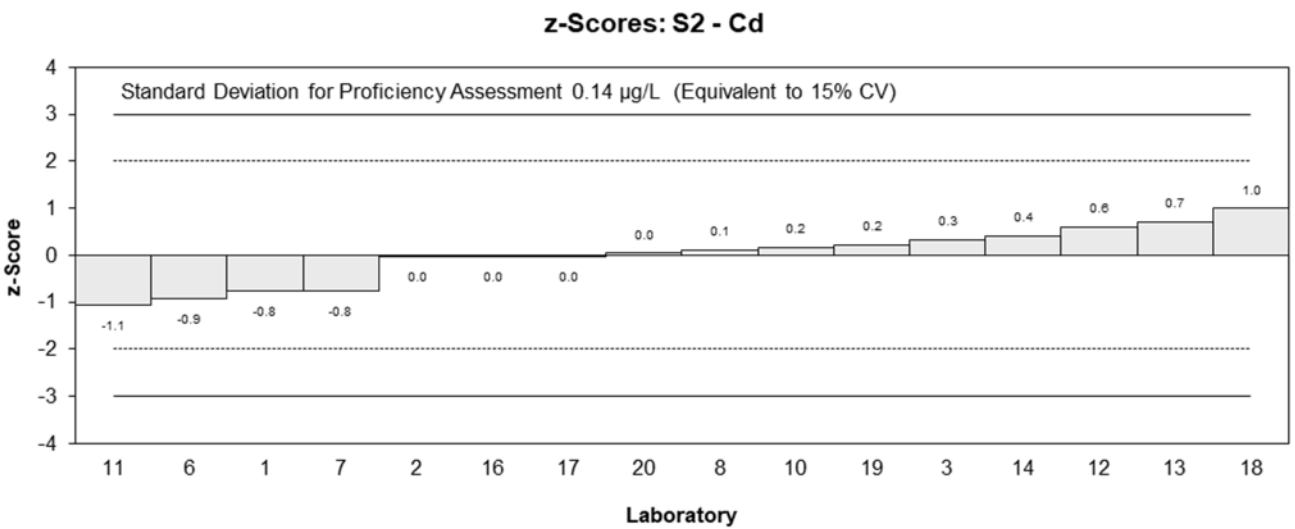
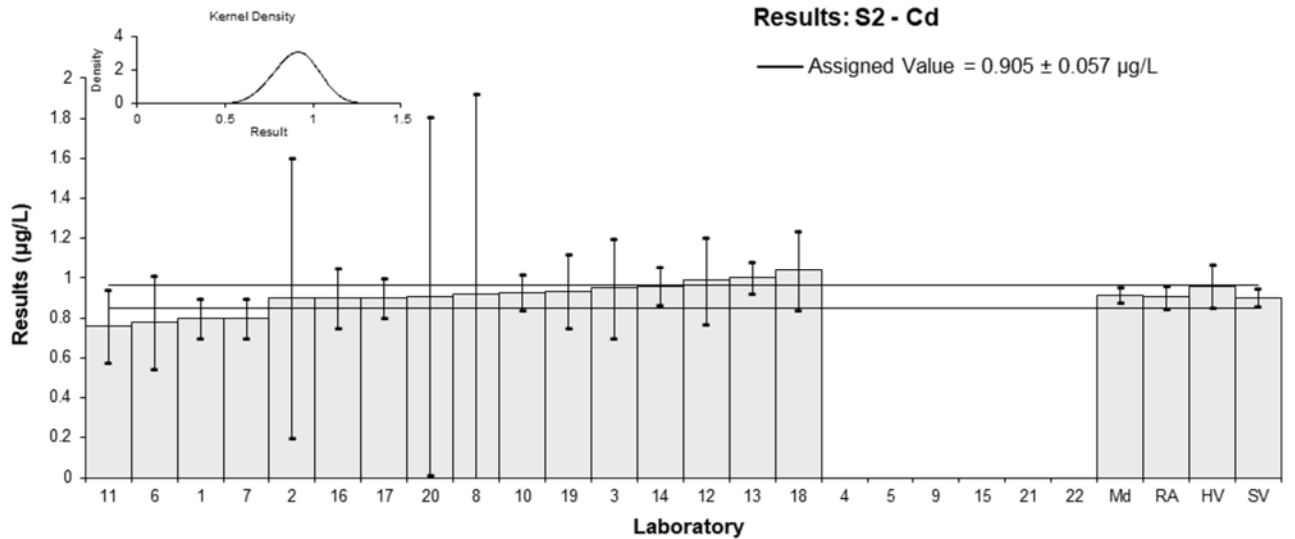


Figure 26

Table 30

Sample Details

Sample No.	S2
Matrix	Seawater
Analyte	Cr
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	1.5	0.1	-1.20	-1.48
2	2.3	1.2	1.71	0.39
3	< 2	1.4		
4	NT	NT		
5	NT	NT		
6	< 5	NR		
7	1.6	0.35	-0.84	-0.57
8*	0.25	1	-5.76	-1.55
9	NT	NT		
10	<5	NR		
11	1.86	0.51	0.11	0.05
12	1.71	0.26	-0.44	-0.37
13*	8	0.7	22.48	8.48
14*	3.5	0.35	6.08	4.14
15*	4.1	0.7	8.27	3.12
16	1.7	0.4	-0.47	-0.29
17	2.0	0.5	0.62	0.32
18	1.82	0.4	-0.04	-0.02
19	2.10	0.42	0.98	0.58
20	1.78	0.18	-0.18	-0.19
21	NT	NT		
22	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	1.83	0.20
Spike Value	1.88	0.09
Homogeneity Value	1.74	0.21
Robust Average	2.12	0.65
Median	1.84	0.25
Mean	2.44	
N	14	
Max	8	
Min	0.25	
Robust SD	0.98	
Robust CV	46%	

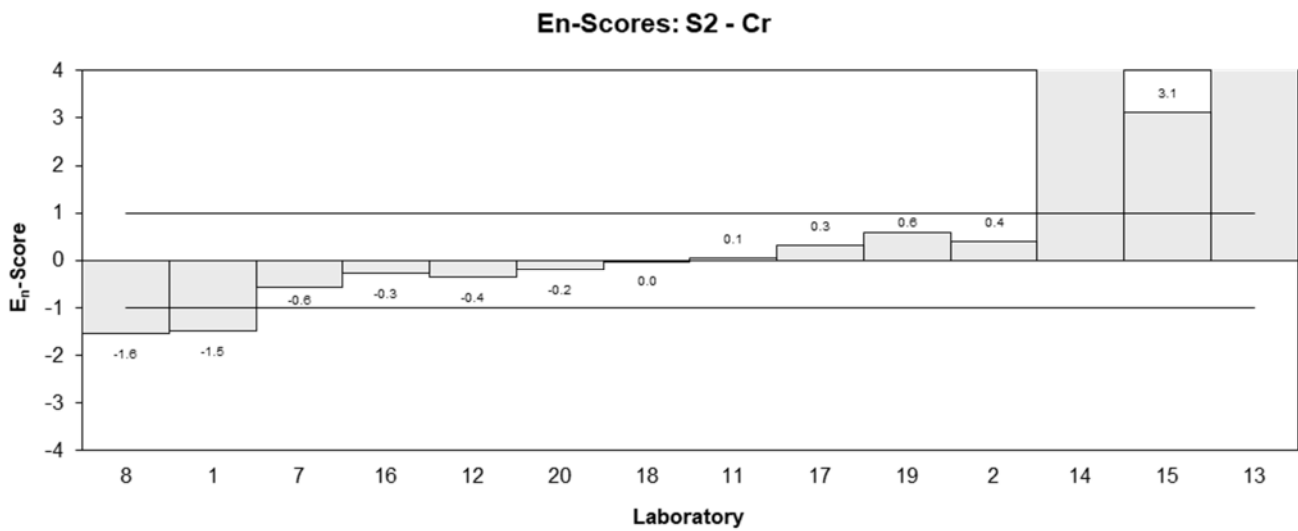
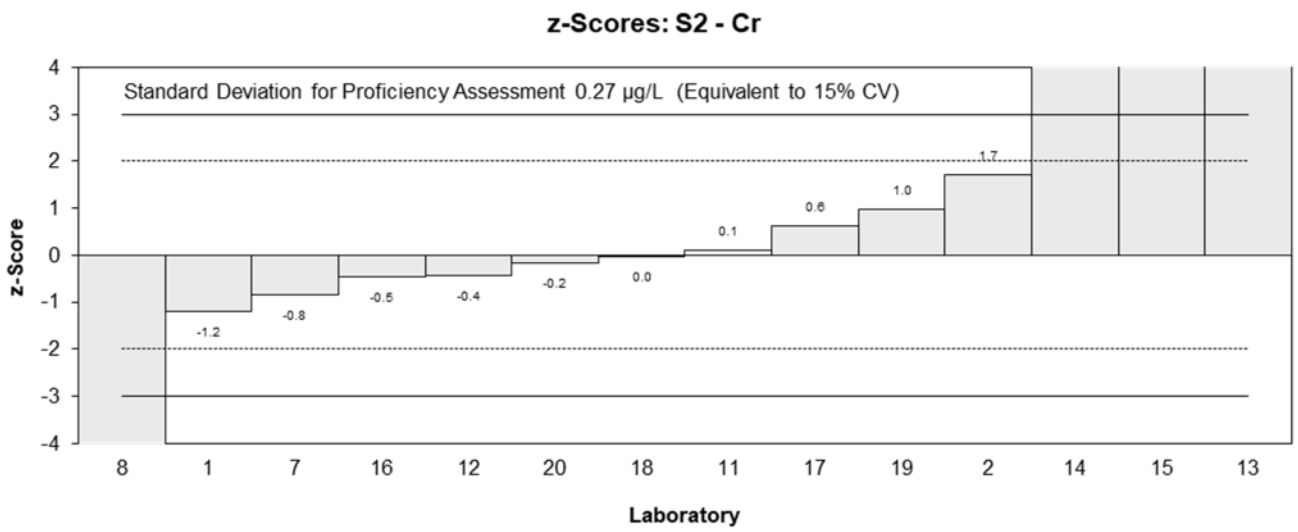
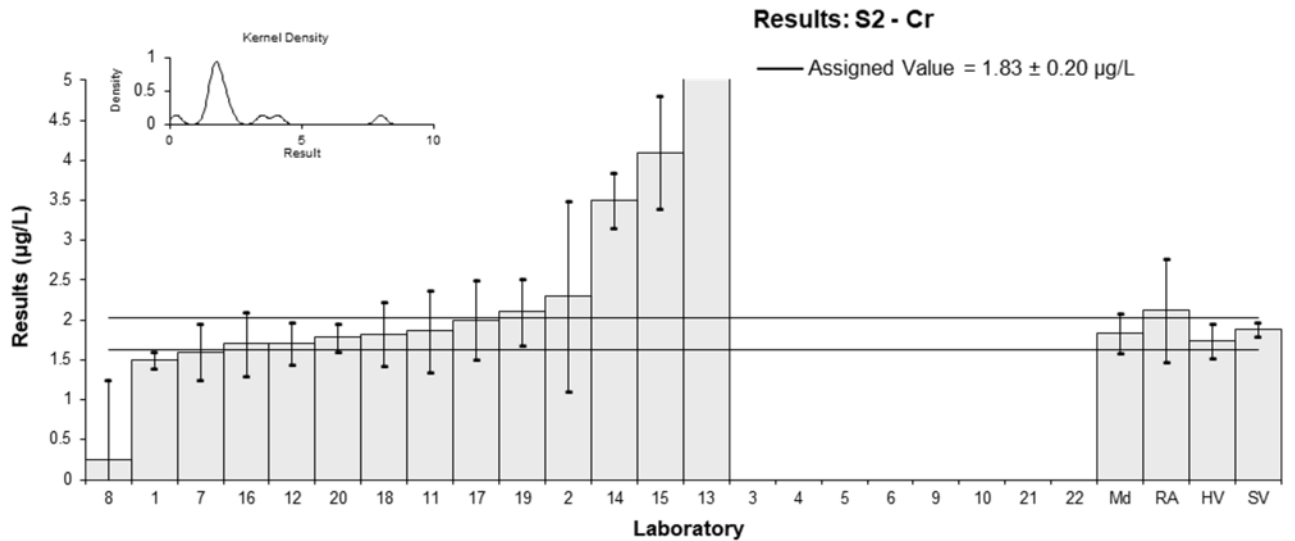


Figure 27

Table 31

Sample Details

Sample No.	S2
Matrix	Seawater
Analyte	Cu
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	5	0.7	-0.33	-0.34
2	5	2	-0.33	-0.13
3	4.9	1.4	-0.46	-0.25
4	NT	NT		
5	NT	NT		
6	5.2	1.56	-0.08	-0.04
7	5	0.64	-0.33	-0.37
8	5.6	1.5	0.43	0.22
9	NT	NT		
10	6.00	0.47	0.94	1.31
11	4.63	1.07	-0.80	-0.57
12	5.66	0.96	0.51	0.40
13	5	0.48	-0.33	-0.46
14	7.4	0.74	2.71	2.67
15	4.3	0.7	-1.22	-1.25
16	5	0.84	-0.33	-0.29
17	5.7	0.6	0.56	0.65
18	5.18	0.6	-0.10	-0.12
19	5.52	1.10	0.33	0.23
20	5.5	0.55	0.30	0.38
21	NT	NT		
22	NT	NT		

Statistics

Assigned Value	5.26	0.31
Spike Value	Not Spiked	
Homogeneity Value	5.17	0.62
Robust Average	5.26	0.31
Median	5.18	0.29
Mean	5.33	
N	17	
Max	7.4	
Min	4.3	
Robust SD	0.50	
Robust CV	9.6%	

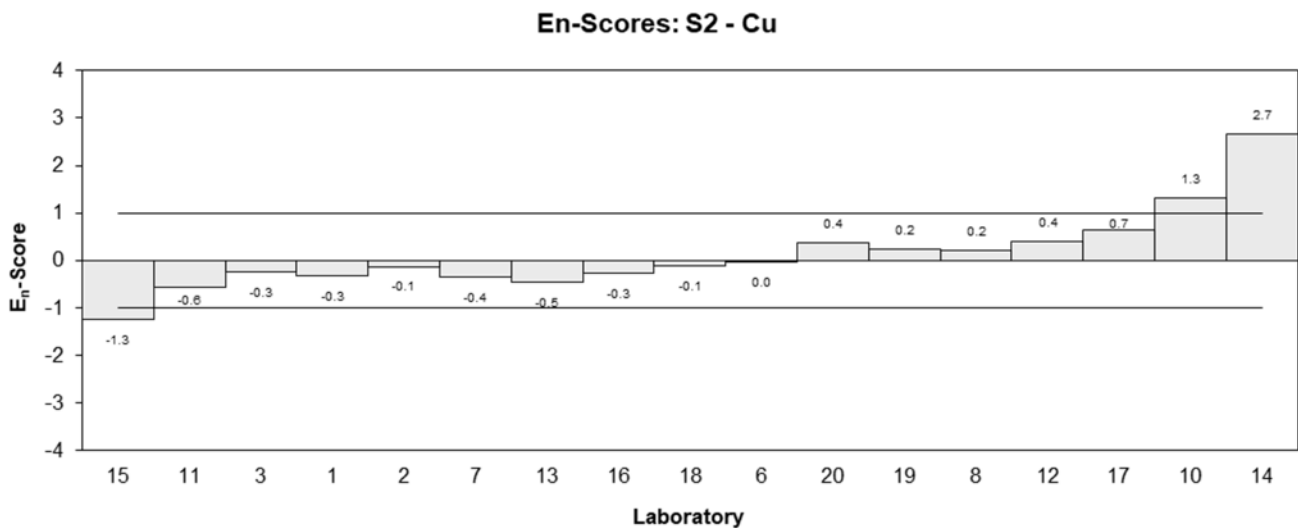
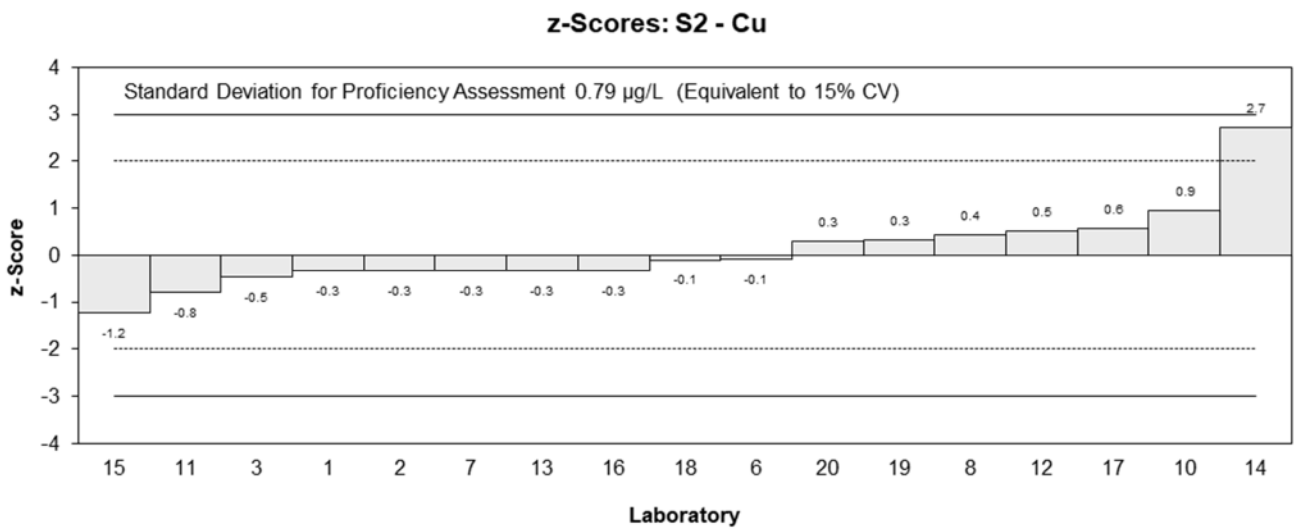
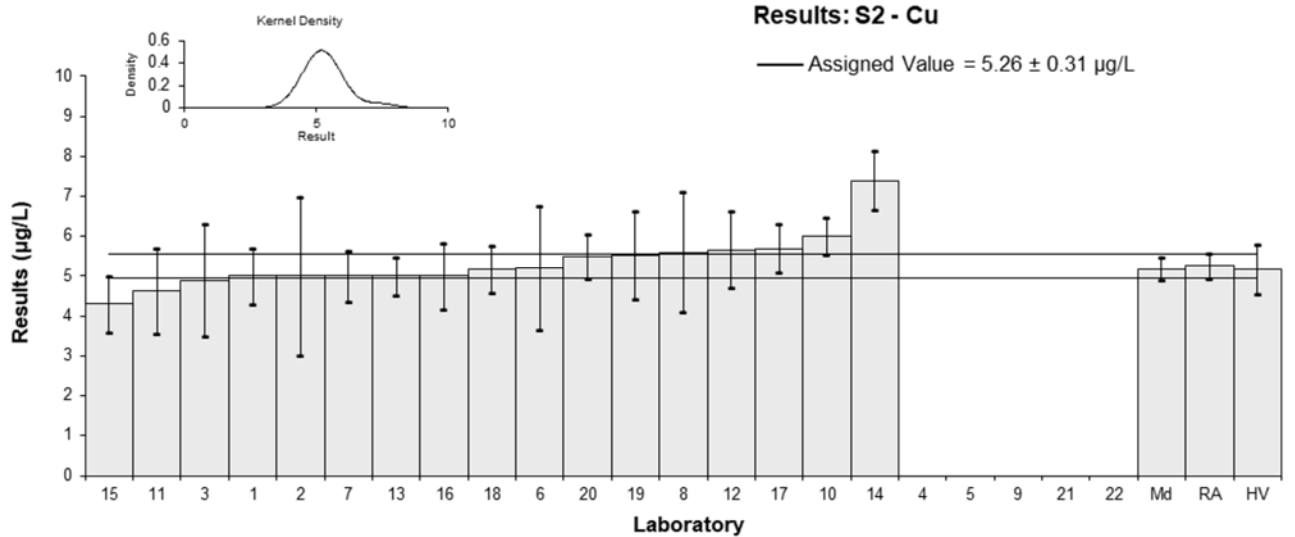


Figure 28

Table 32

Sample Details

Sample No.	S2
Matrix	Seawater
Analyte	Fe
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	25	7	0.64	0.30
3	23	14	0.06	0.01
4	NT	NT		
5	NT	NT		
6	< 100	NR		
7	21	5.37	-0.53	-0.30
8	31	16	2.40	0.51
9	NT	NT		
10	<250	NR		
11	24.0	8.5	0.35	0.14
12	19.4	2.7	-0.99	-0.92
13*	10	0.96	-3.74	-4.78
14	24	0.24	0.35	0.48
15	12	2.2	-3.16	-3.24
16	20	0.4	-0.82	-1.11
17	21	5.8	-0.53	-0.28
18	22.9	2.5	0.03	0.03
19	30.7	6.1	2.31	1.20
20	21.8	2.2	-0.29	-0.30
21	NT	NT		
22	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	22.8	2.5
Spike Value	20.0	1.0
Homogeneity Value	21.6	2.6
Robust Average	22.2	3.5
Median	22.4	2.0
Mean	21.8	
N	14	
Max	31	
Min	10	
Robust SD	5.3	
Robust CV	24%	

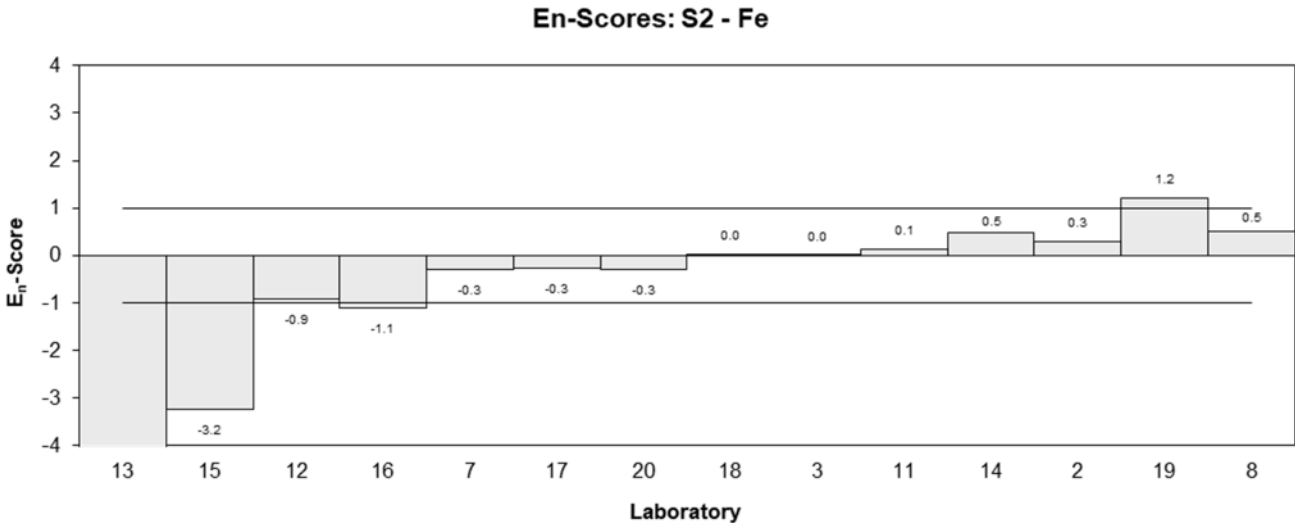
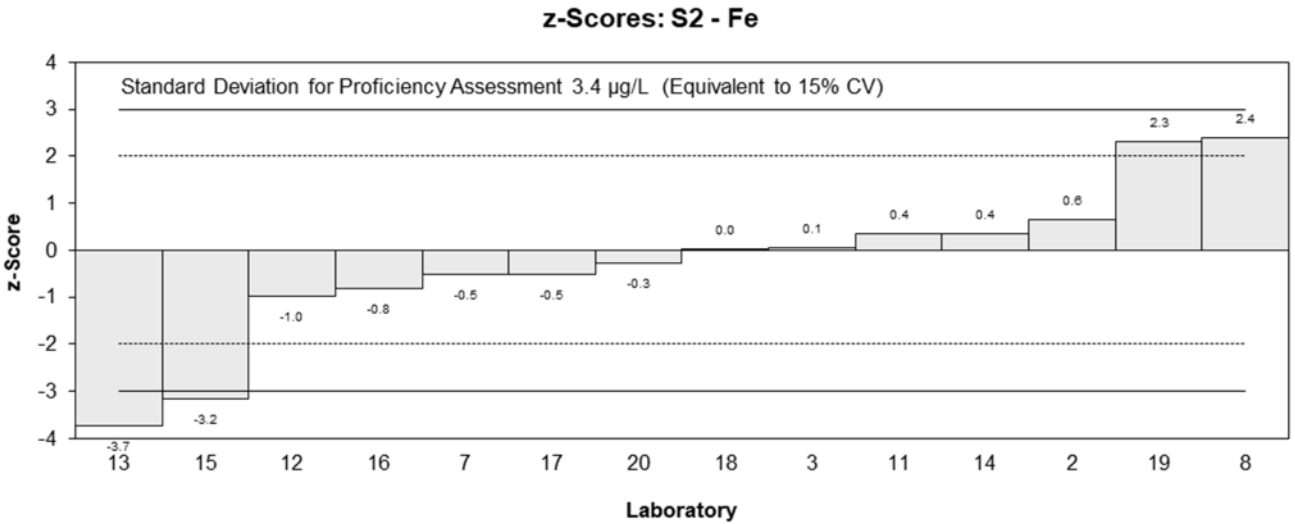
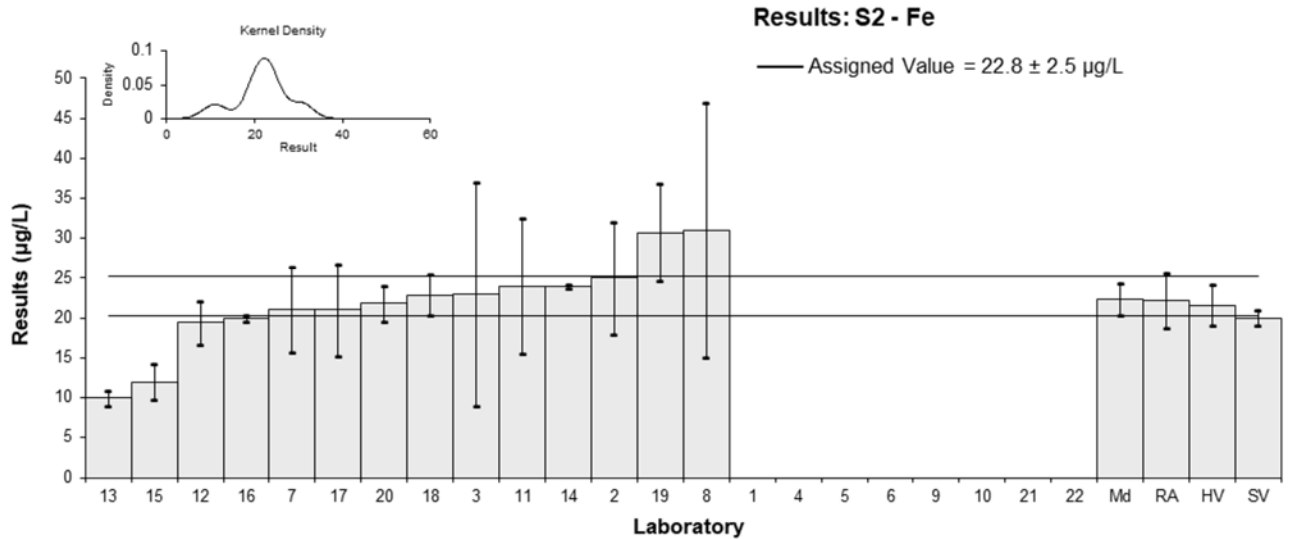


Figure 29

Table 33

Sample Details

Sample No.	S2
Matrix	Seawater
Analyte	Hg
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	NT	NT		
2	0.3	0.08	0.33	0.17
3	0.286	0.063	0.00	0.00
4	NT	NT		
5	NT	NT		
6	< 0.5	NR		
7	0.27	0.027	-0.37	-0.49
8	0.27	0.07	-0.37	-0.22
9	NT	NT		
10	0.22	0.038	-1.54	-1.57
11	0.28	0.02	-0.14	-0.22
12	0.327	0.075	0.96	0.53
13*	1	0.05	16.64	13.44
14	0.28	0.028	-0.14	-0.18
15	0.31	0.06	0.56	0.38
16	0.25	0.03	-0.84	-1.03
17	0.3	0.05	0.33	0.26
18	<0.5	NR		
19	0.306	0.061	0.47	0.31
20	0.29	0.03	0.09	0.11
21	NT	NT		
22	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	0.286	0.018
Spike Value	0.300	0.015
Homogeneity Value	0.292	0.035
Robust Average	0.289	0.020
Median	0.288	0.018
Mean	0.33	
N	14	
Max	1	
Min	0.22	
Robust SD	0.029	
Robust CV	10%	

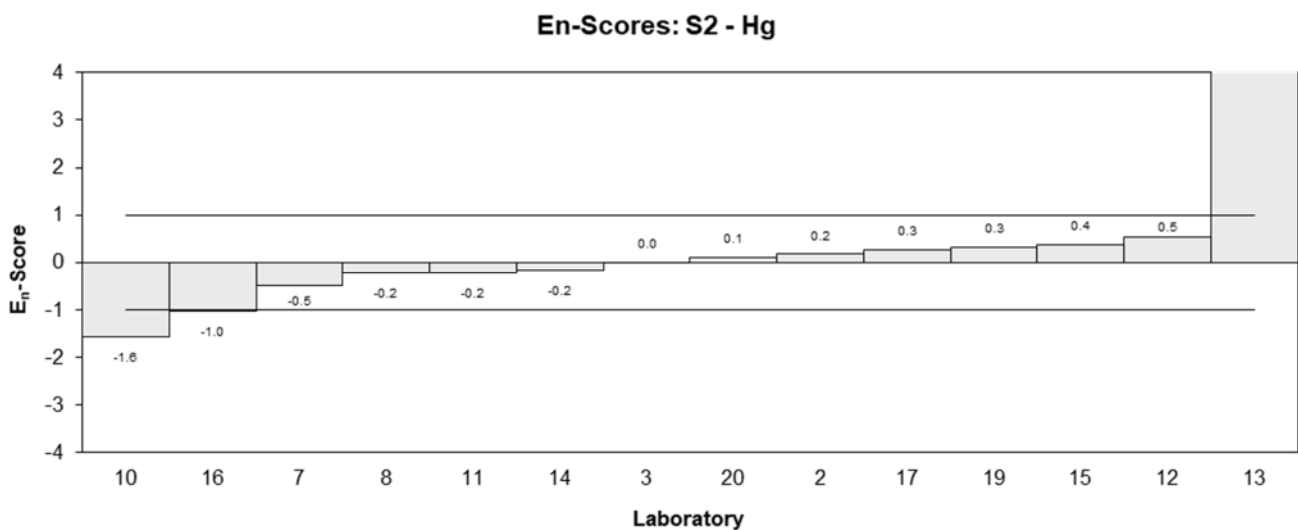
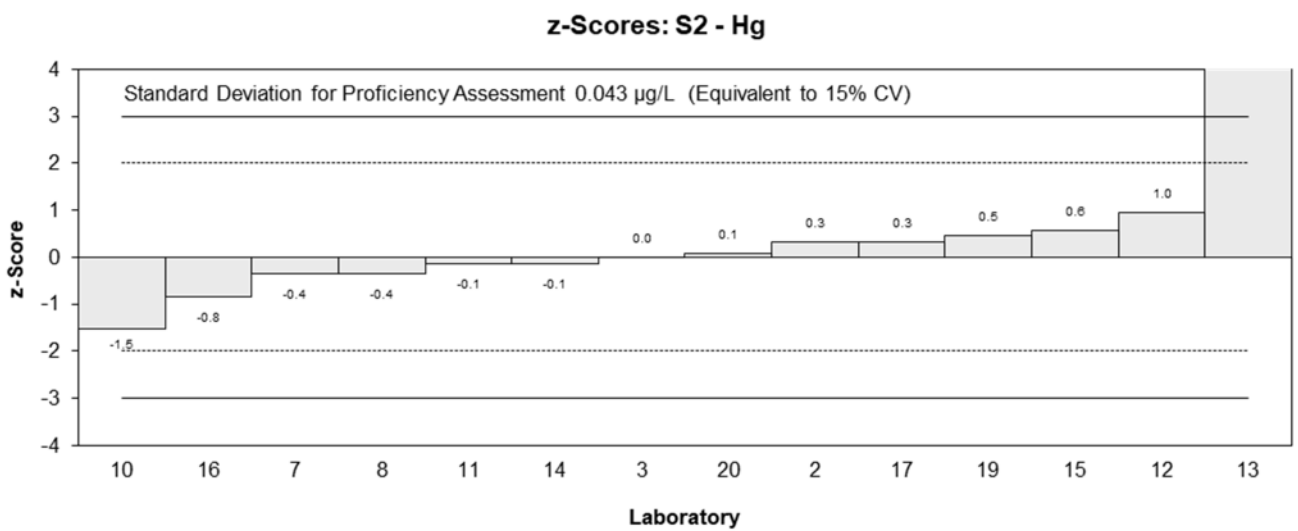
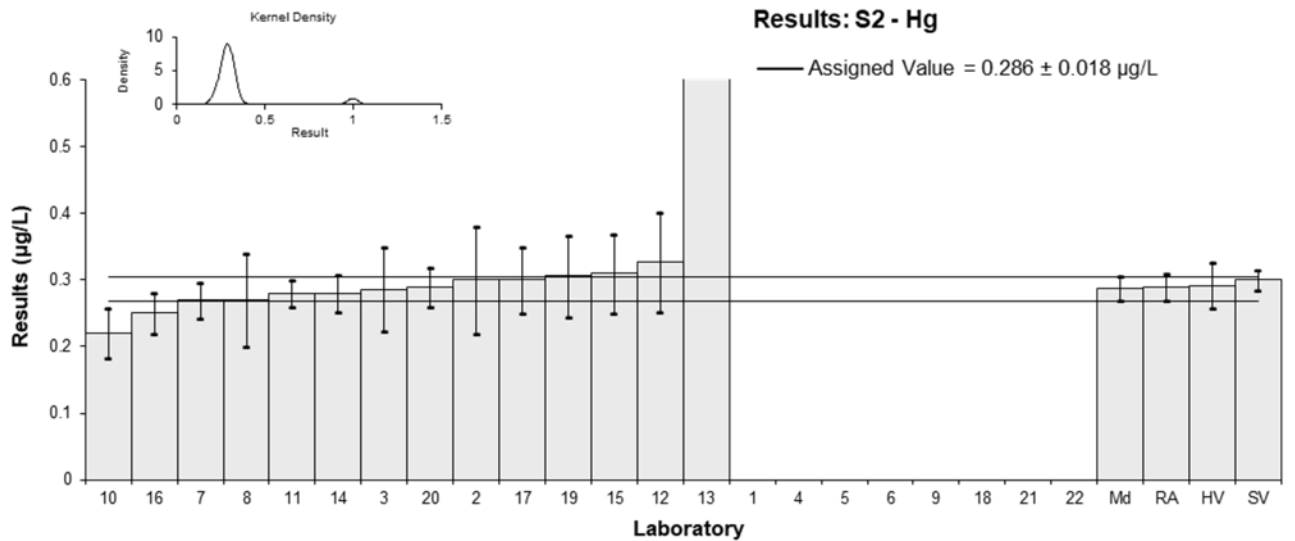


Figure 30

Table 34

Sample Details

Sample No.	S2
Matrix	Seawater
Analyte	Mn
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	4.0	0.4	-0.77	-0.98
2	5.2	2	1.00	0.33
3	4.14	0.69	-0.56	-0.49
4	NT	NT		
5	NT	NT		
6	< 10	NR		
7	3.9	0.56	-0.91	-0.94
8	4.2	1	-0.47	-0.30
9	NT	NT		
10	<5	NR		
11	4.42	1.21	-0.15	-0.08
12	4.53	0.73	0.01	0.01
13*	2	0.17	-3.72	-6.48
14	NT	NT		
15	5	1	0.71	0.45
16	4.2	0.6	-0.47	-0.46
17	5.3	1.1	1.15	0.68
18	4.85	0.6	0.49	0.48
19	4.60	0.92	0.12	0.08
20	4.4	0.44	-0.18	-0.21
21	NT	NT		
22	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	4.52	0.35
Spike Value	4.23	0.20
Homogeneity Value	3.97	0.48
Robust Average	4.45	0.38
Median	4.41	0.34
Mean	4.34	
N	14	
Max	5.3	
Min	2	
Robust SD	0.56	
Robust CV	13%	

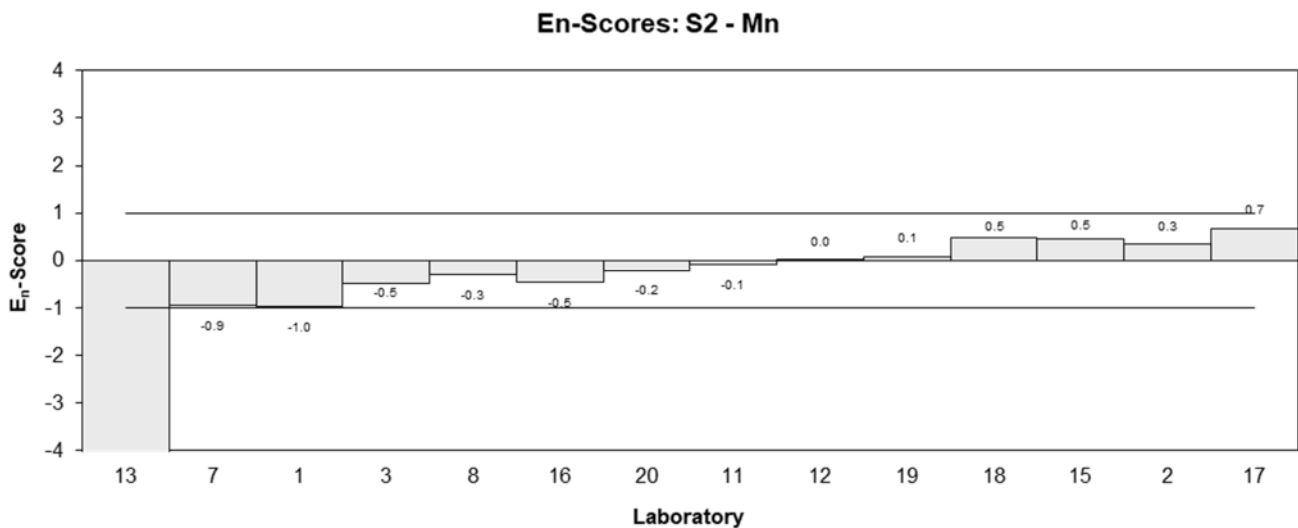
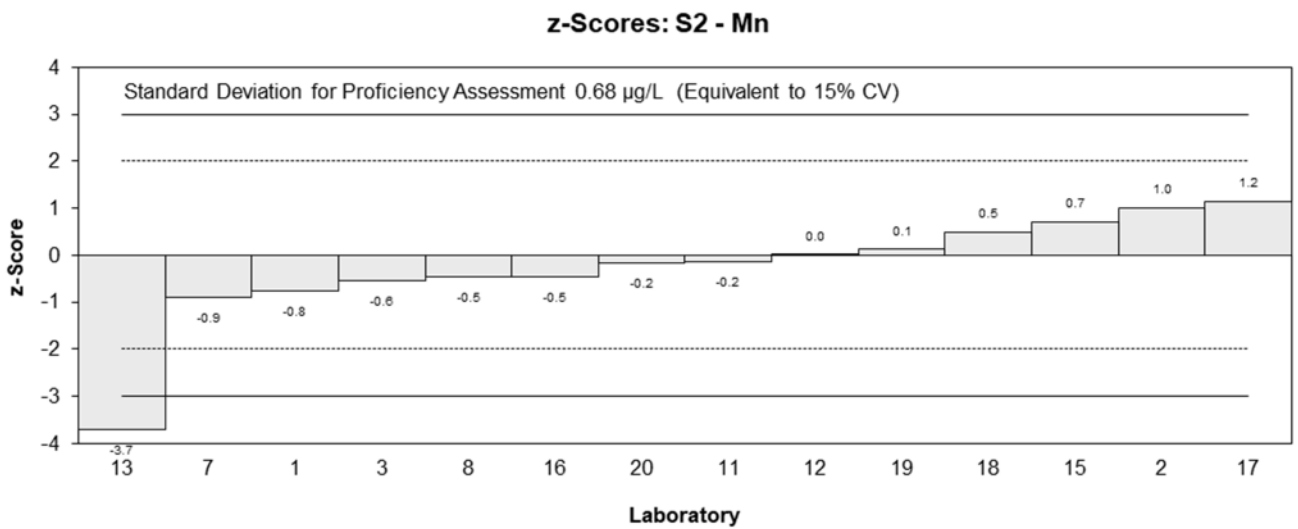
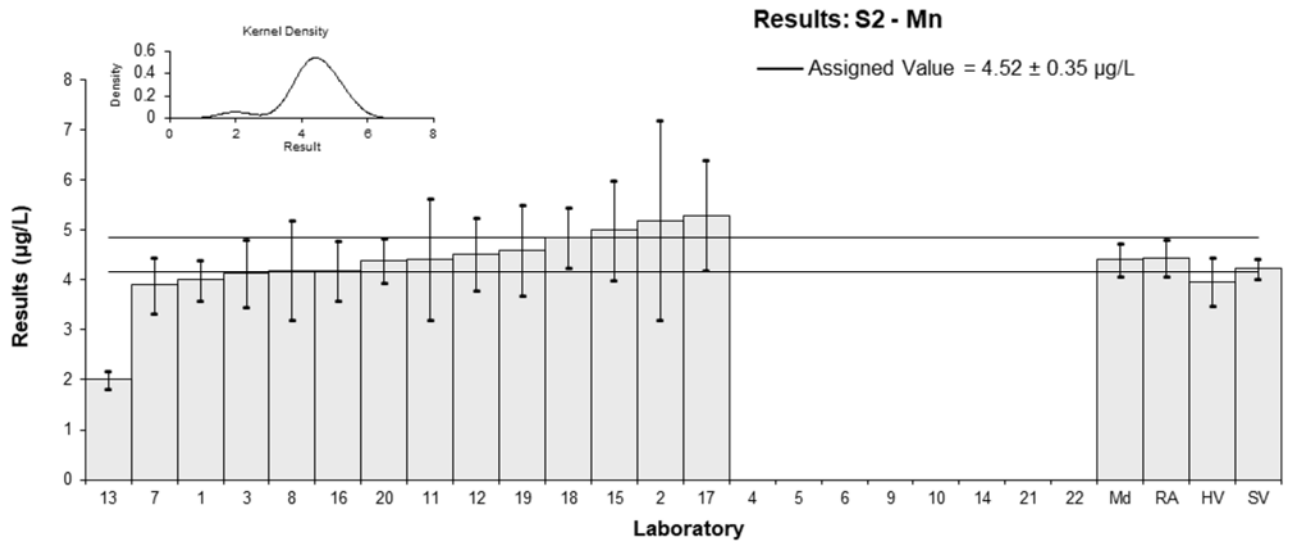


Figure 31

Table 35

Sample Details

Sample No.	S2
Matrix	Seawater
Analyte	Ni
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	2.3	0.4	-0.38	-0.30
2	3	3	1.53	0.19
3	< 7	4.7		
4	NT	NT		
5	NT	NT		
6	< 5	NR		
7	2.5	0.48	0.16	0.11
8*	7.5	1.8	13.83	2.79
9	NT	NT		
10	<5	NR		
11	2.00	0.45	-1.20	-0.87
12	2.44	0.37	0.00	0.00
13*	13	1.16	28.85	8.93
14*	4.5	0.45	5.63	4.08
15	2	0.3	-1.20	-1.16
16	2.4	0.5	-0.11	-0.07
17	2.7	0.5	0.71	0.47
18	2.49	0.4	0.14	0.11
19	2.47	0.49	0.08	0.06
20	2.6	0.26	0.44	0.46
21	NT	NT		
22	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	2.44	0.23
Spike Value	2.70	0.15
Homogeneity Value	2.53	0.30
Robust Average	2.74	0.49
Median	2.50	0.20
Mean	3.7	
N	14	
Max	13	
Min	2	
Robust SD	0.73	
Robust CV	27%	

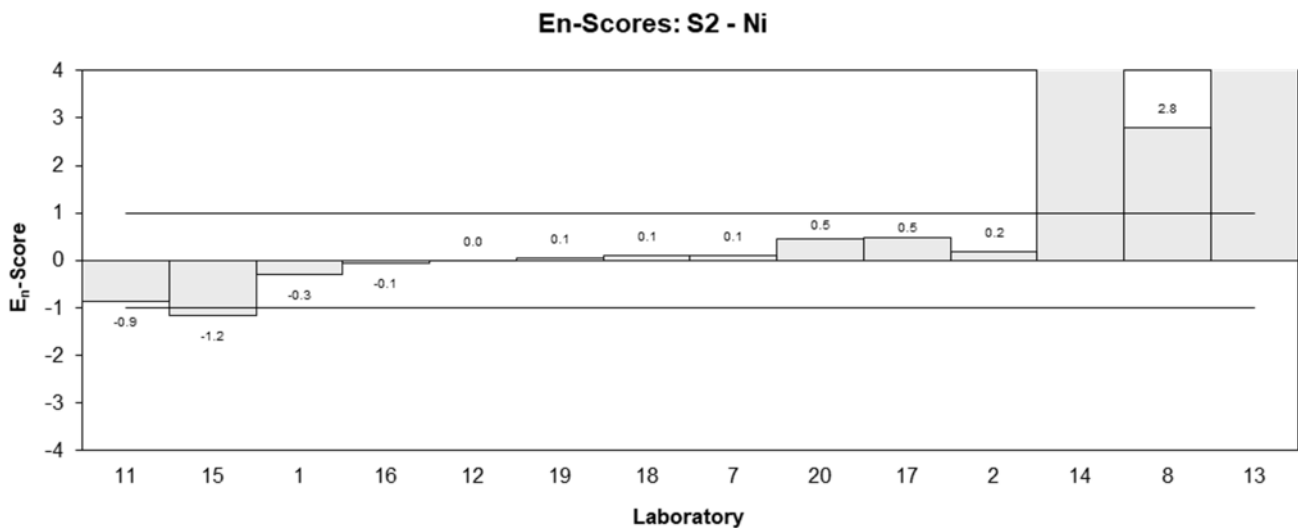
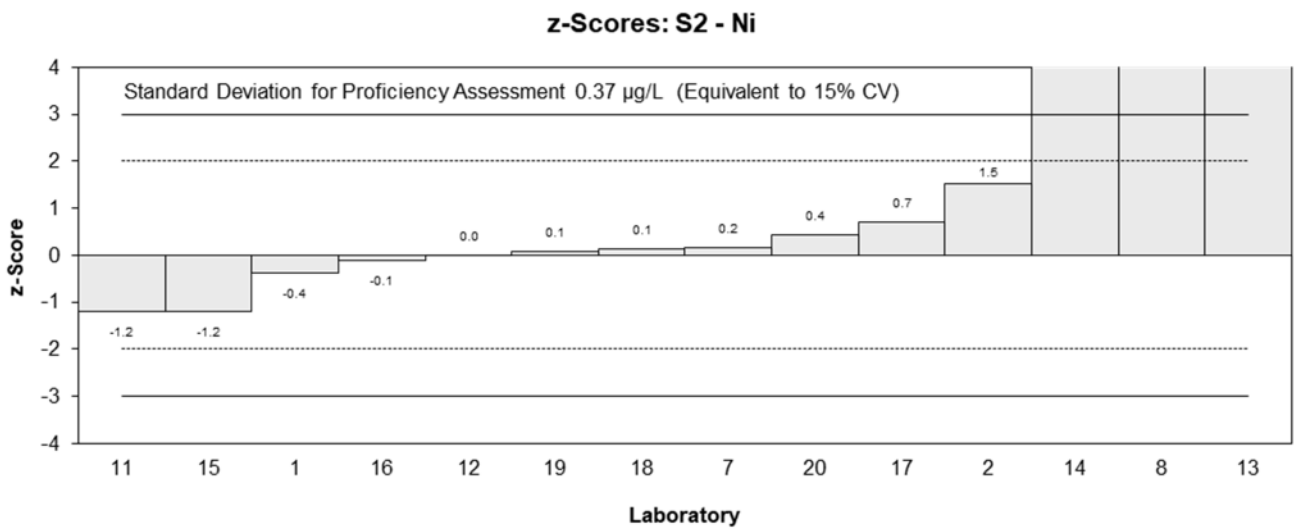
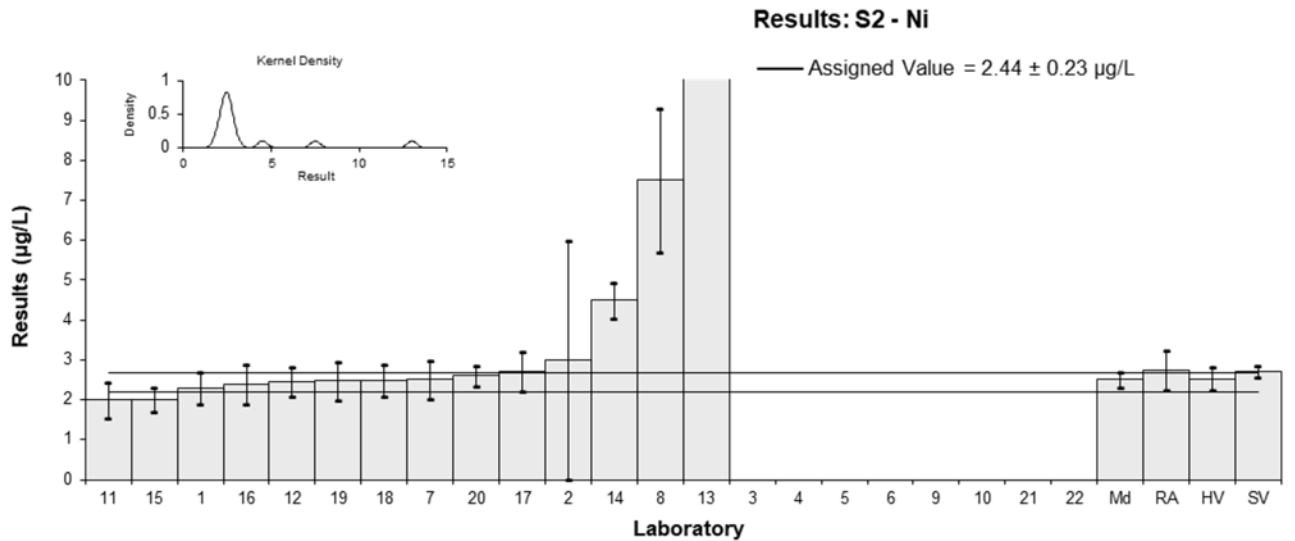


Figure 32

Table 36

Sample Details

Sample No.	S2
Matrix	Seawater
Analyte	P
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty
1	NT	NT
2	NT	NT
3	NT	NT
4	NT	NT
5	NT	NT
6	103	30.9
7	<1000	NR
8	18	2.3
9	NT	NT
10	<1000	NR
11	100	25
12	NT	NT
13	48	4.28
14	90	0.90
15	NT	NT
16	<10000	2000
17	NR	NR
18	NT	NT
19	112	22
20	60	6
21	NT	NT
22	NT	NT

Statistics

Assigned Value	Not Set	
Spike Value	90.1	4.2
Homogeneity Value	87	10
Robust Average	76	37
Median	90	31
Mean	76	
N	7	
Max	112	
Min	18	
Robust SD	39	
Robust CV	52%	

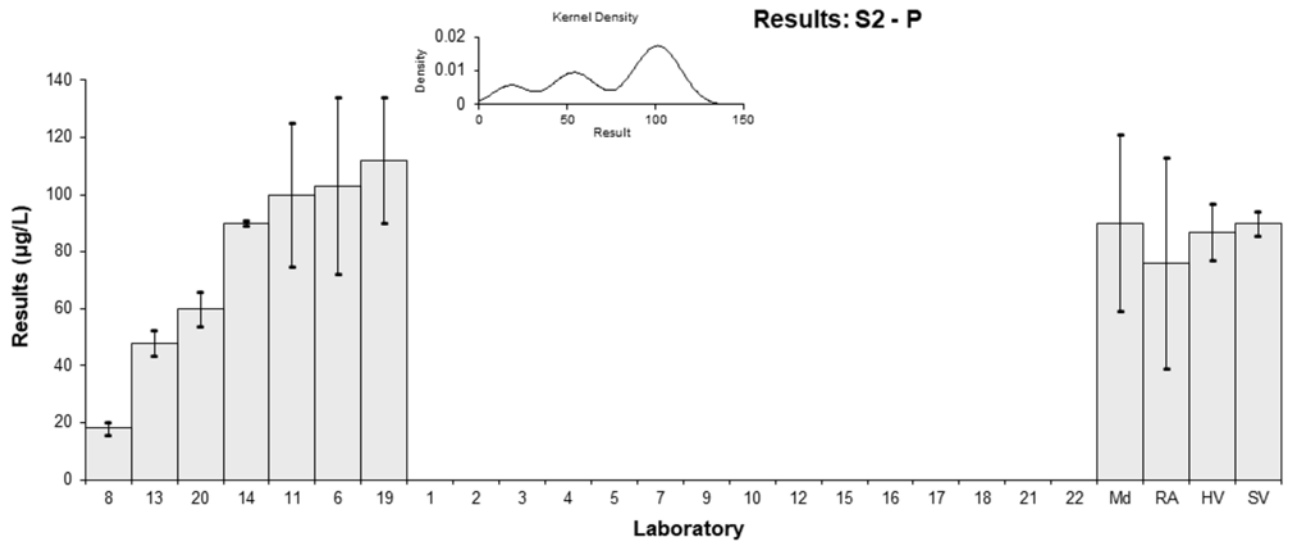


Figure 33

Table 37

Sample Details

Sample No.	S2
Matrix	Seawater
Analyte	Pb
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	1.4	0.1	-0.49	-0.78
2	1.2	3	-1.37	-0.10
3	1.51	0.72	0.00	0.00
4	NT	NT		
5	NT	NT		
6	< 5	NR		
7	1.4	0.2	-0.49	-0.49
8	1.2	1	-1.37	-0.31
9	NT	NT		
10	<5	NR		
11	1.67	0.37	0.71	0.42
12	1.64	0.33	0.57	0.38
13*	9	0.91	33.07	8.18
14	1.6	0.16	0.40	0.48
15	1.4	0.2	-0.49	-0.49
16	1.6	0.3	0.40	0.28
17	1.6	0.1	0.40	0.64
18	1.63	0.4	0.53	0.29
19	1.50	0.3	-0.04	-0.03
20	1.65	0.17	0.62	0.71
21	NT	NT		
22	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	1.51	0.10
Spike Value	1.51	0.08
Homogeneity Value	1.57	0.19
Robust Average	1.53	0.11
Median	1.60	0.09
Mean	2.0	
N	15	
Max	9	
Min	1.2	
Robust SD	0.17	
Robust CV	11%	

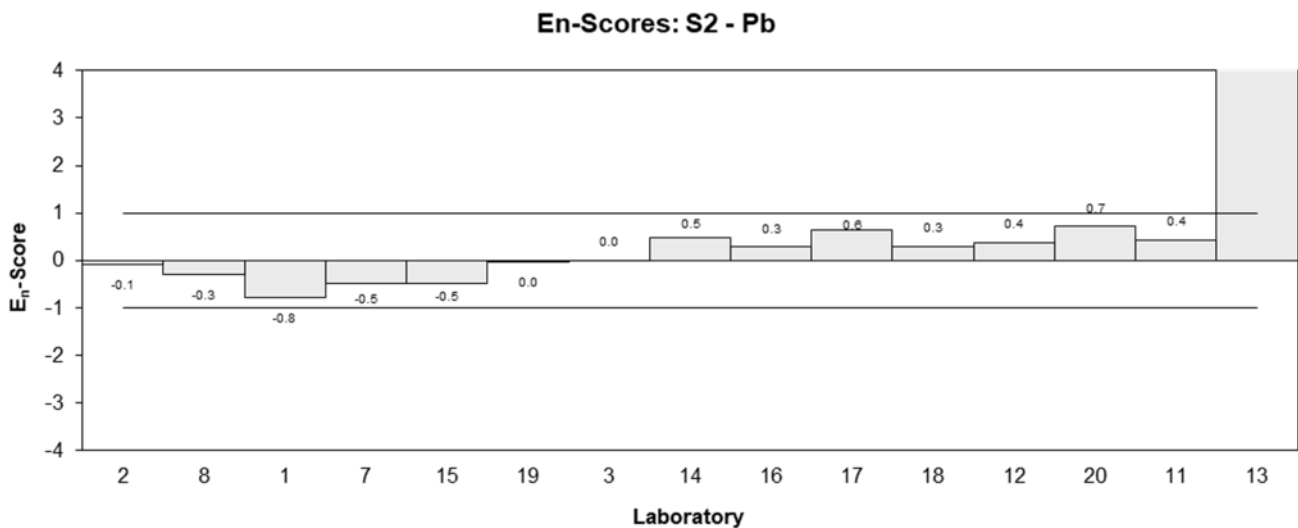
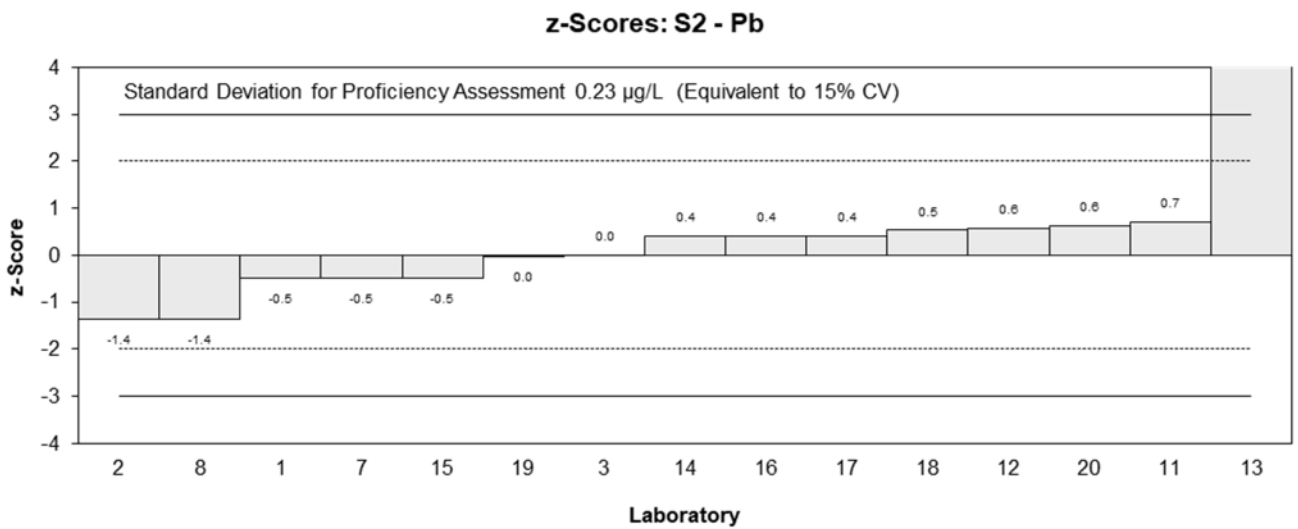
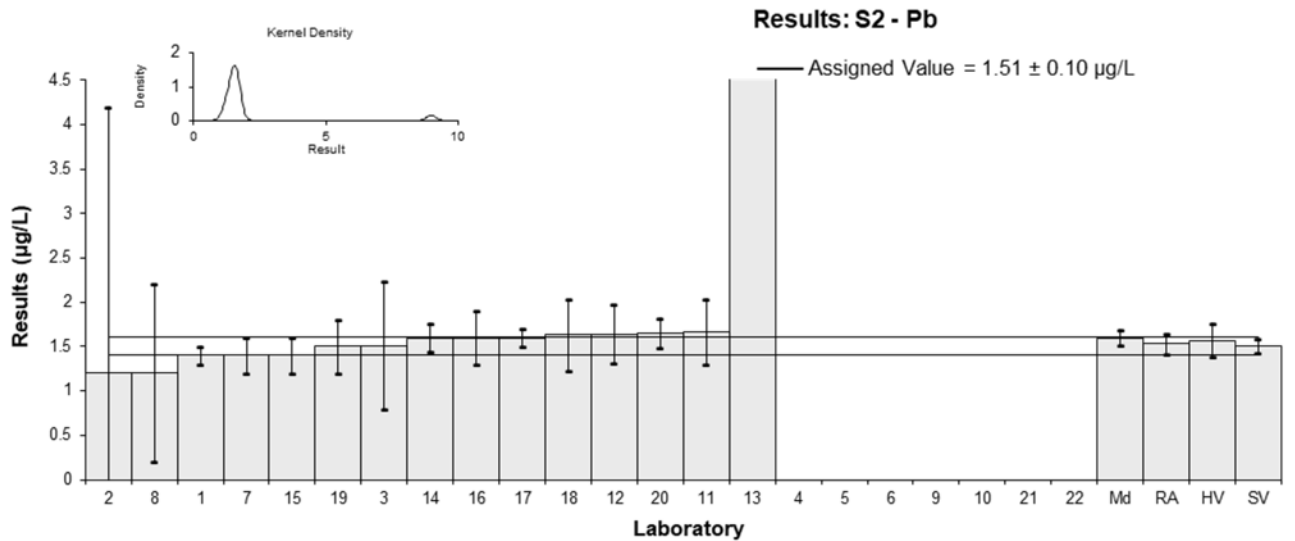


Figure 34

Table 38

Sample Details

Sample No.	S2
Matrix	Seawater
Analyte	Sb
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	2.5	0.5	-0.88	-0.69
2	2.7	0.8	-0.42	-0.22
3	3.01	0.77	0.30	0.16
4	NT	NT		
5	NT	NT		
6	< 10	NR		
7	3.2	0.78	0.74	0.39
8	3.1	1.5	0.51	0.14
9	NT	NT		
10	<5	NR		
11	2.48	0.55	-0.93	-0.67
12	3.19	0.70	0.72	0.42
13*	7	0.40	9.54	8.83
14*	5.5	0.55	6.06	4.37
15	2	0.3	-2.04	-2.29
16	2.9	0.18	0.05	0.07
17	3.2	0.3	0.74	0.83
18	2.93	0.6	0.12	0.08
19	2.64	0.53	-0.56	-0.41
20	3.18	0.32	0.69	0.75
21	NT	NT		
22	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	2.88	0.24
Spike Value	2.69	0.13
Homogeneity Value	2.82	0.34
Robust Average	2.98	0.30
Median	3.01	0.18
Mean	3.30	
N	15	
Max	7	
Min	2	
Robust SD	0.46	
Robust CV	15%	

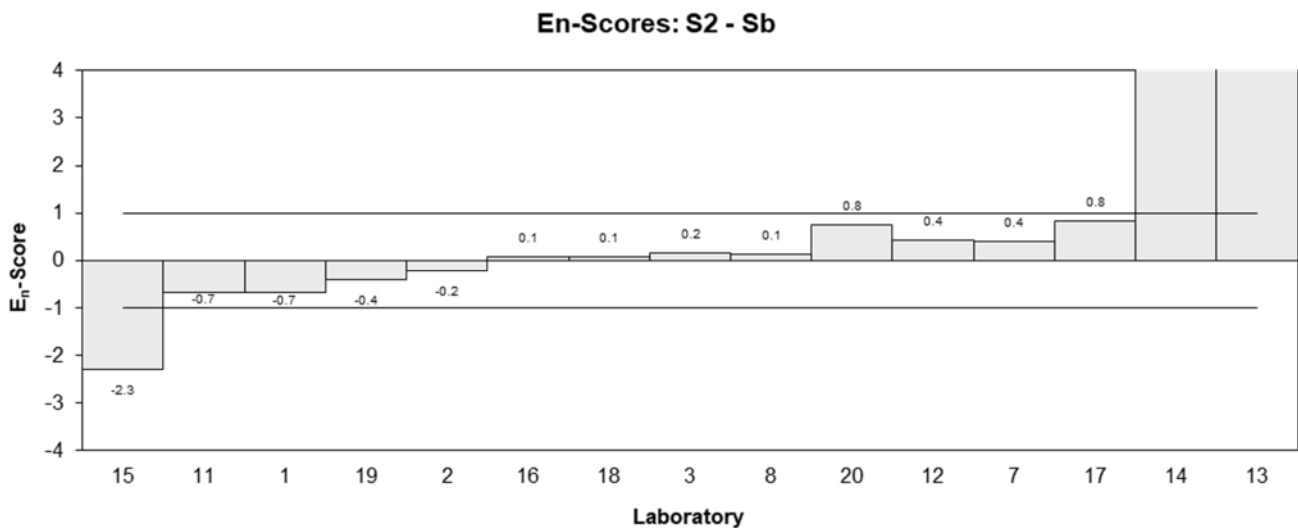
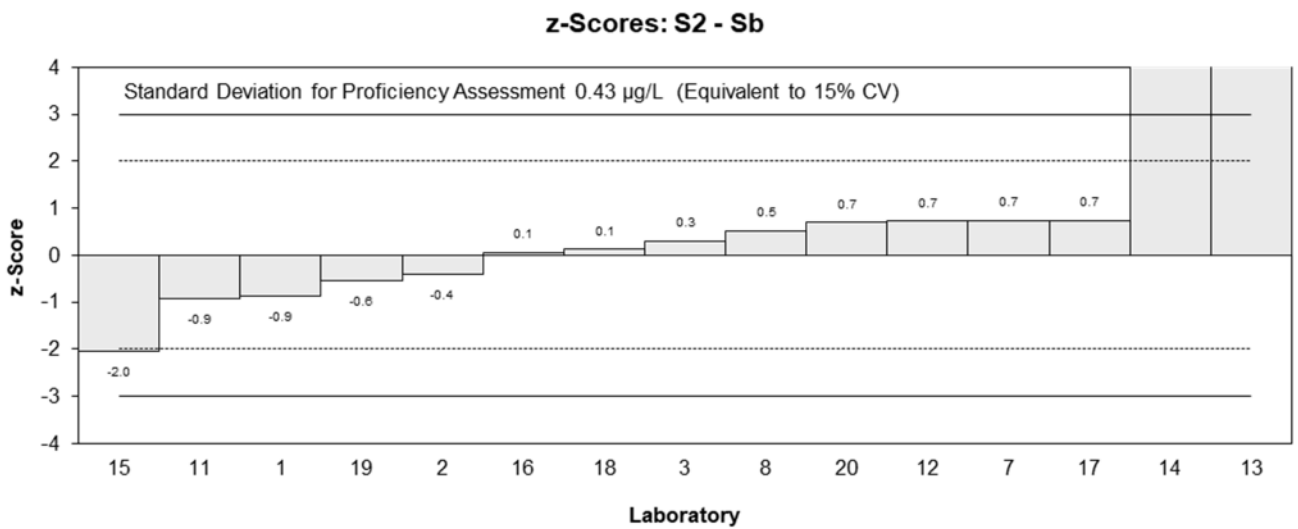
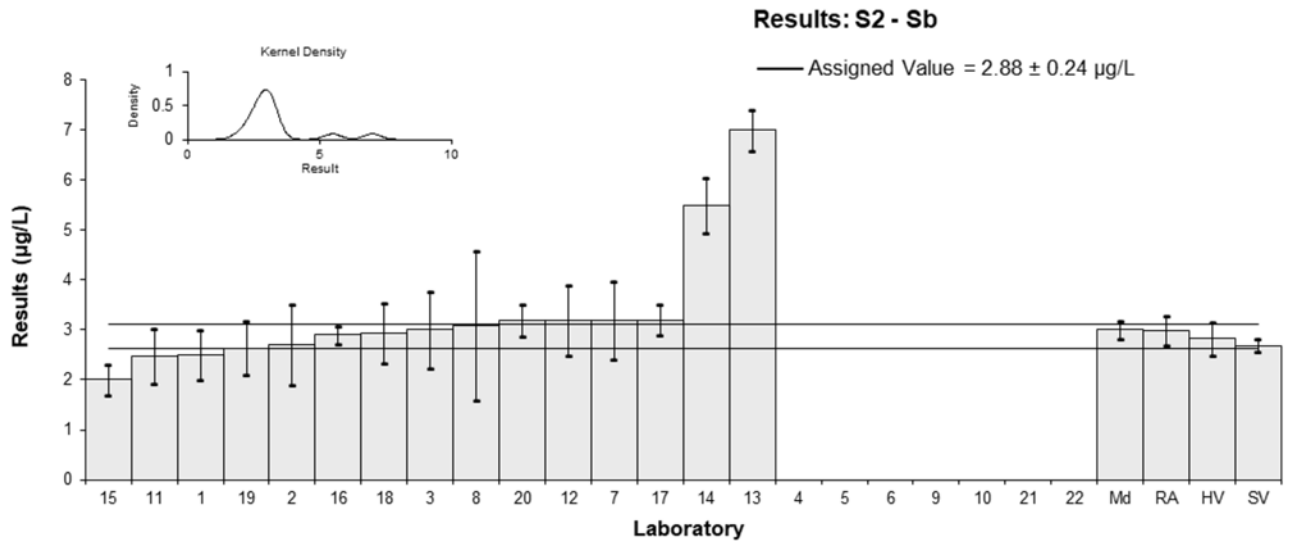


Figure 35

Table 39

Sample Details

Sample No.	S2
Matrix	Seawater
Analyte	Se
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	4	0.8	-0.77	-0.66
2	7	3	2.40	0.73
3	< 10	5.0		
4	NT	NT		
5	NT	NT		
6	< 10	NR		
7	5	0.80	0.29	0.24
8	6.1	1.5	1.45	0.81
9	NT	NT		
10	<50	NR		
11	3.53	0.87	-1.27	-1.04
12	3.83	0.77	-0.95	-0.83
13	3	0.28	-1.83	-2.14
14	5.6	0.56	0.92	0.92
15	4.8	0.9	0.07	0.06
16	5	1	0.29	0.21
17	3.8	1.0	-0.98	-0.74
18	4.56	0.6	-0.18	-0.18
19	5.03	1.01	0.32	0.24
20	5.5	0.5	0.81	0.85
21	NT	NT		
22	NT	NT		

Statistics

Assigned Value	4.73	0.76
Spike Value	4.38	0.21
Homogeneity Value	4.27	0.51
Robust Average	4.73	0.76
Median	4.90	0.79
Mean	4.77	
N	14	
Max	7	
Min	3	
Robust SD	1.1	
Robust CV	24%	

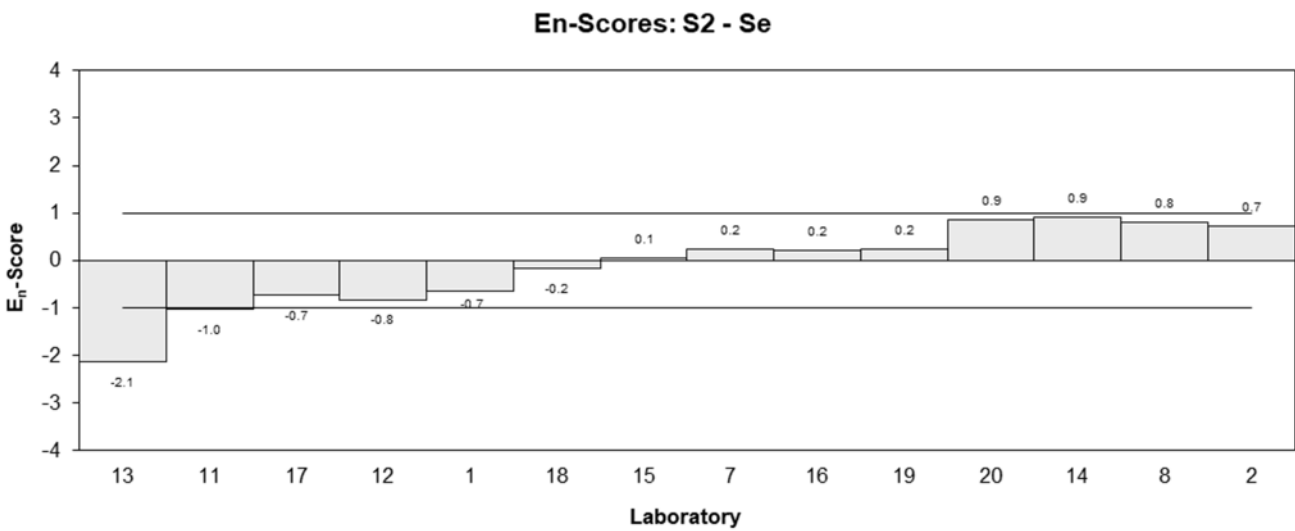
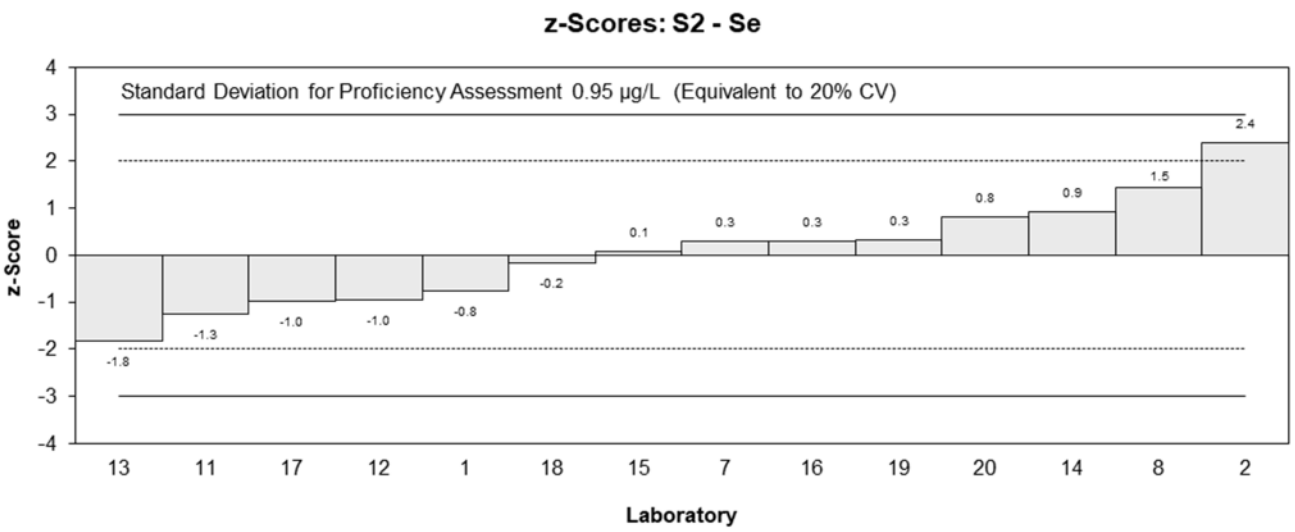
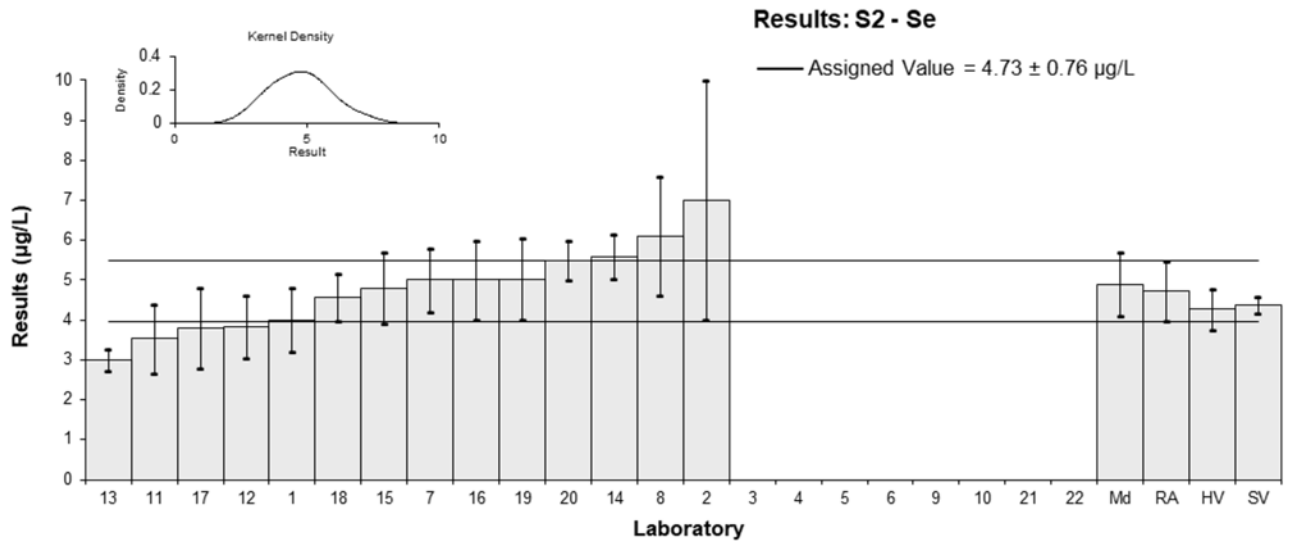


Figure 36

Table 40

Sample Details

Sample No.	S2
Matrix	Seawater
Analyte	Sn
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	<5	NR		
2	NT	NT		
3	< 5.0	3.4		
4	NT	NT		
5	NT	NT		
6	< 10	NR		
7	<5	NR		
8	4.9	1.3	2.67	0.95
9	NT	NT		
10	<5	NR		
11	2.93	0.72	-1.09	-0.57
12	3.52	0.74	0.04	0.02
13*	14	0.6	20.00	11.48
14	4.2	0.42	1.33	0.87
15	2.5	0.4	-1.90	-1.25
16	<5	0.5		
17	3.3	0.5	-0.38	-0.23
18	NT	NT		
19	3.67	0.73	0.32	0.17
20	3.21	0.32	-0.55	-0.38
21	NT	NT		
22	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	3.50	0.69
Spike Value	3.21	0.16
Homogeneity Value	3.87	0.46
Robust Average	3.72	0.86
Median	3.52	0.73
Mean	4.7	
N	9	
Max	14	
Min	2.5	
Robust SD	1.0	
Robust CV	28%	

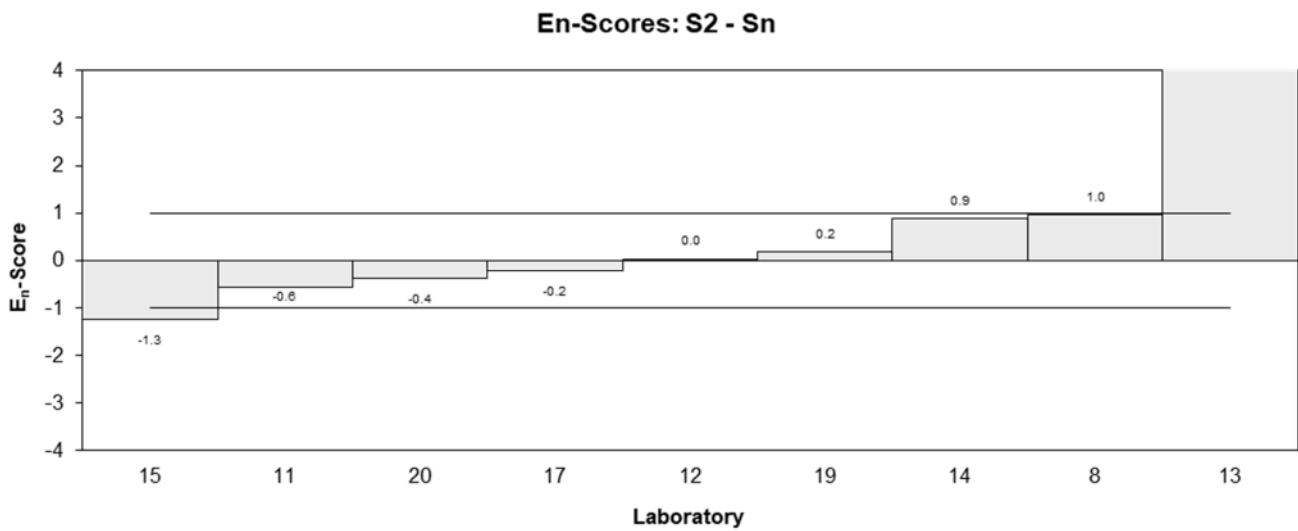
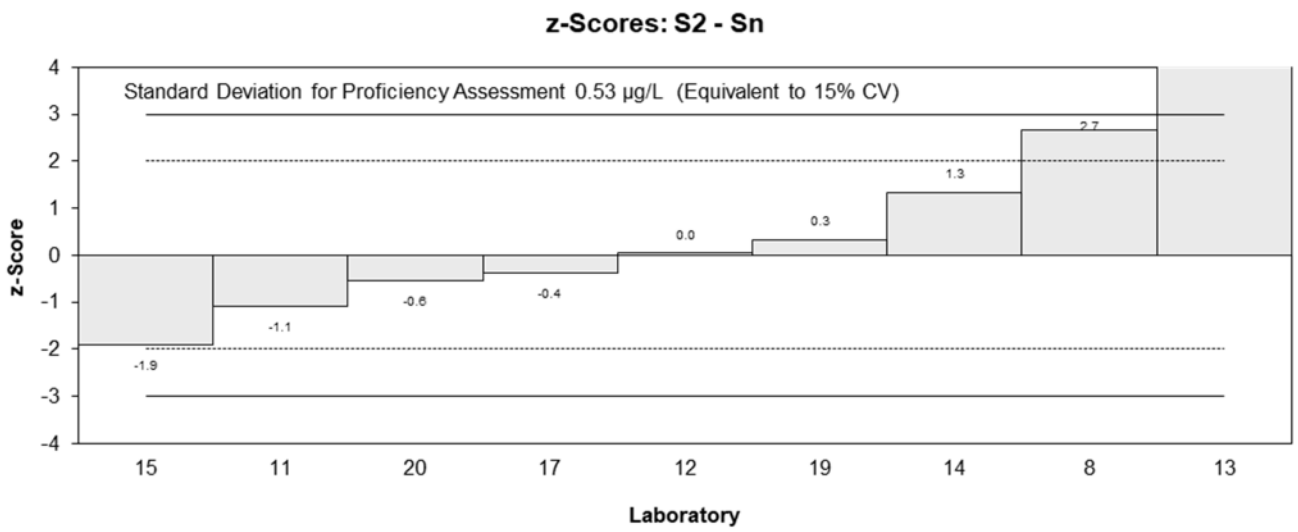
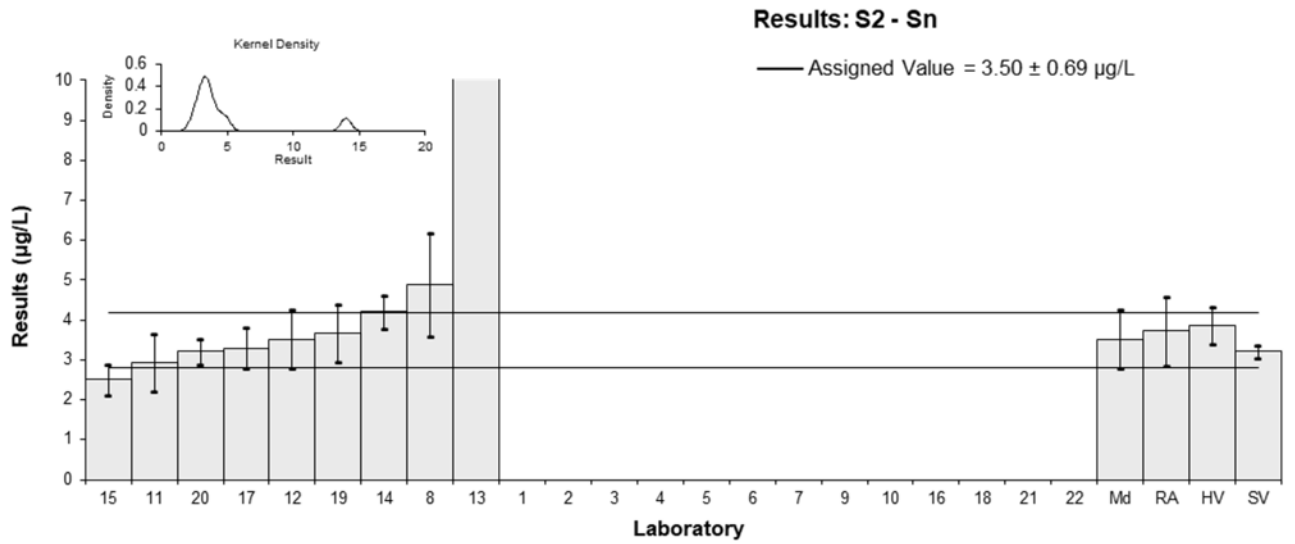


Figure 37

Table 41

Sample Details

Sample No.	S2
Matrix	Seawater
Analyte	TI
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	NT	NT		
2	1.5	1	-0.22	-0.05
3	1.61	0.25	0.26	0.23
4	NT	NT		
5	NT	NT		
6	< 10	NR		
7	1.2	0.15	-1.51	-2.06
8	1.7	1	0.65	0.15
9	NT	NT		
10	<5	NR		
11	1.67	0.39	0.52	0.30
12	1.54	0.25	-0.04	-0.04
13*	13	0.78	49.25	14.60
14	NT	NT		
15	NT	NT		
16	1.5	0.2	-0.22	-0.23
17	1.5	0.2	-0.22	-0.23
18	1.59	0.3	0.17	0.13
19	1.46	0.29	-0.39	-0.30
20	1.62	0.16	0.30	0.39
21	NT	NT		
22	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	1.55	0.08
Spike Value	1.50	0.08
Homogeneity Value	1.51	0.18
Robust Average	1.57	0.09
Median	1.57	0.07
Mean	2.5	
N	12	
Max	13	
Min	1.2	
Robust SD	0.12	
Robust CV	7.7%	

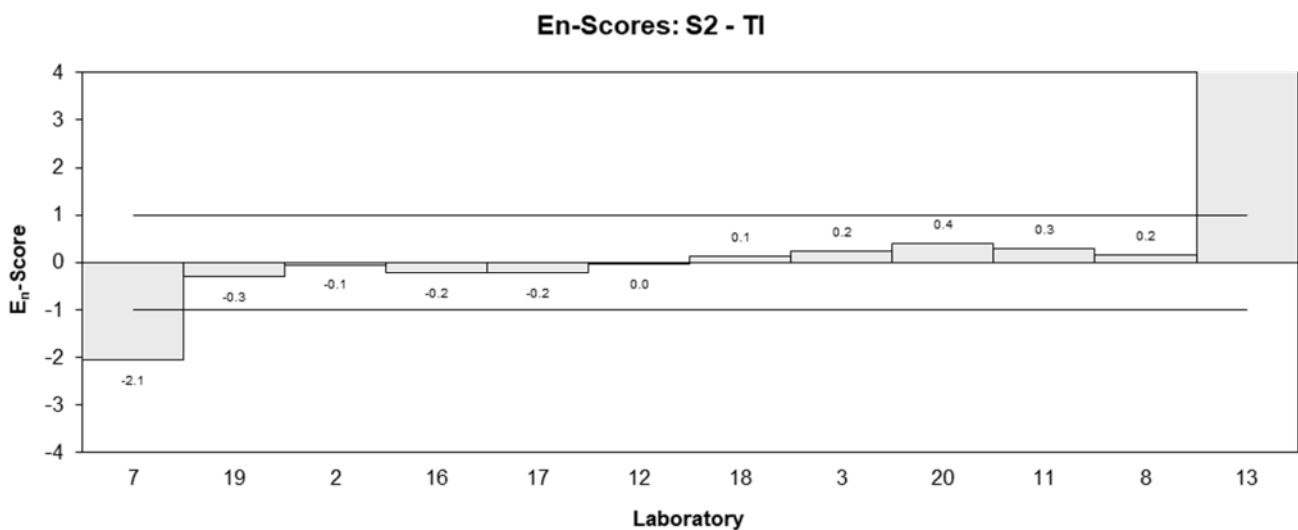
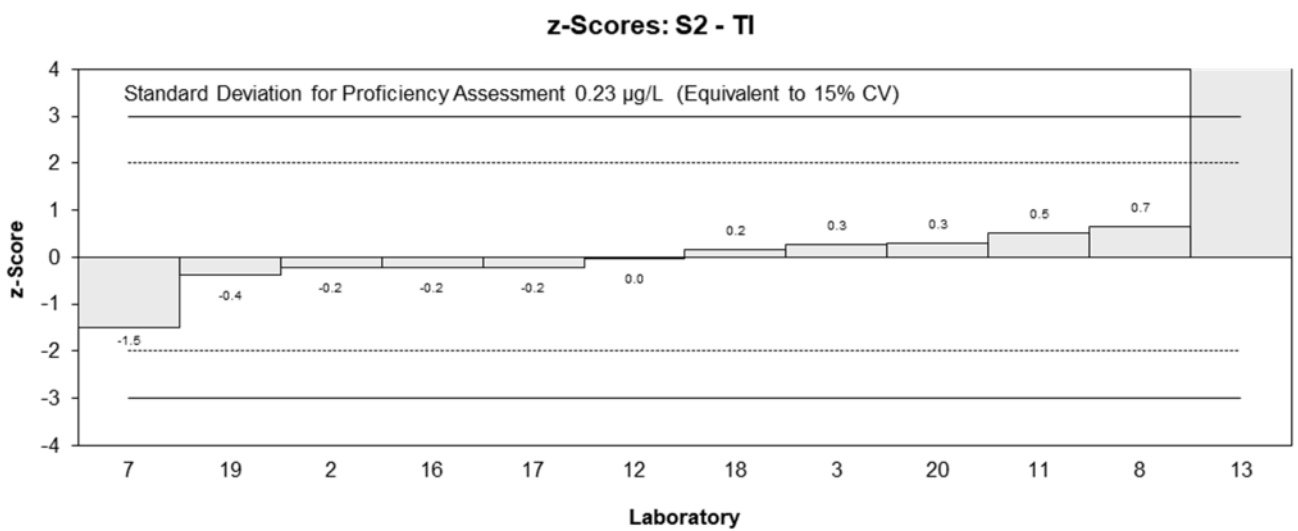
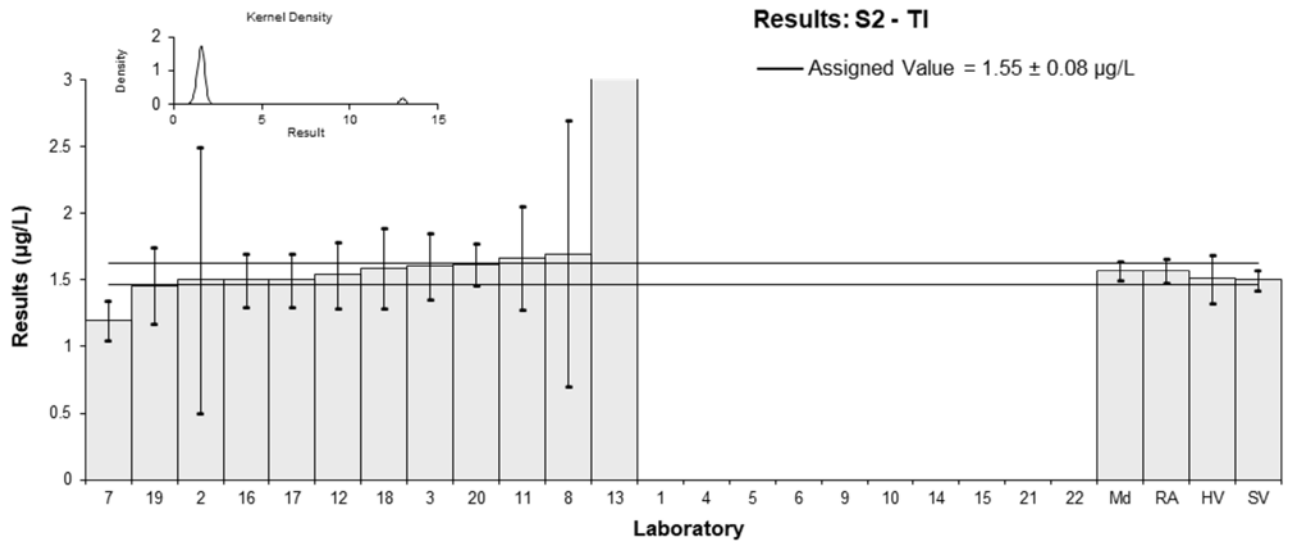


Figure 38

Table 42

Sample Details

Sample No.	S2
Matrix	Seawater
Analyte	U
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	2.9	0.1	-0.74	-1.83
2	3	1	-0.53	-0.26
3	3.34	0.48	0.16	0.16
4	NT	NT		
5	NT	NT		
6	< 10	NR		
7	3.1	0.50	-0.33	-0.30
8	3.4	0.8	0.29	0.17
9	NT	NT		
10	<5	NR		
11	3.12	0.70	-0.29	-0.19
12	3.47	0.49	0.43	0.40
13	NT	NT		
14	3.8	0.38	1.10	1.30
15	3.2	0.6	-0.12	-0.10
16	3.5	0.22	0.49	0.86
17	3.1	0.4	-0.33	-0.37
18	3.41	0.6	0.31	0.24
19	3.10	0.62	-0.33	-0.25
20	3.43	0.34	0.35	0.45
21	NT	NT		
22	NT	NT		

Statistics

Assigned Value	3.26	0.17
Spike Value	Not Spiked	
Homogeneity Value	3.37	0.40
Robust Average	3.26	0.17
Median	3.27	0.17
Mean	3.28	
N	14	
Max	3.8	
Min	2.9	
Robust SD	0.25	
Robust CV	7.6%	

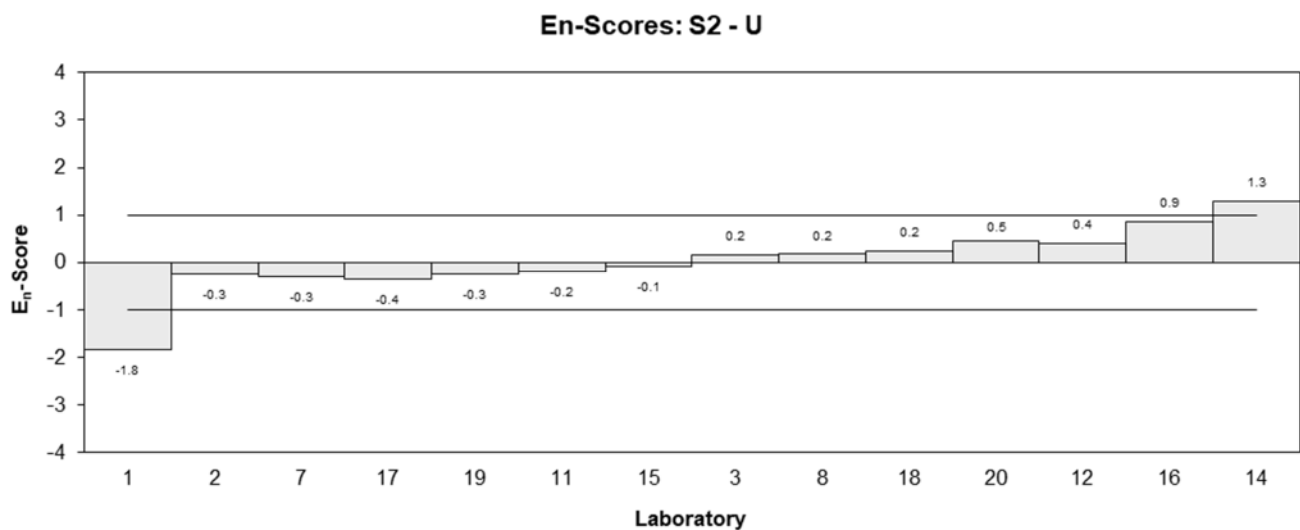
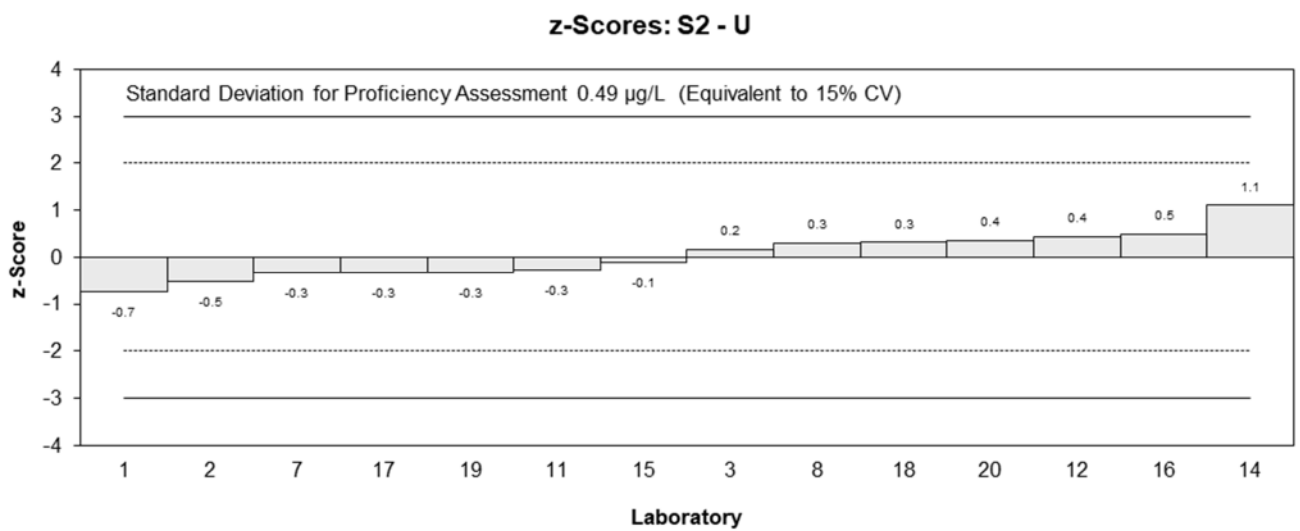
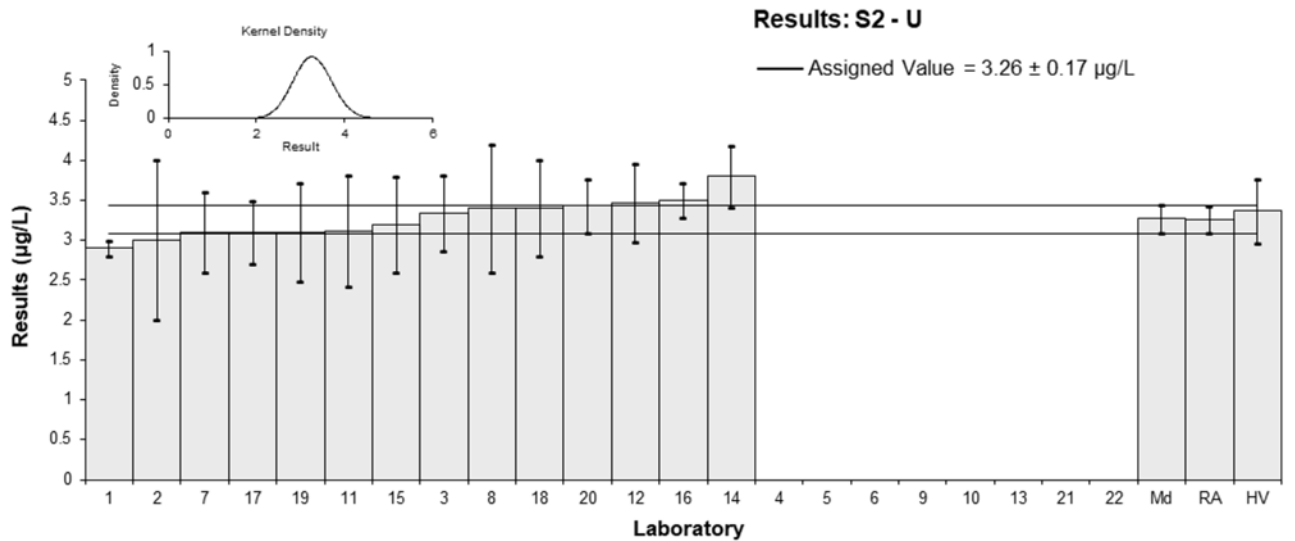


Figure 39

Table 43

Sample Details

Sample No.	S2
Matrix	Seawater
Analyte	V
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	1.5	0.1	-1.54	-2.01
2	2	2	0.17	0.02
3	< 10	6.7		
4	NT	NT		
5	NT	NT		
6	< 10	NR		
7	1.9	0.60	-0.17	-0.08
8	2.3	1	1.20	0.34
9	NT	NT		
10	<50	NR		
11	2.00	0.57	0.17	0.08
12	1.73	0.33	-0.75	-0.57
13*	5	0.38	10.43	7.10
14	2.3	0.23	1.20	1.15
15	2.3	0.4	1.20	0.78
16	1.7	0.2	-0.85	-0.88
17	2.1	0.3	0.51	0.42
18	1.86	0.4	-0.31	-0.20
19	1.92	0.38	-0.10	-0.07
20	1.69	0.17	-0.89	-0.99
21	NT	NT		
22	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	1.95	0.20
Spike Value	Not Spiked	
Homogeneity Value	2.00	0.24
Robust Average	1.98	0.21
Median	1.96	0.24
Mean	2.16	
N	14	
Max	5	
Min	1.5	
Robust SD	0.32	
Robust CV	16%	

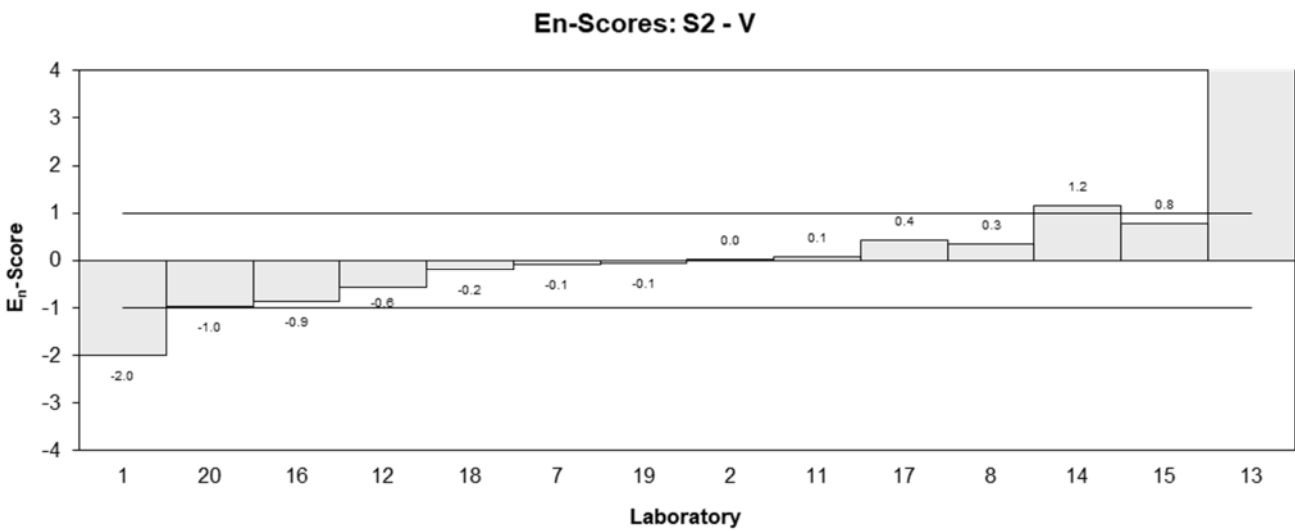
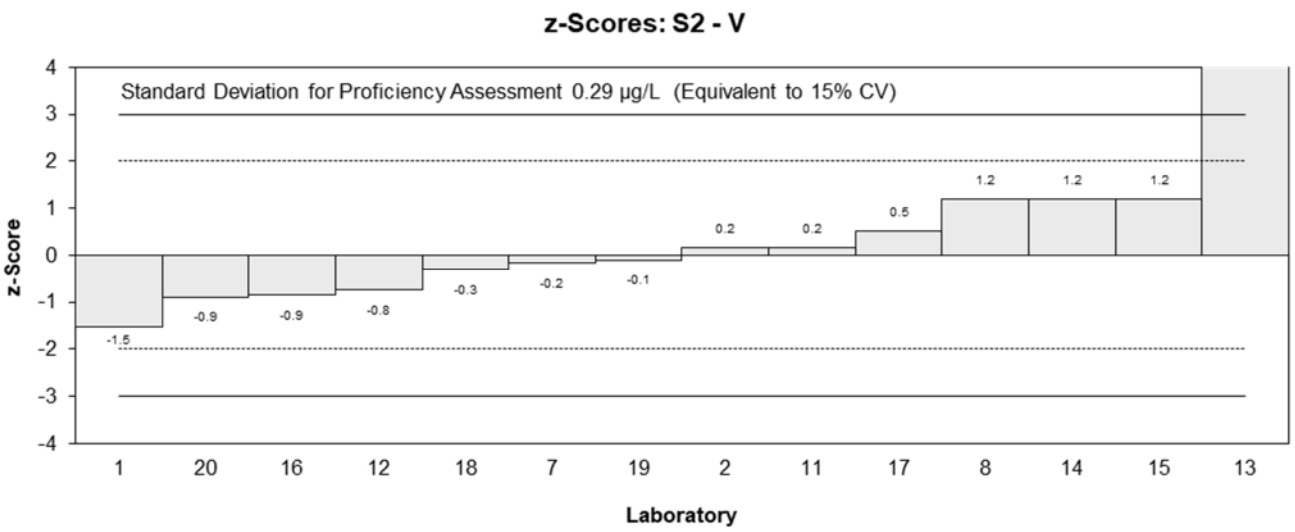
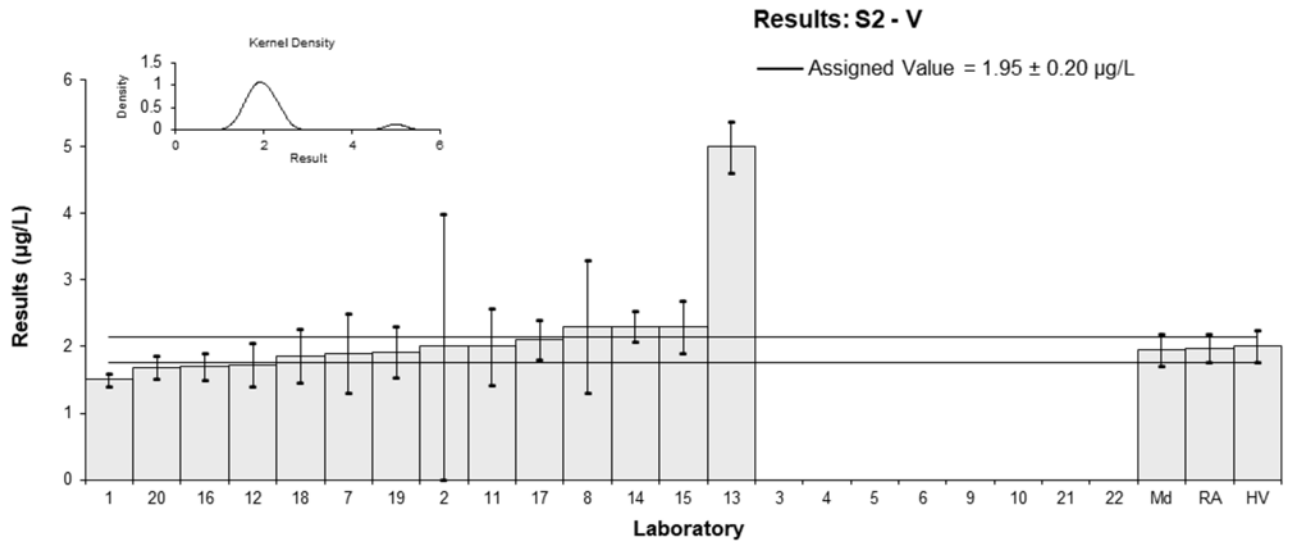


Figure 40

Table 44

Sample Details

Sample No.	S2
Matrix	Seawater
Analyte	Zn
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	15	4	-0.09	-0.05
2	17	5	0.79	0.35
3	17.0	3.8	0.79	0.45
4	NT	NT		
5	NT	NT		
6	17.04	5.112	0.81	0.35
7	15	2.25	-0.09	-0.08
8	15	3.8	-0.09	-0.05
9	NT	NT		
10	<25	NR		
11	11.2	2.7	-1.75	-1.35
12	14.8	3.1	-0.18	-0.12
13	10	0.87	-2.28	-3.51
14	16	0.16	0.35	0.66
15	12	2.9	-1.40	-1.02
16	16	3	0.35	0.25
17	17	1.5	0.79	0.94
18	17.0	2.0	0.79	0.77
19	16.2	3.2	0.44	0.29
20	14.1	1.4	-0.48	-0.60
21	NT	NT		
22	NT	NT		

Statistics

Assigned Value	15.2	1.2
Spike Value	16.3	0.8
Homogeneity Value	17.0	2.0
Robust Average	15.2	1.2
Median	15.5	1.3
Mean	15.0	
N	16	
Max	17.04	
Min	10	
Robust SD	2.0	
Robust CV	13%	

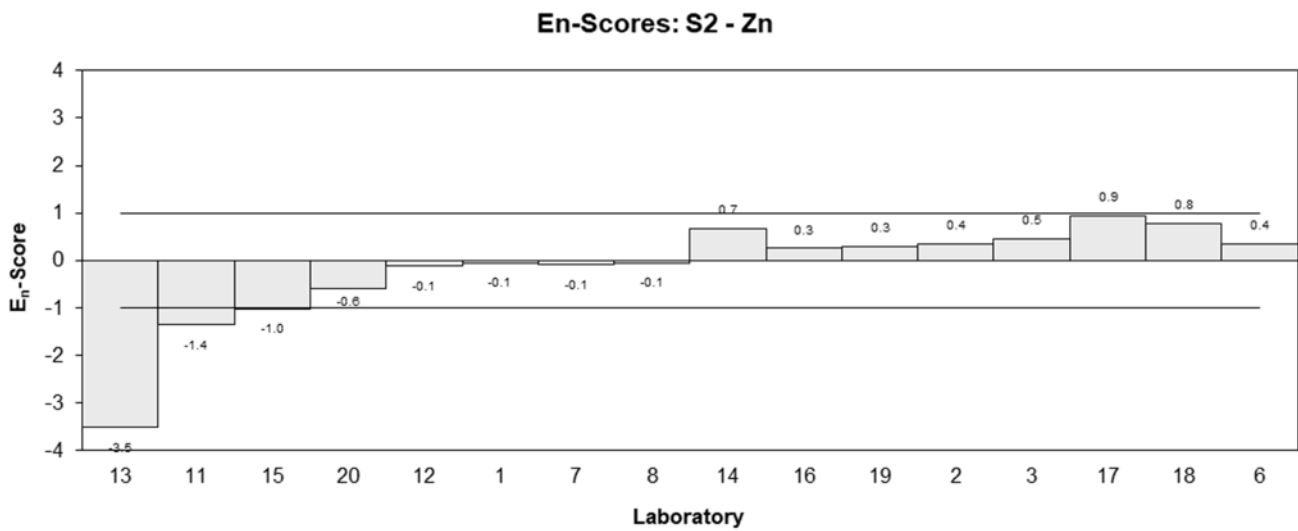
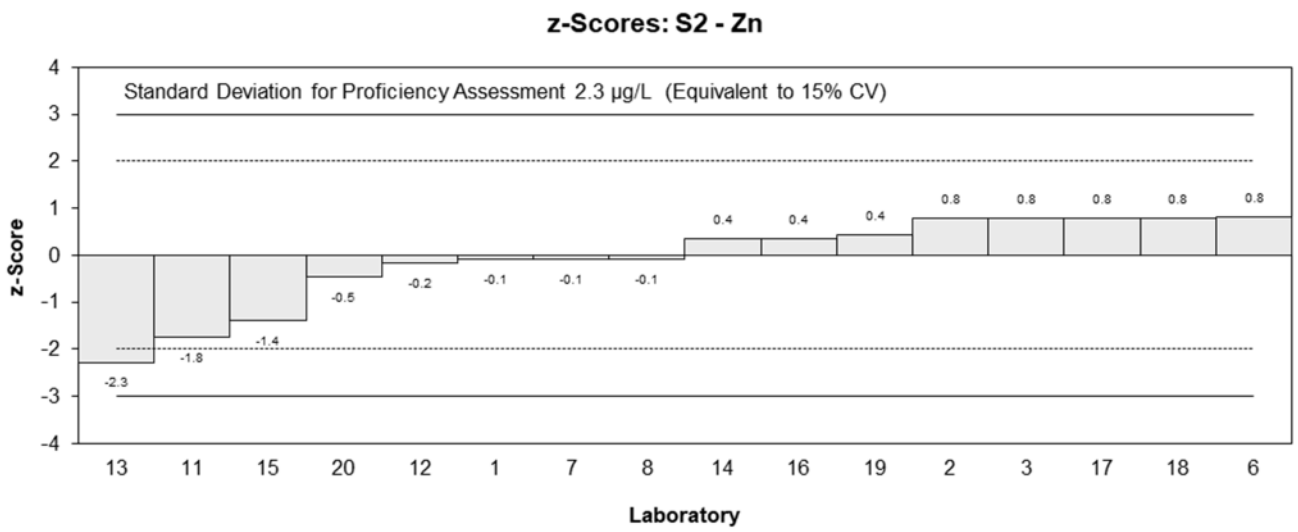
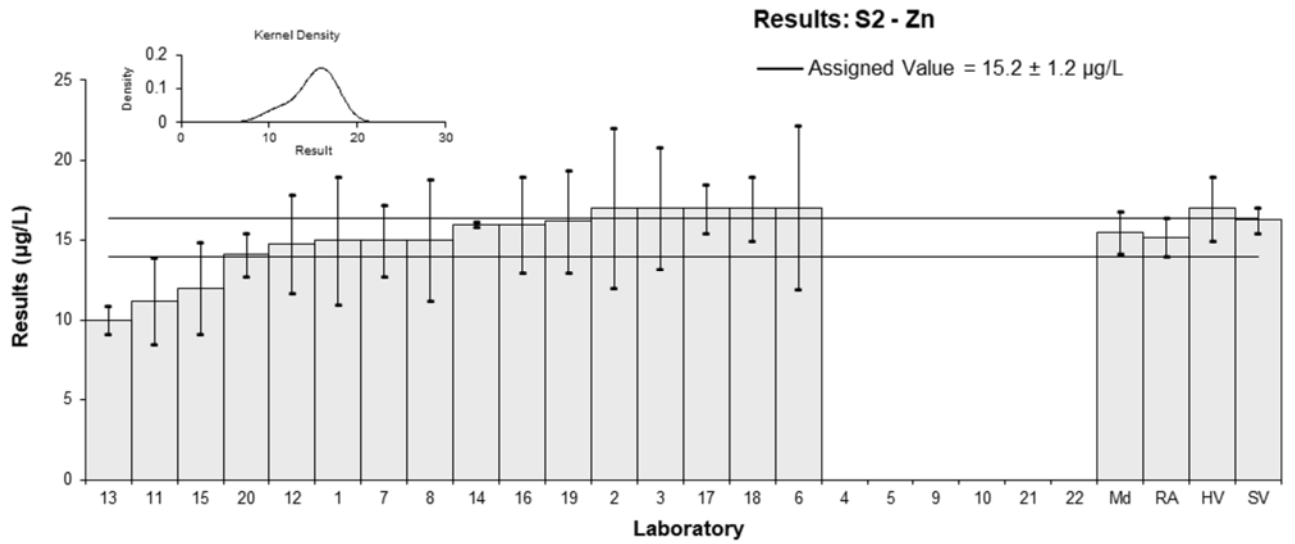


Figure 41

Table 45

Sample Details

Sample No.	S3
Matrix	River Water
Analyte	TDS
Unit	mg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	497	35	0.04	0.05
2	NR	454		
3	NT	NT		
4	522	57	0.55	0.45
5	486	58.8	-0.18	-0.15
6	NT	NT		
7	492	78	-0.06	-0.04
8	NT	NT		
9	456.0	3.50	-0.79	-2.25
10	525	57.39	0.61	0.50
11	NT	NT		
12	495	49	0.00	0.00
13	NT	NT		
14	480	48	-0.30	-0.29
15	500	35	0.10	0.13
16	501	32	0.12	0.17
17	460	47	-0.71	-0.70
18	493	50	-0.04	-0.04
19	525	105	0.61	0.28
20	NT	NT		
21	NT	NT		
22	NT	NT		

Statistics

Assigned Value	495	17
Spike Value	535	37
Homogeneity Value	490	74
Robust Average	495	17
Median	495	9
Mean	495	
N	13	
Max	525	
Min	456	
Robust SD	24	
Robust CV	4.9%	

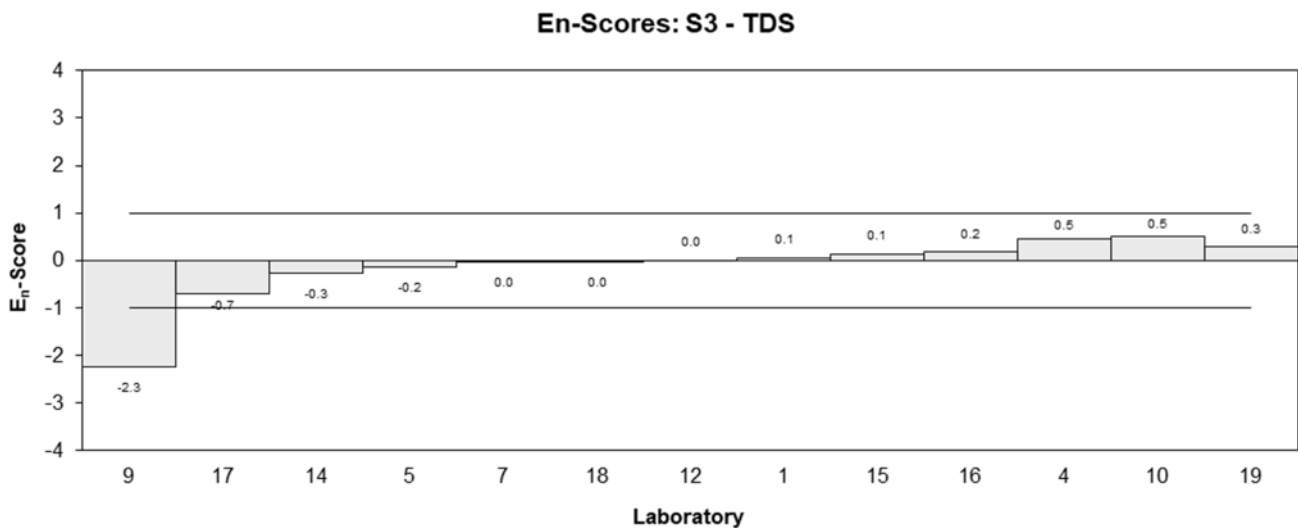
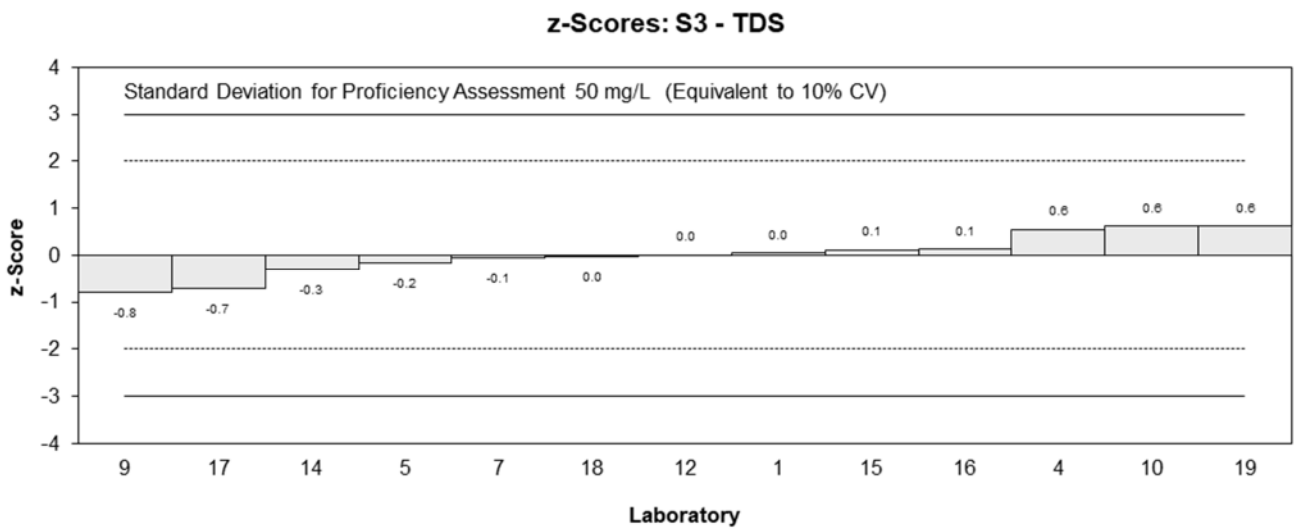
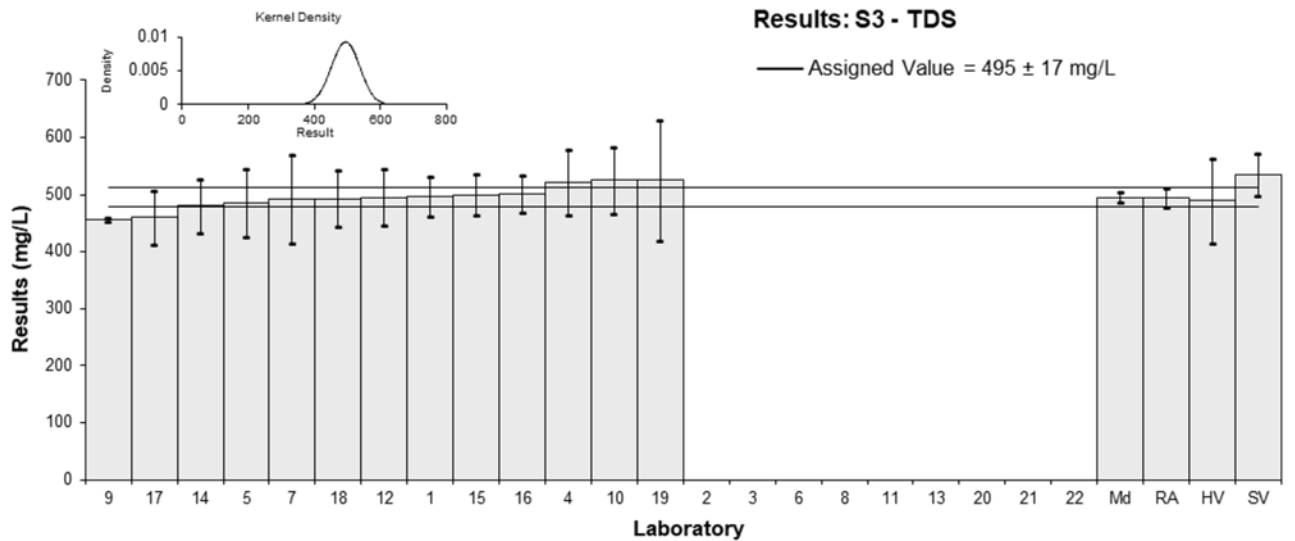


Figure 42

Table 46

Sample Details

Sample No.	S3
Matrix	River Water
Analyte	TSS
Unit	mg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	19	5	-1.87	-2.30
2	38	88	0.27	0.03
3	NT	NT		
4	34	5	-0.18	-0.22
5	33	5.0	-0.29	-0.36
6	NT	NT		
7	40	5.5	0.49	0.58
8	NT	NT		
9	28.05	1.52	-0.85	-1.39
10	42.5	4.48	0.78	1.01
11	NT	NT		
12	39.8	4.4	0.47	0.62
13	NT	NT		
14	35	3.6	-0.07	-0.09
15	42	4.6	0.72	0.92
16	20	6.22	-1.75	-1.92
17	52	4.6	1.84	2.36
18	37	4.0	0.16	0.21
19	34	7	-0.18	-0.18
20	NT	NT		
21	NT	NT		
22	NT	NT		

Statistics

Assigned Value	35.6	5.2
Spike Value	52.6	2.6
Homogeneity Value	35.0	5.3
Robust Average	35.6	5.2
Median	36.0	3.9
Mean	35.3	
N	14	
Max	52	
Min	19	
Robust SD	7.8	
Robust CV	22%	

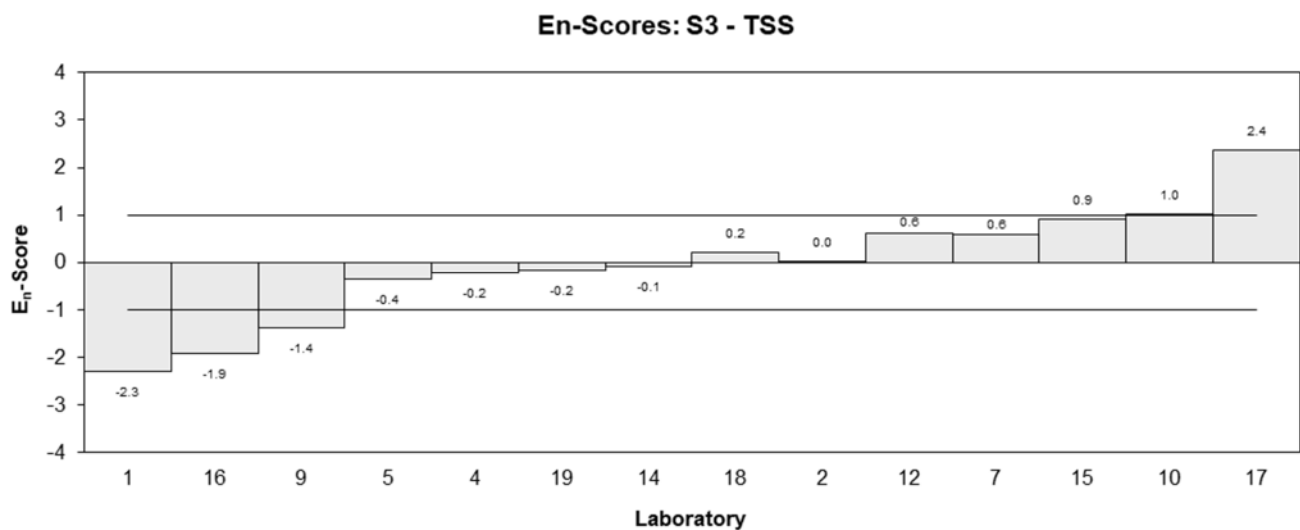
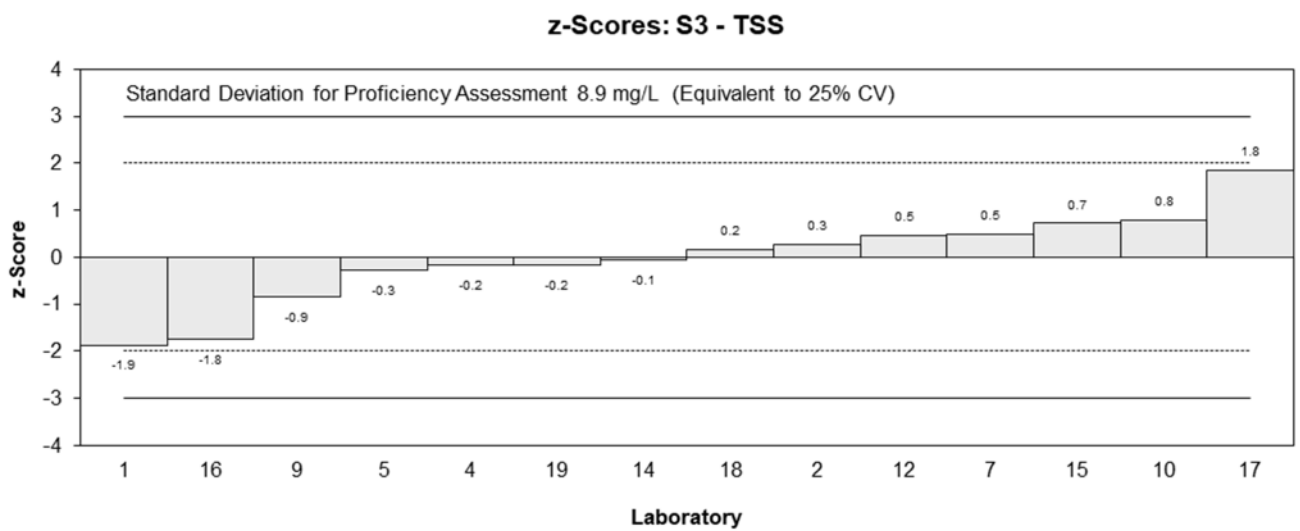
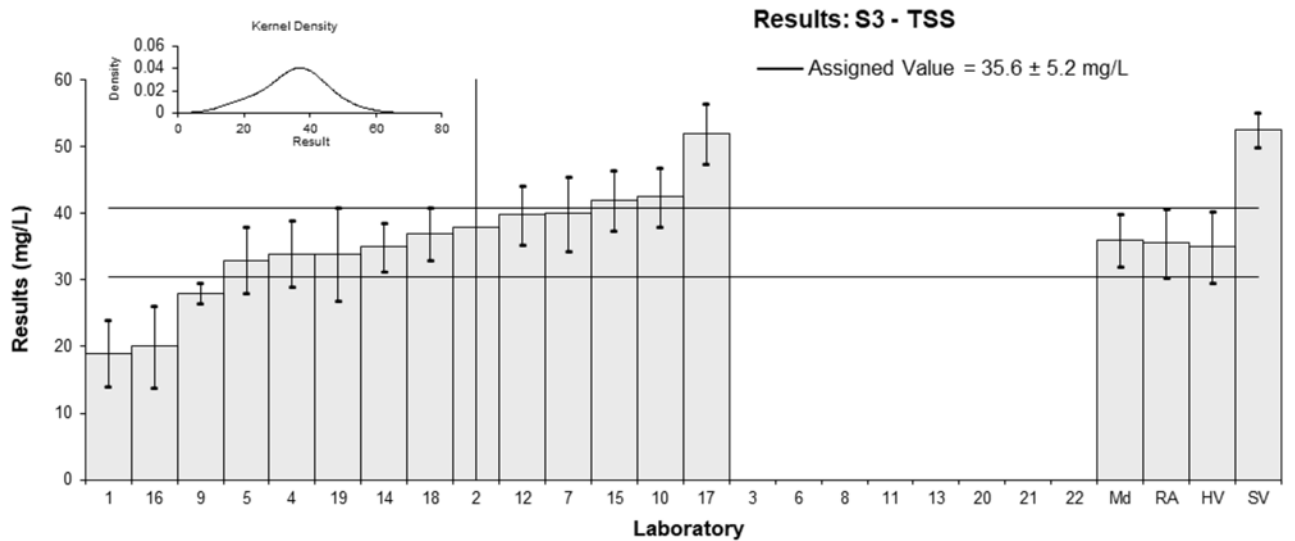


Figure 43

Table 47

Sample Details

Sample No.	S3
Matrix	River Water
Analyte	TS
Unit	mg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	520	48	-0.26	-0.26
2	NR	NR		
3	NT	NT		
4	580	71	0.86	0.61
5	566	87.2	0.60	0.35
6	NT	NT		
7	530	62.5	-0.07	-0.06
8	NT	NT		
9	484.05	5.10	-0.94	-1.96
10	560.5	61.5	0.50	0.40
11	NT	NT		
12	NR	NR		
13	NT	NT		
14	530	53	-0.07	-0.07
15	NT	NT		
16	520	43	-0.26	-0.28
17	500	27	-0.64	-0.92
18	528	55	-0.11	-0.10
19	559	112	0.47	0.22
20	NT	NT		
21	NT	NT		
22	NT	NT		

Statistics

Assigned Value	534	25
Spike Value	588	38
Homogeneity Value	540	81
Robust Average	534	25
Median	530	32
Mean	534	
N	11	
Max	580	
Min	484.05	
Robust SD	33	
Robust CV	6.2%	

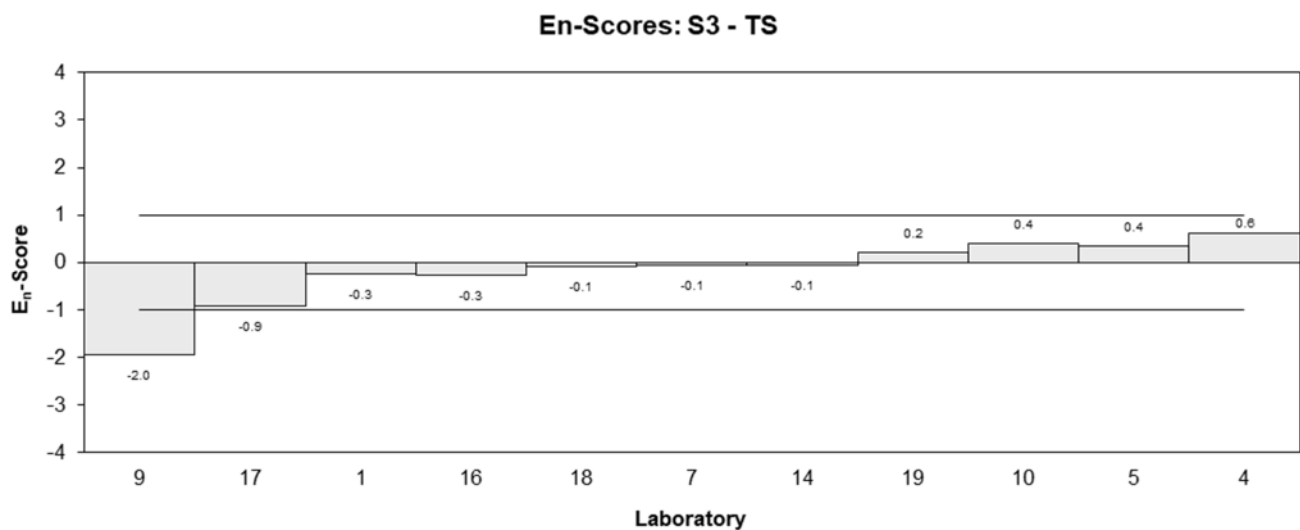
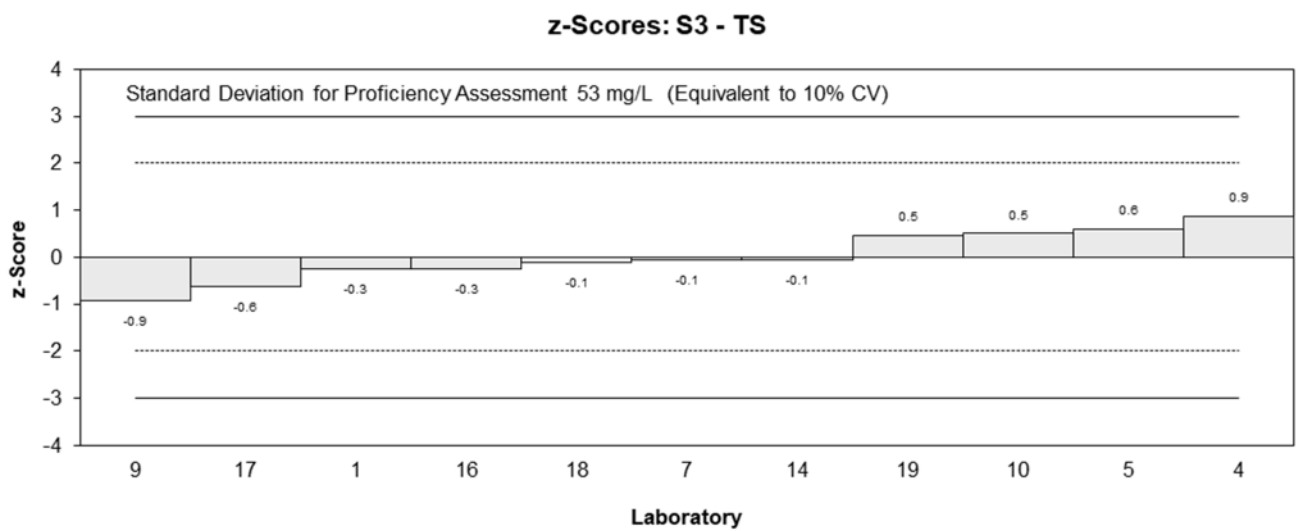
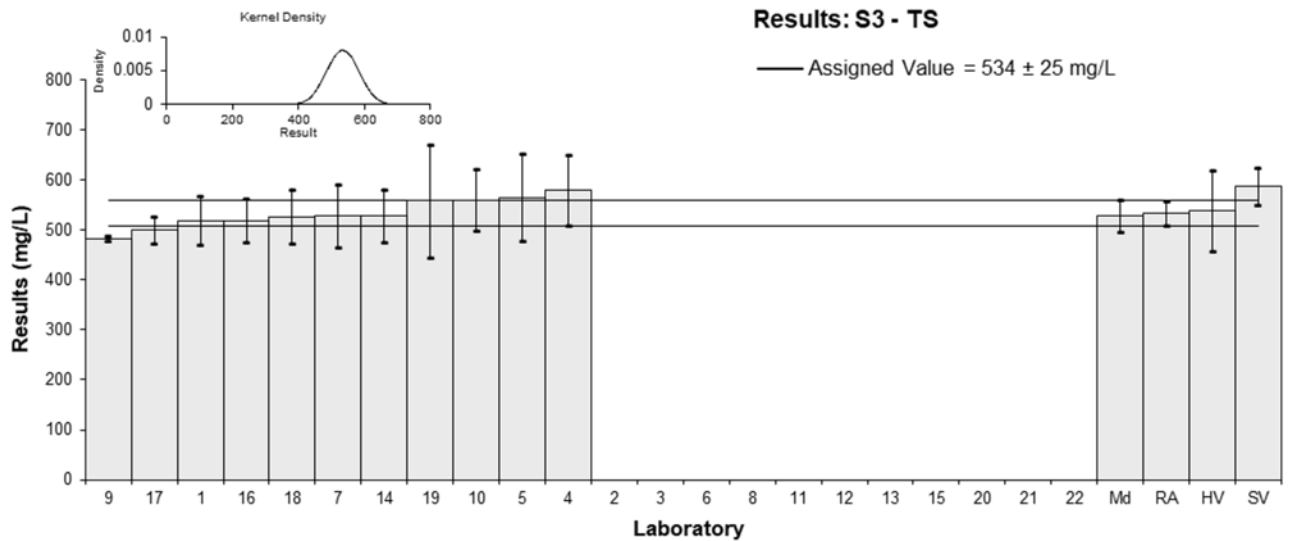


Figure 44

Table 48

Sample Details

Sample No.	S3
Matrix	River Water
Analyte	Turbidity
Unit	NTU

Participant Results

Lab. Code	Result	Uncertainty	z	E _n
1	14.5	0.5	0.37	0.56
2	16	2	0.93	0.95
3	NT	NT		
4	15.2	1.2	0.63	0.82
5	12.0	0.97	-0.56	-0.77
6	NT	NT		
7	14.6	0.66	0.41	0.60
8	NT	NT		
9	8.52	0.39	-1.84	-2.86
10	10.4	0.56	-1.15	-1.73
11	NT	NT		
12	15.1	1.2	0.59	0.77
13	NT	NT		
14	15	1.5	0.56	0.66
15	15	3.4	0.56	0.39
16	14	0.95	0.19	0.26
17	NR	NR		
18	14	1.5	0.19	0.22
19	10	2	-1.30	-1.33
20	NT	NT		
21	NT	NT		
22	NT	NT		

Statistics

Assigned Value	13.5	1.7
Spike Value	Not Spiked	
Homogeneity Value	13.0	2.0
Robust Average	13.5	1.7
Median	14.5	0.6
Mean	13.4	
N	13	
Max	16	
Min	8.52	
Robust SD	2.5	
Robust CV	18%	

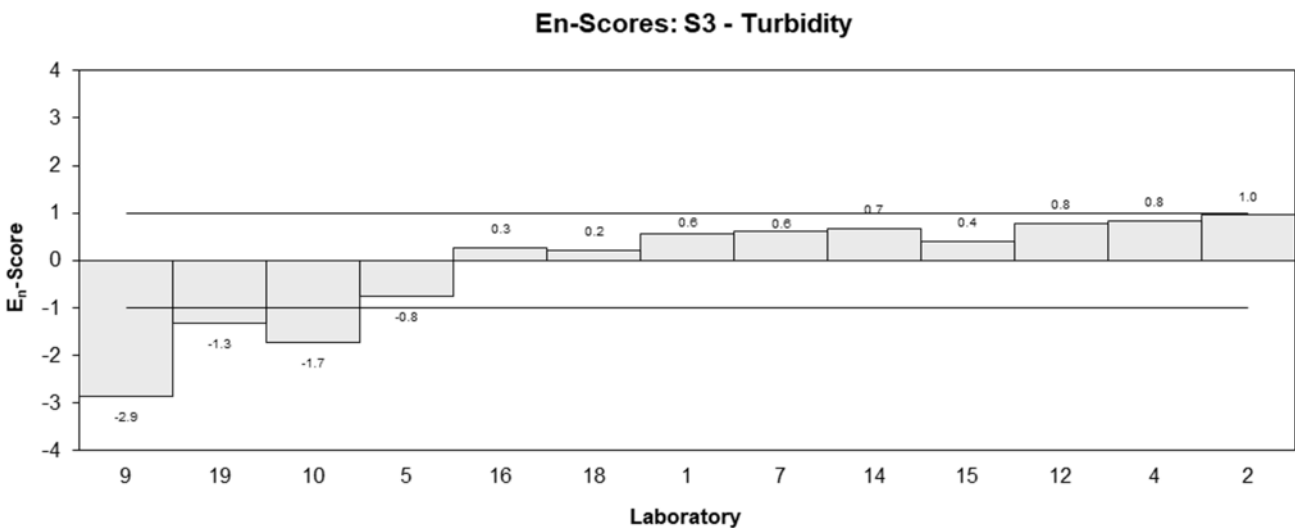
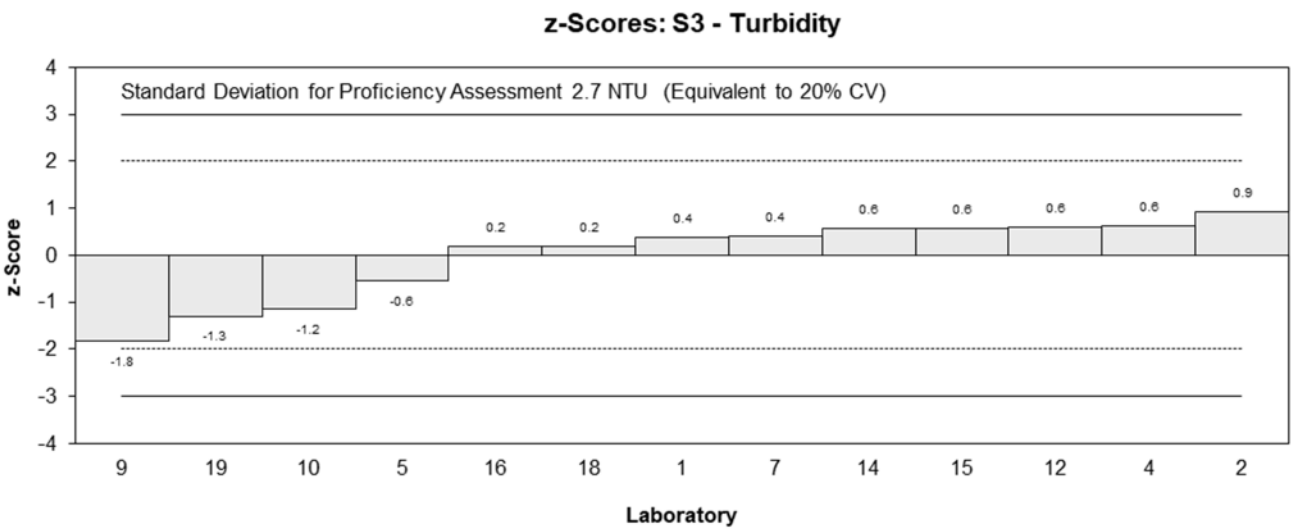
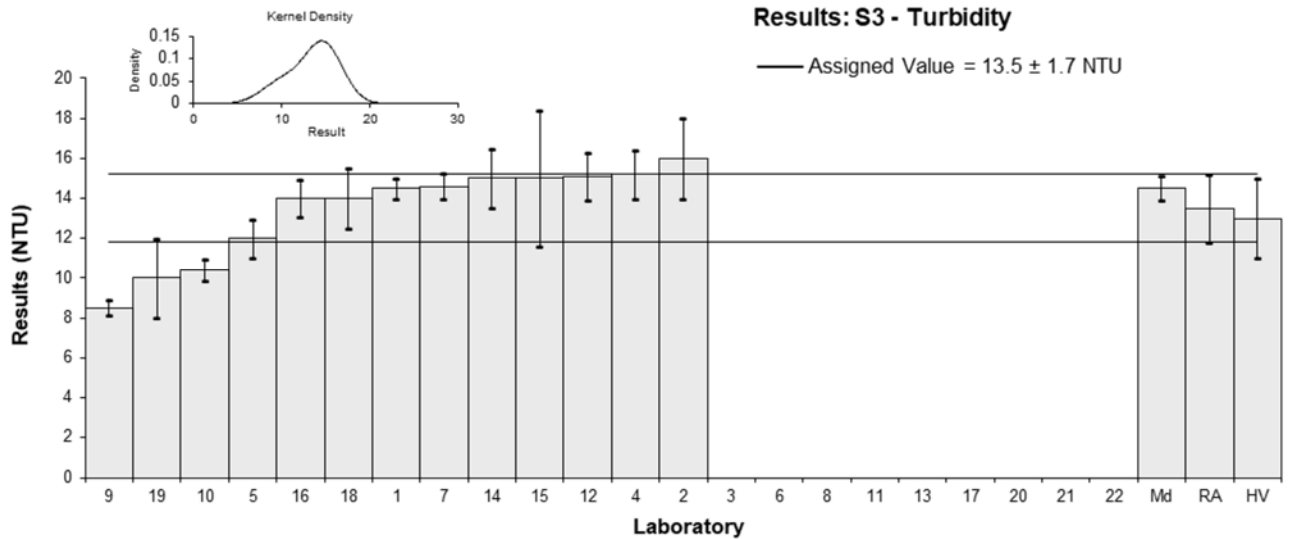


Figure 45

6 DISCUSSION OF RESULTS

6.1 Assigned Value

Assigned Values were the robust average of participants' results. The robust averages and their associated expanded uncertainties were calculated using the procedure described in ISO13528. Results less than 50% and more than 150% of the robust average were excluded prior to the calculation of each assigned value.⁶ Appendix 2 sets out the calculation for the robust average of Cd in Sample S1 and its associated uncertainty.

The spike value, where applicable, includes both the incurred and the fortified values. The incurred value was determined using a routine method.

Traceability: The consensus of participants' results (robust average) is not traceable to any external reference. So, although expressed in SI units, the metrological traceability of these assigned values has not been established.

6.2 Measurement Uncertainty Reported by Participants

Participants were asked to report an evaluation of the expanded measurement uncertainty associated with their results. All 606 numeric results were reported with an expanded uncertainty, with the exception of one. The magnitude of these expanded uncertainties was within the range 0.004% to 500% of the reported value. The participants used a wide variety of procedures to evaluate the expanded measurement uncertainty, which are presented in Table 4.

Approaches to evaluating measurement uncertainty include: standard deviation of replicate analysis, Thompson-Horwitz formula, long term reproducibility, professional judgement, bottom up approach, top down approach using precision and evaluations of method and laboratory bias, and top down approach using only the reproducibility from inter-laboratory comparison studies.⁹⁻¹⁴

Participation in proficiency testing programs allows laboratories to check how reasonable their evaluations of uncertainty are. Results and the associated expanded uncertainties are presented in the bar charts for each analyte in chapter 5 (Figures 2 to 45). As a simple rule of thumb, when the uncertainty evaluation is smaller than uncertainty of the assigned value, or larger than the uncertainty of the assigned value plus twice the standard deviation for proficiency assessment, then this should be reviewed as suspect. For example, 14 laboratories reported results for U in Sample S2. The uncertainty of the assigned value evaluated from the robust standard deviation of the 14 laboratories' results is 0.17 µg/L (5.2% of the assigned value). Laboratory 1's reported result for U in S2 of 0.1 µg/L or 3.4% might have been underestimated as an uncertainty evaluated from one measurement is unlikely to be smaller than the uncertainty evaluated from 14 measurements. Alternatively, evaluations of uncertainty for Al in S2 larger than 7.4 µg/L (the uncertainty of the assigned value, 2.3 µg/L, plus the allowable variation from the assigned value, the standard deviation for proficiency assessment of 2.5 µg/L, multiplied by 2, the coverage factor for a confidence interval of 95%), should also be viewed as suspect. For example, the expanded measurement uncertainty reported by Laboratory 2 for Al in S2 (9 µg/L) might have been over-estimated.

When a laboratory has successfully participated in at least 6 proficiency testing studies, the standard deviation from proficiency testing studies only can also be used to evaluate the uncertainty of their measurement results.¹⁰ An example of evaluating measurement uncertainty using proficiency testing data only is given in Appendix 3.

Laboratory 9 may need to review their procedure for evaluating measurement uncertainty as most of their reported uncertainties were low.

Laboratories 2, 8, and 14 should also review their procedure for evaluating measurement uncertainty. They reported an expanded measurement uncertainty for some results which was equal to or larger than the result itself.

Laboratories 2, 3, and 16 attached expanded measurement uncertainty to results reported as being less than their limit of detection. An evaluation of uncertainty expressed as a value cannot be attached to a result expressed as a range.⁹

In some cases, the results were reported with an inappropriate number of significant figures. The recommended format is to write the uncertainty to no more than two significant figures and then to write the result with the corresponding number of decimal places. For example, instead of $0.3622 \pm 0.10866 \mu\text{g/L}$, it is better to report $0.36 \pm 0.11 \mu\text{g/L}$ or, instead of $486 \pm 58.8 \text{ mg/L}$, it is better to report $486 \pm 59 \text{ mg/L}$.⁹

6.3 z-Score

The z-score compares the participant's deviation from the assigned value with the standard deviation for proficiency assessment (SDPA).

The SDPA defines acceptable performance in a proficiency test. SDPA's equivalent to 10% to 25% PCV were used to calculate z-scores. Unlike the standard deviation based on between-laboratory CV, setting the SDPA as a realistic value enables z-scores to be used as fixed reference value points for assessing laboratory performance independent of group performance.

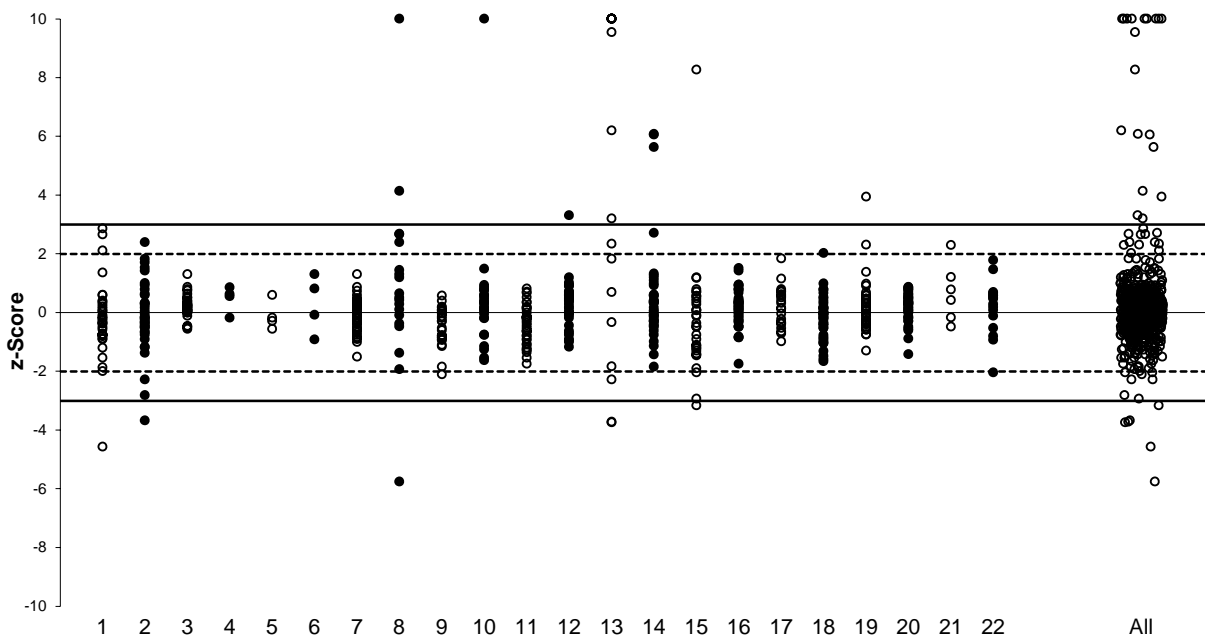
The between-laboratory coefficient of variation predicted by the Thompson/Horwitz equation⁷ and the participants' coefficient of variation in this study are presented for comparison in Table 49.

Table 49 Between-Laboratory CV of this Study, Thompson/Horwitz CV and SDPA

Sample	Test	Assigned value ($\mu\text{g/L}$)	SDPA (as PCV, %)	Thompson/ Horwitz CV (%)	Between- Laboratory CV (%)*
S1	Ag	1.84	10	22	11
S1	Al	33.0	10	22	7.8
S1	As	1.02	10	22	6.3
S1	Be	1.06	10	22	4.7
S1	Cd	0.813	10	22	7.6
S1	Co	1.52	15	22	12
S1	Cr	1.40	15	22	15
S1	Cu	14.7	10	22	5.2
S1	Fe	173	10	21	6.9
S1	Hg	0.286	15	22	16
S1	Mn	0.493	15	22	16
S1	Mo	5.28	10	22	9.6
S1	Ni	2.83	10	22	6.2
S1	Pb	1.58	10	22	8.1
S1	Sb	2.83	10	22	11
S1	Se	1.75	10	22	10
S1	Tl	1.18	10	22	6.2
S1	U	1.99	10	22	4.7
S1	V	1.39	10	22	12
S1	Zn	20.4	10	22	8.3
S2	Ag	1.48	15	22	7.5
S2	Al	16.9	15	22	18
S2	As	5.18	15	22	18
S2	Be	1.57	15	22	6.4

Sample	Test	Assigned value (µg/L)	SDPA (as PCV, %)	Thompson/Horwitz CV (%)	Between-Laboratory CV (%)*
S2	Cd	0.905	15	22	10
S2	Cr	1.83	15	22	14
S2	Cu	5.26	15	22	9.6
S2	Fe	22.8	15	22	16
S2	Hg	0.286	15	22	9.1
S2	Mn	4.52	15	22	11
S2	Ni	2.44	15	22	12
S2	P	76**	Not Set	22	52
S2	Pb	1.51	15	22	10
S2	Sb	2.88	15	22	12
S2	Se	4.73	20	22	24
S2	Sn	3.50	15	22	22
S2	Tl	1.55	15	22	6.8
S2	U	3.26	15	22	7.6
S2	V	1.95	15	22	15
S2	Zn	15.2	15	22	13
S3	TDS	495 (mg/L)	10	6.3	4.9
S3	TSS	35.6 (mg/L)	25	9.3	22
S3	TS	534 (mg/L)	10	6.2	6.2
S3	Turbidity	13.5 (NTU)	20	11	18

*Robust between-laboratory CV outliers removed. Shaded cells represent between-laboratory CVs higher than both the SDPA and the Thompson-Horwitz CV. **Robust Average, outliers removed.



Scores greater than 10 have been plotted as 10.

Figure 46 z-Score Dispersal by Laboratory

The dispersal of participants' z-scores is presented in Figure 46 (by laboratory code) and in Figure 48 (by analyte). Of the 599 results for which z-scores were calculated, 555 (93%) returned an acceptable score of $|z| \leq 2.0$ and 19 (3%) were questionable with $2.0 < |z| < 3.0$. Participants with multiple z-scores larger than 2 or smaller than -2 should check for laboratory bias.

A summary of participants' performance is presented in Figure 49.

Laboratories 7 and 16 returned the highest number of acceptable z-scores, with 41 out of 41 reported results.

All results reported by **Laboratories 20** (39), **11** (37), **3** (32), **17** (21), **4** (4), **5** (4), and **6** (4) returned acceptable z-scores.

6.4 E_n-score

E_n-score can be interpreted only in conjunction with z-scores. The E_n-score indicates how closely a result agrees with the assigned value considering their respective uncertainties. An unacceptable E_n score for an analyte can either be caused by an inappropriate measurement, an inappropriate evaluation of measurement uncertainty, or both.

The dispersal of participants' E_n-scores is graphically presented in Figure 47. Where a laboratory did not report an expanded uncertainty with a result, an expanded uncertainty of zero (0) was used to calculate the E_n-score.

Of 599 results for which E_n-scores were calculated, 513 (86%) returned an acceptable score of $|E_n| < 1.0$ indicating agreement of the participants' results with the assigned values within their respective expanded measurement uncertainties.

Laboratory 7 had the highest number of acceptable E_n scores, with 40 out of 41 reported.

All results reported by Laboratories **2** (37), **3** (32), **22** (16), **4** (4), **5** (4), and **6** (4) returned acceptable E_n-scores.

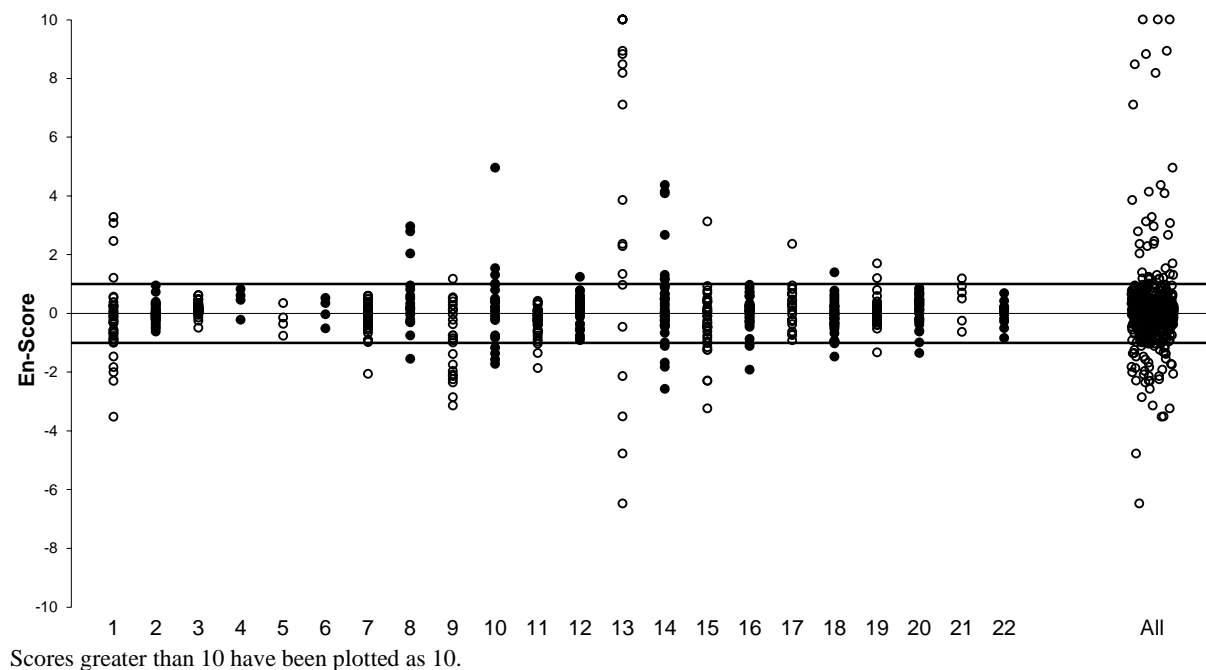
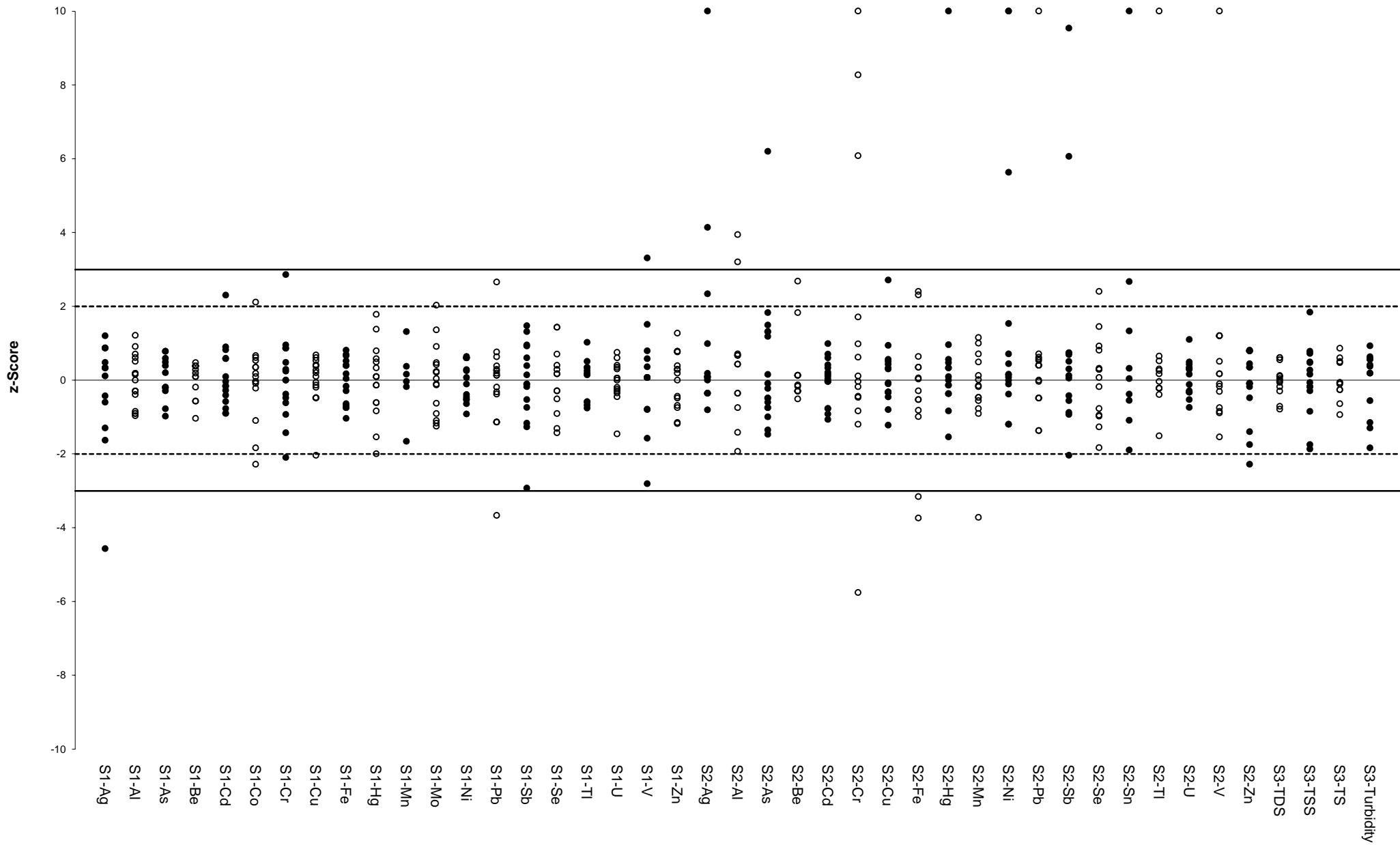


Figure 47 E_n-Score Dispersal by Laboratory



Scores greater than 10 have been plotted as 10.

Figure 48 z-Score Dispersal by Analyte

Summary of Participants' Performance in AQA 25-13 Samples S1, S2, and S3

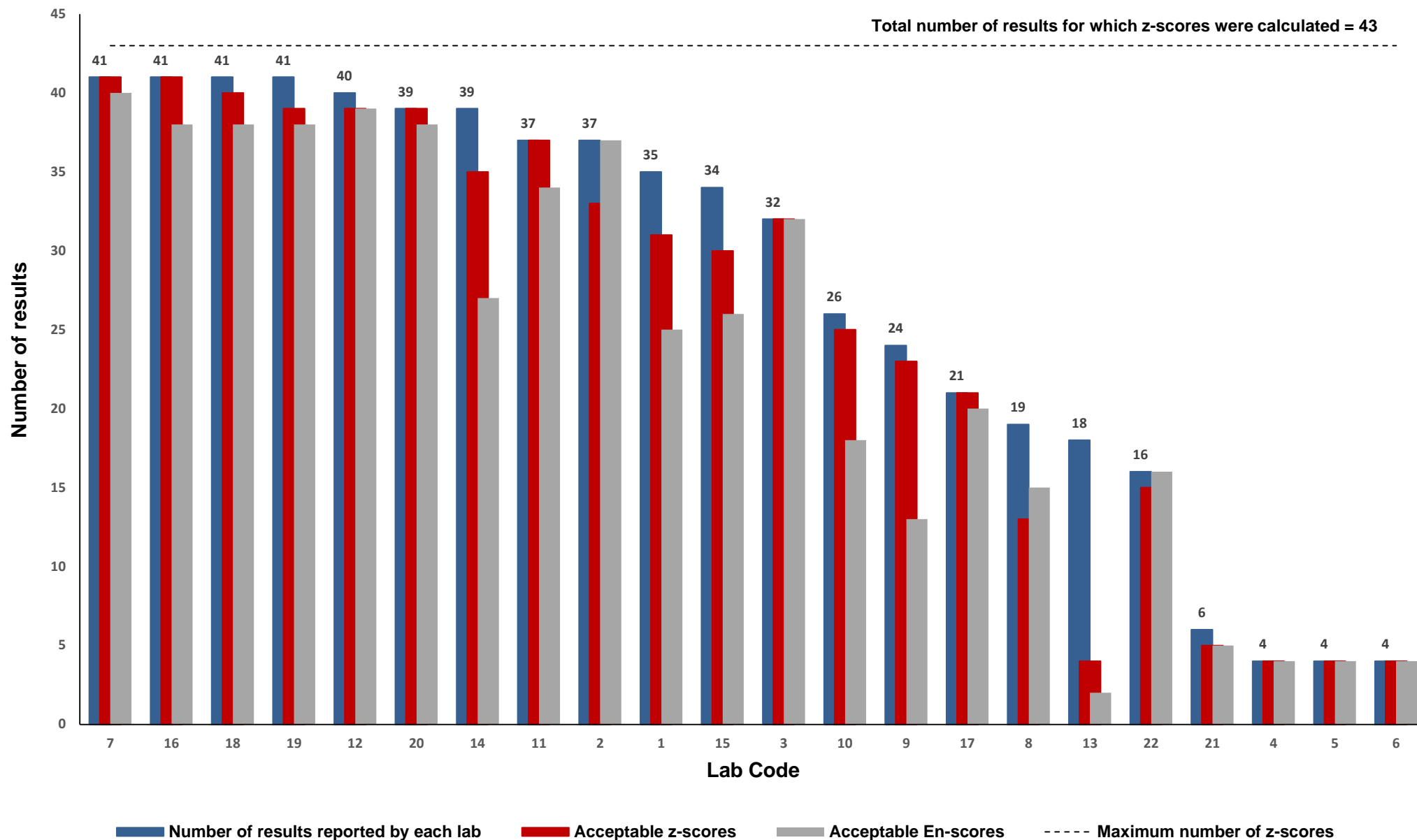


Figure 49 Summary of Participants Performance in AQA 25-13

AQA 25-13 Trace Elements and Solids in Sea and River Water

Table 50 Summary of Participants' Results and Performance for Sample S1

Lab	Ag µg/L	Al µg/L	As µg/L	Be µg/L	Cd µg/L	Co µg/L	Cr µg/L	Cu µg/L	Fe µg/L	Hg µg/L
AV	1.84	33.0	1.02	1.06	0.813	1.52	1.40	14.7	173	0.286
HV	1.89	33.9	1.09	1.02	0.823	1.63	1.43	14.7	183	0.319
1	1	30	1	1	0.8	2	2	15	180	0.2
2	1.9	32	1	<1	0.8	1	1.3	14	162	0.28
3	2.0	33.6	1.07	1.07	0.82	1.64	1.45	15.1	180	0.29
4	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
5	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
6	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
7	2	32	1	1	0.81	1.6	1.4	15.3	168	0.26
8	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
9	1.73	30.20	0.99	1.08	0.86	1.27	0.96	14.84	173.74	0.29
10	1.54	33.61	1.00	1.07	0.75	1.51	1.58	15.26	179.72	0.311
11	NR	33.5	0.94	1.04	0.74	1.47	1.40	14.5	187	0.22
12	2.06	35.3	1.06	NT	0.886	1.67	1.27	15.6	161	0.307
13	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
14	1.9	35	0.92	1.1	0.78	1.1	1.1	14	160	0.26
15	1.6	30	<1	1.1	<1	1.5	1.5	14	160	0.32
16	1.9	36	1.1	1.1	0.88	1.6	1.6	15.7	176	0.28
17	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
18	1.76	29.8	1.10	0.95	0.74	1.51	1.32	14.4	155	0.25
19	1.86	31.7	<1	1.11	0.766	1.56	1.46	14.6	185	0.345
20	2.0	33	1.04	1.09	0.79	1.66	1.58	15.48	182	0.30
21	<3	37	<20	<2	1	<3	<3	14	170	<5
22	1.9278	34.6992	1.0806	<0.5	0.861	1.5407	1.2044	11.7072	184.3423	0.3622

Shaded cells are results which returned a questionable or unacceptable z-score. AV = Assigned Value, HV = Homogeneity Value, SV = Spike Value, NT = Not Tested. NA = Not Applicable.

Table 50 Summary of Participants' Results and Performance for Sample S1 (continued)

Lab	Mn µg/L	Mo µg/L	Ni µg/L	Pb µg/L	Sb µg/L	Se µg/L	Tl µg/L	U µg/L	V µg/L	Zn µg/L
AV	0.493	5.28	2.83	1.58	2.83	1.75	1.18	1.99	1.39	20.4
HV	0.532	5.35	2.66	1.58	2.75	1.63	1.11	2.02	1.46	20.0
1	<1	6	3	2	3	<10	NT	2	<10	21
2	<0.5	4.8	3	1	2.5	2	1.1	2	1	18
3	0.59	5.39	3.01	1.62	2.80	1.78	1.196	2.14	1.40	21.2
4	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
5	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
6	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
7	<0.5	5.4	2.8	1.6	3.2	1.8	1.21	2.11	1.4	19
8	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
9	0.49	5.21	2.57	1.55	2.68	1.82	1.20	1.93	1.28	18.05
10	<1	4.62	2.85	1.70	2.78	<10	1.22	2.05	<10	18.88
11	0.48	4.95	2.65	1.61	2.47	1.66	1.11	1.92	1.44	19.5
12	0.505	4.66	3.00	1.68	3.09	1.59	1.30	2.07	1.85	21.0
13	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
14	NT	5.3	3	1.4	2.8	1.7	1.2	1.9	1.4	23
15	<1	4.7	2.7	1.4	2	1.5	NT	1.7	1.4	21
16	<0.5	5.4	2.9	1.6	3.1	2.0	1.22	1.99	1.6	22
17	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
18	0.37	6.35	2.68	1.52	2.94	1.52	1.09	1.95	1.17	20.4
19	<1	5.76	2.72	1.53	2.62	1.70	1.11	1.94	1.47	19.4
20	0.52	5.53	2.91	1.64	2.87	1.78	1.24	2.06	1.50	21.95
21	<2	5.5	<4	<7	<10	<20	<50	<40	<3	22
22	<0.5	5.2233	2.6831	1.6261	3.2455	1.8731	NT	NT	1.2792	20.787

Shaded cells are results which returned a questionable or unacceptable z-score. AV = Assigned Value, HV = Homogeneity Value, SV = Spike Value, NT = Not Tested. NA = Not Applicable.

Table 51 Summary of Participants' Results and Performance for Samples S2 and S3

Lab	S2											
	Ag µg/L	Al µg/L	As µg/L	Be µg/L	Cd µg/L	Cr µg/L	Cu µg/L	Fe µg/L	Hg µg/L	Mn µg/L	Ni µg/L	P µg/L
AV	1.48	16.9	5.18	1.57	0.905	1.83	5.26	22.8	0.286	4.52	2.44	Not Set
HV	1.49	18.0	4.64	1.62	0.96	1.74	5.17	21.6	0.292	3.97	2.53	87
1	1.3	16	4.6	1.6	0.8	1.5	5	NT	NT	4.0	2.3	NT
2	1.4	15	6.6	<1	0.9	2.3	5	25	0.3	5.2	3	NT
3	1.49	<40	4.8	NT	0.95	<2	4.9	23	0.286	4.14	<7	NT
4	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
5	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
6	<5	<50	6.2	<5	0.78	<5	5.2	<100	<0.5	<10	<5	103
7	1.4	18	4.4	1.6	0.8	1.6	5	21	0.27	3.9	2.5	<1000
8	2.4	12	6.2	2.2	0.92	0.25	5.6	31	0.27	4.2	7.5	18
9	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
10	5.17	<50	6.34	<5	0.927	<5	6.00	<250	0.22	<5	<5	<1000
11	NR	18.6	4.13	1.53	0.76	1.86	4.63	24.0	0.28	4.42	2.00	100
12	1.52	18.7	5.11	NT	0.987	1.71	5.66	19.4	0.327	4.53	2.44	NT
13	2	25	10	2	1	8	5	10	1	2	13	48
14	1.7	NT	5	1.5	0.96	3.5	7.4	24	0.28	NT	4.5	90
15	<1	16	6.1	<1	<1	4.1	4.3	12	0.31	5	2	NT
16	1.5	18	4.8	1.5	0.9	1.7	5	20	0.25	4.2	2.4	<10000
17	1.4	NR	5.3	1.6	0.9	2.0	5.7	21	0.3	5.3	2.7	NR
18	1.48	18.6	4.04	1.45	1.04	1.82	5.18	22.9	<0.5	4.85	2.49	NT
19	1.50	26.9	4.60	1.50	0.934	2.10	5.52	30.7	0.306	4.60	2.47	112
20	1.5	13.3	4.71	1.54	0.91	1.78	5.5	21.8	0.29	4.4	2.6	60
21	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
22	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT

Shaded cells are results which returned a questionable or unacceptable z-score. AV = Assigned Value, HV = Homogeneity Value, SV = Spike Value, NT = Not Tested, NR = Not Reported. NA = Not Applicable.

Table 51 Summary of Participants' Results and Performance for Samples S2 and S3 (continued)

Lab	S2								S3			
	Pb µg/L	Sb µg/L	Se µg/L	Sn µg/L	Tl µg/L	U µg/L	V µg/L	Zn µg/L	TDS mg/L	TSS mg/L	TS mg/L	Turbidity NTU
AV	1.51	2.88	4.73	3.50	1.55	3.26	1.95	15.2	495	35.6	534	13.5
HV	1.57	2.82	4.27	3.87	1.51	3.37	2.00	17.0	490	35.0	540	13.0
1	1.4	2.5	4	<5	NT	2.9	1.5	15	497	19	520	14.5
2	1.2	2.7	7	NT	1.5	3	2	17	NR	38	NR	16
3	1.51	3.01	< 10	< 5.0	1.61	3.34	< 10	17.0	NT	NT	NT	NT
4	NT	NT	NT	NT	NT	NT	NT	NT	522	34	580	15.2
5	NT	NT	NT	NT	NT	NT	NT	NT	486	33	566	12.0
6	< 5	< 10	< 10	< 10	< 10	< 10	< 10	17.04	NT	NT	NT	NT
7	1.4	3.2	5	<5	1.2	3.1	1.9	15	492	40	530	14.6
8	1.2	3.1	6.1	4.9	1.7	3.4	2.3	15	NT	NT	NT	NT
9	NT	NT	NT	NT	NT	NT	NT	NT	456.0	28.05	484.05	8.52
10	<5	<5	<50	<5	<5	<5	<50	<25	525	42.5	560.5	10.4
11	1.67	2.48	3.53	2.93	1.67	3.12	2.00	11.2	NT	NT	NT	NT
12	1.64	3.19	3.83	3.52	1.54	3.47	1.73	14.8	495	39.8	NR	15.1
13	9	7	3	14	13	NT	5	10	NT	NT	NT	NT
14	1.6	5.5	5.6	4.2	NT	3.8	2.3	16	480	35	530	15
15	1.4	2	4.8	2.5	NT	3.2	2.3	12	500	42	NT	15
16	1.6	2.9	5	<5	1.5	3.5	1.7	16	501	20	520	14
17	1.6	3.2	3.8	3.3	1.5	3.1	2.1	17	460	52	500	NR
18	1.63	2.93	4.56	NT	1.59	3.41	1.86	17.0	493	37	528	14
19	1.50	2.64	5.03	3.67	1.46	3.10	1.92	16.2	525	34	559	10
20	1.65	3.18	5.5	3.21	1.62	3.43	1.69	14.1	NT	NT	NT	NT
21	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
22	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT

Shaded cells are results which returned a questionable or unacceptable z-score. AV = Assigned Value, HV = Homogeneity Value, SV = Spike Value, NT = Not Tested, NR = Not Reported. NA = Not Applicable.

6.5 Participants' Results and Analytical Methods

Samples S1 and **S2** were filtered river and seawater respectively, and **Sample S3** was unfiltered river water.

Rounding of results and reporting results with an insufficient number of significant figures was the main cause of unacceptable results. Analytical test results are rounded to avoid presenting a misleading impression of precision. However, most of the instrumental techniques used by participants in the present study should be capable of producing results with a reasonable degree of certainty to up to two significant figures at ppb level for most tests in both matrices, river water and seawater.

Caution should be exercised when a rounding protocol is designed by a laboratory in order to avoid inadvertent loss of important information. According to Eurachem/CITAC Guide, "The reported result has to provide enough information in case a decision has to be made (e.g. when the result is close to the accepted guideline)." Laboratories 1, 2, 15 and 21 should consider revising their rounding protocol.

Laboratory 1 applied inconsistent rounding practices, reporting most analytes in river water to only one significant figure, but using two significant figures for seawater, despite river water being the less challenging matrix.

Seawater contains significant quantities of dissolved salts, especially sodium chloride and sulphates. Molecular ions originated from dissolved salts can frequently cause severe interference in ICP-MS measurements because these molecular ions have similar masses to the isotopes used in elemental determination. As a result, false positives, and concentrations much higher than the true values are frequently obtained by conventional quadrupole ICP-MS which does not have the resolution required to separate molecular ions from the isotope of interest. The isotopes most frequently affected in saltwater analysis are ^{52}Cr , ^{58}Ni , ^{60}Ni , ^{63}Cu , ^{65}Cu , ^{64}Zn , ^{66}Zn , ^{75}As , ^{78}Se , ^{82}Se . Overall, the between-laboratory CVs of the seawater Sample S2 were higher than those of the river water sample S1.

As, Fe, and Al in seawater were the tests which most challenged participants' analytical techniques when compared to the river water sample. The between-laboratory CVs for these tests in S2 were approximately 2.5 times higher than in S1.

P in seawater was the test that most challenged participants' analytical techniques.

A summary of participants' results and performance in the three study samples is presented in Tables 50 and 51 and Figures 46 to 49.

Individual Element Commentary

Participants were requested to analyse Samples S1 and S2 for dissolved elements using their normal test methods and to report a single result as they would normally report to a client. The method descriptions provided by participants are presented in Tables 1 and 3 and instrumental conditions in Appendix 5.

No significant difference was observed between the performances of participants who performed digestion and those who did not. Instrumental measurement was one of the main factors that influenced results in the samples. However, participants' performance reflects not only the performance of the analytical instrument but also the performance of the analyst and the analytical method used by the testing laboratory. Thus, these results should not be construed as an evaluation of a particular instrument.

Most laboratories reported using ICP-MS or ICP-MS/MS with a collision/reaction cell.

Laboratory 21 used ICP-OES for the determination of analytes in the river water sample (S1), whereas Laboratory 13 used ICP-OES for analytes determination in the low-level seawater

sample (S2).

Caution should be exercised when using ICP-OES for analytes at the parts-per-billion (ppb) level, as this technique has optimal detection limits above 20 ppb for many elements. The high salt content of seawater requires dilution prior to ICP-OES analysis, which further lowers the analyte concentrations—often below the ppb level and the optimal detection capability of the instrument. This likely explains the large number of unacceptable results (14 out of 19) reported by Laboratory 13. This laboratory should consider reviewing its method detection limit and increasing the reporting accordingly.

Laboratory 21 was able to report only 6/20 results in the river water sample (S1), five being acceptable. The remaining results were below their reporting limit which confirms the limitations of using ICP-OES.

Aluminium level in the river water sample was 33.0 µg/L, while in the seawater sample it was 16.9 µg/L. Although all results obtained using ICP-OES for the river water returned acceptable z-scores, both ICP-OES results for the seawater sample were unacceptable. This instrumental technique may not be suitable for low level Al in seawater matrices. Plots of instrumental techniques versus z-scores are presented in Figure 50.

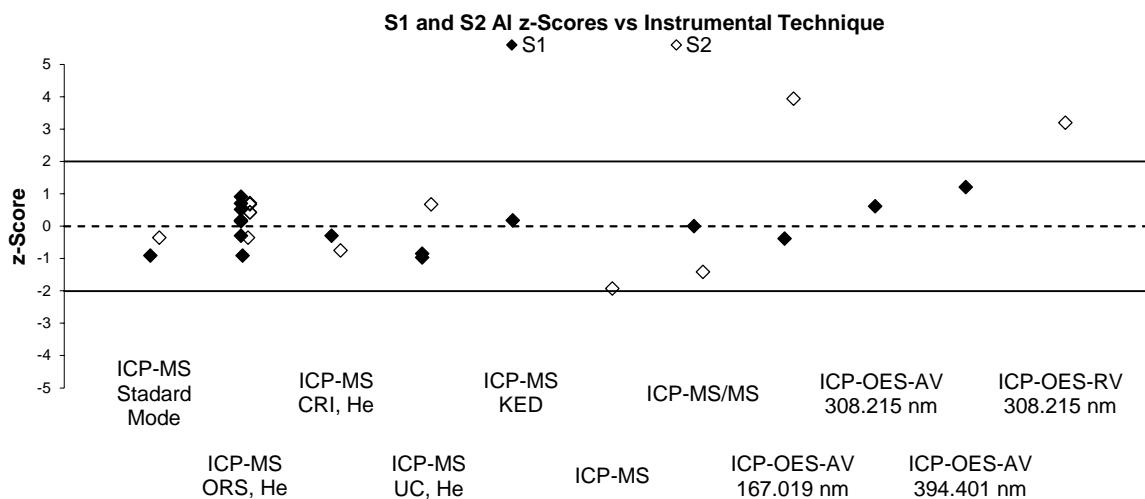
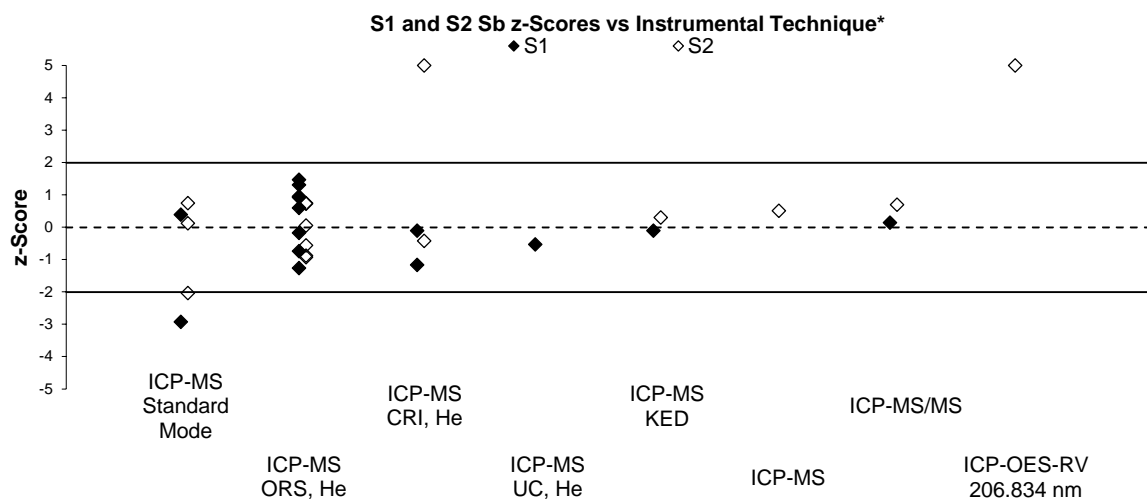


Figure 50 S1 and S2 Al z-scores vs Instrumental Technique

Antimony was at a similar level in the two test samples S1 and S2 and overall, the participants' performance was comparable.

Rounding of results and reporting results with an insufficient number of significant figures may explain some of the unacceptable Sb results.

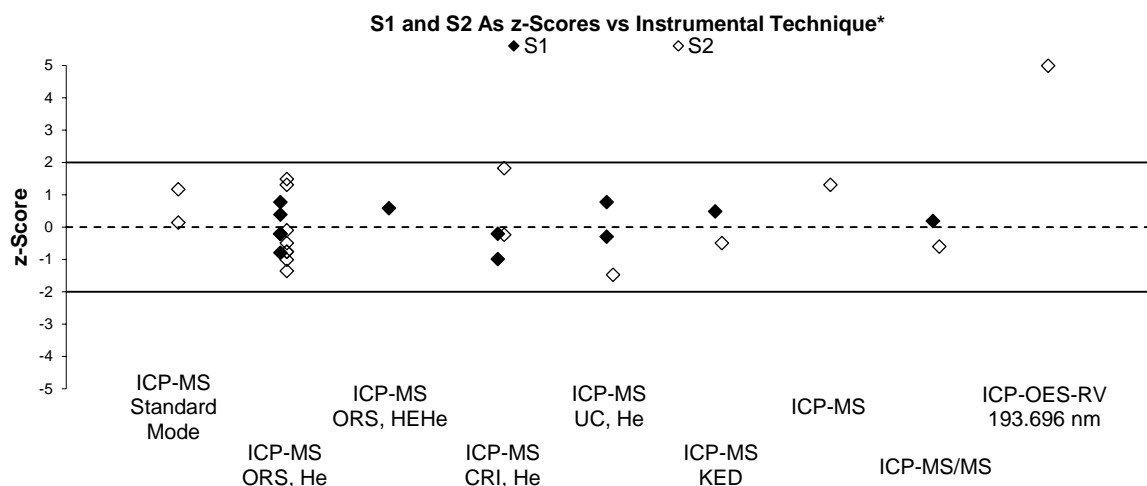
Plots of instrumental techniques versus z-scores are presented in Figure 51. Measurement of Sb in low level seawater by ICP-OES may challenge the capability of this instrument.



* z-Scores larger than 5 have been set to 5.

Figure 51 S1 and S2 Sb z-scores vs Instrumental Technique

Arsenic Low level As in S1 and S2 did not challenge participants' analytical techniques. All reported results returned acceptable z-scores, except for one. For As measurements in the both water samples participants used a wide variety of instrumental techniques: ICP-MS/MS, ICP-MS in standard mode, ICP-MS in collision mode with He or HEHe, or ICP-OES with wavelength 193.696 nm. Plots of participants' performance in the two water samples versus instrumental technique used are presented in Figure 52. ICP-OES may not be a suitable technique for determining low concentrations of As in seawater due to its limited detection capability especially in high-salt matrices where direct reading is not possible.



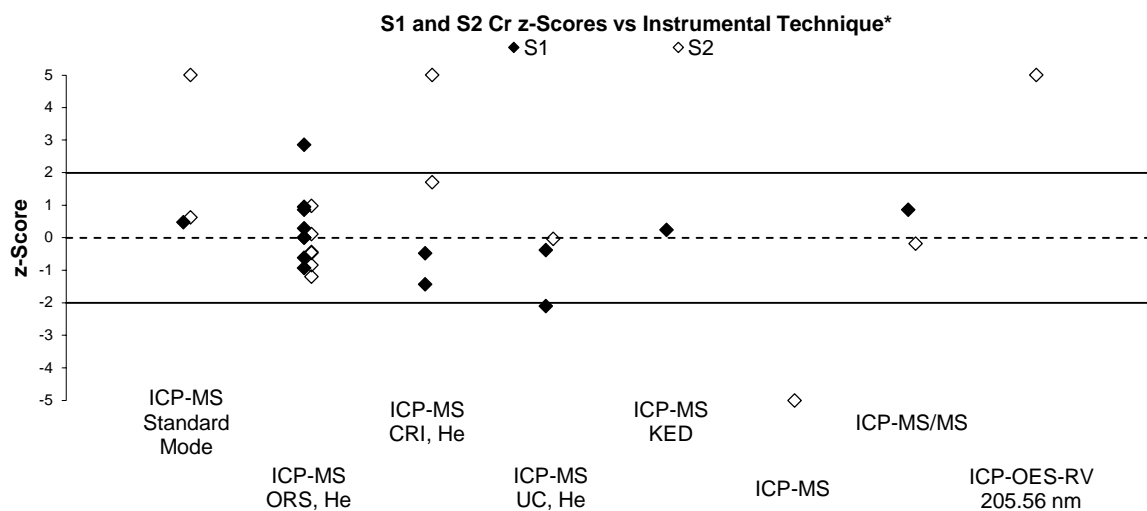
* z-Scores larger than 5 have been set to 5.

Figure 52 S1 and S2 As z-scores vs Instrumental Technique

Cadmium concentration in both samples was similar, with the concentration in S1 being 0.813 µg/L and in S2 being 0.905 µg/L. Participants performed well in both samples, with between-laboratory CVs of 7.6% and 10% in Sample S1 and S2 respectively. Only one reported result across the samples was questionable (Tables 50 and 51). Rounding of the result and reporting the result with an insufficient number of significant figures may explain the questionable performance.

Chromium Plots of participants' performance for Cr in the two water samples versus instrumental technique used are presented in Figure 53.

^{52}Cr has significant interferences from polyatomic species such as $^{35}\text{Cl}^{16}\text{O}^1\text{H}^+$ or $^{35}\text{Cl}^{14}\text{N}^1\text{H}^+$. Unresolved interference issues may explain the high unacceptable Cr results reported by Laboratories 14 and 15 from the ICP-MS determination of the seawater sample S2.



* z-Scores larger than 5 or less than -5 have been set to 5 or -5 respectively.

Figure 53 S1 and S2 Cr z-Scores vs Instrumental Technique

Cobalt was present only in the river water sample S1, and most participants performed well (Table 50). Two participants returned questionable results, potentially due to inappropriate rounding.

Iron in the seawater sample was approximately eight times lower than in the river water, and it was one of the analytes that most challenged participants' analytical techniques when compared with the river water sample. Fe is ubiquitous in the environment; sample contamination or blank contamination may explain some of the high and low unacceptable results, respectively. No trends were evident between participants' performance and the instrumental techniques used Figure 54.

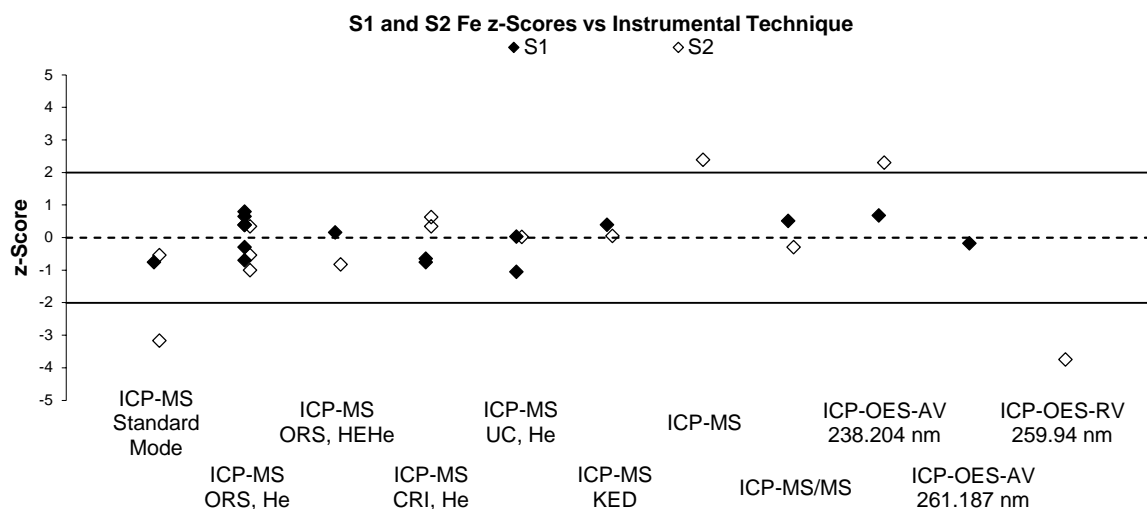
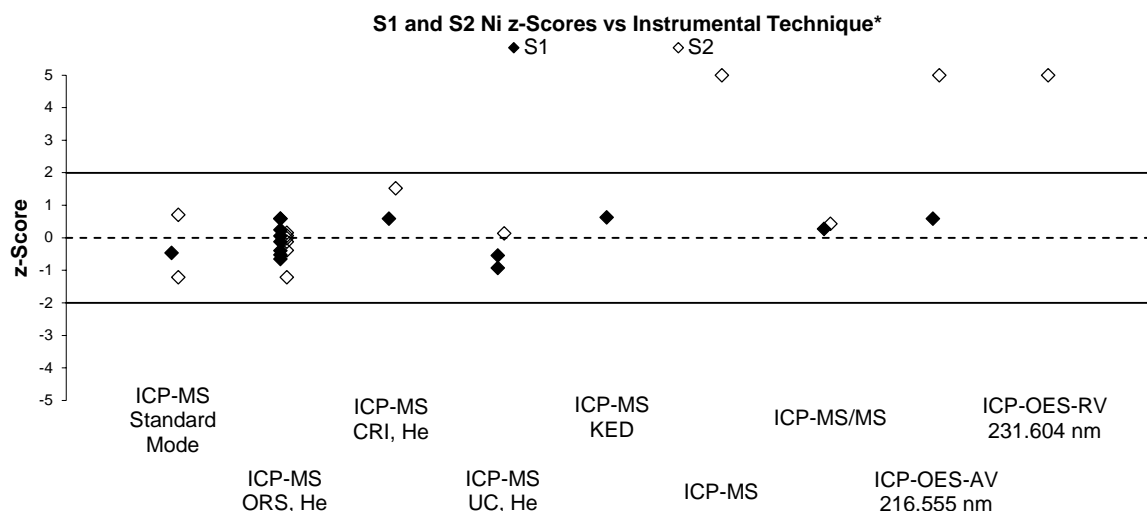


Figure 54 S1 and S2 Fe z-scores vs Instrumental Technique

Nickel level in the two water samples was similar. While all the reported Ni results in the fresh water samples returned acceptable z-scores, of 14 results reported in the seawater sample, 3 returned unacceptable z-scores.

Seawater is one of the most challenging matrices for Ni determination by ICP-MS without a collision/reaction cell. ^{58}Ni has significant interferences from $^{40}\text{Ar}^{18}\text{O}^+$, $^{40}\text{Ar}^{14}\text{N}_2^+$, $^{23}\text{Na}^{35}\text{Cl}^+$ while ^{60}Ni has significant interferences from $^{44}\text{Ca}^{16}\text{O}^+$, $^{24}\text{Mg}^{36}\text{Ar}^+$ and $^{40}\text{Ar}^{20}\text{Ne}^+$. Unsolved interference issues may explain the high unacceptable z-score from ICP-MS determination (Figure 55). As with arsenic, the detection limits of ICP-OES are usually inadequate for accurately quantifying trace concentrations of Ni in a seawater matrix.



* z-Scores larger than 5 have been set as 5.

Figure 55 S1 and S2 Ni z-Scores vs Instrumental Technique

Phosphorus results for Sample S2 were too few (7) and too variable (between-laboratory CV 52%) and no assigned value could be set for this test. As in previous studies, measurement of low-level P in seawater challenged participants' analytical techniques. The results reported by Laboratories 6, 11, 14, 19 and 20 were in relatively good agreement with each other and with the homogeneity value ($87 \pm 10 \mu\text{g/L}$) and spiked value ($90.1 \pm 4.2 \mu\text{g/L}$). Plots of participants' results versus the instrumental techniques used are presented in Figure 56.

Several laboratories (Laboratory 8, 13, 14 and 20) reported uncertainties for P in S2 that the study coordinator considers unrealistically small for P measurements in seawater using a routine method.

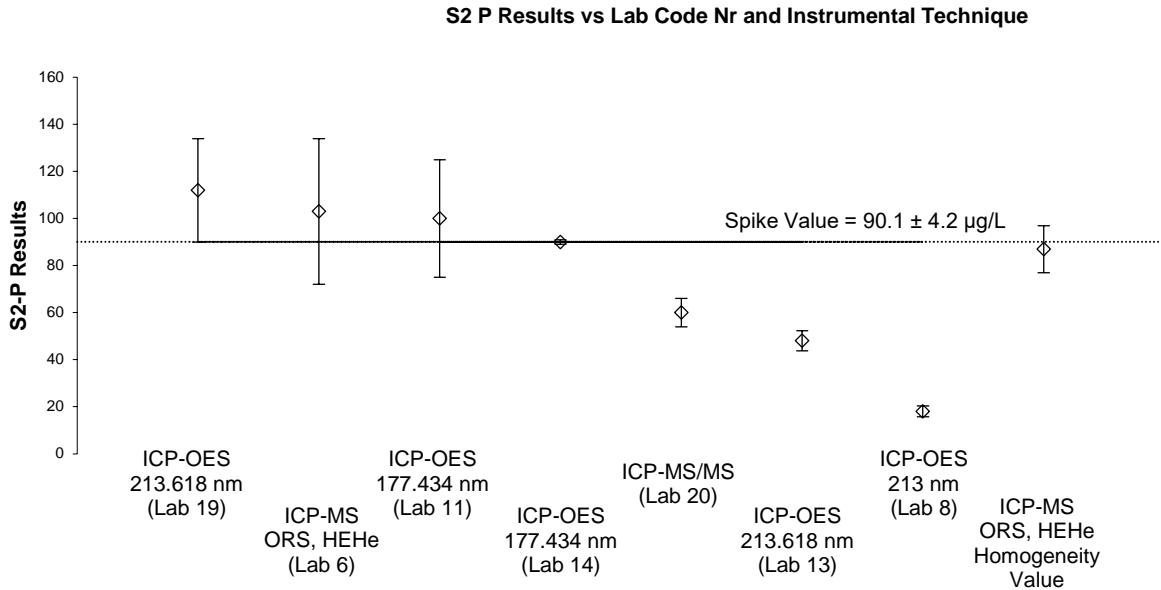


Figure 56 S2 P Results vs Instrumental Technique and Laboratory Code Number

Selenium The between-laboratory CV for Se in seawater Sample S2 was 24%, more than double the CV observed for river water sample S1 (10%). Seawater contains significant quantities of dissolved salts, especially sodium chloride and sulphates. Molecular ions originated from dissolved salts with a mass similar to the Se isotope used in elemental determination can cause severe interference. As a result, false positives and concentrations much higher than the true values are frequently obtained when Se is measured by ICP-MS without the help of collision/reaction cell.

Participants employed a wide range of instrumental techniques to overcome these interferences: ICP-MS/MS, ICP-MS in reaction mode, ICP-MS with high energy helium or ICP-MS in reaction mode with H₂ or NH₃. All laboratories using these approaches produced acceptable results, with the exception of one. One laboratory reporting using ICP-OES with wavelength 196 nm also performed acceptably (Figure 57).

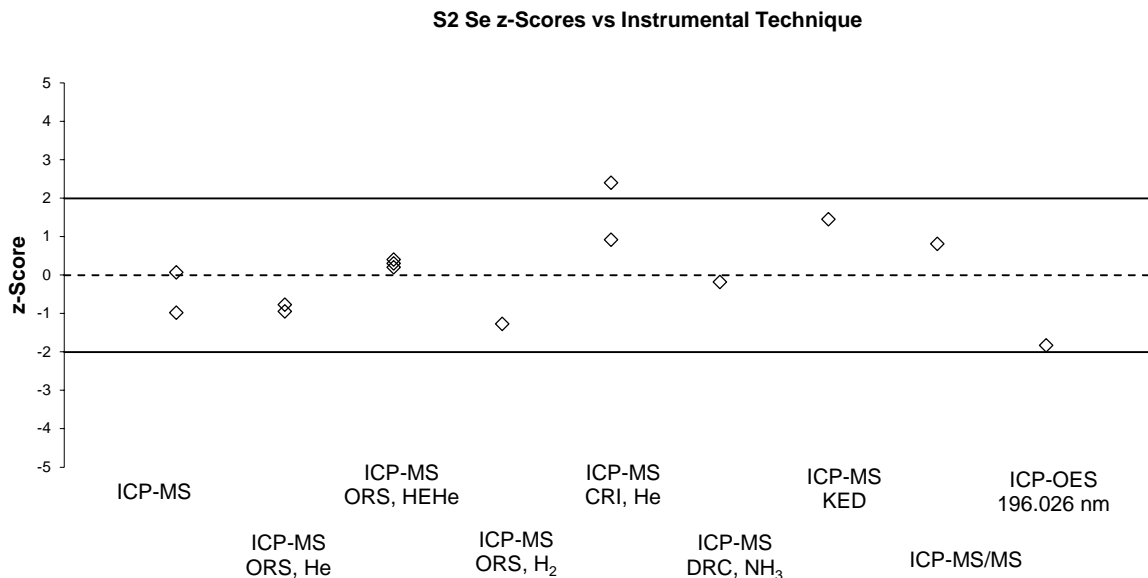
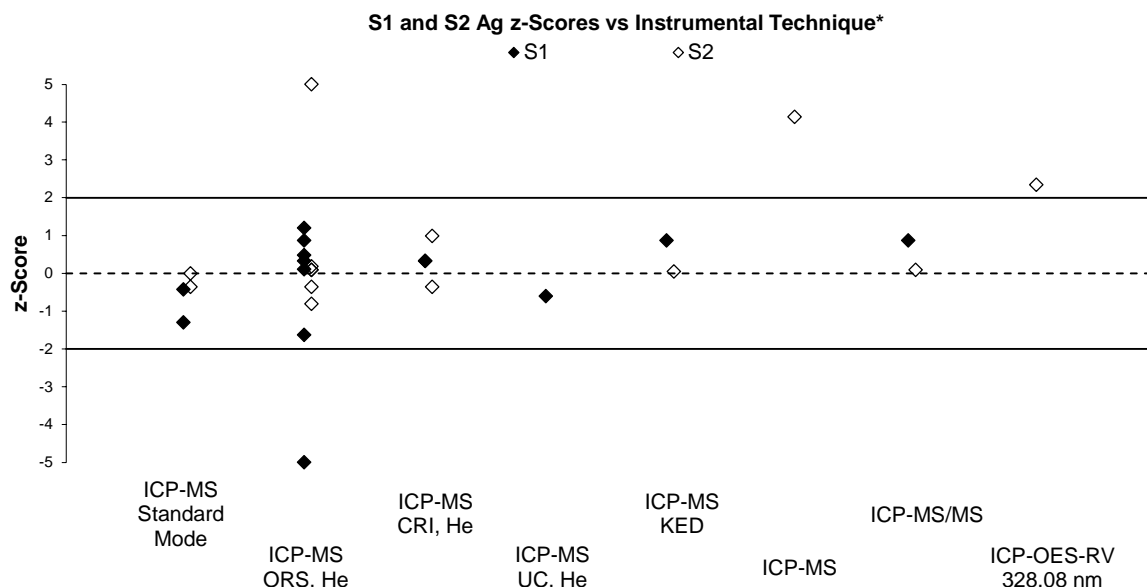


Figure 57 S1 and S2 Se z-Scores vs Instrumental Technique

Silver levels in Samples S1 and S2 were low, at 1.84 µg/L and 1.48 µg/L respectively. Participants' performance in the two samples is presented in Figure 60. There was no significant difference in participants' performance in the two samples.

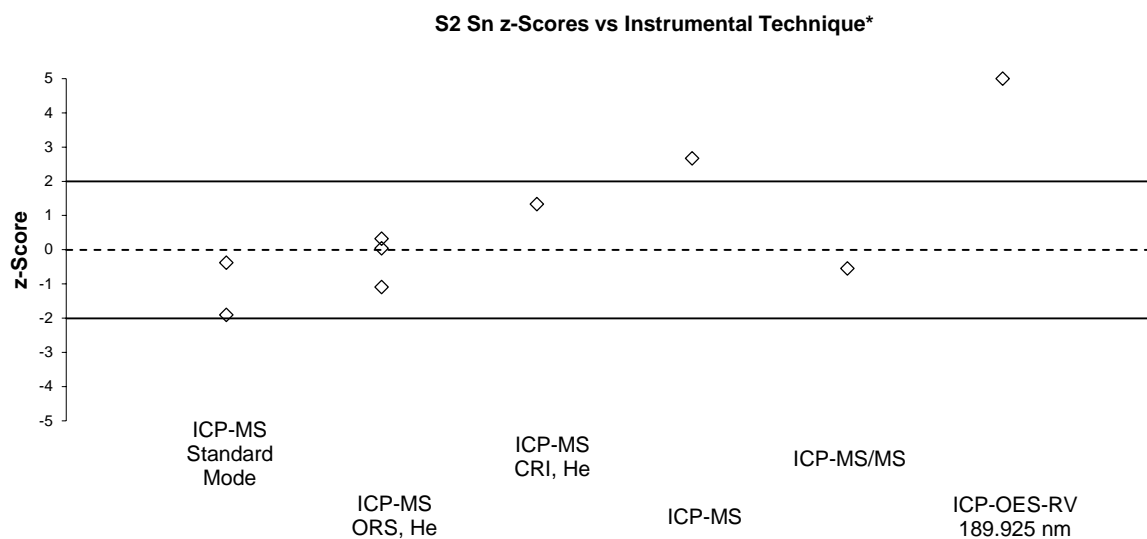
Laboratories whose results returned high unacceptable z-scores should consider checking the validity of their standards. Silver solutions are photosensitive and can easily precipitate when exposed to light, even for short periods of time. This instability increases with higher silver concentration.¹⁵



* z-Scores larger than 5 and less than -5 have been set as 5 and -5 respectively.

Figure 58 S1 and S2 Ag z-Scores vs Laboratory Code

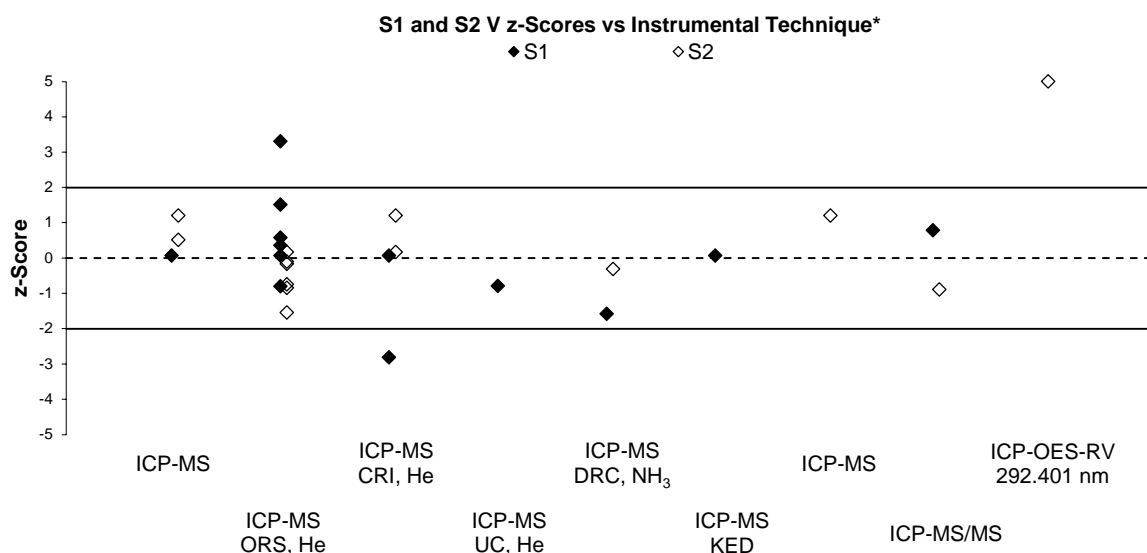
Tin was only present in seawater Sample S2, at a level of 3.50 µg/L. Of the nine participants who reported results, two returned values that were not acceptable (Figure 59). ICP-OES may not be an appropriate technique for measuring low-level Sn in seawater. The participating laboratory that reported using this technique should consider using a different instrumental technique or reviewing method detection limit for Sn in seawater and increasing its reporting level accordingly.



* z-Scores larger than 5 have been set as 5.

Figure 59 S1 and S2 Sn z-Scores vs Laboratory Code

Vanadium Participants' performance for V in the two types of water was similar (Table 49). Participants used various instrumental techniques and most produced compatible results (Figure 62).



* z-Scores larger than 5 have been set as 5.

Figure 60 S1 and S2-V z-Scores vs Instrumental Technique

Solids and Turbidity The method descriptions provided by participants is presented in Table 2. Most participants used APHA Method 2540 for solids and APHA Method 2130 for Turbidity. All reported results for these tests returned acceptable z-scores.

6.6 Comparison with Previous NMIA Proficiency Tests of Metals in Water

AQA 25-13 is the 36th NMIA proficiency study of metals in water. Participants' performance in the measurement of trace elements and solids in water (river water, seawater, wastewater and potable water) over the last ten years is presented in Figure 61. Over this period, the average proportion of acceptable scores was 93% for z-scores and 85% for E_n -scores.

Over time, laboratories should expect at least 95% of their scores to lay within the range $|z| \leq 2.0$. Scores in the range $2.0 < |z| < 3.0$ occasionally can occur, however these should be interpreted in conjunction with the other scores obtained by that laboratory. For example, a trend of z-scores on one side of the zero line is an indication of method or laboratory bias.

Individual performance history reports are emailed to each participant at the end of the study; the consideration of z-scores for an analyte over time provides much more useful information than a single z-score.

6.7 Reference Materials and Certified Reference Materials

Participants reported whether control samples (spiked samples, certified reference materials-CRMs or matrix specific reference materials-RMs) had been used (Table 52).

Table 52 Control Samples Used by Participants

Lab. Code	Description of Control Samples
1	CRM: Multiple CRMs from Choice Analytical
2	CRM: CRM-TMDW from HPS lot 2435313
3	SS

Lab. Code	Description of Control Samples
4	CRM
5	CRM, SS
6	CRM, SS
7	CRM
8	SS
9	SS
10	CRM, SS
11	SS
12	SS
13	RM / Ex PT Sample, SS
15	CRM, SS
16	CRM, SS
17	CRM, SS
18	CRM: NASS 7, CASS 6, MX014 and AQA 24-17 S2 (Seawater) CWW-TM-B and CWW-TM-C (River water)
19	CRM: Agal 51
20	CRM
21	CRM, SS
22	CRM, SS

Matrix matched control samples taken through all steps of the analytical process, are the most valuable quality control tools for assessing the methods' performance.

Some laboratories reported using certified reference materials. These materials may not meet the internationally recognised definition of a Certified Reference Material:

*' a reference material, accompanied by documentation issued by an authoritative body and providing one or more specified property values with associated uncertainties and traceabilities, using valid procedures'*¹⁶

A certified reference material for trace elements in seawater (MX014) is available from NMIA. (<https://www.industry.gov.au/national-measurement-institute/nmi-services/chemical-and-biological-measurement-services/chemical-reference-materials/matrix-reference-materials>)

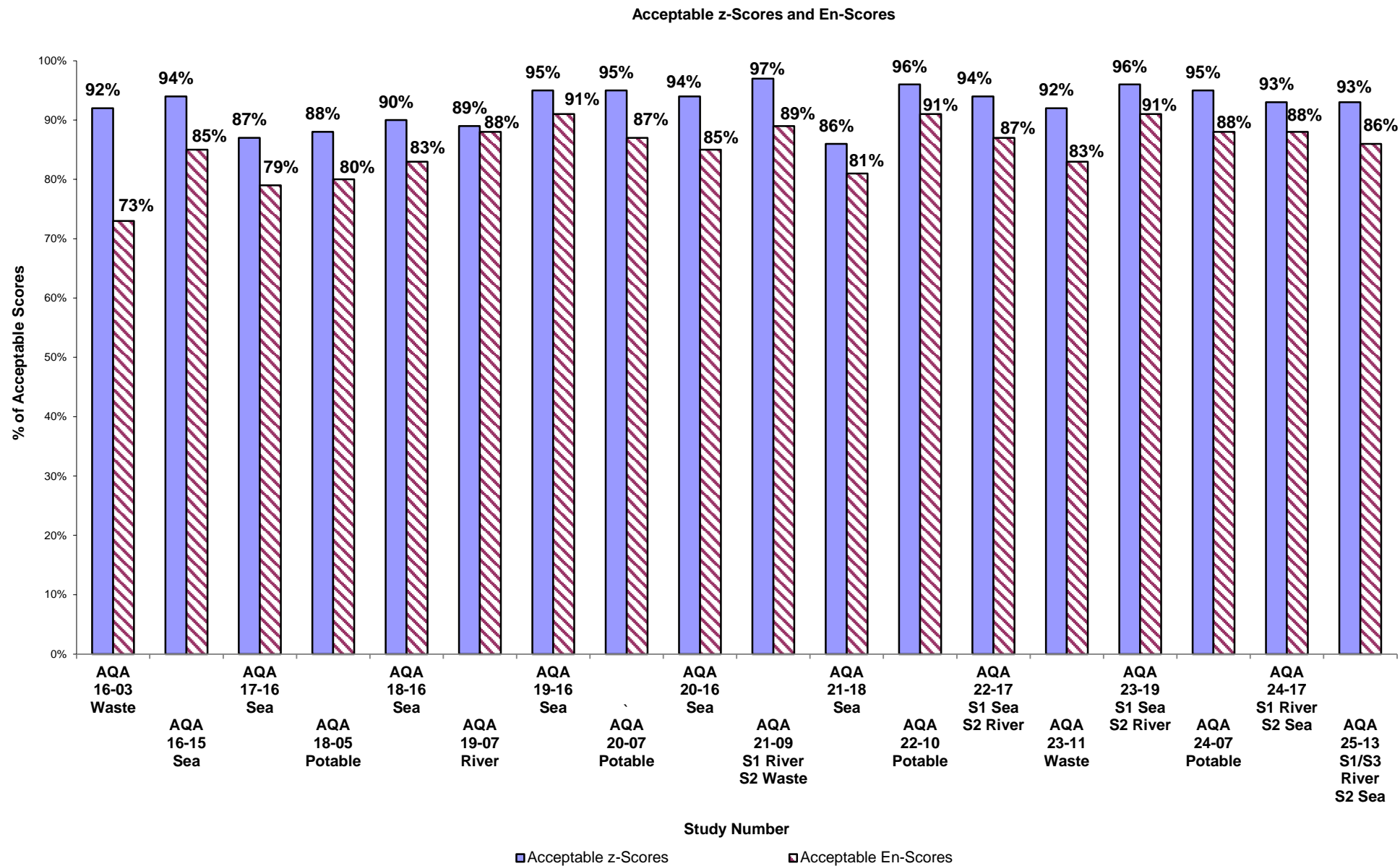


Figure 61 Participants' Performance in Metals in Water PT Studies over Last Ten Years

7 REFERENCES

Note: For all undated references, the latest edition of the referenced document (including any amendments) applies

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APPENDIX 1 – SAMPLE PREPARATION, ANALYSIS AND HOMOGENEITY TESTING

Sample Preparation

Sample S1 was prepared from river water. Approximately 6 L of river water was filtered, acidified and fortified for 18 elements.

Sample S2 was prepared from seawater. Approximately 6 L of seawater was filtered, acidified and fortified for 17 elements.

Sample S3 was prepared from river water. Approximately 18 L of river water was filtered and fortified with a high-level solids standard.

Sample Analysis and Homogeneity Testing

A partial homogeneity test was conducted for all analytes in Samples S1 and S2.

Three bottles were analysed in duplicate, and the average of the results was reported as the homogeneity value.

Sample Analysis for Dissolved Elements

The analyses for partial homogeneity were conducted by CRV section of NMIA as per method NT2.47.¹⁷ For river water sample S1, a test portion of 8 mL was used, and for the seawater sample S2 a 1 mL test portion was used.¹⁶ Both were diluted to 10 mL with 2% HNO₃.¹⁶ Testing was completed using ICP-MS instrumentation. The measurement instrument was calibrated using external standards for targeted analytes. A set of quality control samples consisting of blanks, a blank matrix spike, duplicates, sample matrix spikes and control samples was carried through the same set of procedures and analysed simultaneously with the samples. A summary of the instrument conditions used for each analyte is presented in Table 53.

Table 53 Instrumental Techniques used for Dissolved Elements in S1 and S2

Analyte	Instrument	Internal Standard	Reaction/ Collision Cell	Cell Mode/Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Ion
Ag	ICP-MS	Rh	ORS	He	1.25	10	107 m/z
Al	ICP-MS	Rh	NA	NA	1.25	10	27 m/z
As	ICP-MS	Rh	ORS	He	1.25	10	75 m/z
Be	ICP-MS	Rh	NA	NA	1.25	10	9 m/z
Cd	ICP-MS	Rh	ORS	He	1.25	10	111 m/z
Co	ICP-MS	Rh	ORS	He	1.25	NA	59 m/z
Cr	ICP-MS	Rh	ORS	He	1.25	10	52 m/z
Cu	ICP-MS	Rh	ORS	He	1.25	10	63 m/z
Fe	ICP-MS	Rh	ORS	He	1.25	10	56 m/z
Hg	ICP-MS	Ir	ORS	He	1.25	10	202 m/z
Mn	ICP-MS	Rh	ORS	He	1.25	10	55 m/z
Mo	ICP-MS	Rh	ORS	He	1.25	NA	95 m/z
Ni	ICP-MS	Rh	ORS	He	1.25	10	60 m/z
P	ICP-MS	Rh	ORS	HEHe	NA	10	31 m/z
Pb	ICP-MS	Ir	ORS	He	1.25	10	206 m/z
Sb	ICP-MS	Rh	ORS	He	1.25	10	121 m/z
Se	ICP-MS	Rh	ORS	HEHe	1.25	10	78 m/z
Sn	ICP-MS	Rh	ORS	He	NA	10	118 m/z
Tl	ICP-MS	Rh	ORS	He	1.25	10	205 m/z
U	ICP-MS	Ir	ORS	He	1.25	10	238 m/z
V	ICP-MS	Rh	ORS	He	1.25	10	51 m/z
Zn	ICP-MS	Rh	ORS	He	1.25	10	64 m/z

Methodology for TDS, TSS, TS, and Turbidity

Analyses for TDS, TSS, TS and Turbidity in sample S3 were conducted by NMIA Analytical Services Branch Inorganics section. Methods for TDS, TSS, and TDS were in-house methods based on APHA 2540 B, D, and E with Turbidity based on APHA 2130 B.

APPENDIX 2 – ASSIGNED VALUE, Z-SCORE AND E_n SCORE CALCULATION

The assigned value was calculated as the robust average using the procedure described in ISO13528 ‘Statistical methods for use in proficiency testing by inter-laboratory comparisons – Annex C’.⁷ The uncertainty was evaluated as:

$$u_{rob\ av} = 1.25 * S_{rob\ av} / \sqrt{p} \quad \text{Equation 4}$$

where:

$u_{rob\ av}$ robust average standard uncertainty
 $S_{rob\ av}$ robust average standard deviation
 p number of results

The expanded uncertainty ($U_{rob\ av}$) is the standard uncertainty multiplied by a coverage factor of 2 at approximately 95% confidence level.

A worked example is set out below in Table 54.

Table 54 Uncertainty of Assigned Value for Cd in Sample S2

No. results (p)	16
Robust Average	0.905 µg/L
$S_{rob\ av}$	0.091 µg/L
$u_{rob\ av}$	0.028 µg/L
k	2
$U_{rob\ av}$	0.057 µg/L

The assigned value for Cd in Sample S1 is **0.905 ± 0.057 µg/L**.

z-Score and E_n-score

For each participant’s result a z-score and E_n-score are calculated according to Equation 2 and Equation 3 respectively (see page 11).

A worked example is set out below in Table 55.

Table 55 z-Score and E_n-score for Cd result reported by Laboratory **10** in S2

Cd Result µg/L	Assigned Value µg/L	Standard Deviation for Proficiency Assessment	z-Score	E _n -Score
0.927 ± 0.089	0.905 ± 0.057	15% as CV or 0.15 x 0.905 = 0.136 µg/L	$z = \frac{(0.927 - 0.905)}{0.136}$ $z = 0.16$	$E_n = \frac{(0.927 - 0.905)}{\sqrt{0.089^2 + 0.057^2}}$ $E_n = 0.21$

APPENDIX 3 - USING PT DATA FOR UNCERTAINTY EVALUATION

When a laboratory has successfully participated in at least 6 proficiency testing studies, the standard deviation from proficiency testing studies can also be used to evaluate the uncertainty of their measurement results.^{10, 12} Between 2011 and 2025, NMIA carried out 36 proficiency tests for metals in water. These involved analyses of dissolved or total elements at low and high levels in potable, fresh (river), sea, ground and waste water. Laboratory X participated and submitted acceptable results for Ni in all of these PTs. This data can be separated into two ranges of results: 0.0005 to 0.01 mg/L and 0.01 to 0.10 mg/L. Results are presented in Tables 56 and 57.

Table 56 Laboratory X Reported Results for Ni at 0.0005 to 0.01 mg/L Level

Study No.	Sample	Laboratory result mg/L	Assigned value mg/L	Number of Results	Robust CV of all results (%)
AQA 11-07	Fresh	0.0015 ± 0.0003	0.00100 ± 0.00001	15	24
	Fresh	0.0039 ± 0.00078	0.00306 ± 0.00016	19	18
	Fresh	0.0039 ± 0.00078	0.00306 ± 0.00016	19	9.6
AQA 12-20	Saline	0.0039 ± 0.0008	0.00370 ± 0.00028	19	13
AQA 13-09	Fresh	0.0044 ± 0.0009	0.00409 ± 0.00017	15	7.9
AQA 13-22	Saline	0.00170 ± 0.00034	0.00165 ± 0.00014	14	13
	Saline	0.00384 ± 0.00077	0.00378 ± 0.00012	14	13
AQA 15-06	Sea	0.00180 ± 0.0004	0.00177 ± 0.00021	12	28
	Sea	0.00172 ± 0.0004	0.00177 ± 0.00021	11	28
AQA 15-18	Surface	0.002 ± 0.0003	0.00196 ± 0.00013	10	7.8
AQA 16-03	Waste	0.0041 ± 0.0008	0.00398 ± 0.00031	9	8.6
AQA 16-15	Sea	0.0070 ± 0.0010	0.00652 ± 0.00038	16	9.4
AQA 17-16	Sea	0.0015 ± 0.0003	0.00143 ± 0.00029	10	22
AQA 18-16	Sea	0.0022 ± 0.0005	0.00206 ± 0.00015	14	11
AQA 19-07	Fresh	0.0018 ± 0.0004	0.00187 ± 0.00009	10	5.3
AQA 19-16	Sea	0.0021 ± 0.0004	0.00168 ± 0.00037	8	25
AQA 20-16	Sea	0.0013 ± 0.0003	0.00178 ± 0.00034	10	24
AQA 21-09	River	0.0007 ± 0.0002	0.000756 ± 0.000059	8	8.9
AQA 21-18	Saline	0.0029 ± 0.0006	0.00298 ± 0.00031	6	13
AQA 22-10	Potable	0.007 ± 0.0011	0.00845 ± 0.00036	13	6.1
AQA 22-17	Sea	0.0028 ± 0.00056	0.00286 ± 0.00027	15	12
AQA 22-17	River	0.0035 ± 0.00027	0.00364 ± 0.00026	13	10
AQA 23-11	Waste	0.0085 ± 0.0009	0.00825 ± 0.0052	13	9.2
AQA 23-18	Sea	0.00236 ± 0.0003	0.00253 ± 0.00042	9	20
	River	0.00565 ± 0.0007	0.00580 ± 0.00024	10	5.2
AQA 24-07	Potable	0.0073 ± 0.0009	0.00772 ± 0.00020	14	3.8
AQA 24-17	River	0.00266 ± 0.0004	0.00238 ± 0.00016	18	12
	Sea	0.00232 ± 0.0003	0.00247 ± 0.00033	16	21
AQA 25-13	River	0.00268 ± 0.0003	0.00283 ± 0.00011	15	6.2
	Sea	0.00249 ± 0.0004	0.00244 ± 0.00023	11	12
Average					14%*
$pooled\ s\% = \sqrt{\frac{(15 - 1) \times 24^2 + (19 - 1) \times 18^2 + \dots + (11 - 1) \times 12^2}{386 - 30}}$					15%

*The pooled standard deviation was used.

Table 57 Laboratory X Reported Results for Ni at 0.01 to 0.10 mg/L Level

Study No.	Sample	Laboratory result mg/L	Assigned value mg/L	Number of Results	Robust CV of all results (%)
AQA 11-17	Waste	0.10 ± 0.009	0.099 ± 0.001	15	2
	Waste	0.10 ± 0.009	0.098 ± 0.001	15	2
AQA 12-09	Potable	0.047 ± 0.007	0.045 ± 0.002	19	6.7
	Potable	0.055 ± 0.008	0.053 ± 0.002	19	7.4
AQA 12-20	Saline	0.0415 ± 0.0083	0.0384 ± 0.0021	22	11
AQA 13-09	Fresh	0.0393 ± 0.0040	0.0361 ± 0.0010	16	4.8
	Fresh	0.0258 ± 0.0030	0.0272 ± 0.0025	15	15
AQA 14-08	Ground	0.019 ± 0.004	0.0191 ± 0.0007	13	7.9
AQA 14-19	Potable	0.019 ± 0.004	0.0183 ± 0.0013	14	11
AQA 15-18	Surface	0.036 ± 0.0035	0.0336 ± 0.0013	13	5.1
AQA 16-03	Waste	0.042 ± 0.0045	0.0352 ± 0.0050	11	19
AQA 16-15	Sea	0.0456 ± 0.0060	0.0409 ± 0.0029	17	12
AQA 17-16	Sea	0.0116 ± 0.0012	0.0101 ± 0.0023	9	27
AQA 18-05	Potable	0.017 ± 0.002	0.0172 ± 0.0010	16	8.7
AQA 18-16	Sea	0.015 ± 0.0030	0.0138 ± 0.0014	15	15
AQA 19-07	Fresh	0.029 ± 0.0035	0.0283 ± 0.0009	11	4.3
AQA 20-07	Potable	0.010 ± 0.002	0.0106 ± 0.0004	16	6
AQA 21-09	Waste	0.014 ± 0.0021	0.0143 ± 0.0006	21	8.1
Average					9.6*
$pooled\ s\% = \sqrt{\frac{(15 - 1) \times 2^2 + (15 - 1) \times 2^2 + \dots + (21 - 1) \times 8.1^2}{277 - 18}}$					11%

*The pooled standard deviation was used.

The pooled standard deviation of the robust CV over these PT samples for each concentration range gives evaluations of the relative standard uncertainty of 15% and 11% respectively. Using a coverage factor of two gives relative expanded uncertainties of 30% and 21% respectively, at a level of confidence of approximately 95%.

Table 58 sets out the expanded uncertainty for results of the measurement of Ni in fresh, saline, waste or potable water over the ranges 0.0005 – 0.01 mg/L and 0.01 – 0.10 mg/L.

Table 58 Uncertainty of Ni results evaluated using PT data

Results mg/L	Uncertainty mg/L
0.00050	0.00015
0.00100	0.00030
0.0100	0.0030
0.100	0.021
0.150	0.032

The evaluations of 30% and 21% relative passes the test of being reasonable, and the analysis of the 48 different PT samples over 15 years can be assumed to include all the relevant uncertainty components (different matrices, operators, reagents, calibrators etc.), and so complies with ISO 17025.⁸

APPENDIX 4 - ACRONYMS AND ABBREVIATIONS

APHA	American Public Health Association
ASTM	American Society for Testing and Materials
CITAC	Cooperation on International Traceability in Analytical Chemistry
CRI	Collision Reaction Interface
CRM	Certified Reference Material
CV	Coefficient of Variation
CVAAS	Cold Vapour Atomic Absorption Spectrometry
CVAFS	Cold Vapour Atomic Fluorescence Spectrometry
DRC	Dynamic Reaction Cell
EPA	Environmental Protection Agency
GUM	Guide to the Expression of Uncertainty in Measurement
HEHe	High energy He mode
HV	Homogeneity Value
ICP-MS	Inductively Coupled Plasma – Mass Spectrometry
ICP-MS/MS	Inductively Coupled Plasma – Tandem Mass Spectrometry
ICP-OES-AV	Inductively Coupled Plasma – Optical Emission Spectrometry – Axial View
ICP-OES-RV	Inductively Coupled Plasma – Optical Emission Spectrometry – Radial View
ISO/IEC	International Organisation for Standardisation / International Electrotechnical Commission
KED	Kinetic Energy Discrimination
Max	Maximum value in a set of results
Md	Median
Min	Minimum value in a set of results
MU	Measurement Uncertainty
N	Number of Participants
NMIA	National Measurement Institute Australia
NR	Not Reported
NT	Not Tested
ORS	Octopole Reaction System
PCV	Performance Coefficient of Variation
PT	Proficiency Test
RM	Reference Material
SD_{rob}	Robust Standard Deviation
SDPA	Standard deviation for proficiency assessment (symbol: σ)
SI	The International System of Units
SS	Spiked sample
SV	Spiked or formulated concentration of a PT sample
UC	Universal Cell
VGA-ICP-OES	Vapour Generation Accessory – Inductively Coupled Plasma – Optical Emission Spectrometry

APPENDIX 5 - INSTRUMENT DETAILS FOR DISSOLVED ELEMENTS

Table 59 Instrument Conditions Ag

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	ORS	He	1	1	328.069nm
3	ICP-MS	Rh	KED	He	1	5	109
6	ICP-MS	89 Y	ORS	He	NA	5	m/z 107
7	ICP-MS	103	ORS	He	1	1	107
8	ICP-MS	Y		O2	NA		107
9	ICP-MS	Rh	DRC	He		NA	
10	ICP-MS	Sc,Ir,Rh	ORS	He			107
11	ICP-MS	Rh	ORS	He	1.05	1.05	107
12	ICP-MS	103	ORS	He	1	1	107
13	ICP-OES-RV	NA	NA	NA	NA	NA	328.08
14	ICP-MS	Rh	CRI	He			107
15	ICP-MS						
16	ICP-MS	Rh	ORS	He	NA	NA	107
17	ICP-MS				NA		
18	ICP-MS	Ir	NA	standard mode	1	1	109
19	ICP-MS	Rh	ORS	He	1.25	10	107
20	ICP-MS/MS						
21	ICP-OES-AV	Sc	NA	NA	1	NA	328.068 nm
22	ICP-MS	175 Lu	ORS	He	1	NA	107

Table 60 Instrument Conditions Al

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	ORS	He	1	1	27 (m/z)
3	ICP-MS	Sc	KED	He	1	5	27
6	ICP-MS	45 Sc	ORS	He	NA	5	m/z 27
7	ICP-MS	45	ORS	He	1	1	27
8	ICP-MS	Li6		O2	NA		27
9	ICP-MS	Sc	DRC	He		NA	
10	ICP-MS	Sc,Ir,Rh	ORS				
11	ICP-MS	Ge	ORS	He	1.05	1.05	27
12	ICP-MS	45	ORS	He	1	1	27
13	ICP-OES-RV	NA	NA	NA	NA	NA	308.215
14	ICP-MS						308.215
15	ICP-MS						
16	ICP-MS	Sc	ORS	He	NA	NA	27
18	ICP-MS	Sc	UC	He	1	1	27
19	ICP-OES-AV	Y	NA	NA	2	2	167.019
20	ICP-MS/MS						
21	ICP-OES-AV	Sc	NA	NA	1	NA	394.401 nm
22	ICP-MS	72 Ge	ORS	He	1	NA	27

Table 61 Instrument Conditions As

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	ORS	He	1	1	75 (m/z)
3	ICP-MS	Te/Rn	KED	He	1	5	75
6	ICP-MS	89 Y	ORS	He	NA	5	m/z 75
7	ICP-MS	45	ORS	He	1	1	75
8	ICP-MS	Y		O2	NA		75
9	ICP-MS	Rh	DRC	He		NA	
10	ICP-MS	Sc,Ir,Rh	ORS				75
11	ICP-MS	Ge	ORS	He	1.05	1.05	75
12	ICP-MS	72	ORS	He	1	1	75
13	ICP-OES-RV	NA	NA	NA	NA	NA	193.696
14	ICP-MS	Ge	CRI	He			75
15	ICP-MS						
16	ICP-MS	Rh	ORS	He	NA	NA	75
17	ICP-MS				NA		
18	ICP-MS	Sc	UC	He	1	1	75
19	ICP-MS	Rh	ORS	He	1.25	10	75
20	ICP-MS/MS						
21	ICP-OES-AV	Sc	NA	NA	1	NA	193.696 nm
22	ICP-MS	175 Lu	ORS	HEHe	1	NA	75

Table 62 Instrument Conditions Be

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	ORS	He	1	1	9 (m/z)
3	ICP-MS	Sc	KED	He	1	NA	9
6	ICP-MS	45 Sc	ORS	No gas	NA	5	m/z 9
7	ICP-MS	45	NA	NA	1	1	9
8	ICP-MS	Li6		Standard Mode	NA		9
9	ICP-MS	Sc	DRC	He		NA	
10	ICP-MS	Sc,Ir,Rh	ORS				9
11	ICP-MS	Li6	Standard Mode	Standard Mode	1.05	1.05	9
13	ICP-OES-RV	NA	NA	NA	NA	NA	313.042
14	ICP-MS	Ge	CRI	He			9
15	ICP-MS						
16	ICP-MS	Sc	ORS	NA	NA	NA	9
17	ICP-MS				NA		
18	ICP-MS	Sc	NA	standard mode	1	1	9
19	ICP-MS	Rh	ORS	He	1.25	10	9
20	ICP-MS/MS						
21	ICP-OES-AV	Sc	NA	NA	1	NA	313.042 nm
22	ICP-MS	72 Ge	ORS	He	1	NA	9

Table 63 Instrument Conditions Cd

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	ORS	He	1	1	111 (m/z)
3	ICP-MS	Rh	KED	He	1	5	111
6	ICP-MS	89 Y	ORS	He	NA	5	m/z 111
7	ICP-MS	103	ORS	He	1	1	111
8	ICP-MS	In		O2	NA		111
9	ICP-MS	Rh	DRC	He		NA	
10	ICP-MS	Sc,Ir,Rh	ORS				111
11	ICP-MS	In	ORS	He	1.05	1.05	111
12	ICP-MS	103	ORS	He	1	1	114
13	ICP-OES-RV	NA	NA	NA	NA	NA	228.802
14	ICP-MS	Rh	CRI	He			111
15	ICP-MS						
16	ICP-MS	Rh	ORS	He	NA	NA	111
17	ICP-MS				NA		
18	ICP-MS	Ir	NA	standard mode	1	1	111
19	ICP-MS	Rh	ORS	He	1.25	10	111
20	ICP-MS/MS						
21	ICP-OES-AV	Sc	NA	NA	1	NA	214.439 nm
22	ICP-MS	175 Lu	ORS	He	1	NA	111

Table 64 Instrument Conditions Co

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	ir, Rh & Sc	ORS	He	1	NA	59 (m/z)
3	ICP-MS	Ga	KED	He	1	NA	59
7	ICP-MS	45	ORS	He	1	NA	59
9	ICP-MS	Ge	DRC	He		NA	
10	ICP-MS	Sc,Ir,Rh	ORS			NA	59
11	ICP-MS	Ge	ORS	He	1.05	NA	59
12	ICP-MS	115	ORS	He	1	1	59
14	ICP-MS	Ge	CRI	He			59
15	ICP-MS					NA	
16	ICP-MS	Rh	ORS	He	NA	NA	59
18	ICP-MS	Sc	UC	He	1	NA	59
19	ICP-MS	Rh	ORS	He	1.25	10	59
20	ICP-MS/MS						
21	ICP-OES-AV	Sc	NA	NA	1	NA	230.786 nm
22	ICP-MS	72 Ge	ORS	He	1	NA	59

Table 65 Instrument Conditions Cr

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	ORS	He	1	1	52 (m/z)
3	ICP-MS	Sc	KED	He	1	5	52
6	ICP-MS	89 Y	ORS	He	NA	5	m/z 52
7	ICP-MS	45	ORS	He	1	1	52
8	ICP-MS	Sc		O2	NA		52
9	ICP-MS	Sc	DRC	He		NA	
10	ICP-MS	Sc,Ir,Rh	ORS				52
11	ICP-MS	Ge	ORS	He	1.05	1.05	52
12	ICP-MS	72	ORS	He	1	1	52
13	ICP-OES-RV	NA	NA	NA	NA	NA	205.56
14	ICP-MS	Ge	CRI	He			52
15	ICP-MS						
16	ICP-MS	Sc	ORS	He	NA	NA	52
17	ICP-MS				NA		
18	ICP-MS	Sc	UC	He	1	1	52
19	ICP-MS	Rh	ORS	He	1.25	10	52
20	ICP-MS/MS						
21	ICP-OES-AV	Sc	NA	NA	1	NA	206.158 nm
22	ICP-MS	72 Ge	ORS	He	1	NA	52

Table 66 Instrument Conditions Cu

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	ORS	He	1	1	63 (m/z)
3	ICP-MS	Ga	KED	He	1	5	63
6	ICP-MS	89 Y	ORS	He	NA	5	m/z 63
7	ICP-MS	103	ORS	He	1	1	63
8	ICP-MS	Sc		O2	NA		63
9	ICP-MS	Ge	DRC	He		NA	
10	ICP-MS	Sc,Ir,Rh	ORS				63
11	ICP-MS	Ge	ORS	He	1.05	1.05	63
12	ICP-MS	103	ORS	He	1	1	65
13	ICP-OES-RV	NA	NA	NA	NA	NA	324.754
14	ICP-MS						217.895
15	ICP-MS						
16	ICP-MS	Rh	ORS	He	NA	NA	65
17	ICP-MS				NA		
18	ICP-MS	Sc	UC	He	1	1	65
19	ICP-MS	Rh	ORS	He	1.25	10	63
20	ICP-MS/MS						
21	ICP-OES-AV	Sc	NA	NA	1	NA	327.395 nm
22	ICP-MS	72 Ge	ORS	He	1	NA	63

Table 67 Instrument Conditions Fe

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	ir, Rh & Sc	ORS	He	1	NA	56 (m/z)
3	ICP-MS	Sc	KED	He	1	5	56
6	ICP-MS	45 Sc	ORS	He	NA	5	m/z 56
7	ICP-MS	45	ORS	He	1	1	56
8	ICP-MS	Sc		O2	NA		56
9	ICP-MS	Sc	DRC	He		NA	
10	ICP-MS	Sc,Ir,Rh	ORS				258.58
11	ICP-MS	Ge	ORS	He	1.05	1.05	56
12	ICP-MS	72	ORS	He	1	1	56
13	ICP-OES-RV	NA	NA	NA	NA	NA	259.94
14	ICP-MS		CRI	He			240.489
15	ICP-MS						
16	ICP-MS	Sc	ORS	HEHe	NA	NA	56
17	ICP-MS				NA		
18	ICP-MS	Sc	UC	He	1	1	56
19	ICP-OES-AV	Y	NA	NA	2	2	238.204
20	ICP-MS/MS						
21	ICP-OES-AV	Sc	NA	NA	1	NA	261.187 nm
22	ICP-MS	72 Ge	ORS	He	1	NA	56

Table 68 Instrument Conditions Hg

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	CETAC	NA	NA	NA	1	NA	253 nm
3	ICP-MS/CVAFS	Tb/NA	KED/NA	He/NA	1	5	201/254
6	ICP-MS	175 Lu	ORS	He	NA	5	m/z 201
7	CVAAS	N/A	NA	NA	1	1	253
8	CVAAS	SnCl2		NA	NA		
9	ICP-MS	Ir	DRC	He		NA	
11	CVAFS	NA	NA	NA	2	2	253.7
12	VGA-ICP-OES				1	1	194.164
13	ICP-OES-RV	NA	NA	NA	NA	NA	194.164
14	ICP-MS	Ir	CRI	He			202
16	CVAAS	N/A	N/A	NA	NA	NA	253nm
17	CVAAS				NA		
18	ICP-MS	Ir	NA	standard mode	1	1	201
19	CVAAS	NA	NA	NA	2	2	253.7
20	ICP-MS/MS						
21	ICP-OES-AV	Sc	NA	NA	1	NA	194.164 nm
22	ICP-MS	175 Lu	ORS	He	1	NA	200

Table 69 Instrument Conditions Mn

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	ORS	He	1	1	55 (m/z)
3	ICP-MS	Sc	KED	He	1	5	55
6	ICP-MS	103 Rh	ORS	He	NA	5	m/z. 55
7	ICP-MS	45	ORS	He	1	1	55
8	ICP-MS	Sc		O2	NA		55
9	ICP-MS	Sc	DRC	He		NA	
10	ICP-MS	Sc,Ir,Rh	ORS				55
11	ICP-MS	Ge	ORS	He	1.05	1.05	55
12	ICP-MS	72	ORS	He	1	1	55
13	ICP-OES-RV	NA	NA	NA	NA	NA	257.61
14	ICP-MS						257.61
15	ICP-MS						
16	ICP-MS	Sc	ORS	He	NA	NA	55
17	ICP-MS				NA		
18	ICP-MS	Sc	UC	He	1	1	55
19	ICP-OES-AV	Y	NA	NA	2	2	257.61
20	ICP-MS/MS						
21	ICP-OES-AV	Sc	NA	NA	1	NA	260.568 nm
22	ICP-MS	72 Ge	ORS	He	1	NA	55

Table 70 Instrument Conditions Mo

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	ir, Rh & Sc	ORS	He	1	NA	95 (m/z)
3	ICP-MS	Rh	KED	He	1	NA	98
7	ICP-MS	103	ORS	He	1	NA	95
9	ICP-MS	Rh	DRC	He		NA	
10	ICP-MS	Sc,Ir,Rh	ORS			NA	95
11	ICP-MS	Rh	ORS	He	1.05	NA	95
12	ICP-MS	72	ORS	He	1	1	98
14	ICP-MS	Rh	CRI	He			95
15	ICP-MS					NA	
16	ICP-MS	Rh	ORS	He	NA	NA	95
18	ICP-MS	Ir	NA	standard mode	1	NA	95
19	ICP-MS	Rh	ORS	He	1.25	10	95
20	ICP-MS/MS						
21	ICP-OES-AV	Sc	NA	NA	1	NA	202.032 nm
22	ICP-MS	175 Lu	ORS	He	1	NA	95

Table 71 Instrument Conditions Ni

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	ORS	He	1	1	60 (m/z)
3	ICP-MS	Ga	KED	He	1	5	60
6	ICP-MS	89 Y	ORS	He	NA	5	m/z 60
7	ICP-MS	103	ORS	He	1	1	60
8	ICP-MS	Sc		O2	NA		60
9	ICP-MS	Ge	DRC	He		NA	
10	ICP-MS	Sc,Ir,Rh	ORS				60
11	ICP-MS	Ge	ORS	He	1.05	1.05	60
12	ICP-MS	103	ORS	He	1	1	60
13	ICP-OES-RV	NA	NA	NA	NA	NA	231.604
14	ICP-MS						216.555
15	ICP-MS						
16	ICP-MS	Rh	ORS	He	NA	NA	60
17	ICP-MS				NA		
18	ICP-MS	Sc	UC	He	1	1	60
19	ICP-MS	Rh	ORS	He	1.25	10	60
20	ICP-MS/MS						
21	ICP-OES-AV	Sc	NA	NA	1	NA	231.604 nm
22	ICP-MS	72 Ge	ORS	He	1	NA	60

Table 72 Instrument Conditions P

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
6	ICP-MS	Germanium	ORS	HEHe	NA	5	31
7	ICP-OES-AV	Eu	NA	NA	NA	1	185
8	ICP-OES-AV	Yb		NA	NA		213nm
10	ICP-OES-AV	Eu			NA		185.827
11	ICP-OES-AV	Lu	NA	NA	NA	1.05	177.434
13	ICP-OES-RV	NA	NA	NA	NA	NA	213.618
14	ICP-OES-RV	Te					177.434
15	ICP-MS				NA		
16	ICP-OES-AV-buffer	Eu	N/A	NA	NA	NA	185.827nm
19	ICP-OES-AV	Y	NA	NA	2	2	213.618
20	ICP-MS/MS						

Table 73 Instrument Conditions Pb

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	ORS	He	1	1	208 (m/z)
3	ICP-MS	Tb	KED	He	1	5	206+207+208
6	ICP-MS	89 Y	ORS	He	NA	5	m/z 208
7	ICP-MS	193	ORS	He	1	1	208
8	ICP-MS	Ir		O2	NA		206
9	ICP-MS	Ir	DRC	He		NA	
10	ICP-MS	Sc, Ir, Rh	ORS				208
11	ICP-MS	Ir	ORS	He	1.05	1.05	208
12	ICP-MS	193	ORS	He	1	1	208
13	ICP-OES-RV	NA	NA	NA	NA	NA	220.353
14	ICP-MS						217
15	ICP-MS						
16	ICP-MS	Ir	ORS	He	NA	NA	208
17	ICP-MS				NA		
18	ICP-MS	Ir	NA	standard mode	1	1	206+207+208
19	ICP-MS	Ir	ORS	He	1.25	10	208
20	ICP-MS/MS						
21	ICP-OES-AV	Sc	NA	NA	1	NA	220.353 nm
22	ICP-MS	209 Bi	ORS	He	1	NA	208

Table 74 Instrument Conditions Sb

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	ir, Rh & Sc	ORS	He	1	1	121 (m/z)
3	ICP-MS	Rh	KED	He	1	5	121
6	ICP-MS	89 Y	ORS	He	NA	5	m/z 121
7	ICP-MS	103	ORS	He	1	1	121
8	ICP-MS	In		O2	NA		121
9	ICP-MS	Rh	DRC	He		NA	
10	ICP-MS	Sc, Ir, Rh	ORS				121
11	ICP-MS	In	ORS	He	1.05	1.05	121
12	ICP-MS	72	ORS	He	1	1	121
13	ICP-OES-RV	NA	NA	NA	NA	NA	206.834
14	ICP-MS	Rh	CRI	He			121
15	ICP-MS						
16	ICP-MS	Rh	ORS	He	NA	NA	121
17	ICP-MS				NA		
18	ICP-MS	Ir	NA	standard mode	1	1	121
19	ICP-MS	Rh	ORS	He	1.25	10	121
20	ICP-MS/MS						
21	ICP-OES-AV	Sc	NA	NA	1	NA	217.582 nm
22	ICP-MS	175 Lu	ORS	He	1	NA	123

Table 75 Instrument Conditions Se

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	ORS	He	1	1	78 (m/z)
3	ICP-MS	Te	KED	He	1	5	82/78
6	ICP-MS	45 Sc	ORS	H2	NA	5	m/z 78
7	ICP-MS	45	ORS	HEHe	1	1	78
8	ICP-MS	Y		O2	NA		78
9	ICP-MS	Rh	DRC	He		NA	
10	ICP-MS	Sc,Ir,Rh	ORS				78
11	ICP-MS	Ge	ORS	H2	1.05	1.05	78
12	ICP-MS	72	ORS	He	1	1	78
13	ICP-OES-RV	NA	NA	NA	NA	NA	196.026
14	ICP-MS	Rh	CRI	He			78
15	ICP-MS						
16	ICP-MS	Rh	ORS	HEHe	NA	NA	78
17	ICP-MS				NA		
18	ICP-MS	Rh	DRC	NH3	1	1	82
19	ICP-MS	Rh	ORS	HEHe	1.25	10	78
20	ICP-MS/MS						
21	ICP-OES-AV	Sc	NA	NA	1	NA	196.026 nm
22	ICP-MS	175 Lu	ORS	HEHe	1	NA	78

Table 76 Instrument Conditions Sn

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	ORS	He	NA	1	188 (m/z)
3	ICP-MS	Rh	KED	He	1	5	120
6	ICP-MS	175 Lu	ORS	He	NA	5	m/z 118
7	ICP-MS	103	ORS	He	NA	1	118
8	ICP-MS	In		O2	NA		118
10	ICP-MS	Sc,Ir,Rh	ORS		NA		118
11	ICP-MS	In	ORS	He	NA	1.05	118
12	ICP-MS	45	ORS	He	1	1	118
13	ICP-OES-RV	NA	NA	NA	NA	NA	189.925
14	ICP-MS	Rh	CRI	He			118
16	ICP-MS	Rh	ORS	He	NA	NA	118
17	ICP-MS				NA		
19	ICP-MS	Rh	ORS	He	1.25	10	118
20	ICP-MS/MS						

Table 74 Instrument Conditions Tl

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	ir, Rh & Sc	ORS	He	1	NA	205 (m/z)
3	ICP-MS	Tb	KED	He	1	5	205
6	ICP-MS	175 Lu	ORS	He	NA	5	m/z 205
7	ICP-MS	193	ORS	He	1	1	205
8	ICP-MS	Ir		O2	NA		205
9	ICP-MS	Ir	DRC	He		NA	
10	ICP-MS	Sc,Ir,Rh	ORS				205
11	ICP-MS	Ir	ORS	He	1.05	1.05	205
12	ICP-MS	193	ORS	He	1	1	205
13	ICP-OES-RV	NA	NA	NA	NA	NA	276.789
14	ICP-MS	Ge	CRI	He			205
16	ICP-MS	Ir	ORS	He	NA	NA	205
17	ICP-MS				NA		
18	ICP-MS	Ir	NA	standard mode	1	1	205
19	ICP-MS	Ir	ORS	He	1.25	10	205
20	ICP-MS/MS						
21	ICP-OES-AV	Sc	NA	NA	1	NA	351.923 nm

Table 75 Instrument Conditions U

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	ORS	He	1	1	238 (m/z)
3	ICP-MS	Tb	KED	He	1	5	238
6	ICP-MS	175 Lu	ORS	He	NA	5	m/z 238
7	ICP-MS	193	ORS	He	1	1	238
8	ICP-MS	Ir		O2	NA		238
9	ICP-MS	Ir	DRC	He		NA	
10	ICP-MS	Sc,Ir,Rh	ORS				238
11	ICP-MS	Ir	ORS	He	1.05	1.05	238
12	ICP-MS	103	ORS	He	1	1	238
14	ICP-MS	Ir	CRI	He			238
15	ICP-MS						
16	ICP-MS	Ir	ORS	He	NA	NA	238
17	ICP-MS				NA		
18	ICP-MS	Ir	NA	standard mode	1	1	238
19	ICP-MS	Ir	ORS	He	1.25	10	238
20	ICP-MS/MS						
21	ICP-OES-AV	Sc	NA	NA	1	NA	409.013 nm

Table 76 Instrument Conditions V

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	ORS	He	1	1	51 (m/z)
3	ICP-MS	Sc	KED	He	1	5	51
6	ICP-MS	45 Sc	ORS	He	NA	5	m/z 51
7	ICP-MS	45	ORS	He	1	1	51
8	ICP-MS	Sc		O2	NA		51
9	ICP-MS	Sc	DRC	He		NA	
10	ICP-MS	Sc,Ir,Rh	ORS				51
11	ICP-MS	Ge	ORS	He	1.05	1.05	51
12	ICP-MS	45	ORS	He	1	1	51
13	ICP-OES-RV	NA	NA	NA	NA	NA	292.401
14	ICP-MS	Ge	CRI	He			51
15	ICP-MS						
16	ICP-MS	Sc	ORS	He	NA	NA	51
17	ICP-MS				NA		
18	ICP-MS	Rh	DRC	NH3	1	1	51
19	ICP-MS	Rh	ORS	He	1.25	10	51
20	ICP-MS/MS						
21	ICP-OES-AV	Sc	NA	NA	1	NA	292.401 nm
22	ICP-MS	72 Ge	ORS	He	1	NA	51

Table 77 Instrument Conditions Zn

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	ORS	He	1	1	64 (m/z)
3	ICP-MS	Te/Rh	KED	He	1	5	66
6	ICP-MS	89 Y	ORS	He	NA	5	m/z 66
7	ICP-MS	103	ORS	He	1	1	66
8	ICP-MS	Y		O2	NA		66
9	ICP-MS	Ge	DRC	He		NA	
10	ICP-MS	Sc,Ir,Rh	ORS				66
11	ICP-MS	Ge	ORS	He	1.05	1.05	66
12	ICP-MS	115	ORS	He	1	1	66
13	ICP-OES-RV	NA	NA	NA	NA	NA	213.857
14	ICP-MS		CRI	He			334.502
15	ICP-MS						
16	ICP-MS	Rh	ORS	He	NA	NA	66
17	ICP-MS				NA		
18	ICP-MS	Sc	UC	He	1	1	66
19	ICP-MS	Rh	ORS	He	1.25	10	64
20	ICP-MS/MS						
21	ICP-OES-AV	Sc	NA	NA	1	NA	213.857 nm
22	ICP-MS	72 Ge	ORS	He	1	NA	66

END OF REPORT