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Proficiency Test Final Report AQA 26-08 Trace Elements and Solids in Potable Water

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EXECUTIVE SUMMARY

This report presents the results of the proficiency testing study AQA 26-08 Trace Elements and Solids in Potable Water. The study focused on the measurement of total Al, As, B, Ba, Be, Bi, Cd, Co, Cr, Cs, Cu, Fe, Hg, La, Mn, Mo, Na, Ni, P, Pb, Sb, Se, Sn, Tl, U, V, and Zn. Participant were also asked to report total dissolved solids (TDS), total suspended solids (TSS), total solids (TS) and turbidity.

The sample set consisted of three potable 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 potable water;

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

Of 527 scored results, 501 (95%) returned an acceptable score of $|z| \leq 2.0$.

Of 527 scored results, 472 (90%) returned an acceptable score of $|E_n| < 1.0$.

38 tests were scored in this proficiency study, and Laboratories 6 and 16 returned acceptable z-scores for all these analytes.

Laboratories 6, 16, and 19 received the highest number of acceptable E_n-scores,36

ii. evaluate the laboratories' methods used in the determination of inorganic analytes in potable water;

Rounding results and reporting results with an insufficient number of significant figures was the main cause of laboratories' poor performance in this study. According to the 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 the measurement of analytes at parts-per-billion (ppb) level. Laboratories using this technique should consider reviewing their method detection limit and increase the reporting level accordingly if required.

iii. evaluate participants' within laboratory repeatability-precision;

Sample S2 was prepared by further fortifying Sample S1 with all analytes of interest except Se. Selenium concentration was expected to be the same in both study samples. With the exception of one laboratory, participants reported comparable Se concentrations and associated measurement uncertainties for the two water samples.

iv. assess participants' ability to determine whether potable water samples comply with the Australian Drinking Water Guidelines;

The results reported by most laboratories correctly assessed sample compliance against the ADWG. However, for several analytes, the results reported by some laboratories, when considered together with their associated measurement uncertainties, would have led to an inconclusive compliance assessment despite the assigned value indicating either compliance or non-compliance.

v. compare the performance of participant laboratories with their past performance;

Over the last 10 years, participants performance remained the same regardless of the matrix and analyte level with an average of acceptable z-scores at 93% and of E_n-scores at 86%.

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

531 out of 540 numerical results were reported with an expanded measurement uncertainty. The magnitude of these expanded uncertainties was within the range 0.8% to 150% of the reported value.

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

vii. produce materials that can be used in method validation and as control samples.

The test samples from the present study are homogeneous and well characterised and can be used for method development and quality control. Surplus samples are available for sale.

TABLE OF CONTENTS

1 INTRODUCTION 1
1.1 NMIA Proficiency Testing Program 1
1.2 Study Aims 1
1.3 Study Conduct 1
2 STUDY INFORMATION 2
2.1 Selection of Matrices and Inorganic Analytes 2
2.2 Participation 2
2.3 Test Material Specification 2
2.4 Laboratory Code 2
2.5 Sample Preparation, Analysis and Homogeneity Testing 2
2.6 Stability of Analytes 2
2.7 Sample Storage, Dispatch and Receipt 2
2.8 Instructions to Participants 2
2.9 Interim Report and Preliminary Report 3
3 PARTICIPANT LABORATORY INFORMATION 4
3.1 Test Method Summaries 4
3.2 Additional Information 5
3.3 Basis of Participants' Measurement Uncertainty Evaluations 5
3.4 Participant Comments on this PT Study or Suggestions for Future Studies 7
4 PRESENTATION OF RESULTS AND STATISTICAL ANALYSIS 8
4.1 Results Summary 8
4.4 Robust Average and Robust Between-Laboratory Coefficient of Variation 8
5 TABLES AND FIGURES 10
6 DISCUSSION OF RESULTS 92
6.1 Assigned Value 92
6.2 Measurement Uncertainty Reported by Participants 92
6.3 z-Score 93
6.4 E_n-score 95
6.5 Participants' Results and Analytical Methods 102
6.6 Participants' Within – Laboratory Repeatability 108
6.7 Fitness for Purpose of Participants' Results 109
6.8 Reference Materials and Certified Reference Materials 114
6.9 Comparison with Previous NMIA Proficiency Tests of Metals in Water 116
7 REFERENCES 117
APPENDIX 1 – SAMPLE PREPARATION, ANALYSIS AND HOMOGENEITY TESTING 118
Sample Preparation 118
Sample Analysis and Homogeneity Testing 118
APPENDIX 2 – ASSIGNED VALUE, Z-SCORE AND E_N SCORE CALCULATION 119
APPENDIX 3 - USING PT DATA FOR UNCERTAINTY EVALUATION 120
APPENDIX 4 - ACRONYMS AND ABBREVIATIONS 122
APPENDIX 5 - INSTRUMENT DETAILS 123

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 26-08 is the 37th 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 potable water;
- evaluate the laboratories' methods used in the determination of inorganic analytes in potable water;
- evaluate participants' within laboratory repeatability-precision;
- assess participants' ability to determine whether potable water samples comply with the Australian Drinking Water Guidelines (ADWG);
- 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 measurement 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 Study Protocol for Proficiency Testing.[2] The statistical methods used are described in the NMIA Chemical Proficiency Testing Statistical Manual.[3] These documents have been prepared with reference to ISO/IEC 17043[1] and The International Harmonized Protocol for Proficiency Testing of Analytical Chemistry Laboratories.[4]

NMIA is accredited by National Association of Testing Authorities, Australia (NATA) to ISO/IEC 17043 as a provider of proficiency testing schemes. This study falls within the scope of NMIA's accreditation (Accreditation No. 198; Site No. 14485).

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

2 STUDY INFORMATION

2.1 Selection of Matrices and Inorganic Analytes

The 41 tests in this study were selected from those for which a guideline value is published in the Australian Drinking Water Guidelines[5] 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:	7 April 2026
Samples dispatched:	4 May 2026
Results due:	22 May 2026
Interim report issued	25 May 2026
Preliminary report issued:	27 May 2026

2.3 Test Material Specification

Three samples were provided for analysis:

Samples S1 and **S2** were 100 mL of potable water preserved with 2% HNO_3 and 0.01% HCl (v/w); and

Sample S3 was 750 mL of potable 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, with the exception of turbidity in Sample S3. 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 the samples in this study. Stability studies conducted for similar previous studies of metals in water found no significant changes.

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 4 May 2026.

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 routine test method.
- If samples cannot be analysed on the day of receipt, please store Samples S1 and S2 refrigerated, and S3 at room temperature
- Participants are asked to report results in units of mg/L, except for turbidity (NTU) for:

SAMPLE S1 100 mL potable water		**SAMPLE S2 100 mL potable water**		**SAMPLE S3 750 mL potable water**	
Test TOTAL	**Estimated Value[#] mg/L**	**Test TOTAL**	**Estimated Value[#] mg/L**	**Test**	**Estimated Value[#] mg/L**
As	0.0005-0.02	Al	0.005-0.2	TDS*	50-2000
Ba	0.005-0.2	As	0.005-0.2	TSS**	5-200
Be	0.0005-0.02	B	0.005-0.2	TS**	50-2000
Bi	0.0005-0.02	Be	0.005-0.2	Turbidity (NTU)	NA
Cd	0.0005-0.02	Bi	0.0005-0.02		
Cr	0.0005-0.02	Cd	0.0005-0.02		
Cu	0.05-2	Co	0.0005-0.02		
Fe	0.05-2	Cr	0.005-0.2		
Hg	0.00005-0.002	Cs	0.0005-0.02		
Mo	0.0005-0.02	Fe	0.05-2		
Ni	0.0005-0.02	Hg	0.0005-0.02		
Pb	0.0005-0.02	La	0.0005-0.02		
Sb	0.0005-0.02	Mn	0.005-0.02		
Se	0.0005-0.02	Na	5-200		
Sn	0.0005-0.02	P	0.05-2		
Tl	0.0005-0.02	Pb	0.0005-0.02		
U	0.005-0.2	Se	0.0005-0.02		
V	0.0005-0.02	Zn	0.05-2		
Zn	0.005-0.2				

[#]Please note these are real samples and the given values are estimates. * Dried at 180 ± 5°C. **Dried at 103-105°C. NA = Not Available.

- Report results using the electronic results sheet emailed to you. Report any listed analyte not tested as NT.
- 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 ± 0.51 µg/L).
- Please send us the requested details regarding the test method and the basis of your measurement uncertainty evaluation.
- Please return the completed results sheet by 22 May 2026.

2.9 Interim Report and Preliminary Report

An interim report was emailed to participants on 25 May 2026.
A preliminary report was issued on 27 May 2026. This report included: a summary of the results reported by laboratories, assigned values, performance coefficient of variations, z-scores and E_n-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 total 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. Some responses may be modified so the participant cannot be identified.

Table 1 Methodology for Total Elements

Lab. Code	Method Reference	Sample Mass (mL)	Temp. (°C)	Time (min)	Vol. HNO_3 (mL)	Vol. HCl (mL)
3*	APHA Method 3030 E, APHA 3125 B, US EPA Method 245.7 (Hg)	10	95	50	0.5	
6	USEPA 3005 DIGEST	10	95	120	0.5	
7	In House Method	25	96	180	0.25	0.125
9*	US EPA 3005A	10	95	120	0.2	0.5
10	In House Method					
11	US EPA METHOD 3010	20	95-105	60	0.5	0.5
12	No Sample Digestion					
13	In house Method					
14	APHA 3125 , EPA 200.8	5	95	120	2	1
15 (S1)	In-house method		120	240		
15 (S2)	No Sample Digestion					
16	Inhouse, with reference to USEPA 6010,6020	14	95	90	0.28	0.42
17	USEPA SW846 - 6020	N/A	N/A	N/A		
19		30	100	90	2	
22		20	95	120	1	0.5

*Additional Information in Table 3.

Table 2 Method References for Solids and Turbidity

Lab. Code	TDS Method Reference (e.g. APHA)	TSS Method Reference	TS Method Reference	Turbidity Method Reference
1*	In-house method based on APHA 23rd Edition 2540 C	In-house method based on APHA 23rd Edition 2540 D	In-house method based on APHA 23rd Edition 2540 B	In-house method based on APHA 23rd Edition 2130 B
2*	2540 C APHA 23rd Edition 2017	2540 D APHA 23rd Edition 2017	2540 B APHA 23rd Edition 2017	NA
4	APHA 2540 C	APHA 2540 D	NA	APHA 2130B
5	APHA 2540C	APHA 2540D	NA	APHA 2130B
6	APHA 2540C	APHA 2540D	APHA 2540B	APHA 2130B
7	APHA 2540 C	APHA 2540 D	APHA 2540 B	APHA 2130 B
8	APHA 2540 C	APHA 2540 D	APHA 2540 B	APHA 2130 B
9*	APHA 2540C	APHA 2540D	APHA 2540B	APHA 2130B
10	In House Method	In House Method	In House Method	In House Method
11	In-house method	In-house method	In-house method	In-house method
12	APHA 2540 C	NT	APHA 2540B	APHA - Section 2130 Turbidity – Nephelometric Method
13	APHA 2540C	GFC equiv. filter - APHA 2540-D		APHA 2130
14	APHA 2540	APHA 2540	NA	APHA 2130-Turbidity
15	In-house method	In-house method	Calculation of TDS + TSS	In-house method
16	APHA 2540C	APHA 2540 D & E	APHA 2540B	APHA 2130B

Lab. Code	TDS Method Reference (e.g. APHA)	TSS Method Reference	TS Method Reference	Turbidity Method Reference
19*	APHA	APHA	APHA	APHA
20	2540C	2540D	NT	NT
21	in-house method based on APHA 2540	APHA 2540	APHA 2540	APHA 2130B
22	In House Method	In House Method		In House Method

*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
1	S3 Methodology: The sample had particles that settle quickly, therefore the turbidity reading was calculated from the average of 3 highest readings
2	S3 Methodology: Our default detection limits for TDS = 20mg/L, TSS = 5mg/L and TS = 20mg/L
3	Total Elements Methodology: Digestion for Hg only: Sample Volume 2 mL, Regent 8 mL H2O, 1.5mL of 33% HCl and 0.2 mL 0.1N Potassium Bromide/potassium bromate solution
9	Accredited for Solids and Turbidity. Currently being assessed for accreditation for metals.
19	S3 Methodology: TDS was calculated as the difference between TS and TSS

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 evaluations of the method and laboratory bias Coverage factor not reported	Duplicate Analysis	Recoveries of SS	NATA General Accreditation Guidance, Estimating and Reporting MU
2	Coverage factor not reported			
3	Standard deviation of replicate analyses multiplied by 2 or 3 Coverage factor not reported	Standard deviation from PT studies only		Eurachem/CITAC Guide
		Control Samples - SS Duplicate Analysis Instrument Calibration	Instrument Calibration Recoveries of SS	
4	Bottom Up (ISO/GUM, fish bone/ cause and effect diagram) Coverage factor not reported	Control Samples - CRM Duplicate Analysis Instrument Calibration	Instrument Calibration	ISO/GUM
5	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Control Samples - CRM Duplicate Analysis Instrument Calibration	CRM Instrument Calibration	ISO/GUM
6	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

Lab. Code	Approach to Evaluating MU	Information Sources for MU Evaluation[a]		Guide Document for Evaluating MU
		Precision	Method Bias	
7	Standard deviation of replicate analyses multiplied by 2 or 3 Coverage factor not reported	Control Samples - SS Duplicate Analysis	CRM Recoveries of SS	NATA General Accreditation, Guidance, Estimating and Reporting MU (Replace TN 33)
8	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Control Samples Duplicate Analysis	CRM	ISO/GUM
9	Top Down - precision and evaluations of the method and laboratory bias k = 2	Control Samples - CRM Duplicate Analysis Instrument Calibration	CRM Instrument Calibration	Eurachem/CITAC Guide
10	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Control Samples - CRM	CRM Instrument Calibration	ISO/GUM
11	Coverage factor not reported	Control samples - CRM Instrument Calibration	CRM	ASTM E2554-13
12	Top Down - precision and evaluations of the method and laboratory bias k = 2	Control Samples - CRM Duplicate Analysis	CRM Recoveries of SS	
13	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Control Samples - CRM Duplicate Analysis	CRM	Nordtest Report TR537
14	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Control Samples - CRM Duplicate Analysis Instrument Calibration	CRM Instrument Calibration Laboratory Bias from PT Studies Recoveries of SS	Eurachem/CITAC Guide
15	Standard deviation of replicate analyses multiplied by 2 or 3 k = 2	Control Samples - CRM Duplicate Analysis	CRM	Eurachem/CITAC Guide
16	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
17	Top Down - precision and evaluations of the method and laboratory bias k = 2	Control Samples - SS Duplicate Analysis Instrument Calibration	Instrument Calibration Recoveries of SS	ISO/GUM
18	Top Down - precision and evaluations of the method and laboratory bias k = 2	Control Samples - CRM	CRM	

Lab. Code	Approach to Evaluating MU	Information Sources for MU Evaluation[a]		Guide Document for Evaluating MU
		Precision	Method Bias	
19	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Control Samples - Reference Material / Ex PT Sample Duplicate Analysis Instrument Calibration		Nordtest Report TR537
20	Standard deviation of replicate analyses multiplied by 2 or 3 k = 2	Duplicate Analysis	Instrument Calibration	Nordtest Report TR537
21	Top Down - precision and evaluations of the method and laboratory bias k = 2	Control Samples - Reference Material / Ex PT Sample Duplicate Analysis	CRM	ASTM E2554-13
22	Top Down - precision and evaluations of the method and laboratory bias k = 2	Control Samples - SS Duplicate Analysis Instrument Calibration	CRM Instrument Calibration Recoveries of SS	Eurachem/CITAC Guide

[a]CRM = Certified Reference Material, SS = Spiked samples, PT = Proficiency Testing

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.

Participants' comments are reproduced in Table 5.

Table 5 Participants' Comments

Lab. Code	Participant's Comments	Study Coordinator's Response
12	Insufficient sample for total suspended solids - volume required is 1000 mL	Sufficient headspace must be maintained in the 1 L container to allow proper mixing before subsampling. A second unit can be purchased on request.
22	NR for TS due to not enough volume to perform test.	

4 PRESENTATION OF RESULTS AND STATISTICAL ANALYSIS

4.1 Results Summary

Participant results are listed in Tables 6 to 46 with results summary statistics, along with other estimates of analyte concentration. Bar charts of results and performance scores are presented in Figures 2 to 42. An example chart with an interpretation guide is shown in Figure 1.

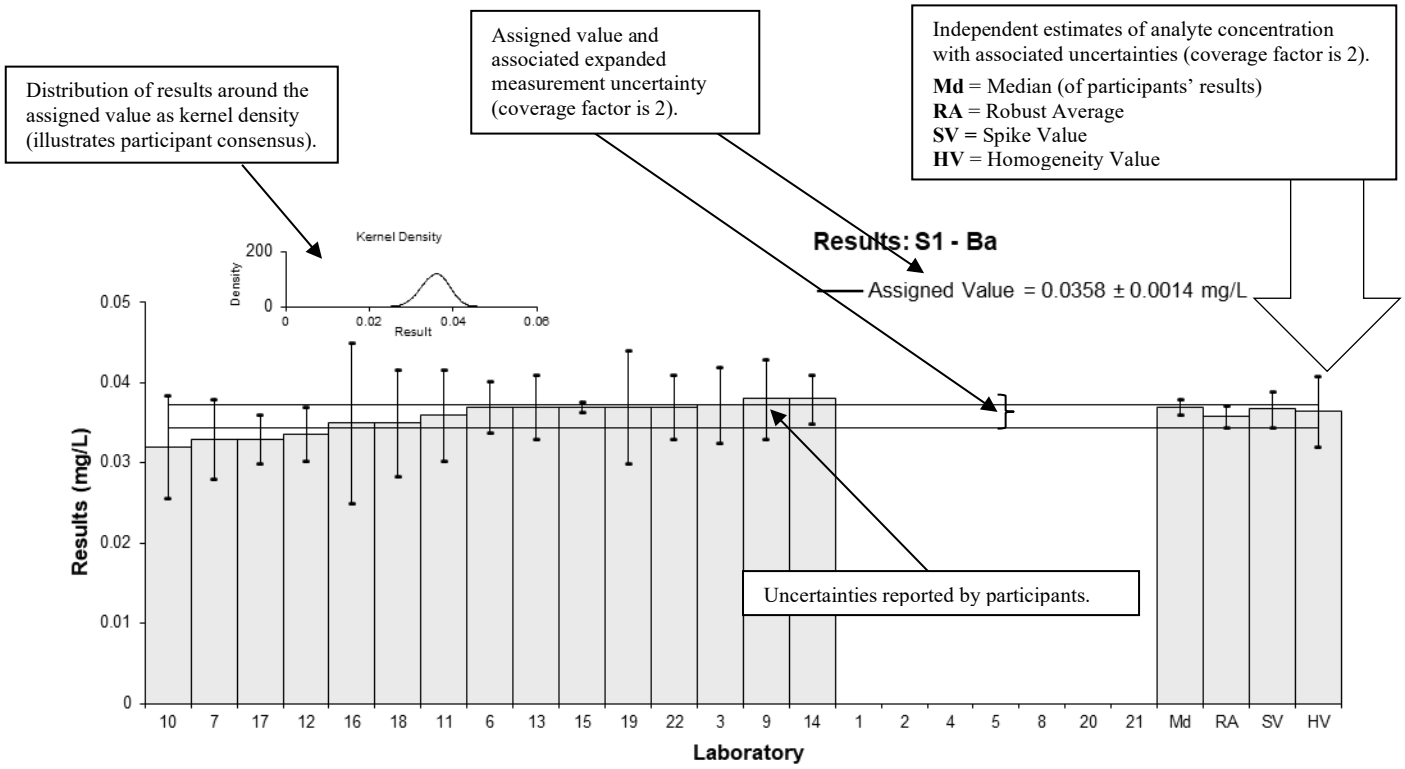


Figure 1 Guide to Presentation of Results

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 or characteristic of a proficiency testing 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 tables 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.

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

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 participant's result, a z-score is calculated according to Equation 2 below:

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

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:

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

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 ISO/IEC Standard 17025[8] 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 6

Sample Details

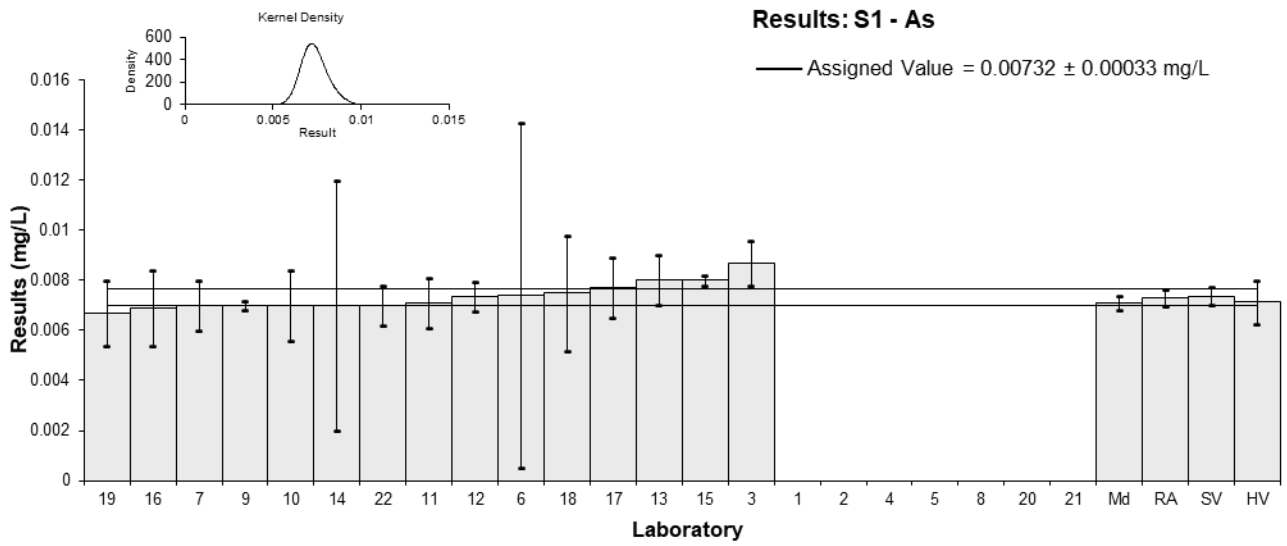
Sample No.	S1
Matrix	Potable Water
Analyte	As
Unit	mg/L

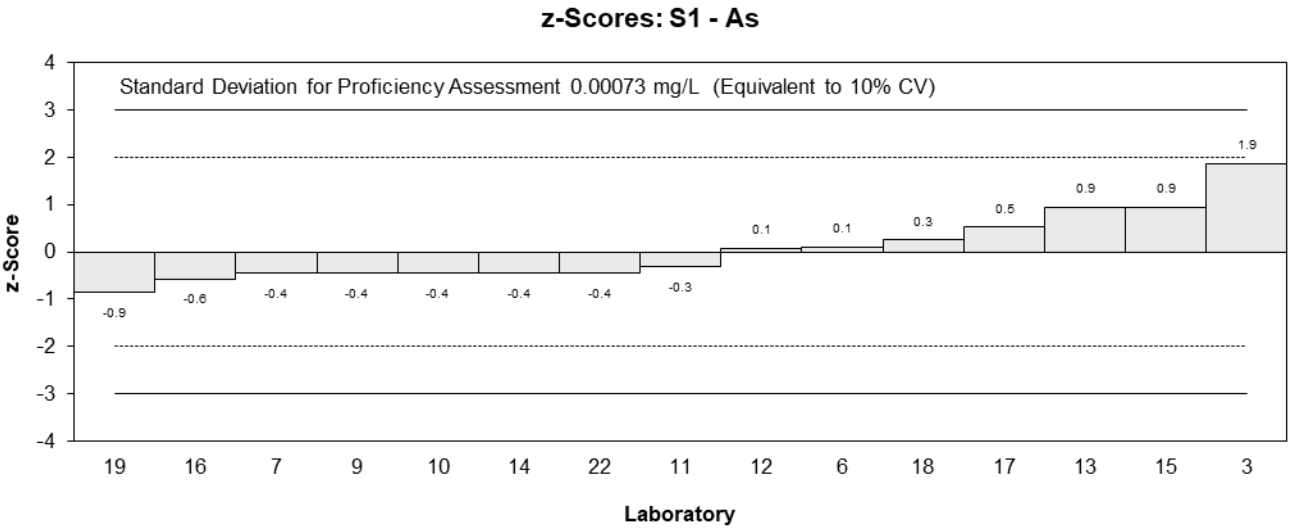
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.00869	0.00090	1.87	1.43
4	NT	NT		
5	NT	NT		
6	0.0074	0.0069	0.11	0.01
7	0.007	0.001	-0.44	-0.30
8	NT	NT		
9	0.007	0.0002	-0.44	-0.83
10	0.0070	0.0014	-0.44	-0.22
11	0.0071	0.0010	-0.30	-0.21
12	0.00737	0.00060	0.07	0.07
13	0.008	0.001	0.93	0.65
14	0.007	0.005	-0.44	-0.06
15	0.0080	0.0002	0.93	1.76
16	0.0069	0.0015	-0.57	-0.27
17	0.0077	0.0012	0.52	0.31
18	0.0075	0.0023	0.25	0.08
19	0.0067	0.0013	-0.85	-0.46
20	NT	NT		
21	NT	NT		
22	0.007	0.0008	-0.44	-0.37

Statistics

Assigned Value	0.00732	0.00033
Spike Value	0.00736	0.00036
Homogeneity Value	0.00713	0.00086
Robust Average	0.00732	0.00033
Median	0.00710	0.00026
Mean	0.00736	
N	15	
Max	0.00869	
Min	0.0067	
Robust SD	0.00051	
Robust CV	6.9%	


Results: S1 - As
Assigned Value = 0.00732 ± 0.00033 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
19 16 7 9 10 14 22 11 12 6 18 17 13 15 3 1 2 4 5 8 20 21 Md RA SV HV


z-Scores: S1 - As
Standard Deviation for Proficiency Assessment 0.00073 mg/L (Equivalent to 10% CV)
z-Score
-0.9 -0.6 -0.4 -0.4 -0.4 -0.4 -0.4 -0.3 0.1 0.1 0.3 0.5 0.9 0.9 1.9
Laboratory
19 16 7 9 10 14 22 11 12 6 18 17 13 15 3

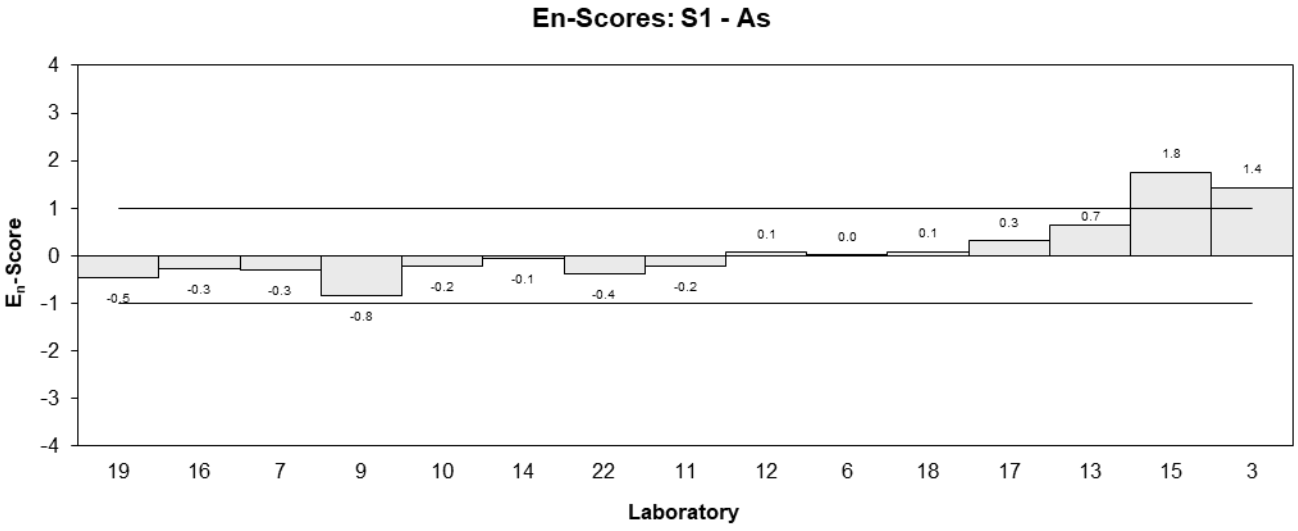

En-Scores: S1 - As
En-Score
-0.5 -0.3 -0.3 -0.8 -0.2 -0.1 -0.4 -0.2 0.1 0.0 0.1 0.3 0.7 1.8 1.4
Laboratory
19 16 7 9 10 14 22 11 12 6 18 17 13 15 3

Figure 2

Table 7

Sample Details

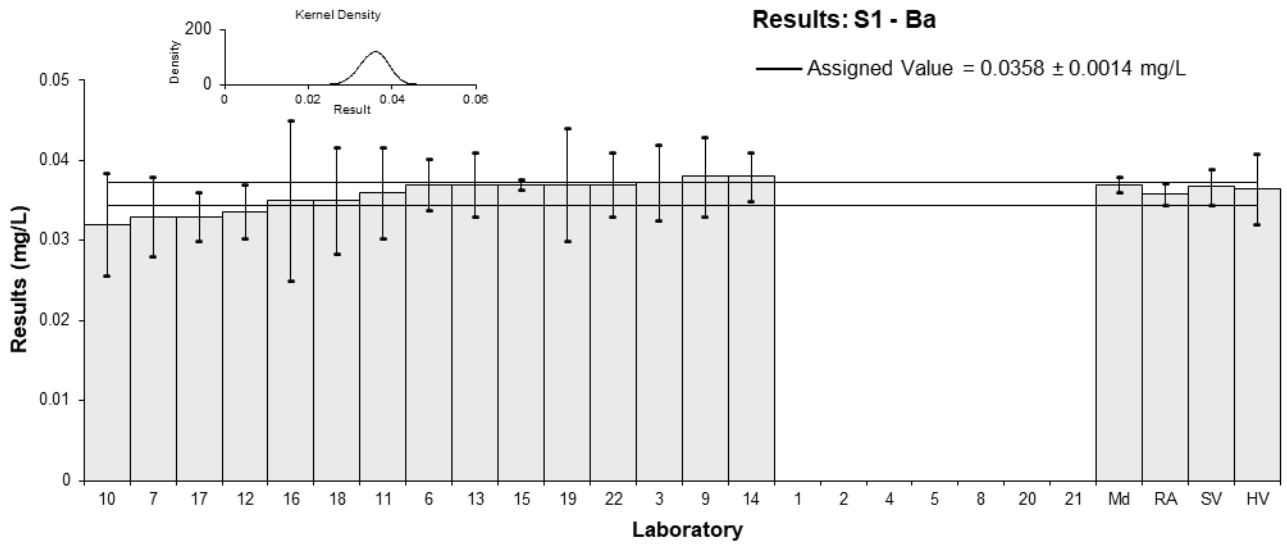
Sample No.	S1
Matrix	Potable Water
Analyte	Ba
Unit	mg/L

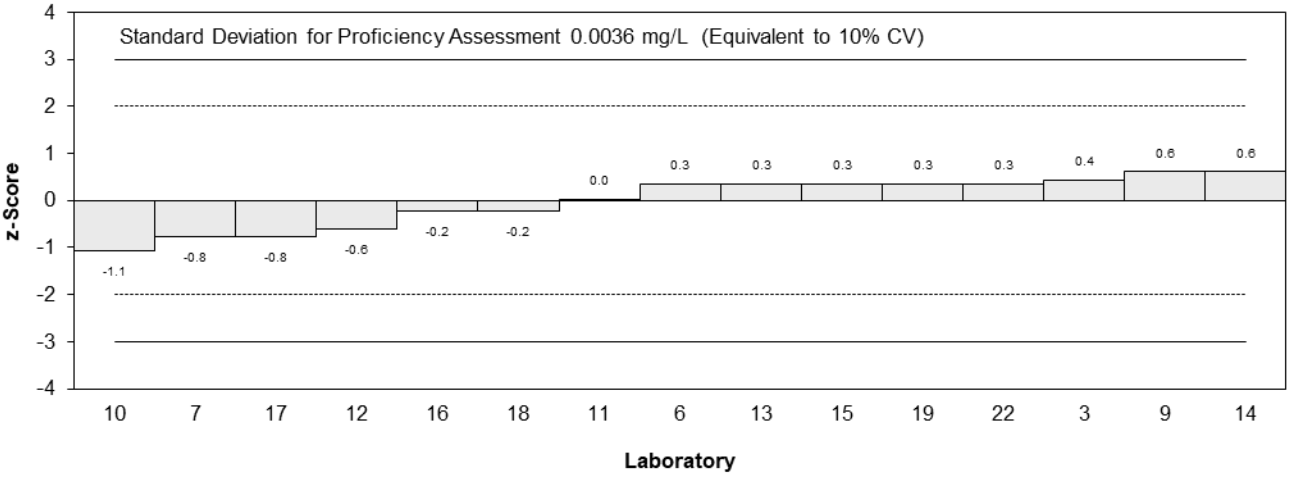
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.0373	0.0047	0.42	0.31
4	NT	NT		
5	NT	NT		
6	0.037	0.0032	0.34	0.34
7	0.033	0.005	-0.78	-0.54
8	NT	NT		
9	0.038	0.005	0.61	0.42
10	0.032	0.0064	-1.06	-0.58
11	0.0359	0.0057	0.03	0.02
12	0.0336	0.0034	-0.61	-0.60
13	0.037	0.004	0.34	0.28
14	0.038	0.003	0.61	0.66
15	0.037	0.0007	0.34	0.77
16	0.035	0.010	-0.22	-0.08
17	0.033	0.003	-0.78	-0.85
18	0.035	0.0067	-0.22	-0.12
19	0.037	0.007	0.34	0.17
20	NT	NT		
21	NT	NT		
22	0.037	0.004	0.34	0.28

Statistics

Assigned Value	0.0358	0.0014
Spike Value	0.0367	0.0022
Homogeneity Value	0.0364	0.0044
Robust Average	0.0358	0.0014
Median	0.0370	0.0010
Mean	0.0357	
N	15	
Max	0.038	
Min	0.032	
Robust SD	0.0022	
Robust CV	6.1%	


Kernel Density
Density
Result
Results: S1 - Ba
Assigned Value = 0.0358 ± 0.0014 mg/L
Results (mg/L)
Laboratory
10 7 17 12 16 18 11 6 13 15 19 22 3 9 14 1 2 4 5 8 20 21 Md RA SV HV


z-Scores: S1 - Ba
Standard Deviation for Proficiency Assessment 0.0036 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
10 7 17 12 16 18 11 6 13 15 19 22 3 9 14

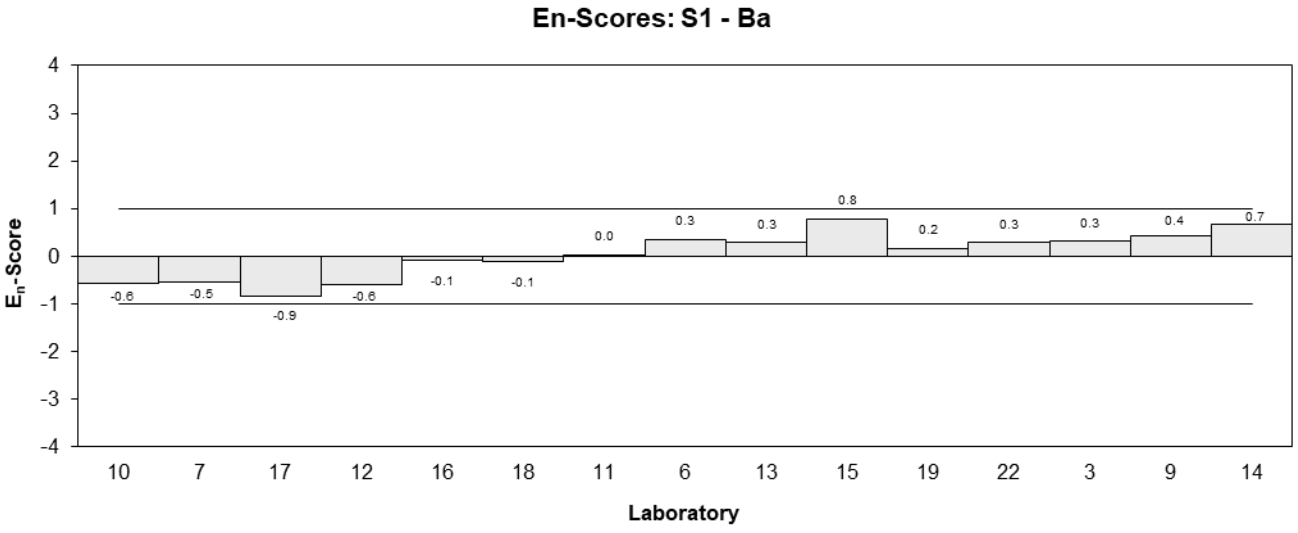

En-Scores: S1 - Ba
En-Score
Laboratory
10 7 17 12 16 18 11 6 13 15 19 22 3 9 14

Figure 3

Table 8

Sample Details

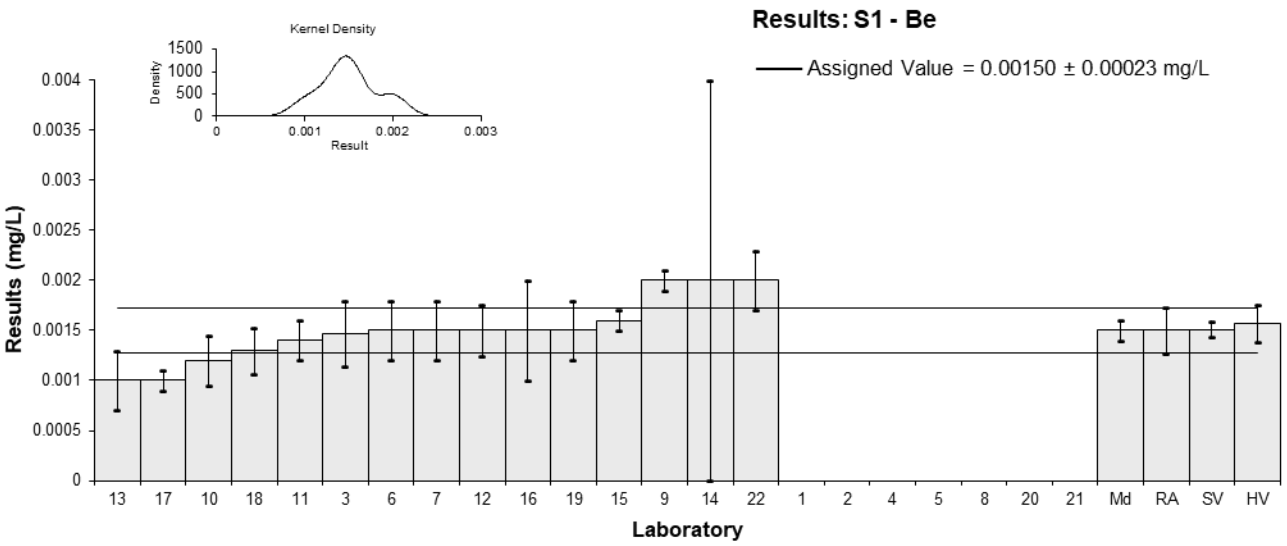
Sample No.	S1
Matrix	Potable Water
Analyte	Be
Unit	mg/L

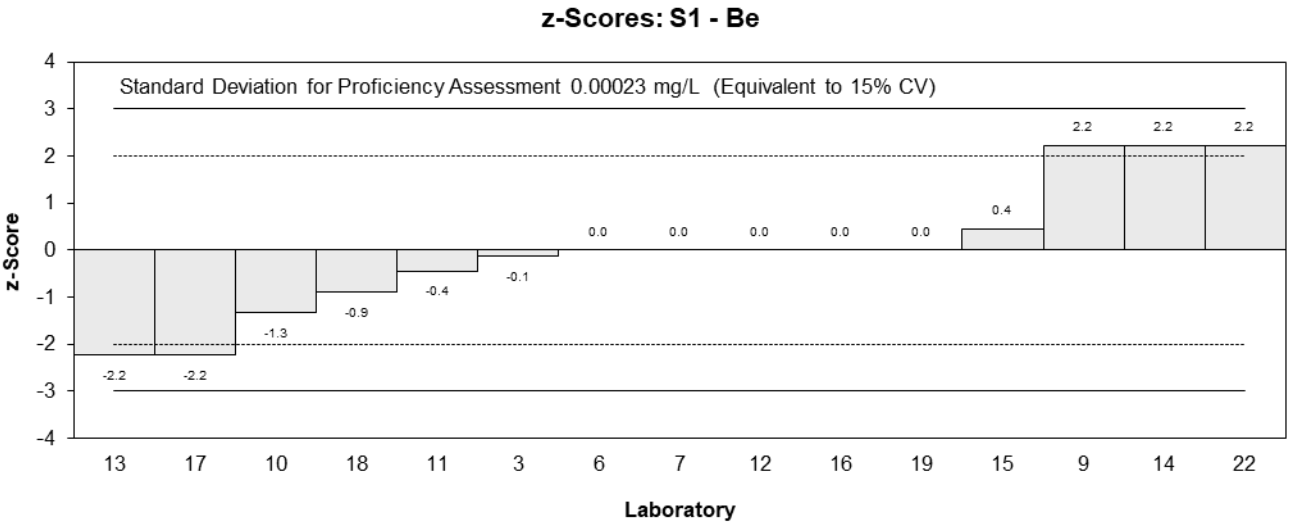
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.00147	0.00033	-0.13	-0.07
4	NT	NT		
5	NT	NT		
6	0.0015	0.0003	0.00	0.00
7	0.0015	0.0003	0.00	0.00
8	NT	NT		
9	0.002	0.0001	2.22	1.99
10	0.0012	0.00025	-1.33	-0.88
11	0.0014	0.0002	-0.44	-0.33
12	0.00150	0.00026	0.00	0.00
13	0.001	0.0003	-2.22	-1.32
14	0.002	0.002	2.22	0.25
15	0.0016	0.0001	0.44	0.40
16	0.0015	0.0005	0.00	0.00
17	0.001	0.0001	-2.22	-1.99
18	0.0013	0.00023	-0.89	-0.61
19	0.0015	0.0003	0.00	0.00
20	NT	NT		
21	NT	NT		
22	0.002	0.0003	2.22	1.32

Statistics

Assigned Value	0.00150	0.00023
Spike Value	0.00151	0.00008
Homogeneity Value	0.00157	0.00019
Robust Average	0.00150	0.00023
Median	0.00150	0.00010
Mean	0.00150	
N	15	
Max	0.002	
Min	0.001	
Robust SD	0.00036	
Robust CV	24%	


Results: S1 - Be
Assigned Value = 0.00150 ± 0.00023 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
13 17 10 18 11 3 6 7 12 16 19 15 9 14 22 1 2 4 5 8 20 21 Md RA SV HV


z-Scores: S1 - Be
Standard Deviation for Proficiency Assessment 0.00023 mg/L (Equivalent to 15% CV)
z-Score
Laboratory
13 17 10 18 11 3 6 7 12 16 19 15 9 14 22
-2.2 -2.2 -1.3 -0.9 -0.4 -0.1 0.0 0.0 0.0 0.0 0.0 0.4 2.2 2.2 2.2

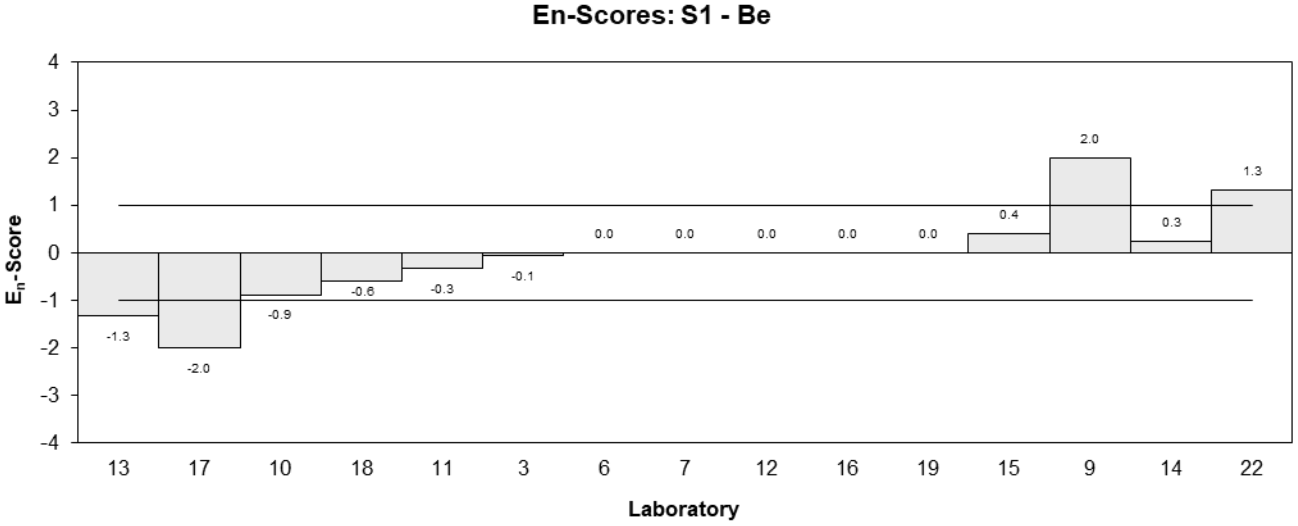

En-Scores: S1 - Be
En-Score
Laboratory
13 17 10 18 11 3 6 7 12 16 19 15 9 14 22
-1.3 -2.0 -0.9 -0.6 -0.3 -0.1 0.0 0.0 0.0 0.0 0.0 0.4 2.0 0.3 1.3

Figure 4

Table 9

Sample Details

Sample No.	S1
Matrix	Potable Water
Analyte	Bi
Unit	mg/L

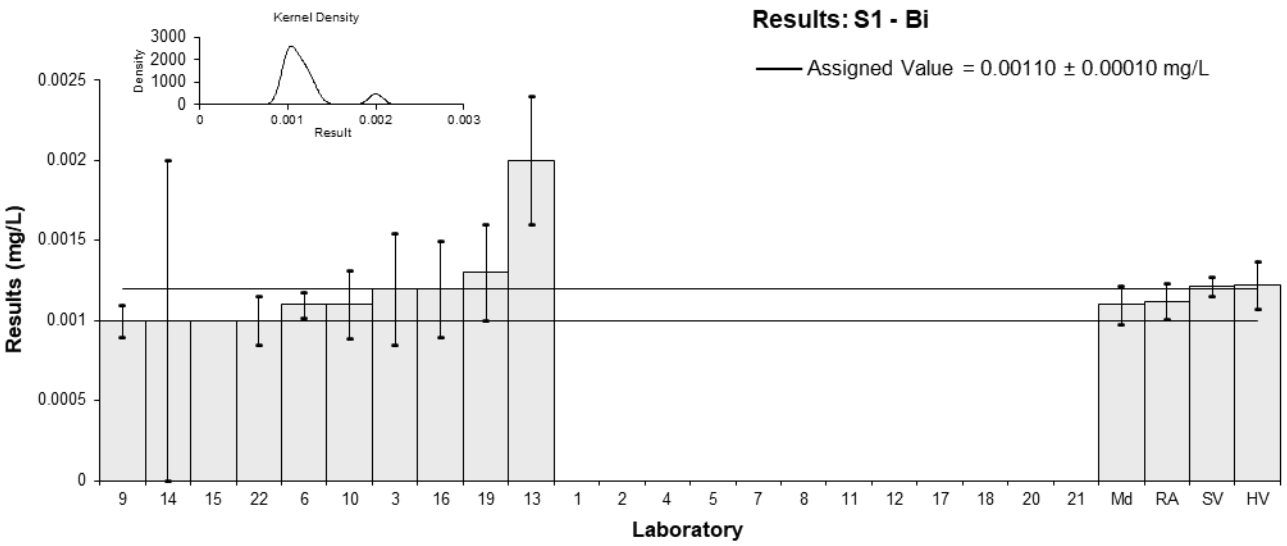
Participant Results

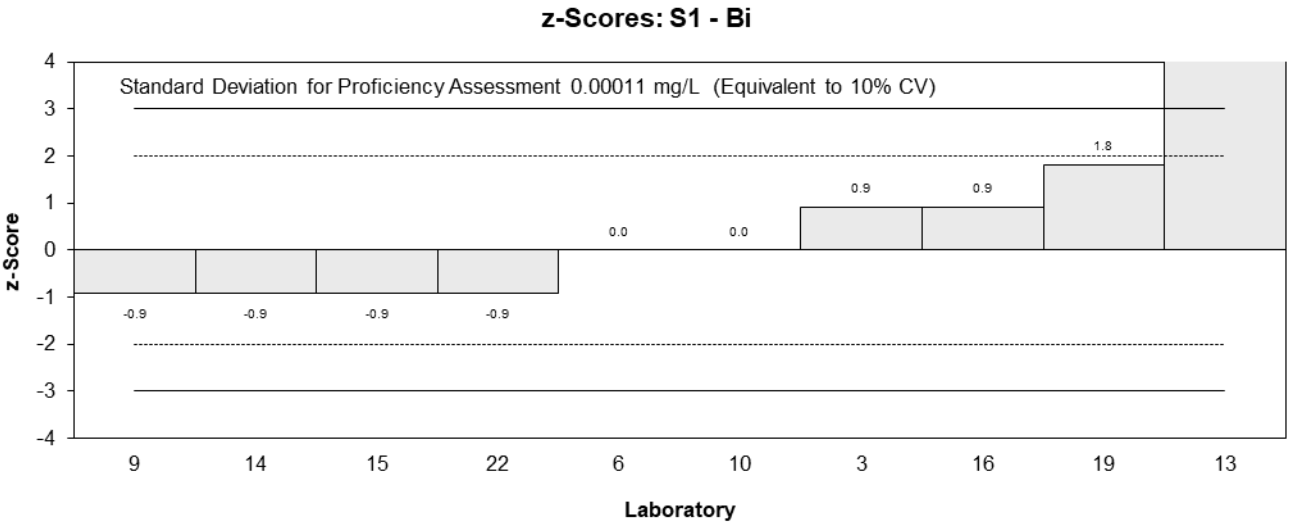
Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.00120	0.00035	0.91	0.27
4	NT	NT		
5	NT	NT		
6	0.0011	0.00008	0.00	0.00
7	NT	NT		
8	NT	NT		
9	0.001	0.0001	-0.91	-0.71
10	0.0011	0.00021	0.00	0.00
11	< 0.005	NR		
12	NT	NT		
13*	0.002	0.0004	8.18	2.18
14	0.001	0.001	-0.91	-0.10
15	0.0010	NR	-0.91	-1.00
16	0.0012	0.0003	0.91	0.32
17	<0.001	NR		
18	NT	NT		
19	0.0013	0.0003	1.82	0.63
20	NT	NT		
21	NT	NT		
22	0.001	0.00015	-0.91	-0.55

* Outlier, see Section 4.2

Statistics

Assigned Value	0.00110	0.00010
Spike Value	0.00121	0.00006
Homogeneity Value	0.00122	0.00015
Robust Average	0.00112	0.00011
Median	0.00110	0.00012
Mean	0.00119	
N	10	
Max	0.002	
Min	0.001	
Robust SD	0.00014	
Robust CV	13%	


Results: S1 - Bi
Assigned Value = 0.00110 ± 0.00010 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
9 14 15 22 6 10 3 16 19 13 1 2 4 5 7 8 11 12 17 18 20 21 Md RA SV HV


z-Scores: S1 - Bi
Standard Deviation for Proficiency Assessment 0.00011 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
9 14 15 22 6 10 3 16 19 13

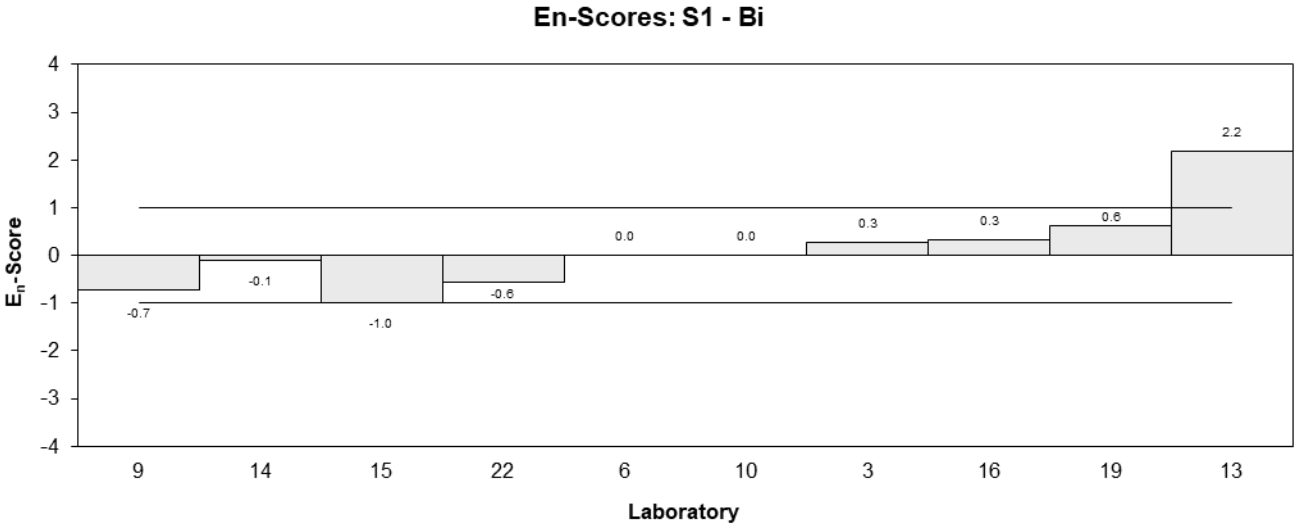

En-Scores: S1 - Bi
En-Score
Laboratory
9 14 15 22 6 10 3 16 19 13

Figure 5

Table 10

Sample Details

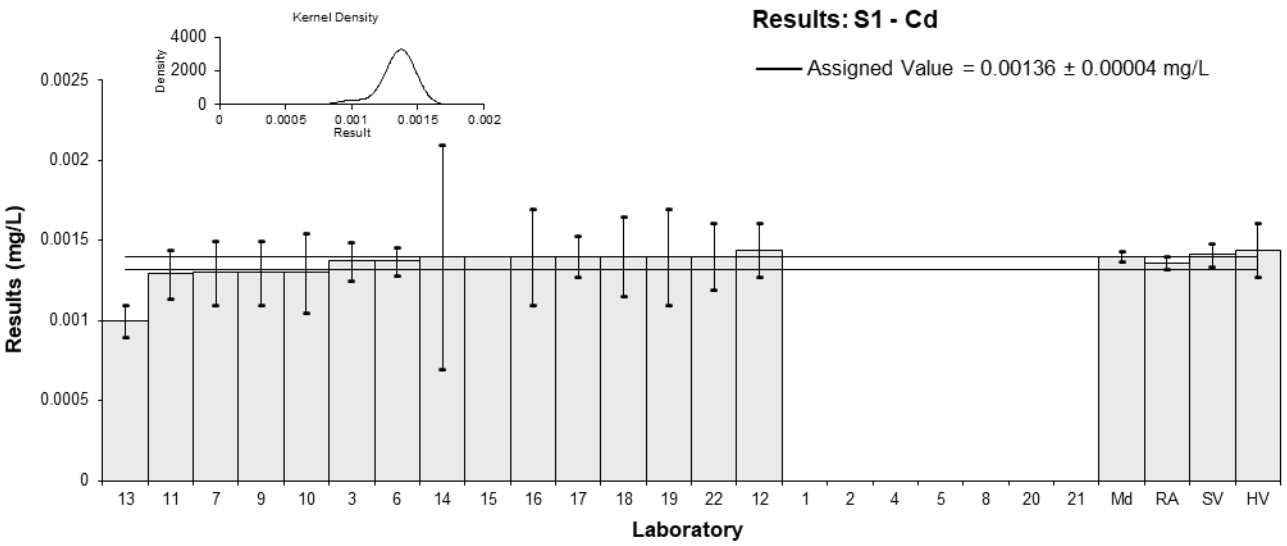
Sample No.	S1
Matrix	Potable Water
Analyte	Cd
Unit	mg/L

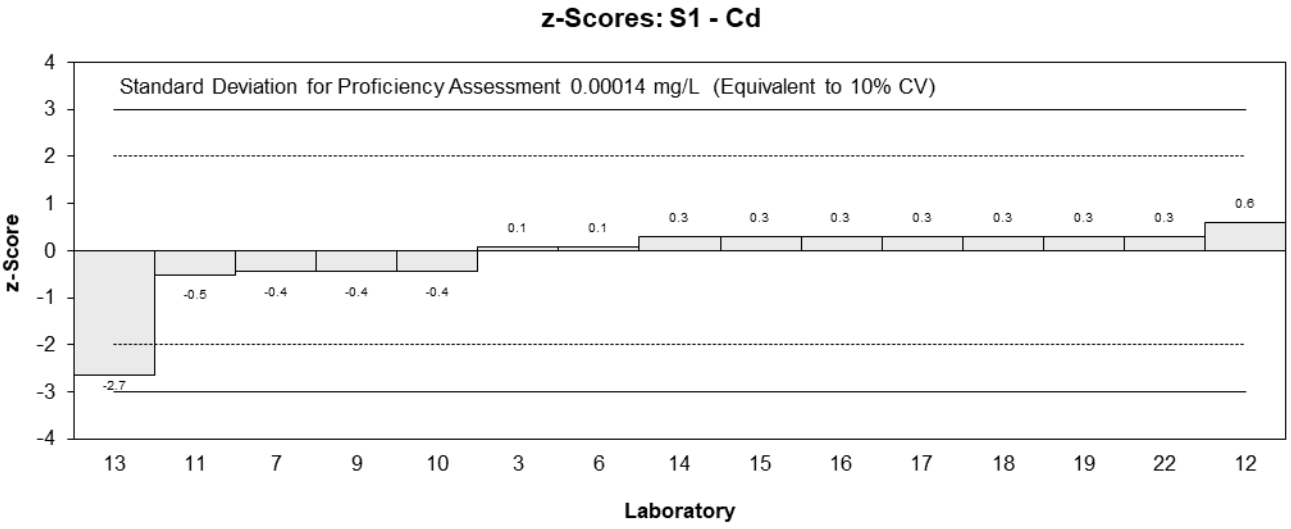
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.00137	0.00012	0.07	0.08
4	NT	NT		
5	NT	NT		
6	0.00137	0.00009	0.07	0.10
7	0.0013	0.0002	-0.44	-0.29
8	NT	NT		
9	0.0013	0.0002	-0.44	-0.29
10	0.0013	0.00025	-0.44	-0.24
11	0.00129	0.00015	-0.51	-0.45
12	0.00144	0.00017	0.59	0.46
13	0.001	0.0001	-2.65	-3.34
14	0.0014	0.0007	0.29	0.06
15	0.0014	NR	0.29	1.00
16	0.0014	0.0003	0.29	0.13
17	0.0014	0.00013	0.29	0.29
18	0.0014	0.00025	0.29	0.16
19	0.0014	0.0003	0.29	0.13
20	NT	NT		
21	NT	NT		
22	0.0014	0.00021	0.29	0.19

Statistics

Assigned Value	0.00136	0.00004
Spike Value	0.00141	0.00007
Homogeneity Value	0.00144	0.00017
Robust Average	0.00136	0.00004
Median	0.00140	0.00003
Mean	0.00134	
N	15	
Max	0.00144	
Min	0.001	
Robust SD	0.000062	
Robust CV	4.5%	


Kernel Density
Density
Result
Results: S1 - Cd
Assigned Value = 0.00136 ± 0.00004 mg/L
Results (mg/L)
Laboratory
13 11 7 9 10 3 6 14 15 16 17 18 19 22 12 1 2 4 5 8 20 21 Md RA SV HV


z-Scores: S1 - Cd
Standard Deviation for Proficiency Assessment 0.00014 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
13 11 7 9 10 3 6 14 15 16 17 18 19 22 12

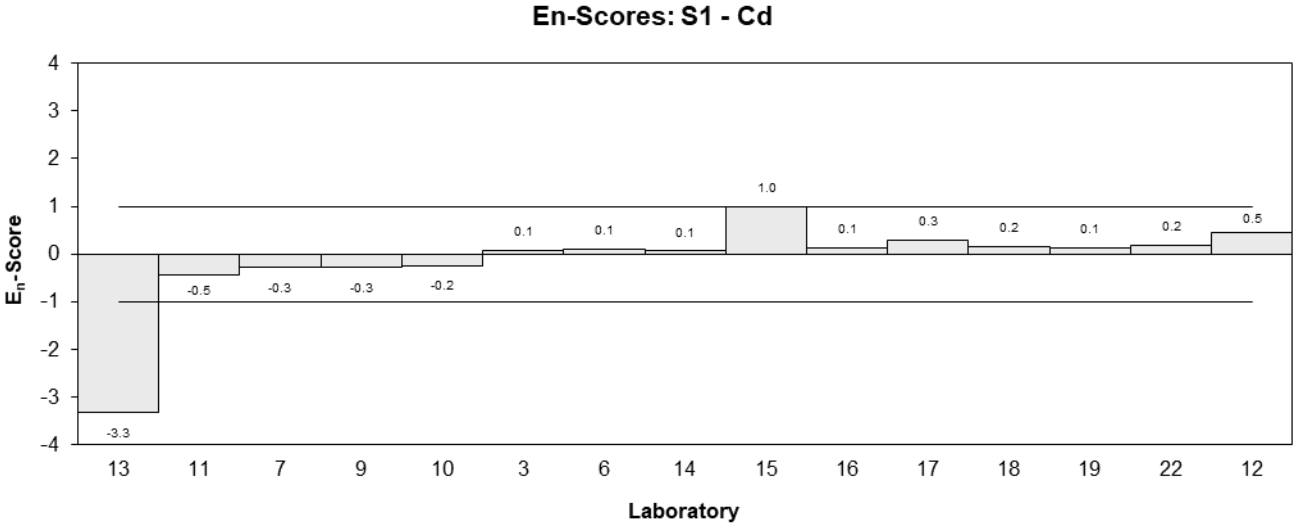

En-Scores: S1 - Cd
En-Score
Laboratory
13 11 7 9 10 3 6 14 15 16 17 18 19 22 12

Figure 6

Table 11

Sample Details

Sample No.	S1
Matrix	Potable Water
Analyte	Cr
Unit	mg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.00102	0.00037	-0.29	-0.08
4	NT	NT		
5	NT	NT		
6	0.0011	0.0002	0.48	0.24
7	0.001	0.0005	-0.48	-0.10
8	NT	NT		
9	0.001	0.0002	-0.48	-0.24
10	< 0.001	NR		
11	0.0012	0.0002	1.43	0.73
12	0.00104	0.00019	-0.10	-0.05
13	<0.001	NR		
14	<0.005	0.005		
15	0.0011	NR	0.48	1.00
16	0.0010	0.0003	-0.48	-0.16
17	0.0009	0.00009	-1.43	-1.46
18	0.0011	0.00024	0.48	0.20
19	0.0011	0.0003	0.48	0.16
20	NT	NT		
21	NT	NT		
22	0.001	0.0002	-0.48	-0.24

Statistics

Assigned Value	0.00105	0.00005
Spike Value	0.00100	0.00005
Homogeneity Value	0.00102	0.00012
Robust Average	0.00105	0.00005
Median	0.00103	0.00005
Mean	0.00105	
N	12	
Max	0.0012	
Min	0.0009	
Robust SD	0.000072	
Robust CV	6.9%	

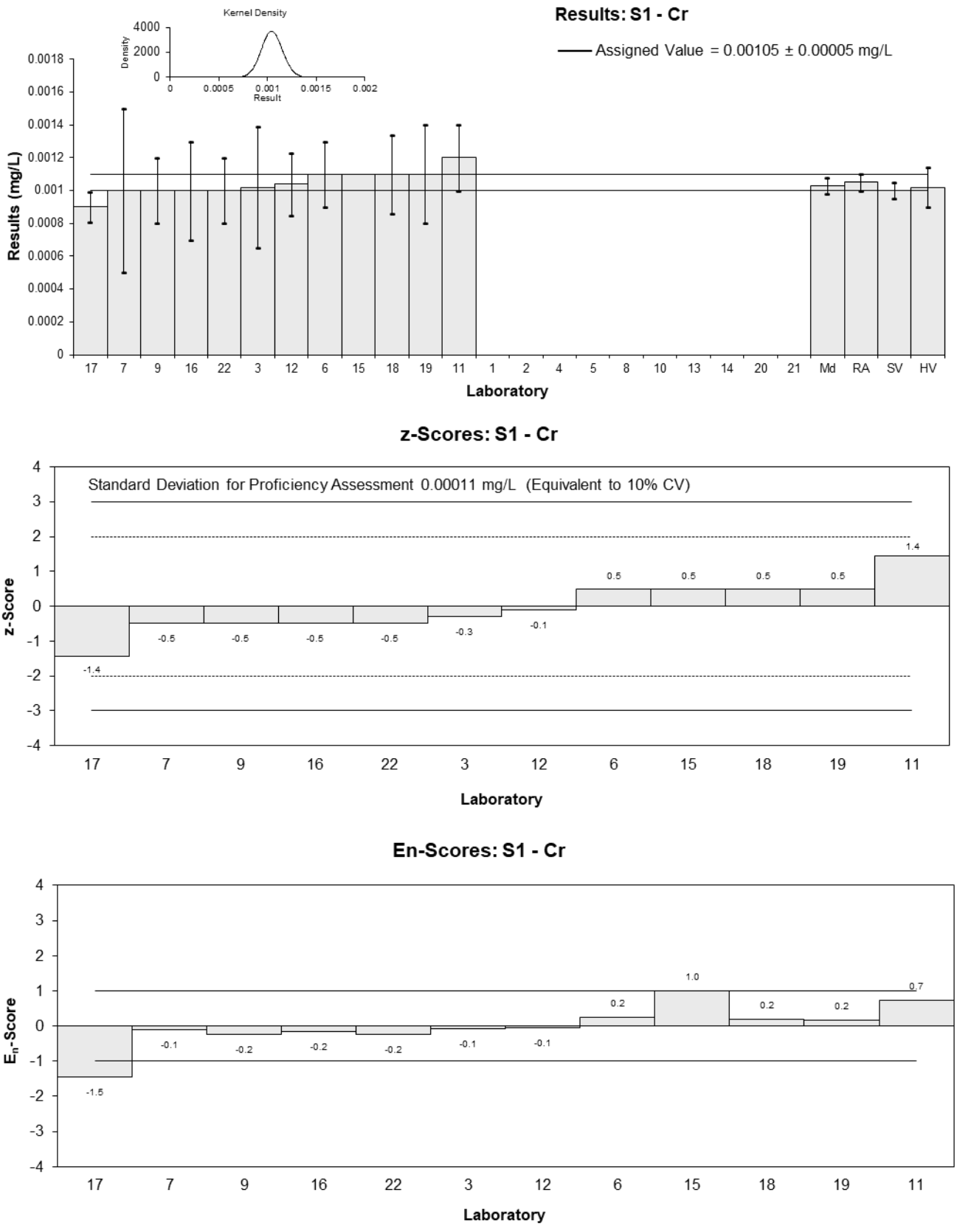

Results: S1 - Cr
Assigned Value = 0.00105 ± 0.00005 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
17 7 9 16 22 3 12 6 15 18 19 11 1 2 4 5 8 10 13 14 20 21 Md RA SV HV
z-Scores: S1 - Cr
Standard Deviation for Proficiency Assessment 0.00011 mg/L (Equivalent to 10% CV)
z-Score
-1.4 -0.5 -0.5 -0.5 -0.5 -0.3 -0.1 0.5 0.5 0.5 0.5 1.4
17 7 9 16 22 3 12 6 15 18 19 11
Laboratory
En-Scores: S1 - Cr
En-Score
-1.5 -0.1 -0.2 -0.2 -0.2 -0.1 -0.1 0.2 1.0 0.2 0.2 0.7
17 7 9 16 22 3 12 6 15 18 19 11
Laboratory

Figure 7

Table 12

Sample Details

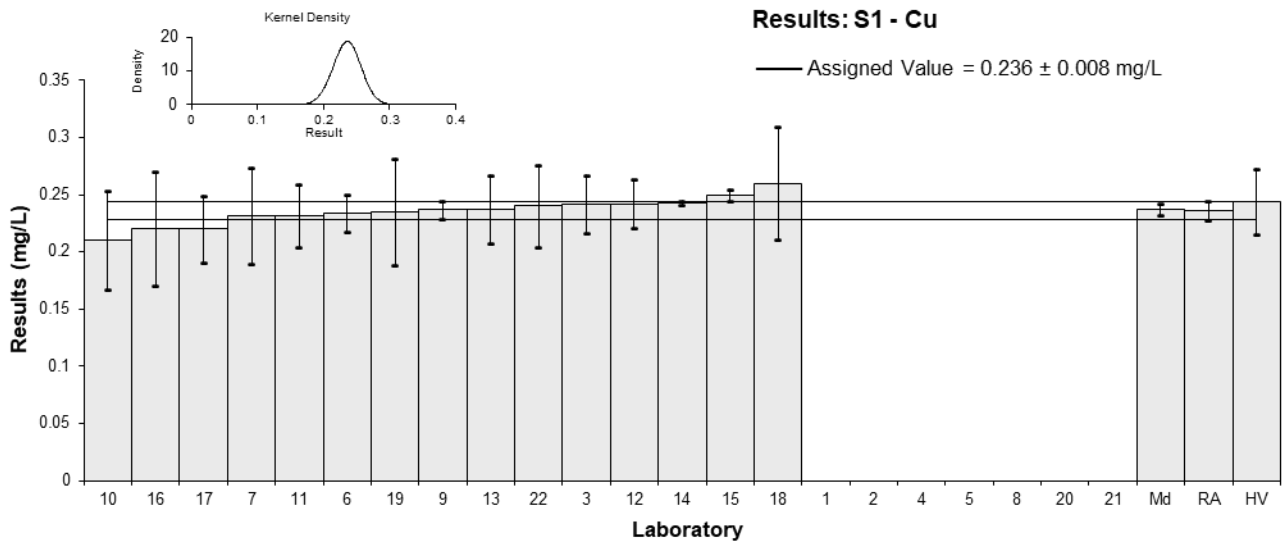
Sample No.	S1
Matrix	Potable Water
Analyte	Cu
Unit	mg/L

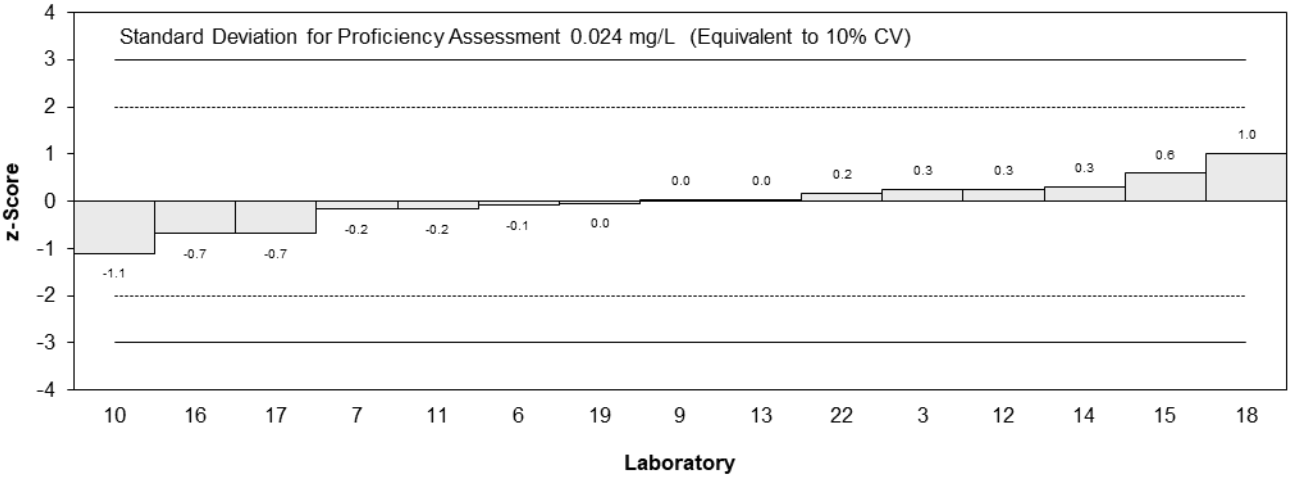
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.242	0.025	0.25	0.23
4	NT	NT		
5	NT	NT		
6	0.234	0.016	-0.08	-0.11
7	0.232	0.042	-0.17	-0.09
8	NT	NT		
9	0.237	0.008	0.04	0.09
10	0.21	0.043	-1.10	-0.59
11	0.2320	0.0275	-0.17	-0.14
12	0.242	0.021	0.25	0.27
13	0.237	0.03	0.04	0.03
14	0.243	0.002	0.30	0.85
15	0.25	0.005	0.59	1.48
16	0.22	0.05	-0.68	-0.32
17	0.22	0.029	-0.68	-0.53
18	0.26	0.049	1.02	0.48
19	0.235	0.047	-0.04	-0.02
20	NT	NT		
21	NT	NT		
22	0.24	0.036	0.17	0.11

Statistics

Assigned Value	0.236	0.008
Spike Value	Not Spiked	
Homogeneity Value	0.244	0.029
Robust Average	0.236	0.008
Median	0.237	0.005
Mean	0.236	
N	15	
Max	0.26	
Min	0.21	
Robust SD	0.012	
Robust CV	5%	


Kernel Density
Density
Result
Results: S1 - Cu
Assigned Value = 0.236 ± 0.008 mg/L
Results (mg/L)
Laboratory
10 16 17 7 11 6 19 9 13 22 3 12 14 15 18 1 2 4 5 8 20 21 Md RA HV


z-Scores: S1 - Cu
Standard Deviation for Proficiency Assessment 0.024 mg/L (Equivalent to 10% CV)
z-Score
-1.1 -0.7 -0.7 -0.2 -0.2 -0.1 0.0 0.0 0.0 0.2 0.3 0.3 0.3 0.6 1.0
Laboratory
10 16 17 7 11 6 19 9 13 22 3 12 14 15 18

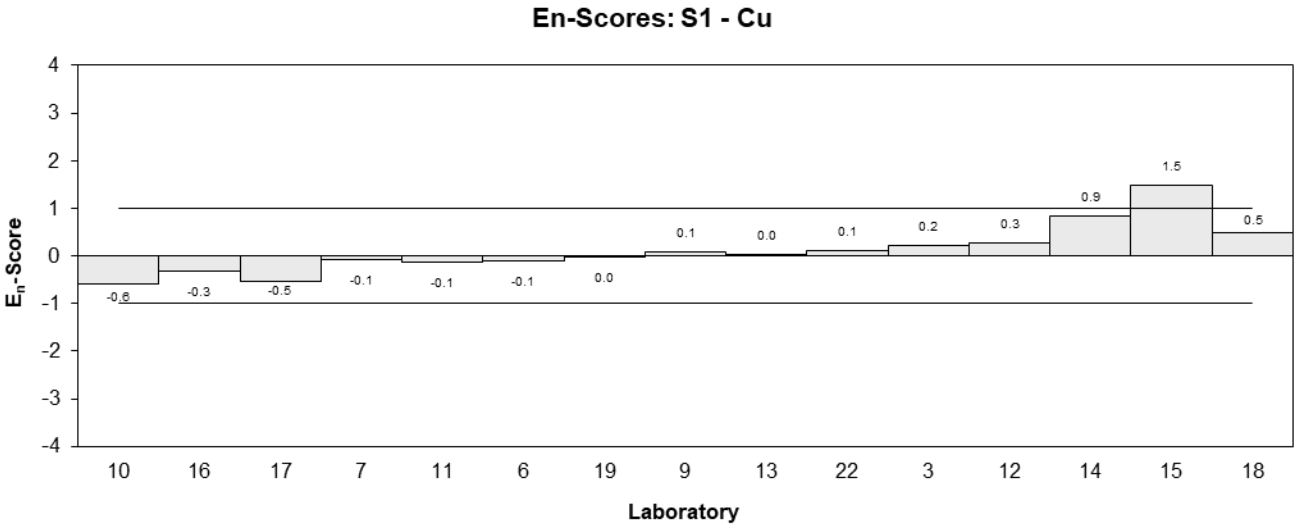

En-Scores: S1 - Cu
En-Score
-0.6 -0.3 -0.5 -0.1 -0.1 -0.1 0.0 0.1 0.0 0.1 0.2 0.3 0.9 1.5 0.5
Laboratory
10 16 17 7 11 6 19 9 13 22 3 12 14 15 18

Figure 8

Table 13

Sample Details

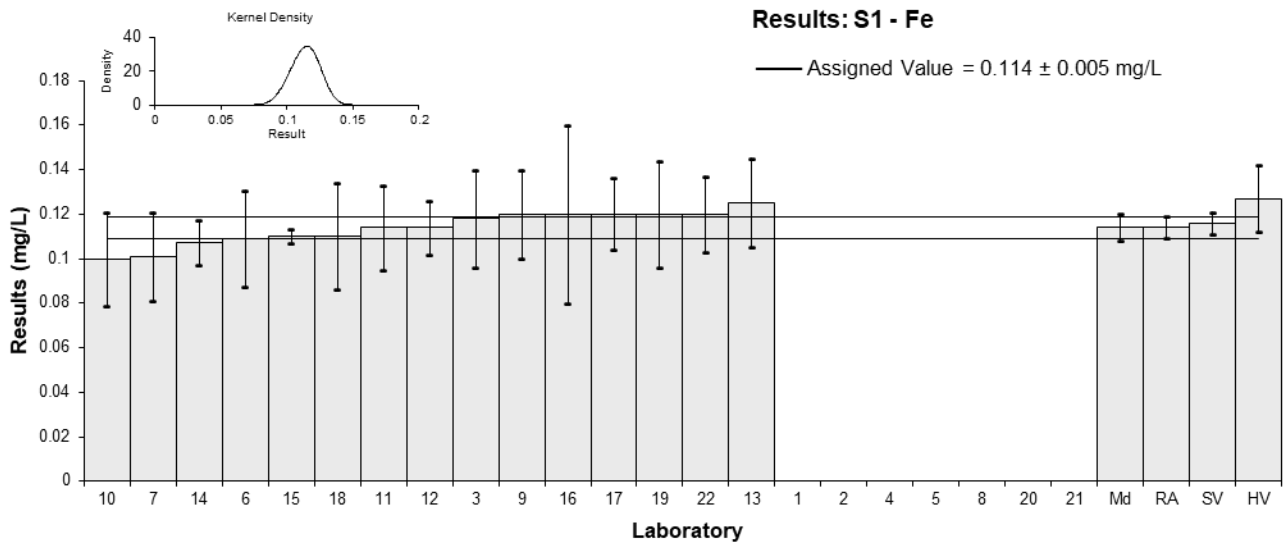
Sample No.	S1
Matrix	Potable Water
Analyte	Fe
Unit	mg/L

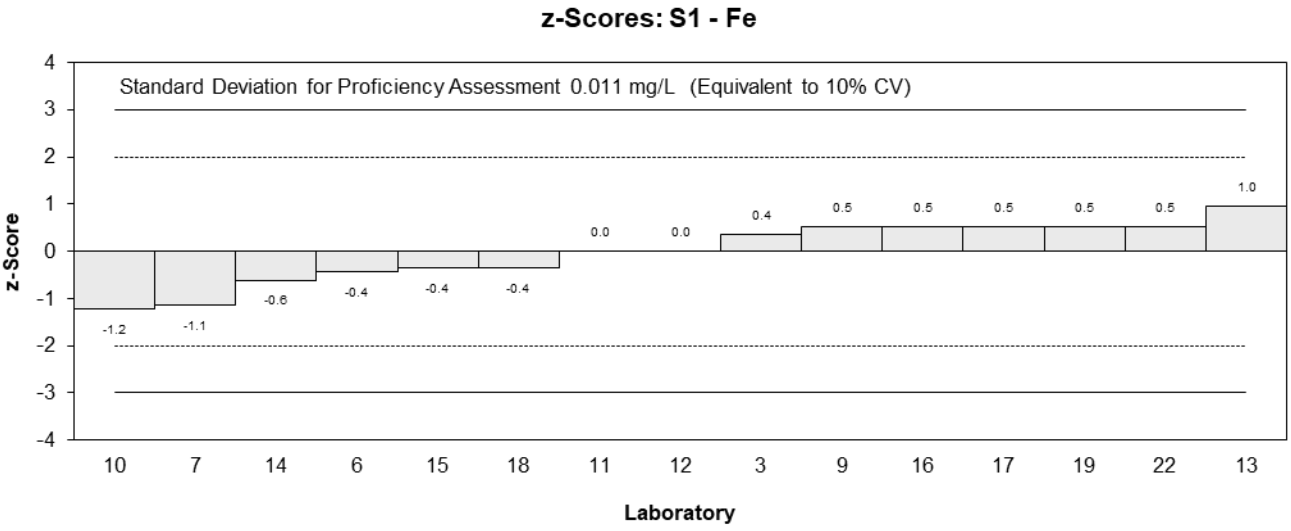
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.118	0.022	0.35	0.18
4	NT	NT		
5	NT	NT		
6	0.109	0.0218	-0.44	-0.22
7	0.101	0.02	-1.14	-0.63
8	NT	NT		
9	0.12	0.02	0.53	0.29
10	0.10	0.021	-1.23	-0.65
11	0.114	0.019	0.00	0.00
12	0.114	0.012	0.00	0.00
13	0.125	0.02	0.96	0.53
14	0.107	0.01	-0.61	-0.63
15	0.11	0.003	-0.35	-0.69
16	0.12	0.04	0.53	0.15
17	0.12	0.016	0.53	0.36
18	0.11	0.024	-0.35	-0.16
19	0.120	0.024	0.53	0.24
20	NT	NT		
21	NT	NT		
22	0.12	0.017	0.53	0.34

Statistics

Assigned Value	0.114	0.005
Spike Value	0.116	0.005
Homogeneity Value	0.127	0.015
Robust Average	0.114	0.005
Median	0.114	0.006
Mean	0.114	
N	15	
Max	0.125	
Min	0.10	
Robust SD	0.0081	
Robust CV	7.1%	


Results: S1 - Fe
Assigned Value = 0.114 ± 0.005 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
10 7 14 6 15 18 11 12 3 9 16 17 19 22 13 1 2 4 5 8 20 21 Md RA SV HV


z-Scores: S1 - Fe
Standard Deviation for Proficiency Assessment 0.011 mg/L (Equivalent to 10% CV)
z-Score
-1.2 -1.1 -0.6 -0.4 -0.4 -0.4 0.0 0.0 0.4 0.5 0.5 0.5 0.5 0.5 1.0
Laboratory
10 7 14 6 15 18 11 12 3 9 16 17 19 22 13

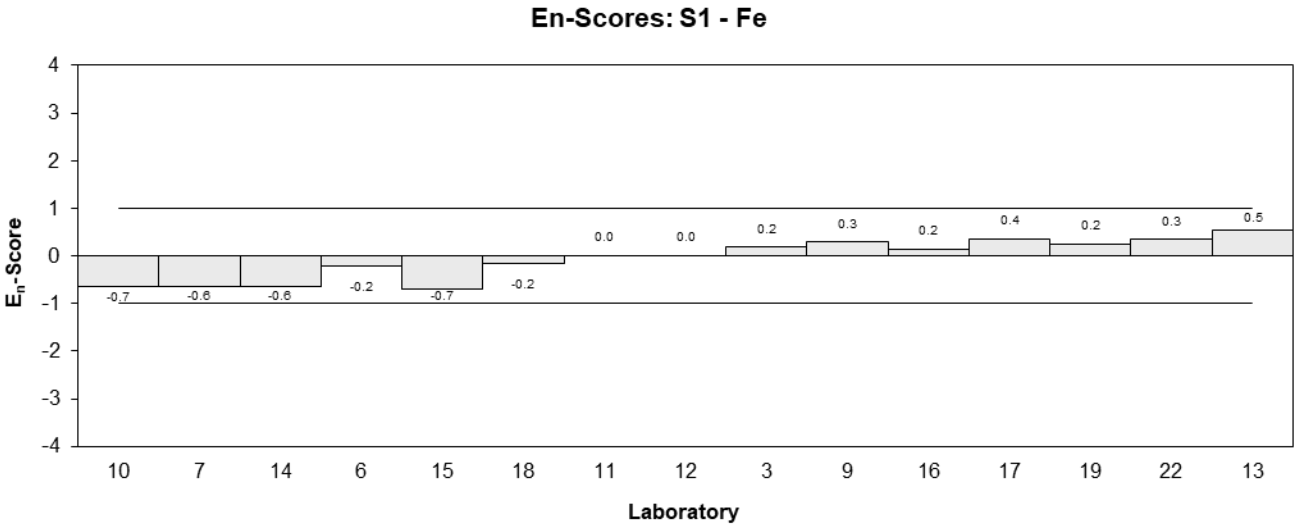

En-Scores: S1 - Fe
En-Score
-0.7 -0.6 -0.6 -0.2 -0.7 -0.2 0.0 0.0 0.2 0.3 0.2 0.4 0.2 0.3 0.5
Laboratory
10 7 14 6 15 18 11 12 3 9 16 17 19 22 13

Figure 9

Table 14

Sample Details

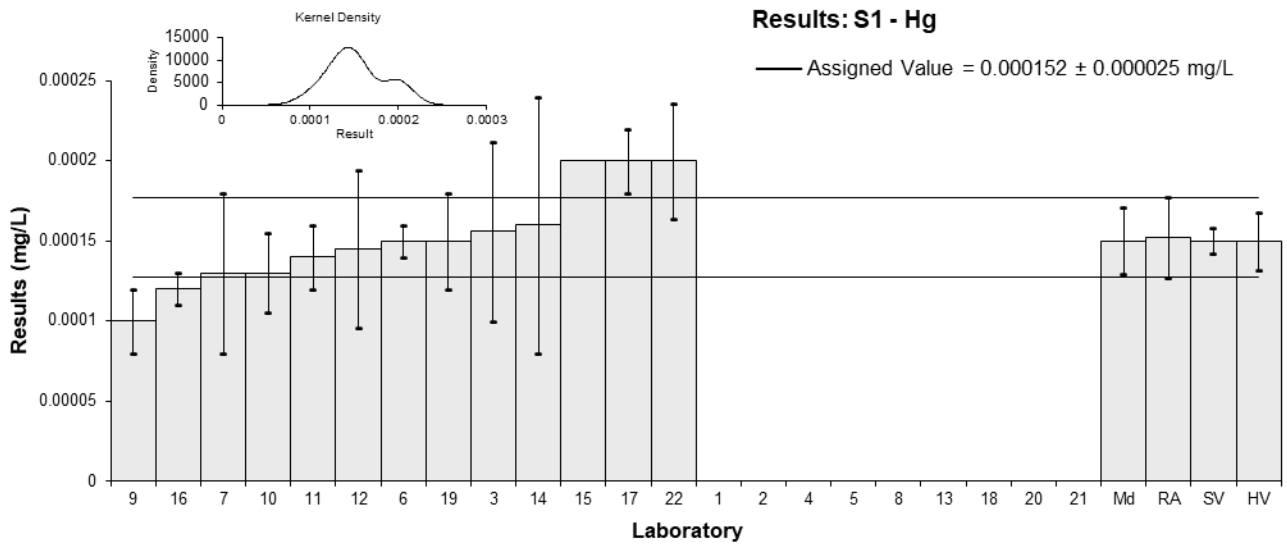
Sample No.	S1
Matrix	Potable Water
Analyte	Hg
Unit	mg/L

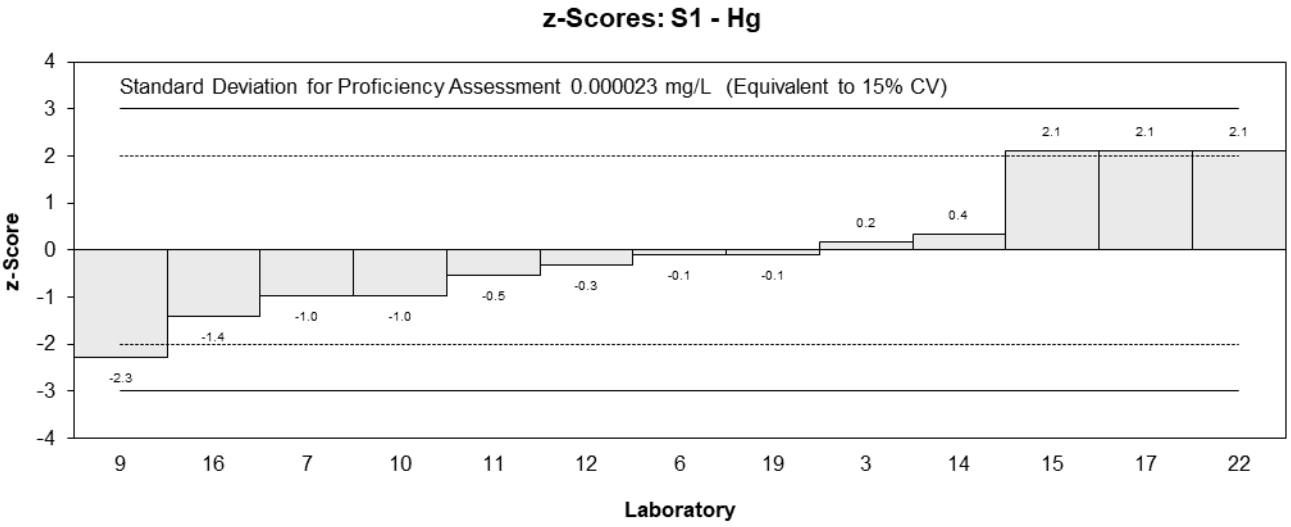
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.000156	0.000056	0.18	0.07
4	NT	NT		
5	NT	NT		
6	0.00015	0.00001	-0.09	-0.07
7	0.00013	0.00005	-0.96	-0.39
8	NT	NT		
9	0.0001	0.00002	-2.28	-1.62
10	0.00013	0.000025	-0.96	-0.62
11	0.00014	0.00002	-0.53	-0.37
12	0.000145	0.000049	-0.31	-0.13
13	<0.0005	NR		
14	0.00016	0.00008	0.35	0.10
15	0.0002	NR	2.11	1.92
16	0.00012	0.00001	-1.40	-1.19
17	0.0002	0.00002	2.11	1.50
18	NT	NT		
19	0.00015	0.00003	-0.09	-0.05
20	NT	NT		
21	NT	NT		
22	0.0002	0.000036	2.11	1.10

Statistics

Assigned Value	0.000152	0.000025
Spike Value	0.000150	0.000008
Homogeneity Value	0.000150	0.000018
Robust Average	0.000152	0.000025
Median	0.000150	0.000021
Mean	0.000152	
N	13	
Max	0.0002	
Min	0.0001	
Robust SD	0.000036	
Robust CV	23%	


Results: S1 - Hg
Assigned Value = 0.000152 ± 0.000025 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
9 16 7 10 11 12 6 19 3 14 15 17 22 1 2 4 5 8 13 18 20 21 Md RA SV HV


z-Scores: S1 - Hg
Standard Deviation for Proficiency Assessment 0.000023 mg/L (Equivalent to 15% CV)
z-Score
Laboratory
9 16 7 10 11 12 6 19 3 14 15 17 22
-2.3 -1.4 -1.0 -1.0 -0.5 -0.3 -0.1 -0.1 0.2 0.4 2.1 2.1 2.1

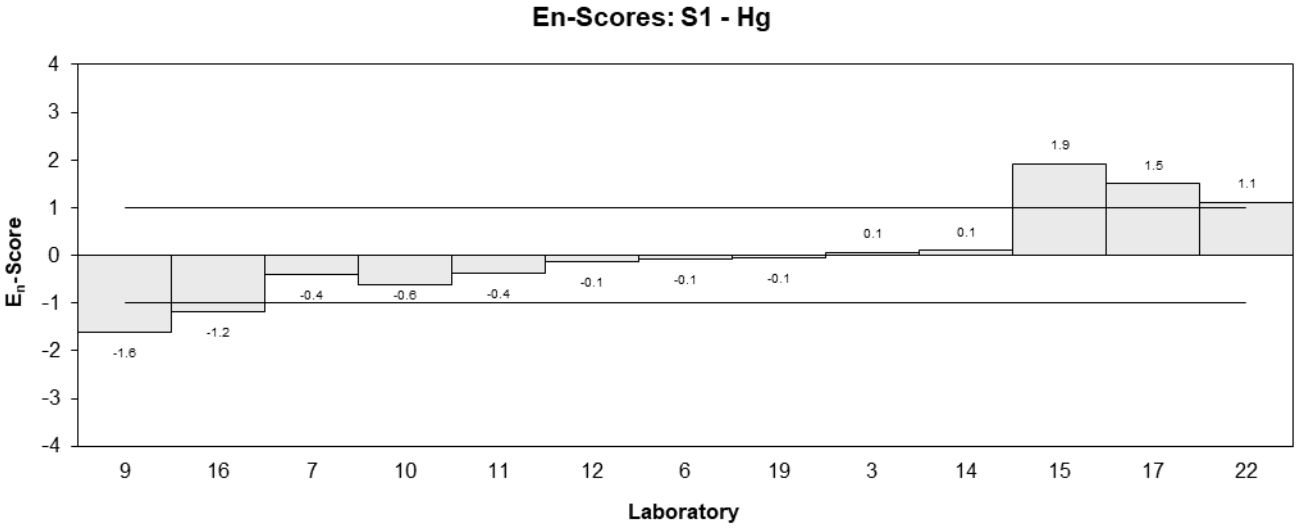

En-Scores: S1 - Hg
En-Score
Laboratory
9 16 7 10 11 12 6 19 3 14 15 17 22
-1.6 -1.2 -0.4 -0.6 -0.4 -0.1 -0.1 -0.1 0.1 0.1 1.9 1.5 1.1

Figure 10

Table 15

Sample Details

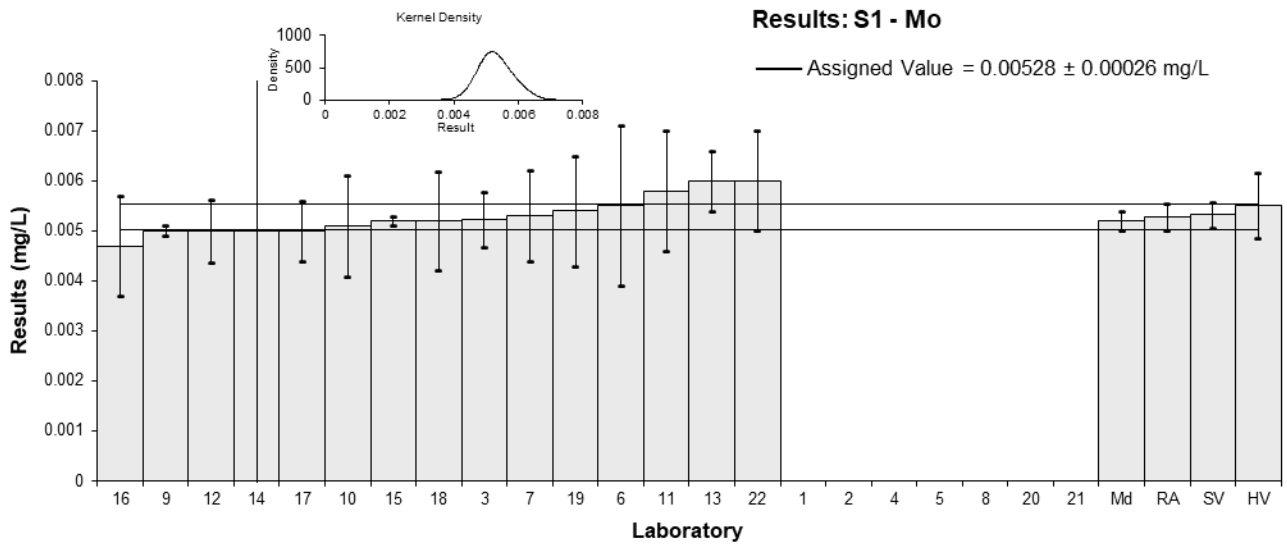
Sample No.	S1
Matrix	Potable Water
Analyte	Mo
Unit	mg/L

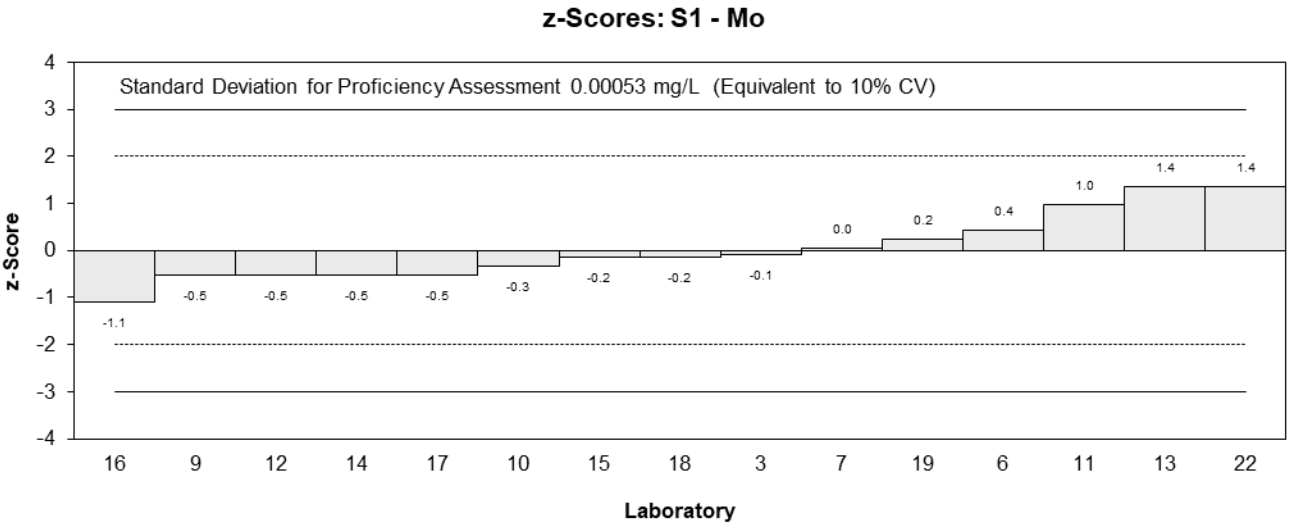
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.00523	0.00055	-0.09	-0.08
4	NT	NT		
5	NT	NT		
6	0.0055	0.0016	0.42	0.14
7	0.0053	0.0009	0.04	0.02
8	NT	NT		
9	0.005	0.0001	-0.53	-1.01
10	0.0051	0.001	-0.34	-0.17
11	0.0058	0.0012	0.98	0.42
12	0.00500	0.00063	-0.53	-0.41
13	0.006	0.0006	1.36	1.10
14	0.005	0.006	-0.53	-0.05
15	0.0052	0.0001	-0.15	-0.29
16	0.0047	0.0010	-1.10	-0.56
17	0.005	0.0006	-0.53	-0.43
18	0.0052	0.00099	-0.15	-0.08
19	0.0054	0.0011	0.23	0.11
20	NT	NT		
21	NT	NT		
22	0.006	0.001	1.36	0.70

Statistics

Assigned Value	0.00528	0.00026
Spike Value	0.00532	0.00025
Homogeneity Value	0.00551	0.00066
Robust Average	0.00528	0.00026
Median	0.00520	0.00019
Mean	0.00530	
N	15	
Max	0.006	
Min	0.0047	
Robust SD	0.0004	
Robust CV	7.5%	


Results: S1 - Mo
Assigned Value = 0.00528 ± 0.00026 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
16 9 12 14 17 10 15 18 3 7 19 6 11 13 22 1 2 4 5 8 20 21 Md RA SV HV


z-Scores: S1 - Mo
Standard Deviation for Proficiency Assessment 0.00053 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
16 9 12 14 17 10 15 18 3 7 19 6 11 13 22
-1.1 -0.5 -0.5 -0.5 -0.5 -0.3 -0.2 -0.2 -0.1 0.0 0.2 0.4 1.0 1.4 1.4

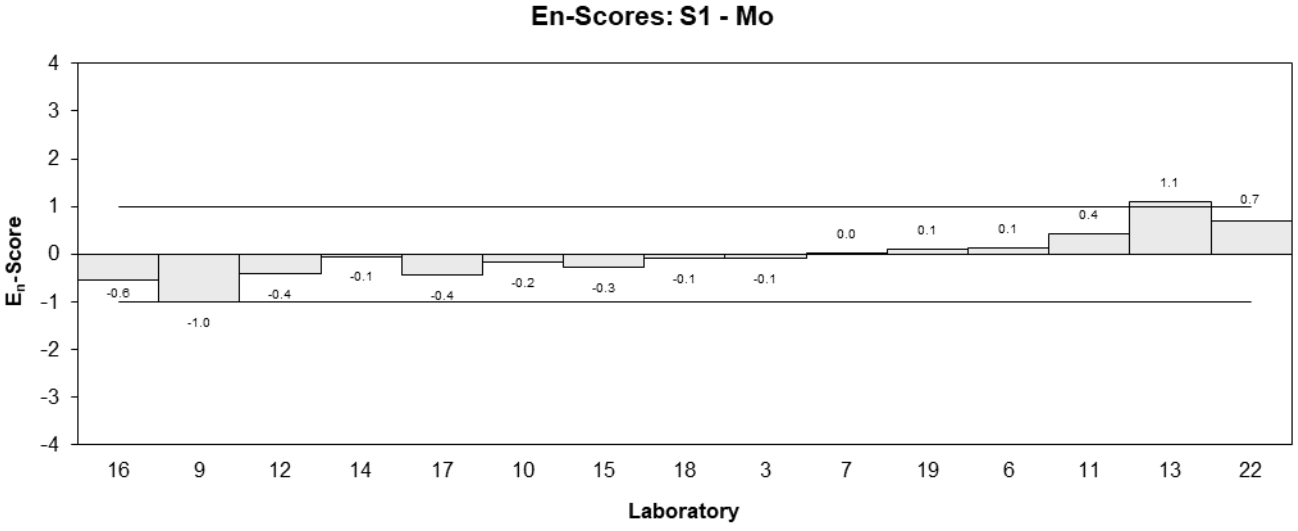

En-Scores: S1 - Mo
En-Score
Laboratory
16 9 12 14 17 10 15 18 3 7 19 6 11 13 22
-0.6 -1.0 -0.4 -0.1 -0.4 -0.2 -0.3 -0.1 -0.1 0.0 0.1 0.1 0.4 1.1 0.7

Figure 11

Table 16

Sample Details

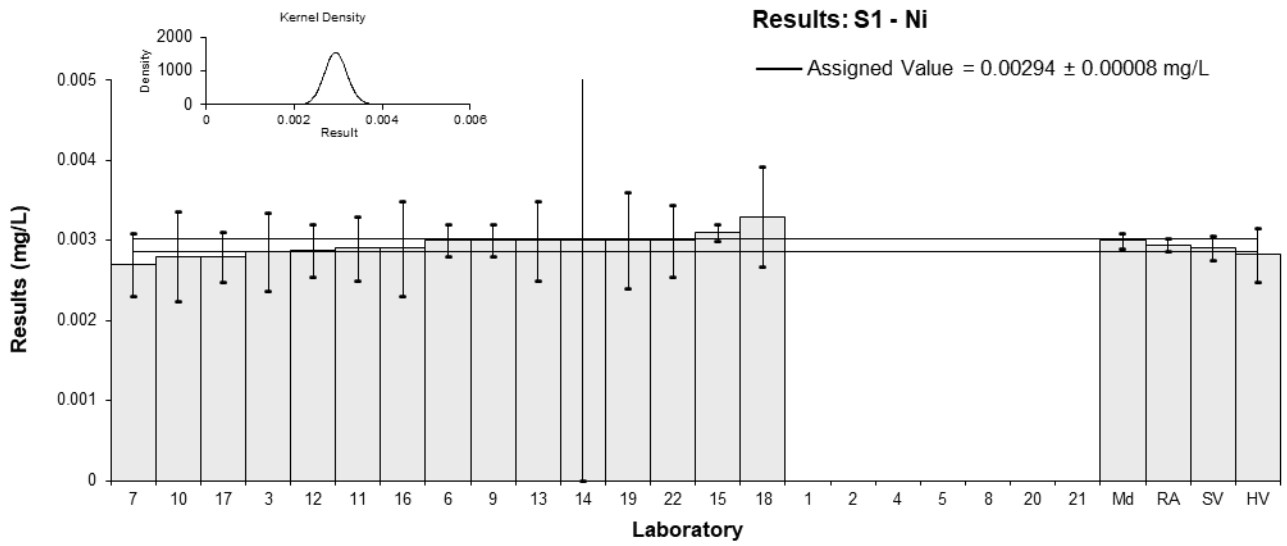
Sample No.	S1
Matrix	Potable Water
Analyte	Ni
Unit	mg/L

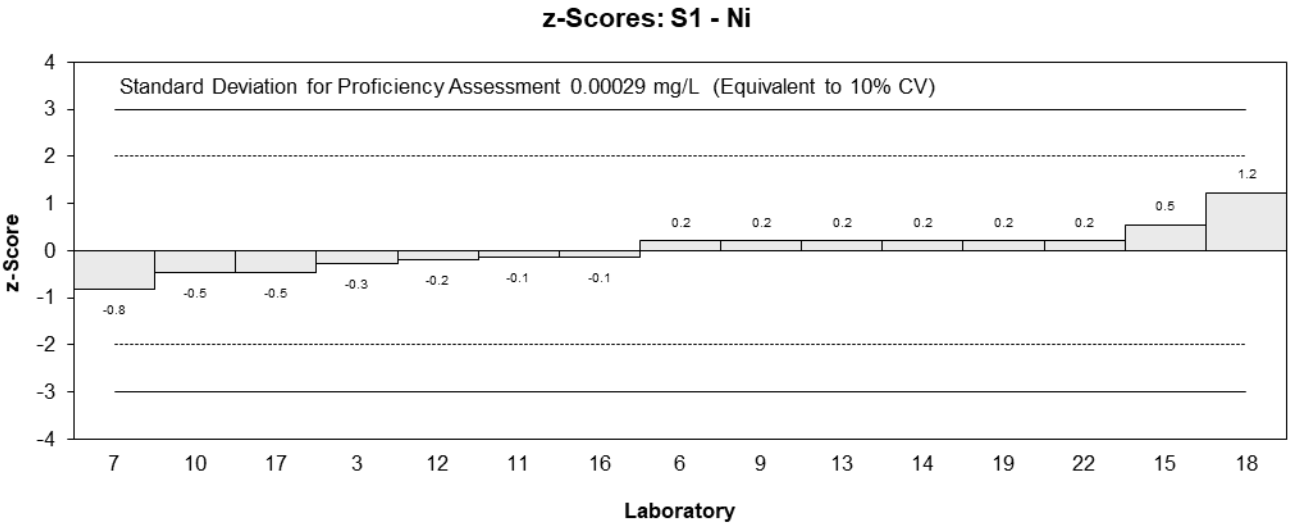
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.00286	0.00049	-0.27	-0.16
4	NT	NT		
5	NT	NT		
6	0.003	0.0002	0.20	0.28
7	0.0027	0.0004	-0.82	-0.59
8	NT	NT		
9	0.003	0.0002	0.20	0.28
10	0.0028	0.00056	-0.48	-0.25
11	0.0029	0.0004	-0.14	-0.10
12	0.00288	0.00033	-0.20	-0.18
13	0.003	0.0005	0.20	0.12
14	0.003	0.003	0.20	0.02
15	0.0031	0.0001	0.54	1.25
16	0.0029	0.0006	-0.14	-0.07
17	0.0028	0.00031	-0.48	-0.44
18	0.0033	0.00063	1.22	0.57
19	0.003	0.0006	0.20	0.10
20	NT	NT		
21	NT	NT		
22	0.003	0.00045	0.20	0.13

Statistics

Assigned Value	0.00294	0.00008
Spike Value	0.00291	0.00015
Homogeneity Value	0.00282	0.00034
Robust Average	0.00294	0.00008
Median	0.00300	0.00010
Mean	0.00295	
N	15	
Max	0.0033	
Min	0.0027	
Robust SD	0.00013	
Robust CV	4.3%	


Kernel Density
Density
Result
Results: S1 - Ni
Assigned Value = 0.00294 ± 0.00008 mg/L
Results (mg/L)
Laboratory
7 10 17 3 12 11 16 6 9 13 14 19 22 15 18 1 2 4 5 8 20 21 Md RA SV HV


z-Scores: S1 - Ni
Standard Deviation for Proficiency Assessment 0.00029 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
7 10 17 3 12 11 16 6 9 13 14 19 22 15 18

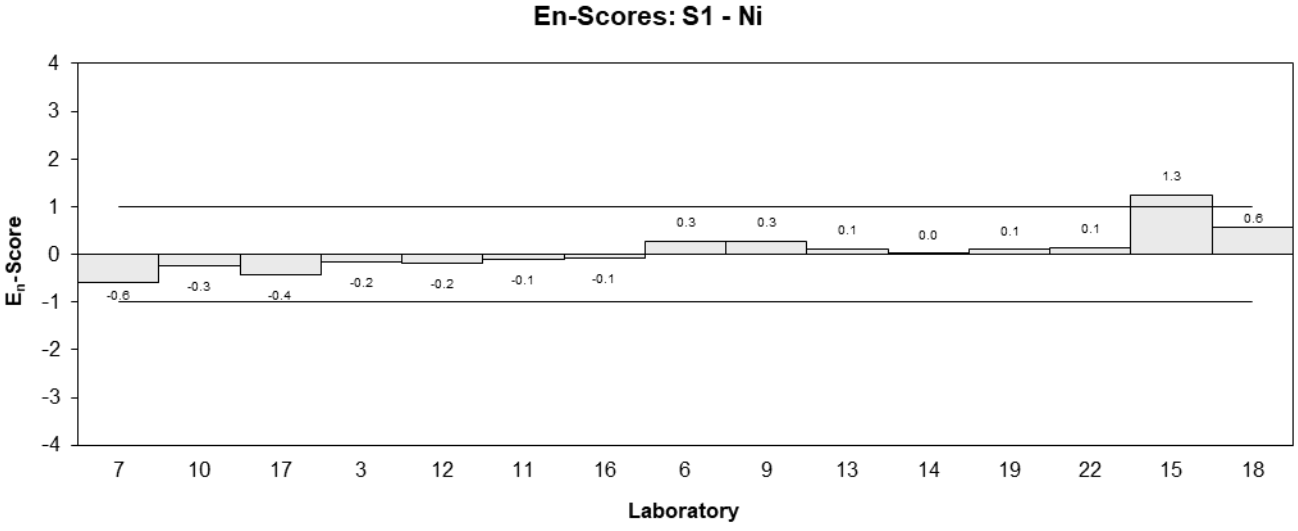

En-Scores: S1 - Ni
En-Score
Laboratory
7 10 17 3 12 11 16 6 9 13 14 19 22 15 18

Figure 12

Table 17

Sample Details

Sample No.	S1
Matrix	Potable Water
Analyte	Pb
Unit	mg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.00262	0.00018	0.65	0.65
4	NT	NT		
5	NT	NT		
6	0.0025	0.00017	0.16	0.17
7	0.0025	0.0004	0.16	0.09
8	NT	NT		
9	0.003	0.0001	2.20	2.74
10	0.0023	0.00045	-0.65	-0.33
11	0.0024	0.0003	-0.24	-0.17
12	0.00253	0.00040	0.28	0.16
13	0.003	0.0005	2.20	1.02
14	0.002	0.003	-1.87	-0.15
15	0.0026	NR	0.57	0.82
16	0.0024	0.0005	-0.24	-0.11
17	0.0022	0.00031	-1.06	-0.74
18	0.0025	0.0003	0.16	0.12
19	0.0025	0.0005	0.16	0.08
20	NT	NT		
21	NT	NT		
22	0.002	0.0003	-1.87	-1.33

Statistics

Assigned Value	0.00246	0.00017
Spike Value	Not Spiked	
Homogeneity Value	0.00251	0.00030
Robust Average	0.00246	0.00017
Median	0.00250	0.00010
Mean	0.00247	
N	15	
Max	0.003	
Min	0.002	
Robust SD	0.00027	
Robust CV	11%	

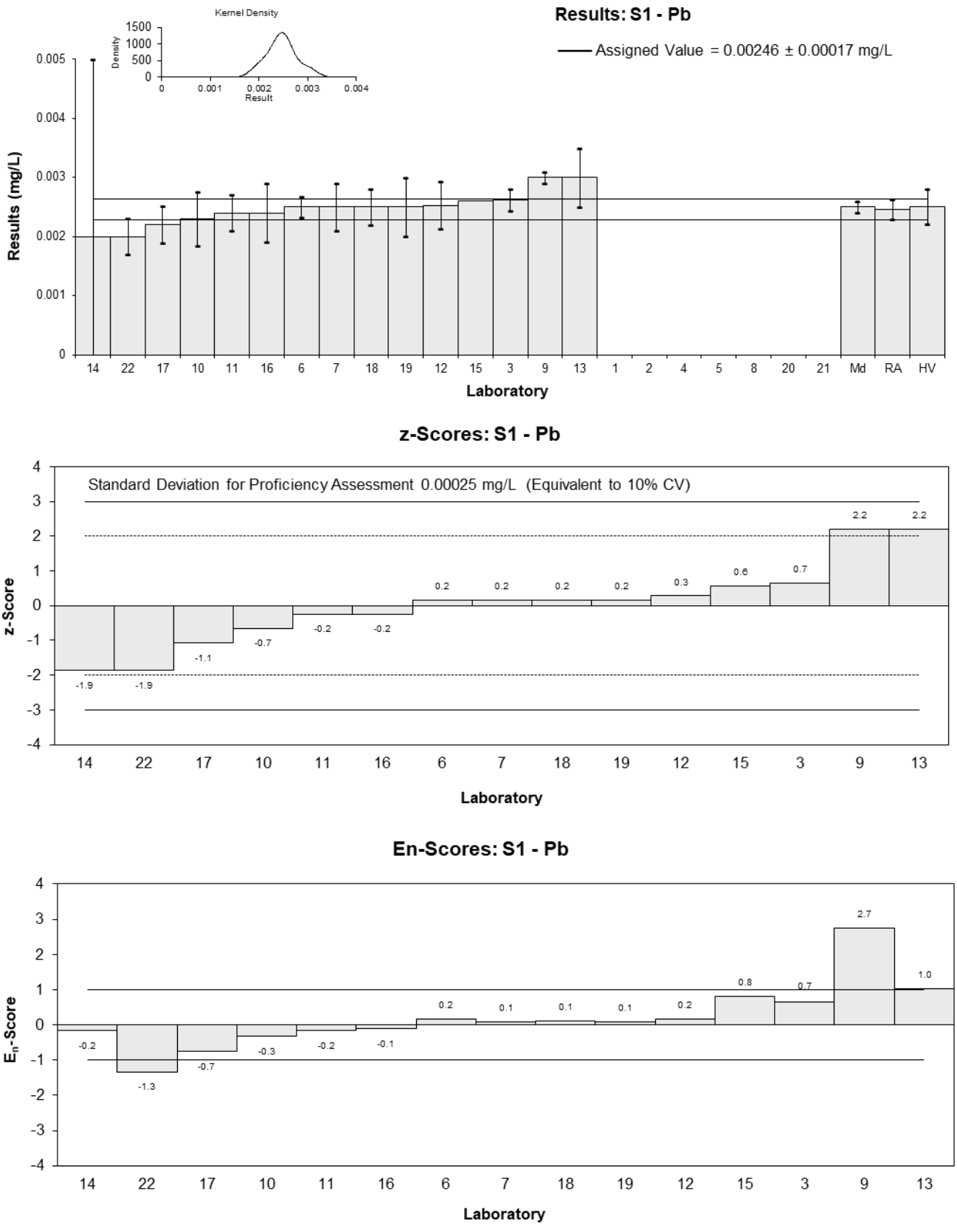

Results: S1 - Pb
Assigned Value = 0.00246 ± 0.00017 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
14 22 17 10 11 16 6 7 18 19 12 15 3 9 13 1 2 4 5 8 20 21 Md RA HV
z-Scores: S1 - Pb
Standard Deviation for Proficiency Assessment 0.00025 mg/L (Equivalent to 10% CV)
z-Score
-1.9 -1.9 -1.1 -0.7 -0.2 -0.2 0.2 0.2 0.2 0.2 0.3 0.6 0.7 2.2 2.2
Laboratory
14 22 17 10 11 16 6 7 18 19 12 15 3 9 13
En-Scores: S1 - Pb
En-Score
-0.2 -1.3 -0.7 -0.3 -0.2 -0.1 0.2 0.1 0.1 0.1 0.2 0.8 0.7 2.7 1.0
Laboratory
14 22 17 10 11 16 6 7 18 19 12 15 3 9 13

Figure 13

Table 18

Sample Details

Sample No.	S1
Matrix	Potable Water
Analyte	Sb
Unit	mg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.0023	0.0013	0.75	0.12
4	NT	NT		
5	NT	NT		
6	0.0023	0.0004	0.75	0.38
7	0.0020	0.0003	-0.65	-0.42
8	NT	NT		
9	0.002	0.0001	-0.65	-0.81
10	< 0.005	NR		
11	< 0.005	NR		
12	0.00235	0.00030	0.98	0.63
13	0.002	0.0005	-0.65	-0.27
14	0.0027	0.0008	2.62	0.69
15	0.0022	NR	0.28	0.43
16	0.0019	0.0004	-1.12	-0.57
17	<0.001	NR		
18	0.002	0.0004	-0.65	-0.33
19	0.0022	0.0005	0.28	0.12
20	NT	NT		
21	NT	NT		
22	0.002	0.00024	-0.65	-0.50

Statistics

Assigned Value	0.00214	0.00014
Spike Value	0.00213	0.00010
Homogeneity Value	0.00220	0.00026
Robust Average	0.00214	0.00014
Median	0.00210	0.00011
Mean	0.00216	
N	12	
Max	0.0027	
Min	0.0019	
Robust SD	0.0002	
Robust CV	9.3%	

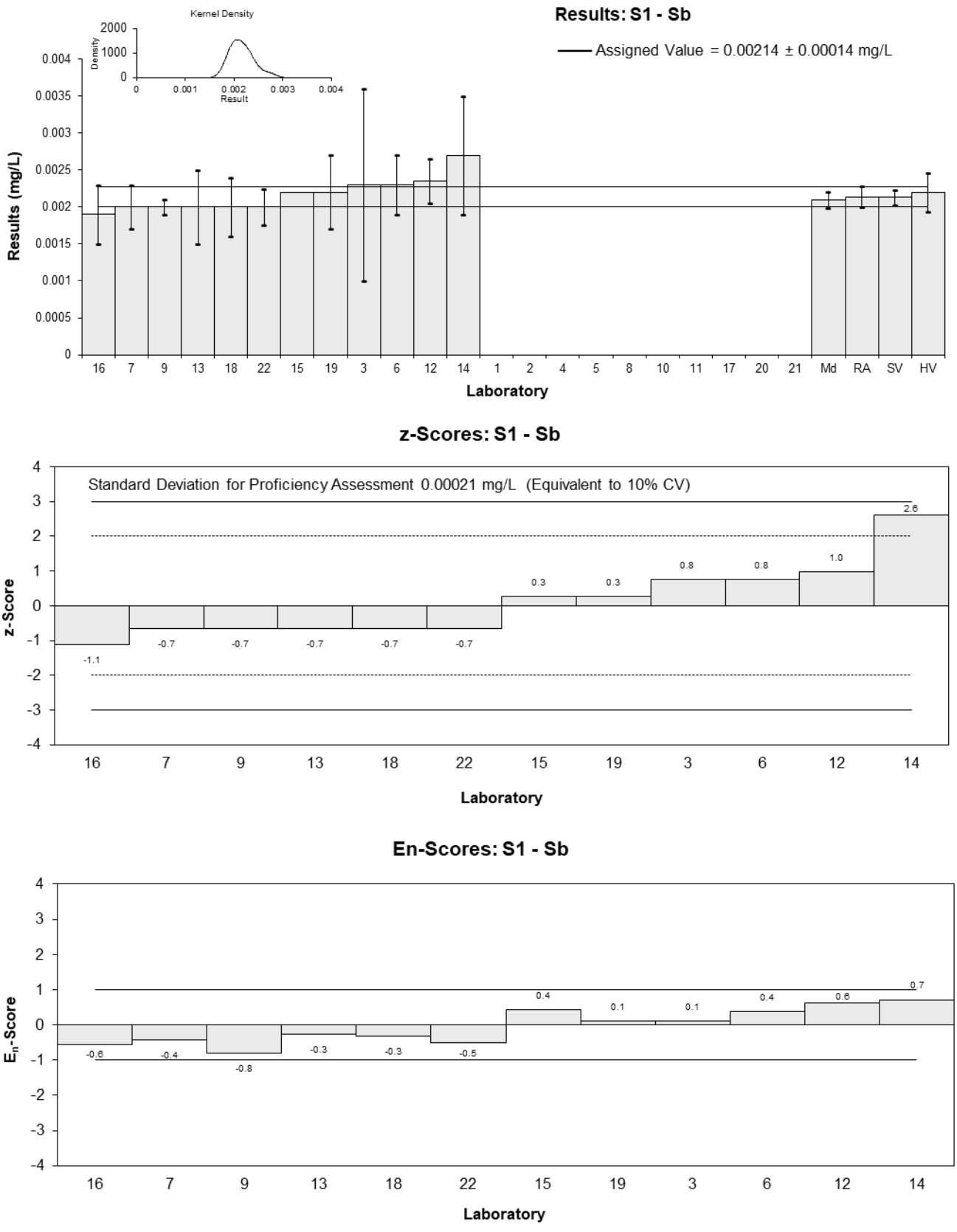

Results: S1 - Sb
Assigned Value = 0.00214 ± 0.00014 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
16 7 9 13 18 22 15 19 3 6 12 14 1 2 4 5 8 10 11 17 20 21 Md RA SV HV
z-Scores: S1 - Sb
Standard Deviation for Proficiency Assessment 0.00021 mg/L (Equivalent to 10% CV)
z-Score
-1.1 -0.7 -0.7 -0.7 -0.7 -0.7 0.3 0.3 0.8 0.8 1.0 2.6
Laboratory
16 7 9 13 18 22 15 19 3 6 12 14
En-Scores: S1 - Sb
En-Score
-0.6 -0.4 -0.8 -0.3 -0.3 -0.5 0.4 0.1 0.1 0.4 0.6 0.7
Laboratory
16 7 9 13 18 22 15 19 3 6 12 14

Figure 14

Table 19

Sample Details

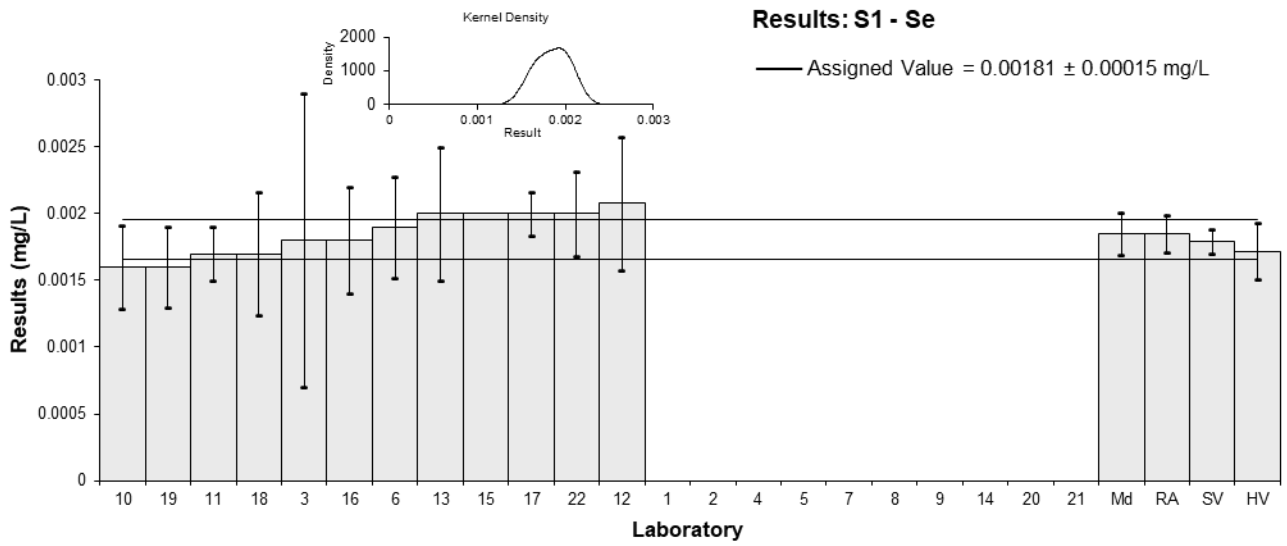
Sample No.	S1
Matrix	Potable Water
Analyte	Se
Unit	mg/L

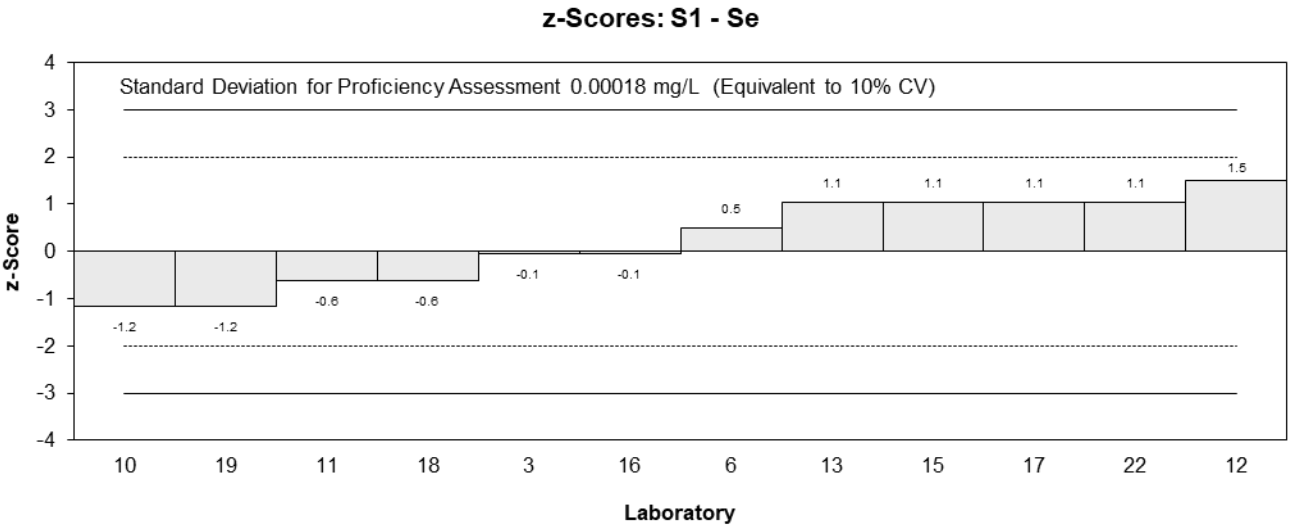
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.0018	0.0011	-0.06	-0.01
4	NT	NT		
5	NT	NT		
6	0.0019	0.00038	0.50	0.22
7	<0.0020	NR		
8	NT	NT		
9	<0.004	NR		
10	0.0016	0.00031	-1.16	-0.61
11	0.0017	0.0002	-0.61	-0.44
12	0.00208	0.00050	1.49	0.52
13	0.002	0.0005	1.05	0.36
14	<0.01	0.01		
15	0.002	NR	1.05	1.27
16	0.0018	0.0004	-0.06	-0.02
17	0.002	0.00016	1.05	0.87
18	0.0017	0.00046	-0.61	-0.23
19	0.0016	0.0003	-1.16	-0.63
20	NT	NT		
21	NT	NT		
22	0.002	0.00032	1.05	0.54

Statistics

Assigned Value	0.00181	0.00015
Spike Value	0.00179	0.00009
Homogeneity Value	0.00172	0.00021
Robust Average	0.00185	0.00014
Median	0.00185	0.00016
Mean	0.00185	
N	12	
Max	0.00208	
Min	0.0016	
Robust SD	0.00019	
Robust CV	10%	


Results: S1 - Se
Assigned Value = 0.00181 ± 0.00015 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
10 19 11 18 3 16 6 13 15 17 22 12 1 2 4 5 7 8 9 14 20 21 Md RA SV HV


z-Scores: S1 - Se
Standard Deviation for Proficiency Assessment 0.00018 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
10 19 11 18 3 16 6 13 15 17 22 12

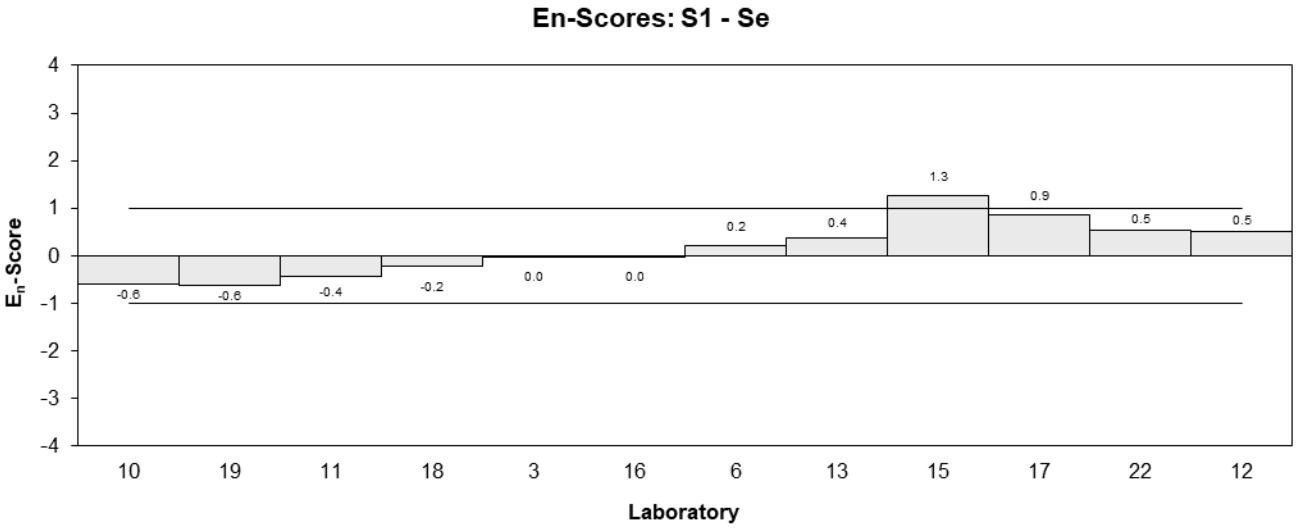

En-Scores: S1 - Se
En-Score
Laboratory
10 19 11 18 3 16 6 13 15 17 22 12

Figure 15

Table 20

Sample Details

Sample No.	S1
Matrix	Potable Water
Analyte	Sn
Unit	mg/L

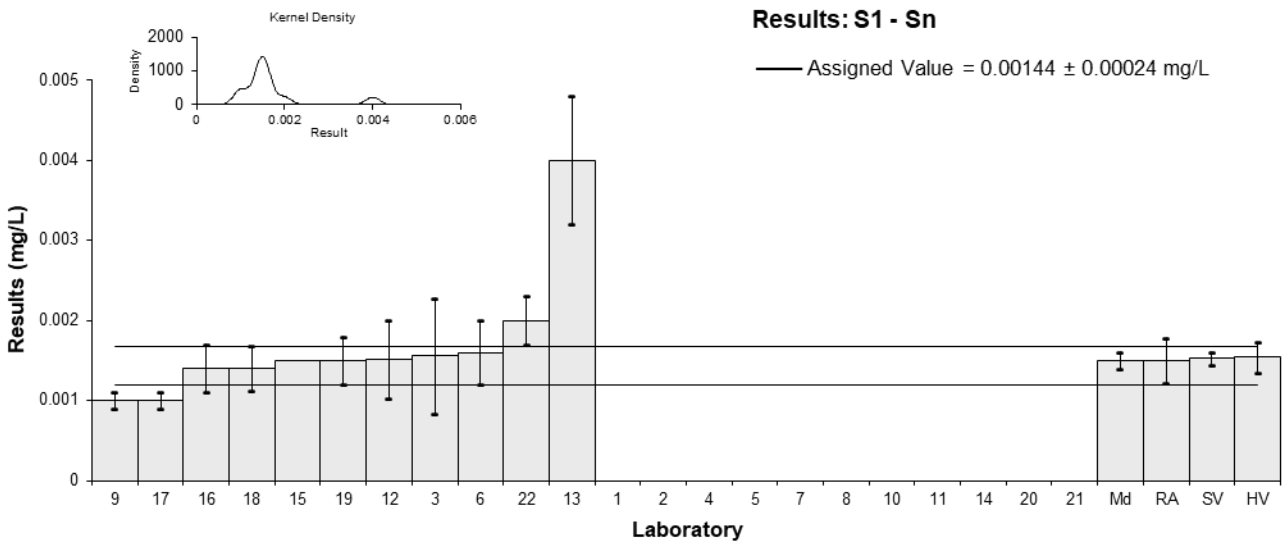
Participant Results

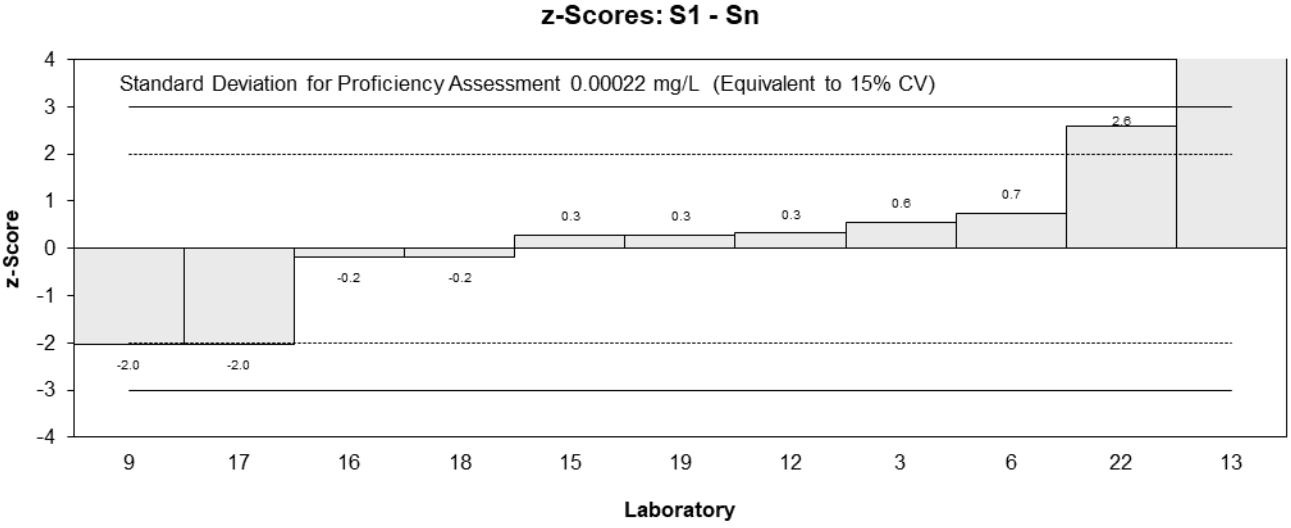
Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.00156	0.00072	0.56	0.16
4	NT	NT		
5	NT	NT		
6	0.0016	0.0004	0.74	0.34
7	NT	NT		
8	NT	NT		
9	0.001	0.0001	-2.04	-1.69
10	< 0.005	NR		
11	< 0.005	NR		
12	0.00151	0.00049	0.32	0.13
13*	0.004	0.0008	11.85	3.07
14	NT	NT		
15	0.0015	NR	0.28	0.25
16	0.0014	0.0003	-0.19	-0.10
17	0.001	0.0001	-2.04	-1.69
18	0.0014	0.00028	-0.19	-0.11
19	0.0015	0.0003	0.28	0.16
20	NT	NT		
21	NT	NT		
22	0.002	0.0003	2.59	1.46

* Outlier, see Section 4.2

Statistics

Assigned Value	0.00144	0.00024
Spike Value	0.00153	0.00008
Homogeneity Value	0.00154	0.00019
Robust Average	0.00150	0.00028
Median	0.00150	0.00011
Mean	0.00168	
N	11	
Max	0.004	
Min	0.001	
Robust SD	0.00038	
Robust CV	25%	


Results: S1 - Sn
Assigned Value = 0.00144 ± 0.00024 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
9 17 16 18 15 19 12 3 6 22 13 1 2 4 5 7 8 10 11 14 20 21 Md RA SV HV


z-Scores: S1 - Sn
Standard Deviation for Proficiency Assessment 0.00022 mg/L (Equivalent to 15% CV)
z-Score
Laboratory
9 17 16 18 15 19 12 3 6 22 13
-2.0 -2.0 -0.2 -0.2 0.3 0.3 0.3 0.6 0.7 2.6

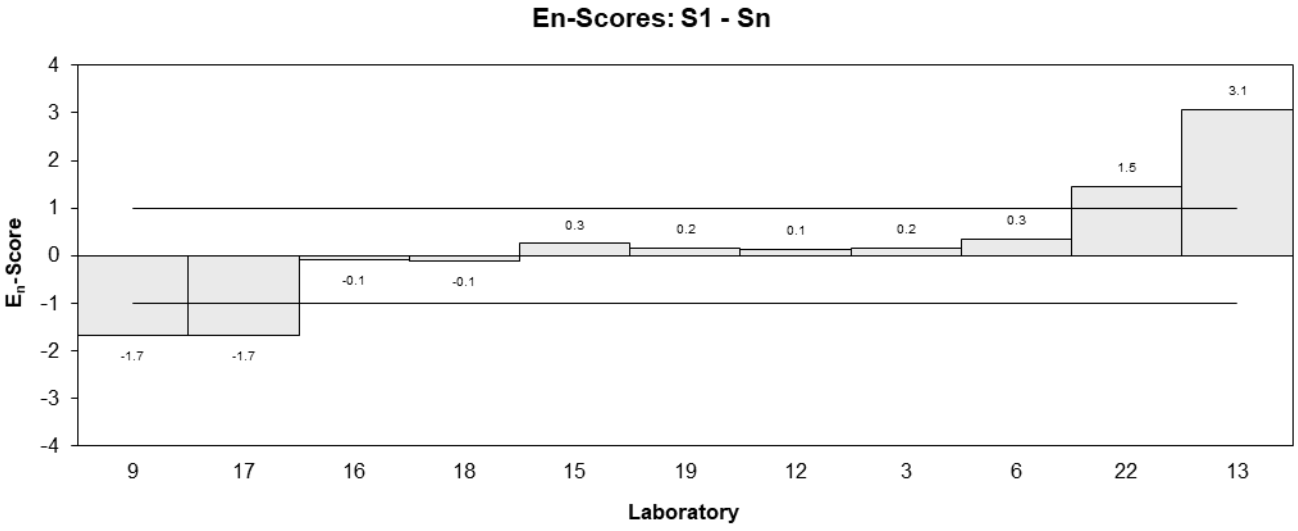

En-Scores: S1 - Sn
En-Score
Laboratory
9 17 16 18 15 19 12 3 6 22 13
-1.7 -1.7 -0.1 -0.1 0.3 0.2 0.1 0.2 0.3 1.5 3.1

Figure 16

Table 21

Sample Details

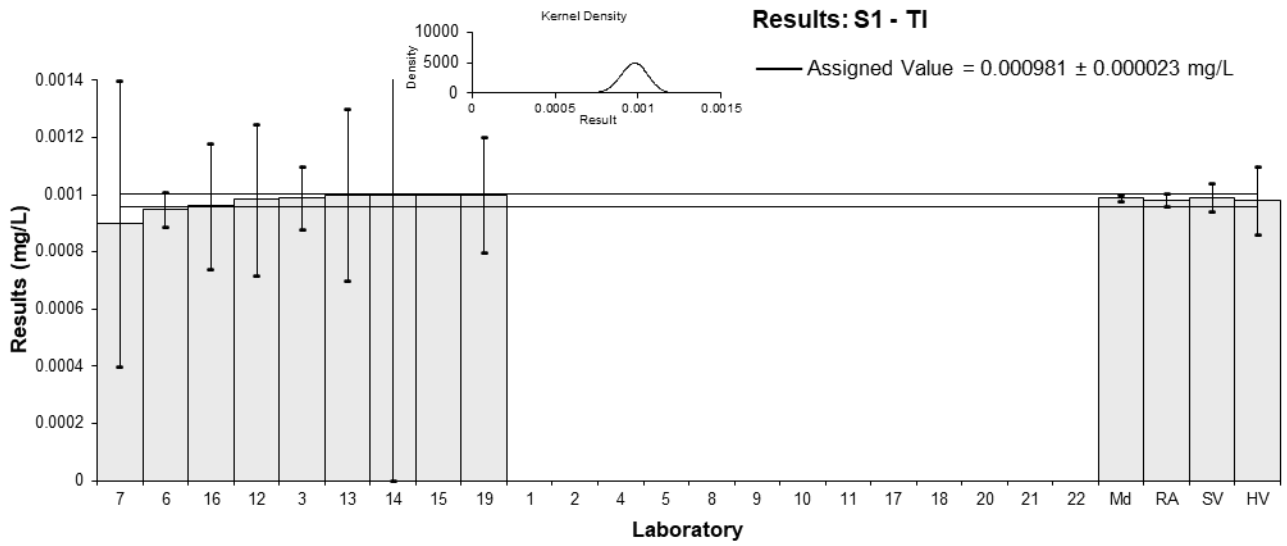
Sample No.	S1
Matrix	Potable Water
Analyte	Tl
Unit	mg/L

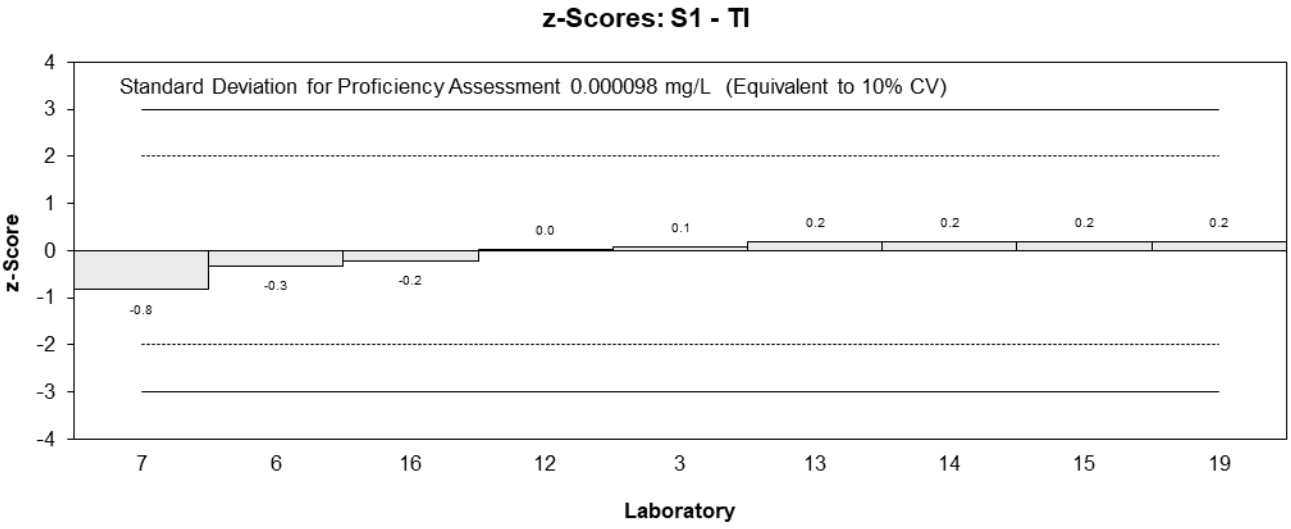
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.00099	0.00011	0.09	0.08
4	NT	NT		
5	NT	NT		
6	0.00095	0.00006	-0.32	-0.48
7	0.0009	0.0005	-0.83	-0.16
8	NT	NT		
9	<0.001	NR		
10	< 0.005	NR		
11	< 0.005	NR		
12	0.000984	0.000265	0.03	0.01
13	0.001	0.0003	0.19	0.06
14	0.001	0.001	0.19	0.02
15	0.0010	NR	0.19	0.83
16	0.00096	0.00022	-0.21	-0.09
17	<0.001	NR		
18	NT	NT		
19	0.001	0.0002	0.19	0.09
20	NT	NT		
21	NT	NT		
22	<0.001	NR		

Statistics

Assigned Value	0.000981	0.000023
Spike Value	0.000990	0.000049
Homogeneity Value	0.00098	0.00012
Robust Average	0.000981	0.000023
Median	0.000990	0.000012
Mean	0.000976	
N	9	
Max	0.001	
Min	0.0009	
Robust SD	0.000027	
Robust CV	2.8%	


Results: S1 - Tl
Assigned Value = 0.000981 ± 0.000023 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
7 6 16 12 3 13 14 15 19 1 2 4 5 8 9 10 11 17 18 20 21 22 Md RA SV HV


z-Scores: S1 - Tl
Standard Deviation for Proficiency Assessment 0.000098 mg/L (Equivalent to 10% CV)
z-Score
-0.8 -0.3 -0.2 0.0 0.1 0.2 0.2 0.2 0.2
Laboratory
7 6 16 12 3 13 14 15 19

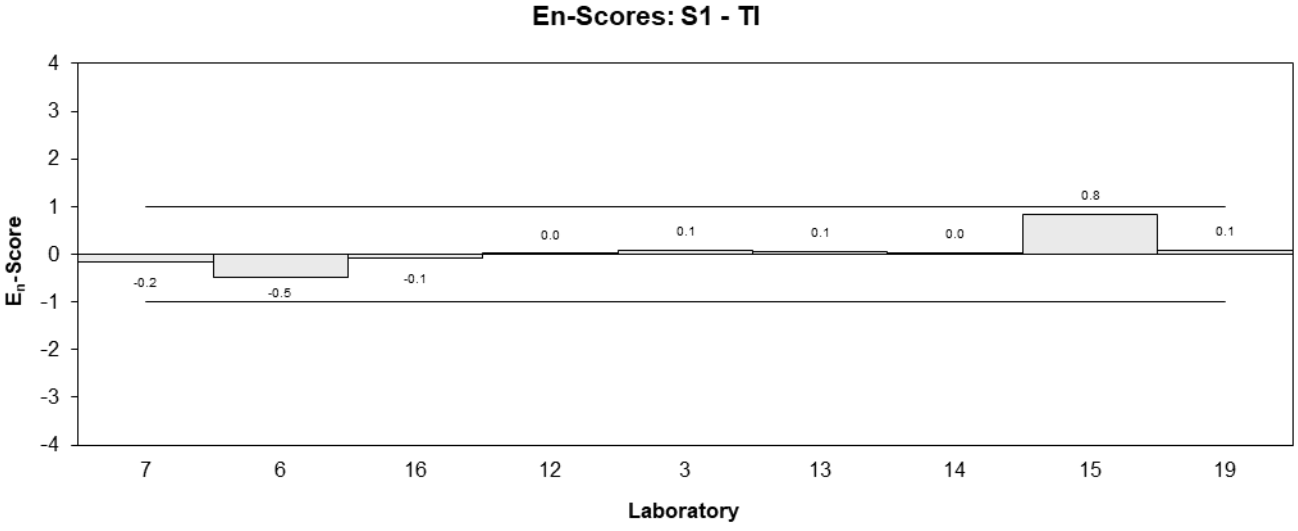

En-Scores: S1 - Tl
En-Score
-0.2 -0.5 -0.1 0.0 0.1 0.1 0.0 0.8 0.1
Laboratory
7 6 16 12 3 13 14 15 19

Figure 17

Table 22

Sample Details

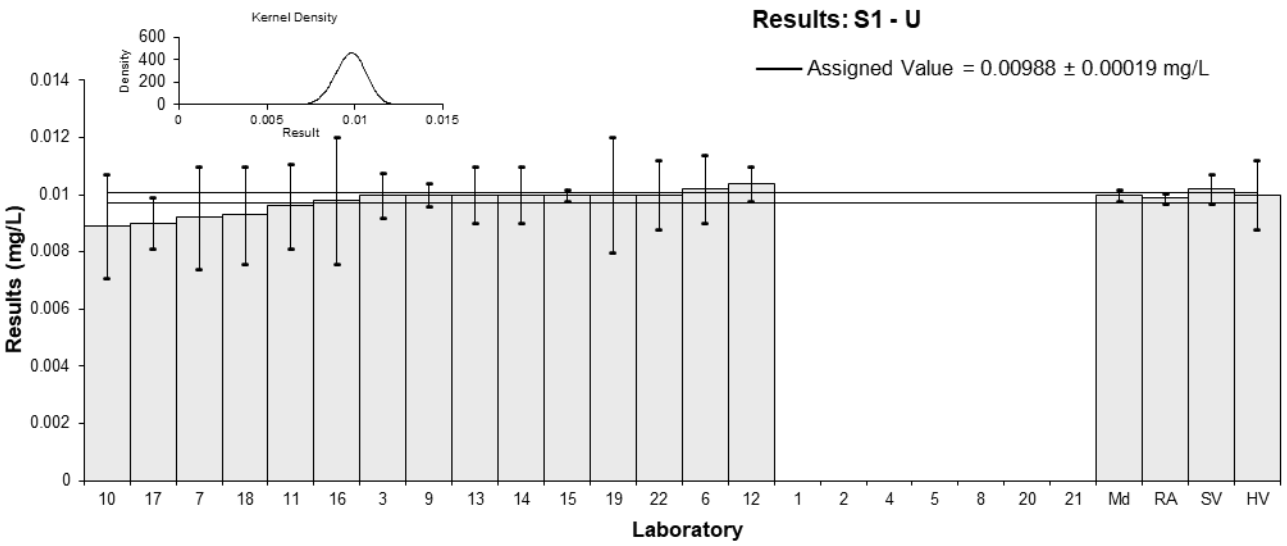
Sample No.	S1
Matrix	Potable Water
Analyte	U
Unit	mg/L

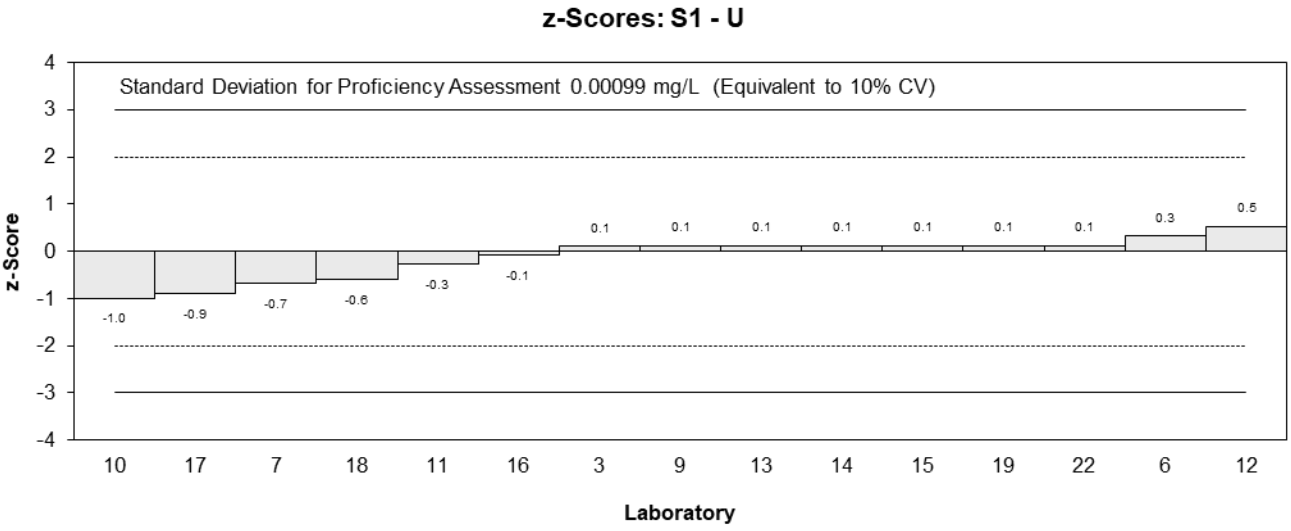
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.00998	0.00080	0.10	0.12
4	NT	NT		
5	NT	NT		
6	0.0102	0.0012	0.32	0.26
7	0.0092	0.0018	-0.69	-0.38
8	NT	NT		
9	0.010	0.0004	0.12	0.27
10	0.0089	0.0018	-0.99	-0.54
11	0.0096	0.0015	-0.28	-0.19
12	0.0104	0.0006	0.53	0.83
13	0.010	0.001	0.12	0.12
14	0.01	0.001	0.12	0.12
15	0.010	0.0002	0.12	0.43
16	0.0098	0.0022	-0.08	-0.04
17	0.009	0.0009	-0.89	-0.96
18	0.0093	0.0017	-0.59	-0.34
19	0.01	0.002	0.12	0.06
20	NT	NT		
21	NT	NT		
22	0.010	0.0012	0.12	0.10

Statistics

Assigned Value	0.00988	0.00019
Spike Value	0.0102	0.0005
Homogeneity Value	0.0100	0.0012
Robust Average	0.00988	0.00019
Median	0.0100	0.0002
Mean	0.00976	
N	15	
Max	0.0104	
Min	0.0089	
Robust SD	0.0003	
Robust CV	3%	


Results: S1 - U
Assigned Value = 0.00988 ± 0.00019 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
10 17 7 18 11 16 3 9 13 14 15 19 22 6 12 1 2 4 5 8 20 21 Md RA SV HV


z-Scores: S1 - U
Standard Deviation for Proficiency Assessment 0.00099 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
10 17 7 18 11 16 3 9 13 14 15 19 22 6 12

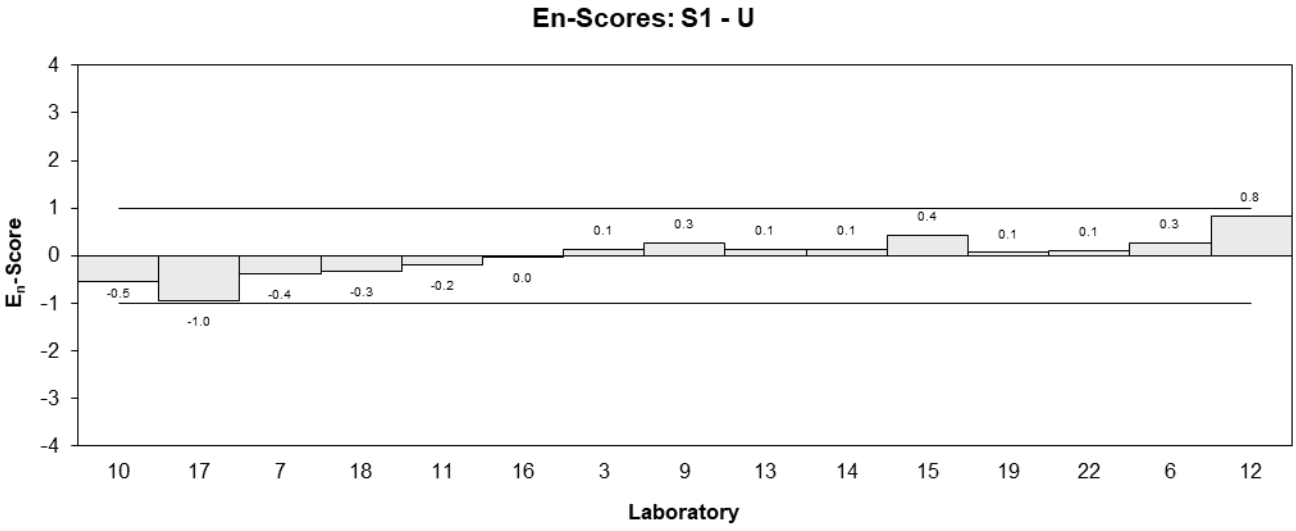

En-Scores: S1 - U
En-Score
Laboratory
10 17 7 18 11 16 3 9 13 14 15 19 22 6 12

Figure 18

Table 23

Sample Details

Sample No.	S1
Matrix	Potable Water
Analyte	V
Unit	mg/L

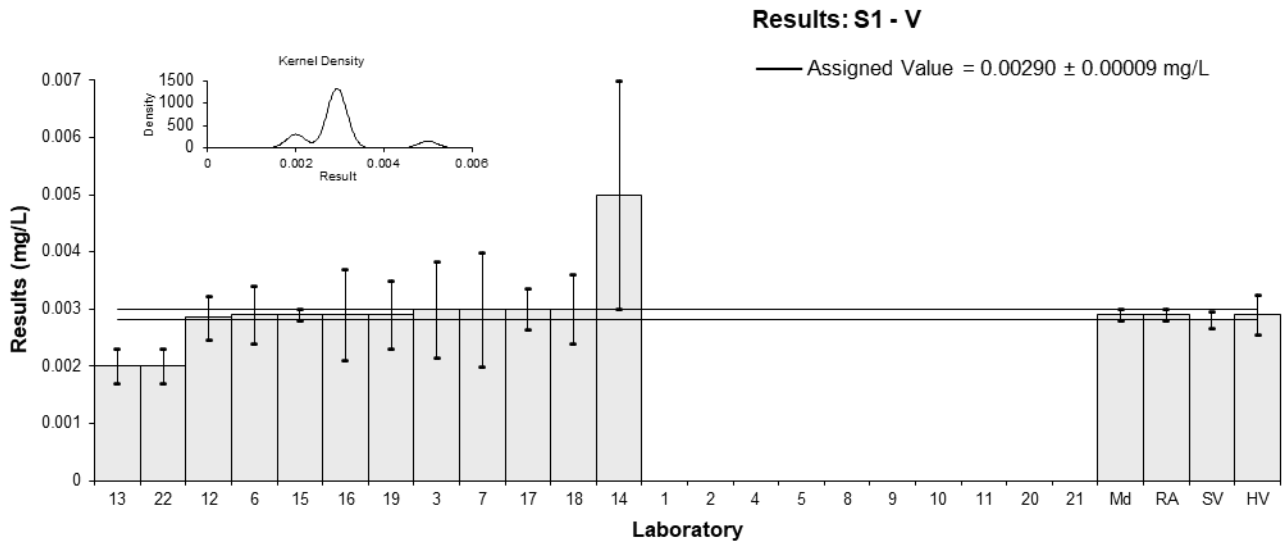
Participant Results

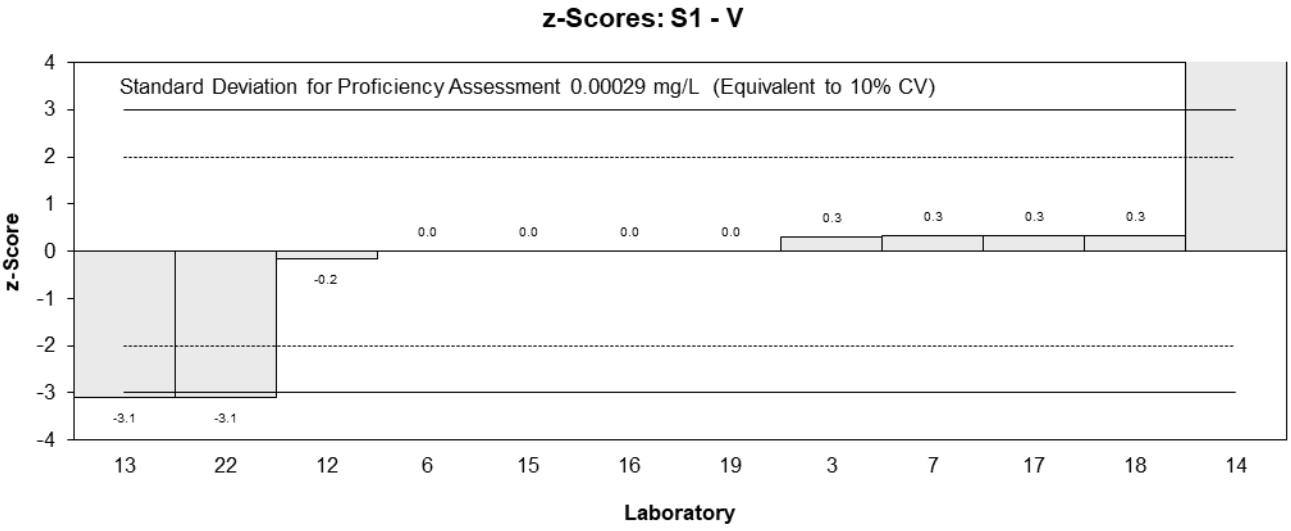
Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.00299	0.00084	0.31	0.11
4	NT	NT		
5	NT	NT		
6	0.0029	0.0005	0.00	0.00
7	0.0030	0.001	0.34	0.10
8	NT	NT		
9	<0.01	NR		
10	< 0.005	NR		
11	< 0.005	NR		
12	0.00285	0.00038	-0.17	-0.13
13	0.002	0.0003	-3.10	-2.87
14*	0.005	0.002	7.24	1.05
15	0.0029	0.0001	0.00	0.00
16	0.0029	0.0008	0.00	0.00
17	0.003	0.00036	0.34	0.27
18	0.003	0.0006	0.34	0.16
19	0.0029	0.0006	0.00	0.00
20	NT	NT		
21	NT	NT		
22	0.002	0.0003	-3.10	-2.87

* Outlier, see Section 4.2

Statistics

Assigned Value	0.00290	0.00009
Spike Value	0.00281	0.00014
Homogeneity Value	0.00291	0.00035
Robust Average	0.00291	0.00010
Median	0.00290	0.00010
Mean	0.00295	
N	12	
Max	0.005	
Min	0.002	
Robust SD	0.00014	
Robust CV	4.9%	


Results: S1 - V
Assigned Value = 0.00290 ± 0.00009 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
13 22 12 6 15 16 19 3 7 17 18 14 1 2 4 5 8 9 10 11 20 21 Md RA SV HV


z-Scores: S1 - V
Standard Deviation for Proficiency Assessment 0.00029 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
13 22 12 6 15 16 19 3 7 17 18 14

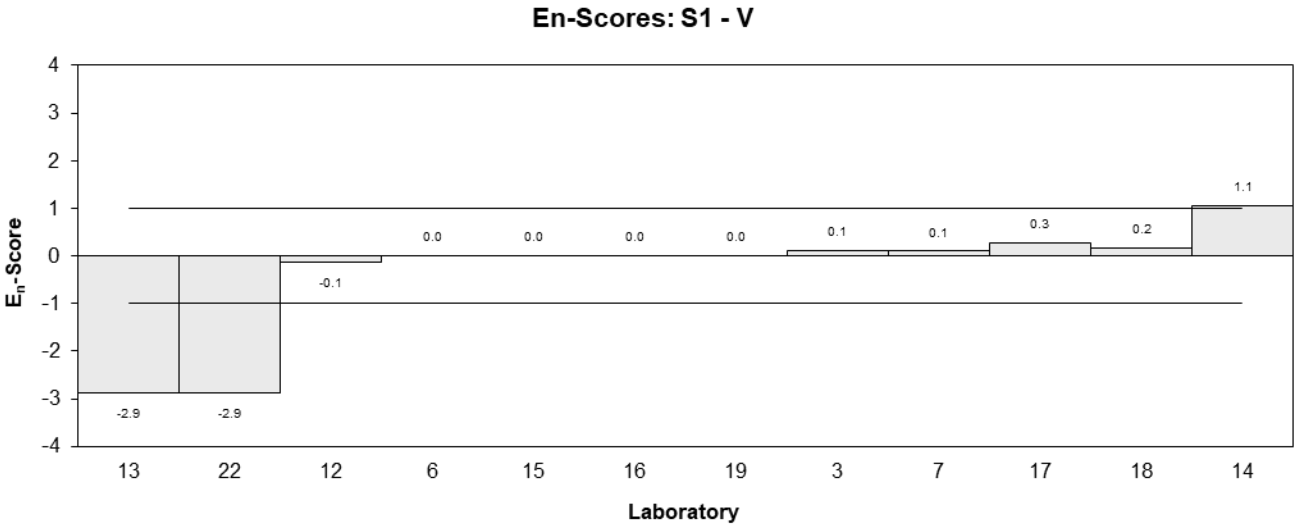

En-Scores: S1 - V
En-Score
Laboratory
13 22 12 6 15 16 19 3 7 17 18 14

Figure 19

Table 24

Sample Details

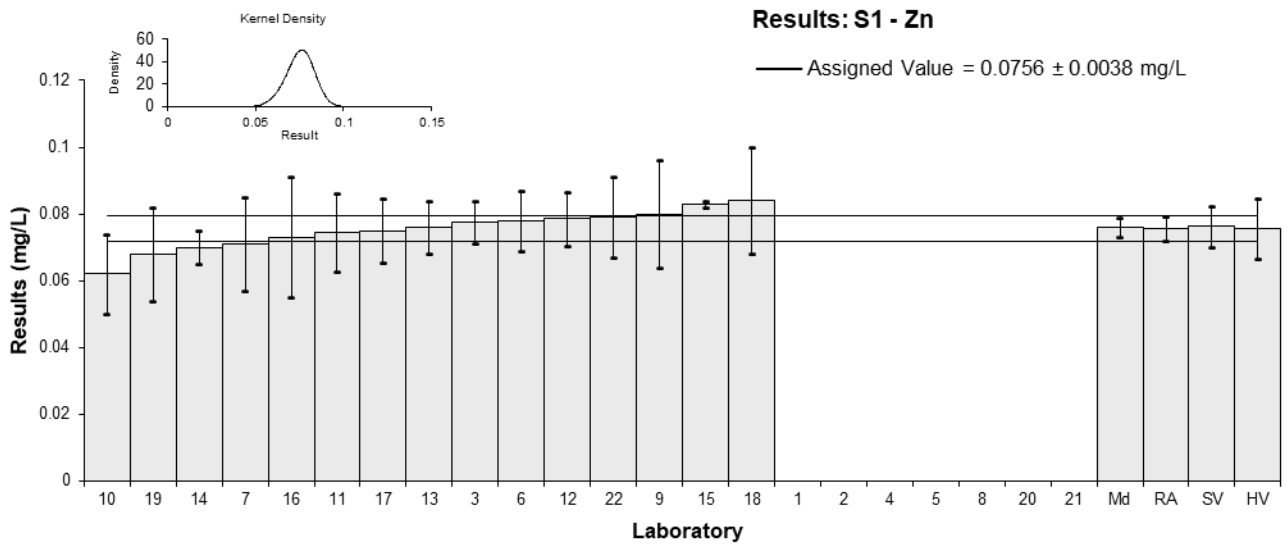
Sample No.	S1
Matrix	Potable Water
Analyte	Zn
Unit	mg/L

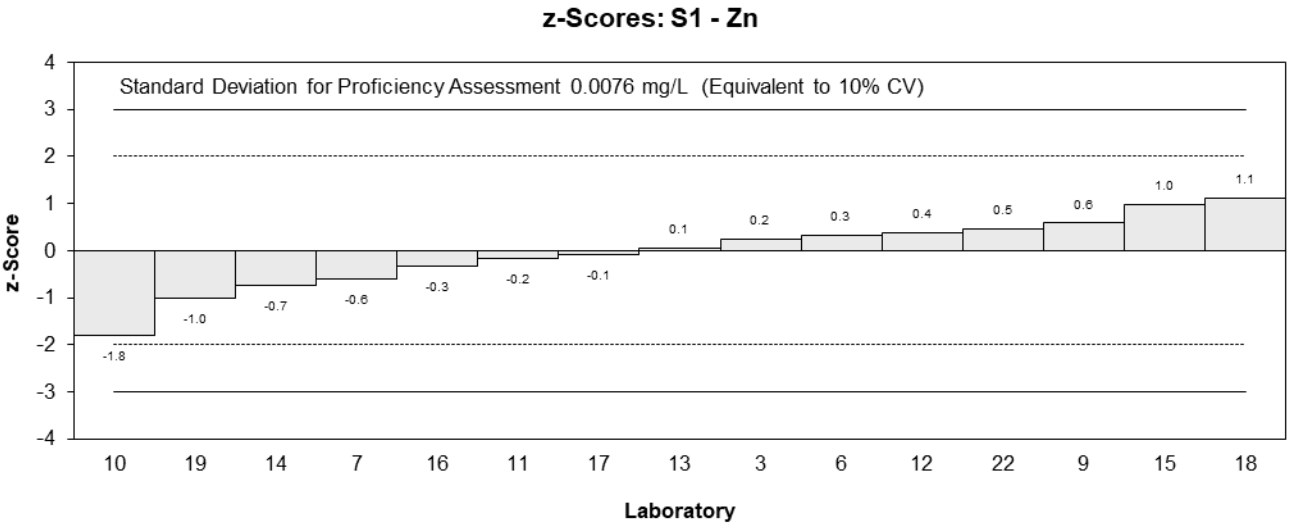
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.0774	0.0063	0.24	0.24
4	NT	NT		
5	NT	NT		
6	0.078	0.009	0.32	0.25
7	0.071	0.014	-0.61	-0.32
8	NT	NT		
9	0.080	0.016	0.58	0.27
10	0.062	0.012	-1.80	-1.08
11	0.0744	0.0117	-0.16	-0.10
12	0.0785	0.0081	0.38	0.32
13	0.076	0.008	0.05	0.05
14	0.07	0.005	-0.74	-0.89
15	0.083	0.001	0.98	1.88
16	0.073	0.018	-0.34	-0.14
17	0.075	0.00975	-0.08	-0.06
18	0.084	0.016	1.11	0.51
19	0.068	0.014	-1.01	-0.52
20	NT	NT		
21	NT	NT		
22	0.079	0.012	0.45	0.27

Statistics

Assigned Value	0.0756	0.0038
Spike Value	0.0762	0.0062
Homogeneity Value	0.0756	0.0091
Robust Average	0.0756	0.0038
Median	0.0760	0.0029
Mean	0.0753	
N	15	
Max	0.084	
Min	0.062	
Robust SD	0.0058	
Robust CV	7.7%	


Results: S1 - Zn
Assigned Value = 0.0756 ± 0.0038 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
10 19 14 7 16 11 17 13 3 6 12 22 9 15 18 1 2 4 5 8 20 21 Md RA SV HV


z-Scores: S1 - Zn
Standard Deviation for Proficiency Assessment 0.0076 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
10 19 14 7 16 11 17 13 3 6 12 22 9 15 18
-1.8 -1.0 -0.7 -0.6 -0.3 -0.2 -0.1 0.1 0.2 0.3 0.4 0.5 0.6 1.0 1.1

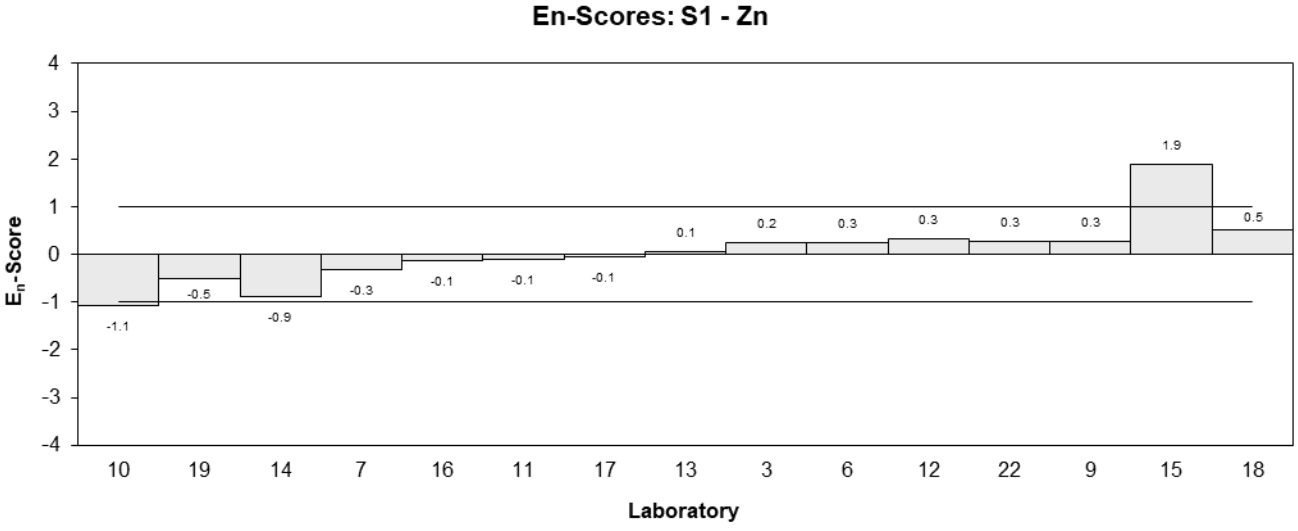

En-Scores: S1 - Zn
En-Score
Laboratory
10 19 14 7 16 11 17 13 3 6 12 22 9 15 18
-1.1 -0.5 -0.9 -0.3 -0.1 -0.1 -0.1 0.1 0.2 0.3 0.3 0.3 0.3 1.9 0.5

Figure 20

Table 25

Sample Details

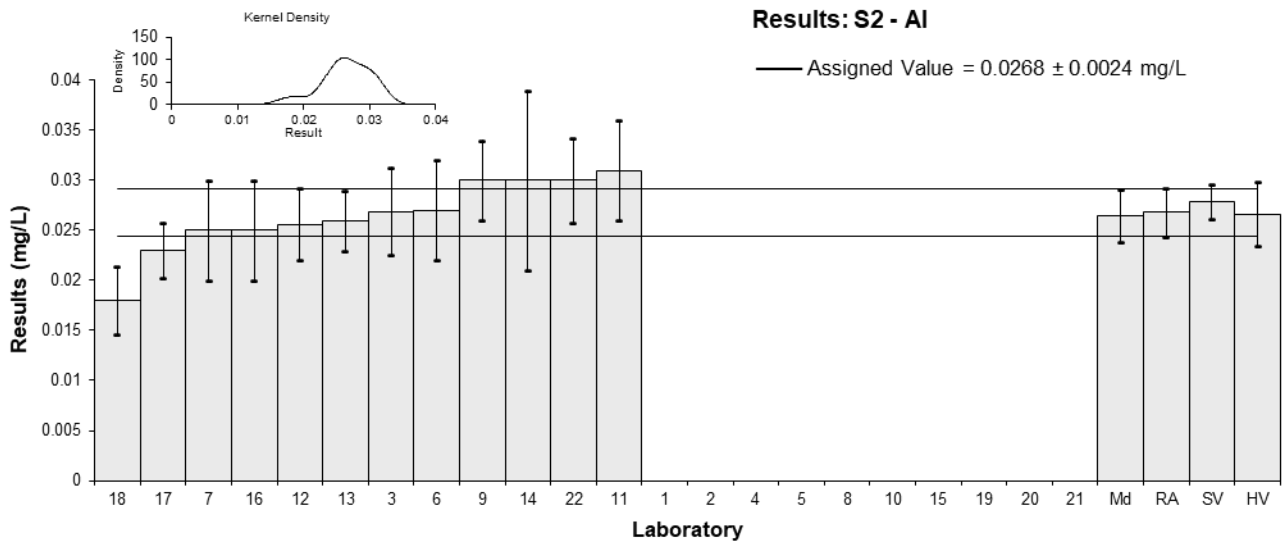
Sample No.	S2
Matrix	Potable Water
Analyte	Al
Unit	mg/L

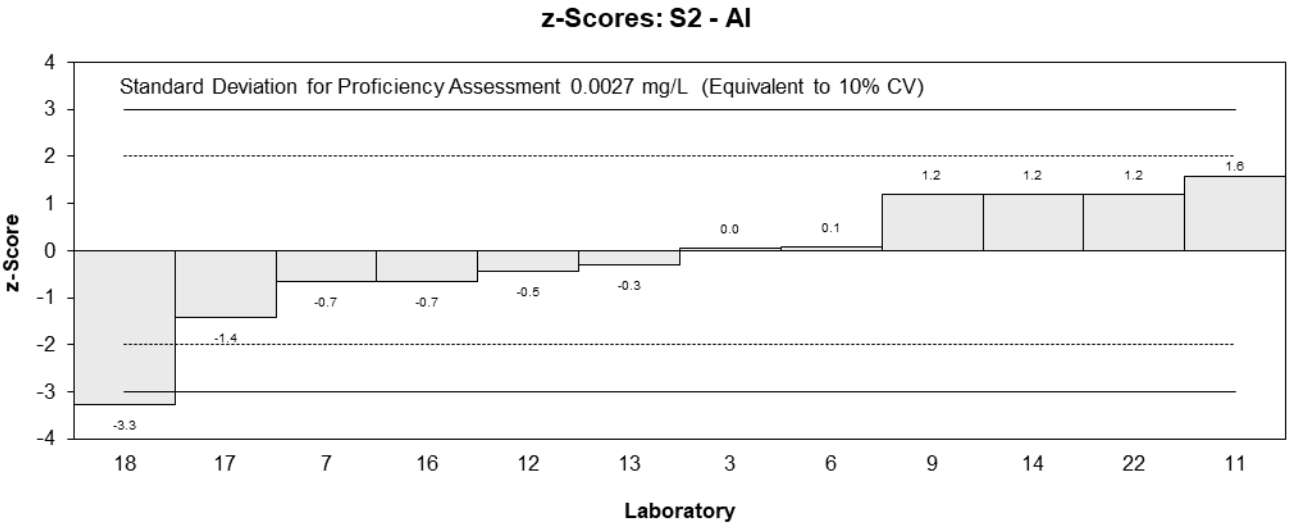
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.0269	0.0044	0.04	0.02
4	NT	NT		
5	NT	NT		
6	0.027	0.005	0.07	0.04
7	0.025	0.005	-0.67	-0.32
8	NT	NT		
9	0.03	0.004	1.19	0.69
10	< 0.05	NR		
11	0.031	0.005	1.57	0.76
12	0.0256	0.0036	-0.45	-0.28
13	0.026	0.003	-0.30	-0.21
14	0.03	0.009	1.19	0.34
15	< 0.03	NR		
16	0.025	0.005	-0.67	-0.32
17	0.023	0.0028	-1.42	-1.03
18	0.018	0.0034	-3.28	-2.11
19	NR	NR		
20	NT	NT		
21	NT	NT		
22	0.03	0.0042	1.19	0.66

Statistics

Assigned Value	0.0268	0.0024
Spike Value	0.0279	0.0017
Homogeneity Value	0.0266	0.0032
Robust Average	0.0268	0.0024
Median	0.0265	0.0026
Mean	0.0265	
N	12	
Max	0.031	
Min	0.018	
Robust SD	0.0034	
Robust CV	13%	


Results: S2 - Al
Assigned Value = 0.0268 ± 0.0024 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
18 17 7 16 12 13 3 6 9 14 22 11 1 2 4 5 8 10 15 19 20 21 Md RA SV HV


z-Scores: S2 - Al
Standard Deviation for Proficiency Assessment 0.0027 mg/L (Equivalent to 10% CV)
z-Score
-3.3 -1.4 -0.7 -0.7 -0.5 -0.3 0.0 0.1 1.2 1.2 1.2 1.6
Laboratory
18 17 7 16 12 13 3 6 9 14 22 11

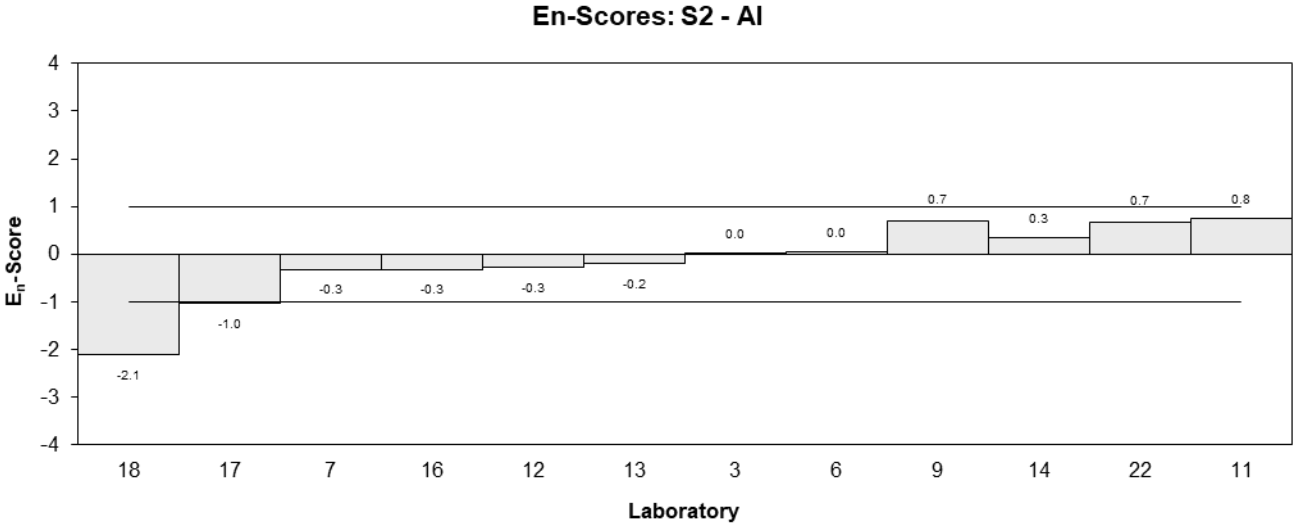

En-Scores: S2 - Al
En-Score
-2.1 -1.0 -0.3 -0.3 -0.3 -0.2 0.0 0.0 0.7 0.3 0.7 0.8
Laboratory
18 17 7 16 12 13 3 6 9 14 22 11

Figure 21

Table 26

Sample Details

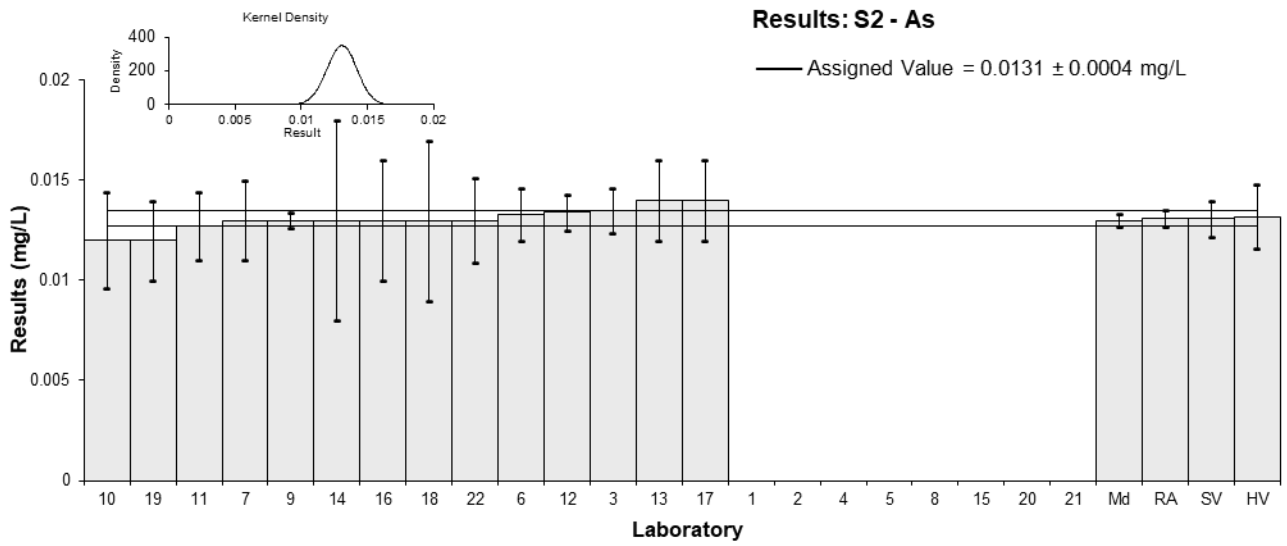
Sample No.	S2
Matrix	Potable Water
Analyte	As
Unit	mg/L

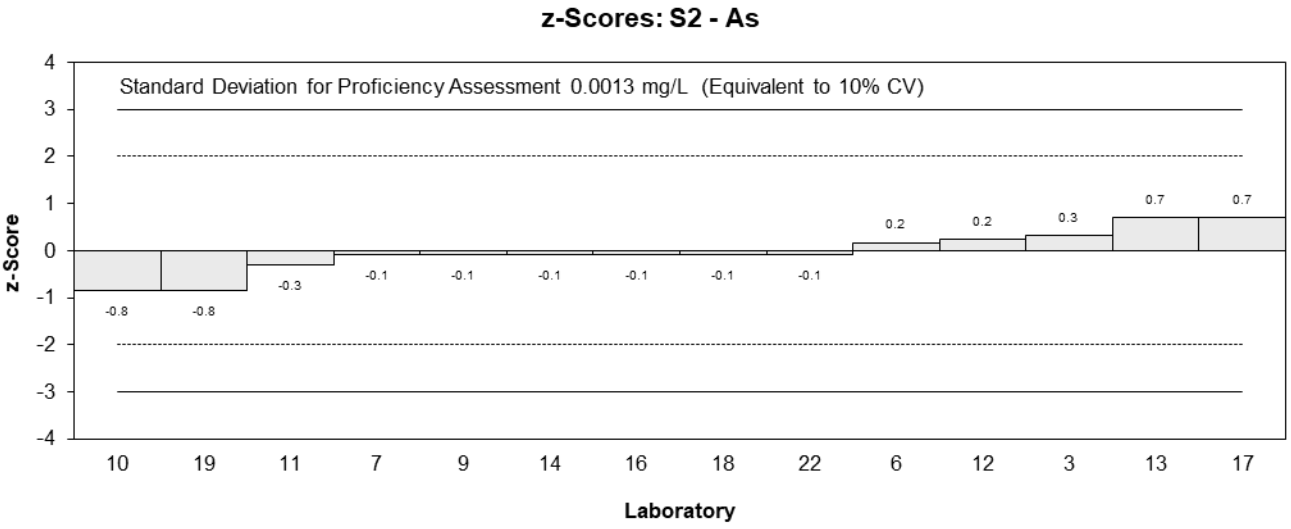
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.0135	0.0011	0.31	0.34
4	NT	NT		
5	NT	NT		
6	0.0133	0.0013	0.15	0.15
7	0.013	0.002	-0.08	-0.05
8	NT	NT		
9	0.013	0.0004	-0.08	-0.18
10	0.012	0.0024	-0.84	-0.45
11	0.0127	0.0017	-0.31	-0.23
12	0.0134	0.0009	0.23	0.30
13	0.014	0.002	0.69	0.44
14	0.013	0.005	-0.08	-0.02
15	< 0.07	NR		
16	0.013	0.003	-0.08	-0.03
17	0.014	0.002	0.69	0.44
18	0.013	0.004	-0.08	-0.02
19	0.012	0.002	-0.84	-0.54
20	NT	NT		
21	NT	NT		
22	0.013	0.0021	-0.08	-0.05

Statistics

Assigned Value	0.0131	0.0004
Spike Value	0.0131	0.0009
Homogeneity Value	0.0132	0.0016
Robust Average	0.0131	0.0004
Median	0.0130	0.0003
Mean	0.0131	
N	14	
Max	0.014	
Min	0.012	
Robust SD	0.00062	
Robust CV	4.7%	


Results: S2 - As
Assigned Value = 0.0131 ± 0.0004 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
10 19 11 7 9 14 16 18 22 6 12 3 13 17 1 2 4 5 8 15 20 21 Md RA SV HV


z-Scores: S2 - As
Standard Deviation for Proficiency Assessment 0.0013 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
10 19 11 7 9 14 16 18 22 6 12 3 13 17

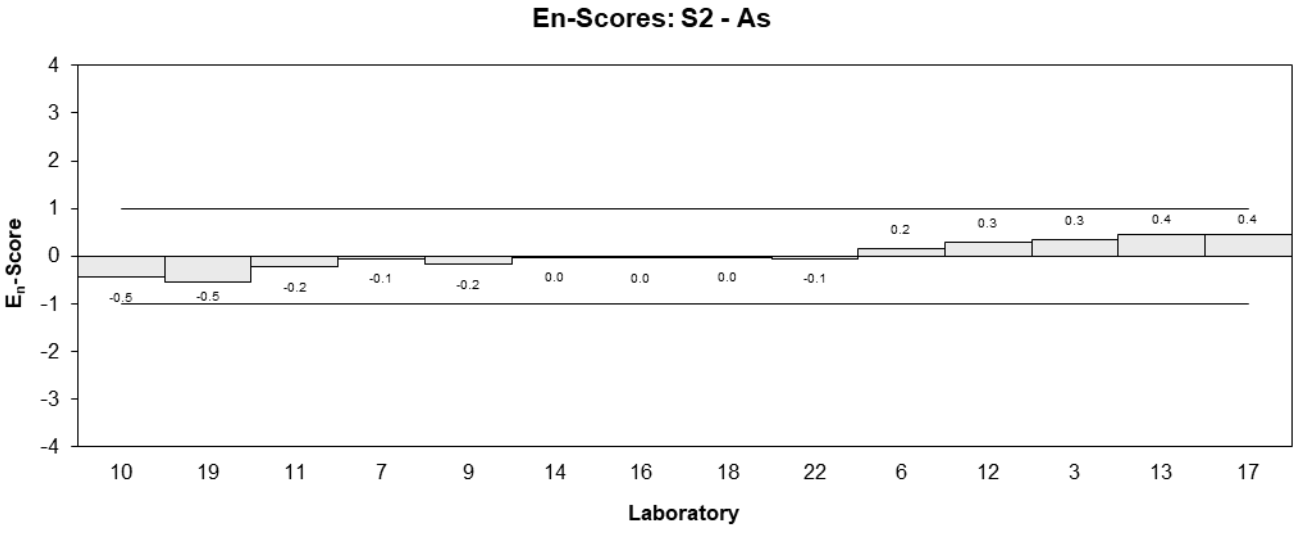

En-Scores: S2 - As
En-Score
Laboratory
10 19 11 7 9 14 16 18 22 6 12 3 13 17

Figure 22

Table 27

Sample Details

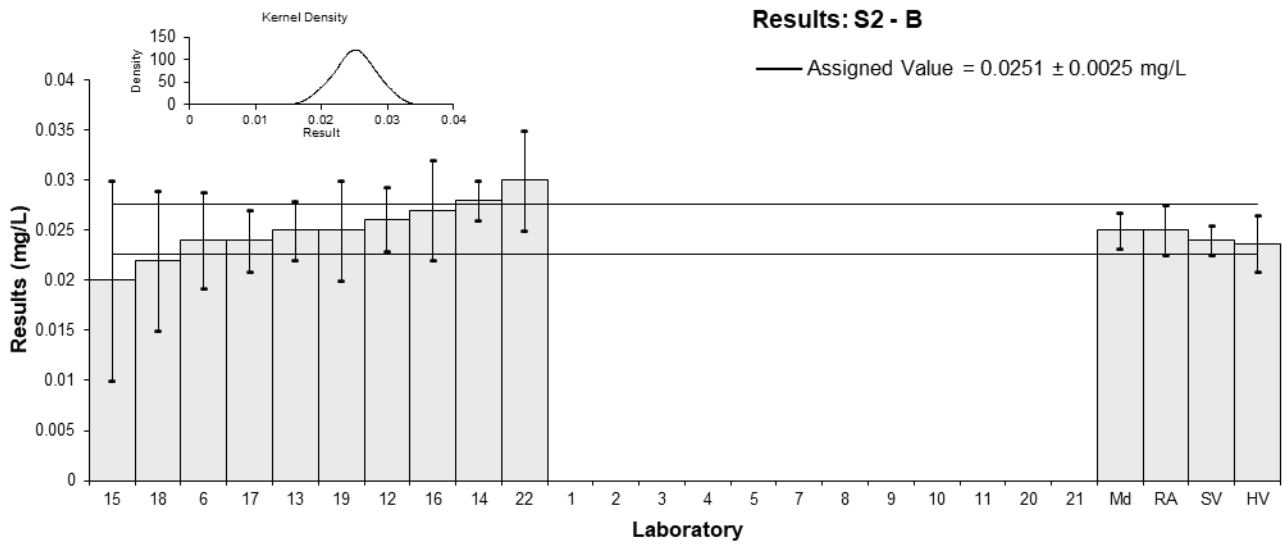
Sample No.	S2
Matrix	Potable Water
Analyte	B
Unit	mg/L

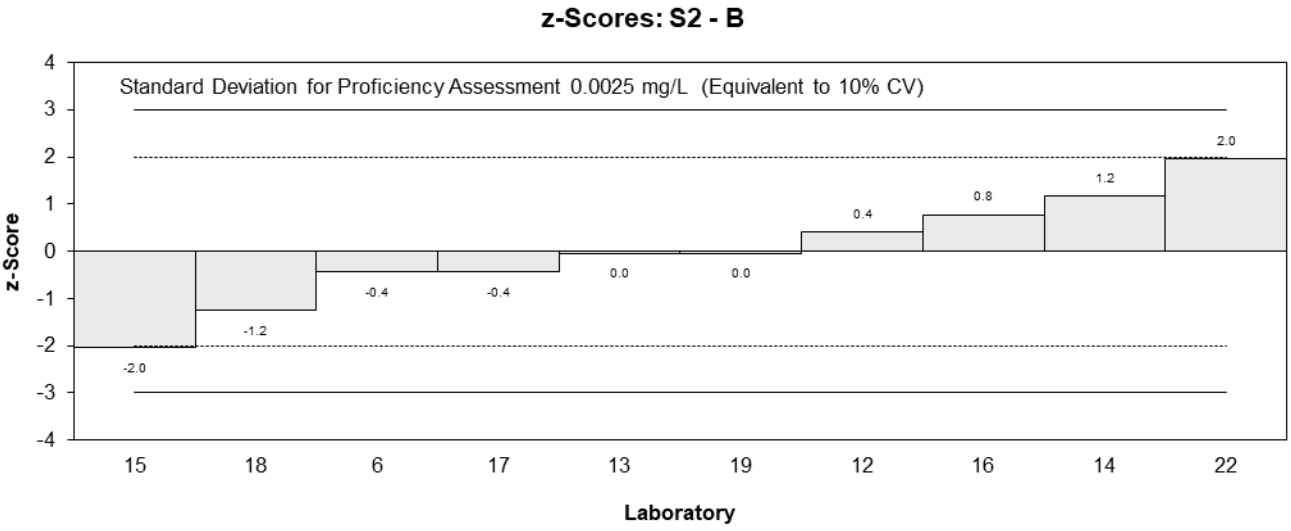
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	< 0.053	0.036		
4	NT	NT		
5	NT	NT		
6	0.024	0.0048	-0.44	-0.20
7	NT	NT		
8	NT	NT		
9	<0.05	NR		
10	< 0.05	NR		
11	< 0.05	NR		
12	0.0261	0.0032	0.40	0.25
13	0.025	0.003	-0.04	-0.03
14	0.028	0.002	1.16	0.91
15	0.02	0.01	-2.03	-0.49
16	0.027	0.005	0.76	0.34
17	0.024	0.0031	-0.44	-0.28
18	0.022	0.007	-1.24	-0.42
19	0.025	0.005	-0.04	-0.02
20	NT	NT		
21	NT	NT		
22	0.03	0.005	1.95	0.88

Statistics

Assigned Value	0.0251	0.0025
Spike Value	0.0240	0.0015
Homogeneity Value	0.0237	0.0028
Robust Average	0.0251	0.0025
Median	0.0250	0.0018
Mean	0.0251	
N	10	
Max	0.03	
Min	0.02	
Robust SD	0.0032	
Robust CV	13%	


Results: S2 - B
Assigned Value = 0.0251 ± 0.0025 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
15 18 6 17 13 19 12 16 14 22 1 2 3 4 5 7 8 9 10 11 20 21 Md RA SV HV


z-Scores: S2 - B
Standard Deviation for Proficiency Assessment 0.0025 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
15 18 6 17 13 19 12 16 14 22
-2.0
-1.2
-0.4
-0.4
0.0
0.0
0.4
0.8
1.2
2.0

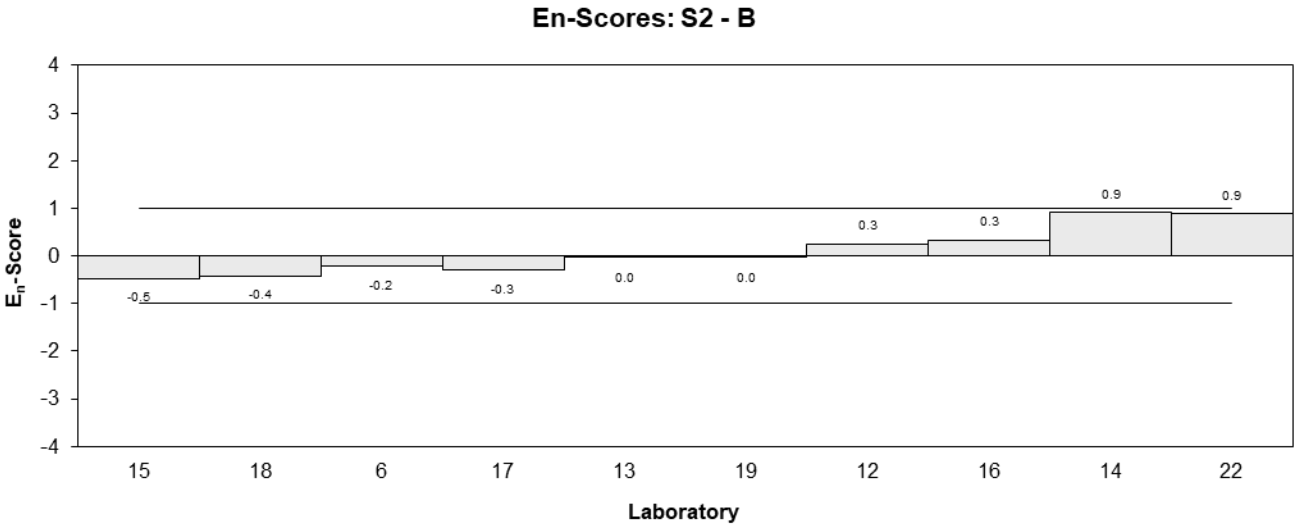

En-Scores: S2 - B
En-Score
Laboratory
15 18 6 17 13 19 12 16 14 22
-0.5
-0.4
-0.2
-0.3
0.0
0.0
0.3
0.3
0.9
0.9

Figure 23

Table 28

Sample Details

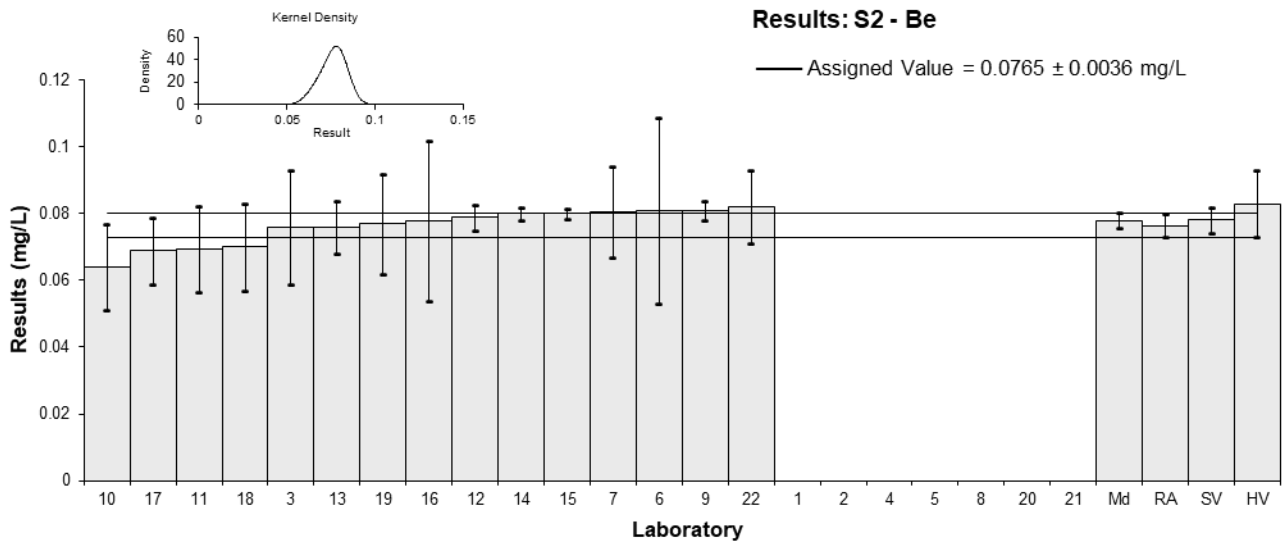
Sample No.	S2
Matrix	Potable Water
Analyte	Be
Unit	mg/L

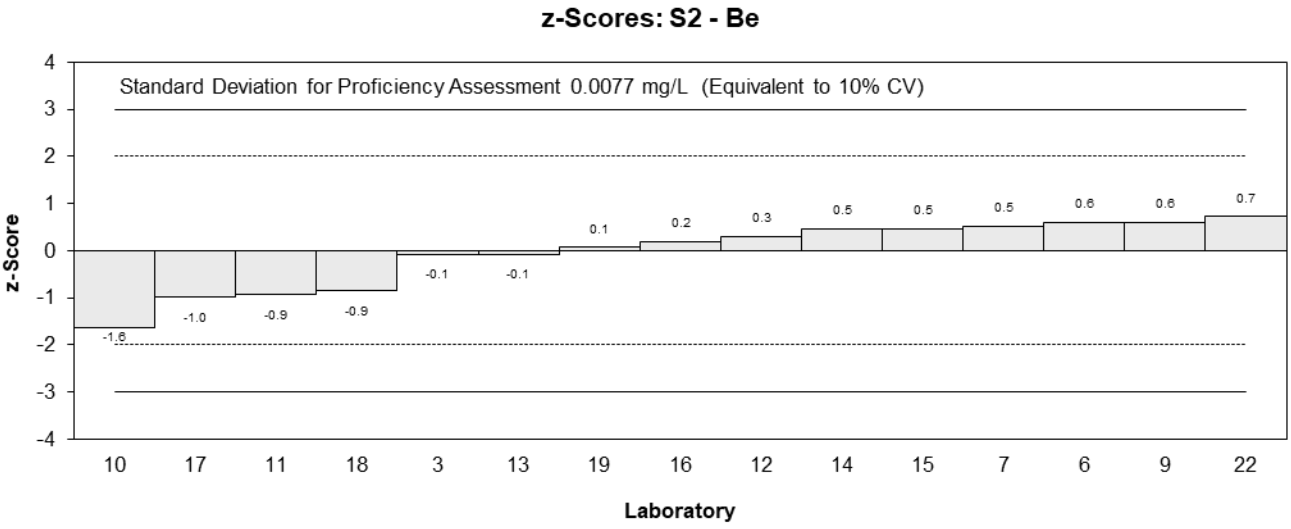
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.076	0.017	-0.07	-0.03
4	NT	NT		
5	NT	NT		
6	0.081	0.028	0.59	0.16
7	0.0805	0.0137	0.52	0.28
8	NT	NT		
9	0.081	0.003	0.59	0.96
10	0.064	0.013	-1.63	-0.93
11	0.0695	0.0128	-0.92	-0.53
12	0.0789	0.0039	0.31	0.45
13	0.076	0.008	-0.07	-0.06
14	0.08	0.002	0.46	0.85
15	0.08	0.0016	0.46	0.89
16	0.078	0.024	0.20	0.06
17	0.069	0.010	-0.98	-0.71
18	0.07	0.013	-0.85	-0.48
19	0.077	0.015	0.07	0.03
20	NT	NT		
21	NT	NT		
22	0.082	0.011	0.72	0.48

Statistics

Assigned Value	0.0765	0.0036
Spike Value	0.0781	0.0038
Homogeneity Value	0.083	0.010
Robust Average	0.0765	0.0036
Median	0.0780	0.0024
Mean	0.0762	
N	15	
Max	0.082	
Min	0.064	
Robust SD	0.0056	
Robust CV	7.3%	


Results: S2 - Be
Assigned Value = 0.0765 ± 0.0036 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
10 17 11 18 3 13 19 16 12 14 15 7 6 9 22 1 2 4 5 8 20 21 Md RA SV HV


z-Scores: S2 - Be
Standard Deviation for Proficiency Assessment 0.0077 mg/L (Equivalent to 10% CV)
z-Score
-1.6 -1.0 -0.9 -0.9 -0.1 -0.1 0.1 0.2 0.3 0.5 0.5 0.5 0.6 0.6 0.7
Laboratory
10 17 11 18 3 13 19 16 12 14 15 7 6 9 22

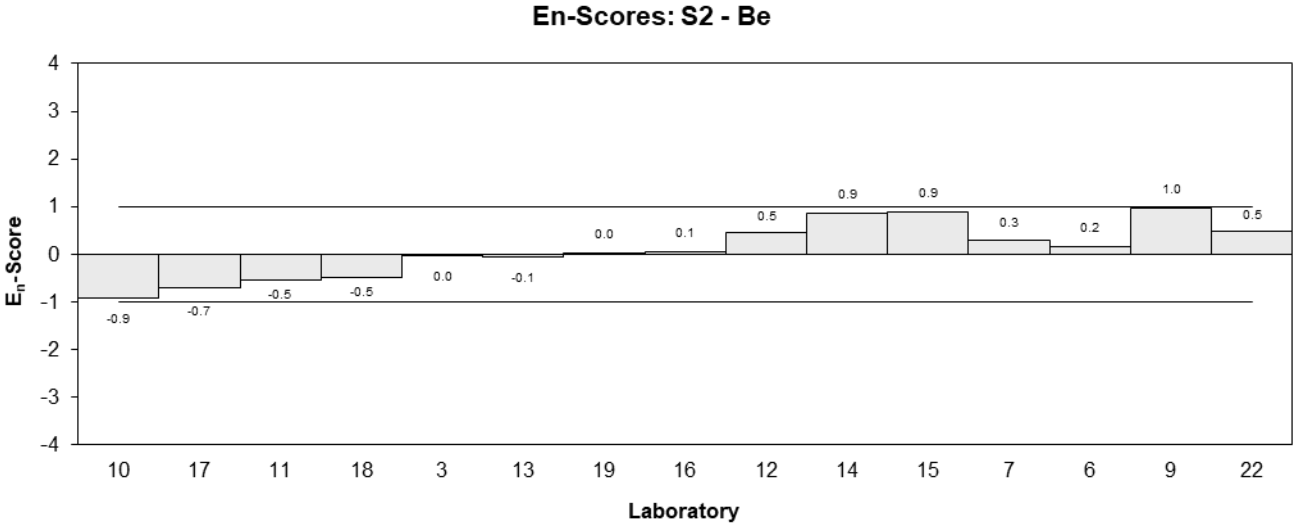

En-Scores: S2 - Be
En-Score
-0.9 -0.7 -0.5 -0.5 0.0 -0.1 0.0 0.1 0.5 0.9 0.9 0.3 0.2 1.0 0.5
Laboratory
10 17 11 18 3 13 19 16 12 14 15 7 6 9 22

Figure 24

Table 29

Sample Details

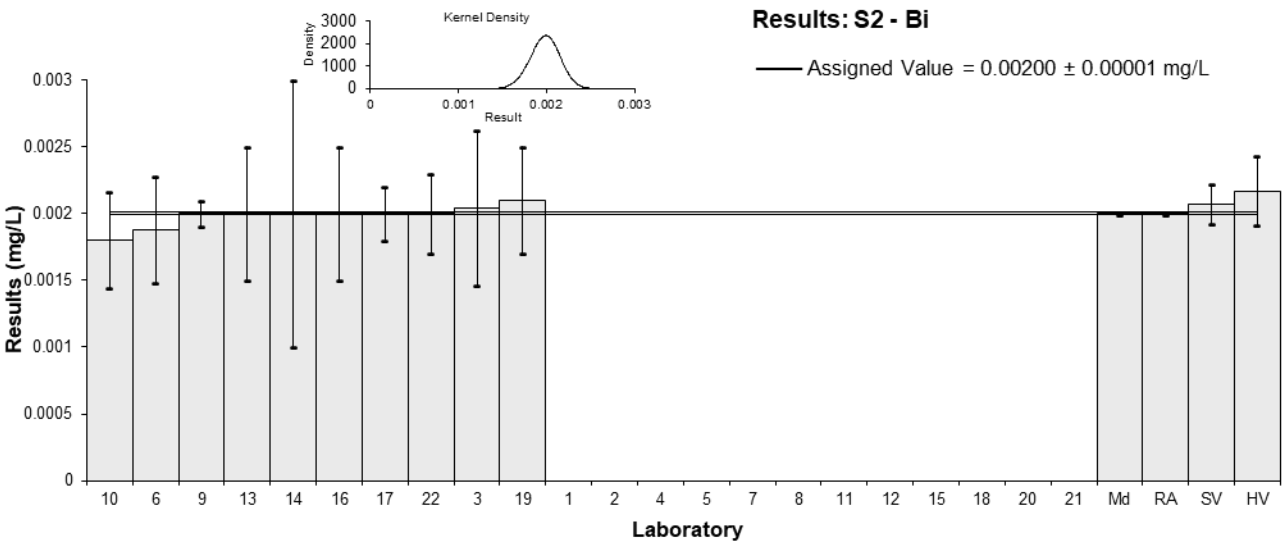
Sample No.	S2
Matrix	Potable Water
Analyte	Bi
Unit	mg/L

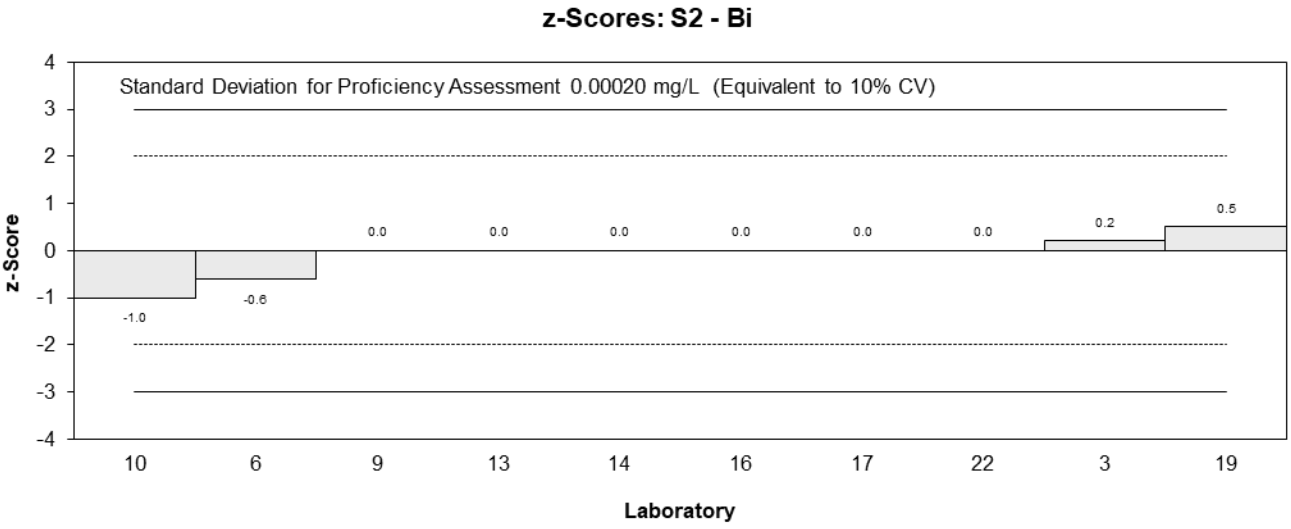
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.00204	0.00058	0.20	0.07
4	NT	NT		
5	NT	NT		
6	0.00188	0.0004	-0.60	-0.30
7	NT	NT		
8	NT	NT		
9	0.002	0.0001	0.00	0.00
10	0.0018	0.00036	-1.00	-0.56
11	< 0.005	NR		
12	NT	NT		
13	0.002	0.0005	0.00	0.00
14	0.002	0.001	0.00	0.00
15	NT	NT		
16	0.0020	0.0005	0.00	0.00
17	0.002	0.0002	0.00	0.00
18	NT	NT		
19	0.0021	0.0004	0.50	0.25
20	NT	NT		
21	NT	NT		
22	0.002	0.0003	0.00	0.00

Statistics

Assigned Value	0.00200	0.00001
Spike Value	0.00207	0.00015
Homogeneity Value	0.00217	0.00026
Robust Average	0.00200	0.00001
Median	0.00200	0.00001
Mean	0.00198	
N	10	
Max	0.0021	
Min	0.0018	
Robust SD	0.00001	
Robust CV	0.5%	


Results: S2 - Bi
Assigned Value = 0.00200 ± 0.00001 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
10 6 9 13 14 16 17 22 3 19 1 2 4 5 7 8 11 12 15 18 20 21 Md RA SV HV


z-Scores: S2 - Bi
Standard Deviation for Proficiency Assessment 0.00020 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
10 6 9 13 14 16 17 22 3 19

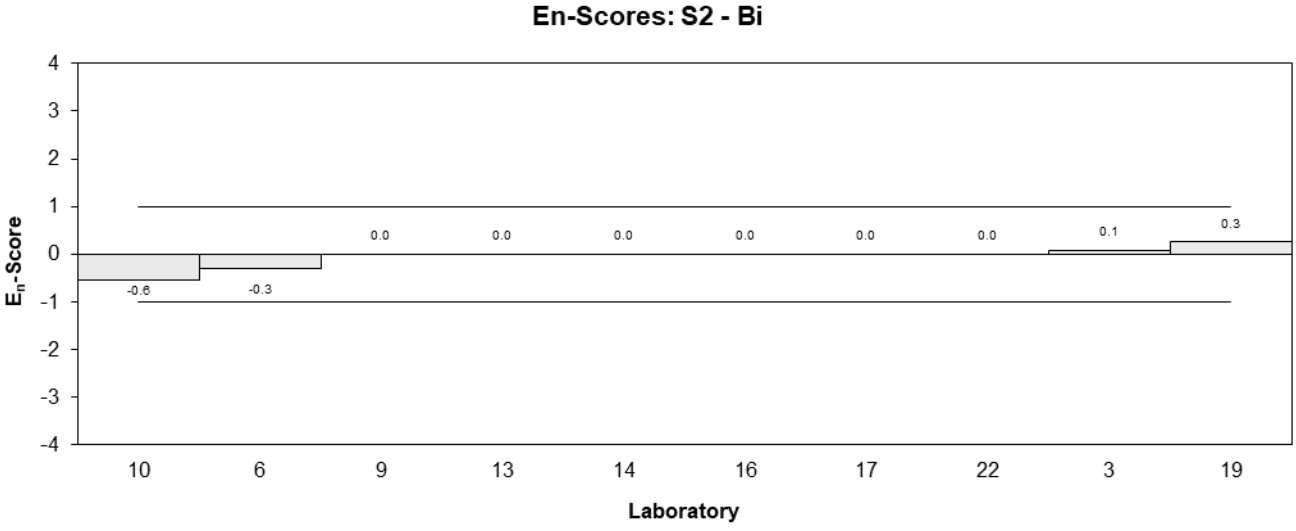

En-Scores: S2 - Bi
En-Score
Laboratory
10 6 9 13 14 16 17 22 3 19

Figure 25

Table 30

Sample Details

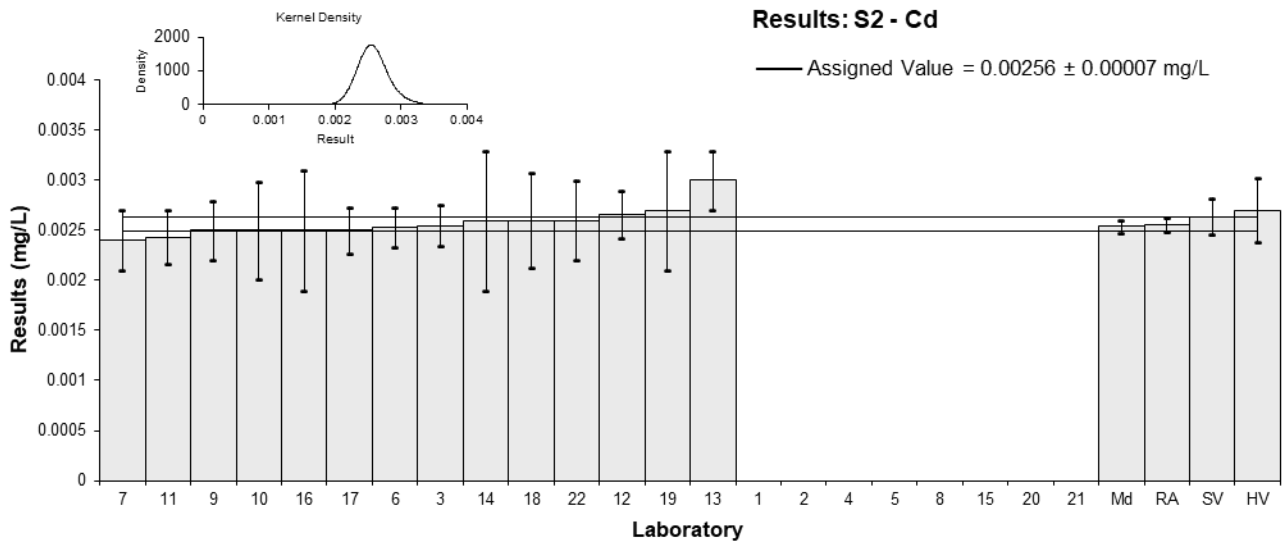
Sample No.	S2
Matrix	Potable Water
Analyte	Cd
Unit	mg/L

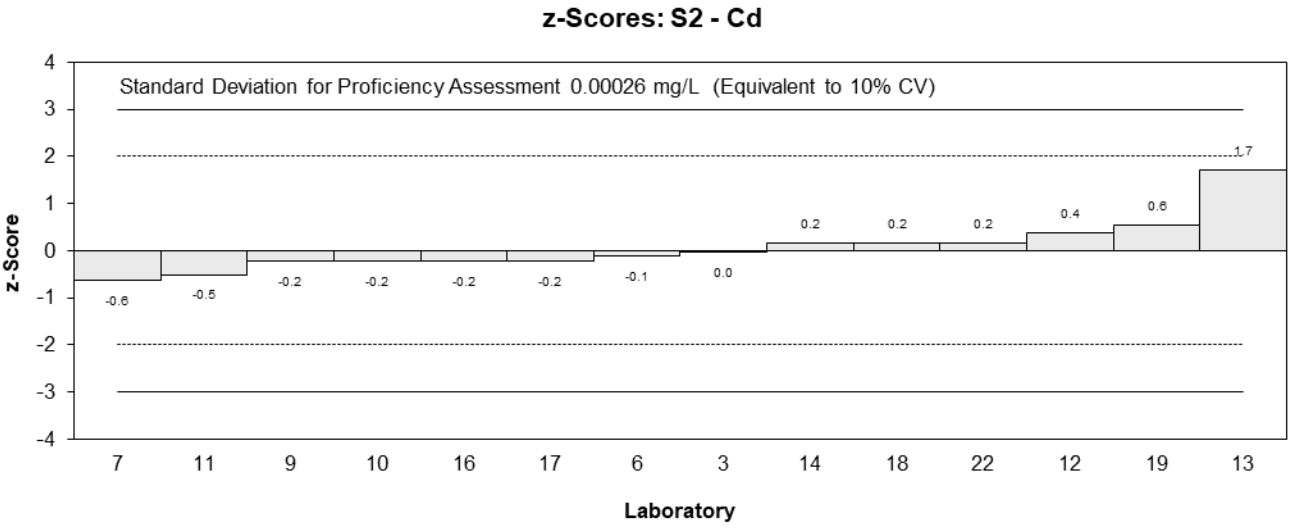
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.00255	0.00021	-0.04	-0.05
4	NT	NT		
5	NT	NT		
6	0.00253	0.0002	-0.12	-0.14
7	0.0024	0.0003	-0.63	-0.52
8	NT	NT		
9	0.0025	0.0003	-0.23	-0.19
10	0.0025	0.00049	-0.23	-0.12
11	0.00243	0.00027	-0.51	-0.47
12	0.00266	0.00024	0.39	0.40
13	0.003	0.0003	1.72	1.43
14	0.0026	0.0007	0.16	0.06
15	< 0.005	NR		
16	0.0025	0.0006	-0.23	-0.10
17	0.0025	0.00023	-0.23	-0.25
18	0.0026	0.00047	0.16	0.08
19	0.0027	0.0006	0.55	0.23
20	NT	NT		
21	NT	NT		
22	0.0026	0.0004	0.16	0.10

Statistics

Assigned Value	0.00256	0.00007
Spike Value	0.00264	0.00018
Homogeneity Value	0.00270	0.00032
Robust Average	0.00256	0.00007
Median	0.00254	0.00006
Mean	0.00258	
N	14	
Max	0.003	
Min	0.0024	
Robust SD	0.00011	
Robust CV	4.2%	


Results: S2 - Cd
Assigned Value = 0.00256 ± 0.00007 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
7 11 9 10 16 17 6 3 14 18 22 12 19 13 1 2 4 5 8 15 20 21 Md RA SV HV


z-Scores: S2 - Cd
Standard Deviation for Proficiency Assessment 0.00026 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
7 11 9 10 16 17 6 3 14 18 22 12 19 13
-0.6 -0.5 -0.2 -0.2 -0.2 -0.2 -0.1 0.0 0.2 0.2 0.2 0.4 0.6 1.7

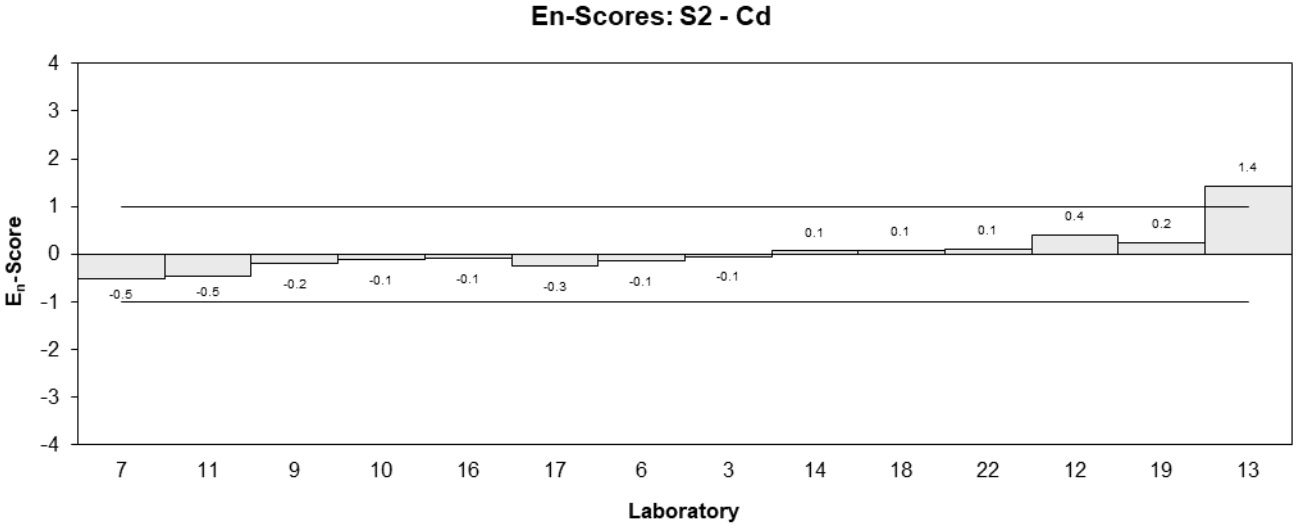

En-Scores: S2 - Cd
En-Score
Laboratory
7 11 9 10 16 17 6 3 14 18 22 12 19 13
-0.5 -0.5 -0.2 -0.1 -0.1 -0.3 -0.1 -0.1 0.1 0.1 0.1 0.4 0.2 1.4

Figure 26

Table 31

Sample Details

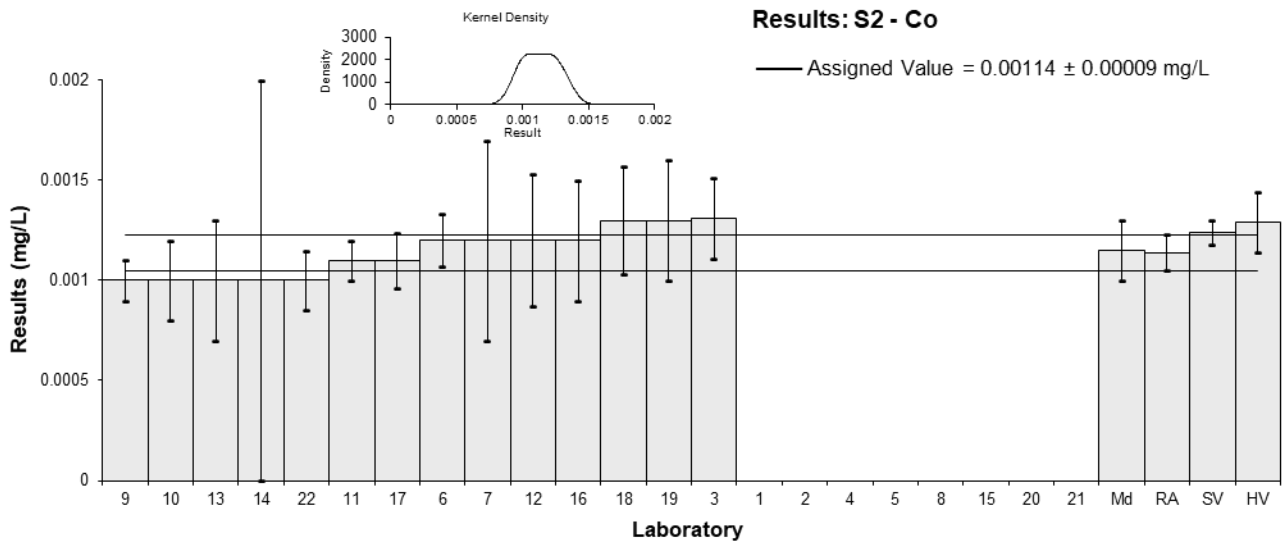
Sample No.	S2
Matrix	Potable Water
Analyte	Co
Unit	mg/L

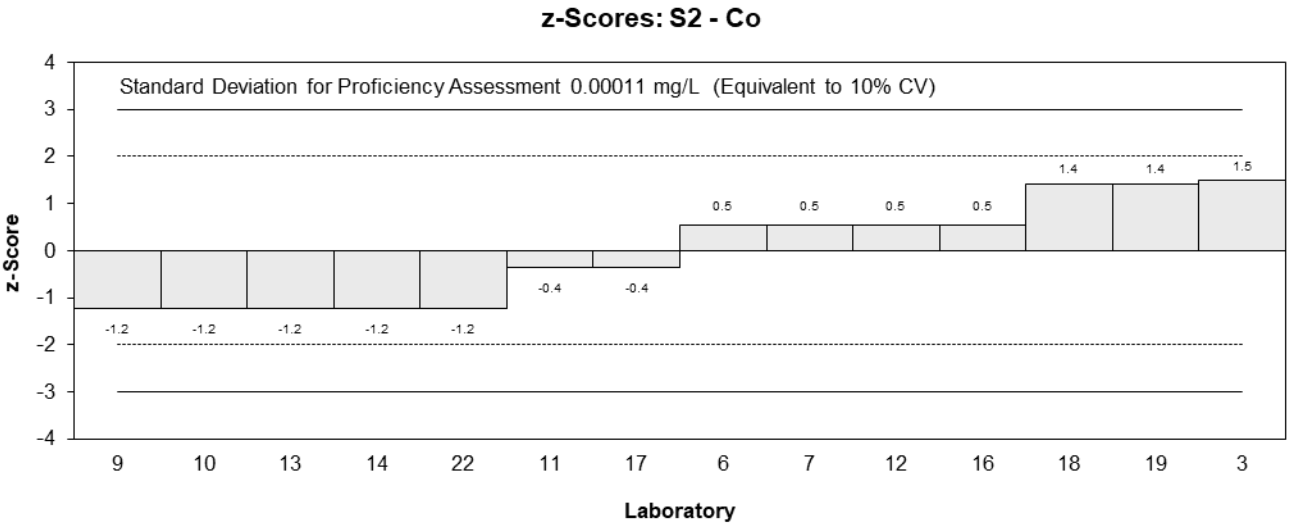
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.00131	0.00020	1.49	0.78
4	NT	NT		
5	NT	NT		
6	0.0012	0.000132	0.53	0.38
7	0.0012	0.0005	0.53	0.12
8	NT	NT		
9	0.001	0.0001	-1.23	-1.04
10	0.0010	0.00020	-1.23	-0.64
11	0.0011	0.0001	-0.35	-0.30
12	0.00120	0.00033	0.53	0.18
13	0.001	0.0003	-1.23	-0.45
14	0.001	0.001	-1.23	-0.14
15	< 0.02	NR		
16	0.0012	0.0003	0.53	0.19
17	0.0011	0.00014	-0.35	-0.24
18	0.0013	0.00027	1.40	0.56
19	0.0013	0.0003	1.40	0.51
20	NT	NT		
21	NT	NT		
22	0.001	0.00015	-1.23	-0.80

Statistics

Assigned Value	0.00114	0.00009
Spike Value	0.00124	0.00006
Homogeneity Value	0.00129	0.00015
Robust Average	0.00114	0.00009
Median	0.00115	0.00015
Mean	0.00114	
N	14	
Max	0.00131	
Min	0.001	
Robust SD	0.00014	
Robust CV	12%	


Results: S2 - Co
Assigned Value = 0.00114 ± 0.00009 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
9 10 13 14 22 11 17 6 7 12 16 18 19 3 1 2 4 5 8 15 20 21 Md RA SV HV


z-Scores: S2 - Co
Standard Deviation for Proficiency Assessment 0.00011 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
9 10 13 14 22 11 17 6 7 12 16 18 19 3

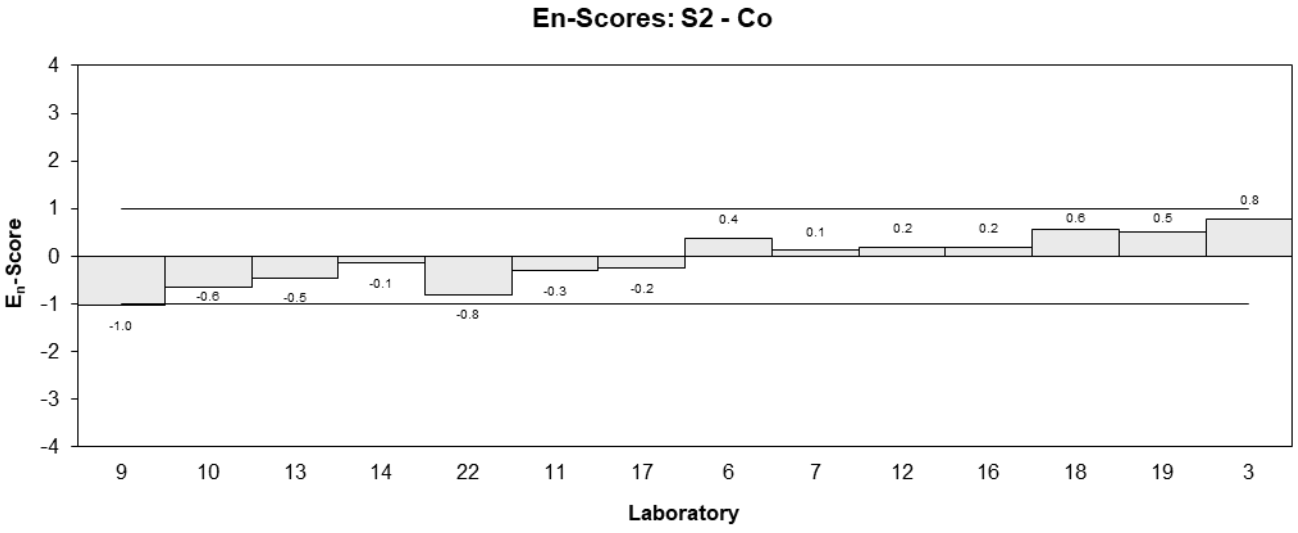

En-Scores: S2 - Co
En-Score
Laboratory
9 10 13 14 22 11 17 6 7 12 16 18 19 3

Figure 27

Table 32

Sample Details

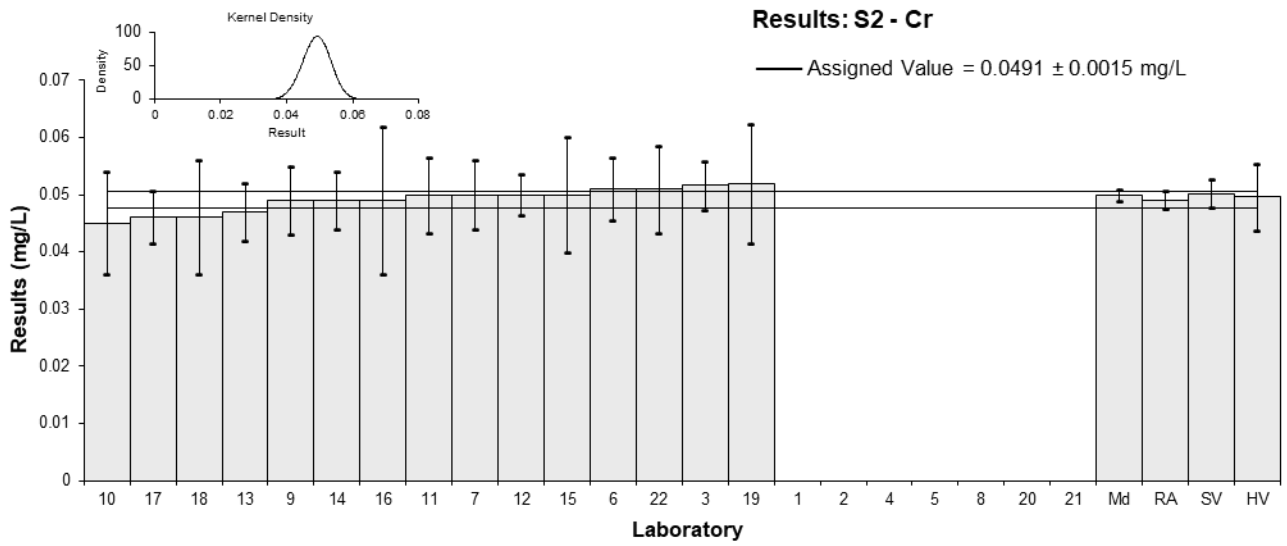
Sample No.	S2
Matrix	Potable Water
Analyte	Cr
Unit	mg/L

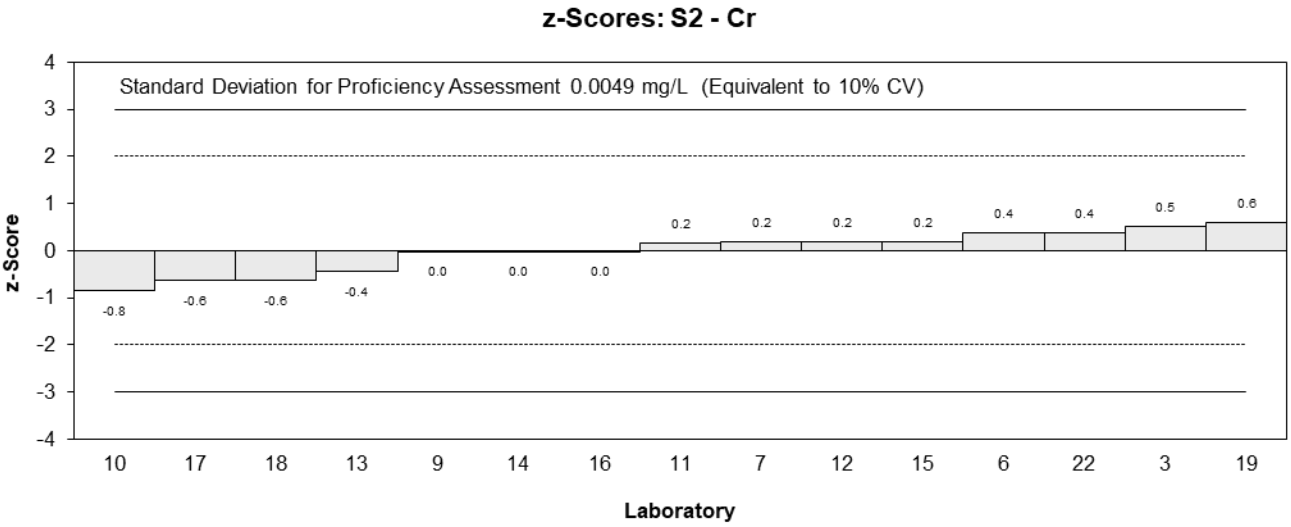
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.0516	0.0042	0.51	0.56
4	NT	NT		
5	NT	NT		
6	0.051	0.0055	0.39	0.33
7	0.050	0.006	0.18	0.15
8	NT	NT		
9	0.049	0.006	-0.02	-0.02
10	0.045	0.0090	-0.84	-0.45
11	0.0499	0.0066	0.16	0.12
12	0.0500	0.0036	0.18	0.23
13	0.047	0.005	-0.43	-0.40
14	0.049	0.005	-0.02	-0.02
15	0.05	0.01	0.18	0.09
16	0.049	0.013	-0.02	-0.01
17	0.046	0.0046	-0.63	-0.64
18	0.046	0.01	-0.63	-0.31
19	0.052	0.0104	0.59	0.28
20	NT	NT		
21	NT	NT		
22	0.051	0.0076	0.39	0.25

Statistics

Assigned Value	0.0491	0.0015
Spike Value	0.0502	0.0025
Homogeneity Value	0.0496	0.0059
Robust Average	0.0491	0.0015
Median	0.0499	0.0011
Mean	0.0491	
N	15	
Max	0.052	
Min	0.045	
Robust SD	0.0024	
Robust CV	4.8%	


Results: S2 - Cr
Assigned Value = 0.0491 ± 0.0015 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
10 17 18 13 9 14 16 11 7 12 15 6 22 3 19 1 2 4 5 8 20 21 Md RA SV HV


z-Scores: S2 - Cr
Standard Deviation for Proficiency Assessment 0.0049 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
10 17 18 13 9 14 16 11 7 12 15 6 22 3 19

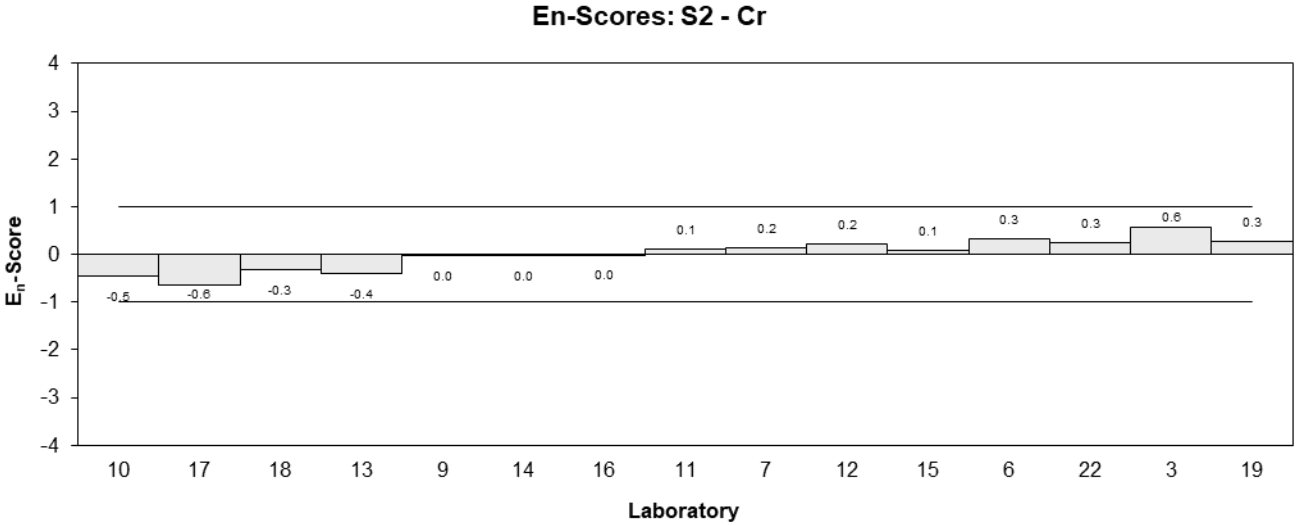

En-Scores: S2 - Cr
En-Score
Laboratory
10 17 18 13 9 14 16 11 7 12 15 6 22 3 19

Figure 28

Table 33

Sample Details

Sample No.	S2
Matrix	Potable Water
Analyte	Cs
Unit	mg/L

Participant Results

Lab. Code	Result	Uncertainty
1	NT	NT
2	NT	NT
3	0.00202	0.00015
4	NT	NT
5	NT	NT
6	0.002	0.0004
7	NT	NT
8	NT	NT
9	0.002	0.0001
10	NT	NT
11	NT	NT
12	NT	NT
13	NT	NT
14	NT	NT
15	NT	NT
16	NT	NT
17	<0.01	NR
18	NT	NT
19	0.0022	0.0004
20	NT	NT
21	NT	NT
22	NR	NR

Statistics

Assigned Value	Not Set	
Spike Value	0.00201	0.00010
Homogeneity Value	0.00213	0.00026
Robust Average	NA (N<6)	
Median	0.00201	0.00002
Mean	0.00206	
N	4	
Max	0.0022	
Min	0.002	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

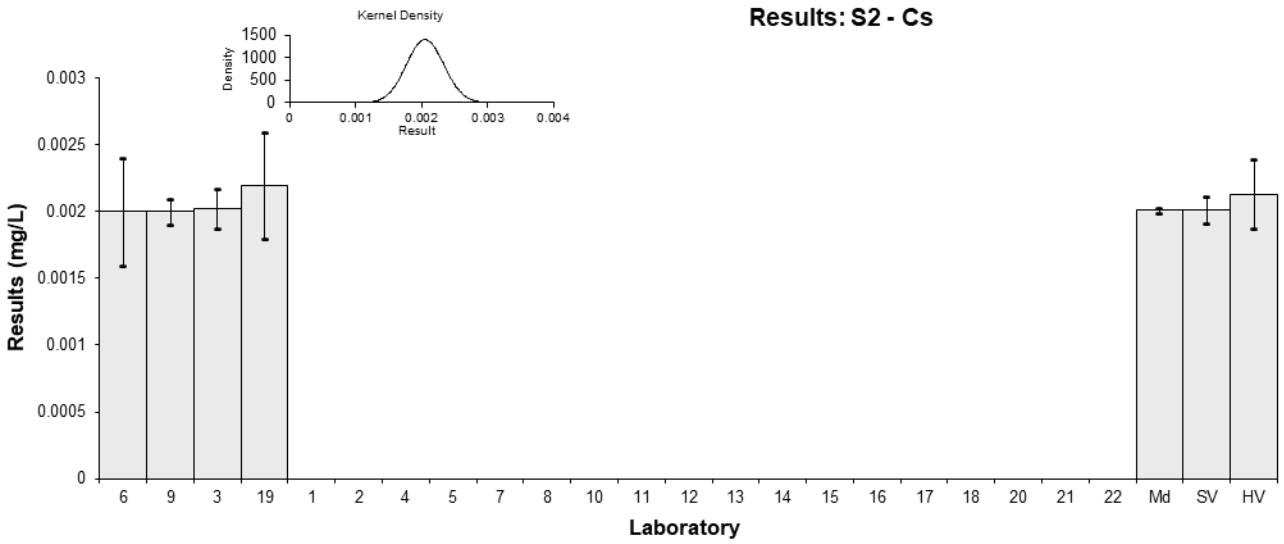

Results: S2 - Cs
Kernel Density
Density
1500
1000
500
0
0
0.001
0.002
0.003
0.004
Result
Results (mg/L)
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
6
9
3
19
1
2
4
5
7
8
10
11
12
13
14
15
16
17
18
20
21
22
Md
SV
HV
Laboratory

Figure 29

Table 34

Sample Details

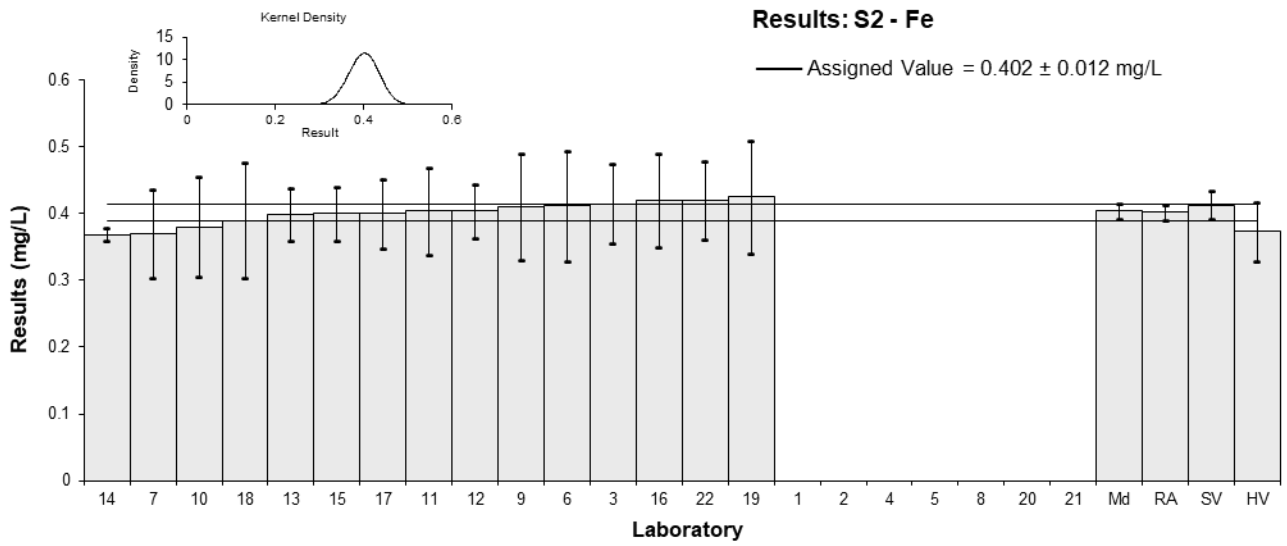
Sample No.	S2
Matrix	Potable Water
Analyte	Fe
Unit	mg/L

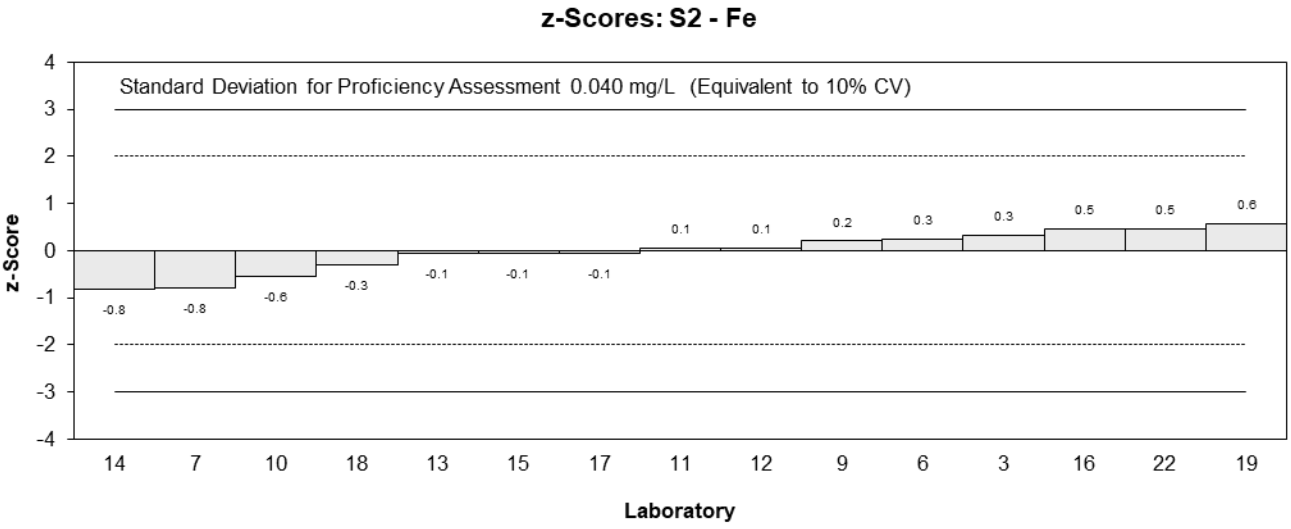
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.415	0.060	0.32	0.21
4	NT	NT		
5	NT	NT		
6	0.412	0.0824	0.25	0.12
7	0.370	0.067	-0.80	-0.47
8	NT	NT		
9	0.41	0.08	0.20	0.10
10	0.38	0.075	-0.55	-0.29
11	0.404	0.065	0.05	0.03
12	0.404	0.041	0.05	0.05
13	0.399	0.04	-0.07	-0.07
14	0.369	0.01	-0.82	-2.11
15	0.4	0.04	-0.05	-0.05
16	0.42	0.07	0.45	0.25
17	0.40	0.052	-0.05	-0.04
18	0.39	0.086	-0.30	-0.14
19	0.425	0.085	0.57	0.27
20	NT	NT		
21	NT	NT		
22	0.42	0.0588	0.45	0.30

Statistics

Assigned Value	0.402	0.012
Spike Value	0.413	0.021
Homogeneity Value	0.373	0.045
Robust Average	0.402	0.012
Median	0.404	0.011
Mean	0.401	
N	15	
Max	0.425	
Min	0.369	
Robust SD	0.018	
Robust CV	4.6%	


Results: S2 - Fe
Kernel Density
Density
Result
Assigned Value = 0.402 ± 0.012 mg/L
Results (mg/L)
Laboratory
14 7 10 18 13 15 17 11 12 9 6 3 16 22 19 1 2 4 5 8 20 21 Md RA SV HV


z-Scores: S2 - Fe
Standard Deviation for Proficiency Assessment 0.040 mg/L (Equivalent to 10% CV)
z-Score
-0.8 -0.8 -0.6 -0.3 -0.1 -0.1 -0.1 0.1 0.1 0.2 0.3 0.3 0.5 0.5 0.6
Laboratory
14 7 10 18 13 15 17 11 12 9 6 3 16 22 19

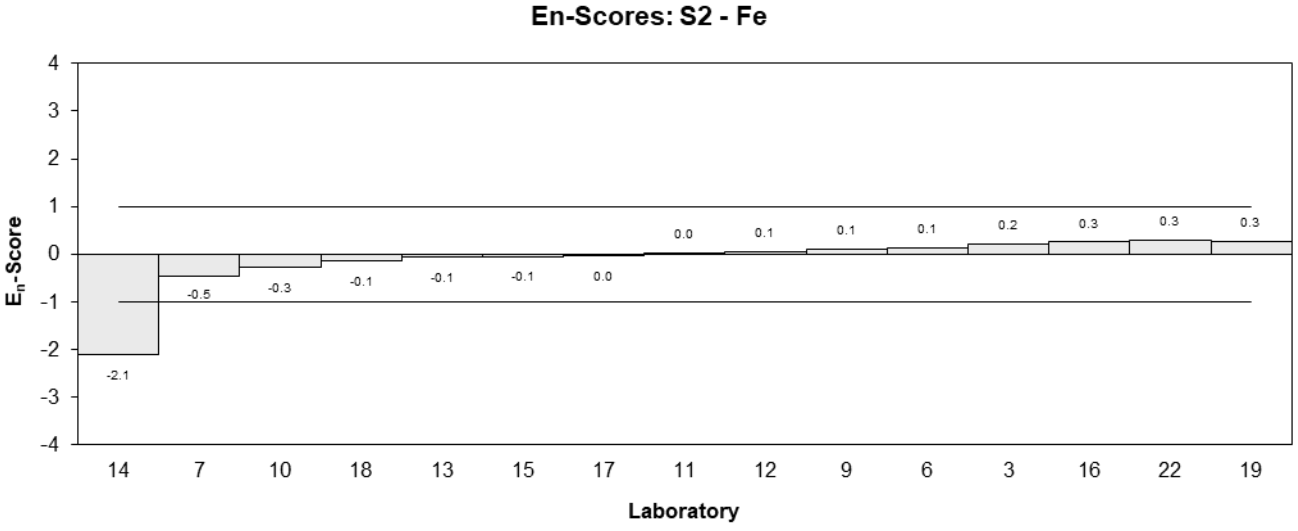

En-Scores: S2 - Fe
En-Score
-2.1 -0.5 -0.3 -0.1 -0.1 -0.1 0.0 0.0 0.1 0.1 0.1 0.2 0.3 0.3 0.3
Laboratory
14 7 10 18 13 15 17 11 12 9 6 3 16 22 19

Figure 30

Table 35

Sample Details

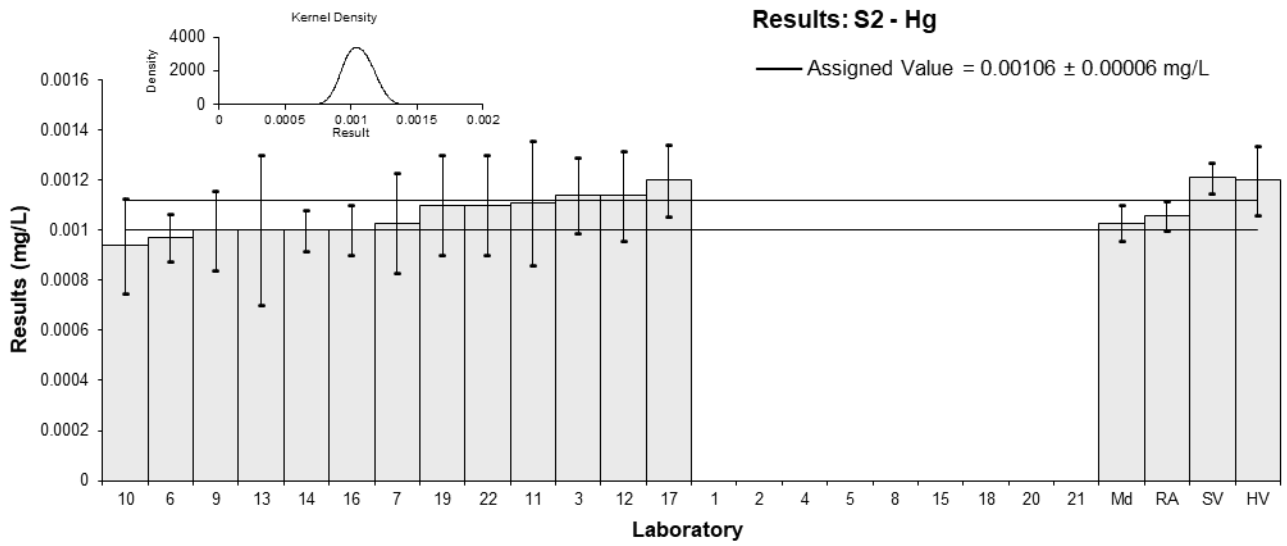
Sample No.	S2
Matrix	Potable Water
Analyte	Hg
Unit	mg/L

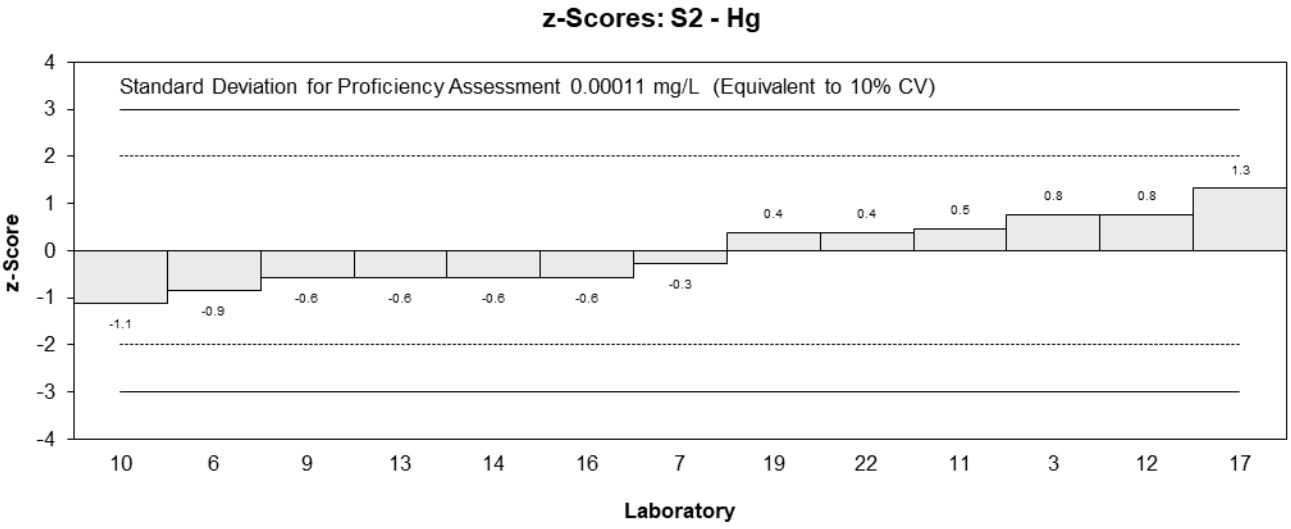
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.00114	0.00015	0.75	0.50
4	NT	NT		
5	NT	NT		
6	0.00097	0.000095	-0.85	-0.80
7	0.00103	0.0002	-0.28	-0.14
8	NT	NT		
9	0.0010	0.00016	-0.57	-0.35
10	0.00094	0.00019	-1.13	-0.60
11	0.00111	0.00025	0.47	0.19
12	0.00114	0.00018	0.75	0.42
13	0.001	0.0003	-0.57	-0.20
14	0.001	0.00008	-0.57	-0.60
15	< 0.05	NR		
16	0.0010	0.0001	-0.57	-0.51
17	0.0012	0.000144	1.32	0.90
18	NT	NT		
19	0.0011	0.0002	0.38	0.19
20	NT	NT		
21	NT	NT		
22	0.0011	0.0002	0.38	0.19

Statistics

Assigned Value	0.00106	0.00006
Spike Value	0.00121	0.00006
Homogeneity Value	0.00120	0.00014
Robust Average	0.00106	0.00006
Median	0.00103	0.00007
Mean	0.00106	
N	13	
Max	0.0012	
Min	0.00094	
Robust SD	0.000088	
Robust CV	8.3%	


Results: S2 - Hg
Assigned Value = 0.00106 ± 0.00006 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
10 6 9 13 14 16 7 19 22 11 3 12 17 1 2 4 5 8 15 18 20 21 Md RA SV HV


z-Scores: S2 - Hg
Standard Deviation for Proficiency Assessment 0.00011 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
10 6 9 13 14 16 7 19 22 11 3 12 17
-1.1 -0.9 -0.6 -0.6 -0.6 -0.6 -0.3 0.4 0.4 0.5 0.8 0.8 1.3

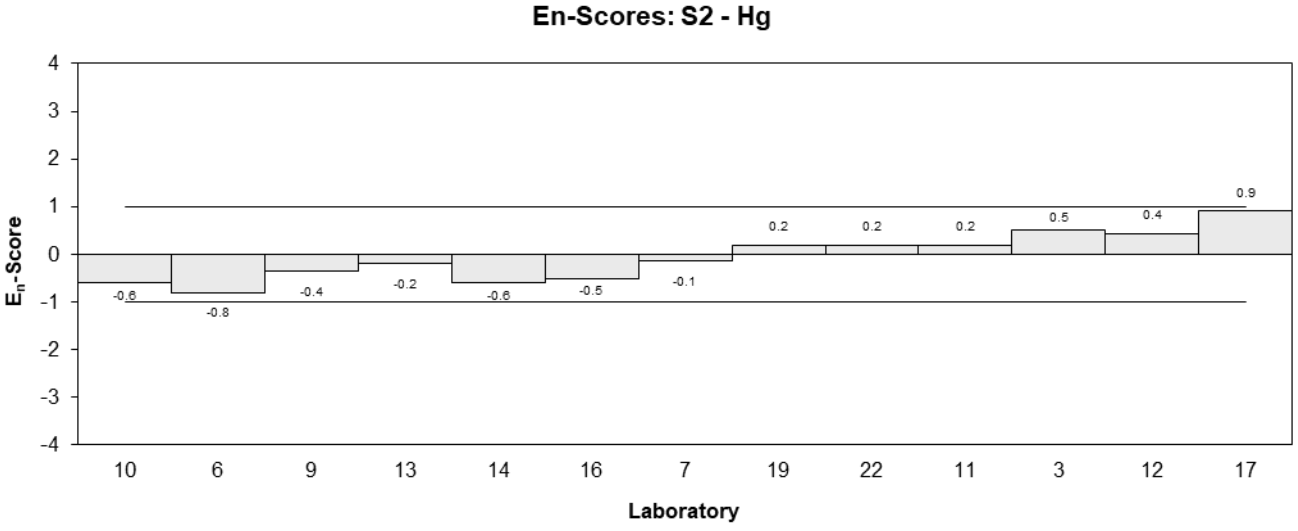

En-Scores: S2 - Hg
En-Score
Laboratory
10 6 9 13 14 16 7 19 22 11 3 12 17
-0.6 -0.8 -0.4 -0.2 -0.6 -0.5 -0.1 0.2 0.2 0.2 0.5 0.4 0.9

Figure 31

Table 36

Sample Details

Sample No.	S2
Matrix	Potable Water
Analyte	La
Unit	mg/L

Participant Results

Lab. Code	Result	Uncertainty
1	NT	NT
2	NT	NT
3	0.00202	0.00026
4	NT	NT
5	NT	NT
6	0.002	0.0004
7	NT	NT
8	NT	NT
9	NT	NT
10	NT	NT
11	NT	NT
12	NT	NT
13	NT	NT
14	NT	NT
15	NT	NT
16	0.0019	0.0005
17	<0.01	NR
18	NT	NT
19	0.0021	0.0004
20	NT	NT
21	NT	NT
22	0.002	0.0003

Statistics

Assigned Value	Not Set	
Spike Value	0.00201	0.00010
Homogeneity Value	0.00209	0.00025
Robust Average	NA (N<6)	
Median	0.00200	0.00003
Mean	0.00200	
N	5	
Max	0.0021	
Min	0.0019	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

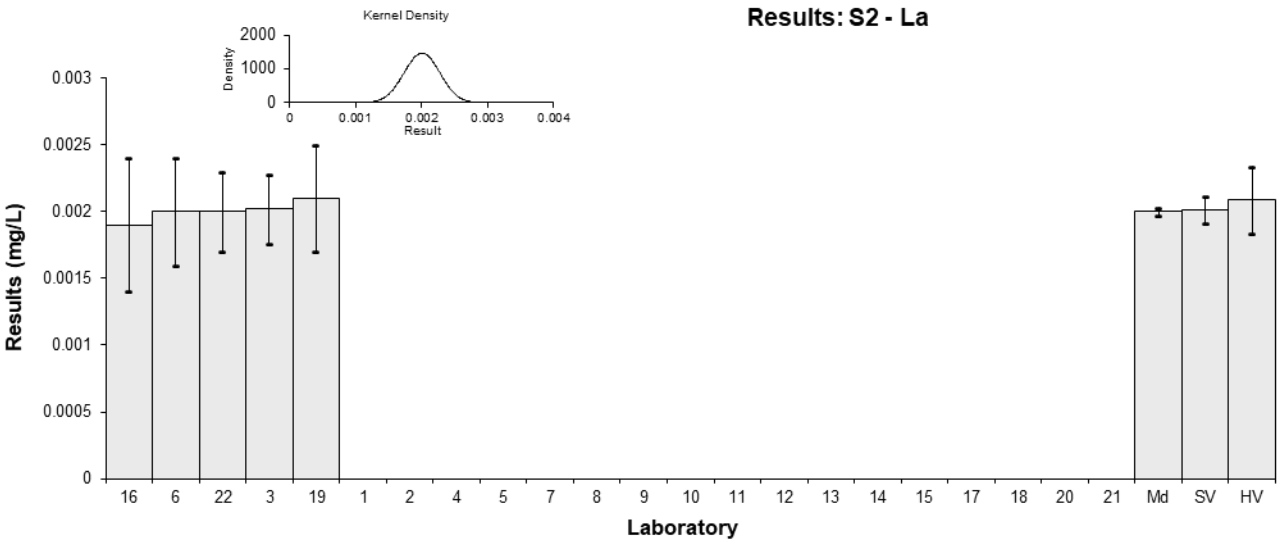

Results: S2 - La
Kernel Density
Density
2000
1000
0
0
0.001
0.002
0.003
0.004
Result
Results (mg/L)
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
16
6
22
3
19
1
2
4
5
7
8
9
10
11
12
13
14
15
17
18
20
21
Md
SV
HV
Laboratory

Figure 32

Table 37

Sample Details

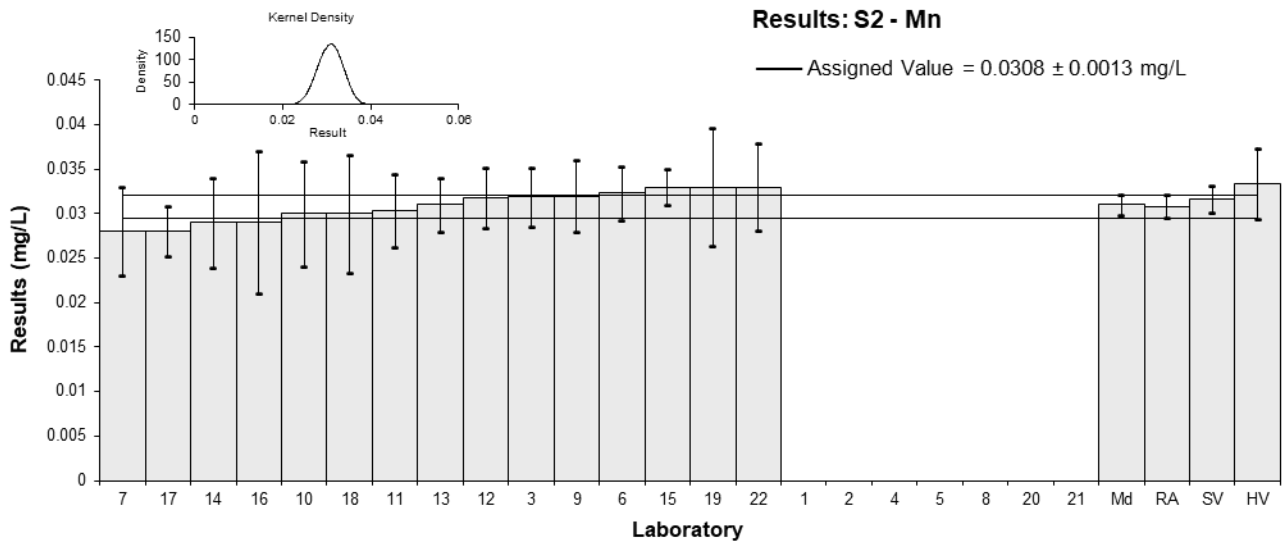
Sample No.	S2
Matrix	Potable Water
Analyte	Mn
Unit	mg/L

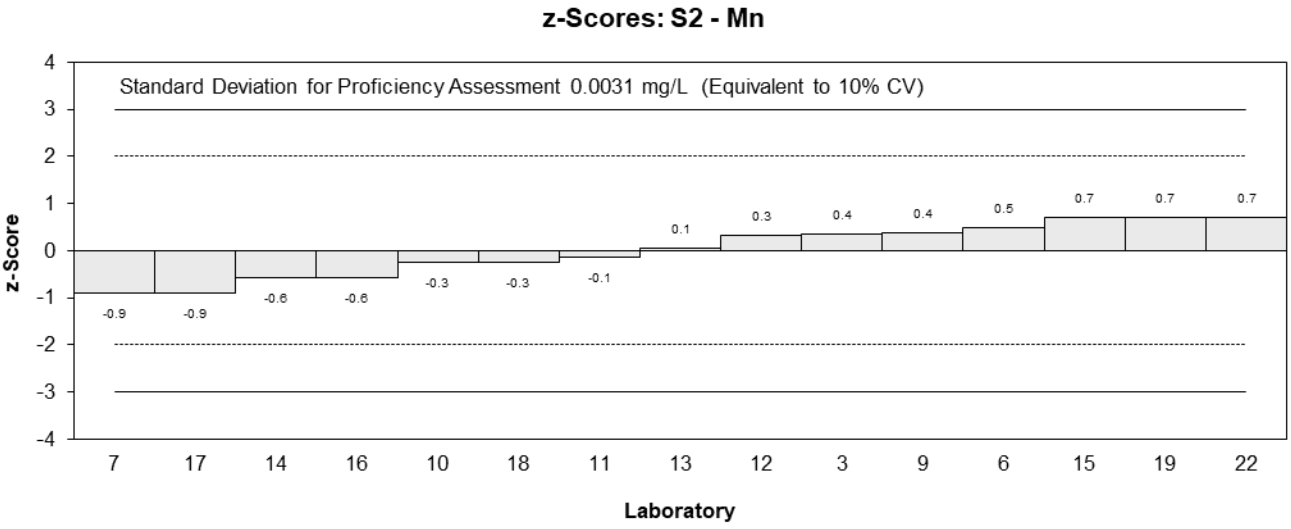
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.0319	0.0033	0.36	0.31
4	NT	NT		
5	NT	NT		
6	0.0323	0.003	0.49	0.46
7	0.028	0.005	-0.91	-0.54
8	NT	NT		
9	0.032	0.004	0.39	0.29
10	0.030	0.0059	-0.26	-0.13
11	0.0304	0.0041	-0.13	-0.09
12	0.0318	0.0034	0.32	0.27
13	0.031	0.003	0.06	0.06
14	0.029	0.005	-0.58	-0.35
15	0.033	0.002	0.71	0.92
16	0.029	0.008	-0.58	-0.22
17	0.028	0.0028	-0.91	-0.91
18	0.03	0.0066	-0.26	-0.12
19	0.033	0.0066	0.71	0.33
20	NT	NT		
21	NT	NT		
22	0.033	0.00495	0.71	0.43

Statistics

Assigned Value	0.0308	0.0013
Spike Value	0.0316	0.0015
Homogeneity Value	0.0334	0.0040
Robust Average	0.0308	0.0013
Median	0.0310	0.0012
Mean	0.0308	
N	15	
Max	0.033	
Min	0.028	
Robust SD	0.002	
Robust CV	6.5%	


Results: S2 - Mn
Assigned Value = 0.0308 ± 0.0013 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
7 17 14 16 10 18 11 13 12 3 9 6 15 19 22 1 2 4 5 8 20 21 Md RA SV HV


z-Scores: S2 - Mn
Standard Deviation for Proficiency Assessment 0.0031 mg/L (Equivalent to 10% CV)
z-Score
-0.9 -0.9 -0.6 -0.6 -0.3 -0.3 -0.1 0.1 0.3 0.4 0.4 0.5 0.7 0.7 0.7
Laboratory
7 17 14 16 10 18 11 13 12 3 9 6 15 19 22

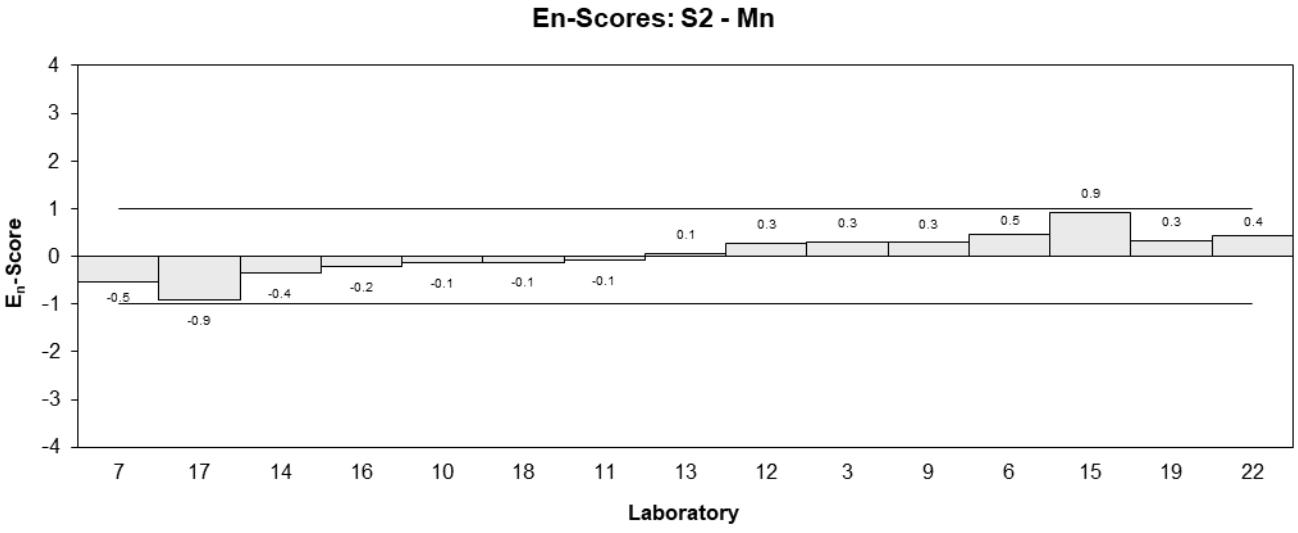

En-Scores: S2 - Mn
En-Score
-0.5 -0.9 -0.4 -0.2 -0.1 -0.1 -0.1 0.1 0.3 0.3 0.3 0.5 0.9 0.3 0.4
Laboratory
7 17 14 16 10 18 11 13 12 3 9 6 15 19 22

Figure 33

Table 38

Sample Details

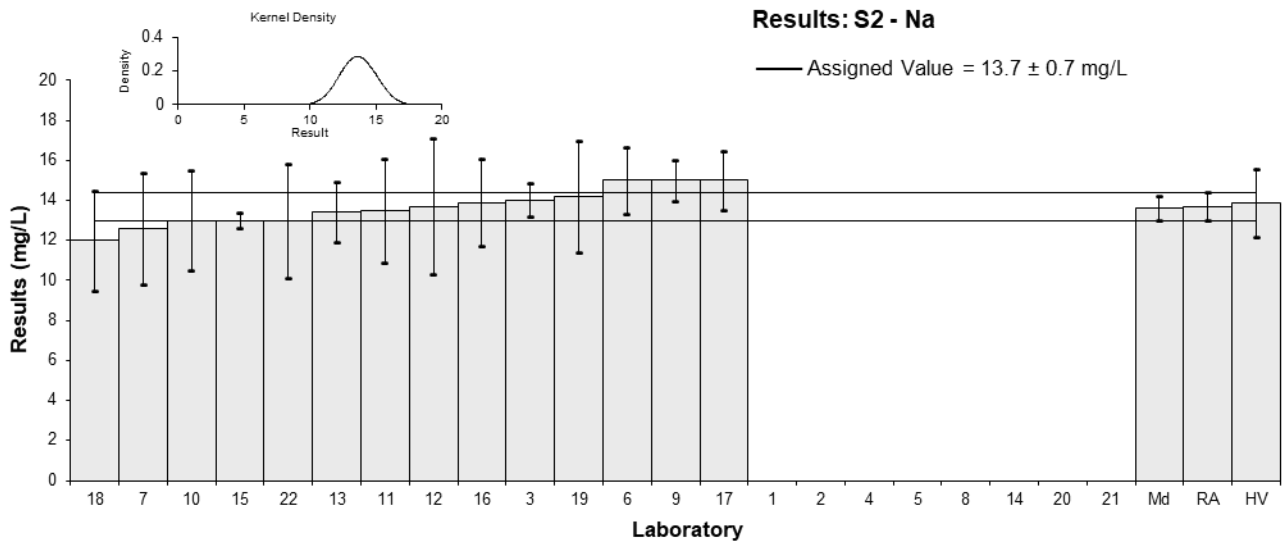
Sample No.	S2
Matrix	Potable Water
Analyte	Na
Unit	mg/L

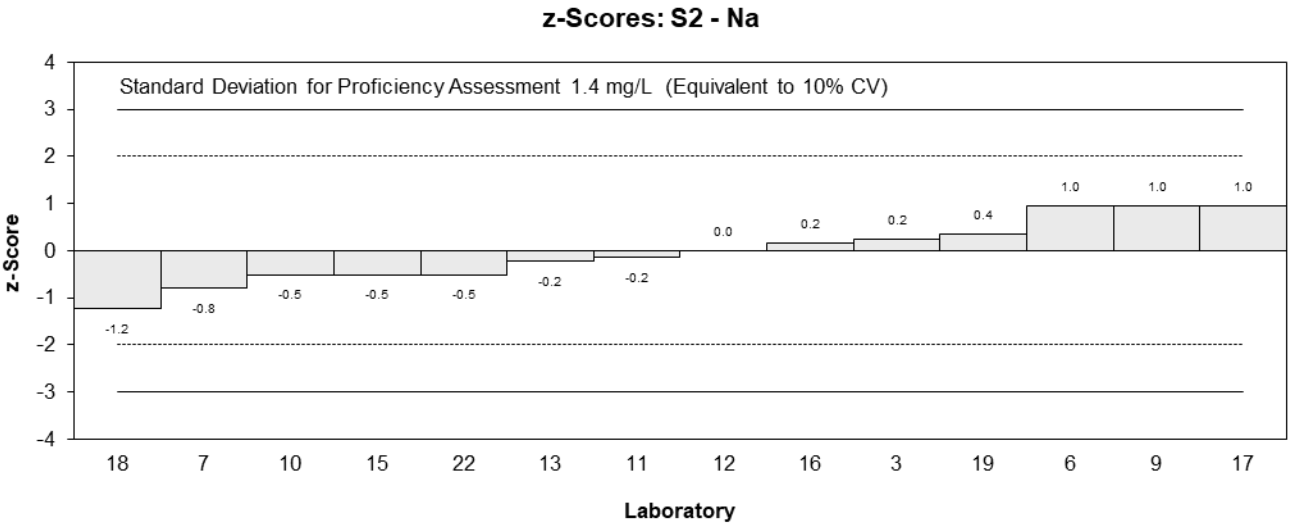
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	14.03	0.85	0.24	0.30
4	NT	NT		
5	NT	NT		
6	15	1.68	0.95	0.71
7	12.6	2.8	-0.80	-0.38
8	NT	NT		
9	15	1	0.95	1.07
10	13	2.50	-0.51	-0.27
11	13.5	2.6	-0.15	-0.07
12	13.7	3.4	0.00	0.00
13	13.4	1.5	-0.22	-0.18
14	NT	NT		
15	13	0.4	-0.51	-0.87
16	13.9	2.2	0.15	0.09
17	15	1.5	0.95	0.79
18	12	2.5	-1.24	-0.65
19	14.2	2.8	0.36	0.17
20	NT	NT		
21	NT	NT		
22	13	2.86	-0.51	-0.24

Statistics

Assigned Value	13.7	0.7
Spike Value	Not Spiked	
Homogeneity Value	13.9	1.7
Robust Average	13.7	0.7
Median	13.6	0.6
Mean	13.7	
N	14	
Max	15	
Min	12	
Robust SD	1.0	
Robust CV	7.5%	


Results: S2 - Na
Assigned Value = 13.7 ± 0.7 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
18 7 10 15 22 13 11 12 16 3 19 6 9 17 1 2 4 5 8 14 20 21 Md RA HV


z-Scores: S2 - Na
Standard Deviation for Proficiency Assessment 1.4 mg/L (Equivalent to 10% CV)
z-Score
-1.2 -0.8 -0.5 -0.5 -0.5 -0.2 -0.2 0.0 0.2 0.2 0.4 1.0 1.0 1.0
Laboratory
18 7 10 15 22 13 11 12 16 3 19 6 9 17

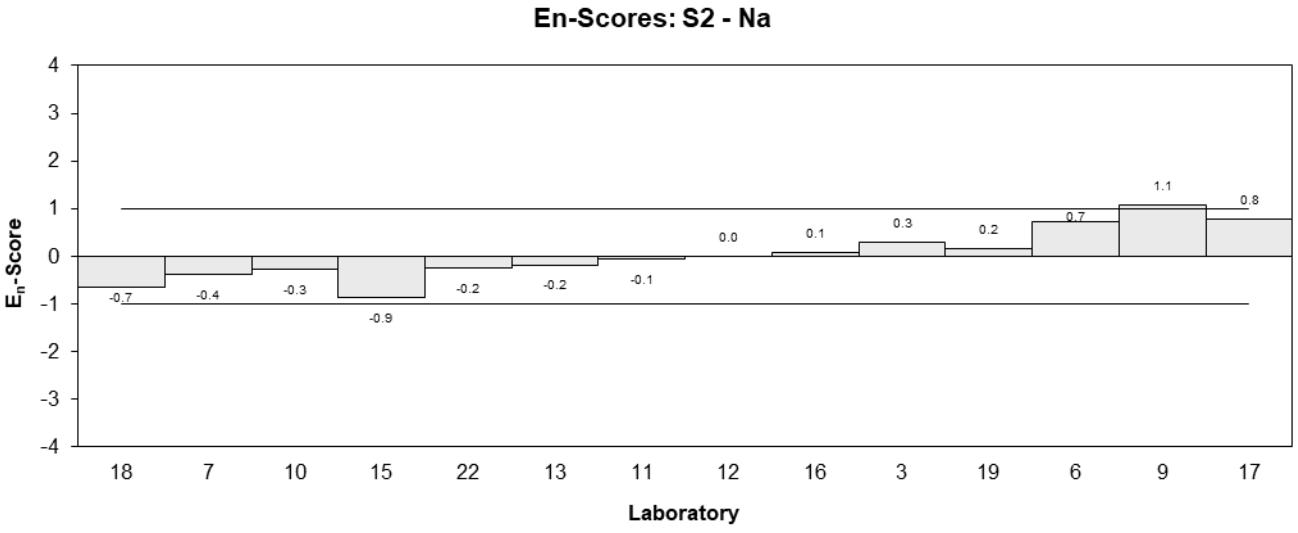

En-Scores: S2 - Na
En-Score
-0.7 -0.4 -0.3 -0.9 -0.2 -0.2 -0.1 0.0 0.1 0.3 0.2 0.7 1.1 0.8
Laboratory
18 7 10 15 22 13 11 12 16 3 19 6 9 17

Figure 34

Table 39

Sample Details

Sample No.	S2
Matrix	Potable Water
Analyte	P
Unit	mg/L

Participant Results

Lab. Code	Result	Uncertainty
1	NT	NT
2	NT	NT
3	0.083	0.016
4	NT	NT
5	NT	NT
6	<1	0.086
7	NT	NT
8	NT	NT
9	NT	NT
10	0.077	0.015
11	< 0.5	NR
12	NT	NT
13	<0.5	NR
14	NT	NT
15	< 0.3	NR
16	0.11	0.03
17	0.10	0.01
18	NT	NT
19	<0.05	NR
20	NT	NT
21	NT	NT
22	<0.1	NR

Statistics

Assigned Value	Not Set	
Spike Value	0.101	0.005
Homogeneity Value	0.101	0.012
Robust Average	NA (N<6)	
Median	0.092	0.021
Mean	0.093	
N	4	
Max	0.11	
Min	0.077	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

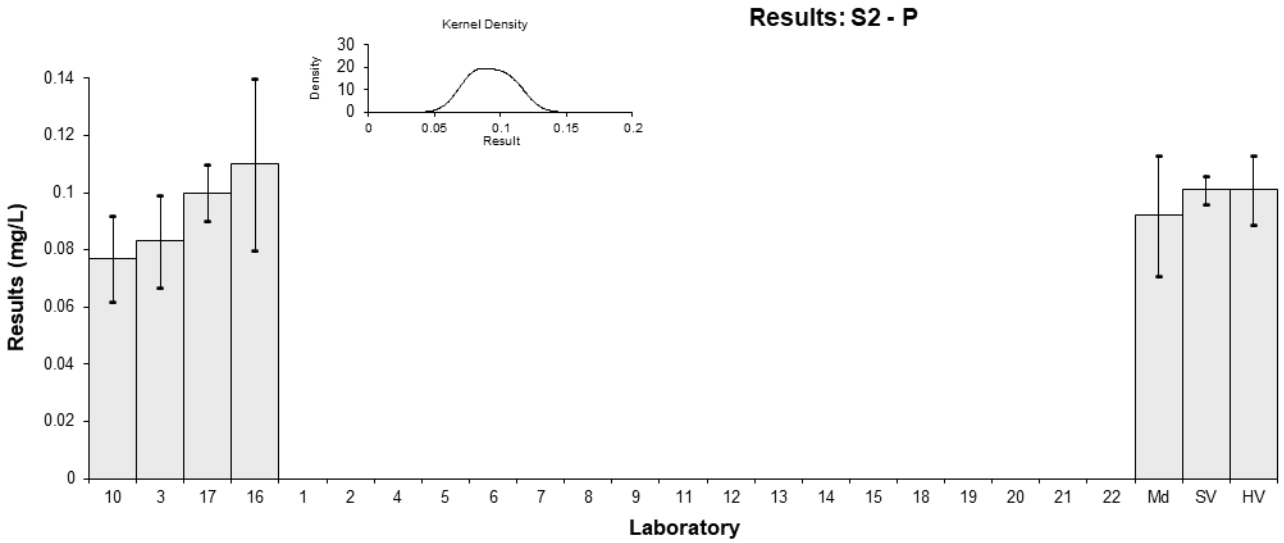

Results: S2 - P
Kernel Density
Density
Result
Results (mg/L)
Laboratory
10
3
17
16
1
2
4
5
6
7
8
9
11
12
13
14
15
18
19
20
21
22
Md
SV
HV

Figure 35

Table 40

Sample Details

Sample No.	S2
Matrix	Potable Water
Analyte	Pb
Unit	mg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.00913	0.00056	0.21	0.34
4	NT	NT		
5	NT	NT		
6	0.0086	0.001	-0.38	-0.34
7	0.0090	0.0013	0.07	0.05
8	NT	NT		
9	0.009	0.0004	0.07	0.15
10	0.0079	0.0016	-1.16	-0.65
11	0.0089	0.0011	-0.04	-0.04
12	0.00906	0.00097	0.13	0.12
13	0.009	0.001	0.07	0.06
14	0.009	0.003	0.07	0.02
15	< 0.04	NR		
16	0.0086	0.0019	-0.38	-0.18
17	0.0080	0.0012	-1.05	-0.78
18	0.0088	0.0011	-0.16	-0.13
19	0.009	0.002	0.07	0.03
20	NT	NT		
21	NT	NT		
22	0.009	0.0014	0.07	0.04

Statistics

Assigned Value	0.00894	0.00008
Spike Value	0.00917	0.00045
Homogeneity Value	0.0092	0.0011
Robust Average	0.00894	0.00008
Median	0.00900	0.00008
Mean	0.00879	
N	14	
Max	0.00913	
Min	0.0079	
Robust SD	0.00012	
Robust CV	1.3%	

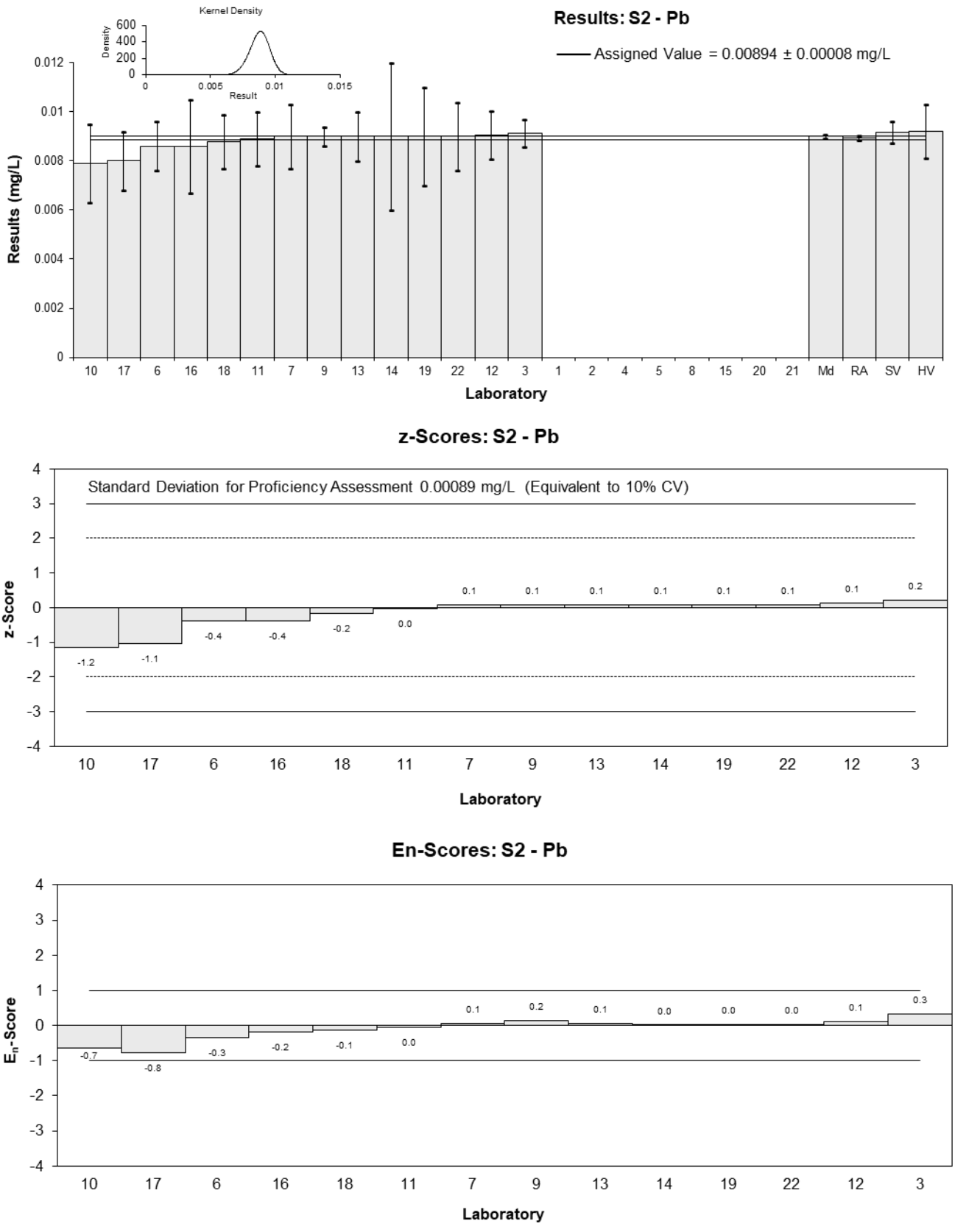

Results: S2 - Pb
Assigned Value = 0.00894 ± 0.00008 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
10 17 6 16 18 11 7 9 13 14 19 22 12 3 1 2 4 5 8 15 20 21 Md RA SV HV
z-Scores: S2 - Pb
Standard Deviation for Proficiency Assessment 0.00089 mg/L (Equivalent to 10% CV)
z-Score
-1.2 -1.1 -0.4 -0.4 -0.2 0.0 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.2
Laboratory
10 17 6 16 18 11 7 9 13 14 19 22 12 3
En-Scores: S2 - Pb
En-Score
-0.7 -0.8 -0.3 -0.2 -0.1 0.0 0.1 0.2 0.1 0.0 0.0 0.0 0.1 0.3
Laboratory
10 17 6 16 18 11 7 9 13 14 19 22 12 3

Figure 36

Table 41

Sample Details

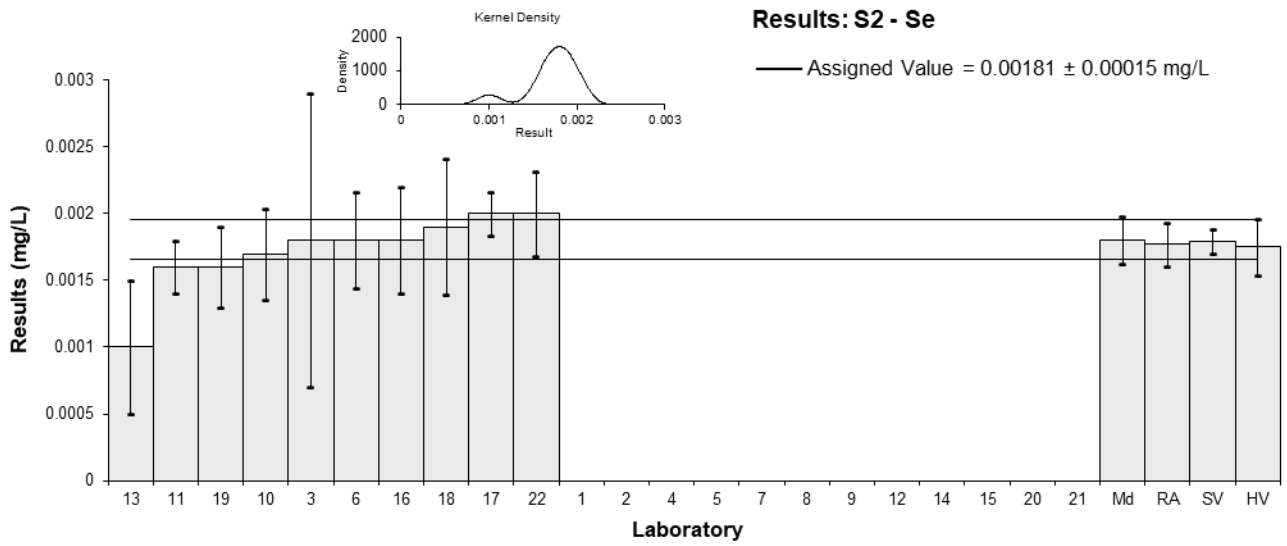
Sample No.	S2
Matrix	Potable Water
Analyte	Se
Unit	mg/L

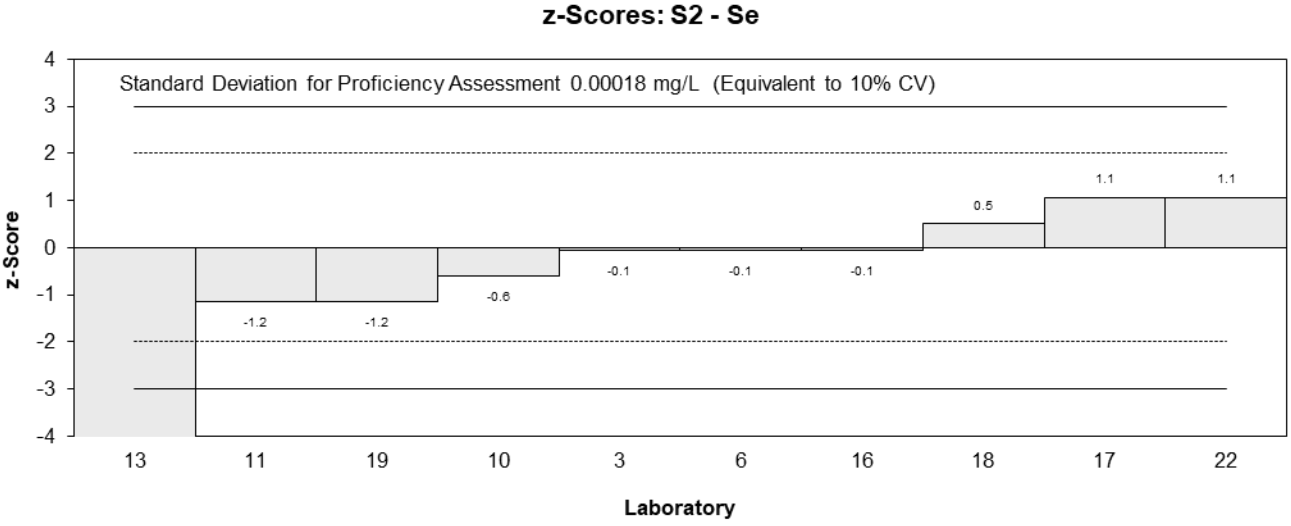
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.0018	0.0011	-0.06	-0.01
4	NT	NT		
5	NT	NT		
6	0.0018	0.00036	-0.06	-0.03
7	<0.002	NR		
8	NT	NT		
9	<0.004	NR		
10	0.0017	0.00034	-0.61	-0.30
11	0.0016	0.0002	-1.16	-0.84
12	<0.002	NR		
13	0.001	0.0005	-4.48	-1.55
14	<0.01	0.01		
15	< 0.2	NR		
16	0.0018	0.0004	-0.06	-0.02
17	0.002	0.00016	1.05	0.87
18	0.0019	0.00051	0.50	0.17
19	0.0016	0.0003	-1.16	-0.63
20	NT	NT		
21	NT	NT		
22	0.002	0.00032	1.05	0.54

Statistics

Assigned Value	0.00181	0.00015
Spike Value	0.00179	0.00009
Homogeneity Value	0.00175	0.00021
Robust Average	0.00177	0.00016
Median	0.00180	0.00018
Mean	0.00172	
N	10	
Max	0.002	
Min	0.001	
Robust SD	0.0002	
Robust CV	11%	


Results: S2 - Se
Kernel Density
Density
Result
Assigned Value = 0.00181 ± 0.00015 mg/L
Results (mg/L)
Laboratory
13 11 19 10 3 6 16 18 17 22 1 2 4 5 7 8 9 12 14 15 20 21 Md RA SV HV


z-Scores: S2 - Se
Standard Deviation for Proficiency Assessment 0.00018 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
13 11 19 10 3 6 16 18 17 22

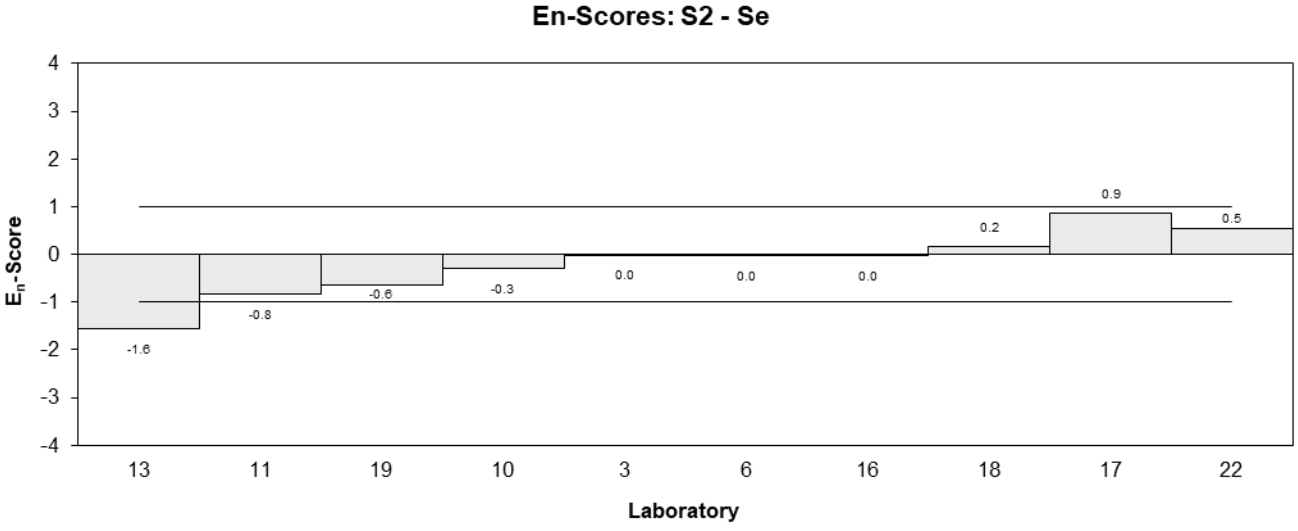

En-Scores: S2 - Se
En-Score
Laboratory
13 11 19 10 3 6 16 18 17 22

Figure 37

Table 42

Sample Details

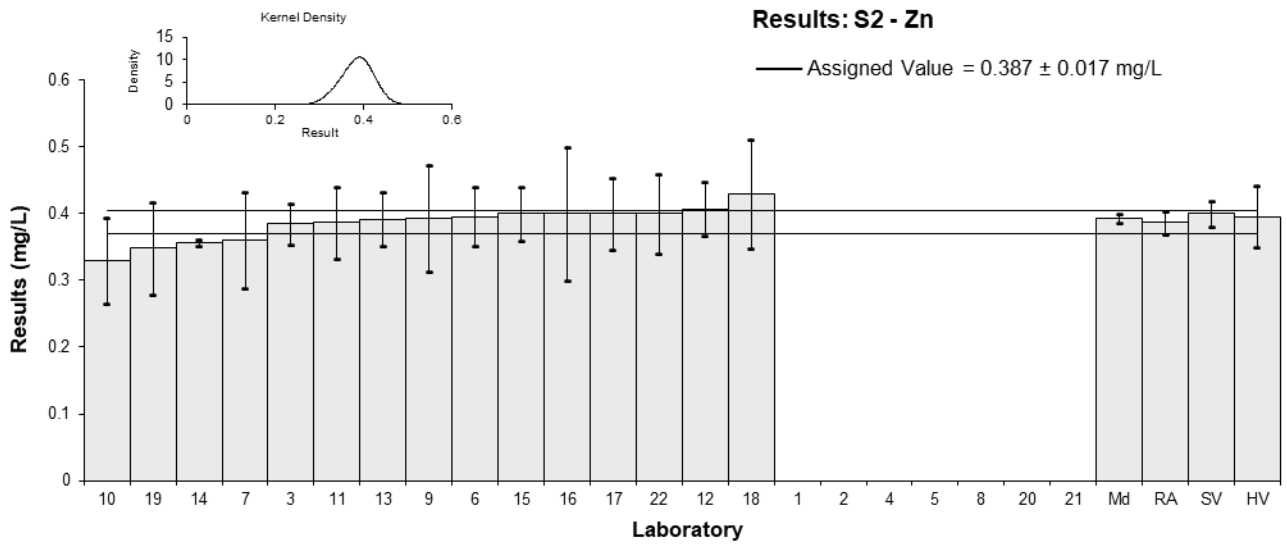
Sample No.	S2
Matrix	Potable Water
Analyte	Zn
Unit	mg/L

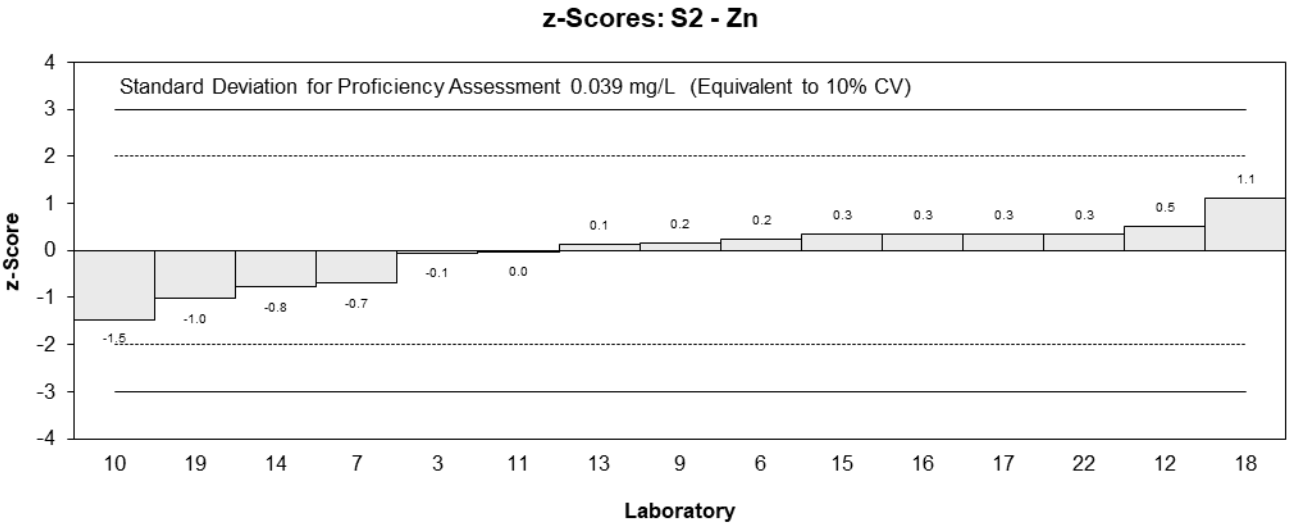
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.385	0.031	-0.05	-0.06
4	NT	NT		
5	NT	NT		
6	0.396	0.045	0.23	0.19
7	0.360	0.072	-0.70	-0.36
8	NT	NT		
9	0.393	0.080	0.16	0.07
10	0.33	0.065	-1.47	-0.85
11	0.3865	0.0547	-0.01	-0.01
12	0.407	0.040	0.52	0.46
13	0.392	0.04	0.13	0.12
14	0.357	0.005	-0.78	-1.69
15	0.4	0.04	0.34	0.30
16	0.40	0.10	0.34	0.13
17	0.40	0.054	0.34	0.23
18	0.43	0.082	1.11	0.51
19	0.348	0.07	-1.01	-0.54
20	NT	NT		
21	NT	NT		
22	0.40	0.06	0.34	0.21

Statistics

Assigned Value	0.387	0.017
Spike Value	0.400	0.019
Homogeneity Value	0.396	0.047
Robust Average	0.387	0.017
Median	0.393	0.007
Mean	0.386	
N	15	
Max	0.43	
Min	0.33	
Robust SD	0.026	
Robust CV	6.8%	


Results: S2 - Zn
Kernel Density
Density
Result
Assigned Value = 0.387 ± 0.017 mg/L
Results (mg/L)
Laboratory
10 19 14 7 3 11 13 9 6 15 16 17 22 12 18 1 2 4 5 8 20 21 Md RA SV HV


z-Scores: S2 - Zn
Standard Deviation for Proficiency Assessment 0.039 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
10 19 14 7 3 11 13 9 6 15 16 17 22 12 18
-1.5 -1.0 -0.8 -0.7 -0.1 0.0 0.1 0.2 0.2 0.3 0.3 0.3 0.3 0.5 1.1

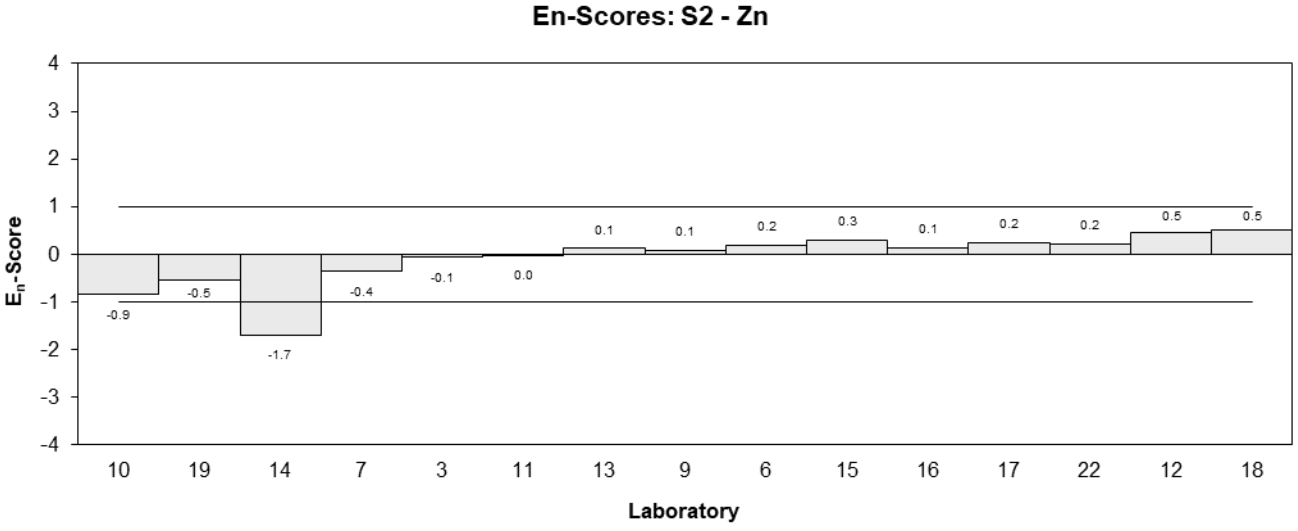

En-Scores: S2 - Zn
En-Score
Laboratory
10 19 14 7 3 11 13 9 6 15 16 17 22 12 18
-0.9 -0.5 -1.7 -0.4 -0.1 0.0 0.1 0.1 0.2 0.3 0.1 0.2 0.2 0.5 0.5

Figure 38

Table 43

Sample Details

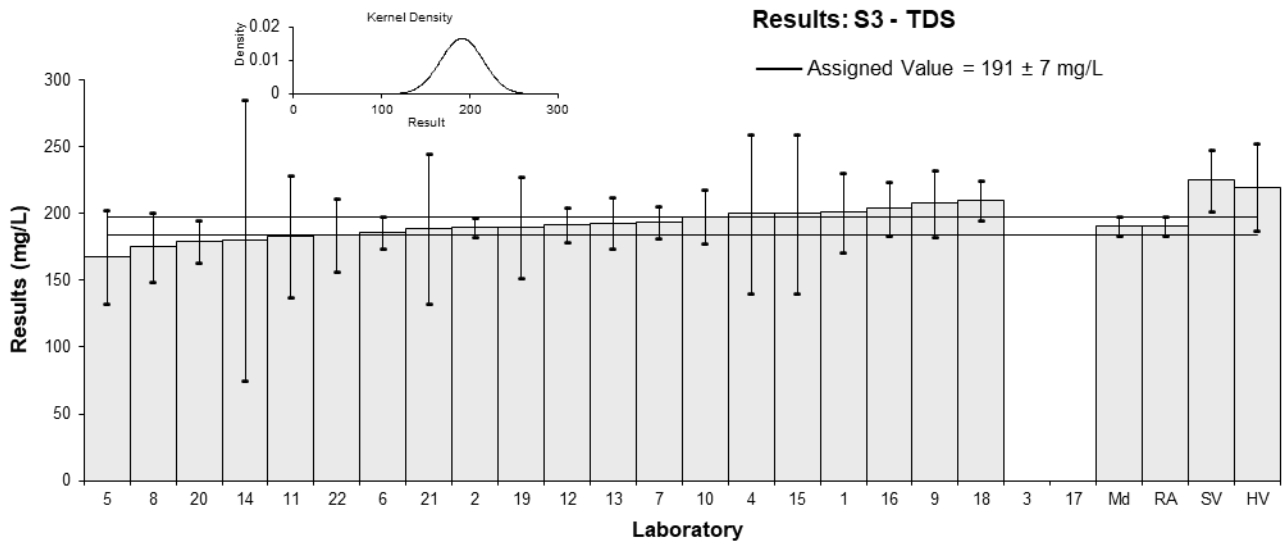
Sample No.	S3
Matrix	Potable Water
Analyte	TDS
Unit	mg/L

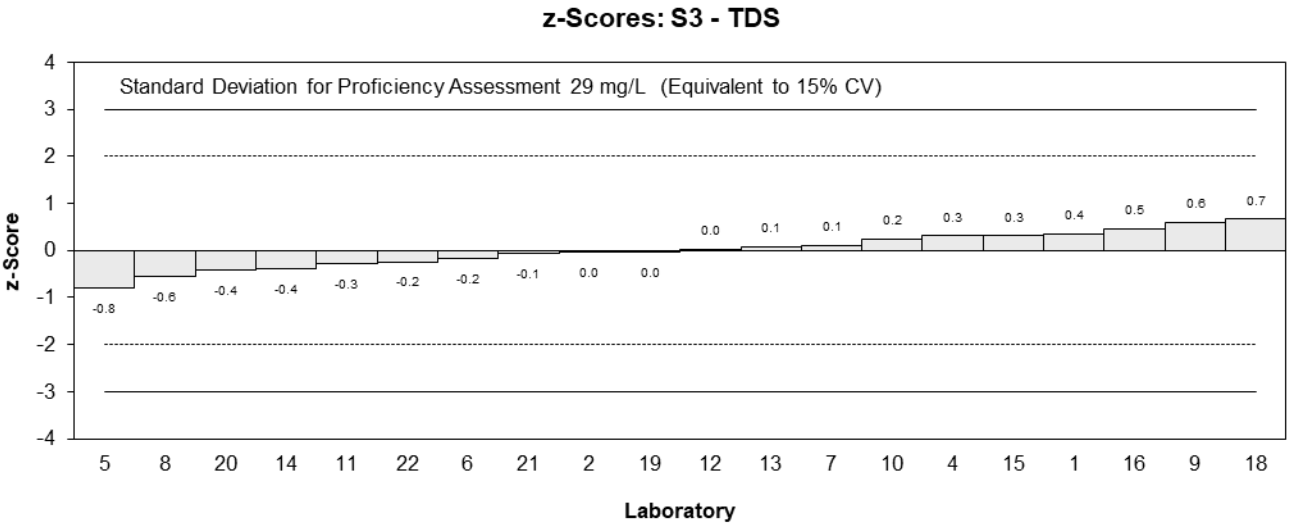
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	201	30.15	0.35	0.32
2	190	7	-0.03	-0.10
3	NT	NT		
4	200	60	0.31	0.15
5	168	35	-0.80	-0.64
6	186	11.7	-0.17	-0.37
7	194	12	0.10	0.22
8	175	26	-0.56	-0.59
9	208	25	0.59	0.65
10	198	19.8	0.24	0.33
11	183	45.75	-0.28	-0.17
12	192	13	0.03	0.07
13	193	19	0.07	0.10
14	180	105	-0.38	-0.10
15	200	60	0.31	0.15
16	204	20.4	0.45	0.60
17	NT	NT		
18	210	15	0.66	1.15
19	190	38	-0.03	-0.03
20	179	16	-0.42	-0.69
21	189	56	-0.07	-0.04
22	184	27.6	-0.24	-0.25

Statistics

Assigned Value	191	7
Spike Value	225	23
Homogeneity Value	220	33
Robust Average	191	7
Median	191	7
Mean	191	
N	20	
Max	210	
Min	168	
Robust SD	12	
Robust CV	6.2%	


Results: S3 - TDS
Assigned Value = 191 ± 7 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
5 8 20 14 11 22 6 21 2 19 12 13 7 10 4 15 1 16 9 18 3 17 Md RA SV HV


z-Scores: S3 - TDS
Standard Deviation for Proficiency Assessment 29 mg/L (Equivalent to 15% CV)
z-Score
Laboratory
5 8 20 14 11 22 6 21 2 19 12 13 7 10 4 15 1 16 9 18
-0.8 -0.6 -0.4 -0.4 -0.3 -0.2 -0.2 -0.1 0.0 0.0 0.0 0.1 0.1 0.2 0.3 0.3 0.4 0.5 0.6 0.7

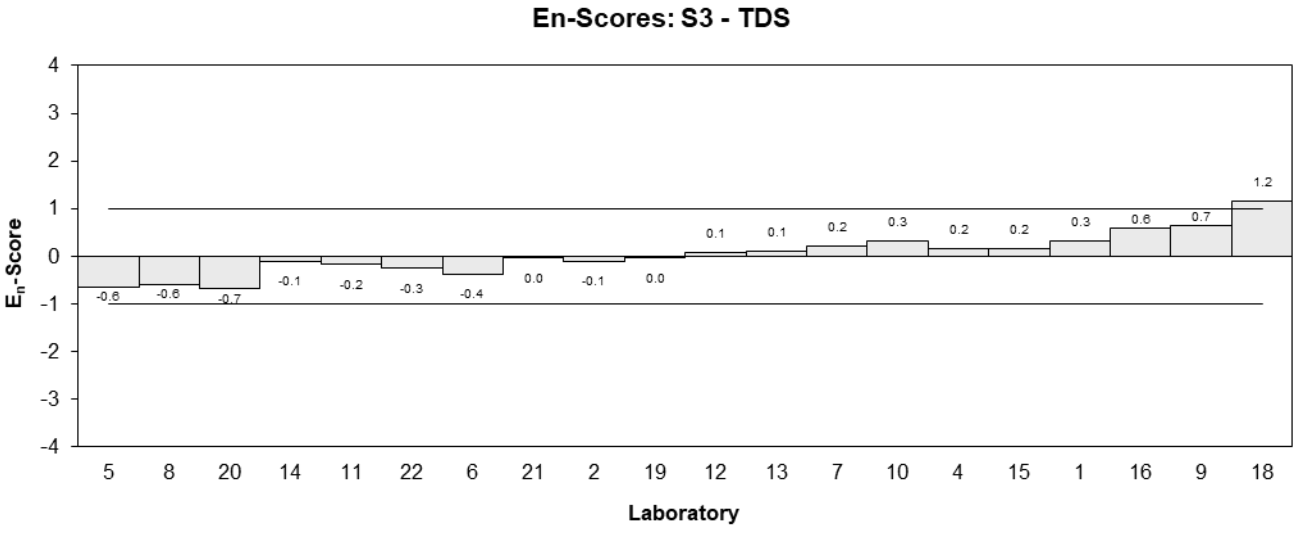

En-Scores: S3 - TDS
En-Score
Laboratory
5 8 20 14 11 22 6 21 2 19 12 13 7 10 4 15 1 16 9 18
-0.6 -0.6 -0.7 -0.1 -0.2 -0.3 -0.4 0.0 -0.1 0.0 0.1 0.1 0.2 0.3 0.2 0.2 0.3 0.6 0.7 1.2

Figure 39

Table 44

Sample Details

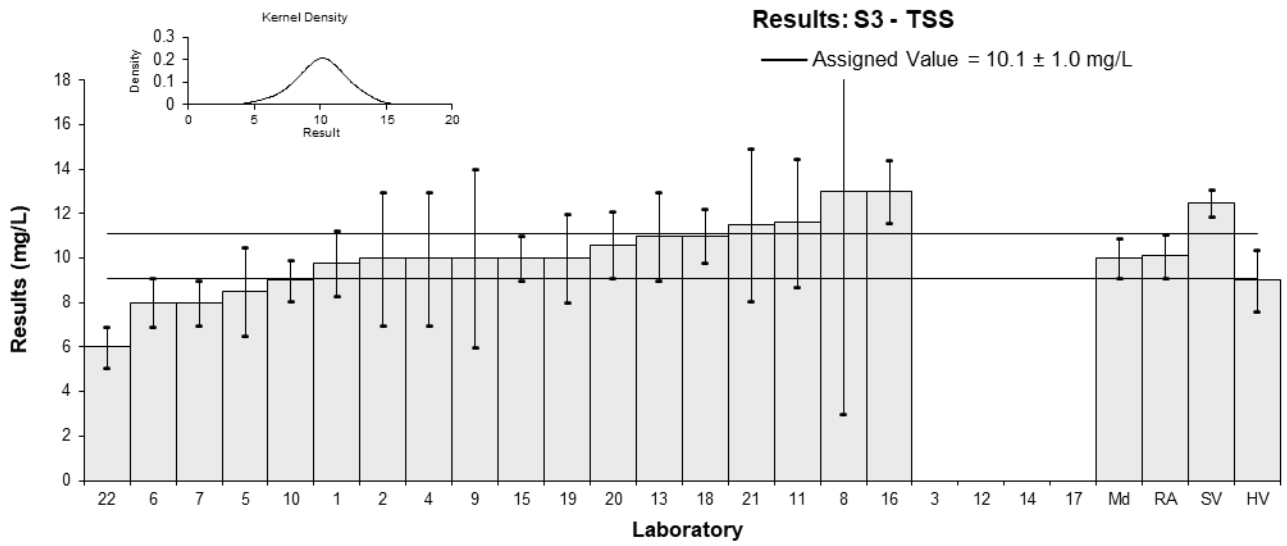
Sample No.	S3
Matrix	Potable Water
Analyte	TSS
Unit	mg/L

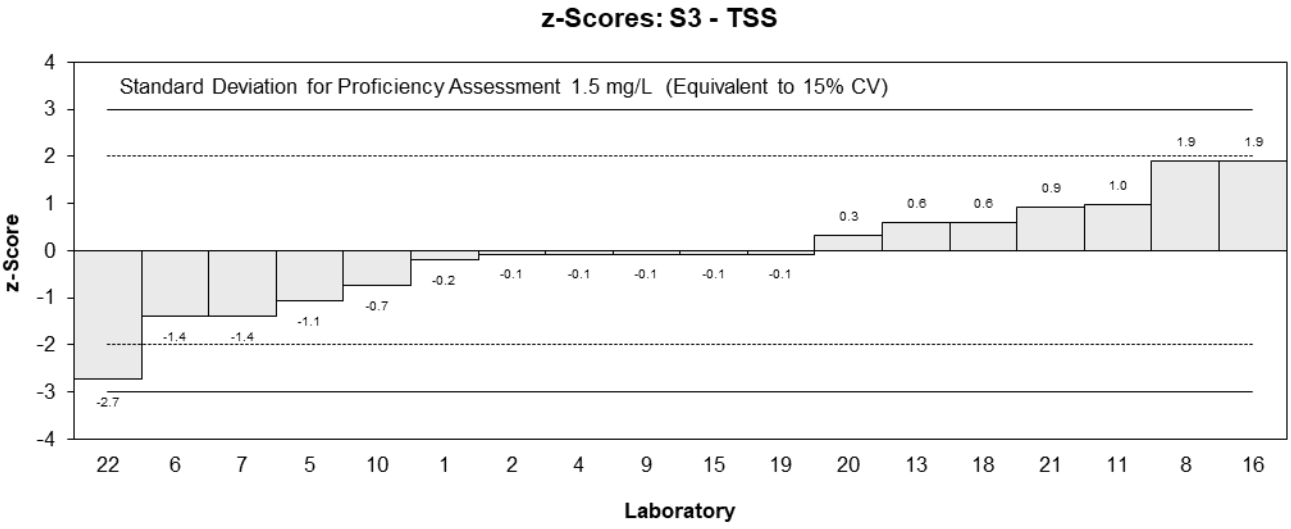
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	9.80	1.47	-0.20	-0.17
2	10	3	-0.07	-0.03
3	NT	NT		
4	10	3	-0.07	-0.03
5	8.5	2	-1.06	-0.72
6	8	1.1	-1.39	-1.41
7	8	1	-1.39	-1.48
8	13	10	1.91	0.29
9	10	4	-0.07	-0.02
10	9.0	0.9	-0.73	-0.82
11	11.6	2.9	0.99	0.49
12	NT	NT		
13	11	2	0.59	0.40
14	<10	88		
15	10	1	-0.07	-0.07
16	13	1.4	1.91	1.69
17	NT	NT		
18	11	1.2	0.59	0.58
19	10	2	-0.07	-0.04
20	10.6	1.5	0.33	0.28
21	11.5	3.45	0.92	0.39
22	6	0.9	-2.71	-3.05

Statistics

Assigned Value	10.1	1.0
Spike Value	12.5	0.6
Homogeneity Value	9.0	1.4
Robust Average	10.1	1.0
Median	10.0	0.9
Mean	10.1	
N	18	
Max	13	
Min	6	
Robust SD	1.7	
Robust CV	17%	


Results: S3 - TSS
Assigned Value = 10.1 ± 1.0 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
22 6 7 5 10 1 2 4 9 15 19 20 13 18 21 11 8 16 3 12 14 17 Md RA SV HV


z-Scores: S3 - TSS
Standard Deviation for Proficiency Assessment 1.5 mg/L (Equivalent to 15% CV)
z-Score
Laboratory
22 6 7 5 10 1 2 4 9 15 19 20 13 18 21 11 8 16
-2.7 -1.4 -1.4 -1.1 -0.7 -0.2 -0.1 -0.1 -0.1 -0.1 -0.1 0.3 0.6 0.6 0.9 1.0 1.9 1.9

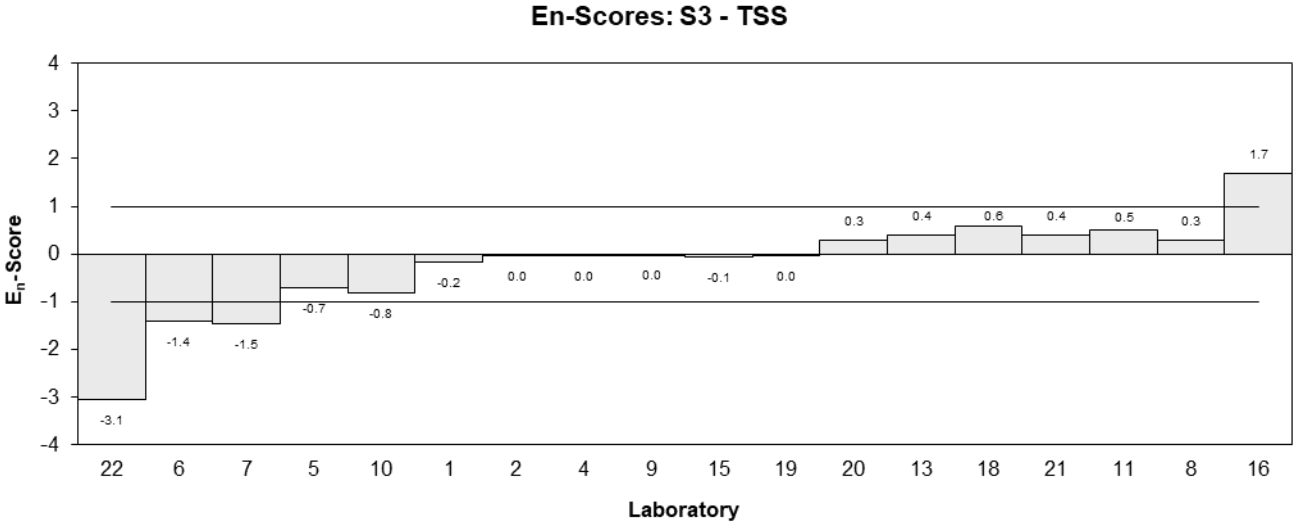

En-Scores: S3 - TSS
En-Score
Laboratory
22 6 7 5 10 1 2 4 9 15 19 20 13 18 21 11 8 16
-3.1 -1.4 -1.5 -0.7 -0.8 -0.2 0.0 0.0 0.0 -0.1 0.0 0.3 0.4 0.6 0.4 0.5 0.3 1.7

Figure 40

Table 45

Sample Details

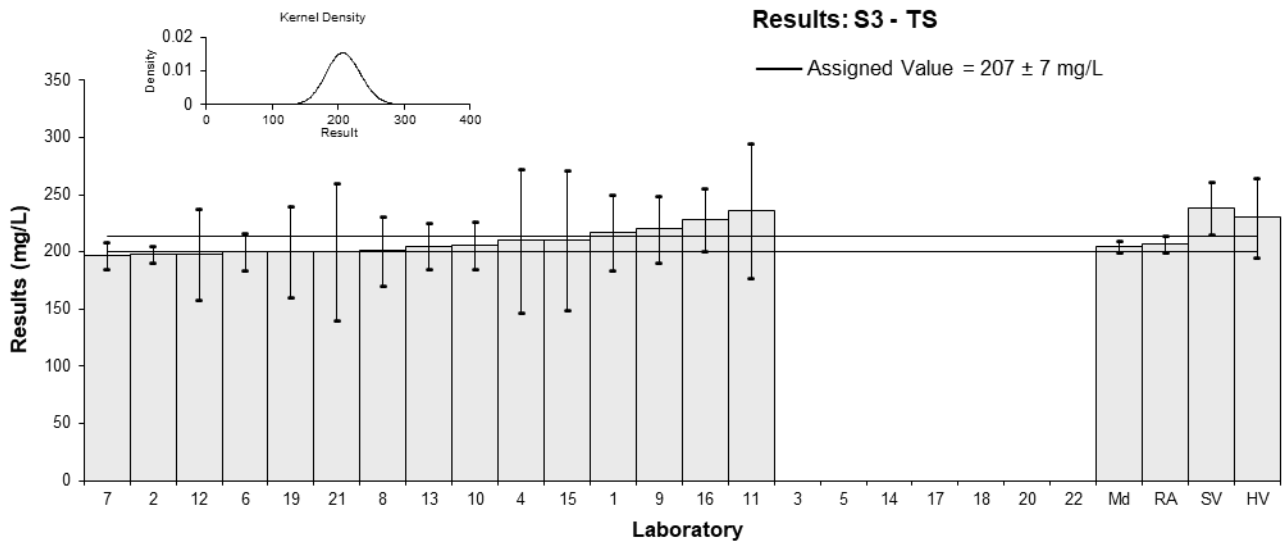
Sample No.	S3
Matrix	Potable Water
Analyte	TS
Unit	mg/L

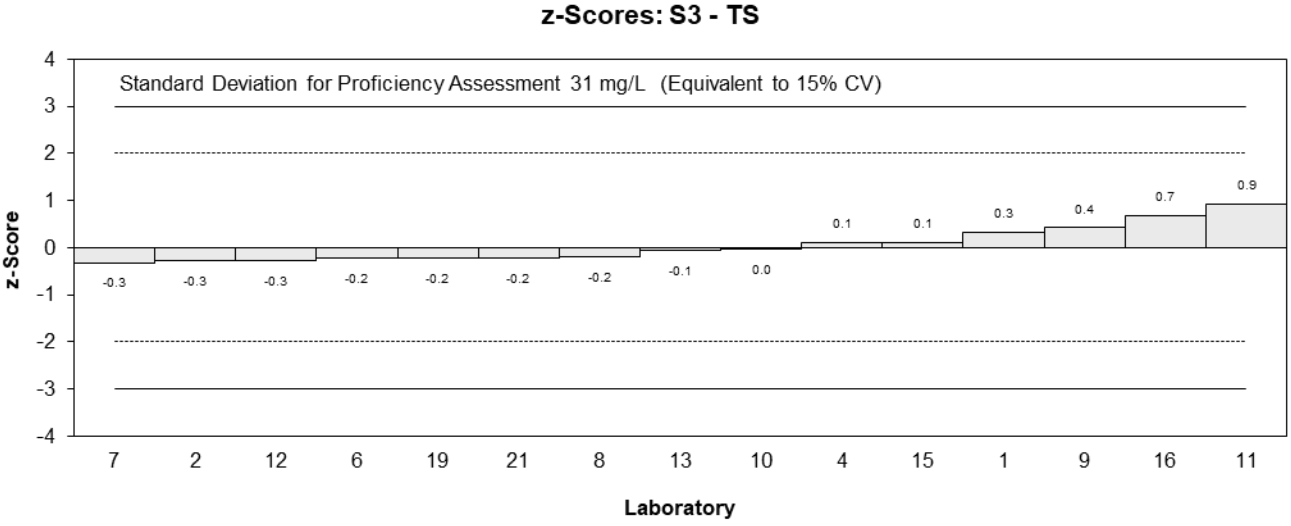
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	217	32.55	0.32	0.30
2	198	7	-0.29	-0.91
3	NT	NT		
4	210	63	0.10	0.05
5	NT	NT		
6	200	16	-0.23	-0.40
7	197	12	-0.32	-0.72
8	201	30	-0.19	-0.19
9	220	29	0.42	0.44
10	206	20.6	-0.03	-0.05
11	236	59	0.93	0.49
12	198	40	-0.29	-0.22
13	205	20	-0.06	-0.09
14	NT	NT		
15	210	61	0.10	0.05
16	228	27.4	0.68	0.74
17	NT	NT		
18	NT	NT		
19	200	40	-0.23	-0.17
20	NT	NT		
21	200	60	-0.23	-0.12
22	NR	NR		

Statistics

Assigned Value	207	7
Spike Value	238	23
Homogeneity Value	230	35
Robust Average	207	7
Median	205	5
Mean	208	
N	15	
Max	236	
Min	197	
Robust SD	11	
Robust CV	5.2%	


Kernel Density
Density
Result
Results: S3 - TS
Assigned Value = 207 ± 7 mg/L
Results (mg/L)
Laboratory
7 2 12 6 19 21 8 13 10 4 15 1 9 16 11 3 5 14 17 18 20 22 Md RA SV HV


z-Scores: S3 - TS
Standard Deviation for Proficiency Assessment 31 mg/L (Equivalent to 15% CV)
z-Score
-0.3 -0.3 -0.3 -0.2 -0.2 -0.2 -0.2 -0.1 0.0 0.1 0.1 0.3 0.4 0.7 0.9
Laboratory
7 2 12 6 19 21 8 13 10 4 15 1 9 16 11

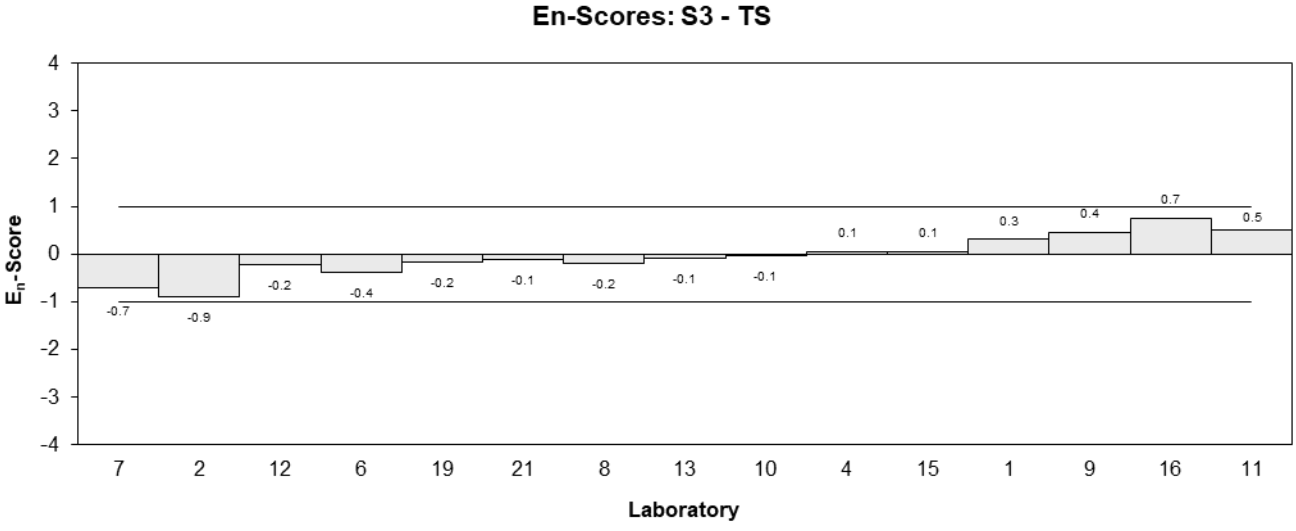

En-Scores: S3 - TS
En-Score
-0.7 -0.9 -0.2 -0.4 -0.2 -0.1 -0.2 -0.1 -0.1 0.1 0.1 0.3 0.4 0.7 0.5
Laboratory
7 2 12 6 19 21 8 13 10 4 15 1 9 16 11

Figure 41

Table 46

Sample Details

Sample No.	S3
Matrix	Potable Water
Analyte	Turbidity
Unit	NTU

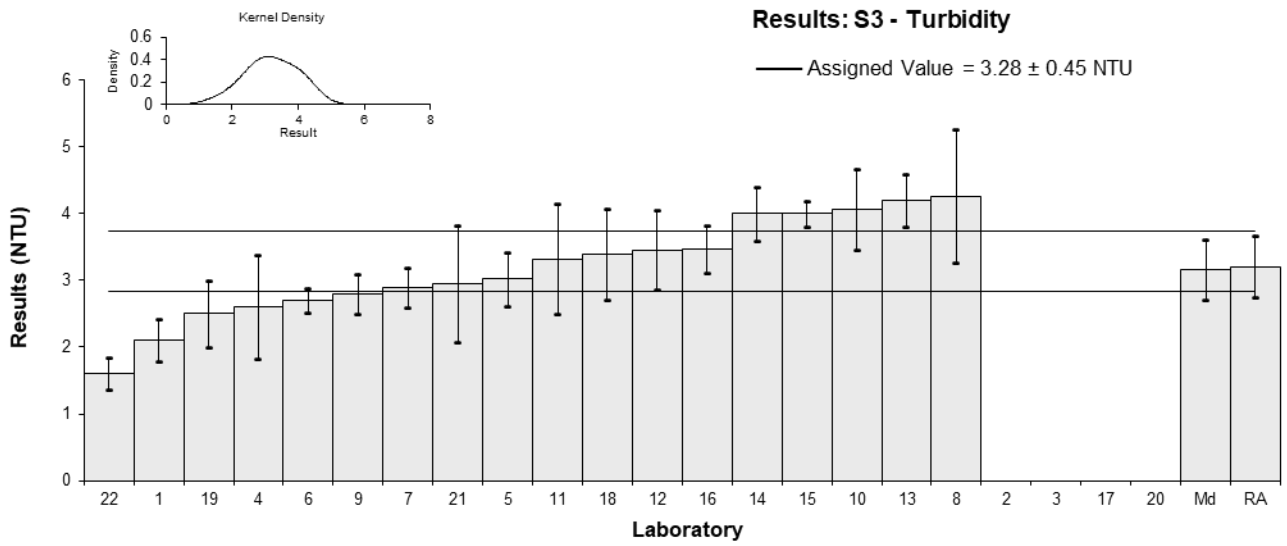
Participant Results

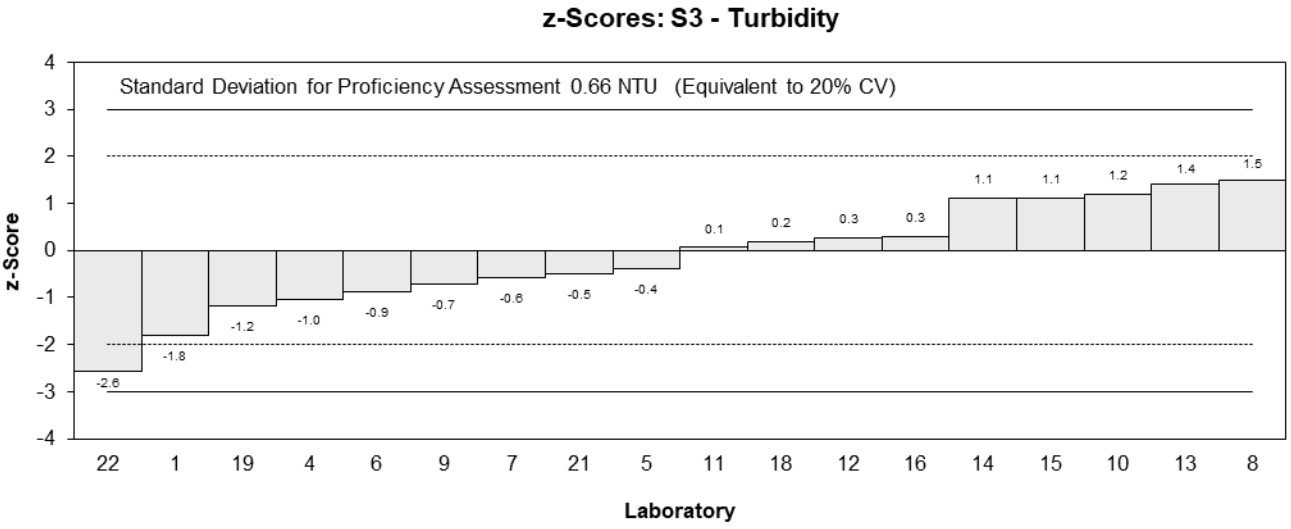
Lab. Code	Result	Uncertainty	z	E_n
1	2.1	0.315	-1.80	-2.15
2	NR	NR		
3	NT	NT		
4	2.6	0.78	-1.04	-0.76
5	3.02	0.40	-0.40	-0.43
6	2.7	0.19	-0.88	-1.19
7	2.9	0.3	-0.58	-0.70
8	4.26	1	1.49	0.89
9	2.8	0.3	-0.73	-0.89
10	4.07	0.61	1.20	1.04
11	3.32	0.83	0.06	0.04
12	3.46	0.59	0.27	0.24
13	4.2	0.4	1.40	1.53
14	4	0.4	1.10	1.20
15	4	0.2	1.10	1.46
16	3.47	0.35	0.29	0.33
17	NT	NT		
18	3.4	0.68	0.18	0.15
19	2.5	0.5	-1.19	-1.16
20	NT	NT		
21	2.95	0.88	-0.50	-0.33
22*	1.6	0.24	-2.56	-3.29

* Outlier, see Section 4.2

Statistics

Assigned Value	3.28	0.45
Spike Value	Not Spiked	
Robust Average	3.21	0.47
Median	3.17	0.45
Mean	3.19	
N	18	
Max	4.26	
Min	1.6	
Robust SD	0.8	
Robust CV	25%	


Kernel Density
Density
Result
Results: S3 - Turbidity
Assigned Value = 3.28 ± 0.45 NTU
Results (NTU)
Laboratory
22 1 19 4 6 9 7 21 5 11 18 12 16 14 15 10 13 8 2 3 17 20 Md RA


z-Scores: S3 - Turbidity
Standard Deviation for Proficiency Assessment 0.66 NTU (Equivalent to 20% CV)
z-Score
Laboratory
22 1 19 4 6 9 7 21 5 11 18 12 16 14 15 10 13 8
-2.6 -1.8 -1.2 -1.0 -0.9 -0.7 -0.6 -0.5 -0.4 0.1 0.2 0.3 0.3 1.1 1.1 1.2 1.4 1.5

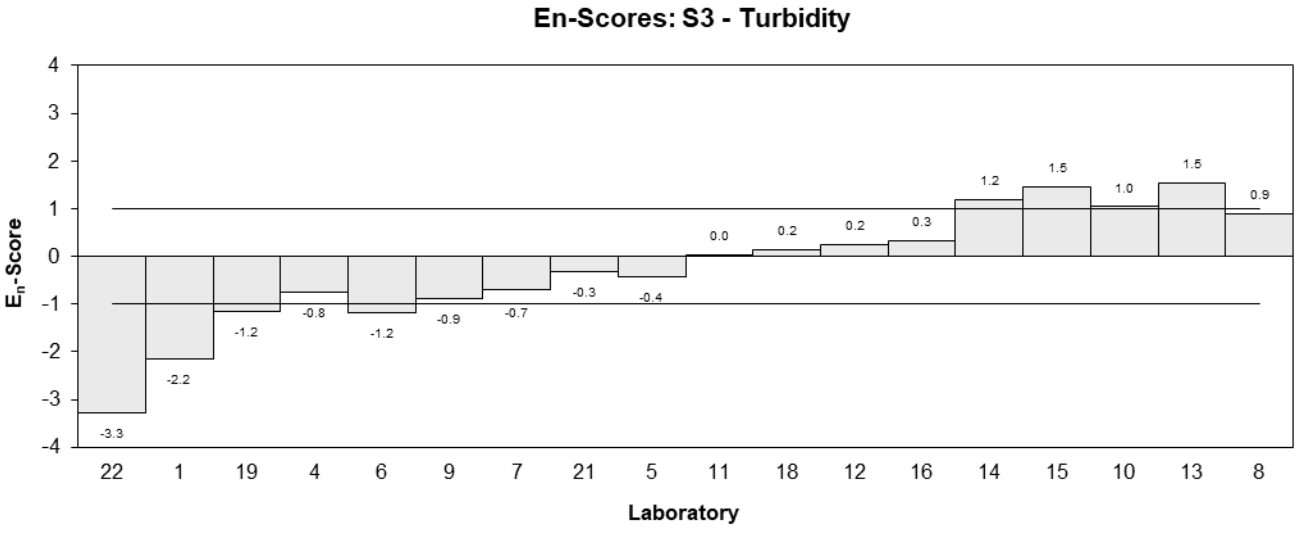

En-Scores: S3 - Turbidity
En-Score
Laboratory
22 1 19 4 6 9 7 21 5 11 18 12 16 14 15 10 13 8
-3.3 -2.2 -1.2 -0.8 -1.2 -0.9 -0.7 -0.3 -0.4 0.0 0.2 0.2 0.3 1.2 1.5 1.0 1.5 0.9

Figure 42

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 ISO 13528. Results less than 50% and more than 150% of the robust average were excluded prior to the calculation of each assigned value.[6] No assigned value was set for Cs, La and P as an insufficient number of results were reported. Appendix 2 sets out the calculation for the robust average of As in Sample S1 and its associated uncertainty.

Sample S2 was prepared from the same fortified potable water used for Sample S1, further fortified for trace elements of interest except Se. Selenium concentration in Sample S2 was expected to be the same as that in Sample S1. The assigned value for Se in Sample S1 and S2 was calculated as the robust average of the combined results of both samples.

The spiked 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. Of the 540 numeric results reported in this study, 531 (98%) were reported with an expanded uncertainty. The magnitude of these expanded uncertainties was within the range 0.8% to 150% of the reported value. The participants used a wide variety of procedures to evaluate the expanded measurement uncertainty; these are presented in Table 4. Two participants reported using the NATA GAG Estimating and Reporting MU as their guide; this document has been officially removed from the NATA website and is considered obsolete.

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 42). As a simple rule of thumb, when the uncertainty evaluation is smaller than the 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, 15 laboratories reported results for Mo in Sample S1. The uncertainty of the assigned value evaluated from the robust standard deviation of the 15 laboratories' results is 0.00026 mg/L (4.9% of the assigned value). Laboratory 9's reported measurement uncertainty for Mo in S1 of 0.0001 mg/L, or 2% of their numerical value. This laboratory might have been under-estimated their uncertainty as an uncertainty evaluated from one measurement is unlikely to be smaller than the uncertainty evaluated from 15 measurements. Alternatively, evaluations of uncertainty for Tl in S1 larger than 0.00022 mg/L (the uncertainty of the assigned value, 0.000023 mg/L, plus the allowable variation from the assigned value, the standard deviation for proficiency assessment of 0.000098 mg/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 7 for Tl in S1 (0.0005 mg/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.

Laboratories 9 and 15 may need to review their procedure for evaluating measurement uncertainty as most of their reported uncertainties were low.

Laboratory 14 should also review their procedure for evaluating measurement uncertainty, as most of their reported uncertainties were either too low or too high. Some uncertainties reported by this laboratory were also either equal to or greater than their reported result.

Laboratories 3, 6, and 14 attached expanded measurement uncertainties 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 4.26 ± 1 NTU, it is better to report 4.3 ± 1.0 NTU or, instead of 228 ± 27.4 mg/L, it is better to report 228 ± 27 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. SDPAs equivalent to 10% to 20% 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.

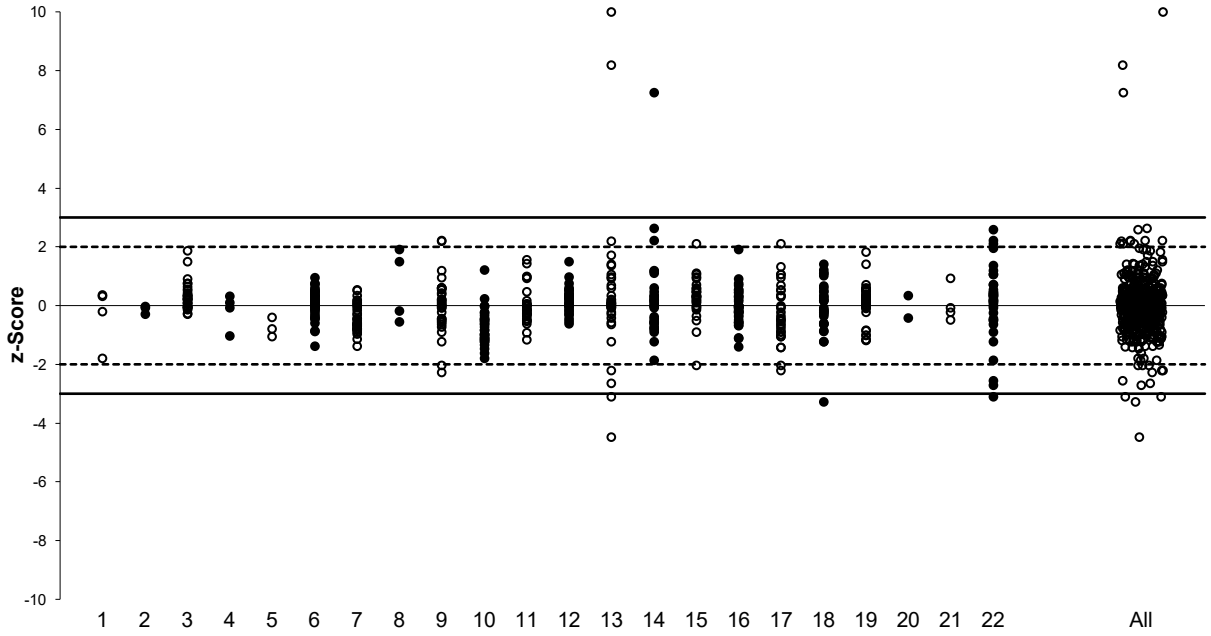
The between-laboratory coefficient of variation predicted by the Thompson-Horwitz equation[7] and the participants' coefficient of variation in this study are presented for comparison in Table 47.

Table 47 Between-Laboratory CV of this Study, Thompson-Horwitz CV, and SDPA

Sample	Analyte	Numeric Results Reported*	Assigned value (mg/L)	Between-Laboratory CV* (%)	Thompson-Horwitz CV (%)	SDPA (as PCV, %)
S1	As	15	0.00732	6.9	22	10
S1	Ba	15	0.0358	6.1	22	10
S1	Be	15	0.00150	24	22	15
S1	Bi	9	0.00110	11	22	10
S1	Cd	15	0.00136	4.5	22	10
S1	Cr	12	0.00105	6.9	22	10
S1	Cu	15	0.236	5	20	10
S1	Fe	15	0.114	7.1	22	10
S1	Hg	13	0.000152	23	22	15
S1	Mo	15	0.00528	7.5	22	10
S1	Ni	15	0.00294	4.3	22	10
S1	Pb	15	0.00246	11	22	10
S1	Sb	12	0.00214	9.3	22	10
S1	Se	12	0.00181	10	22	10

Sample	Analyte	Numeric Results Reported*	Assigned value (mg/L)	Between-Laboratory CV* (%)	Thompson-Horwitz CV (%)	SDPA (as PCV, %)
S1	Sn	10	0.00144	21	22	15
S1	Tl	9	0.000981	2.8	22	10
S1	U	15	0.00988	3	22	10
S1	V	11	0.00290	4.2	22	10
S1	Zn	15	0.0756	7.7	22	10
S2	Al	12	0.0268	13	22	10
S2	As	14	0.0131	4.7	22	10
S2	B	10	0.0251	13	22	10
S2	Be	15	0.0765	7.3	22	10
S2	Bi	10	0.00200	0.5	22	10
S2	Cd	14	0.00256	4.2	22	10
S2	Co	14	0.00114	12	22	10
S2	Cr	15	0.0491	4.8	22	10
S2	Cs	4	Not Set	0.7**	22**	Not Set
S2	Fe	15	0.402	4.6	18	10
S2	Hg	13	0.00106	8.3	22	10
S2	La	5	Not Set	1.5**	22**	Not Set
S2	Mn	15	0.0308	6.5	22	10
S2	Na	14	13.7	7.5	11	10
S2	P	4	Not Set	19**	22**	Not Set
S2	Pb	14	0.00894	1.3	22	10
S2	Se	10	0.00181	11	22	10
S2	Zn	15	0.387	6.8	18	10
S3	TDS	20	191	6.2	7.3	15
S3	TSS	18	10.1	17	11	15
S3	TS	15	207	5.2	7.2	15
S3	Turbidity	17	3.28 (NTU)	22	13	20

*Values exclude outliers if applicable. Shaded cells represent between-laboratory CVs higher than both the SDPA and the Thompson-Horwitz CV for scored analytes.
** Calculated using Median Value (assigned value not set).



Scores greater than 10 have been plotted as 10.

Figure 43 z-Score Dispersal by Laboratory

The dispersal of participants' z-scores is presented in Figure 43 (by laboratory code) and in Figure 45 (by analyte). Of the 527 results for which z-scores were calculated, 501 (95%) returned an acceptable score of $|z| \leq 2.0$ and 19 (4%) 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 46**.**

Laboratories 6 and 16 returned the highest number of acceptable z-scores, 38.

All results reported by Laboratories 19 (37), 12 (34), 3 (33), 7 (32), 10 (31), 11 (31), 1 (4), 4 (4), 8 (4), 21 (4), 2 (3), 5(3), and 20 (2) 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. Results that return a unacceptable E_n-score 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 44. 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 527 results for which E_n-scores were calculated, 472 (90%) 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.

Laboratories 6, 16, and 19 had the highest number of acceptable E_n-scores, 36.

All results reported by Laboratories 12 (34), 11 (31), 4 (4), 8 (4), 21 (4), 2 (3), 5 (3), and 20 (2) returned acceptable E_n-scores.

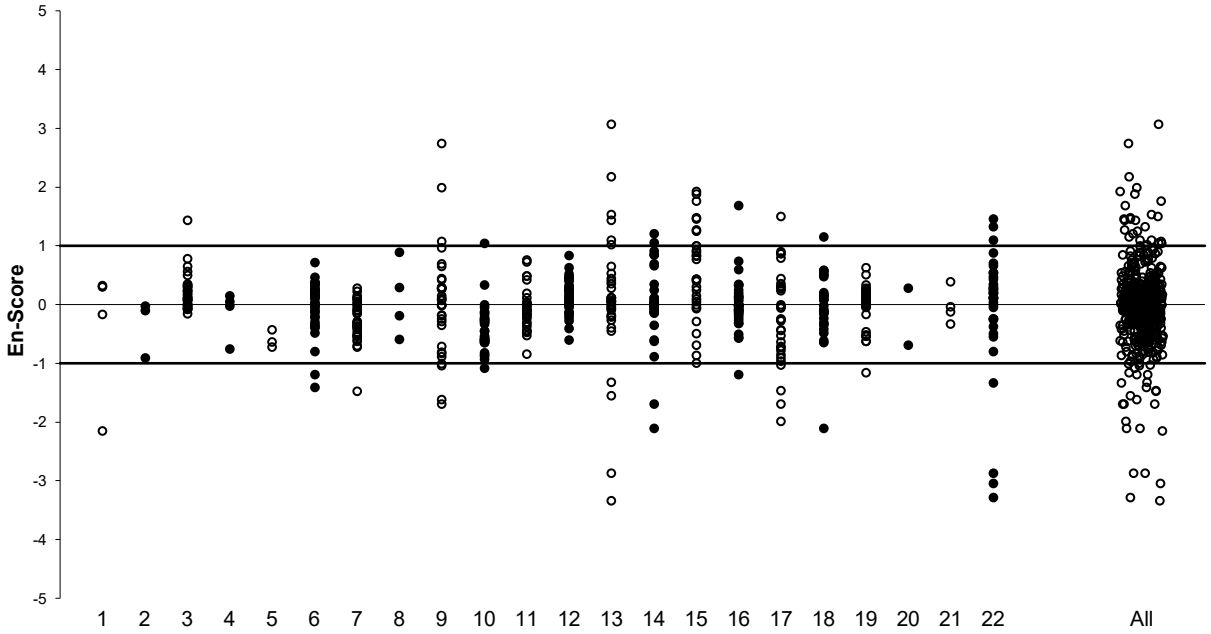
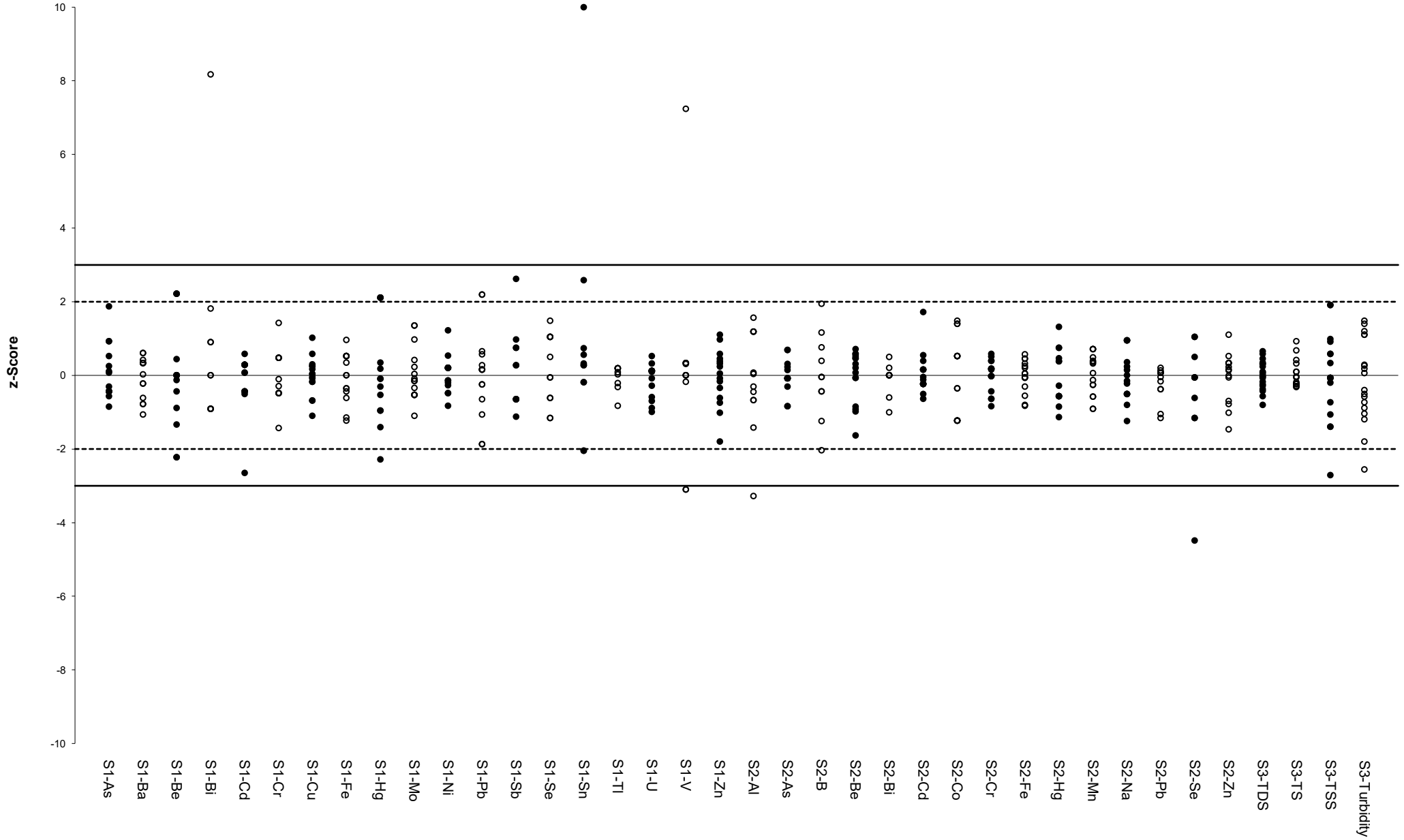


Figure 44 E_n-Score Dispersal by Laboratory



Scores greater than 10 have been plotted as 10.

Figure 45 z-Score Dispersal by Analyte

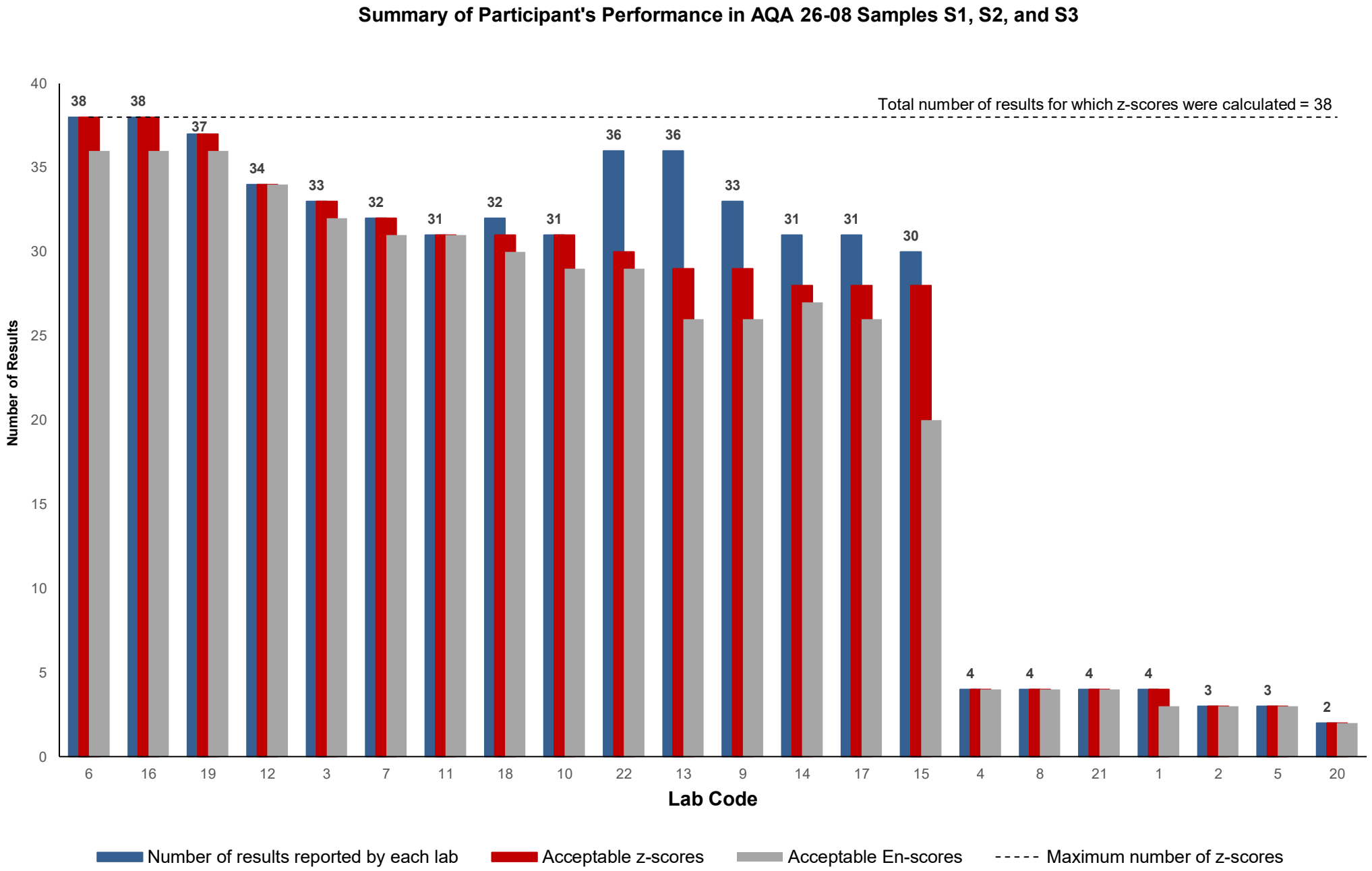


Figure 46 Summary of Participants' Performance in AQA 26-08

Table 48 Summary of Participants' Results and Performance in Sample S1

Lab	As mg/L	Ba mg/L	Be mg/L	Bi mg/L	Cd mg/L	Cr mg/L	Cu mg/L	Fe mg/L	Hg mg/L	Mo mg/L
AV	0.00732	0.0358	0.00150	0.00110	0.00136	0.00105	0.236	0.114	0.000152	0.00528
HV	0.00713	0.0364	0.00157	0.00122	0.00144	0.00102	0.244	0.127	0.000150	0.00551
1	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
2	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
3	0.00869	0.0373	0.00147	0.00120	0.00137	0.00102	0.242	0.118	0.000156	0.00523
4	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
5	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
6	0.0074	0.037	0.0015	0.0011	0.00137	0.0011	0.234	0.109	0.00015	0.0055
7	0.007	0.033	0.0015	NT	0.0013	0.001	0.232	0.101	0.00013	0.0053
8	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
9	0.007	0.038	0.002	0.001	0.0013	0.001	0.237	0.12	0.0001	0.005
10	0.0070	0.032	0.0012	0.0011	0.0013	< 0.001	0.21	0.10	0.00013	0.0051
11	0.0071	0.0359	0.0014	< 0.005	0.00129	0.0012	0.2320	0.114	0.00014	0.0058
12	0.00737	0.0336	0.00150	NT	0.00144	0.00104	0.242	0.114	0.000145	0.00500
13	0.008	0.037	0.001	0.002	0.001	<0.001	0.237	0.125	<0.0005	0.006
14	0.007	0.038	0.002	0.001	0.0014	<0.005	0.243	0.107	0.00016	0.005
15	0.0080	0.037	0.0016	0.0010	0.0014	0.0011	0.25	0.11	0.0002	0.0052
16	0.0069	0.035	0.0015	0.0012	0.0014	0.0010	0.22	0.12	0.00012	0.0047
17	0.0077	0.033	0.001	<0.001	0.0014	0.0009	0.22	0.12	0.0002	0.005
18	0.0075	0.035	0.0013	NT	0.0014	0.0011	0.26	0.11	NT	0.0052
19	0.0067	0.037	0.0015	0.0013	0.0014	0.0011	0.235	0.120	0.00015	0.0054
20	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
21	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
22	0.007	0.037	0.002	0.001	0.0014	0.001	0.24	0.12	0.0002	0.006

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

Table 48 Summary of Participants' Results and Performance in Sample S1 (continued)

Lab	Ni mg/L	Pb mg/L	Sb mg/L	Se mg/L	Sn mg/L	Tl mg/L	U mg/L	V mg/L	Zn mg/L
AV	0.00294	0.00246	0.00214	0.00181	0.00144	0.000981	0.00988	0.00290	0.0756
HV	0.00282	0.00251	0.00220	0.00172	0.00154	0.00098	0.0100	0.00291	0.0756
1	NT	NT	NT	NT	NT	NT	NT	NT	NT
2	NT	NT	NT	NT	NT	NT	NT	NT	NT
3	0.00286	0.00262	0.0023	0.0018	0.00156	0.00099	0.00998	0.00299	0.0774
4	NT	NT	NT	NT	NT	NT	NT	NT	NT
5	NT	NT	NT	NT	NT	NT	NT	NT	NT
6	0.003	0.0025	0.0023	0.0019	0.0016	0.00095	0.0102	0.0029	0.078
7	0.0027	0.0025	0.0020	<0.0020	NT	0.0009	0.0092	0.0030	0.071
8	NT	NT	NT	NT	NT	NT	NT	NT	NT
9	0.003	0.003	0.002	<0.004	0.001	<0.001	0.010	<0.01	0.080
10	0.0028	0.0023	< 0.005	0.0016	< 0.005	< 0.005	0.0089	< 0.005	0.062
11	0.0029	0.0024	< 0.005	0.0017	< 0.005	< 0.005	0.0096	< 0.005	0.0744
12	0.00288	0.00253	0.00235	0.00208	0.00151	0.000984	0.0104	0.00285	0.0785
13	0.003	0.003	0.002	0.002	0.004	0.001	0.010	0.002	0.076
14	0.003	0.002	0.0027	<0.01	NT	0.001	0.01	0.005	0.07
15	0.0031	0.0026	0.0022	0.002	0.0015	0.0010	0.010	0.0029	0.083
16	0.0029	0.0024	0.0019	0.0018	0.0014	0.00096	0.0098	0.0029	0.073
17	0.0028	0.0022	<0.001	0.002	0.001	<0.001	0.009	0.003	0.075
18	0.0033	0.0025	0.002	0.0017	0.0014	NT	0.0093	0.003	0.084
19	0.003	0.0025	0.0022	0.0016	0.0015	0.001	0.01	0.0029	0.068
20	NT	NT	NT	NT	NT	NT	NT	NT	NT
21	NT	NT	NT	NT	NT	NT	NT	NT	NT
22	0.003	0.002	0.002	0.002	0.002	<0.001	0.010	0.002	0.079

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

Table 49 Summary of Participants' Results and Performance in Samples S2 and S3

	S2										
Lab	Al mg/L	As mg/L	B mg/L	Be mg/L	Bi mg/L	Cd mg/L	Co mg/L	Cr mg/L	Cs mg/L	Fe mg/L	Hg mg/L
AV	0.0268	0.0131	0.0251	0.0765	0.00200	0.00256	0.00114	0.0491	Not Set	0.402	0.00106
HV	0.0266	0.0132	0.0237	0.083	0.00217	0.00270	0.00129	0.0496	0.00213	0.373	0.00120
1	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
2	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
3	0.0269	0.0135	< 0.053	0.076	0.00204	0.00255	0.00131	0.0516	0.00202	0.415	0.00114
4	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
5	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
6	0.027	0.0133	0.024	0.081	0.00188	0.00253	0.0012	0.051	0.002	0.412	0.00097
7	0.025	0.013	NT	0.0805	NT	0.0024	0.0012	0.050	NT	0.370	0.00103
8	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
9	0.03	0.013	<0.05	0.081	0.002	0.0025	0.001	0.049	0.002	0.41	0.0010
10	< 0.05	0.012	< 0.05	0.064	0.0018	0.0025	0.0010	0.045	NT	0.38	0.00094
11	0.031	0.0127	< 0.05	0.0695	< 0.005	0.00243	0.0011	0.0499	NT	0.404	0.00111
12	0.0256	0.0134	0.0261	0.0789	NT	0.00266	0.00120	0.0500	NT	0.404	0.00114
13	0.026	0.014	0.025	0.076	0.002	0.003	0.001	0.047	NT	0.399	0.001
14	0.03	0.013	0.028	0.08	0.002	0.0026	0.001	0.049	NT	0.369	0.001
15	< 0.03	< 0.07	0.02	0.08	NT	< 0.005	< 0.02	0.05	NT	0.4	< 0.05
16	0.025	0.013	0.027	0.078	0.0020	0.0025	0.0012	0.049	NT	0.42	0.0010
17	0.023	0.014	0.024	0.069	0.002	0.0025	0.0011	0.046	<0.01	0.40	0.0012
18	0.018	0.013	0.022	0.07	NT	0.0026	0.0013	0.046	NT	0.39	NT
19	NR	0.012	0.025	0.077	0.0021	0.0027	0.0013	0.052	0.0022	0.425	0.0011
20	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
21	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
22	0.03	0.013	0.03	0.082	0.002	0.0026	0.001	0.051	NR	0.42	0.0011

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

Table 49 Summary of Participants' Results and Performance in Samples S2 and S3 (continued)

	S2							S3			
Lab	La mg/L	Mn mg/L	Na mg/L	P mg/L	Pb mg/L	Se mg/L	Zn mg/L	TDS mg/L	TSS mg/L	TS mg/L	Turbidity NTU
AV	Not Set	0.0308	13.7	Not Set	0.00894	0.00181	0.387	191	10.1	207	3.28
HV	0.00209	0.0334	13.9	0.101	0.0092	0.00175	0.396	220	9.0	230	NA
1	NT	NT	NT	NT	NT	NT	NT	201	9.80	217	2.1
2	NT	NT	NT	NT	NT	NT	NT	190	10	198	NR
3	0.00202	0.0319	14.03	0.083	0.00913	0.0018	0.385	NT	NT	NT	NT
4	NT	NT	NT	NT	NT	NT	NT	200	10	210	2.6
5	NT	NT	NT	NT	NT	NT	NT	168	8.5	NT	3.02
6	0.002	0.0323	15	<1	0.0086	0.0018	0.396	186	8	200	2.7
7	NT	0.028	12.6	NT	0.0090	<0.002	0.360	194	8	197	2.9
8	NT	NT	NT	NT	NT	NT	NT	175	13	201	4.26
9	NT	0.032	15	NT	0.009	<0.004	0.393	208	10	220	2.8
10	NT	0.030	13	0.077	0.0079	0.0017	0.33	198	9.0	206	4.07
11	NT	0.0304	13.5	< 0.5	0.0089	0.0016	0.3865	183	11.6	236	3.32
12	NT	0.0318	13.7	NT	0.00906	<0.002	0.407	192	NT	198	3.46
13	NT	0.031	13.4	<0.5	0.009	0.001	0.392	193	11	205	4.2
14	NT	0.029	NT	NT	0.009	<0.01	0.357	180	<10	NT	4
15	NT	0.033	13	< 0.3	< 0.04	< 0.2	0.4	200	10	210	4
16	0.0019	0.029	13.9	0.11	0.0086	0.0018	0.40	204	13	228	3.47
17	<0.01	0.028	15	0.10	0.0080	0.002	0.40	NT	NT	NT	NT
18	NT	0.03	12	NT	0.0088	0.0019	0.43	210	11	NT	3.4
19	0.0021	0.033	14.2	<0.05	0.009	0.0016	0.348	190	10	200	2.5
20	NT	NT	NT	NT	NT	NT	NT	179	10.6	NT	NT
21	NT	NT	NT	NT	NT	NT	NT	189	11.5	200	2.95
22	0.002	0.033	13	<0.1	0.009	0.002	0.40	184	6	NR	1.6

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

6.5 Participants' Results and Analytical Methods

The Australian Drinking Water Guidelines for parameters in water are expressed in units of mg/L.[5] Hence, in the present study, participants were requested to analyse samples using their normal test method and to report a single result in units of mg/L. A summary of participants' results and performance is presented in Tables 48 and 49 and in Figures 43 to 46.

Rounding results and reporting results with an insufficient number of significant figures was the main cause of laboratories poor performance in this study. Analytical test results are rounded to avoid presenting a misleading impression of precision. However, most of the instrumental techniques that participants used in this 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 potable water.

Potable water is a less challenging matrix than sea water; while participants reported test results with 2 - 3 significant figures in the previous PT study in seawater, the same participants reported some results with only one significant figure in the present study. This suggests that change in the unit requested for reporting results is a source of confusion and/or that results could have been transferred from calculation spreadsheets that automatically apply the rounding rule. Laboratories 9, 13, 17, and 22 should consider revising their calculation/reporting procedure.

Caution should be exercised when a rounding protocol is designed by a laboratory to avoid inadvertent loss of important information. According to the 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)."

Cs and La are not in the analytical suite of too many laboratories.

Individual Element Commentary

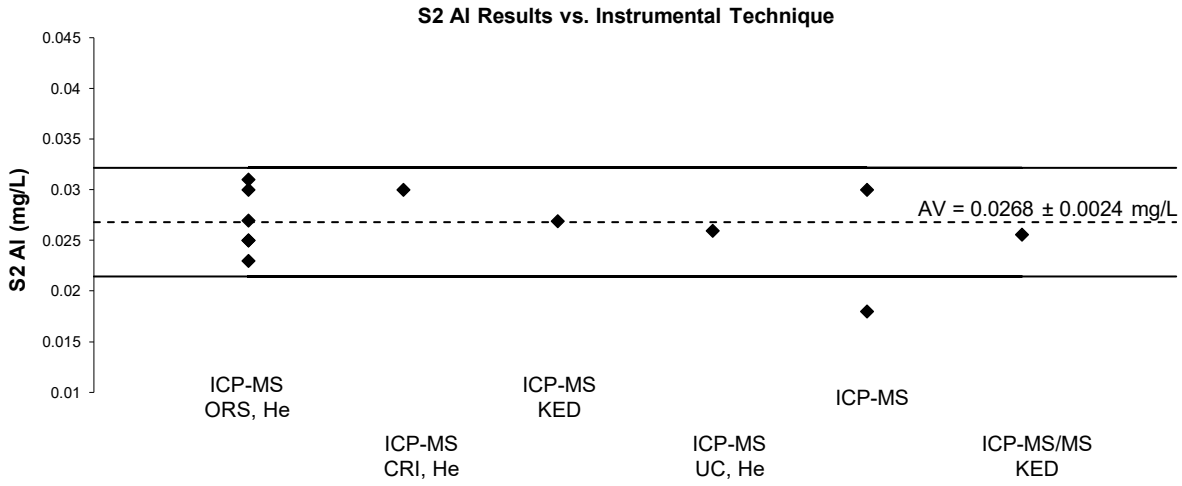
Participants were requested to analyse Samples S1 and S2 for total elements using their routine test method and to report a single result as they would normally report to a client. The method descriptions provided by participants are presented in Tables 1 and 3 and the instrumental conditions used are transcribed 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. Participants' performance reflects not only the performance of the analytical instrument but also that 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 15 used ICP-OES for all analyses in Sample S2. Caution should be exercised when using ICP-OES for the determination of analytes at low, ppb level as the sensitivity of the technique may not be sufficient to provide reliable quantification at these levels for some elements.

Aluminium was present in Sample S2 at a level of 0.0268 mg/L. All laboratories who reported results used an ICP-MS or ICP-MS/MS methodology, and all received an acceptable z-score except one **(**Figure 47).



Horizontal lines are equivalent to z-scores of 2 and -2 respectively.

Figure 47 S2 Al Results vs. Instrumental Technique

Arsenic in Sample S1 was at 0.00732 mg/L and at 0.0131 mg/L in Sample S2. Most participants determined arsenic using ICP-MS in collision mode with He or high-energy He. One participant reported using ICP-MS in reaction mode with O_2. (Figure 48). All reported results returned acceptable z-scores.

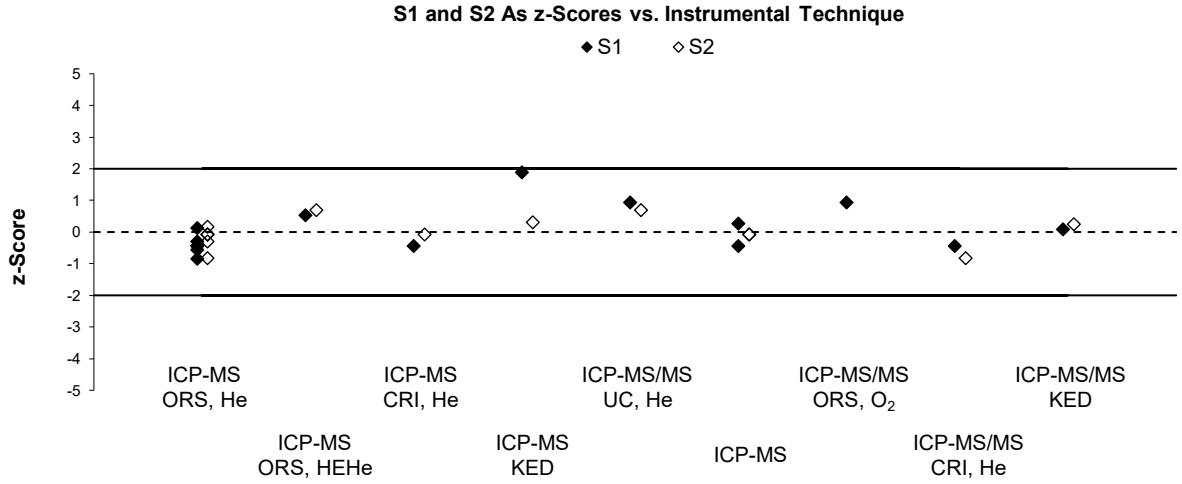


Figure 48 S1 and S2 As z-Scores vs. Instrumental Technique

Beryllium in Sample S1 was one of the analytes with the largest between-laboratory CVs (24%). The low Be concentration in S1 (0.00150 mg/L), together with laboratory rounding practices, may explain the poorer participant performance. Be concentration in S2 was 0.0765 mg/L, and all reported results for S2 achieved acceptable *z*-scores (Figure 49). In S1, only 10 of the 15 laboratories that reported results performed acceptably. Rounding may have contributed, as all laboratories that returned unacceptable *z*-scores reported results with only one significant figure. Plots of participant performance versus instrumental technique are presented in Figure 50. No trends were evident between participant performance and the instrumental technique used.

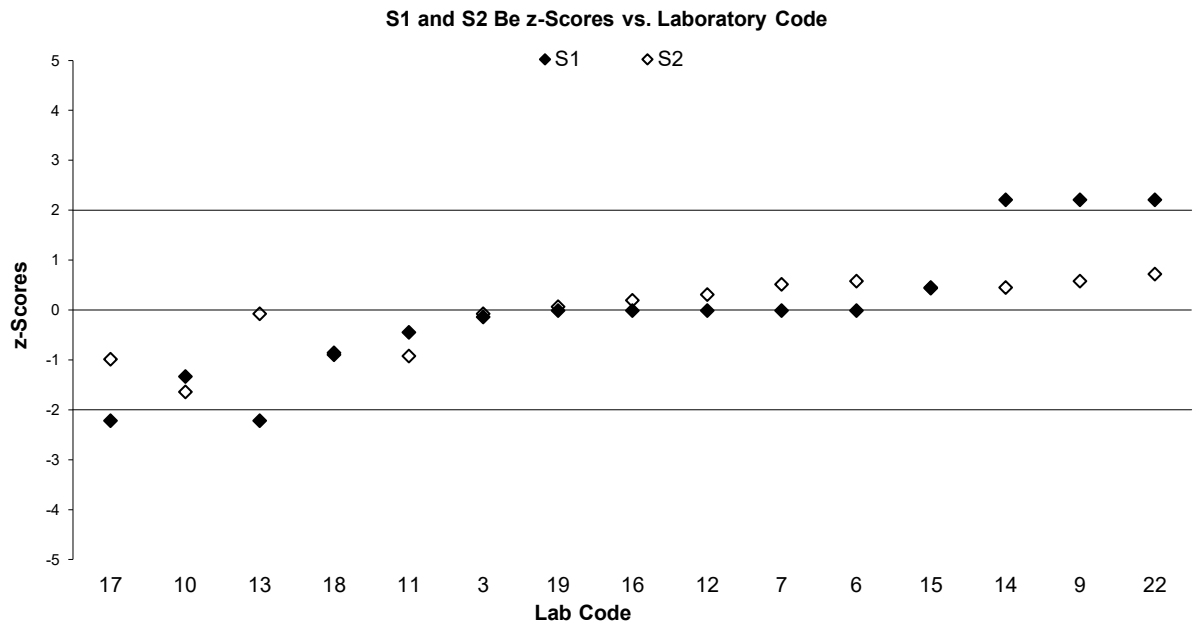


Figure 49 S1 and S2 Be z-Scores vs. Laboratory Code

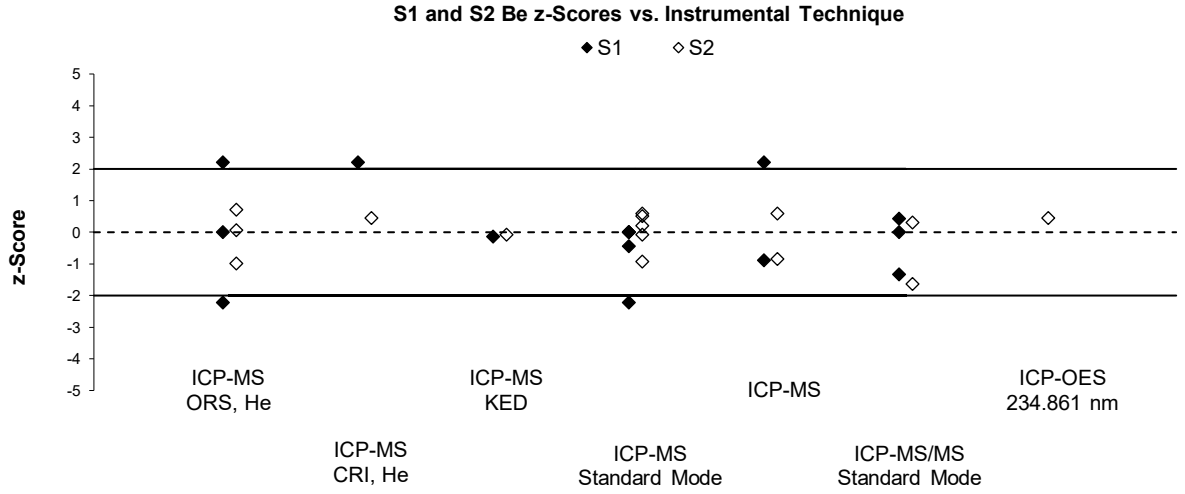


Figure 50 S1 and S2 Be z-Scores vs. Instrumental Technique

Caesium No assigned value was set for Cs in Sample S2, as only four participants reported quantitative results for this test. The reported results were in good agreement with each other and with the spiked value. All laboratories used an ICP-MS technique (Figure 51).

Iron and zinc are known to be ubiquitous in the environment; hence, special precautions (e.g. special gloves) are necessary in order to avoid contamination. Plots of participants' performance versus instrumental technique used are presented in Figure 52, and Figure 53. Neither analyte posed challenges to laboratories in this study.

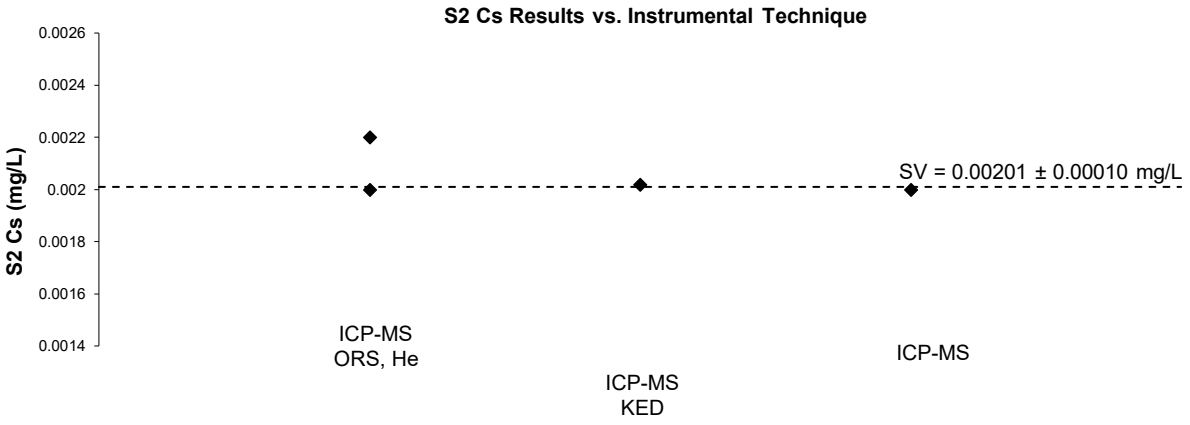


Figure 51 S2 Cs Results vs. Instrumental Technique

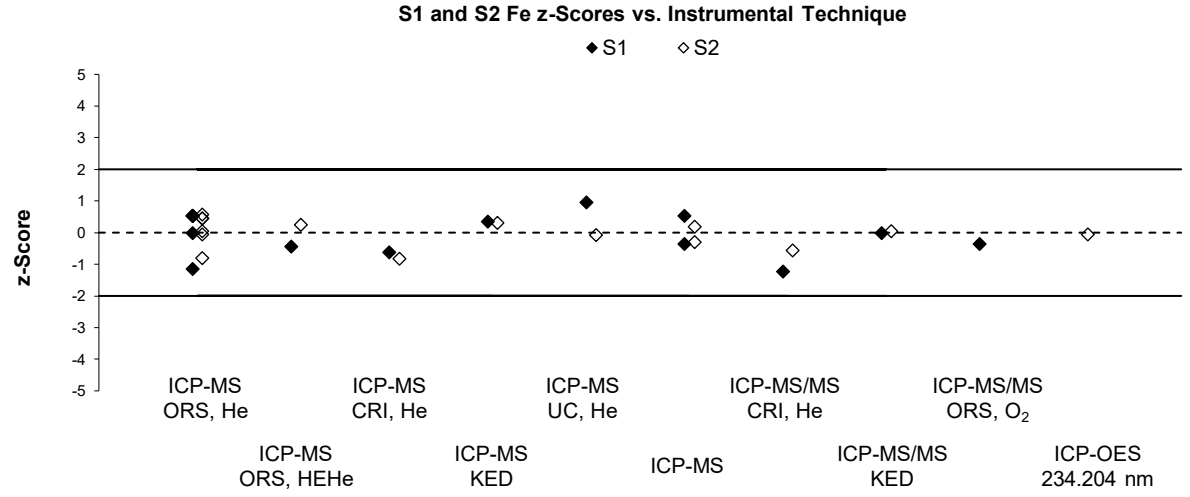


Figure 52 S1 and S2 Fe z-Scores vs. Instrumental Technique

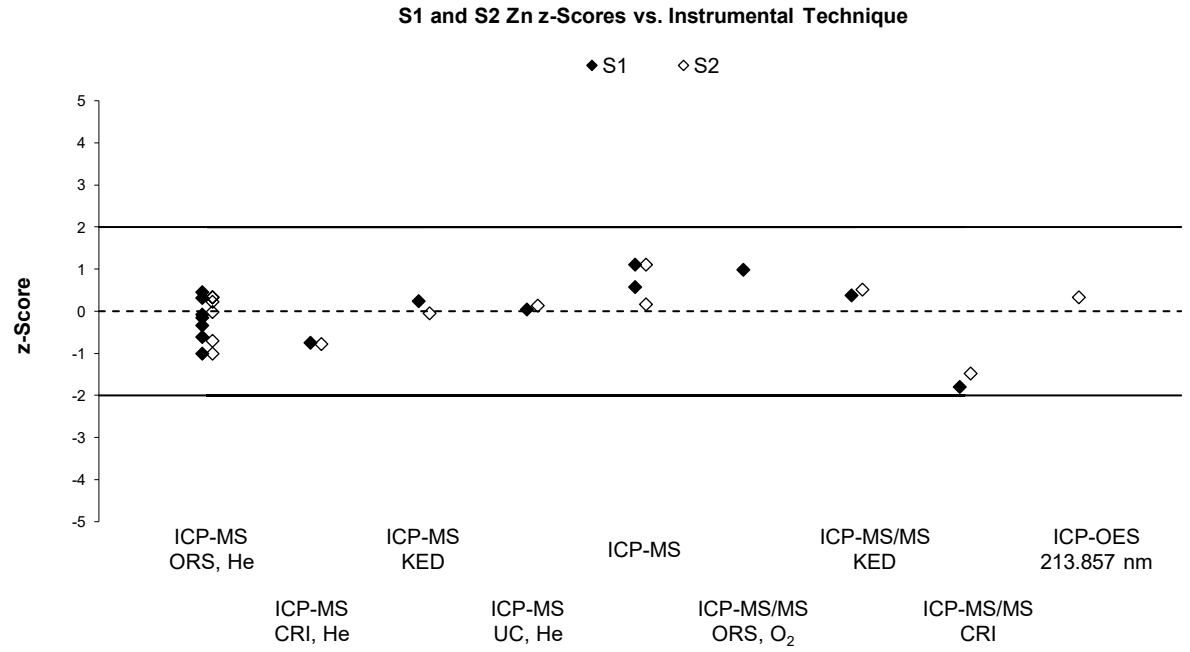


Figure 53 S1 and S2 Zn z-Scores vs. Instrumental Technique

Mercury was spiked at a level approximately seven times lower in Sample S1 than Sample S2. This may have challenged participants' analytical techniques (Figure 54). Four results in Sample S1 were questionable, while all results in Sample S2 were acceptable (Figure 55). Participants that received high z-scores should investigate the stability of their standards, as these are known to degrade depending on storage vessel and laboratory conditions and could explain the positive bias. It is recommended to prepare fresh Hg standards before each instrumental determination for this analyte [15]

However, as with Be in Sample S1, an inappropriate rounding procedure may also explain some of these scores. All results that received a questionable z-score were reported with only one significant figure (0.0001 mg/L or 0.0002 mg/L). Rounding procedures should consider not to inadvertently remove information essential for decision making.

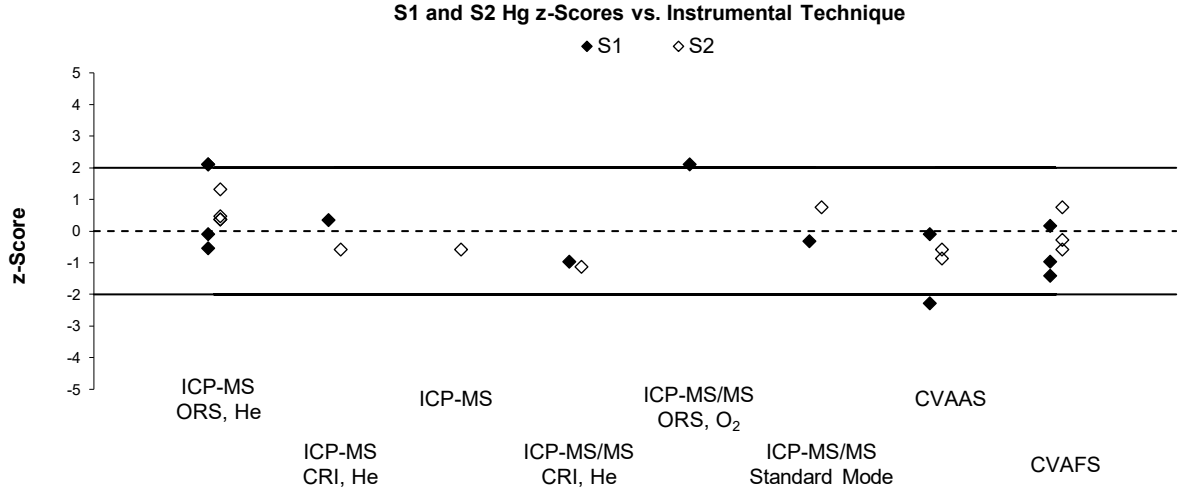


Figure 54 S1 and S2 Hg z-Scores vs. Instrumental Technique

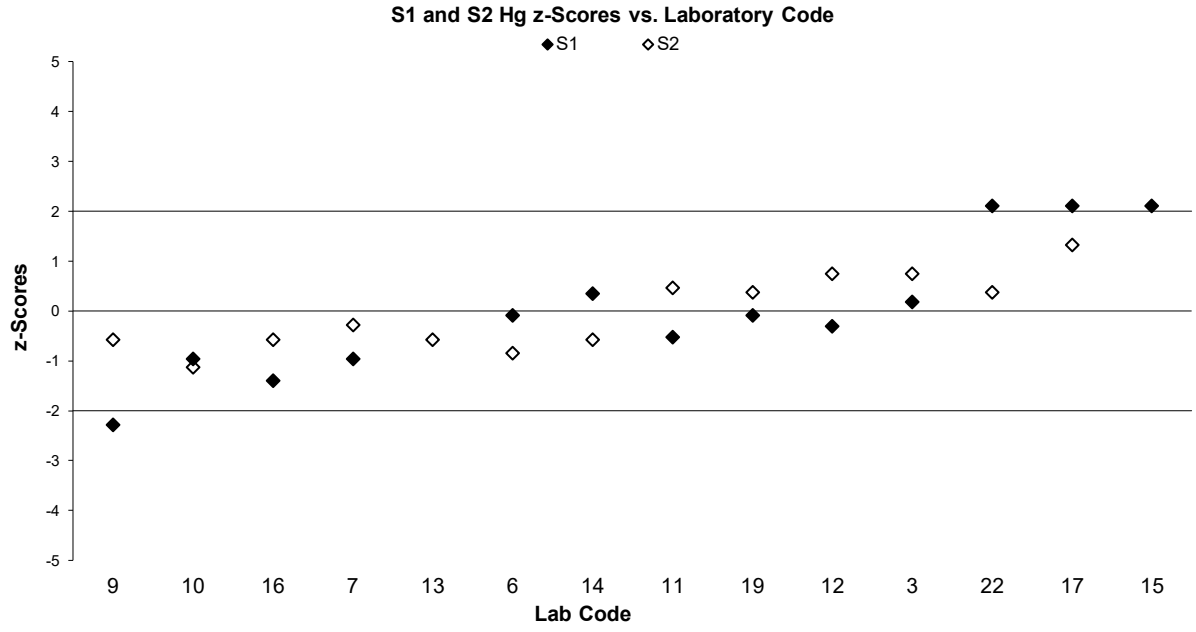


Figure 55 S1 and S2 Hg z-Scores vs. Laboratory Code

Phosphorus level in S2 was low at 0.101 mg/L and this might have challenged participants analytical techniques. This concentration was also below the reporting limit of most participating laboratories. Only four reported numeric results, Laboratories 3, 10, 16, and 17.

The reported results were in excellent agreement with each other and the spiked value. Of these laboratories, three reported using ICP-MS or ICP-MS/MS in collision mode. One used ICP-OES with wavelength 177.434 nm (Figure 56).

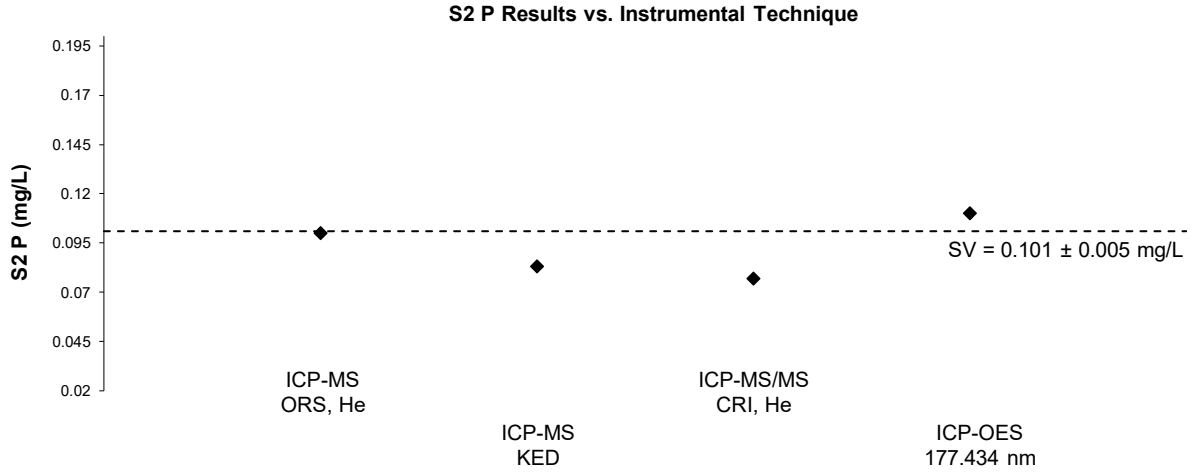


Figure 56 S2 P Results vs. Instrumental Technique

Selenium One laboratory used the same instrumental technique for Se measurements in both samples but reported an acceptable result in S1 and unacceptable in S2. The rounding procedure used might have contributed to the discrepancy.

Laboratories used a range of analytical techniques for Se determination, including ICP-MS in standard mode, ICP-MS and ICP-MS/MS in collision mode with He or high-energy He, and ICP-MS and ICP-MS/MS in reaction mode using NH_3, H_2, or O_2 as reaction gases (Figure 57)

Vanadium Of 12 results reported for V in Sample S1, 9 returned acceptable z-scores. All 3 unacceptable results were reported with only one significant figure.

There are no significant analytical challenges for V in potable water matrix. No trend were evident between the unacceptable results and instrumental technique used (Figure 58).

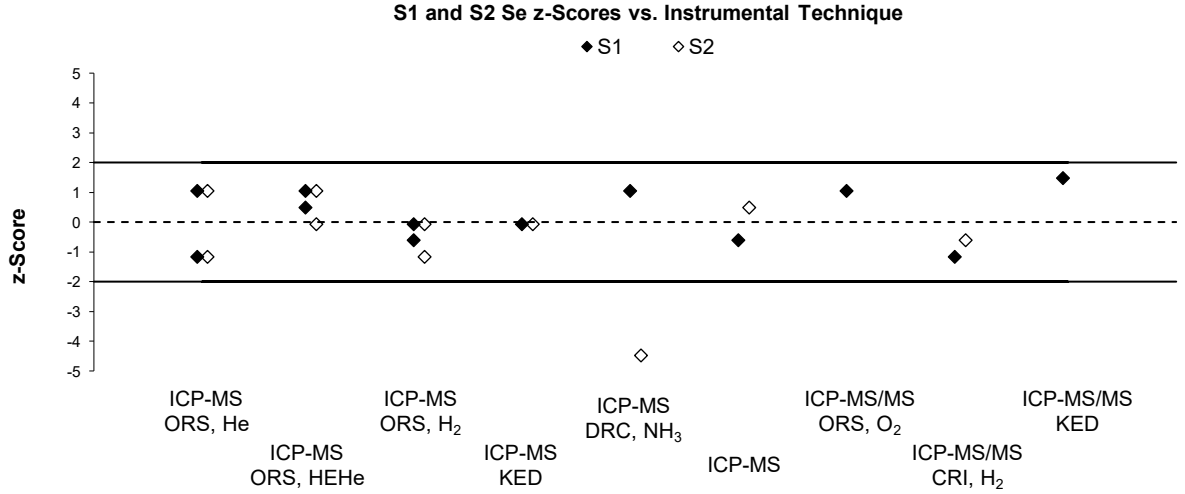
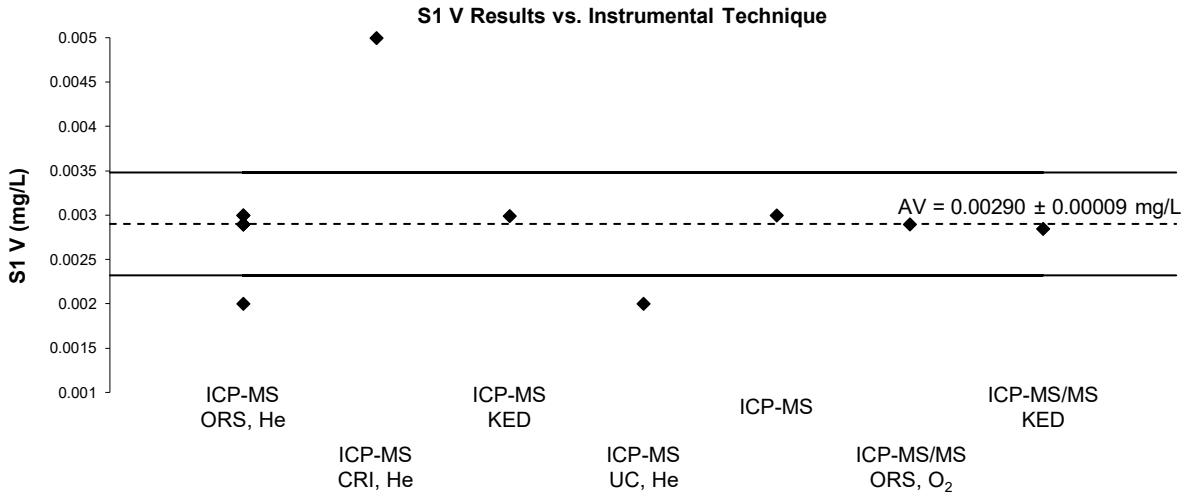


Figure 57 S1 and S2 Se z-Scores vs. Instrumental Technique



Horizontal lines are equivalent to z-scores of 2 and -2 respectively.

Figure 58 S1 V Results vs. Instrumental Technique

Solids and Turbidity The method descriptions provided by participants are 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 except for one laboratory's results for TSS and turbidity (Table 49). This laboratory should check their subsampling procedure to ensure that they adequately analysed a representative subsample.

Laboratory 1 reported that '*The sample had particles that settle quickly, therefore the turbidity reading was calculated from the average of 3 highest readings*.' They performed acceptably.

6.6 Participants' Within – Laboratory Repeatability

Sample S2 was prepared by further fortifying Sample S1 with all analytes of interest except Se. The concentration of Se was thus expected to be the same as in Sample S1.

A scatter plot of Se z-scores in S1 and S2 are presented in Figure 59. Points close to the diagonal axis (from bottom left to top right) represent excellent repeatability and points close to zero represent excellent repeatability and accuracy.

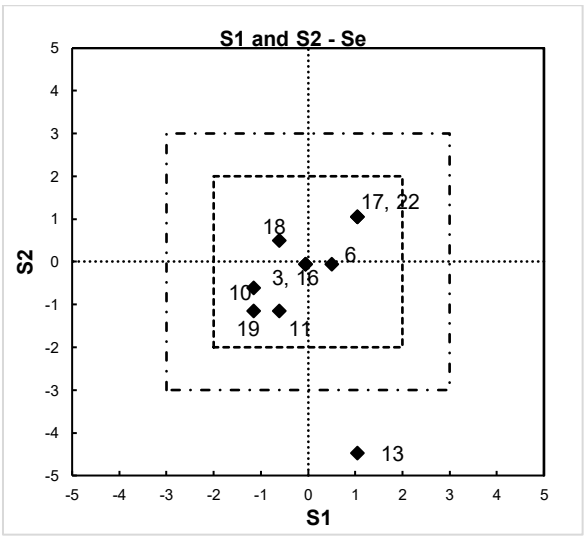


Figure 59 S1 and S2 Se z-Scores Youden Plot

Results reported by laboratories for Se in Samples S1 and S2, together with their reported expanded measurement uncertainties, are presented in the bar charts in Figure 60. With the exception of Laboratory 13, all participants reported similar selenium concentrations in the two water samples and generally reported comparable measurement uncertainties for both sets of results. Laboratory 13 may need to reassess its within-laboratory repeatability, as it reported an acceptable result for Se in Sample S1 but a unacceptable result for Sample S2.

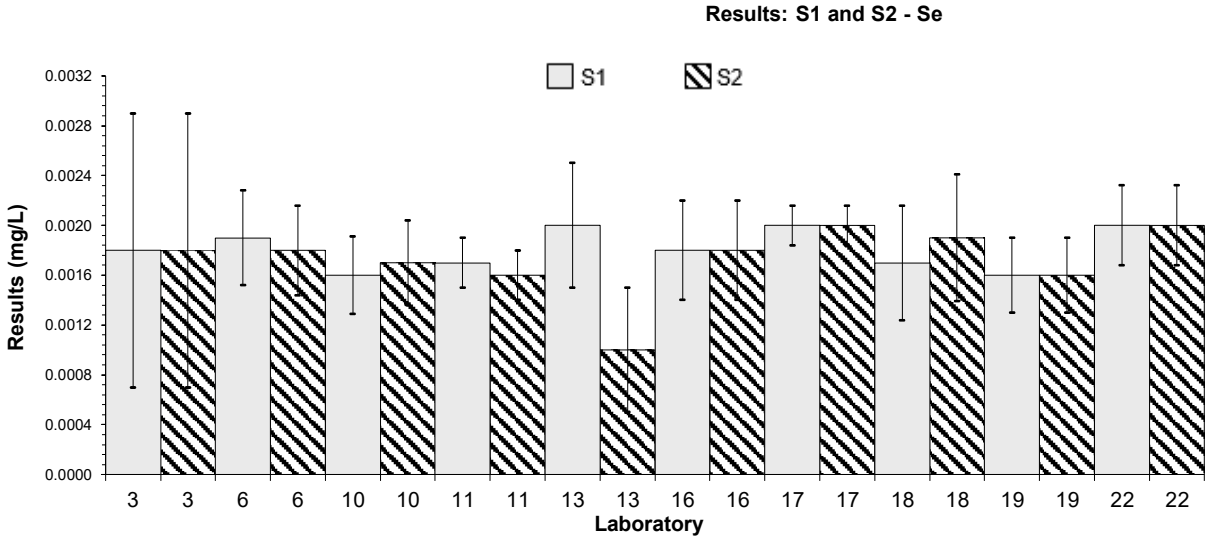


Figure 60 S1 and S2 Se z-Scores Bar Chart

6.7 Fitness for Purpose of Participants' Results

The Australian Drinking Water Guidelines (ADWG) provide a nationally recognised framework for assessing and managing drinking water quality to protect public health and ensure water is safe for consumption.[5] Accurate measurement of metallic contaminants in potable water is essential, as analytical results must reliably indicate whether a water sample complies with the relevant guideline values.

To assist laboratories in assessing their performance against regulatory guideline values, selected analytes were spiked into the study samples at concentrations close to the relevant guideline levels. The assigned values for these analytes, together with the corresponding ADWG guideline values, are presented in Table 50.

Table 50 ADWG Guideline Values and Assigned Values of Test Samples

Analyte	ADWG Health Guideline Value (mg/L)[5]	Sample S1 Assigned Value (mg/L)*	Sample S2 Assigned Value (mg/L)*
As	0.01	0.00732	0.0131
Be	0.06	0.00150	0.0765
Cd	0.002	0.00136	0.00256
Cr	0.05	0.00105	0.0491
Hg	0.001	0.000152	0.00106
La	0.002	NA	SV = 0.00201
Mo	0.05	0.00528	NA
Ni	0.02	0.00294	NA
Pb	0.005	0.00246	0.00894
Sb	0.003	0.00214	NA
Se	0.004	0.00181	0.00181
U	0.02	0.00988	NA

*NA = Not Available

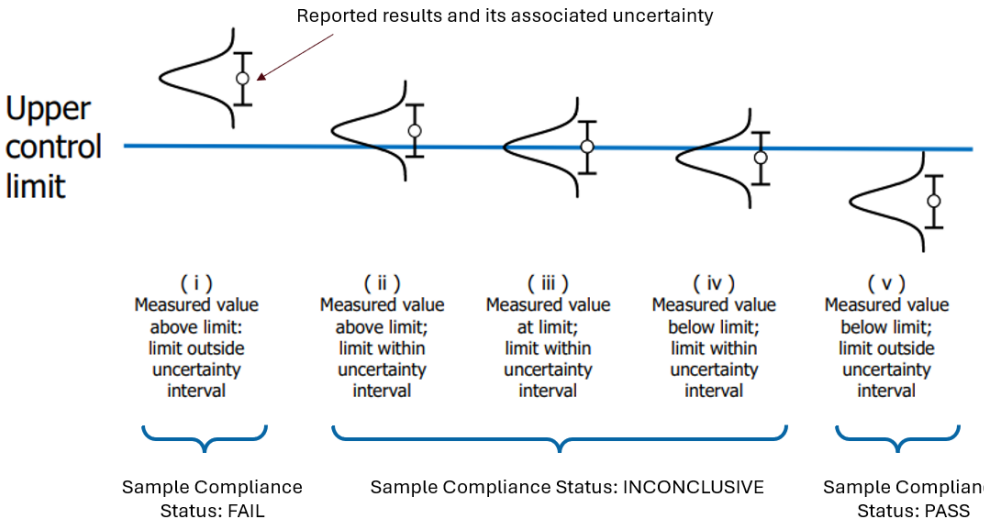


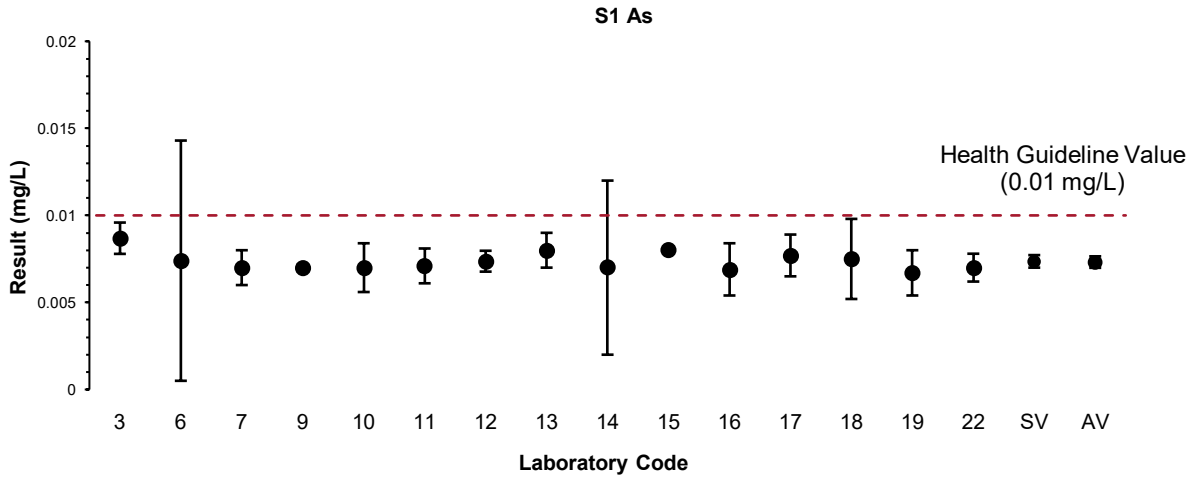
Image adapted from: Eurachem/CITAC Guide Use of Uncertainty Information in Compliance Assessment[17]

Figure 61 Assessment of Compliance with an Upper Limit

When a test result is used to determine whether a sample complies with an upper control limit, the measurement uncertainty of that result is critical. ISO/IEC 17025 defines a decision rule for such assessments as a 'rule that describes how measurement uncertainty is accounted for when stating conformity with a specified requirement'.[8] To determine whether a sample meets a regulatory limit, considering the reported result and its associated uncertainty, decision rules generally provide three possible outcomes: Pass, Fail, or Inconclusive when further testing may be required (Figure 61).[17]

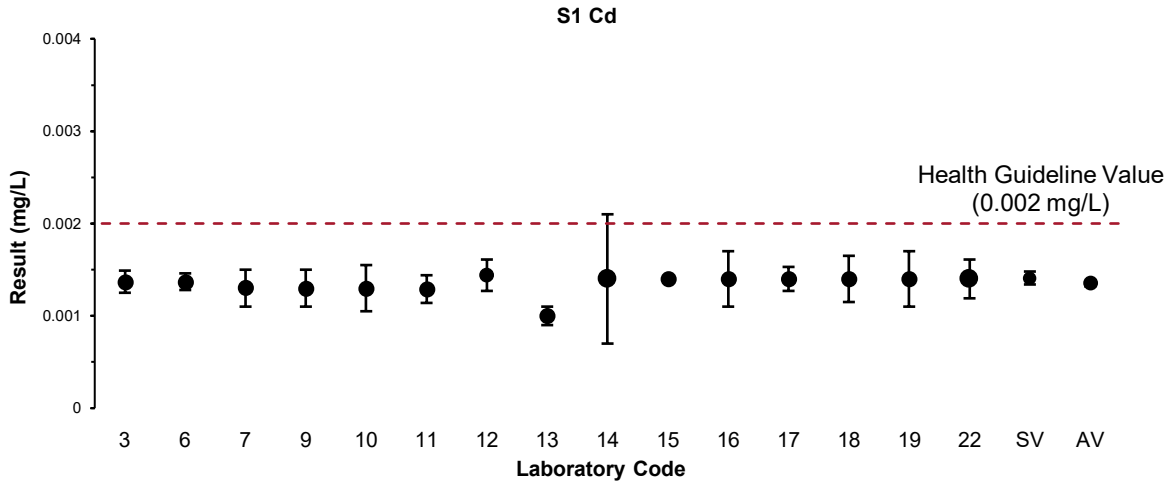
Figures 62 – 70 show comparisons of the spiked value (SV), assigned value (AV), participants' results, and guideline values for selected analytes. The analytes presented are those where the sample was spiked close to the guideline value.

The results reported for As and Cd in Sample S1 correctly indicated compliance with the ADWG, with the exception of the As and Cd results reported by Laboratory 14 and the As result reported by laboratory 6. A decision based on these results when measurement uncertainty is considered, would deem the status of the sample inconclusive, leading to further unnecessary testing (Figures 62 and 63). Reporting realistic uncertainties may help avoid making the wrong decision and incurring additional expenses.



SV=Spike Value, AV=Assigned Value

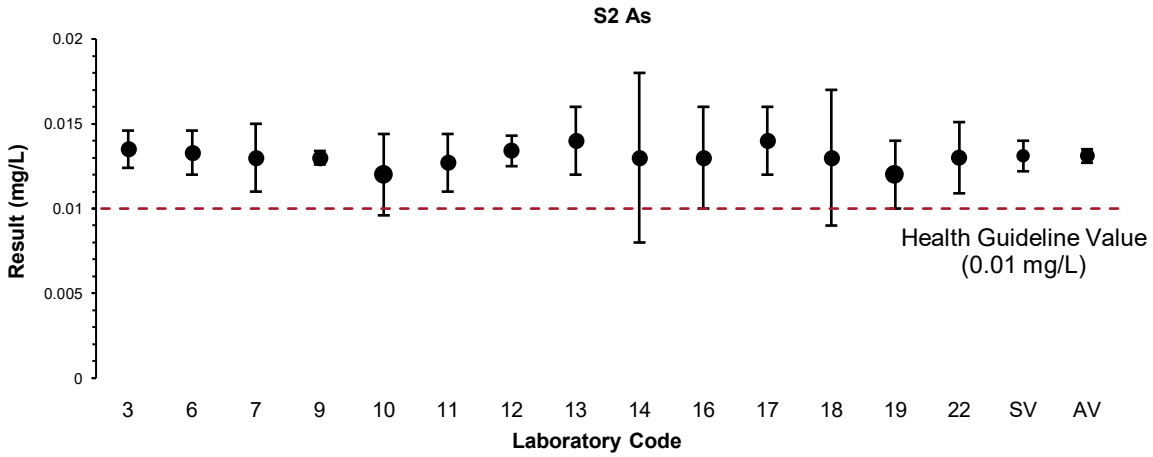
Figure 62 Sample S1 As Results and Guideline Value



SV=Spike Value, AV=Assigned Value

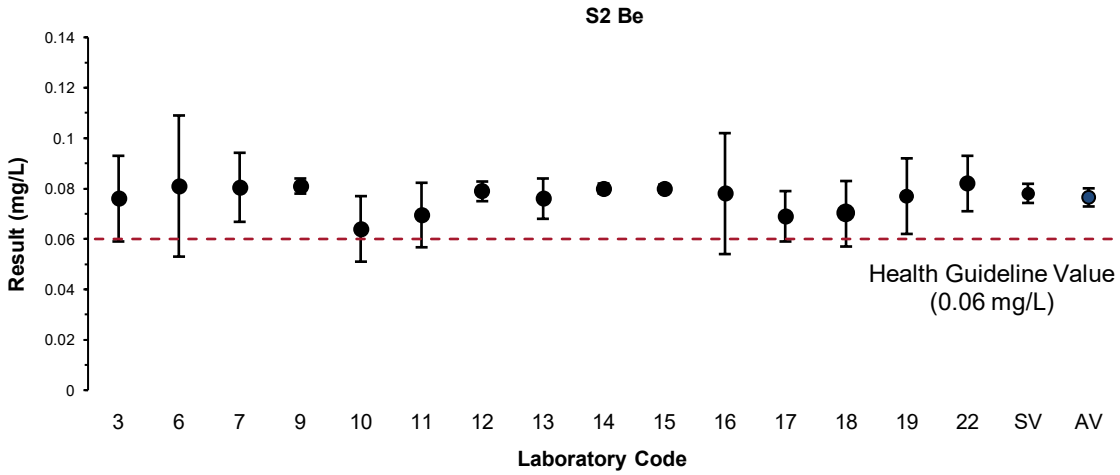
Figure 63 Sample S1 Cd Results and Guideline Value

Sample S2 was spiked close to, but above the ADWG for As, Be and Cd (Figures 64, 65 and 66). While most of the results reported by participants for these analytes correctly indicate the sample as non-compliant, a decision based on some when their measurement uncertainty is considered, would deem the status of the sample inconclusive. Reporting realistic uncertainties or bias correction may help avoid making the wrong decision.



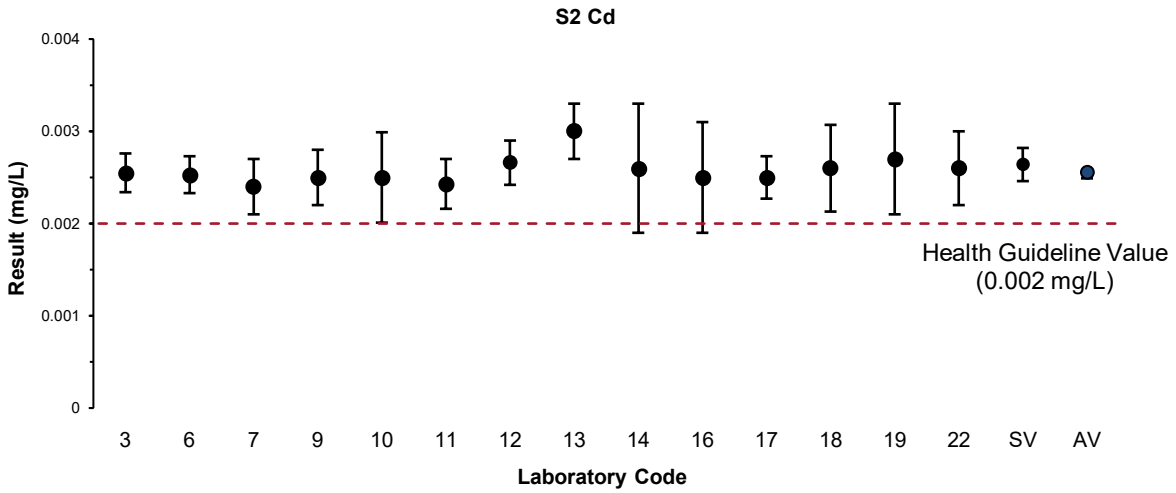
SV=Spike Value, AV=Assigned Value

Figure 64 Sample S2 As Results and Guideline Value



SV=Spike Value, AV=Assigned Value

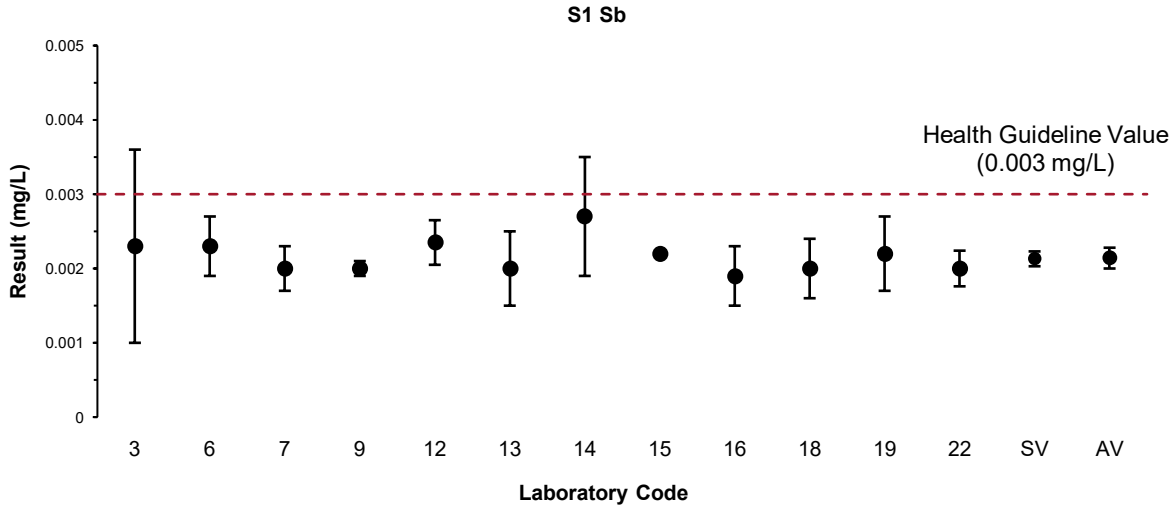
Figure 65 Sample S2 Be Results and Guideline Value



SV=Spike Value, AV=Assigned Value

Figure 66 Sample S2 Cd Results and Guideline Value

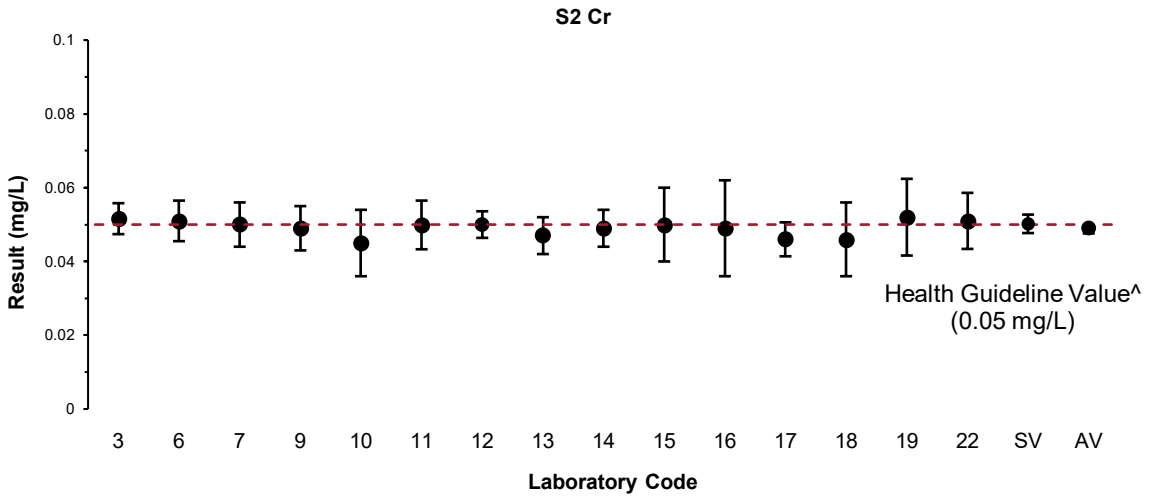
Similarly reporting realistic measurement uncertainties and bias correction may help avoid making the wrong decision when assessing Sb level in potable water against the ADWG. Although the assigned value for Sb in S2 was below the ADWG health guideline, a decision based on the results reported by Laboratories 3 and 14 will deem the status of this sample inconclusive (Figure 67).



SV=Spike Value, AV=Assigned Value

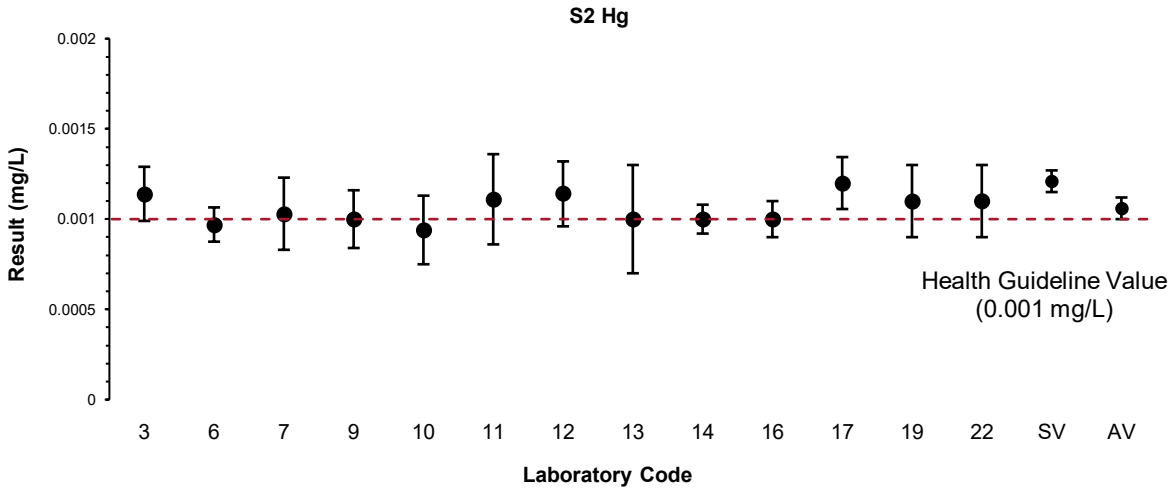
Figure 67 Sample S1 Sb Results and Guideline Value

Chromium, mercury, and lanthanum were present at concentrations close to their respective ADWG health-based guideline values. All reported results for these analytes correctly classified the Sample S2 status as inconclusive when measurement uncertainty was taken into account, indicating that further confirmatory testing may be required for these test before a compliance decision can be made.



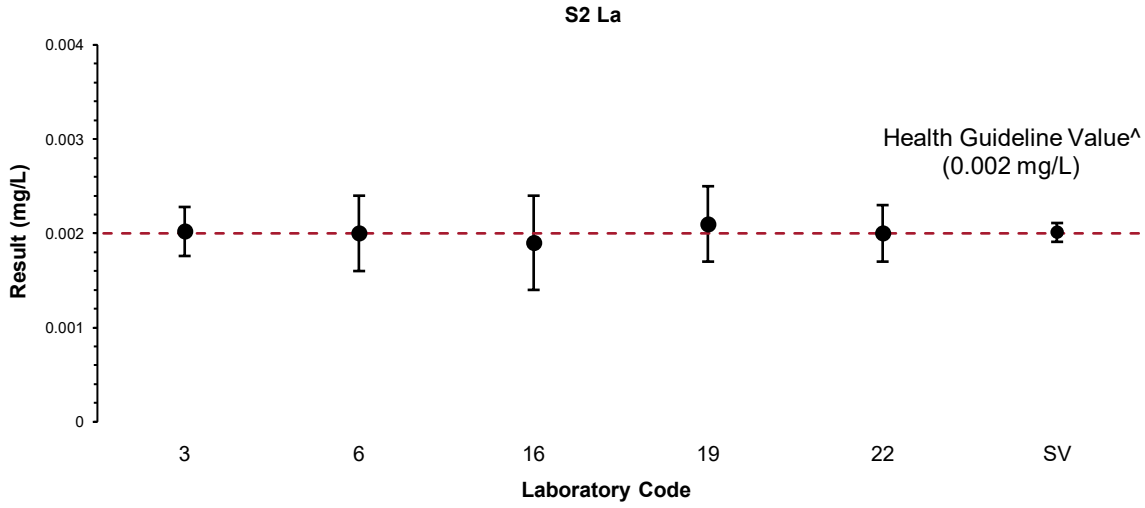
^ Guideline Value is for Cr as Cr(VI). If concentration of total Cr exceeds this value, test for Cr(VI); SV=Spike Value, AV=Assigned Value

Figure 68 Sample S2 Cr Results and Guideline Value



SV=Spike Value, AV=Assigned Value

Figure 69 Sample S2 Hg Results and Guideline Value



^ Guideline value is for La as La(III); SV=Spike Value, AV=Assigned Value

Figure 70 Sample S2 La Results and Guideline Value

6.8 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 51).

Table 51 Control Samples Used by Participants

Lab. Code	Description of Control Samples
1	SS
3	SS
4	CRM
5	CRM
6	SS
7	SS
8	CRM - QCI-171 Multi Analyte Solids Standard & Stablecal 0-800 for turbidity
9	CRM – Accustandard
10	CRM
11	CRM - QCS-01-05 ICP Quality Control Standard #1; High Purity Standards CCV-1 Solution A; High Purity Standards CCV-1 Solution B; Australian Chemical Reagents Multi Element Standard
12	SS, CRM - CWWTMA; CWWTMC
13	CRM - CWW-TM-B and CWW-TM-C (metals)
14	SS, CRM - TMDW from HPS Lot 2508010
15	CRM
16	SS
17	SS
18	CRM
19	RM / Ex PT Sample
21	RM / Ex PT Sample
22	SS, CRM

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]

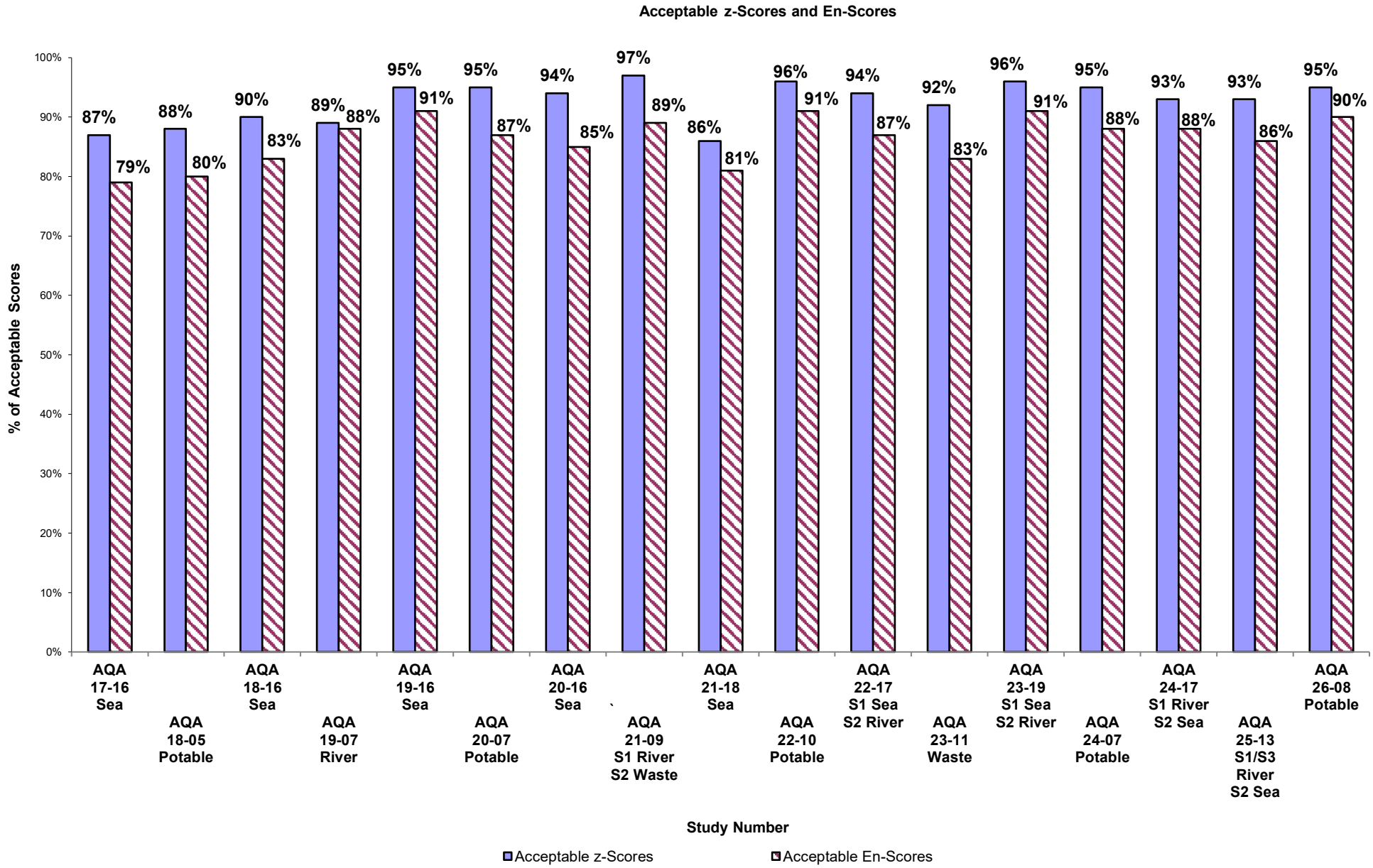


Figure 71 Participants' Performance in Metals in Water PT Studies over Last Ten Years

6.9 Comparison with Previous NMIA Proficiency Tests of Metals in Water

AQA 26-08 is the 37th NMIA proficiency study of metals in water. Participants' performance in the measurement of trace elements and solids in water over the last ten years is presented in Figure 71. Over this period, the participants performance remained similar regardless of the matrix and analyte level with an average of acceptable z-scores at 93% and of En-scores at 86%

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.

7 REFERENCES

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

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[18] National Measurement Institute, Method Number NT2.47: Determination of Total Acid Extractable Metals and Dissolved Elements in Water using Inductively Coupled Plasma Mass Spectrometry and Inductively Coupled Plasma Atomic Emission Spectrometry.

APPENDIX 1 – SAMPLE PREPARATION, ANALYSIS AND HOMOGENEITY TESTING

Sample Preparation

Sample S1 was prepared from potable water. Approximately 10 L of tap water were acidified and fortified for 17 elements.

Sample S2 was prepared from the remaining spiked potable water sample S1 to which 16 analytes were further spiked.

Sample S3 was prepared from potable water. Approximately 20 L of a tap water were fortified with a high-level solids standard.

Sample Analysis and Homogeneity Testing

A partial homogeneity test was conducted for Samples S1, S2, and S3, excluding turbidity. The average of three bottles analysed in duplicate was reported as the homogeneity value.

Sample Analysis for Total Elements

The total elements homogeneity analyses were conducted by NMIA CRV section using the method NT2.47.[18] A 7.5 mL of sample were diluted to 10 mL with 2% HNO_3. Measurements were conducted by ICP-MS in reaction mode with He or high energy He A summary of the instrument conditions used for each analyte is presented in Table 52. 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.

Table 52 Instrumental Techniques used for Total Elements in S1 and S2

Analyte	Instrument	Internal Standard	Reaction/Collision Cell (if applicable)	Cell Mode/Gas (if applicable)	S1 Final Dilution Factor	S2 Final Dilution Factor	Ion (m/z)
Al	ICP-MS	Rh	NA	NA	NA	1.33	27
As	ICP-MS	Rh	ORS	He	1.33	1.33	75
B	ICP-MS	Rh	NA	NA	NA	1.33	11
Ba	ICP-MS	Rh	ORS	He	1.33	NA	137
Be	ICP-MS	Rh	NA	NA	1.33	1.33	9
Bi	ICP-MS	Ir	ORS	He	1.33	1.33	209
Cd	ICP-MS	Rh	ORS	He	1.33	1.33	111
Co	ICP-MS	Rh	ORS	He	NA	1.33	59
Cr	ICP-MS	Rh	ORS	He	1.33	1.33	52
Cs	ICP-MS	Rh	ORS	He	NA	1.33	133
Cu	ICP-MS	Rh	ORS	He	1.33	NA	63
Fe	ICP-OES	Y	NA	NA	1.33	1.33	56
Hg	ICP-MS	Rh	ORS	He	1.33	1.33	201
La	ICP-MS	Rh	ORS	He	NA	1.33	139
Mn	ICP-MS	Rh	ORS	He	NA	1.33	55
Mo	ICP-MS	Rh	ORS	He	1.33	NA	95
Na	ICP-OES	Y	NA	NA	NA	1.33	23
Ni	ICP-MS	Rh	ORS	He	1.33	NA	60
P	ICP-MS	Ir	ORS	HEHe	NA	1.33	31
Pb	ICP-MS	Ir	ORS	He	1.33	1.33	208
Sb	ICP-MS	Rh	ORS	He	1.33	NA	121
Se	ICP-MS	Rh	ORS	HEHe	1.33	1.33	78
Sn	ICP-MS	Rh	ORS	He	1.33	NA	118
Tl	ICP-MS	Rh	ORS	He	1.33	NA	205
U	ICP-MS	Ir	ORS	He	1.33	NA	238
V	ICP-MS	Rh	ORS	He	1.33	NA	51
Zn	ICP-MS	Rh	ORS	He	1.33	1.33	64

Methodology for TDS, TSS, and TS

Analyses for TDS, TSS, and TS 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.

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 ISO 13528 'Statistical methods for use in proficiency testing by inter-laboratory comparisons – Annex C'.[6] The uncertainty was evaluated as:

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

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 53.

Table 53 Uncertainty of Assigned Value for As in Sample S1

No. results (p)	15
Robust Average	0.00732 mg/L
$S_{rob\ av}$	0.00051 mg/L
$u_{rob\ av}$	0.00016 mg/L
k	2
$U_{rob\ av}$	0.00033 mg/L

The assigned value for **As** in Sample S1 is **0.00732 ± 0.00033 mg/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 Section 4).

A worked example is set out below in Table 54.

Table 54 z-Score and E_n-score for As result reported by Laboratory 6 in S1

As Result mg/L	Assigned Value mg/L	Standard Deviation for Proficiency Assessment	z-Score	E_n-Score
0.0074 ± 0.0069	0.00732 ± 0.00033	10% as PCV or 0.1 x 0.00732 = 0.000732 mg/L	$z = \frac{(0.0074 - 0.00732)}{0.000732}$ $z = 0.11$	$En = \frac{(0.0074 - 0.00732)}{\sqrt{0.0069^2 + 0.00033^2}}$ $E_n = 0.01$

APPENDIX 3 - USING PT DATA FOR UNCERTAINTY EVALUATION

When a laboratory has successfully participated in at least 6 proficiency testing studies (e.g. is demonstrating control of bias and verification of repeatability), the standard deviation from proficiency testing studies (the reproducibility between-laboratory variation) can also be used to evaluate the uncertainty of their measurement results.[10, 12] An example is given.

Between 2011 and 2026, NMIA carried out 37 proficiency tests for metals in water. These studies involved analyses of dissolved or total elements at low and high levels in potable, fresh (river), sea, ground and waste water. **Laboratory X** 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 55 and 56.

Table 55 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
AQA 26-08	Potable	0.003 ± 0.0005	0.00294 ± 0.00008	15	4.3
				Average	13%*
$\boldsymbol{pooled\ s\%} = \sqrt{\frac{(\mathbf{15-1})\times\mathbf{24^2}+(\mathbf{19-1})\times\mathbf{18^2}+\cdots\ldots\ldots\ldots\ldots+(\mathbf{15-1})\times\mathbf{4.3^2})}{\mathbf{401-31}}}$					15%

* The pooled standard deviation was used.

Table 56 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*
$\boldsymbol{pooled\ s\%} = \sqrt{\frac{(\mathbf{15-1})\times\mathbf{2^2}+(\mathbf{15-1})\times\mathbf{2^2}+\cdots\ldots\ldots\ldots.+(\mathbf{21-1})\times\mathbf{8.1^2})}{\mathbf{277-18}}}$					11%

*The pooled standard deviation was used.

The pooled standard deviation of 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 57 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 57 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 49 different PT samples over 16 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

APPENDIX 5 - INSTRUMENT DETAILS

Table 58 Instrument Conditions Al

Lab. Code	Instrument	Internal standard	Reaction Collision Cell/Mode (if applicable)	Cell Gas (if applicable)	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-MS	Sc	KED	He	NA	1	27
6	ICP-MS	Sc	ORS	He	NA		
7	ICP-MS	Sc45	ORS	He	NA	1	27(m/z)
9	ICP-MS	Ir, Rh & Sc	NA	NA	NA	1	27 (m/z)
10	ICP-MS/MS	Sc	CRI	He	NA	1	27
11	ICP-MS	Sc	ORS	He	NA	1	27 (m/z)
12	ICP-MS/MS	Ga	KED	He	NA	1	27
13	ICP-MS	Sc	UC	He	NA	1	27
14	ICP-MS	Rh	CRI	He	NA	10	
15 (S2)	ICP-OES-AV	Bi 233.061			NA	NA	237.312
16	ICP-MS	Ge	ORS	He	NA	1.05	27
17	ICP-MS	Sc	ORS	He	NA	1	27
18	ICP-MS				NA		
19	ICP-OES-AV	Y	NA	NA	NA	2	167.019
22	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	NA	1	27

Table 59 Instrument Conditions As

Lab. Code	Instrument	Internal standard	Reaction Collision Cell/Mode (if applicable)	Cell Gas (if applicable)	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-MS	Te	KED	He	1	1	75
6	ICP-MS	Rh	ORS	He			
7	ICP-MS	Ge72	ORS	He	1	1	75(m/z)
9	ICP-MS	Ir, Rh & Sc	NA	NA	1	1	75 (m/z)
10	ICP-MS/MS	Rh	CRI	He	1	1	75
11	ICP-MS	Rh	ORS	He	1	1	75 (m/z)
12	ICP-MS/MS	Ga	KED	He	1	1	75
13	ICP-MS	Ge	UC	He	1	1	75
14	ICP-MS	Rh	CRI	He	10	10	
15 (S1)	ICP-MS/MS	Rh 103	ORS	O2	1		75/91
15 (S2)	ICP-OES-AV	Bi 233.061			NA	1	188.98
16	ICP-MS	Ge	ORS	He	1.05	1.05	75
17	ICP-MS	Rh	ORS	HEHe	1	1	75
18	ICP-MS						
19	ICP-MS	Sc Rh Ir	ORS	He	2	2	75
22	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	1	75

Table 60 Instrument Conditions B

Lab. Code	Instrument	Internal standard	Reaction Collision Cell/Mode (if applicable)	Cell Gas (if applicable)	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-MS	Sc	KED	He	NA	1	10
6	ICP-MS	Sc	ORS	Standard Mode	NA		
9	ICP-MS	Ir, Rh & Sc	NA	NA	NA	1	11 (m/z)
10	ICP-MS/MS	Sc	CRI	No Gas	NA	1	11
11	ICP-MS	Sc	ORS	He	NA	1	11 (m/z)
12	ICP-MS/MS	Ga	STD		NA	1	11
13	ICP-MS	Sc	NA	NA	NA	1	10
14	ICP-MS	Sc	CRI	Standard Mode	NA	10	
15 (S2)	ICP-OES-AV	Bi 233.061			NA	NA	249.678
16	ICP-OES-AV	Lu	NA	NA	NA	1.05	208.956
17	ICP-MS	Sc	ORS	He	NA	1	11
18	ICP-MS				NA		
19	ICP-MS	Sc Rh Ir	ORS	He	NA	2	11
22	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	NA	1	11

Table 61 Instrument Conditions Ba

Lab. Code	Instrument	Internal standard	Reaction Collision Cell/Mode (if applicable)	Cell Gas (if applicable)	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-MS	Tb	KED	He	1	NA	137
6	ICP-MS	Rh	ORS	He		NA	
7	ICP-MS	Tb159	ORS	He	1	NA	137(m/z)
9	ICP-MS	Ir, Rh & Sc	NA	NA	1	NA	137 (m/z)
10	ICP-MS/MS	Rh	CRI	He	1	NA	135
11	ICP-MS	Rh	ORS	He	1	NA	135 (m/z)
12	ICP-MS/MS	In	STD		1	NA	137
13	ICP-MS	Rh	NA	NA	1	NA	138
14	ICP-MS	Rh	CRI	He	10	NA	
15 (S1)	ICP-MS/MS	Rh 103	ORS	O2	1		137/153
16	ICP-MS	Ir	ORS	He	1.05	NA	137
17	ICP-MS	Rh	ORS	He	1	NA	137
18	ICP-MS					NA	
19	ICP-MS	Sc Rh Ir	ORS	He	2	NA	137
22	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	NA	137

Table 62 Instrument Conditions Be

Lab. Code	Instrument	Internal standard	Reaction Collision Cell/Mode (if applicable)	Cell Gas (if applicable)	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-MS	Sc	KED	He	1	1	9
6	ICP-MS	Sc	ORS	Standard Mode			
7	ICP-MS	Sc45	NA	NA	1	1	9(m/z)
9	ICP-MS	Ir, Rh & Sc	NA	NA	1	1	9 (m/z)
10	ICP-MS/MS	Sc	CRI	No Gas	1	1	9
11	ICP-MS	Sc	ORS	Standard Mode	1	1	9 (m/z)
12	ICP-MS/MS	Ga	STD		1	1	9
13	ICP-MS	Sc	NA	NA	1	1	9
14	ICP-MS	Sc	CRI	He	10	10	
15 (S1)	ICP-MS/MS	Sc 45		No Gas	1		9
15 (S2)	ICP-OES-AV	NA			NA	1	234.861
16	ICP-MS	Li6	NA	No Gas	1.05	1.05	9
17	ICP-MS	Sc	ORS	He	1	1	9
18	ICP-MS						
19	ICP-MS	Sc Rh Ir	ORS	He	2	2	9
22	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	1	9

Table 63 Instrument Conditions Bi

Lab. Code	Instrument	Internal standard	Reaction Collision Cell/Mode (if applicable)	Cell Gas (if applicable)	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-MS	Tb	KED	He	1	1	209
6	ICP-MS	Ir	ORS	He			
9	ICP-MS	Ir, Rh & Sc	NA	NA	1	1	209 (m/z)
10	ICP-MS/MS	Lu	CRI	He	1	1	209
11	ICP-MS	Lu	ORS	He	1	1	209 (m/z)
13	ICP-MS	Ir	NA	NA	1	1	209
14	ICP-MS	Ir	CRI	He	10	10	
15 (S1)	ICP-MS/MS	Ir 193		O2	1		209
16	ICP-MS	Ir	ORS	He	1.05	1.05	209
17	ICP-MS	Ir	ORS	He	1	1	209
19	ICP-MS	Sc Rh Ir	ORS	He	2	2	209
22	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	1	209

Table 64 Instrument Conditions Cd

Lab. Code	Instrument	Internal standard	Reaction Collision Cell/Mode (if applicable)	Cell Gas (if applicable)	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-MS	Rh	KED	He	1	1	111
6	ICP-MS	Rh	ORS	He			
7	ICP-MS	Rh103	ORS	He	1	1	111(m/z)
9	ICP-MS	Ir, Rh & Sc	NA	NA	1	1	111 (m/z)
10	ICP-MS/MS	Rh	CRI	He	1	1	111
11	ICP-MS	Rh	ORS	He	1	1	111 (m/z)
12	ICP-MS/MS	In	KED	He	1	1	111
13	ICP-MS	Rh	NA	NA	1	1	111
14	ICP-MS	Rh	CRI	He	10	10	
15 (S1)	ICP-MS/MS	Rh 103		O2	1		111
15 (S2)	ICP-OES-AV	Lu 219.556			NA	1	214.439
16	ICP-MS	Ir	ORS	He	1.05	1.05	111
17	ICP-MS	Rh	ORS	He	1	1	111
18	ICP-MS						
19	ICP-MS	Sc Rh Ir	ORS	He	2	2	111
22	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	1	111

Table 65 Instrument Conditions Co

Lab. Code	Instrument	Internal standard	Reaction Collision Cell/Mode (if applicable)	Cell Gas (if applicable)	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-MS	Ga	KED	He	NA	1	59
6	ICP-MS	Rh	ORS	He	NA		
7	ICP-MS	Rh103	ORS	He	NA	1	59(m/z)
9	ICP-MS	Ir, Rh & Sc	NA	NA	NA	1	59 (m/z)
10	ICP-MS/MS	Sc	CRI	He	NA	1	59
11	ICP-MS	Sc	ORS	He	NA	1	59 (m/z)
12	ICP-MS/MS	Ga	KED	He	NA	1	59
13	ICP-MS	Ge	UC	He	NA	1	59
14	ICP-MS	Rh	CRI	He	NA	10	
15 (S2)	ICP-OES-AV	Lu 219.556			NA	NA	228.615
16	ICP-MS	Ge	ORS	He	NA	1.05	59
17	ICP-MS	Sc	ORS	He	NA	1	59
18	ICP-MS				NA		
19	ICP-MS	Sc Rh Ir	ORS	He	NA	2	59
22	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	NA	1	59

Table 66 Instrument Conditions Cr

Lab. Code	Instrument	Internal standard	Reaction Collision Cell/Mode (if applicable)	Cell Gas (if applicable)	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-MS	Sc	KED	He	1	1	52
6	ICP-MS	Sc	ORS	He			
7	ICP-MS	Ge72	ORS	He	1	1	52(m/z)
9	ICP-MS	Ir, Rh & Sc	NA	NA	1	1	52 (m/z)
10	ICP-MS/MS	Sc	CRI	He	1	1	52
11	ICP-MS	Sc	ORS	He	1	1	52 (m/z)
12	ICP-MS/MS	Ga	KED	He	1	1	52
13	ICP-MS	Sc	UC	He	1	1	52
14	ICP-MS	Rh	CRI	He	10	10	
15 (S1)	ICP-MS/MS	Sc 45/61		O2	1		52
15 (S2)	ICP-OES-AV	Lu 219.556			NA	1	205.56
16	ICP-MS	Ge	ORS	He	1.05	1.05	52
17	ICP-MS	Sc	ORS	He	1	1	52
18	ICP-MS						
19	ICP-MS	Sc Rh Ir	ORS	He	2	2	52
22	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	1	52

Table 67 Instrument Conditions Cs

Lab. Code	Instrument	Internal standard	Reaction Collision Cell/Mode (if applicable)	Cell Gas (if applicable)	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-MS	Tb	KED	He	NA	1	133
6	ICP-MS	Rh	ORS	He	NA		
9	ICP-MS	Ir, Rh & Sc	NA	NA	NA	1	133 (m/z)
17	ICP-MS	Bi	ORS	He	NA	1	133
19	ICP-MS	Sc Rh Ir	ORS	He	NA	2	133
22	NA	NA	NA	NA	NA	1	NA

Table 68 Instrument Conditions Cu

Lab. Code	Instrument	Internal standard	Reaction Collision Cell/Mode (if applicable)	Cell Gas (if applicable)	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-MS	Ga	KED	He	1	NA	63
6	ICP-MS	Rh	ORS	He		NA	
7	ICP-MS	Rh103	ORS	He	1	NA	65(m/z)
9	ICP-MS	Ir, Rh & Sc	NA	NA	1	NA	63 (m/z)
10	ICP-MS/MS	Sc	CRI	He	1	NA	63
11	ICP-MS	Sc	ORS	He	1	NA	63 (m/z)
12	ICP-MS/MS	Ga	KED	He	1	NA	63
13	ICP-MS	Ge	UC	He	1	NA	63
14	ICP-MS	Rh	CRI	He	10	NA	
15 (S1)	ICP-MS/MS	Rh 103		He	1		63
16	ICP-MS	Ge	ORS	He	1.05	NA	63
17	ICP-MS	Sc	ORS	He	10	NA	63
18	ICP-MS					NA	
19	ICP-MS	Sc Rh Ir	ORS	He	2	NA	63
22	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	NA	63

Table 69 Instrument Conditions Fe

Lab. Code	Instrument	Internal standard	Reaction Collision Cell/Mode (if applicable)	Cell Gas (if applicable)	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-MS	Sc	KED	He	1	1	56
6	ICP-MS	Sc	ORS	HEHe			
7	ICP-MS	Bi209	ORS	He	1	1	56(m/z)
9	ICP-MS	Ir, Rh & Sc	NA	NA	1	1	56 (m/z)
10	ICP-MS/MS	Sc	CRI	He	1	1	56
11	ICP-MS	Sc	ORS	He	1	1	56 (m/z)
12	ICP-MS/MS	Ga	KED	He	1	1	56
13	ICP-MS	Sc	UC	He	1	1	56
14	ICP-MS	Rh	CRI	He	10	10	
15 (S1)	ICP-MS/MS	Rh 103		O2	1		56
15 (S2)	ICP-OES-RV	Eu 271.7			NA	1	238.204
16	ICP-MS	Ge	ORS	He	1.05	1.05	56
17	ICP-MS	Sc	ORS	He	1	1	56
18	ICP-MS						
19	ICP-MS	Sc Rh Ir	ORS	He	2	2	238.204
22	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	1	56

Table 70 Instrument Conditions Hg

Lab. Code	Instrument	Internal standard	Reaction Collision Cell/Mode (if applicable)	Cell Gas (if applicable)	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	Atomic Fluorescence	NA	NA	NA	5	5	254
6	CVAAS						253.7nm
7	CVAFS	NA	NA	NA	1.25	1.25	254 nm
9	CETAC	NA	NA	NA	1	1	253 nm
10	ICP-MS/MS	Lu	CRI	He	1	1	202
11	ICP-MS	Lu	ORS	He	1	1	202 (m/z)
12	ICP-MS/MS	Ir	STD		1	1	201
13	ICP-MS	Ir	NA	NA	1	1	201
14	ICP-MS	Ir	CRI	He	10	10	
15 (S1)	ICP-MS/MS	Ir 193		O2	1		202
15 (S2)	ICP-OES-AV	Lu 219.556			NA	1	194.164
16	CVAFS	NA	NA	NA	2	2	253.7
17	ICP-MS	Ir	ORS	He	1	1	202
19	ICP-MS	Sc Rh Ir	ORS	He	2	2	253.7
22	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	1	201

Table 71 Instrument Conditions La

Lab. Code	Instrument	Internal standard	Reaction Collision Cell/Mode (if applicable)	Cell Gas (if applicable)	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-MS	Tb	KED	He	NA	1	139
6	ICP-MS	Rh	ORS	Standard Mode	NA		
16	ICP-MS	Ir	ORS	He	NA	1.05	139
17	ICP-MS	Rh	ORS	He	NA	1	139
19	ICP-MS	Sc Rh Ir	ORS	He	NA	2	139
22	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	NA	1	139

Table 72 Instrument Conditions Mn

Lab. Code	Instrument	Internal standard	Reaction Collision Cell/Mode (if applicable)	Cell Gas (if applicable)	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-MS	Sc	KED	He	NA	1	55
6	ICP-MS	Sc	ORS	He	NA		
7	ICP-MS	Rh103	ORS	He	NA	1	55(m/z)
9	ICP-MS	Ir, Rh & Sc	NA	NA	NA	1	55 (m/z)
10	ICP-MS/MS	Sc	CRI	He	NA	1	55
11	ICP-MS	Sc	ORS	He	NA	1	55 (m/z)
12	ICP-MS/MS	Ga	KED	He	NA	1	55
13	ICP-MS	Sc	UC	He	NA	1	55
14	ICP-MS	Rh	CRI	He	NA	10	
15 (S2)	ICP-OES-AV	Eu 271.7			NA	NA	257.61
16	ICP-MS	Ge	ORS	He	NA	1.05	55
17	ICP-MS	Sc	ORS	He	NA	1	55
18	ICP-MS				NA		
19	ICP-MS	Sc Rh Ir	ORS	He	NA	2	257.61
22	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	NA	1	55

Table 73 Instrument Conditions Mo

Lab. Code	Instrument	Internal standard	Reaction Collision Cell/Mode (if applicable)	Cell Gas (if applicable)	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-MS	Rh	KED	He	1	NA	98
6	ICP-MS	Rh	ORS	He		NA	
7	ICP-MS	Ge72	ORS	He	1	NA	95(m/z)
9	ICP-MS	Ir, Rh & Sc	NA	NA	1	NA	95 (m/z)
10	ICP-MS/MS	Sc	CRI	He	1	NA	95
11	ICP-MS	Rh	ORS	He	1	NA	95 (m/z)
12	ICP-MS/MS	In	STD		1	NA	95
13	ICP-MS	Rh	NA	NA	1	NA	95
14	ICP-MS	Rh	CRI	He	10	NA	
15 (S1)	ICP-MS/MS	Rh 103		He	1		95
16	ICP-MS	Ge	ORS	He	1.05	NA	95
17	ICP-MS	Rh	ORS	He	1	NA	95
18	ICP-MS					NA	
19	ICP-MS	Sc Rh Ir	ORS	He	2	NA	95
22	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	NA	95

Table 74 Instrument Conditions Na

Lab. Code	Instrument	Internal standard	Reaction Collision Cell/Mode (if applicable)	Cell Gas (if applicable)	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-MS	Sc	KED	He	NA	1	23
6	ICP-OES-AV	Eu			NA		589.592nm
7	ICP-MS	Rh103	ORS	He	NA	1	23(m/z)
9	ICP-MS	Ir, Rh & Sc	NA	NA	NA	1	23 (m/z)
10	ICP-MS/MS	Sc	CRI	He	NA	1	23
11	ICP-MS	Sc	ORS	He	NA	1	23 (m/z)
12	ICP-OES-AV-buffer	Y			NA	1	589.592
13	ICP-MS	Sc	UC	He	NA	1	23
15 (S2)	ICP-OES-AV	In 410.176			NA	NA	589.592
16	ICP-OES-RV	Lu	NA	NA	NA	1.05	589.592
17	ICP-MS	Sc	ORS	He	NA	10	23
18	ICP-MS				NA		
19	ICP-OES-AV	Y	NA	NA	NA	2	589.592
22	ICP-OES	Cs,Y	NA	NA	NA	1	588.995

Table 75 Instrument Conditions Ni

Lab. Code	Instrument	Internal standard	Reaction Collision Cell/Mode (if applicable)	Cell Gas (if applicable)	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-MS	Ga	KED	He	1	NA	60
6	ICP-MS	Rh	ORS	He		NA	
7	ICP-MS	Rh103	ORS	He	1	NA	60(m/z)
9	ICP-MS	Ir, Rh & Sc	NA	NA	1	NA	60 (m/z)
10	ICP-MS/MS	Sc	CRI	He	1	NA	60
11	ICP-MS	Sc	ORS	He	1	NA	60 (m/z)
12	ICP-MS/MS	Ga	KED	He	1	NA	60
13	ICP-MS	Ge	UC	He	1	NA	60
14	ICP-MS	Rh	CRI	He	10	NA	
15 (S1)	ICP-MS/MS	Rh 103		O2	1		60
16	ICP-MS	Ge	ORS	He	1.05	NA	60
17	ICP-MS	Sc	ORS	He	1	NA	60
18	ICP-MS					NA	
19	ICP-MS	Sc Rh Ir	ORS	He	2	NA	60
22	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	NA	60

Table 76 Instrument Conditions P

Lab. Code	Instrument	Internal standard	Reaction Collision Cell/Mode (if applicable)	Cell Gas (if applicable)	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-MS	Sc	KED	He	NA	1	31
6	ICP-OES-AV	Eu			NA		185.827nm
10	ICP-MS/MS	Sc	CRI	HEHe	NA	1	31
11	ICP-MS	Sc	ORS	He	NA	1	31 (m/z)
13	ICP-MS	Sc	UC	He	NA	1	31
15 (S2)	ICP-OES-AV	Bi 233.061			NA	NA	185.878
16	ICP-OES-AV	Lu	NA	NA	NA	1.05	177.434
17	ICP-MS	Sc	ORS	He	NA	1	31
19	ICP-OES-AV	Y	NA	NA	NA	2	213.618
22	ICP-OES	Cs,Y	NA	NA	NA	1	213.618

Table 77 Instrument Conditions Pb

Lab. Code	Instrument	Internal standard	Reaction Collision Cell/Mode (if applicable)	Cell Gas (if applicable)	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-MS	Tb	KED	He	1	1	206+207+208
6	ICP-MS	Ir	ORS	He			
7	ICP-MS	Tb159	ORS	He	1	1	208(m/z)
9	ICP-MS	Ir, Rh & Sc	NA	NA	1	1	208 (m/z)
10	ICP-MS/MS	Lu	CRI	He	1	1	208
11	ICP-MS	Lu	ORS	He	1	1	208 (m/z)
12	ICP-MS/MS	Ir	STD		1	1	208
13	ICP-MS	Ir	NA	NA	1	1	206+207+208
14	ICP-MS	Ir	CRI	He	10	10	
15 (S1)	ICP-MS/MS	Ir 193		He	1		208
15 (S2)	ICP-OES-AV	Lu 219.556			NA	1	220.353
16	ICP-MS	Ge	ORS	He	1.05	1.05	208
17	ICP-MS	Ir	ORS	He	1	1	206 + 207 + 208
18	ICP-MS						
19	ICP-MS	Sc Rh Ir	ORS	He	2	2	208
22	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	1	208

Table 78 Instrument Conditions Sb

Lab. Code	Instrument	Internal standard	Reaction Collision Cell/Mode (if applicable)	Cell Gas (if applicable)	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-MS	Rh	KED	He	1	NA	121
6	ICP-MS	Rh	ORS	He		NA	
7	ICP-MS	In115	ORS	He	1	NA	121(m/z)
9	ICP-MS	Ir, Rh & Sc	NA	NA	1	NA	121 (m/z)
10	ICP-MS/MS	Rh	CRI	He	1	NA	123
11	ICP-MS	Rh	ORS	He	1	NA	123 (m/z)
12	ICP-MS/MS	In	STD		1	NA	121
13	ICP-MS	Rh	NA	NA	1	NA	121
14	ICP-MS	Rh	CRI	He	10	NA	
15 (S1)	ICP-MS/MS	Rh 103		He	1		121
16	ICP-MS	In	ORS	He	1.05	NA	121
17	ICP-MS	Rh	ORS	He	1	NA	121
18	ICP-MS					NA	
19	ICP-MS	Sc Rh Ir	ORS	He	2	NA	121
22	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	NA	121

Table 79 Instrument Conditions Se

Lab. Code	Instrument	Internal standard	Reaction Collision Cell/Mode (if applicable)	Cell Gas (if applicable)	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-MS	Te	KED	He	1	1	82
6	ICP-MS	Rh	ORS	HEHe			
7	ICP-MS	Ge72	ORS	He	1	1	78(m/z)
9	ICP-MS	Ir, Rh & Sc	NA	NA	1	1	78 (m/z)
10	ICP-MS/MS	Sc	CRI	H2	1	1	78
11	ICP-MS	Rh	ORS	H2	1	1	78 (m/z)
12	ICP-MS/MS	Ga	KED	He	1	1	78
13	ICP-MS	Rh	DRC	NH3	1	1	82
14	ICP-MS	Rh	CRI	He	10	10	
15 (S1)	ICP-MS/MS	Rh 103	ORS	O2	1		78/94
15 (S2)	ICP-OES-AV	Bi 233.061			NA	1	196.026
16	ICP-MS	Ge	ORS	H2	1.05	1.05	78
17	ICP-MS	Rh	ORS	HEHe	1	1	78
18	ICP-MS						
19	ICP-MS	Sc Rh Ir	ORS	He	2	2	78
22	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	1	78

Table 80 Instrument Conditions Sn

Lab. Code	Instrument	Internal standard	Reaction Collision Cell/Mode (if applicable)	Cell Gas (if applicable)	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-MS	Rh	KED	He	1	NA	120
6	ICP-MS	Rh	ORS	He		NA	
9	ICP-MS	Ir, Rh & Sc	NA	NA	1	NA	188 (m/z)
10	ICP-MS/MS	Rh	CRI	He	1	NA	118
11	ICP-MS	Rh	ORS	He	1	NA	118 (m/z)
12	ICP-MS/MS	In	STD		1	NA	118
13	ICP-MS	Rh	NA	NA	1	NA	118
15 (S1)	ICP-MS/MS	Rh 103		He	1		118
16	ICP-MS	In	ORS	He	1.05	NA	118
17	ICP-MS	Rh	ORS	He	1	NA	118
18	ICP-MS					NA	
19	ICP-MS	Sc Rh Ir	ORS	He	2	NA	118
22	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	NA	118

Table 81 Instrument Conditions Tl

Lab. Code	Instrument	Internal standard	Reaction Collision Cell/Mode (if applicable)	Cell Gas (if applicable)	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-MS	Tb	KED	He	1	NA	205
6	ICP-MS	Ir	ORS	He		NA	
7	ICP-MS	Bi209	ORS	He	1	NA	205(m/z)
9	ICP-MS	Ir, Rh & Sc	NA	NA	1	NA	205 (m/z)
10	ICP-MS/MS	Lu	CRI	He	1	NA	205
11	ICP-MS	Lu	ORS	He	1	NA	205 (m/z)
12	ICP-MS/MS	Ir	STD		1	NA	205
13	ICP-MS	Ir	NA	NA	1	NA	205
14	ICP-MS	Ir	CRI	He	10	NA	
15 (S1)	ICP-MS/MS	Ir 193		O2	1		205
16	ICP-MS	Ir	ORS	He	1.05	NA	205
17	ICP-MS	Ir	ORS	He	1	NA	205
19	ICP-MS	Sc Rh Ir	ORS	He	2	NA	205
22	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	NA	205

Table 82 Instrument Conditions U

Lab. Code	Instrument	Internal standard	Reaction Collision Cell/Mode (if applicable)	Cell Gas (if applicable)	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-MS	Tb	KED	He	1	NA	238
6	ICP-MS	Ir	ORS	He		NA	
7	ICP-MS	Bi209	ORS	He	1	NA	238(m/z)
9	ICP-MS	Ir, Rh & Sc	NA	NA	1	NA	238 (m/z)
10	ICP-MS/MS	Lu	CRI	NA	1	NA	238
11	ICP-MS	Lu	ORS	He	1	NA	238 (m/z)
12	ICP-MS/MS	Ir	STD		4	NA	238
13	ICP-MS	Ir	NA	NA	1	NA	238
14	ICP-MS	Ir	CRI	He	10	NA	
15 (S1)	ICP-MS/MS	Ir 193		He	1		238
16	ICP-MS	Ir	ORS	He	1.05	NA	238
17	ICP-MS	Ir	ORS	He	1	NA	238
18	ICP-MS					NA	
19	ICP-MS	Sc Rh Ir	ORS	He	2	NA	238
22	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	NA	238

Table 83 Instrument Conditions V

Lab. Code	Instrument	Internal standard	Reaction Collision Cell/Mode (if applicable)	Cell Gas (if applicable)	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-MS	Sc	KED	He	1	NA	51
6	ICP-MS	Sc	ORS	He		NA	
7	ICP-MS	Sc45	ORS	He	1	NA	51(m/z)
9	ICP-MS	Ir, Rh & Sc	NA	NA	1	NA	51 (m/z)
10	ICP-MS/MS	Sc	CRI	NA	1	NA	51
11	ICP-MS	Sc	ORS	He	1	NA	51 (m/z)
12	ICP-MS/MS	Ga	KED	He	1	NA	51
13	ICP-MS	Sc	UC	He	1	NA	51
14	ICP-MS	Rh	CRI	He	10	NA	
15 (S1)	ICP-MS/MS	Sc 45/61	ORS	O2	1		51/67
16	ICP-MS	Ge	ORS	He	1.05	NA	51
17	ICP-MS	Sc	ORS	He	1	NA	51
18	ICP-MS					NA	
19	ICP-MS	Sc Rh Ir	ORS	He	2	NA	51
22	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	NA	51

Table 84 Instrument Conditions Zn

Lab. Code	Instrument	Internal standard	Reaction Collision Cell/Mode (if applicable)	Cell Gas (if applicable)	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-MS	Te	KED	He	1	1	66
6	ICP-MS	Rh	ORS	He			
7	ICP-MS	Rh103	ORS	He	1	1	66(m/z)
9	ICP-MS	Ir, Rh & Sc	NA	NA	1	1	64 (m/z)
10	ICP-MS/MS	Sc	CRI	NA	1	1	66
11	ICP-MS	Sc	ORS	He	1	1	66 (m/z)
12	ICP-MS/MS	Ga	KED	He	1	1	66
13	ICP-MS	Ge	UC	He	1	1	66
14	ICP-MS	Rh	CRI	He	10	10	
15 (S1)	ICP-MS/MS	Rh 103		O2	1		66
15 (S2)	ICP-OES-AV	Bi 233.061			NA	1	213.857
16	ICP-MS	Ge	ORS	He	1.05	1.05	66
17	ICP-MS	Sc	ORS	He	1	1	66
18	ICP-MS						
19	ICP-MS	Sc Rh Ir	ORS	He	2	2	64
22	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	1	66

END OF REPORT