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National Measurement Institute

Proficiency Test Final Report
AQA 24-07
Trace Elements and Solids in Potable Water

July 2024

ACKNOWLEDGMENTS

This study was conducted by the National Measurement Institute (NMI). Support funding was provided by the Australian Government Department of Industry, Science and Resources.

I would like to thank the management and staff of the participating laboratories for supporting the study. It is only through widespread participation that we can provide an effective service to laboratories.

The assistance of the following NMI staff members in the planning, conduct and reporting of the study is acknowledged.

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NATA
WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17043

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SUMMARY

This report presents the results of the proficiency test AQA 24-07, 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, Li, Mn, Mo, Na, Ni, P, Pb, Sb, Se, Sn, Sr, Th, Tl, U, V and Zn in potable water. Measurement of Total Dissolved Solids (TDS), Total Solids (TS), Total Suspended Solids (TSS) and Turbidity in potable water were also included in the program.

The sample set consisted of three potable water samples.

Nineteen laboratories registered to participate, and all submitted results.

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

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

i. compare the performance of participant laboratories and assess their accuracy;

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

Of 534 z-scores, 509 (95%) returned an acceptable score of $|z| \leq 2.0$.
Of 534 E_n-scores, 471 (88%) returned an acceptable score of $|E_n| < 1.0$.

Laboratory 3 returned the highest number of acceptable z-scores (41).

Laboratory 15 returned the highest number of acceptable E_n scores (39).

ii. evaluate the laboratories' methods used in determination of total elements in potable water;

Rounding of results and reporting results with an insufficient number of significant figures was one of the main causes for participants' poor performance. Antimony was the analyte with the largest number of unacceptable results.

iii. evaluate within laboratory repeatability-precision;

Samples S1 and S2 were blind duplicates prepared from the same fortified potable water material. The concentration of the common elements (As, Cd, Fe, Hg, Pb, Sb, Se, and Zn) was thus expected to be the same. In some cases, the expanded measurement uncertainty in the two identical study samples were significantly different.

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

Laboratory capabilities in reporting realistic estimates of uncertainties for metals in potable water have improved over the last 7 years.

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

Of 534 numerical results, 518 (97%) were reported with an expanded measurement uncertainty. The magnitude of these expanded uncertainties was within the range 0.83% to 13529% of the reported value. An example of estimating measurement uncertainty using only the proficiency testing data is given in Appendix 3.

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

The study samples were checked for homogeneity and are well characterised, both by in-house testing and from the results of the proficiency round. Surplus test samples are available for sale.

1 INTRODUCTION

1.1 NMI Proficiency Testing Program

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

Proficiency testing (PT) "is evaluation of participant performance against pre-established criteria by means of inter-laboratory comparison."[1] NMI PT studies target chemical testing in areas of high public significance such as trade, environment and food safety. NMI offers studies in:

- inorganic analytes in soil, water, food and pharmaceuticals;
- pesticide residues in fruit and vegetables, soil and water;
- petroleum hydrocarbons in soil and water;
- PFAS in water, soil, biota and food;
- chlorophyll a; and
- controlled drug assay, drugs in wipes and clandestine laboratory.

AQA 24-07 is the 34th NMI proficiency study of inorganic analytes in water.

1.2 Study Aims

The aims of the study were to:

- compare the performance of participant laboratories and assess their accuracy;
- evaluate the laboratories' methods used in determination of total elements in potable water;
- evaluate within laboratory precision repeatability;
- compare the performance of participant laboratories with their past performance;
- develop the practical application of traceability and measurement uncertainty; and
- produce materials that can be used in method validation and as control samples.

1.3 Study Conduct

The conduct of NMI proficiency tests is described in the NMI Chemical Proficiency Testing Study Protocol.[2] The statistical methods used are described in the NMI Chemical Proficiency Statistical Manual.[3] These documents have been prepared with reference to ISO Standard 17043[1] and The International Harmonized Protocol for Proficiency Testing of (Chemical) Analytical Laboratories.[4]

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

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

2 STUDY INFORMATION

2.1 Selection of Matrices and Inorganic Analytes

The 42 tests were selected from those for which an investigation level is published in the Australian Drinking Water Guidelines[5] and are commonly measured by water testing laboratories.

2.2 Participation

Nineteen laboratories participated and all submitted results.

The timetable of the study was:

Invitations issued:	8 April 2024
Samples dispatched:	6 May 2024
Results due:	31 May 2024
Interim report issued:	3 June 2024
Preliminary report issued	7 June 2024

2.3 Test Material Specification

Three samples were provided for analysis:

Samples S1 and S2 were the same unfiltered and acidified potable water spiked for 28 elements.

Sample S3 was unfiltered water spiked for 3 analytes.

2.4 Laboratory Code

All participant laboratories were assigned a confidential code number.

2.5 Sample Preparation, Analysis and Homogeneity Testing

The same preparation procedure was followed as in previous studies. A partial homogeneity test was conducted for all tests.[1] The test samples from previous studies were demonstrated to be sufficiently homogeneous for the evaluation of participants' performance. Results from partial homogeneity testing are reported in this study as homogeneity values.

The preparation, analysis and homogeneity testing of the study samples are described in Appendix 1. In the present study, the test samples were demonstrated to be sufficiently homogeneous for all the analytes assessed.

2.6 Stability of Analytes

No stability study was carried out for samples S1, S2 and S3. Stability studies conducted for previous proficiency studies of metals in water found no significant changes in any of the analytes' concentration.

2.7 Sample Storage, Dispatch and Receipt

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

The samples were dispatched by courier on 6 May 2024.

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 e-mailed to participants.

2.8 Instructions to Participants

Participants were instructed as follows:

- Quantitatively analyse the samples using your normal test method.
- Participants are asked to report results in units of mg/L, except turbidity (NTU) for:

SAMPLE S1 unfiltered, acidified potable water		**SAMPLE S2** unfiltered, acidified potable water		**SAMPLE S3** unfiltered 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 (dried at 180±5 °C)	10-400
Be	0.0005-0.02	As	0.0005-0.02	TSS (dried at 103-105 °C)	10-400
Bi	0.0005-0.02	B	0.005-0.2	TS (dried at 103-105 °C)	10-400
Cd	0.0005-0.02	Ba	0.005-0.2	Turbidity (NTU)	1-40
Co	0.0005-0.02	Cd	0.0005-0.02		
Cr	0.0005-0.02	Cs	0.0005-0.02		
Cu	0.05-2	Fe	0.05-2		
Fe	0.05-2	Hg	0.00005-0.002		
Hg	0.00005-0.002	La	0.005-0.2		
Li	0.005-0.2	Mn	0.005-0.2		
Mo	0.0005-0.02	Na	1-40		
Ni	0.0005-0.02	P	0.05-2		
Pb	0.005-0.2	Pb	0.005-0.2		
Sb	0.0005-0.02	Sb	0.0005-0.02		
Se	0.0005-0.02	Se	0.0005-0.02		
Sn	0.0005-0.02	Sr	0.05-2		
Tl	0.0005-0.02	Th	0.0005-0.02		
V	0.0005-0.02	U	0.0005-0.02		
Zn	0.05-2	Zn	0.05-2		

- Report results using the electronic results sheet emailed to you.
- Report results as you would report to a client. For each analyte in each sample, report the expanded measurement uncertainty associated with your analytical result (e.g. 5.23 ± 0.51 mg/L).
- Please send us the requested details regarding the test method and the basis of your uncertainty estimate.
- Please return the completed results sheet by e-mail (proficiency@measurement.gov.au) by 24 May 2024.

The due date for results was extended to 31 May 2024 due to sample delivery delays for some participants.

2.9 Interim Report and Preliminary Report

An interim report was emailed to participants on 3 June 2024.

A preliminary report was issued on 7 June 2024. 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.

In the present Final Report, no data from the Preliminary Report has been altered except for the assigned value and associated uncertainty for Fe in Samples S1 and S2. The recalculated values are now based on the robust average of the combined results reported by participants for both samples. Specifically:

• The assigned value for Fe in S1 has changed from 0.254 ± 0.007 mg/L to 0.253 ± 0.005 mg/L.

• The assigned value for Fe in S2 has changed from 0.253 ± 0.006 mg/L to 0.253 ± 0.005 mg/L.

All z-scores and En-scores for these tests have been recalculated, resulting in some slight changes.

The assigned value for As, Cd, Hg, Pb, Sb, Se, and Zn in S1 and S2 was calculated as the robust average of the combined average of the results reported by participants for both samples in the preliminary report. These values remained unchanged.

3 PARTICIPANT LABORATORY INFORMATION

3.1 Test Method Summaries

Summaries of test methods for total elements are transcribed in Table 1. The instruments and settings reported by participants are presented in Appendix 5.

Table 1 Methodology for Total Elements

Lab. Code	Method Reference	Sample Volume (mL)	Temp. (°C)	Time (min)	Vol. HNO_3 (mL)	Vol. HCl (mL)
1	USEPA Method 3005A	10	95	120	0.2	0.5
2	APHA 3125, EPA 200.8	5	95	120	2	1
3	APHA 3125; USEPA SW846 - 6020	10	98	120	0.5	
4	APHA 3030	40	100	15	2	
6	USEPA SW846 and in house	10	95	120	0.5	
9		40	95	120	2	1
10	APHA 3125, USEPA SW846-6020	10	95	120	0.5	
12*	APHA Standard Methods for the Examination of Water and Wastewater method 3030F					
14		30	110	90	2	
15	Based on APHA 3030 E	40	100	480	2	
16*	APHA Method 3030 E, APHA 3125 B US EPA Method 245.7 (Hg)	10	100	60	0.5	
17	In house (referencing APHA 3125)					

*Additional Information in Table 3

Table 2 Method References for Solids and Turbidity

Lab. Code	TDS Method Reference	TSS Method Reference	TS Method Reference	Turbidity Method Reference
1	APHA 2540C	APHA 2540D	APHA 2540B	APHA 2130B
2	APHA 2540	APHA 2540	NA	APHA 2130-Turbidity
3	Gravimetric APHA 2540C, APHA 2540 D, APHA 2540 B	Gravimetric APHA 2540C, APHA 2540 D, APHA 2540 B	Gravimetric APHA 2540C, APHA 2540 D, APHA 2540 B	APHA 2130 – Turbidity A and B
6	APHA 2540C	APHA 2540D	APHA 2540B	APHA 2130B
7*	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
8	APHA 2540C	APHA 2540D	APHA 2540B	APHA 2130B
9	In-house	In-house	In-house	In-house
10	APHA 2540C	APHA 2540D	APHA 2540B	APHA 2130B

Lab. Code	TDS Method Reference	TSS Method Reference	TS Method Reference	Turbidity Method Reference
12		American Public Health Association Method 2540D.	Rayment, G.E. and Higginson, F.R. (1992). "Australian Laboratory Handbook of Soil and Water Chemical Methods", (Inkata Press, Melbourne), Method 2A1.	In-house Turbidity Meter instruction manual.
14	APHA	APHA	APHA	APHA
15	APHA 2540 C	APHA 2540 D	APHA 2540 B	APHA 2130 B
17		In-house		In-house
18	In-house: APHA 2540C	In-house: APHA, 2540D	In-house: APHA 2540B	In-house: APHA 2130 – Turbidity A and B
19	APHA	APHA	APHA	APHA

*Additional Information in Table 3

3.2 Additional Information

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

Table 3 Additional Information

Lab Code	Additional Information
7	Turbidity: As the sample had particles that settle quickly, the turbidity reading was taken as the highest number the instrument gave.
12	Total Elements: As per methodology, digestion was not done due to absence of particulate matter in sample.
16	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

3.3 Basis of Participants' Measurement Uncertainty Estimates

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

Table 4 Basis of Uncertainty Estimate

Lab. Code	Approach to Estimating MU	Information Sources for MU Estimation[a]		Guide Document for Estimating MU
		Precision	Method Bias	
1	Top Down - precision and estimates of the method and laboratory bias k = 2	Control Samples - CRM Duplicate Analysis Instrument Calibration	CRM Instrument Calibration	Eurachem/CITAC Guide
2	Coverage factor not reported	Control Samples - CRM Duplicate Analysis Instrument Calibration	CRM Instrument Calibration Laboratory Bias from PT Studies	Eurachem/CITAC Guide
3	Top Down - precision and estimates of the method and laboratory bias Coverage factor not reported	Control Samples - RM Duplicate Analysis		Eurachem/CITAC Guide
4	Top Down - precision and estimates of the method and laboratory bias Coverage factor not reported	Control Samples - CRM Duplicate Analysis Instrument Calibration	Instrument Calibration Standard Purity	Eurachem/CITAC Guide
5	Coverage factor not reported			

Lab. Code	Approach to Estimating MU	Information Sources for MU Estimation[a]		Guide Document for Estimating MU
		Precision	Method Bias	
6	Top Down - precision and estimates of the method and laboratory bias Coverage factor not reported	Control Samples - SS Duplicate Analysis	CRM Recoveries of SS	Eurachem/CITAC Guide
7	Top Down - precision and estimates of the method and laboratory bias Coverage factor not reported	Control Samples - SS Duplicate Analysis	Recoveries of SS	NATA General Accreditation Guidance, Estimating and Reporting MU
8	Top Down - precision and estimates of the method and laboratory bias k = 2	Control Samples - CRM Duplicate Analysis Instrument Calibration	CRM Instrument Calibration	
9	Top Down - precision and estimates of the method and laboratory bias Coverage factor not reported	Control Samples Duplicate Analysis Instrument Calibration	CRM Instrument Calibration Recoveries of SS	Eurachem/CITAC Guide
10	Bottom Up (ISO/GUM, fish bone/ cause and effect diagram) Coverage factor not reported	Control Samples Duplicate Analysis Instrument Calibration	CRM Instrument Calibration Recoveries of SS	Eurachem/CITAC Guide
11	Standard deviation of replicate analyses multiplied by 2 or 3 k = 2	Duplicate Analysis Instrument Calibration	Instrument Calibration Recoveries of SS	ASTM E2554-13
12	Top Down - precision and estimates of the method and laboratory bias Coverage factor not reported	Standard deviation from PT studies only		ISO/GUM
			Laboratory Bias from PT Studies	
13	Top Down - precision and estimates of the method and laboratory bias k = 2	Control Samples - CRM Duplicate Analysis Instrument Calibration	CRM Instrument Calibration Recoveries of SS	ISO/GUM
14	Top Down - precision and estimates of the method and laboratory bias k = 2	Control Samples Duplicate Analysis	CRM Recoveries of SS	Nordtest Report TR537
15	Standard deviation of replicate analyses multiplied by 2 or 3 Coverage factor not reported	Control Samples Duplicate Analysis	CRM Instrument Calibration Recoveries of SS	ISO/GUM
16	Standard deviation of replicate analyses multiplied by 2 or 3 Coverage factor not reported	Control Samples - SS Duplicate Analysis Instrument Calibration	Instrument Calibration Recoveries of SS	Eurachem/CITAC Guide
17	Top Down - precision and estimates of the method and laboratory bias Coverage factor not reported	Control Samples - CRM Duplicate Analysis	CRM	Nordtest Report TR537
18	Bottom Up (ISO/GUM, fish bone/ cause and effect diagram) k = 2	Control Samples - RM Duplicate Analysis Instrument Calibration	CRM Instrument Calibration Laboratory Bias from PT Studies Recoveries of SS	Eurachem 2000 / ISO1993A
19	Top Down – precision and estimates of the method and laboratory bias k=1.97	Control Samples	Recoveries of SS	

[a]RM = Reference Material, CRM = Certified Reference Material, SS =Spiked samples.

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 may be useful in improving future studies.

No comments were made in this study.

4 PRESENTATION OF RESULTS AND STATISTICAL ANALYSIS

4.1 Results Summary

Participant results are listed in Tables 5 to 46 with resultant summary statistics: robust average, median, mean, number of numeric results, maximum, minimum, robust standard deviation (SD_{rob}) and robust coefficient of variation (CV_{rob}). Bar charts of results and performance scores are presented in Figures 2 to 43. An example chart with interpretation guide is shown in Figure 1.

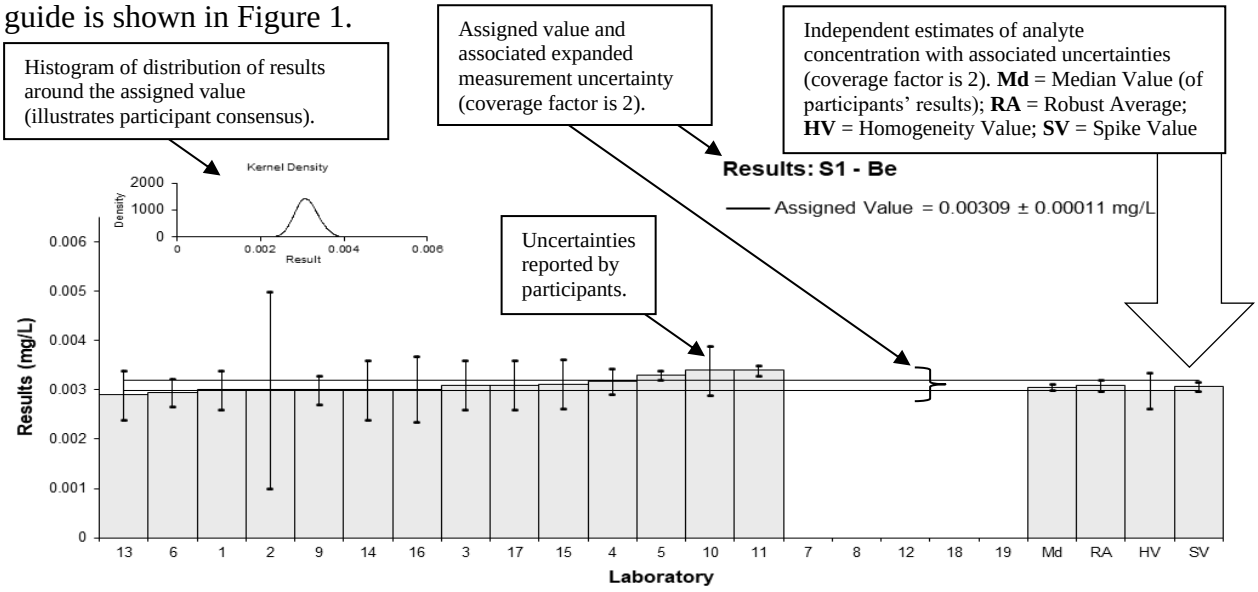


Figure 1 Guide to Presentation of Results

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]

4.3 Assigned Value

An example of the assigned value calculation using data from the present study is given in Appendix 2. The assigned value is defined as: 'the value attributed to a particular property of a proficiency test item.'[1] In this PT study, the property is the mass fraction of analyte. Assigned values were the robust average of participants' results, outliers and extreme outliers removed; the expanded uncertainties were estimated 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 measurement uncertainties were calculated using the procedure described in 'Statistical methods for use in proficiency testing by interlaboratory comparisons, ISO13528'.[6] The robust between-laboratory coefficient of variation (robust CV) is a measure of the variability of participants' results and was calculated using the procedure described in ISO13528.[6]

4.5 Target Standard Deviation for Proficiency Assessment

The target standard deviation for proficiency assessment (σ) is the product of the assigned value (X) and the performance coefficient of variation (PCV). This value is used for calculation of participant z-score and provides scaling for laboratory deviation from the assigned value.

$\sigma = X * PCV$ 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 the 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 participant's result;
X is the assigned value;
σ is the target standard deviation.

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 participant's result;
X is the assigned value;
U_χ is the expanded uncertainty of the participant's 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.

The acceptance criteria for E_n-score has been changed from an acceptable $|E_n|$ score of ≤ 1.0 to an acceptable $|E_n|$ score of < 1.0 as per new IS0/IEC 17043:2023 requirements.[1]

4.8 Traceability and Measurement Uncertainty

Laboratories accredited to ISO/IEC Standard 17025 must establish and demonstrate the traceability and measurement uncertainty associated with their test results.[8] Guidelines for quantifying uncertainty in analytical measurement are described in the Eurachem/CITAC Guide.[9]

5 TABLES AND FIGURES

Table 5

Sample Details

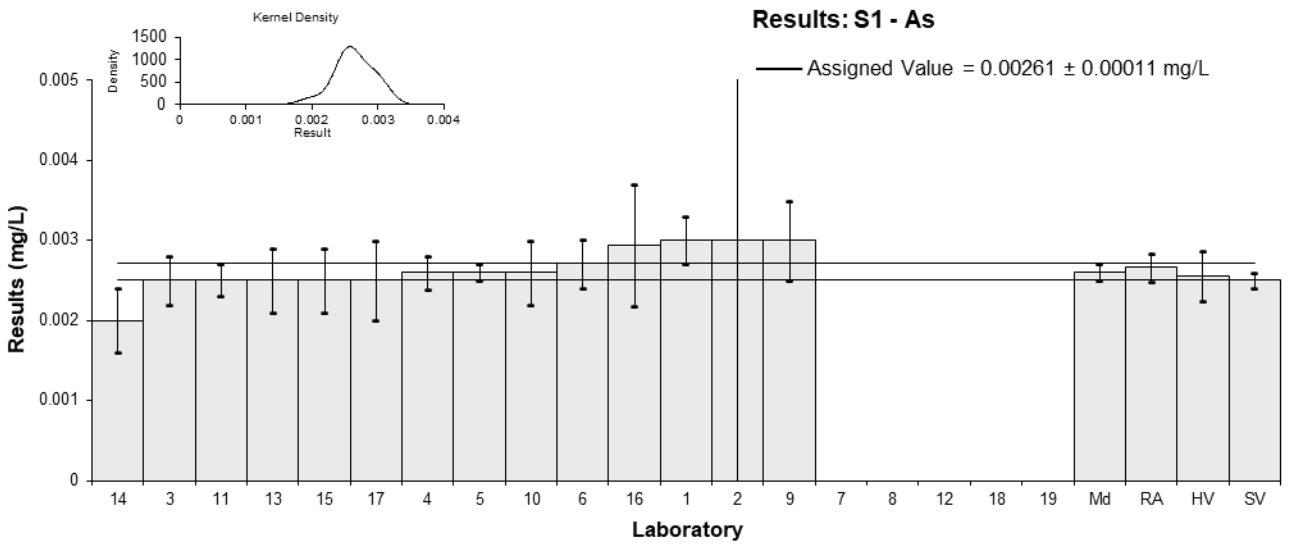
Sample No.	S1
Matrix	Potable Water
Analyte	As
Unit	mg/L

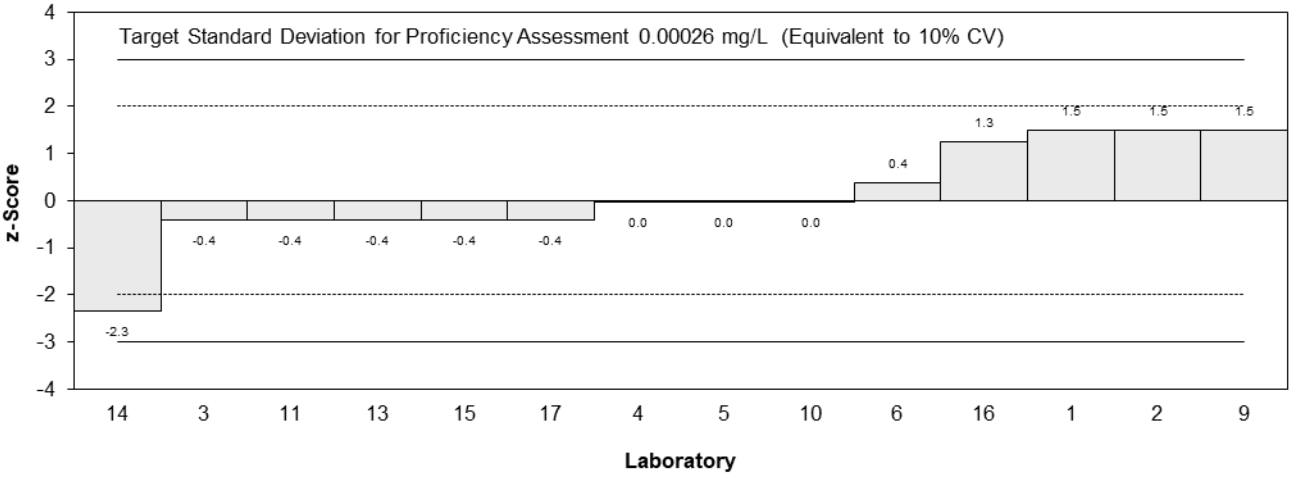
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.003	0.0003	1.49	1.22
2	0.003	0.005	1.49	0.08
3	0.0025	0.0003	-0.42	-0.34
4	0.00260	0.000208	-0.04	-0.04
5	0.0026	0.0001	-0.04	-0.07
6	0.00271	0.00030	0.38	0.31
7	NT	NT		
8	NT	NT		
9	0.003	0.0005	1.49	0.76
10	0.0026	0.0004	-0.04	-0.02
11	0.0025	0.0002	-0.42	-0.48
12	<0.5	NR		
13	0.0025	0.0004	-0.42	-0.27
14	0.002	0.0004	-2.34	-1.47
15	0.0025	0.0004	-0.42	-0.27
16	0.00294	0.00076	1.26	0.43
17	0.0025	0.0005	-0.42	-0.21
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.00261	0.00011
Spike Value	0.00250	0.00009
Homogeneity Value	0.00255	0.00031
Robust Average	0.00266	0.00018
Median	0.00260	0.00010
Mean	0.00264	
N	14	
Max	0.003	
Min	0.002	
Robust SD	0.00027	
Robust CV	10%	


Kernel Density
Density
Result
Results: S1 - As
Assigned Value = 0.00261 ± 0.00011 mg/L
Results (mg/L)
Laboratory
14 3 11 13 15 17 4 5 10 6 16 1 2 9 7 8 12 18 19 Md RA HV SV


z-Scores: S1 - As
Target Standard Deviation for Proficiency Assessment 0.00026 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
14 3 11 13 15 17 4 5 10 6 16 1 2 9

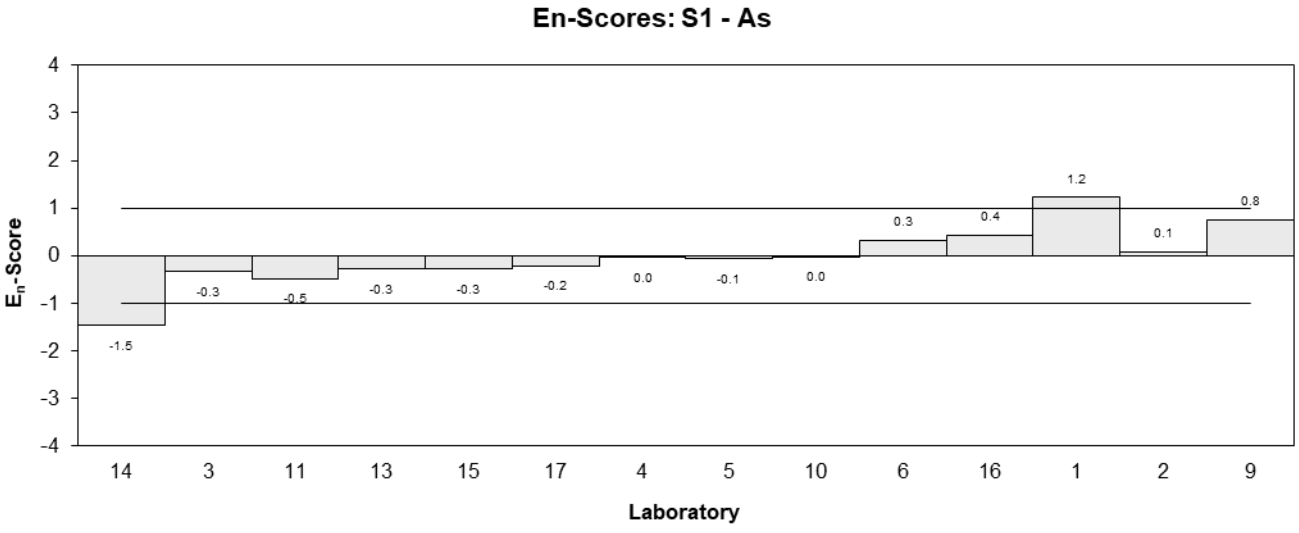

En-Scores: S1 - As
En-Score
Laboratory
14 3 11 13 15 17 4 5 10 6 16 1 2 9

Figure 2

Table 6

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.003	0.0004	-0.29	-0.22
2	0.003	0.002	-0.29	-0.04
3	0.0031	0.0005	0.03	0.02
4	0.00318	0.000255	0.29	0.32
5	0.0033	0.0001	0.68	1.41
6	0.00295	0.00028	-0.45	-0.47
7	NT	NT		
8	NT	NT		
9	0.003	0.0003	-0.29	-0.28
10	0.0034	0.0005	1.00	0.61
11	0.0034	0.0001	1.00	2.09
12	NT	NT		
13	0.0029	0.0005	-0.61	-0.37
14	0.003	0.0006	-0.29	-0.15
15	0.00312	0.0005	0.10	0.06
16	0.00302	0.00067	-0.23	-0.10
17	0.0031	0.0005	0.03	0.02
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.00309	0.00011
Spike Value	0.00307	0.00009
Homogeneity Value	0.00299	0.00036
Robust Average	0.00309	0.00011
Median	0.00306	0.00006
Mean	0.00311	
N	14	
Max	0.0034	
Min	0.0029	
Robust SD	0.00016	
Robust CV	5.2%	

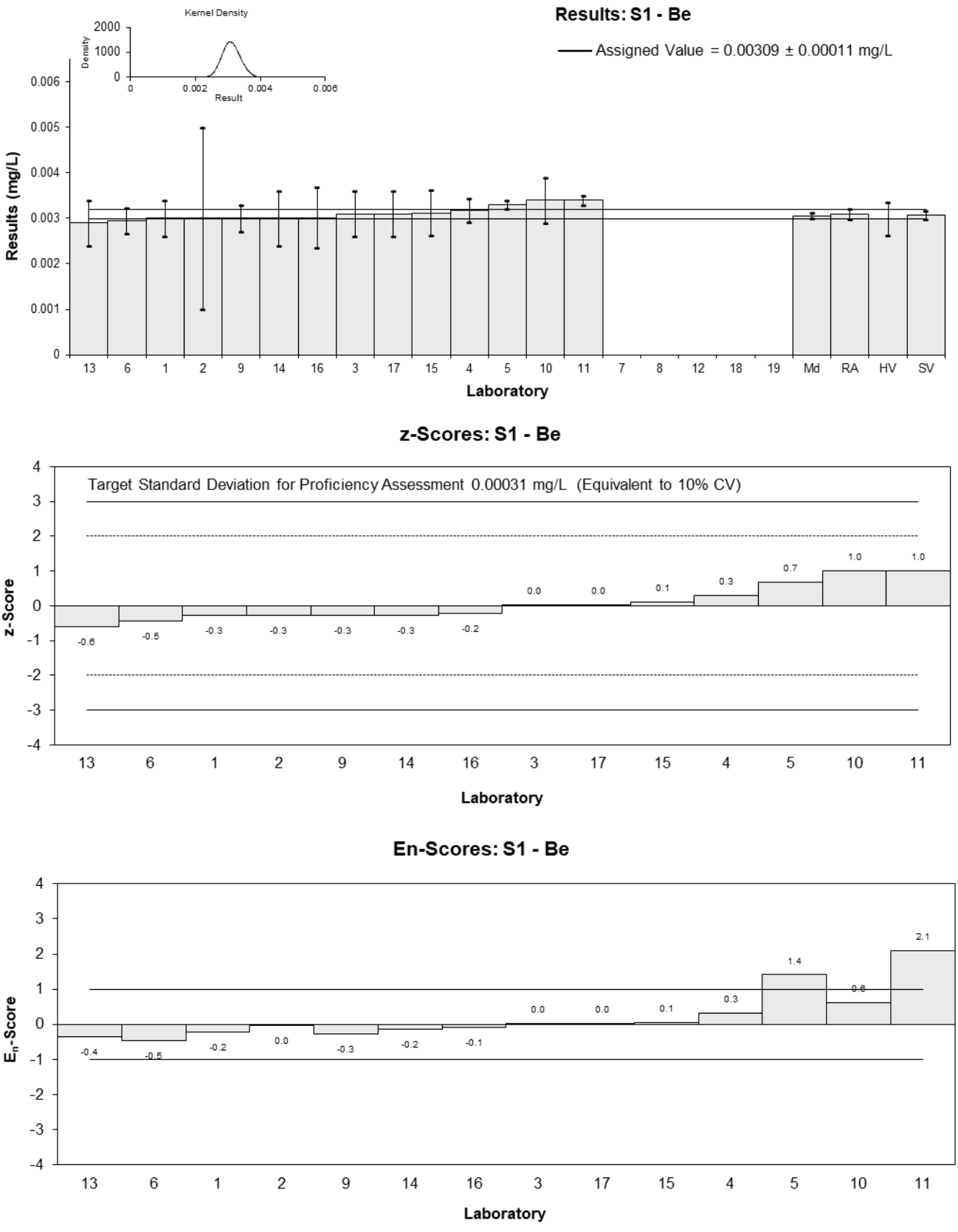

Results: S1 - Be
Assigned Value = 0.00309 ± 0.00011 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
13 6 1 2 9 14 16 3 17 15 4 5 10 11 7 8 12 18 19 Md RA HV SV
z-Scores: S1 - Be
Target Standard Deviation for Proficiency Assessment 0.00031 mg/L (Equivalent to 10% CV)
z-Score
-0.6 -0.5 -0.3 -0.3 -0.3 -0.3 -0.2 0.0 0.0 0.1 0.3 0.7 1.0 1.0
Laboratory
13 6 1 2 9 14 16 3 17 15 4 5 10 11
En-Scores: S1 - Be
En-Score
-0.4 -0.5 -0.2 0.0 -0.3 -0.2 -0.1 0.0 0.0 0.1 0.3 1.4 0.6 2.1
Laboratory
13 6 1 2 9 14 16 3 17 15 4 5 10 11

Figure 3

Table 7

Sample Details

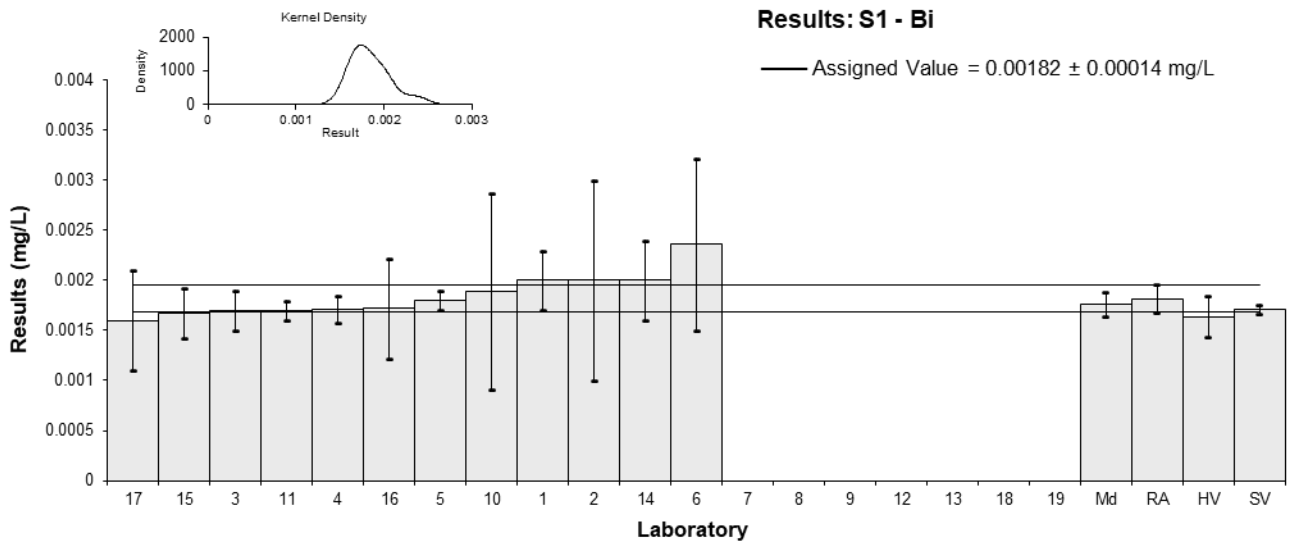
Sample No.	S1
Matrix	Potable Water
Analyte	Bi
Unit	mg/L

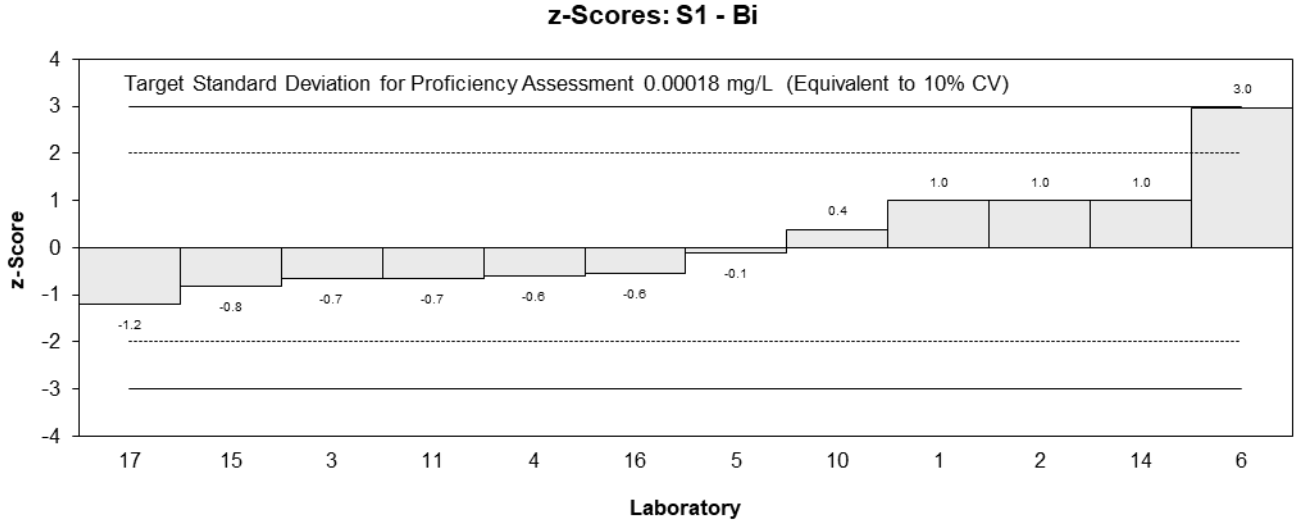
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.002	0.0003	0.99	0.54
2	0.002	0.001	0.99	0.18
3	0.00170	0.0002	-0.66	-0.49
4	0.00171	0.000137	-0.60	-0.56
5	0.0018	0.0001	-0.11	-0.12
6	0.00236	0.00086	2.97	0.62
7	NT	NT		
8	NT	NT		
9	NR	NR		
10	0.00189	0.00098	0.38	0.07
11	0.0017	0.0001	-0.66	-0.70
12	NT	NT		
13	NT	NT		
14	0.002	0.0004	0.99	0.42
15	0.00167	0.00025	-0.82	-0.52
16	0.00172	0.00050	-0.55	-0.19
17	0.0016	0.0005	-1.21	-0.42
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.00182	0.00014
Spike Value	0.00171	0.00005
Homogeneity Value	0.00164	0.00020
Robust Average	0.00182	0.00014
Median	0.00176	0.00012
Mean	0.00185	
N	12	
Max	0.00236	
Min	0.0016	
Robust SD	0.00019	
Robust CV	10%	


Kernel Density
Density
Result
Results: S1 - Bi
Assigned Value = 0.00182 ± 0.00014 mg/L
Results (mg/L)
Laboratory
17 15 3 11 4 16 5 10 1 2 14 6 7 8 9 12 13 18 19 Md RA HV SV


z-Scores: S1 - Bi
Target Standard Deviation for Proficiency Assessment 0.00018 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
17 15 3 11 4 16 5 10 1 2 14 6
-1.2 -0.8 -0.7 -0.7 -0.6 -0.6 -0.1 0.4 1.0 1.0 1.0 3.0

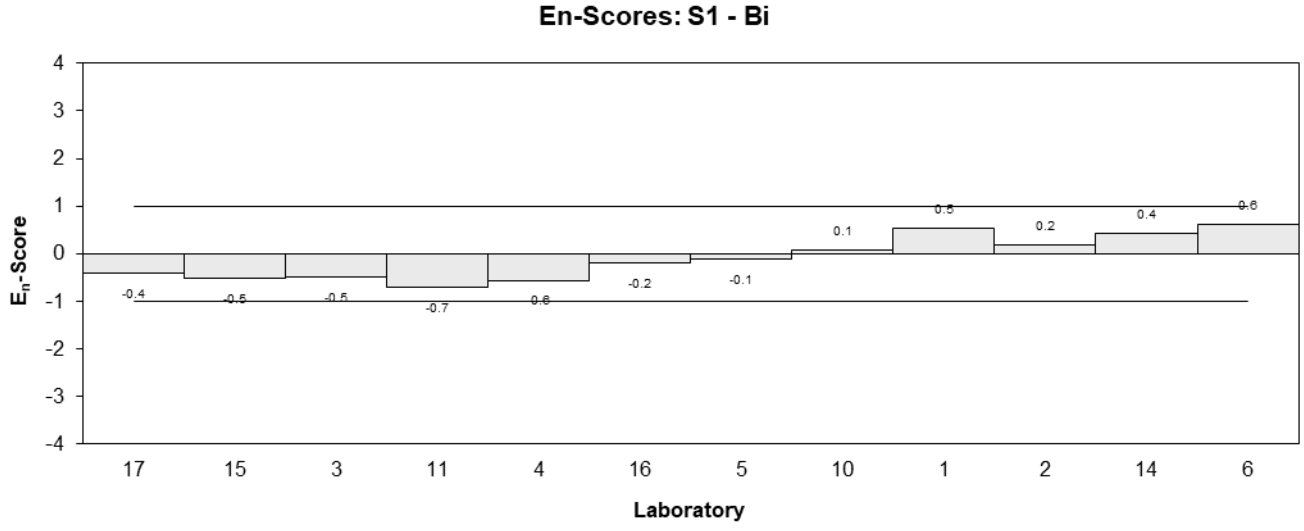

En-Scores: S1 - Bi
En-Score
Laboratory
17 15 3 11 4 16 5 10 1 2 14 6
-0.4 -0.5 -0.5 -0.7 -0.6 -0.2 -0.1 0.1 0.5 0.2 0.4 0.6

Figure 4

Table 8

Sample Details

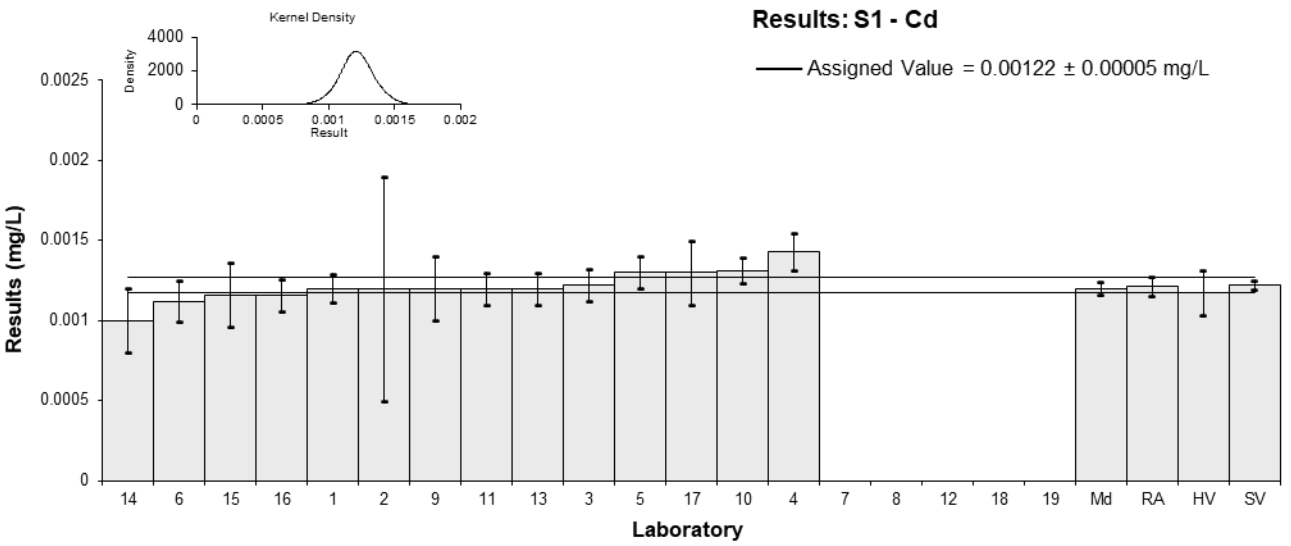
Sample No.	S1
Matrix	Potable Water
Analyte	Cd
Unit	mg/L

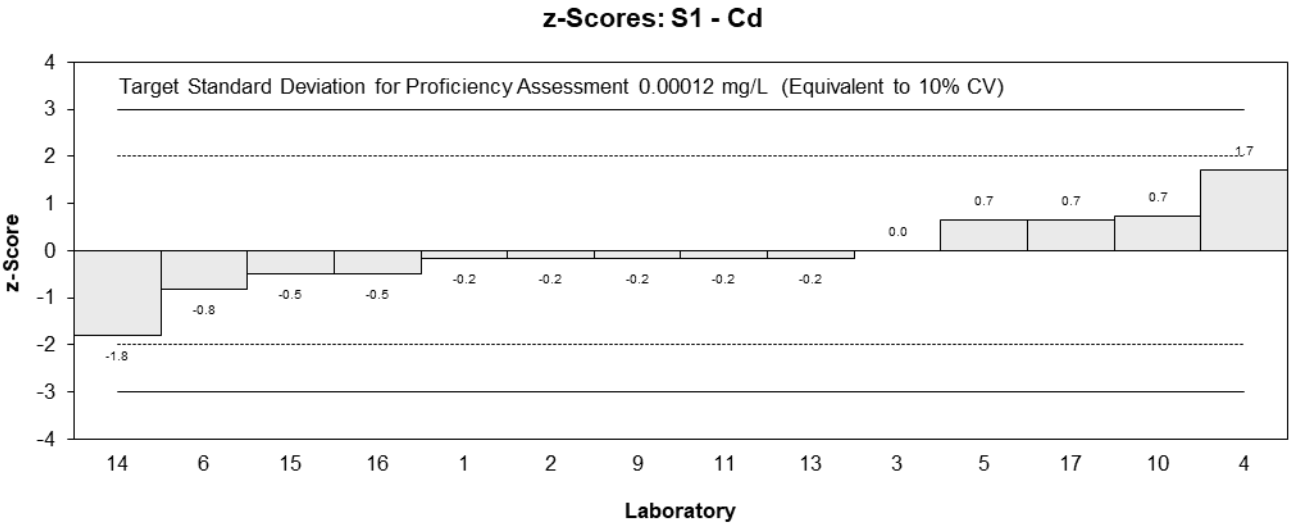
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.0012	0.00009	-0.16	-0.19
2	0.0012	0.0007	-0.16	-0.03
3	0.00122	0.0001	0.00	0.00
4	0.00143	0.000115	1.72	1.67
5	0.0013	0.0001	0.66	0.72
6	0.00112	0.00013	-0.82	-0.72
7	NT	NT		
8	NT	NT		
9	0.0012	0.0002	-0.16	-0.10
10	0.00131	0.00008	0.74	0.95
11	0.0012	0.0001	-0.16	-0.18
12	<0.005	NR		
13	0.0012	0.0001	-0.16	-0.18
14	0.001	0.0002	-1.80	-1.07
15	0.00116	0.0002	-0.49	-0.29
16	0.00116	0.00010	-0.49	-0.54
17	0.0013	0.0002	0.66	0.39
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.00122	0.00005
Spike Value	0.00122	0.00003
Homogeneity Value	0.00117	0.00014
Robust Average	0.00121	0.00006
Median	0.00120	0.00004
Mean	0.00121	
N	14	
Max	0.00143	
Min	0.001	
Robust SD	0.000084	
Robust CV	6.9%	


Results: S1 - Cd
Assigned Value = 0.00122 ± 0.00005 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
14 6 15 16 1 2 9 11 13 3 5 17 10 4 7 8 12 18 19 Md RA HV SV


z-Scores: S1 - Cd
Target Standard Deviation for Proficiency Assessment 0.00012 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
14 6 15 16 1 2 9 11 13 3 5 17 10 4

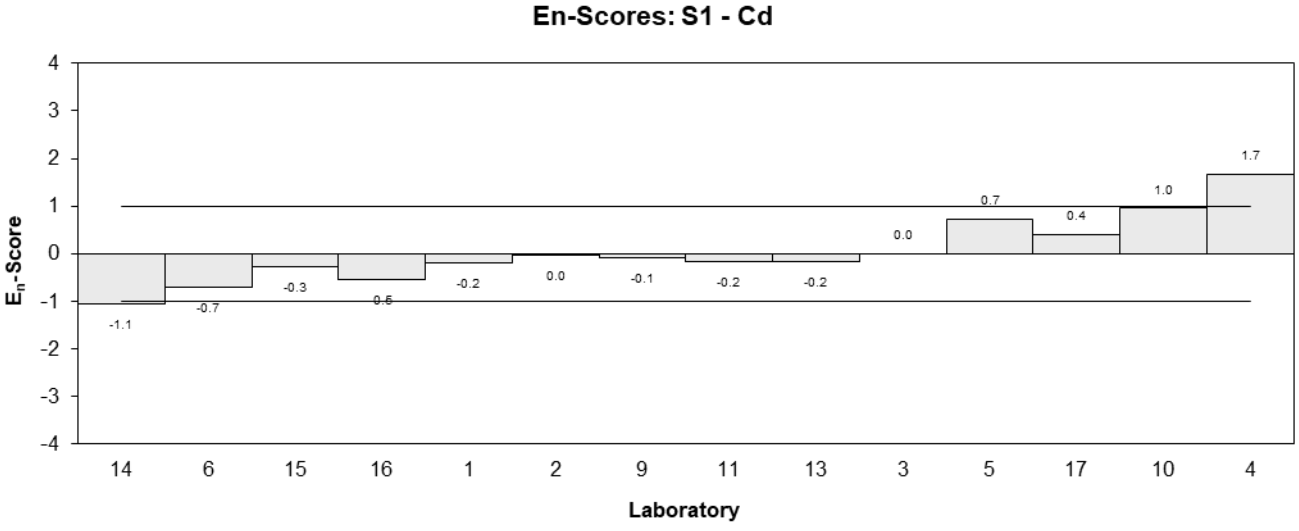

En-Scores: S1 - Cd
En-Score
Laboratory
14 6 15 16 1 2 9 11 13 3 5 17 10 4

Figure 5

Table 9

Sample Details

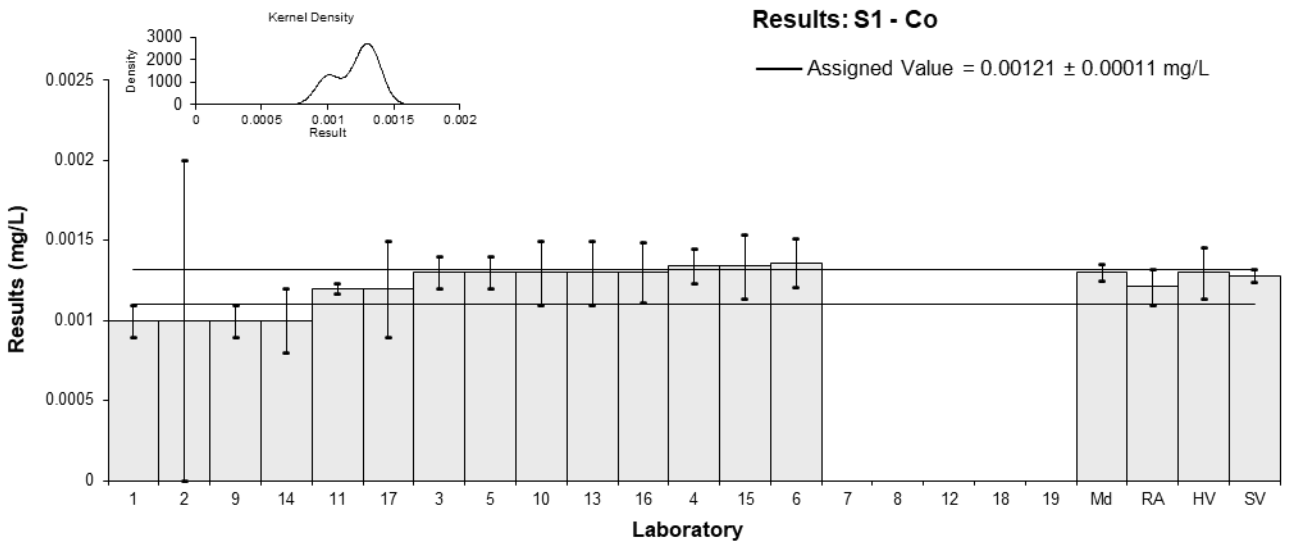
Sample No.	S1
Matrix	Potable Water
Analyte	Co
Unit	mg/L

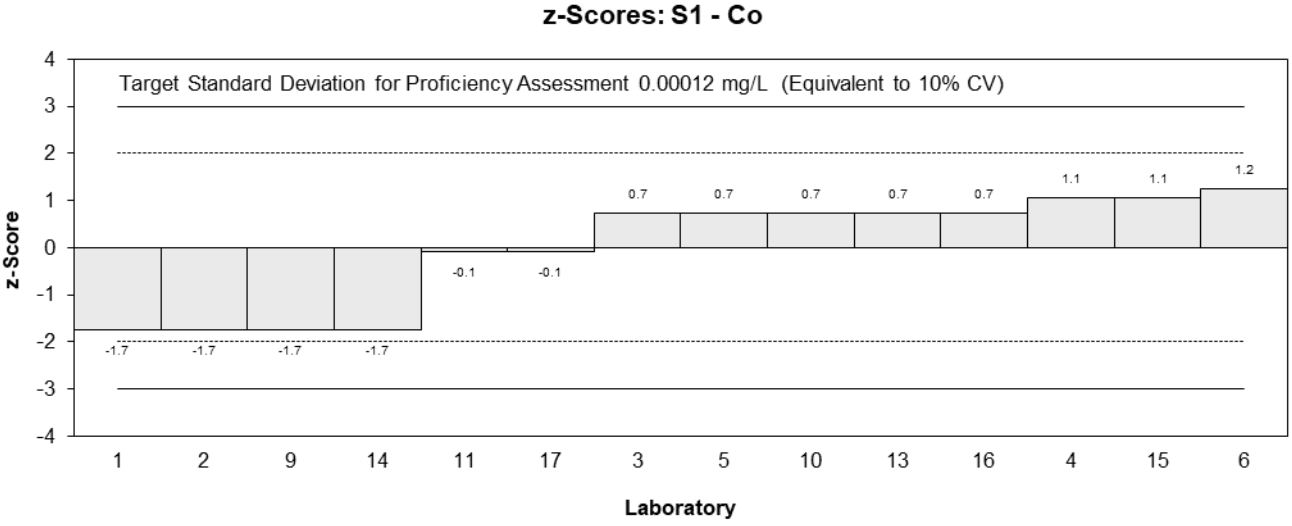
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.001	0.0001	-1.74	-1.41
2	0.001	0.001	-1.74	-0.21
3	0.0013	0.0001	0.74	0.61
4	0.00134	0.000107	1.07	0.85
5	0.0013	0.0001	0.74	0.61
6	0.00136	0.00015	1.24	0.81
7	NT	NT		
8	NT	NT		
9	0.001	0.0001	-1.74	-1.41
10	0.0013	0.0002	0.74	0.39
11	0.0012	0.00003	-0.08	-0.09
12	<0.005	NR		
13	0.0013	0.0002	0.74	0.39
14	0.001	0.0002	-1.74	-0.92
15	0.00134	0.0002	1.07	0.57
16	0.00130	0.00019	0.74	0.41
17	0.0012	0.0003	-0.08	-0.03
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.00121	0.00011
Spike Value	0.00128	0.00004
Homogeneity Value	0.00130	0.00016
Robust Average	0.00121	0.00011
Median	0.00130	0.00005
Mean	0.00121	
N	14	
Max	0.00136	
Min	0.001	
Robust SD	0.00016	
Robust CV	14%	


Results: S1 - Co
Assigned Value = 0.00121 ± 0.00011 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
1 2 9 14 11 17 3 5 10 13 16 4 15 6 7 8 12 18 19 Md RA HV SV


z-Scores: S1 - Co
Target Standard Deviation for Proficiency Assessment 0.00012 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
1 2 9 14 11 17 3 5 10 13 16 4 15 6

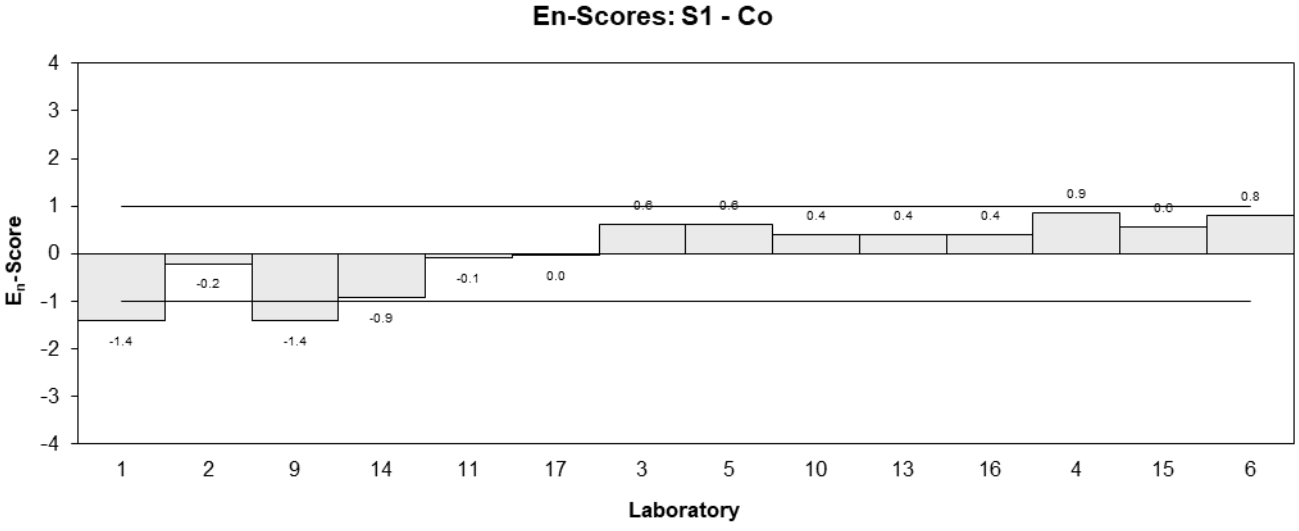

En-Scores: S1 - Co
En-Score
Laboratory
1 2 9 14 11 17 3 5 10 13 16 4 15 6

Figure 6

Table 10

Sample Details

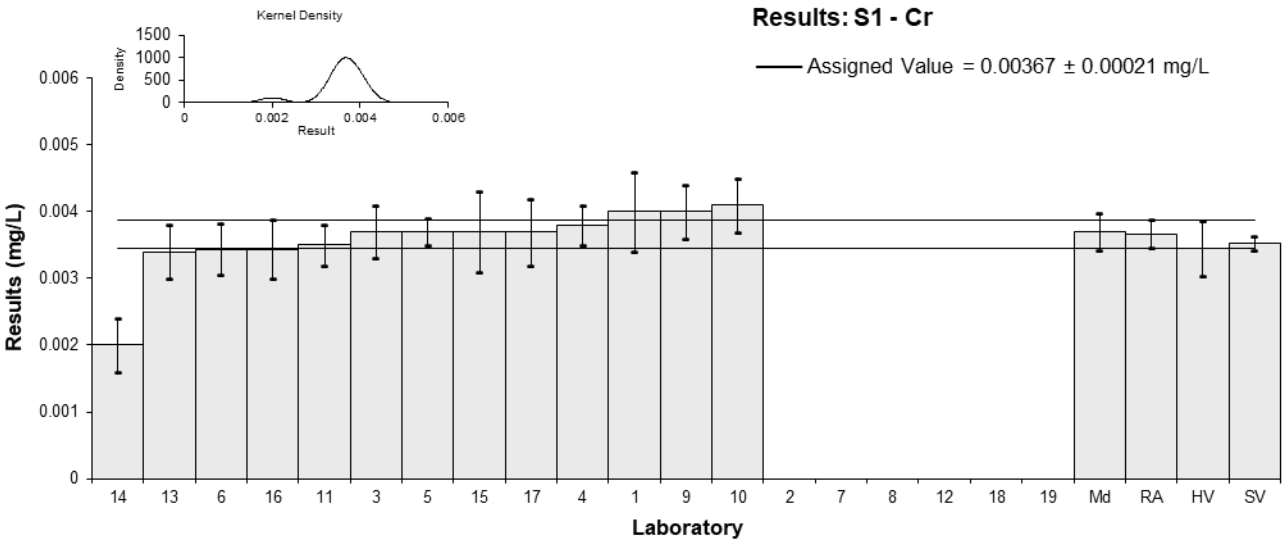
Sample No.	S1
Matrix	Potable Water
Analyte	Cr
Unit	mg/L

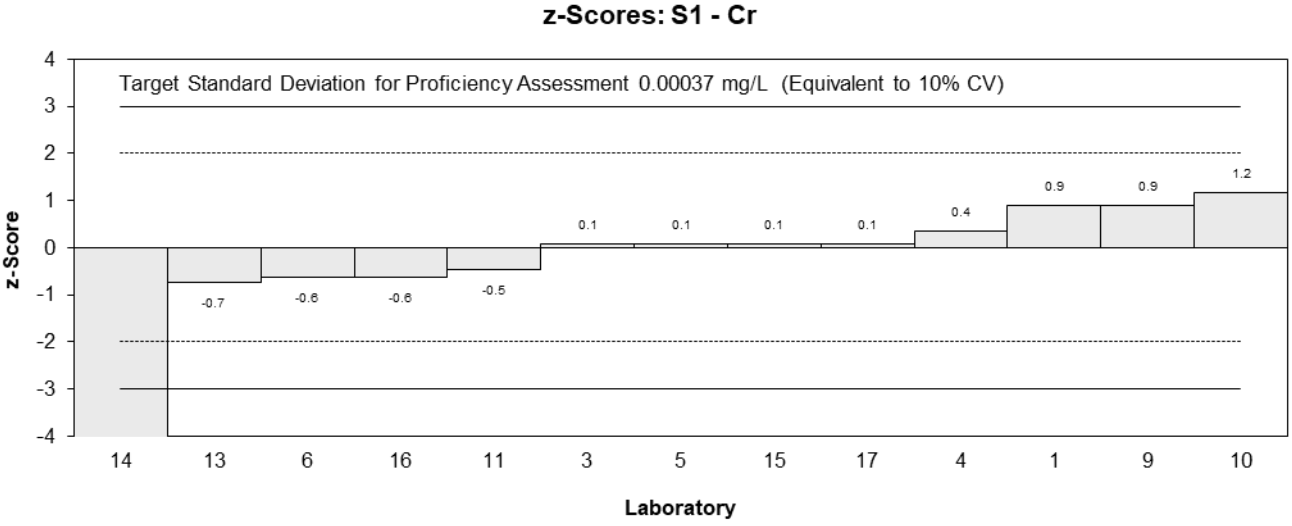
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.004	0.0006	0.90	0.52
2	<0.005	0.005		
3	0.0037	0.0004	0.08	0.07
4	0.00380	0.000304	0.35	0.35
5	0.0037	0.0002	0.08	0.10
6	0.00344	0.00039	-0.63	-0.52
7	NT	NT		
8	NT	NT		
9	0.004	0.0004	0.90	0.73
10	0.0041	0.0004	1.17	0.95
11	0.0035	0.0003	-0.46	-0.46
12	<0.005	NR		
13	0.0034	0.0004	-0.74	-0.60
14	0.002	0.0004	-4.55	-3.70
15	0.0037	0.0006	0.08	0.05
16	0.00344	0.00045	-0.63	-0.46
17	0.0037	0.0005	0.08	0.06
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.00367	0.00021
Spike Value	0.00353	0.00010
Homogeneity Value	0.00345	0.00041
Robust Average	0.00367	0.00021
Median	0.00370	0.00027
Mean	0.00358	
N	13	
Max	0.0041	
Min	0.002	
Robust SD	0.00030	
Robust CV	8.2%	


Results: S1 - Cr
Assigned Value = 0.00367 ± 0.00021 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
14 13 6 16 11 3 5 15 17 4 1 9 10 2 7 8 12 18 19 Md RA HV SV


z-Scores: S1 - Cr
Target Standard Deviation for Proficiency Assessment 0.00037 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
14 13 6 16 11 3 5 15 17 4 1 9 10
-0.7 -0.6 -0.6 -0.5 0.1 0.1 0.1 0.1 0.4 0.9 0.9 1.2

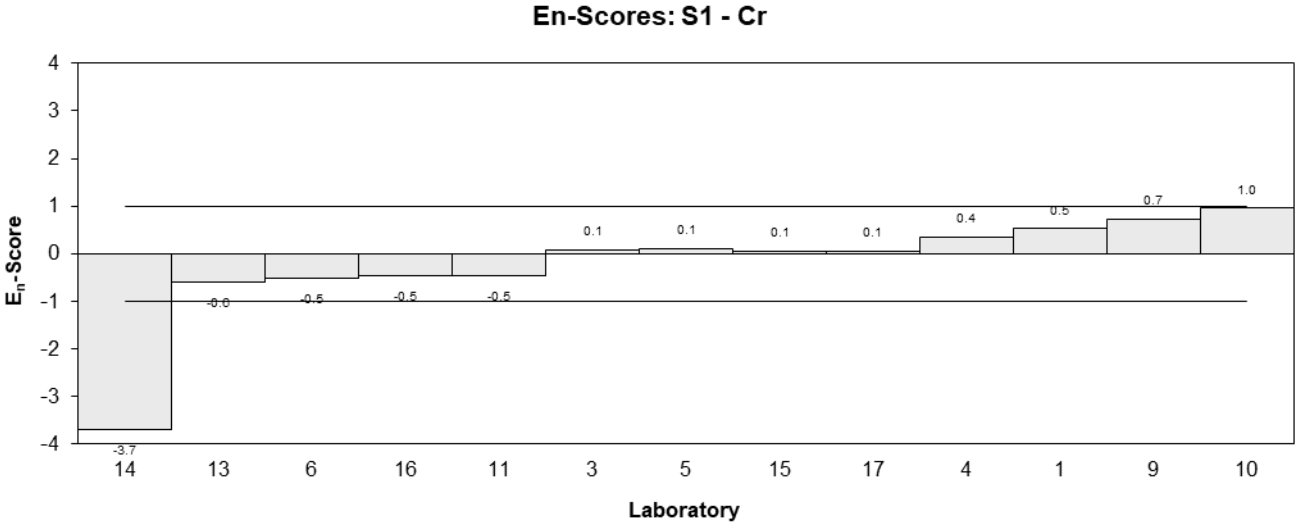

En-Scores: S1 - Cr
En-Score
Laboratory
14 13 6 16 11 3 5 15 17 4 1 9 10
-3.7 -0.6 -0.5 -0.5 -0.5 0.1 0.1 0.1 0.1 0.4 0.5 0.7 1.0

Figure 7

Table 11

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.714	0.054	0.00	0.00
2	0.701	0.07	-0.18	-0.18
3	0.721	0.093	0.10	0.07
4	0.711	0.0570	-0.04	-0.05
5	0.7149	0.036	0.01	0.02
6	0.7086	0.0508	-0.08	-0.11
7	NT	NT		
8	NT	NT		
9	0.67	0.067	-0.62	-0.65
10	0.718	0.064	0.06	0.06
11	0.706	0.0101	-0.11	-0.62
12	0.74	0.148	0.36	0.18
13	0.74	0.04	0.36	0.64
14	0.71	0.14	-0.06	-0.03
15	0.726	0.11	0.17	0.11
16	0.715	0.072	0.01	0.01
17	0.703	0.07	-0.15	-0.16
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.714	0.008
Spike Value	0.703	0.094
Homogeneity Value	0.708	0.085
Robust Average	0.714	0.008
Median	0.714	0.007
Mean	0.713	
N	15	
Max	0.74	
Min	0.67	
Robust SD	0.012	
Robust CV	1.7%	

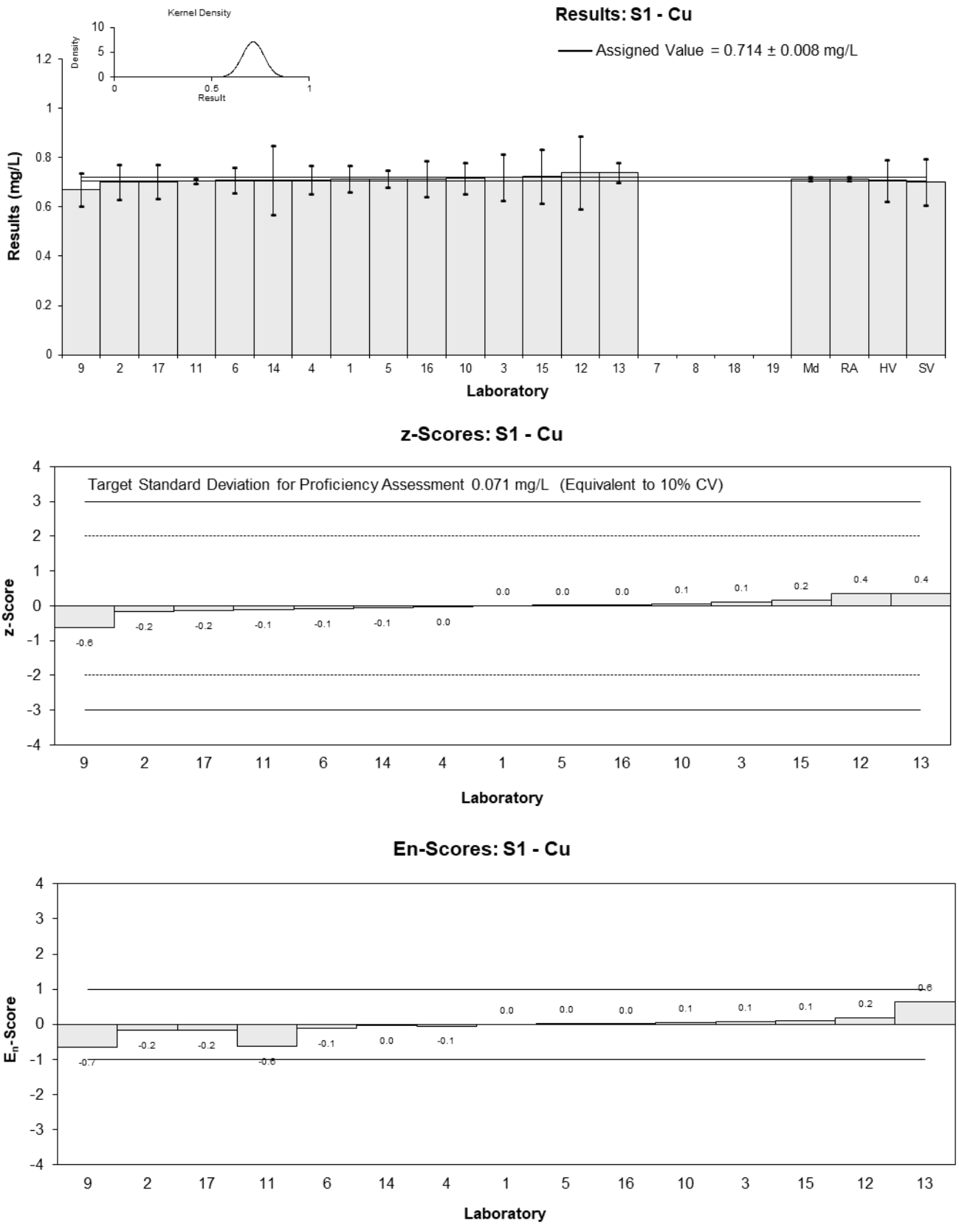

Kernel Density
Density
Result
Results: S1 - Cu
Assigned Value = 0.714 ± 0.008 mg/L
Results (mg/L)
Laboratory
9 2 17 11 6 14 4 1 5 16 10 3 15 12 13 7 8 18 19 Md RA HV SV
z-Scores: S1 - Cu
Target Standard Deviation for Proficiency Assessment 0.071 mg/L (Equivalent to 10% CV)
z-Score
-0.6 -0.2 -0.2 -0.1 -0.1 -0.1 0.0 0.0 0.0 0.0 0.1 0.1 0.2 0.4 0.4
Laboratory
9 2 17 11 6 14 4 1 5 16 10 3 15 12 13
En-Scores: S1 - Cu
En-Score
-0.7 -0.2 -0.2 -0.6 -0.1 0.0 -0.1 0.0 0.0 0.0 0.1 0.1 0.1 0.2 0.6
Laboratory
9 2 17 11 6 14 4 1 5 16 10 3 15 12 13

Figure 8

Table 12

Sample Details

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

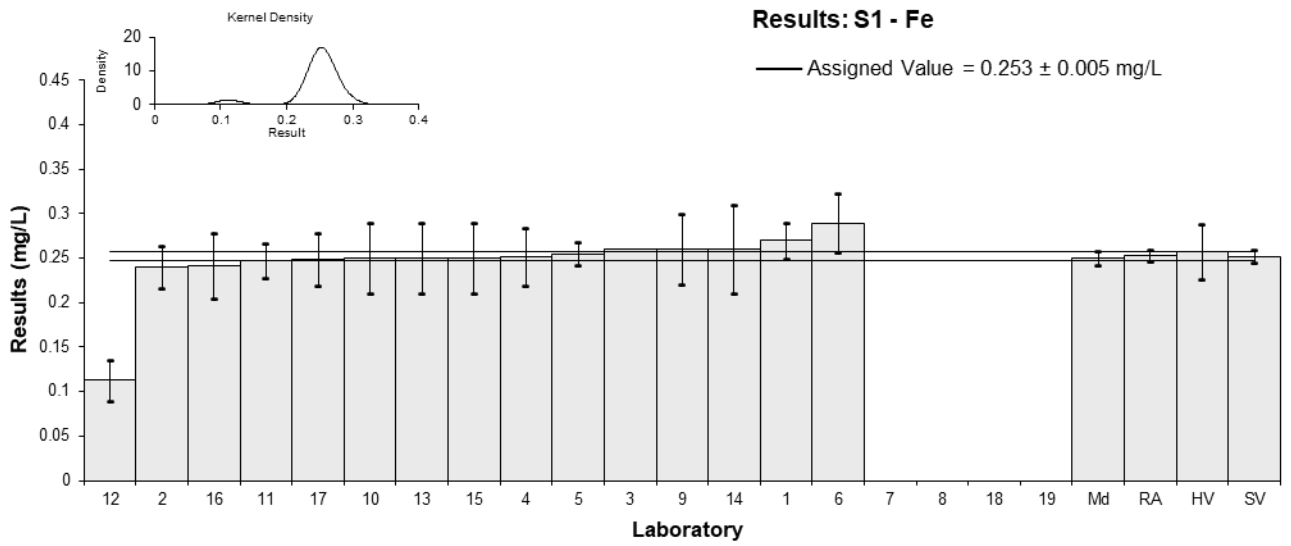
Participant Results

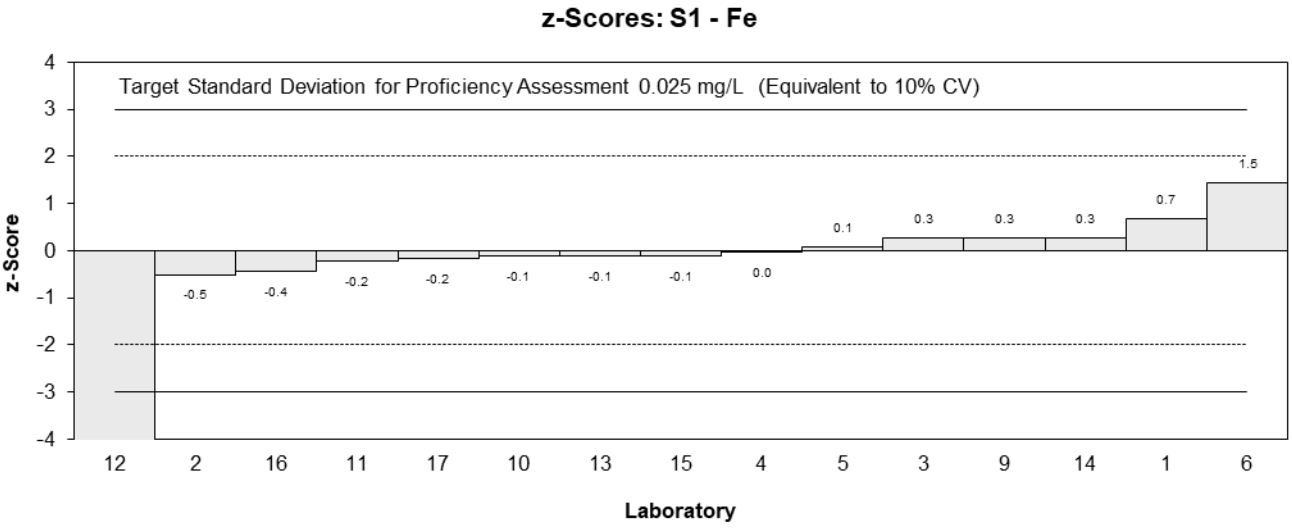
Lab. Code	Result	Uncertainty	z	E_n
1	0.27	0.02	0.67	0.82
2	0.24	0.024	-0.51	-0.53
3	0.260	NR	0.28	1.40
4	0.252	0.0325	-0.04	-0.03
5	0.255	0.013	0.08	0.14
6	0.28958	0.03329	1.45	1.09
7	NT	NT		
8	NT	NT		
9	0.26	0.0398	0.28	0.17
10	0.25	0.04	-0.12	-0.07
11	0.2471	0.0196	-0.23	-0.29
12*	0.1125	0.0225	-5.55	-6.10
13	0.25	0.04	-0.12	-0.07
14	0.26	0.05	0.28	0.14
15	0.25	0.04	-0.12	-0.07
16	0.242	0.037	-0.43	-0.29
17	0.249	0.03	-0.16	-0.13
18	NT	NT		
19	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	0.253	0.005
Spike Value	0.252	0.007
Homogeneity Value	0.257	0.031
Robust Average	0.253	0.007
Median	0.250	0.008
Mean	0.246	
N	15	
Max	0.28958	
Min	0.1125	
Robust SD	0.011	
Robust CV	4.4%	


Kernel Density
Density
Result
Results: S1 - Fe
Assigned Value = 0.253 ± 0.005 mg/L
Results (mg/L)
Laboratory
12 2 16 11 17 10 13 15 4 5 3 9 14 1 6 7 8 18 19 Md RA HV SV


z-Scores: S1 - Fe
Target Standard Deviation for Proficiency Assessment 0.025 mg/L (Equivalent to 10% CV)
z-Score
-0.5 -0.4 -0.2 -0.2 -0.1 -0.1 -0.1 0.0 0.1 0.3 0.3 0.3 0.7 1.5
Laboratory
12 2 16 11 17 10 13 15 4 5 3 9 14 1 6

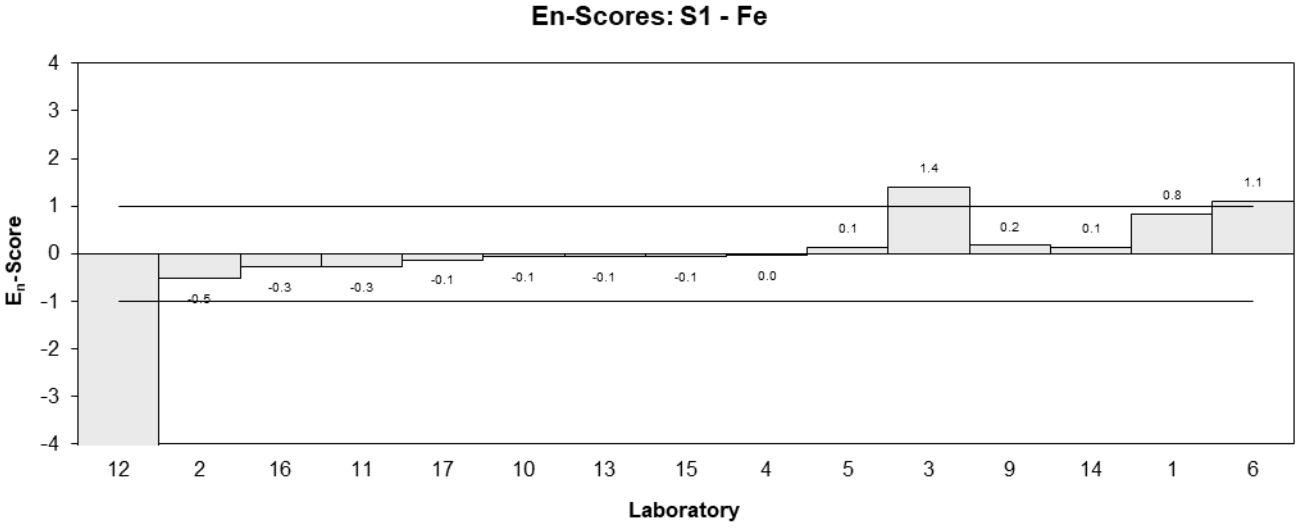

En-Scores: S1 - Fe
En-Score
-0.5 -0.3 -0.3 -0.1 -0.1 -0.1 -0.1 0.0 0.1 1.4 0.2 0.1 0.8 1.1
Laboratory
12 2 16 11 17 10 13 15 4 5 3 9 14 1 6

Figure 9

Table 13

Sample Details

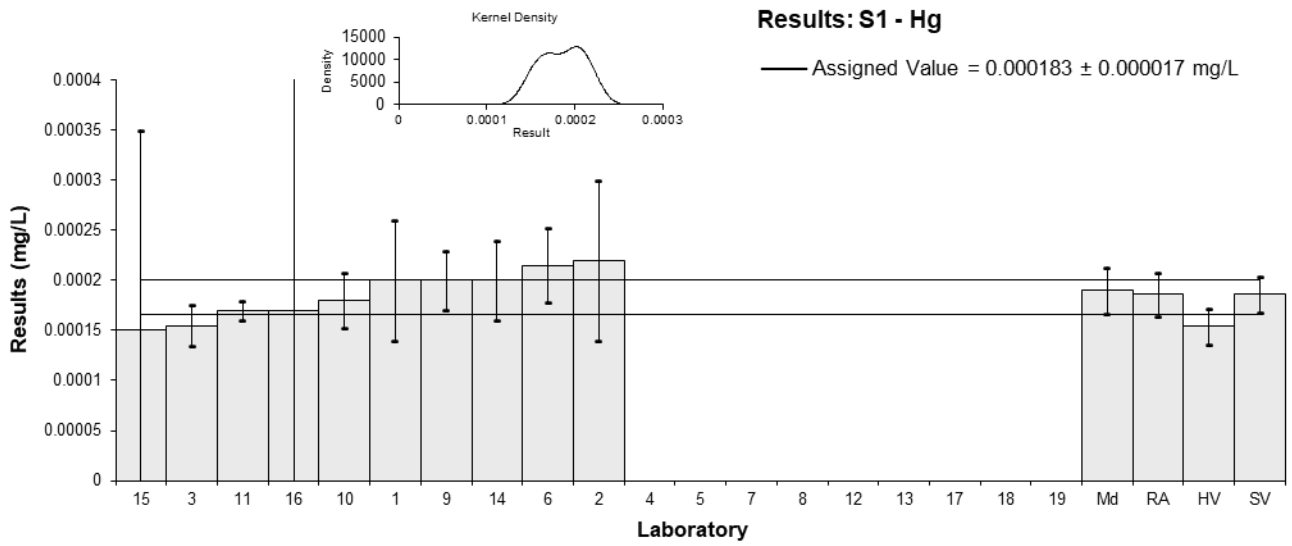
Sample No.	S1
Matrix	Potable Water
Analyte	Hg
Unit	mg/L

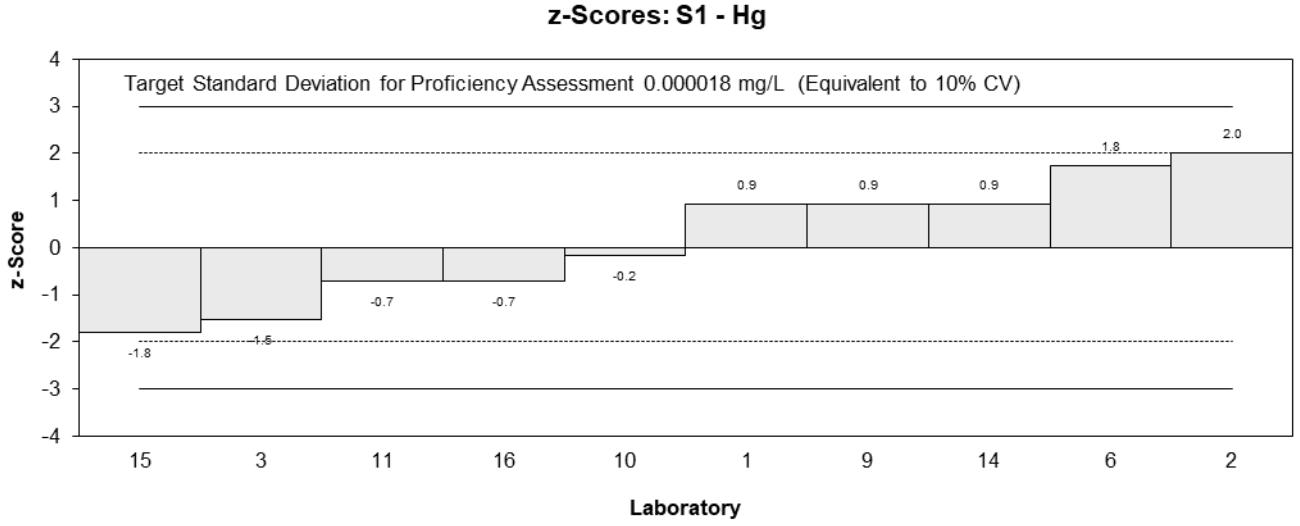
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.0002	0.00006	0.93	0.27
2	0.00022	0.00008	2.02	0.45
3	0.000155	0.00002	-1.53	-1.07
4	<0.0002	0.0000160		
5	NR	NR		
6	0.000215	0.000037	1.75	0.79
7	NT	NT		
8	NT	NT		
9	0.0002	0.00003	0.93	0.49
10	0.00018	0.000027	-0.16	-0.09
11	0.00017	0.00001	-0.71	-0.66
12	<0.25	NR		
13	NT	NT		
14	0.0002	0.00004	0.93	0.39
15	0.00015	0.0002	-1.80	-0.16
16	0.00017	0.00053	-0.71	-0.02
17	<0.0005	NR		
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.000183	0.000017
Spike Value	0.000186	0.000018
Homogeneity Value	0.000154	0.000018
Robust Average	0.000186	0.000022
Median	0.000190	0.000023
Mean	0.000186	
N	10	
Max	0.00022	
Min	0.00015	
Robust SD	0.000028	
Robust CV	15%	


Results: S1 - Hg
Assigned Value = 0.000183 ± 0.000017 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
15 3 11 16 10 1 9 14 6 2 4 5 7 8 12 13 17 18 19 Md RA HV SV


z-Scores: S1 - Hg
Target Standard Deviation for Proficiency Assessment 0.000018 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
15 3 11 16 10 1 9 14 6 2

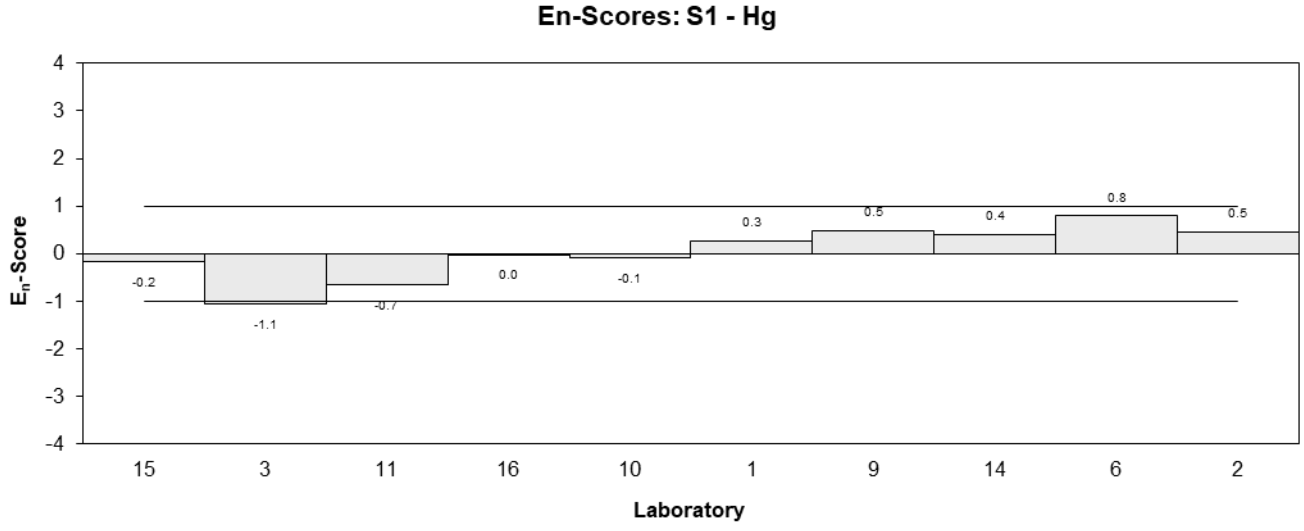

En-Scores: S1 - Hg
En-Score
Laboratory
15 3 11 16 10 1 9 14 6 2

Figure 10

Table 14

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.023	0.003	0.45	0.32
2	NR	NR		
3	0.0217	0.0043	-0.14	-0.07
4	0.0241	0.00193	0.95	0.97
5	0.022	0.001	0.00	0.00
6	0.02127	0.00219	-0.33	-0.30
7	NT	NT		
8	NT	NT		
9	0.02	0.0029	-0.91	-0.65
10	0.0227	0.0044	0.32	0.16
11	0.0214	0.0007	-0.27	-0.49
12	0.0245	0.0049	1.14	0.50
13	NT	NT		
14	0.021	0.004	-0.45	-0.24
15	0.0224	0.0034	0.18	0.11
16	0.0218	0.0027	-0.09	-0.07
17	0.020	0.002	-0.91	-0.89
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.0220	0.0010
Spike Value	0.0212	0.0006
Homogeneity Value	0.0226	0.0027
Robust Average	0.0220	0.0010
Median	0.0218	0.0008
Mean	0.0220	
N	13	
Max	0.0245	
Min	0.02	
Robust SD	0.0015	
Robust CV	6.8%	

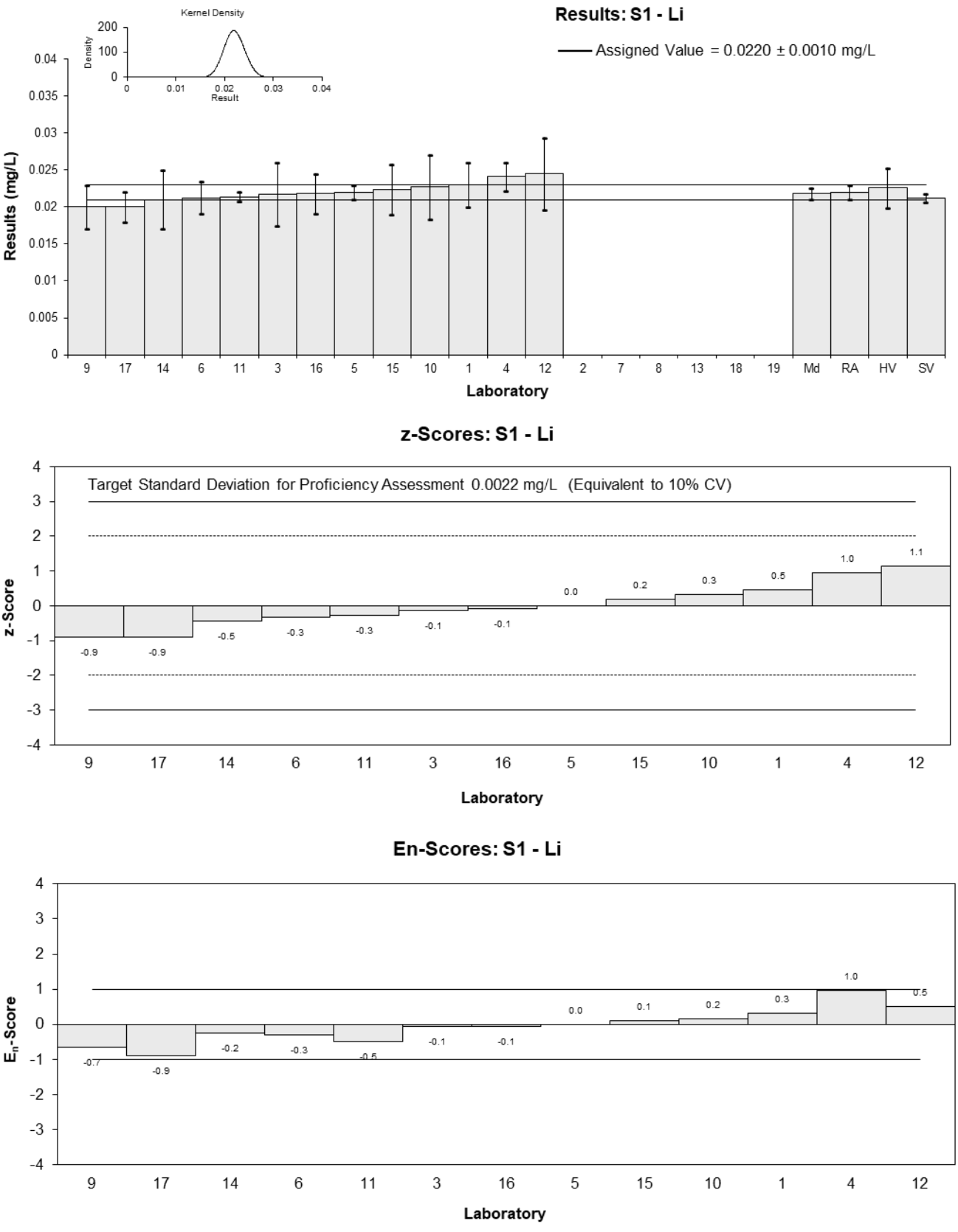

Kernel Density
Density
Result
Results: S1 - Li
Assigned Value = 0.0220 ± 0.0010 mg/L
Results (mg/L)
Laboratory
9 17 14 6 11 3 16 5 15 10 1 4 12 2 7 8 13 18 19 Md RA HV SV
z-Scores: S1 - Li
Target Standard Deviation for Proficiency Assessment 0.0022 mg/L (Equivalent to 10% CV)
z-Score
-0.9 -0.9 -0.5 -0.3 -0.3 -0.1 -0.1 0.0 0.2 0.3 0.5 1.0 1.1
Laboratory
9 17 14 6 11 3 16 5 15 10 1 4 12
En-Scores: S1 - Li
En-Score
-0.7 -0.9 -0.2 -0.3 -0.5 -0.1 -0.1 0.0 0.1 0.2 0.3 1.0 0.5
Laboratory
9 17 14 6 11 3 16 5 15 10 1 4 12

Figure 11

Table 15

Sample Details

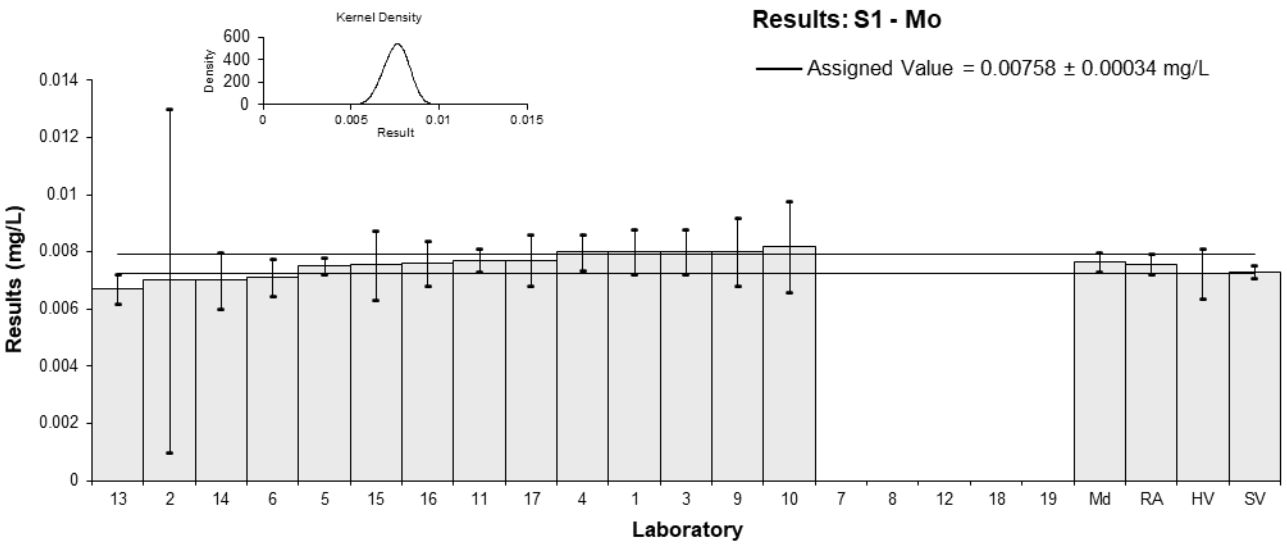
Sample No.	S1
Matrix	Potable Water
Analyte	Mo
Unit	mg/L

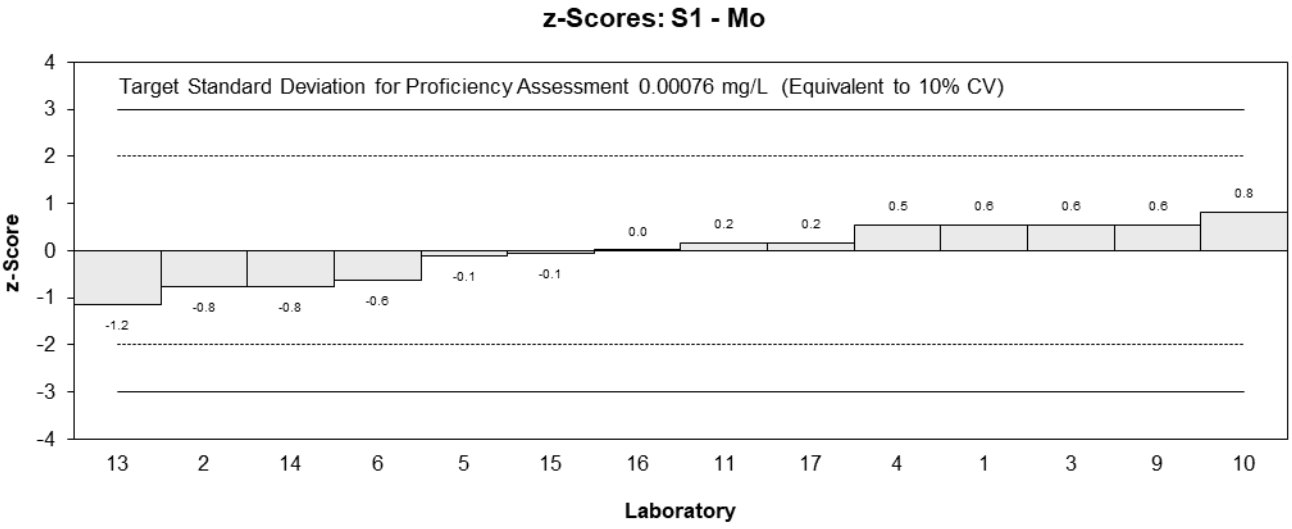
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.008	0.0008	0.55	0.48
2	0.007	0.006	-0.77	-0.10
3	0.0080	0.0008	0.55	0.48
4	0.00799	0.000640	0.54	0.57
5	0.0075	0.0003	-0.11	-0.18
6	0.00711	0.00066	-0.62	-0.63
7	NT	NT		
8	NT	NT		
9	0.008	0.0012	0.55	0.34
10	0.0082	0.0016	0.82	0.38
11	0.0077	0.0004	0.16	0.23
12	<0.05	NR		
13	0.0067	0.0005	-1.16	-1.46
14	0.007	0.001	-0.77	-0.55
15	0.00754	0.0012	-0.05	-0.03
16	0.00759	0.00078	0.01	0.01
17	0.0077	0.0009	0.16	0.12
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.00758	0.00034
Spike Value	0.00731	0.00021
Homogeneity Value	0.00723	0.00087
Robust Average	0.00758	0.00034
Median	0.00765	0.00035
Mean	0.00757	
N	14	
Max	0.0082	
Min	0.0067	
Robust SD	0.00050	
Robust CV	6.6%	


Results: S1 - Mo
Assigned Value = 0.00758 ± 0.00034 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
13 2 14 6 5 15 16 11 17 4 1 3 9 10 7 8 12 18 19 Md RA HV SV


z-Scores: S1 - Mo
Target Standard Deviation for Proficiency Assessment 0.00076 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
13 2 14 6 5 15 16 11 17 4 1 3 9 10

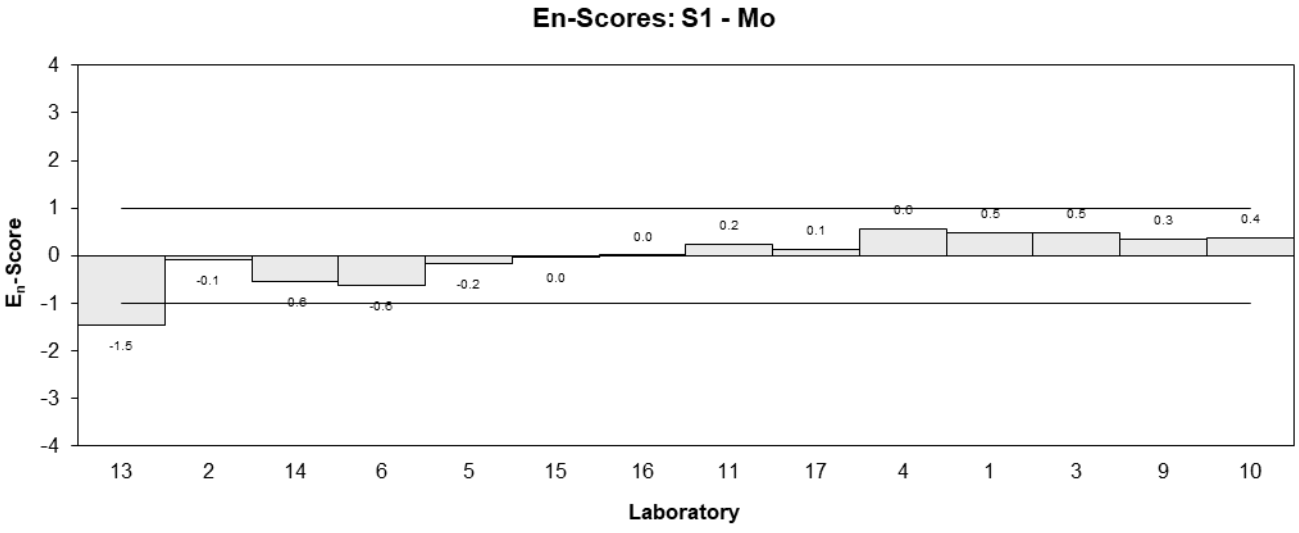

En-Scores: S1 - Mo
En-Score
Laboratory
13 2 14 6 5 15 16 11 17 4 1 3 9 10

Figure 12

Table 16

Sample Details

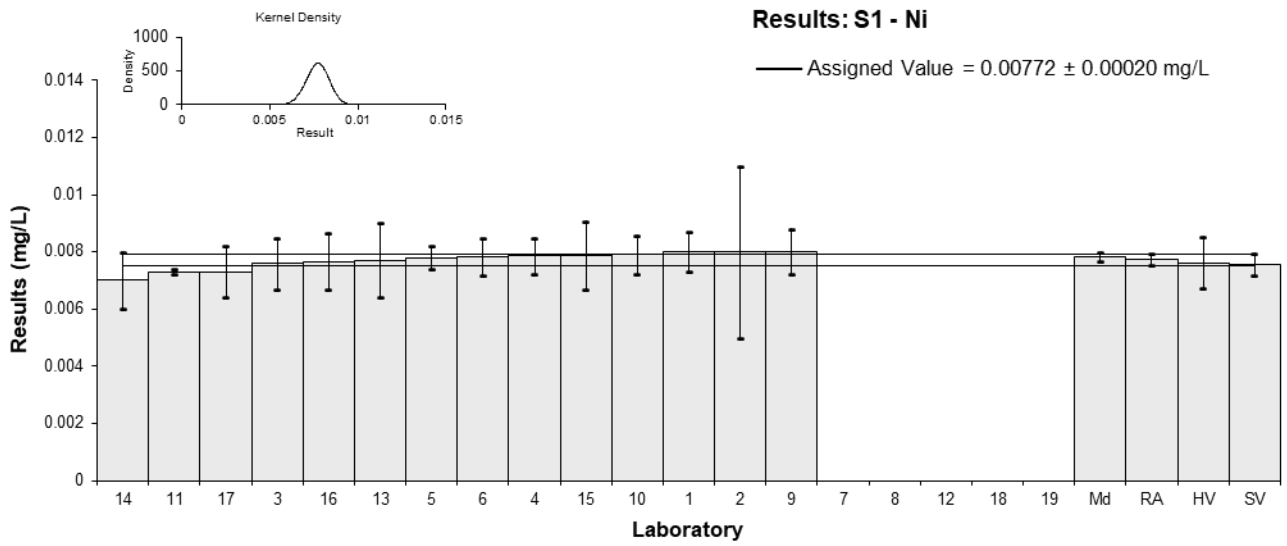
Sample No.	S1
Matrix	Potable Water
Analyte	Ni
Unit	mg/L

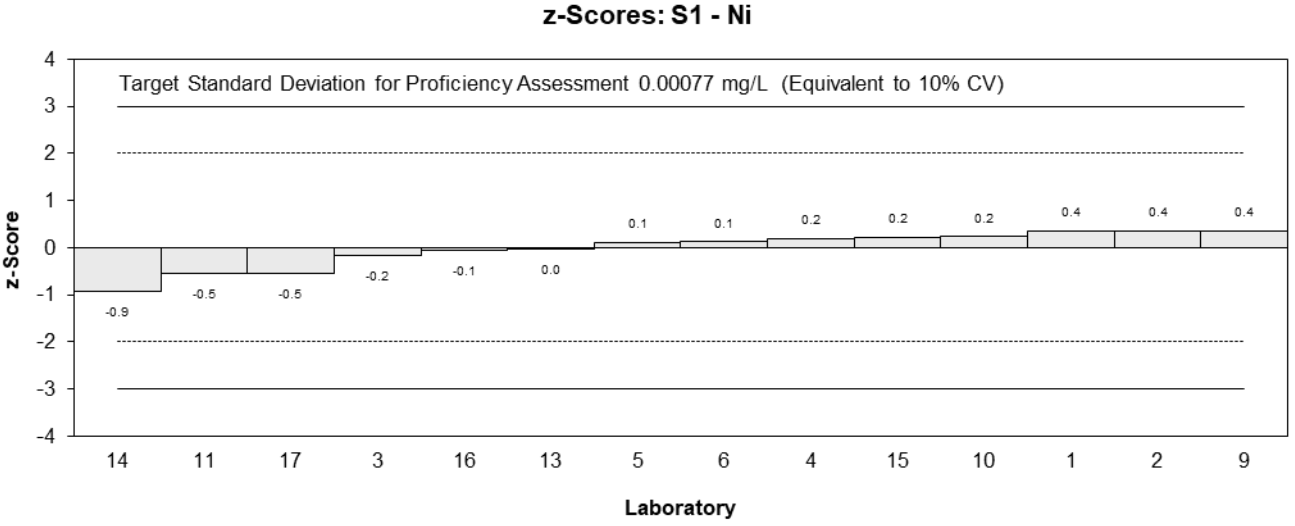
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.008	0.0007	0.36	0.38
2	0.008	0.003	0.36	0.09
3	0.0076	0.0009	-0.16	-0.13
4	0.00786	0.000630	0.18	0.21
5	0.0078	0.0004	0.10	0.18
6	0.00781	0.00065	0.12	0.13
7	NT	NT		
8	NT	NT		
9	0.008	0.0008	0.36	0.34
10	0.0079	0.00068	0.23	0.25
11	0.0073	0.0001	-0.54	-1.88
12	<0.025	NR		
13	0.0077	0.0013	-0.03	-0.02
14	0.007	0.001	-0.93	-0.71
15	0.00788	0.0012	0.21	0.13
16	0.00767	0.00099	-0.06	-0.05
17	0.0073	0.0009	-0.54	-0.46
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.00772	0.00020
Spike Value	0.00757	0.00039
Homogeneity Value	0.00762	0.00091
Robust Average	0.00772	0.00020
Median	0.00781	0.00016
Mean	0.00770	
N	14	
Max	0.008	
Min	0.007	
Robust SD	0.00030	
Robust CV	3.8%	


Results: S1 - Ni
Assigned Value = 0.00772 ± 0.00020 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
14 11 17 3 16 13 5 6 4 15 10 1 2 9 7 8 12 18 19 Md RA HV SV


z-Scores: S1 - Ni
Target Standard Deviation for Proficiency Assessment 0.00077 mg/L (Equivalent to 10% CV)
z-Score
-0.9 -0.5 -0.5 -0.2 -0.1 0.0 0.1 0.1 0.2 0.2 0.2 0.4 0.4 0.4
Laboratory
14 11 17 3 16 13 5 6 4 15 10 1 2 9

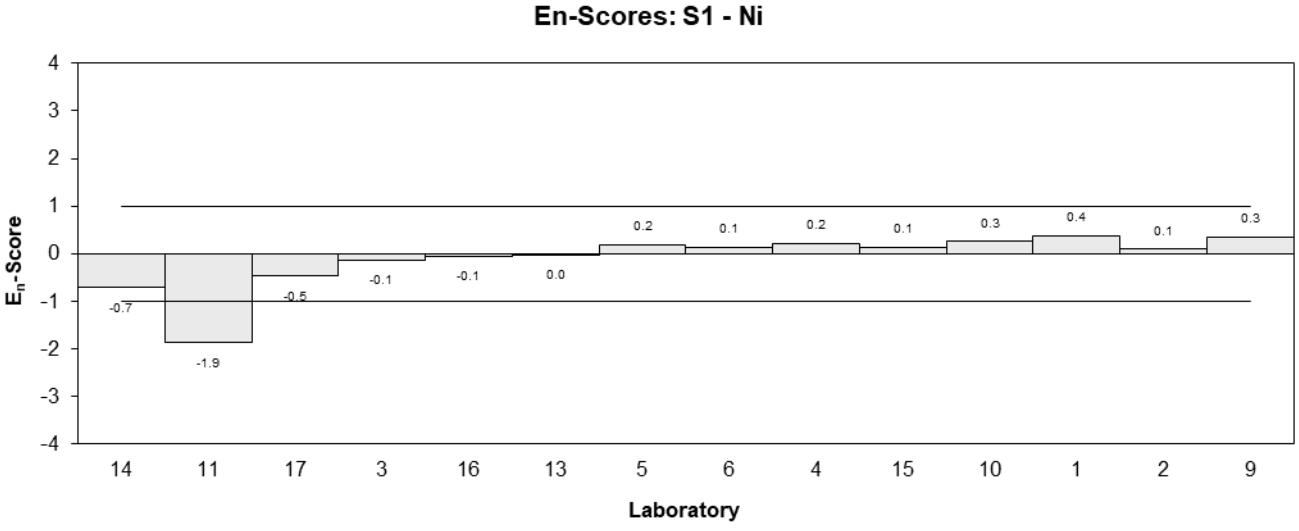

En-Scores: S1 - Ni
En-Score
-0.7 -1.9 -0.5 -0.1 -0.1 0.0 0.2 0.1 0.2 0.1 0.3 0.4 0.1 0.3
Laboratory
14 11 17 3 16 13 5 6 4 15 10 1 2 9

Figure 13

Table 17

Sample Details

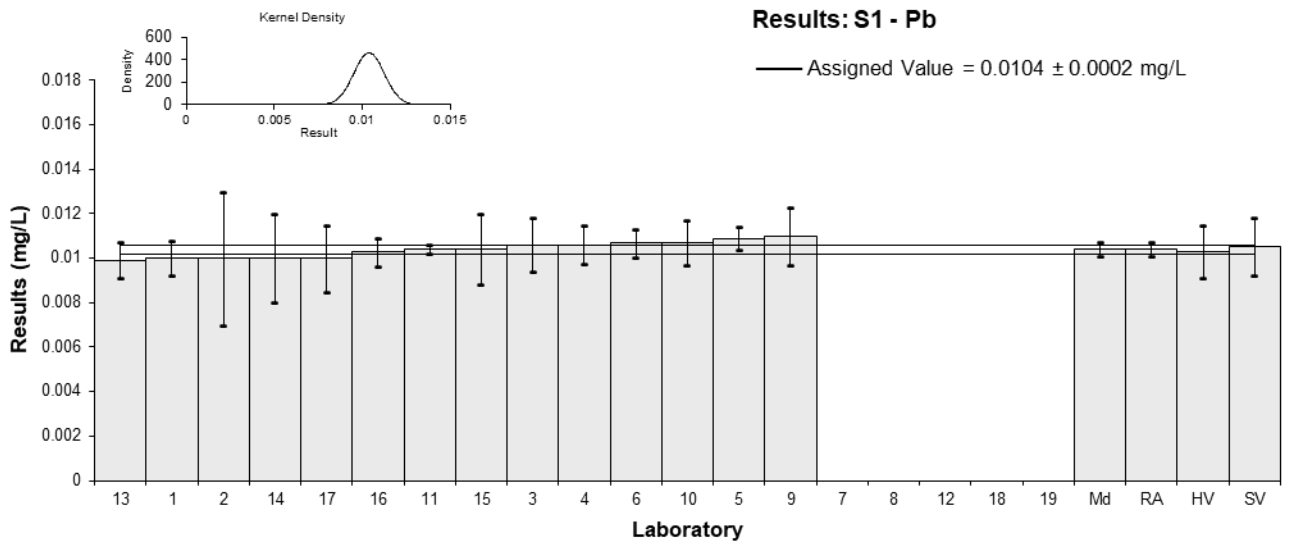
Sample No.	S1
Matrix	Potable Water
Analyte	Pb
Unit	mg/L

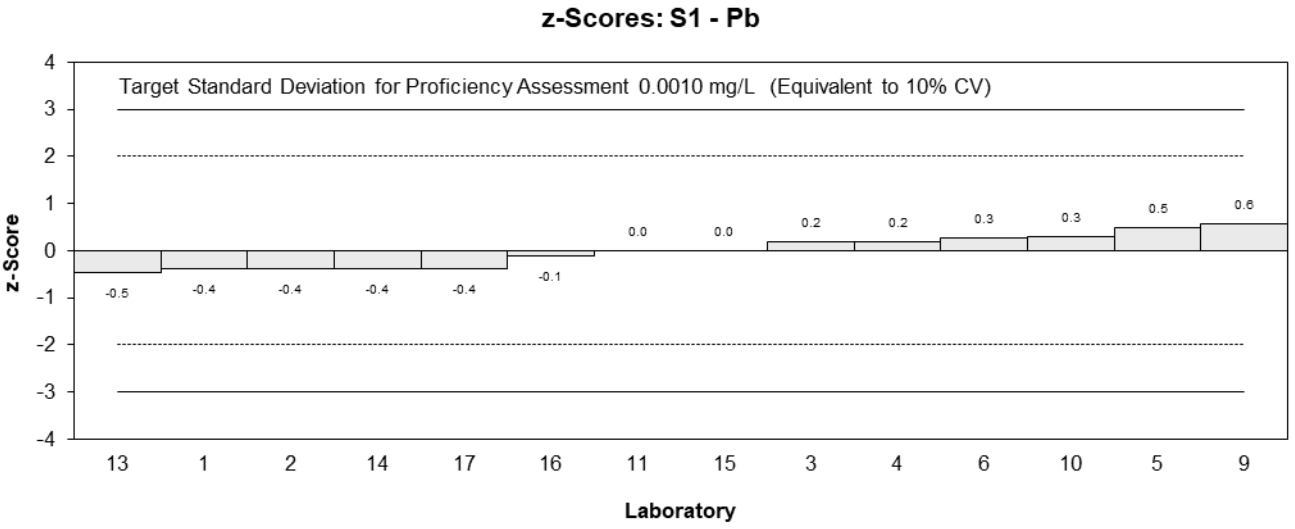
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.010	0.0008	-0.38	-0.49
2	0.010	0.003	-0.38	-0.13
3	0.0106	0.0012	0.19	0.16
4	0.0106	0.000849	0.19	0.23
5	0.0109	0.0005	0.48	0.93
6	0.01068	0.00062	0.27	0.43
7	NT	NT		
8	NT	NT		
9	0.011	0.0013	0.58	0.46
10	0.0107	0.001	0.29	0.29
11	0.0104	0.0002	0.00	0.00
12	<0.25	NR		
13	0.0099	0.0008	-0.48	-0.61
14	0.01	0.002	-0.38	-0.20
15	0.0104	0.0016	0.00	0.00
16	0.01028	0.00063	-0.12	-0.18
17	0.010	0.0015	-0.38	-0.26
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.0104	0.0002
Spike Value	0.0105	0.0013
Homogeneity Value	0.0103	0.0012
Robust Average	0.0104	0.0003
Median	0.0104	0.0003
Mean	0.0104	
N	14	
Max	0.011	
Min	0.0099	
Robust SD	0.00042	
Robust CV	4%	


Kernel Density
Density
Result
Results: S1 - Pb
Assigned Value = 0.0104 ± 0.0002 mg/L
Results (mg/L)
Laboratory
13 1 2 14 17 16 11 15 3 4 6 10 5 9 7 8 12 18 19 Md RA HV SV


z-Scores: S1 - Pb
Target Standard Deviation for Proficiency Assessment 0.0010 mg/L (Equivalent to 10% CV)
z-Score
-0.5 -0.4 -0.4 -0.4 -0.4 -0.1 0.0 0.0 0.2 0.2 0.3 0.3 0.5 0.6
Laboratory
13 1 2 14 17 16 11 15 3 4 6 10 5 9

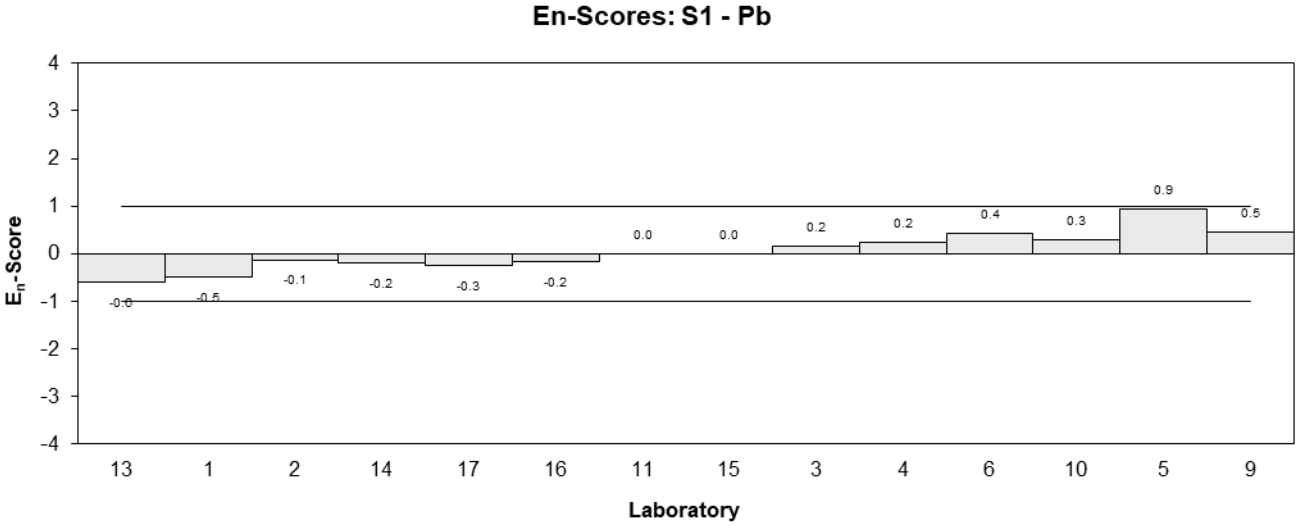

En-Scores: S1 - Pb
En-Score
-0.6 -0.5 -0.1 -0.2 -0.3 -0.2 0.0 0.0 0.2 0.2 0.4 0.3 0.9 0.5
Laboratory
13 1 2 14 17 16 11 15 3 4 6 10 5 9

Figure 14

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	0.002	0.0009	-2.70	-0.79
2	0.0016	0.0008	-4.16	-1.36
3	0.0032	NR	1.68	1.77
4	0.00266	0.000213	-0.29	-0.24
5	0.0026	0.0001	-0.51	-0.50
6	0.00260	0.00143	-0.51	-0.10
7	NT	NT		
8	NT	NT		
9	0.003	0.0005	0.95	0.46
10	0.0035	0.0004	2.77	1.59
11	0.0028	0.0001	0.22	0.22
12	<0.5	NR		
13	0.0020	0.0004	-2.70	-1.55
14	0.003	0.0006	0.95	0.40
15	0.00265	0.0005	-0.33	-0.16
16	0.0026	0.0015	-0.51	-0.09
17	0.0029	0.0005	0.58	0.28
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.00274	0.00026
Spike Value	0.00261	0.00007
Homogeneity Value	0.00245	0.00029
Robust Average	0.00267	0.00034
Median	0.00266	0.00029
Mean	0.00265	
N	14	
Max	0.0035	
Min	0.0016	
Robust SD	0.00051	
Robust CV	19%	

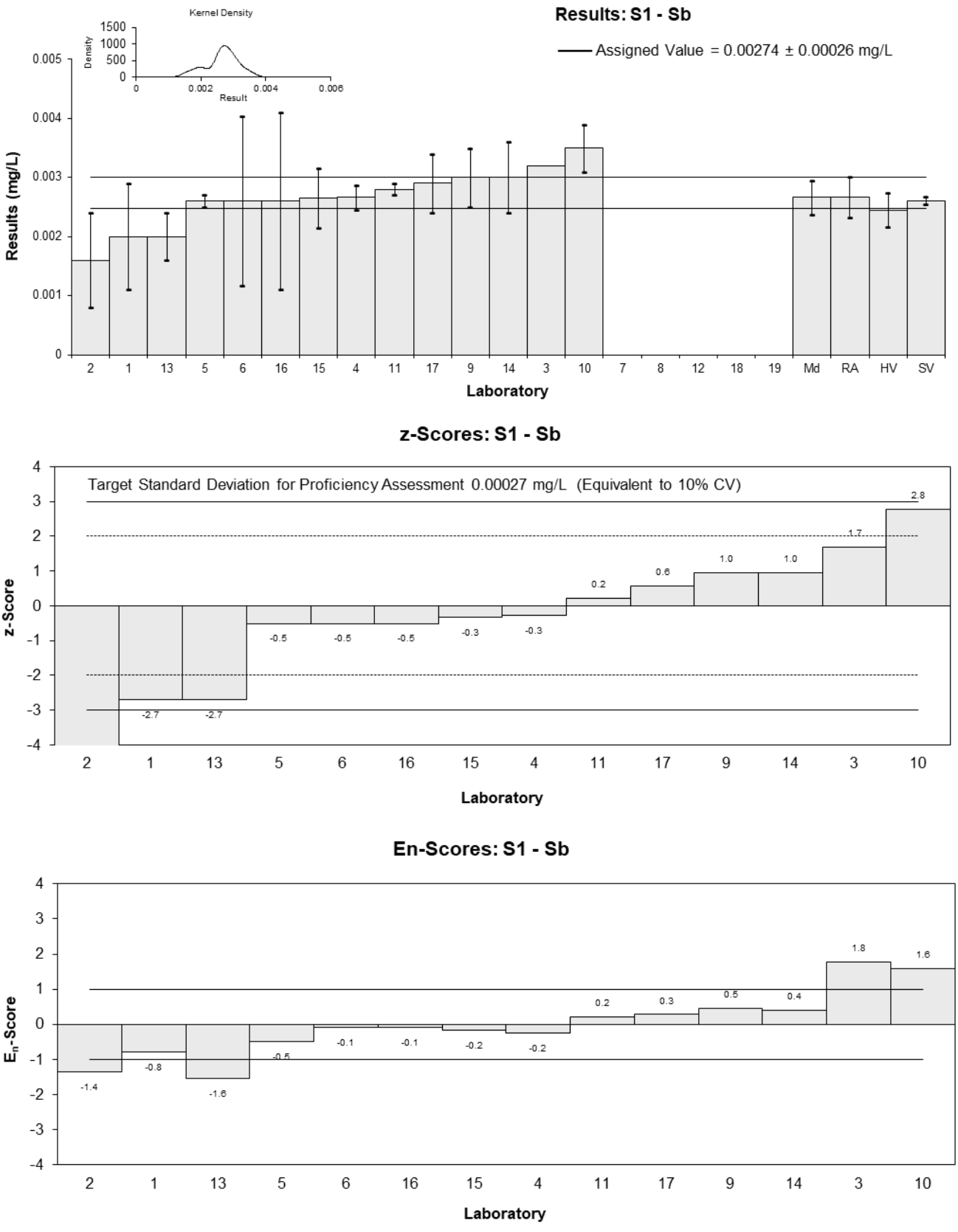

Results: S1 - Sb
Kernel Density
Density
Result
Assigned Value = 0.00274 ± 0.00026 mg/L
Results (mg/L)
Laboratory
2 1 13 5 6 16 15 4 11 17 9 14 3 10 7 8 12 18 19 Md RA HV SV
z-Scores: S1 - Sb
Target Standard Deviation for Proficiency Assessment 0.00027 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
2 1 13 5 6 16 15 4 11 17 9 14 3 10
En-Scores: S1 - Sb
En-Score
Laboratory
2 1 13 5 6 16 15 4 11 17 9 14 3 10

Figure 15

Table 19

Sample Details

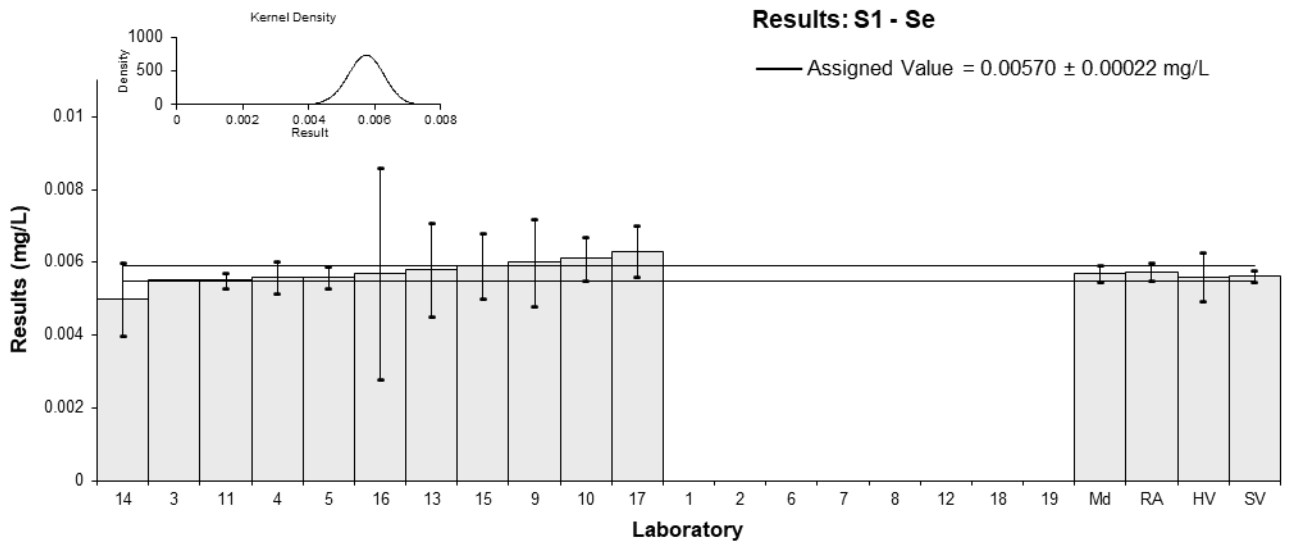
Sample No.	S1
Matrix	Potable Water
Analyte	Se
Unit	mg/L

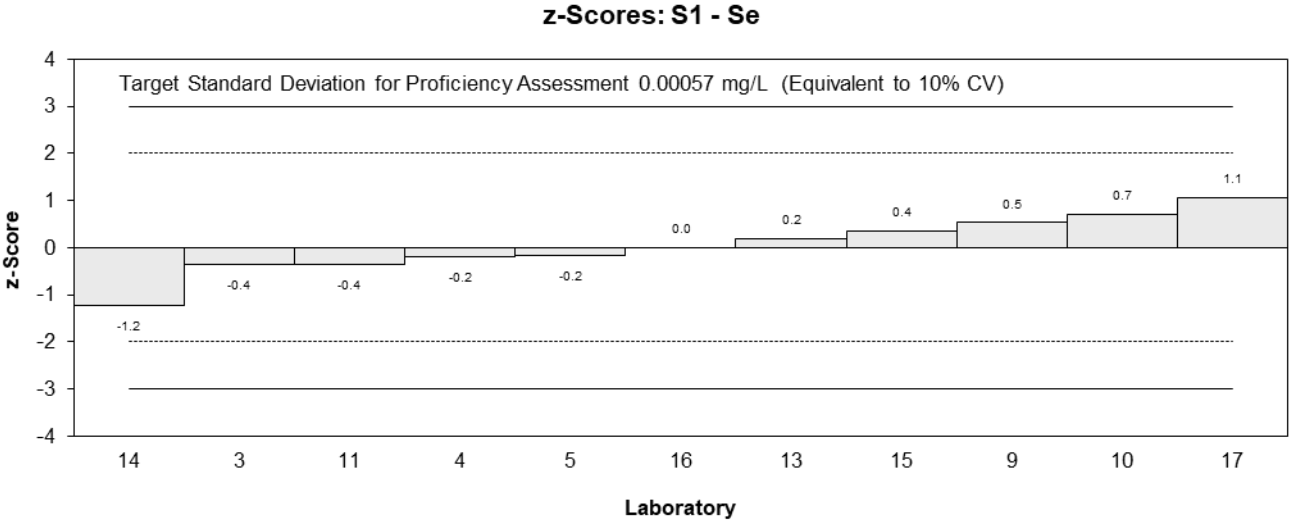
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	<0.01	NR		
2	<0.01	0.010		
3	0.0055	NR	-0.35	-0.91
4	0.00559	0.000448	-0.19	-0.22
5	0.0056	0.0003	-0.18	-0.27
6	<0.01	NR		
7	NT	NT		
8	NT	NT		
9	0.006	0.0012	0.53	0.25
10	0.0061	0.0006	0.70	0.63
11	0.0055	0.0002	-0.35	-0.67
12	<2.5	NR		
13	0.0058	0.0013	0.18	0.08
14	0.005	0.001	-1.23	-0.68
15	0.0059	0.0009	0.35	0.22
16	0.0057	0.0029	0.00	0.00
17	0.0063	0.0007	1.05	0.82
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.00570	0.00022
Spike Value	0.00561	0.00016
Homogeneity Value	0.00559	0.00067
Robust Average	0.00574	0.00025
Median	0.00570	0.00022
Mean	0.00573	
N	11	
Max	0.0063	
Min	0.005	
Robust SD	0.00034	
Robust CV	5.9%	


Results: S1 - Se
Assigned Value = 0.00570 ± 0.00022 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
14 3 11 4 5 16 13 15 9 10 17 1 2 6 7 8 12 18 19 Md RA HV SV


z-Scores: S1 - Se
Target Standard Deviation for Proficiency Assessment 0.00057 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
14 3 11 4 5 16 13 15 9 10 17
-1.2 -0.4 -0.4 -0.2 -0.2 0.0 0.2 0.4 0.5 0.7 1.1

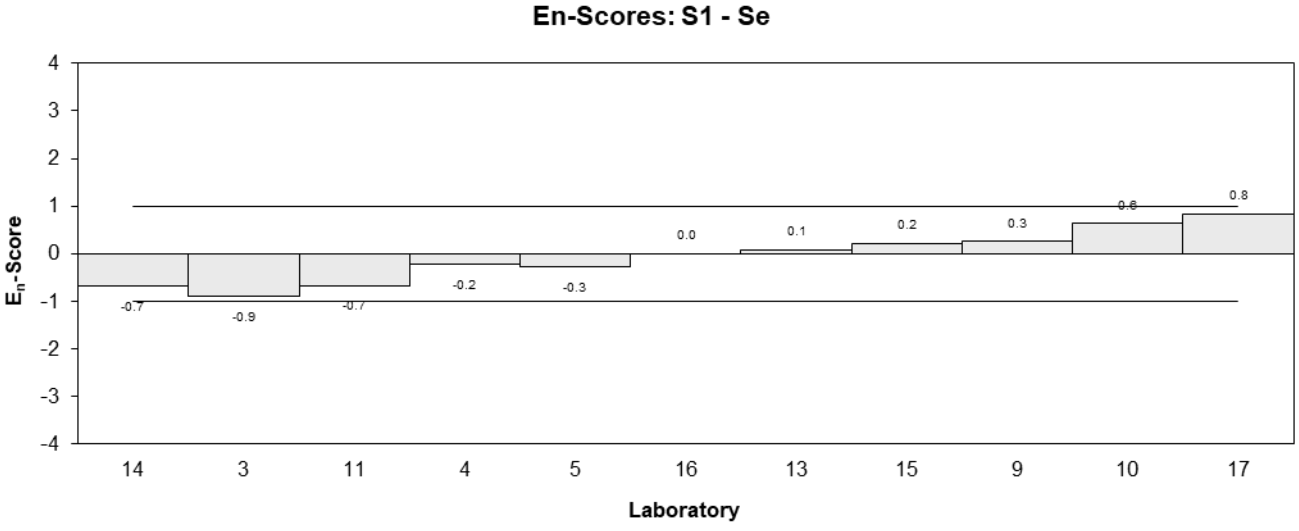

En-Scores: S1 - Se
En-Score
Laboratory
14 3 11 4 5 16 13 15 9 10 17
-0.7 -0.9 -0.7 -0.2 -0.3 0.0 0.1 0.2 0.3 0.6 0.8

Figure 16

Table 20

Sample Details

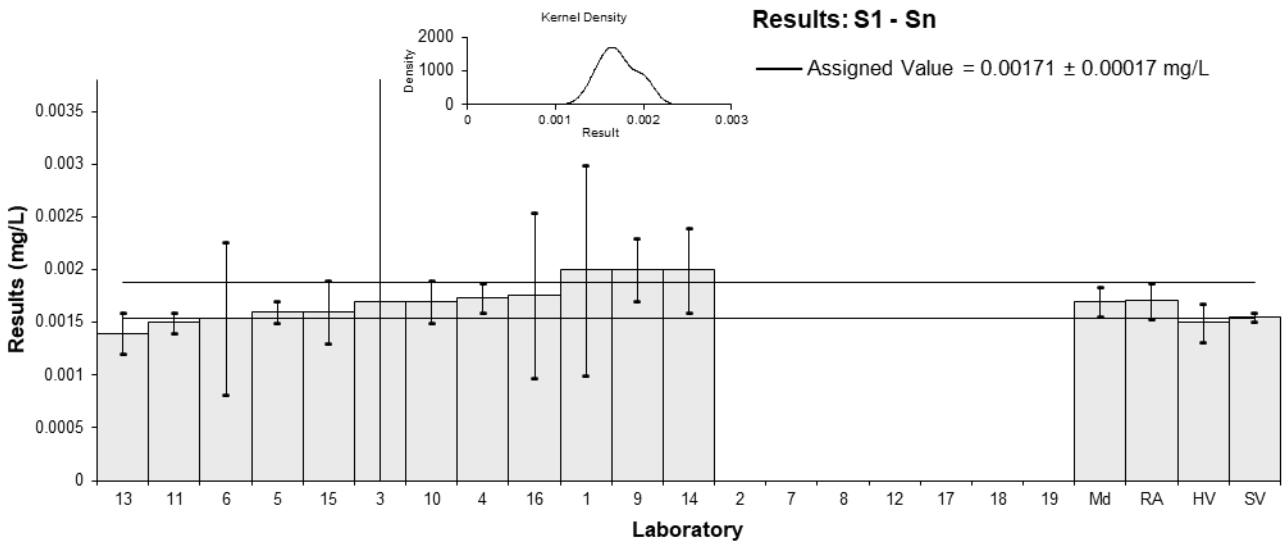
Sample No.	S1
Matrix	Potable Water
Analyte	Sn
Unit	mg/L

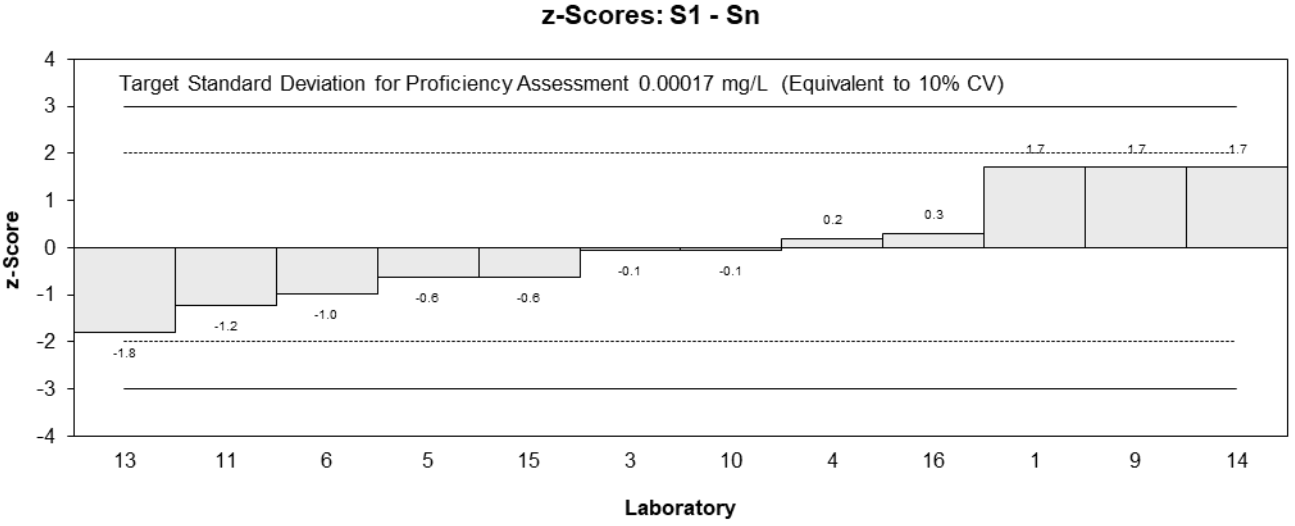
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.002	0.001	1.70	0.29
2	NR	NR		
3	0.0017	0.23	-0.06	0.00
4	0.00174	0.000139	0.18	0.14
5	0.0016	0.0001	-0.64	-0.56
6	0.00154	0.00073	-0.99	-0.23
7	NT	NT		
8	NT	NT		
9	0.002	0.0003	1.70	0.84
10	0.0017	0.0002	-0.06	-0.04
11	0.0015	0.0001	-1.23	-1.06
12	NT	NT		
13	0.0014	0.0002	-1.81	-1.18
14	0.002	0.0004	1.70	0.67
15	0.0016	0.0003	-0.64	-0.32
16	0.00176	0.00079	0.29	0.06
17	NT	NT		
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.00171	0.00017
Spike Value	0.00155	0.00004
Homogeneity Value	0.00150	0.00018
Robust Average	0.00171	0.00017
Median	0.00170	0.00014
Mean	0.00171	
N	12	
Max	0.002	
Min	0.0014	
Robust SD	0.00023	
Robust CV	13%	


Results: S1 - Sn
Assigned Value = 0.00171 ± 0.00017 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
13 11 6 5 15 3 10 4 16 1 9 14 2 7 8 12 17 18 19 Md RA HV SV


z-Scores: S1 - Sn
Target Standard Deviation for Proficiency Assessment 0.00017 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
13 11 6 5 15 3 10 4 16 1 9 14
-1.8 -1.2 -1.0 -0.6 -0.6 -0.1 -0.1 0.2 0.3 1.7 1.7 1.7

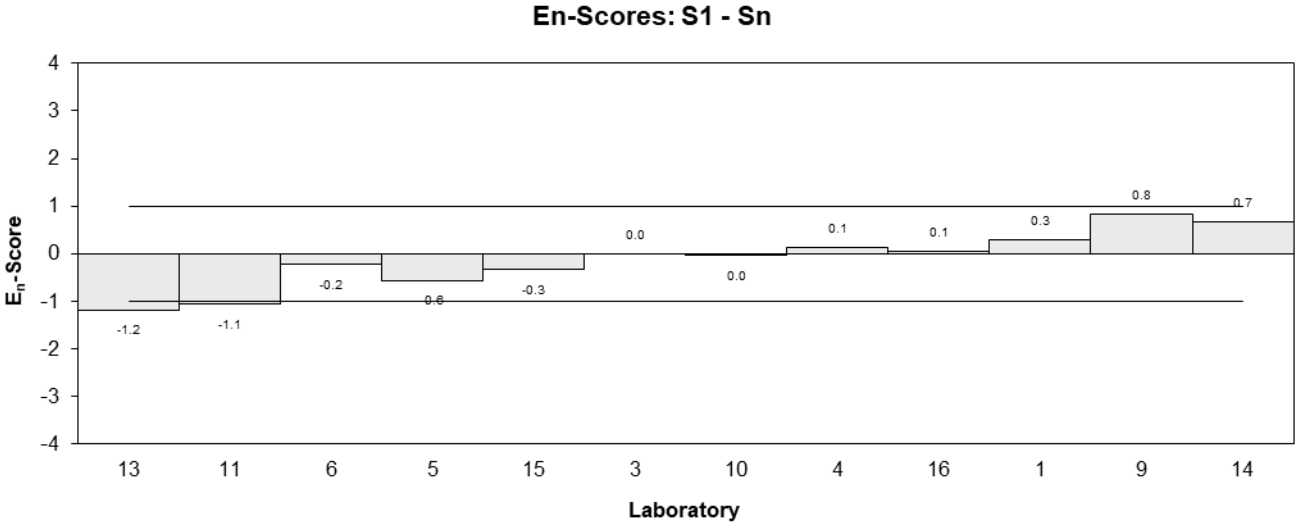

En-Scores: S1 - Sn
En-Score
Laboratory
13 11 6 5 15 3 10 4 16 1 9 14
-1.2 -1.1 -0.2 -0.6 -0.3 0.0 0.0 0.1 0.1 0.3 0.8 0.7

Figure 17

Table 21

Sample Details

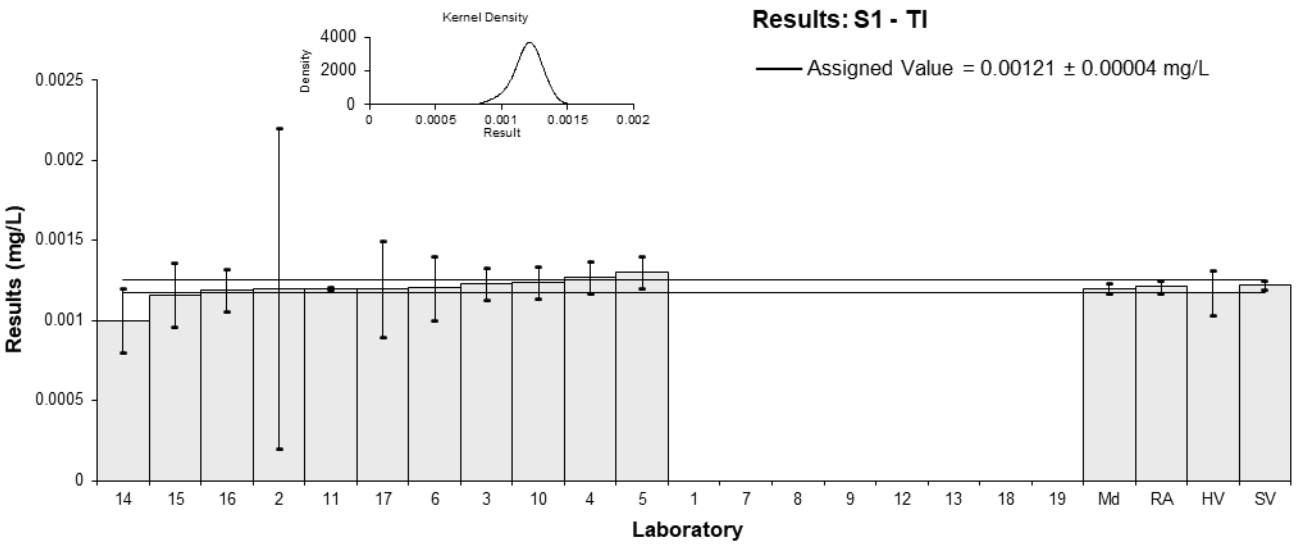
Sample No.	S1
Matrix	Potable Water
Analyte	Tl
Unit	mg/L

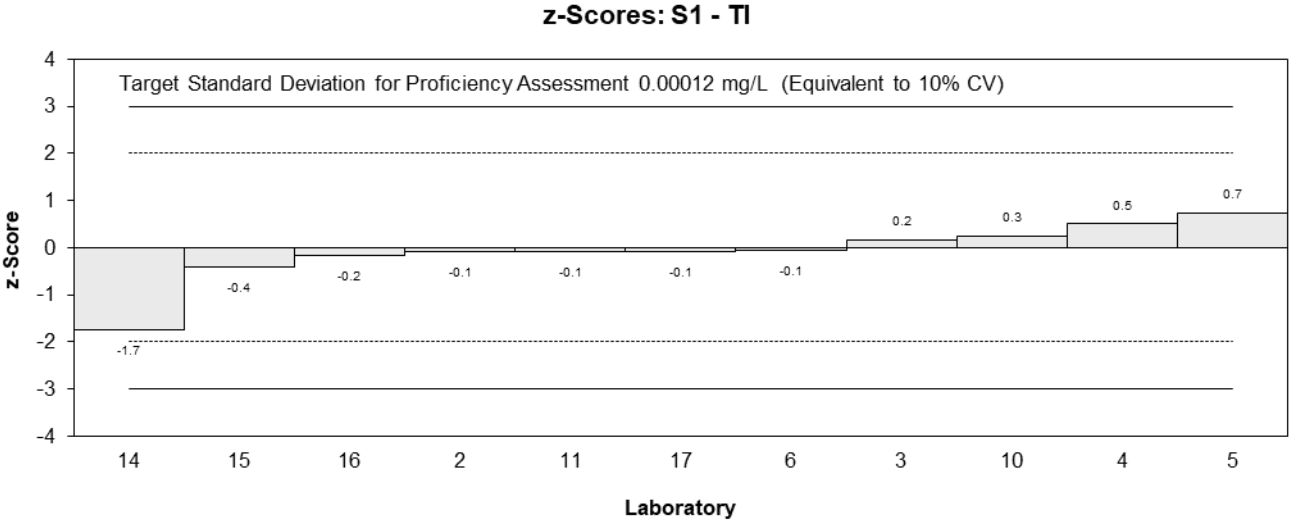
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	0.0012	0.001	-0.08	-0.01
3	0.00123	0.0001	0.17	0.19
4	0.00127	0.000102	0.50	0.55
5	0.0013	0.0001	0.74	0.84
6	0.001202	0.0002	-0.07	-0.04
7	NT	NT		
8	NT	NT		
9	<0.001	NR		
10	0.00124	0.0001	0.25	0.28
11	0.0012	0.00001	-0.08	-0.24
12	NT	NT		
13	NT	NT		
14	0.001	0.0002	-1.74	-1.03
15	0.00116	0.0002	-0.41	-0.25
16	0.00119	0.00013	-0.17	-0.15
17	0.0012	0.0003	-0.08	-0.03
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.00121	0.00004
Spike Value	0.00122	0.00003
Homogeneity Value	0.00117	0.00014
Robust Average	0.00121	0.00004
Median	0.00120	0.00003
Mean	0.00120	
N	11	
Max	0.0013	
Min	0.001	
Robust SD	0.000049	
Robust CV	4.1%	


Kernel Density
Density
Result
Results: S1 - Tl
Assigned Value = 0.00121 ± 0.00004 mg/L
Results (mg/L)
Laboratory
14 15 16 2 11 17 6 3 10 4 5 1 7 8 9 12 13 18 19 Md RA HV SV


z-Scores: S1 - Tl
Target Standard Deviation for Proficiency Assessment 0.00012 mg/L (Equivalent to 10% CV)
z-Score
-1.7 -0.4 -0.2 -0.1 -0.1 -0.1 -0.1 0.2 0.3 0.5 0.7
Laboratory
14 15 16 2 11 17 6 3 10 4 5

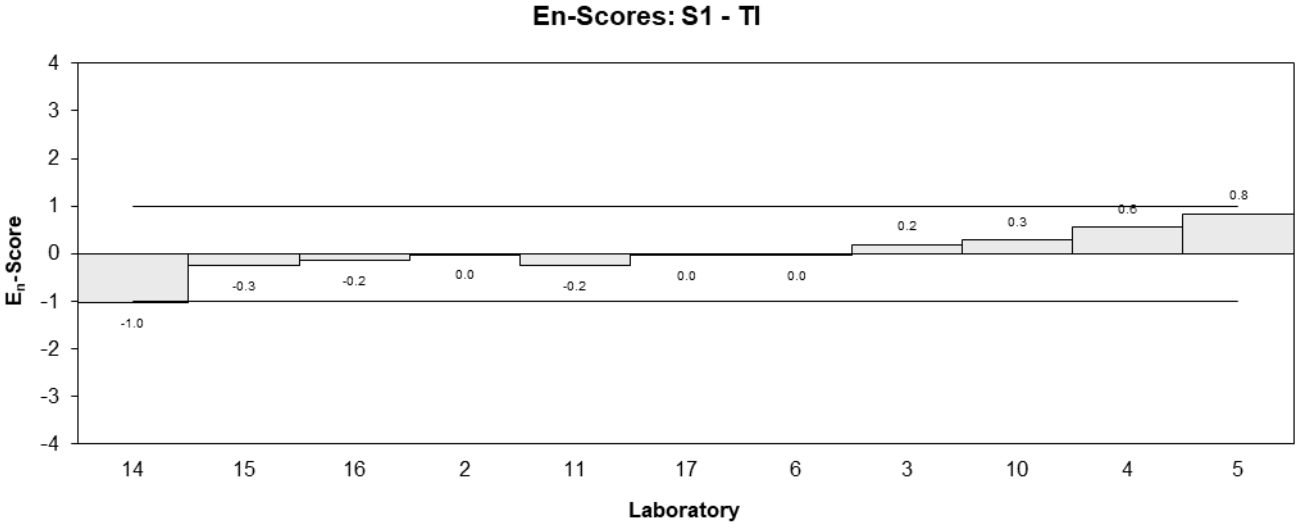

En-Scores: S1 - Tl
En-Score
-1.0 -0.3 -0.2 0.0 -0.2 0.0 0.0 0.2 0.3 0.6 0.8
Laboratory
14 15 16 2 11 17 6 3 10 4 5

Figure 18

Table 22

Sample Details

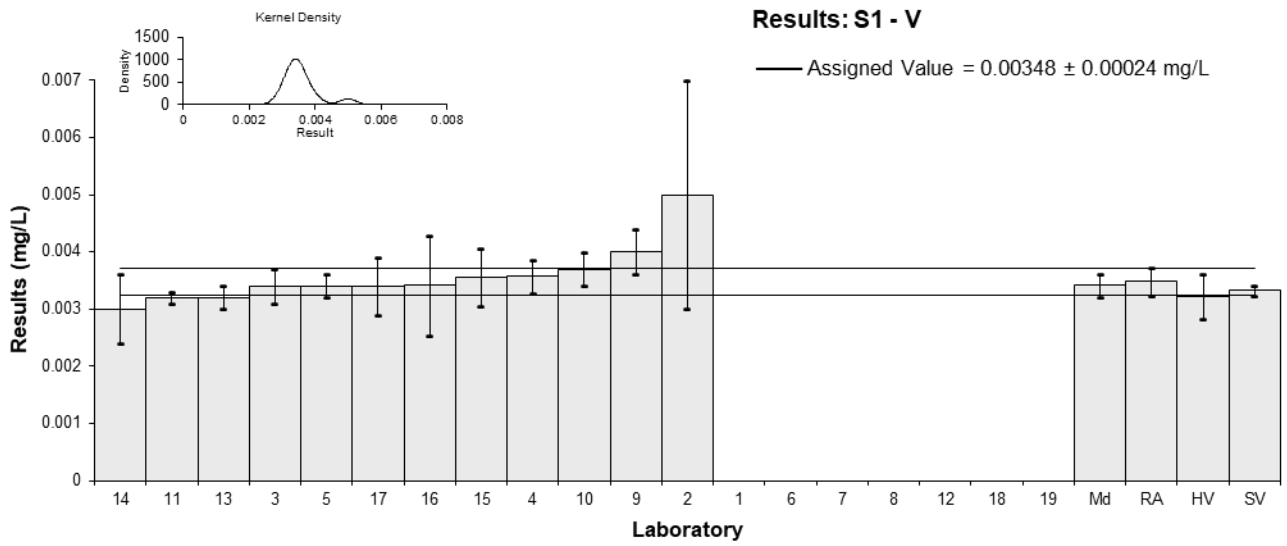
Sample No.	S1
Matrix	Potable Water
Analyte	V
Unit	mg/L

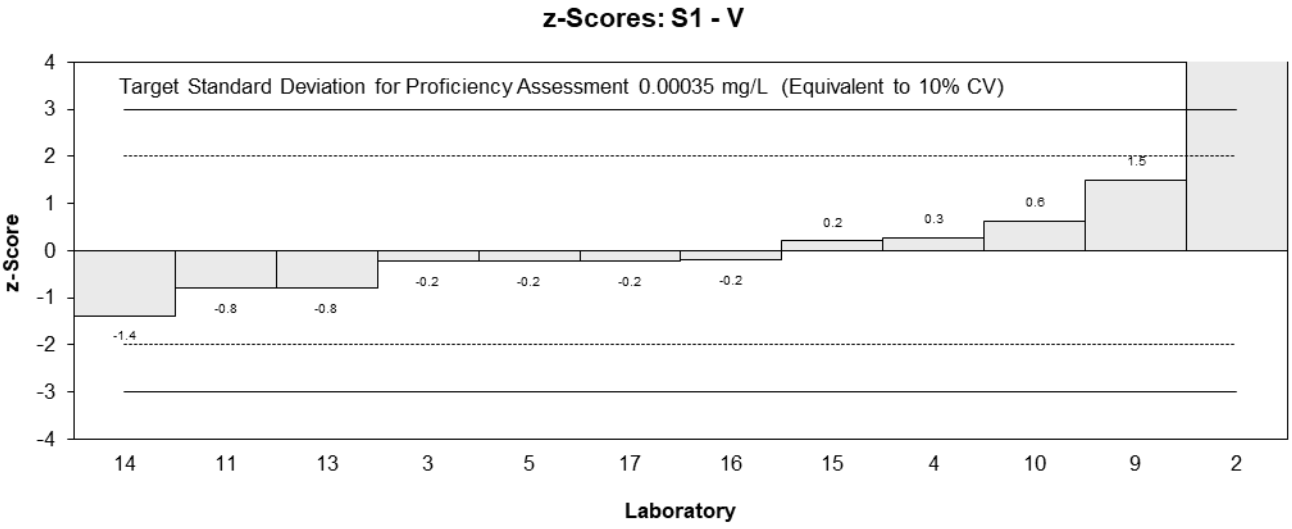
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	<0.01	NR		
2	0.005	0.002	4.37	0.75
3	0.0034	0.0003	-0.23	-0.21
4	0.00357	0.000286	0.26	0.24
5	0.0034	0.0002	-0.23	-0.26
6	<0.01	NR		
7	NT	NT		
8	NT	NT		
9	0.004	0.0004	1.49	1.11
10	0.0037	0.0003	0.63	0.57
11	0.0032	0.0001	-0.80	-1.08
12	<0.01	NR		
13	0.0032	0.0002	-0.80	-0.90
14	0.003	0.0006	-1.38	-0.74
15	0.00355	0.0005	0.20	0.13
16	0.00341	0.00087	-0.20	-0.08
17	0.0034	0.0005	-0.23	-0.14
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.00348	0.00024
Spike Value	0.00332	0.00009
Homogeneity Value	0.00322	0.00039
Robust Average	0.00348	0.00024
Median	0.00341	0.00020
Mean	0.00357	
N	12	
Max	0.005	
Min	0.003	
Robust SD	0.00034	
Robust CV	9.6%	


Kernel Density
Density
1500
1000
500
0
0
0.002
0.004
0.006
0.008
Result
Results: S1 - V
Assigned Value = 0.00348 ± 0.00024 mg/L
Results (mg/L)
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
14 11 13 3 5 17 16 15 4 10 9 2 1 6 7 8 12 18 19 Md RA HV SV
Laboratory


z-Scores: S1 - V
Target Standard Deviation for Proficiency Assessment 0.00035 mg/L (Equivalent to 10% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-1.4
-0.8
-0.8
-0.2
-0.2
-0.2
-0.2
0.2
0.3
0.6
1.5
14 11 13 3 5 17 16 15 4 10 9 2
Laboratory

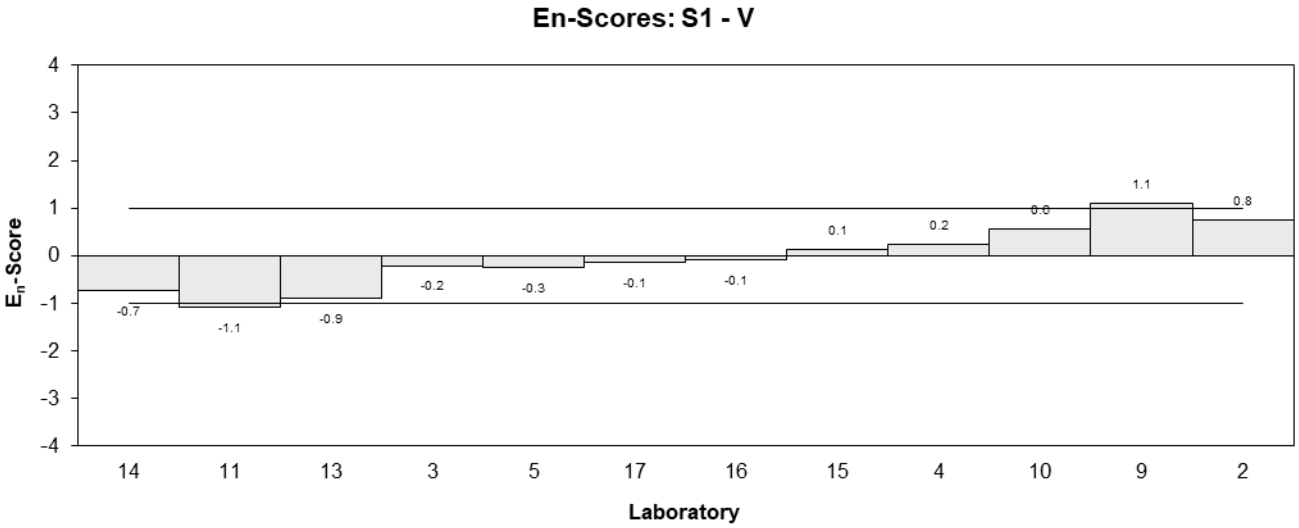

En-Scores: S1 - V
En-Score
4
3
2
1
0
-1
-2
-3
-4
-0.7
-1.1
-0.9
-0.2
-0.3
-0.1
-0.1
0.1
0.2
0.6
1.1
0.8
14 11 13 3 5 17 16 15 4 10 9 2
Laboratory

Figure 19

Table 23

Sample Details

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

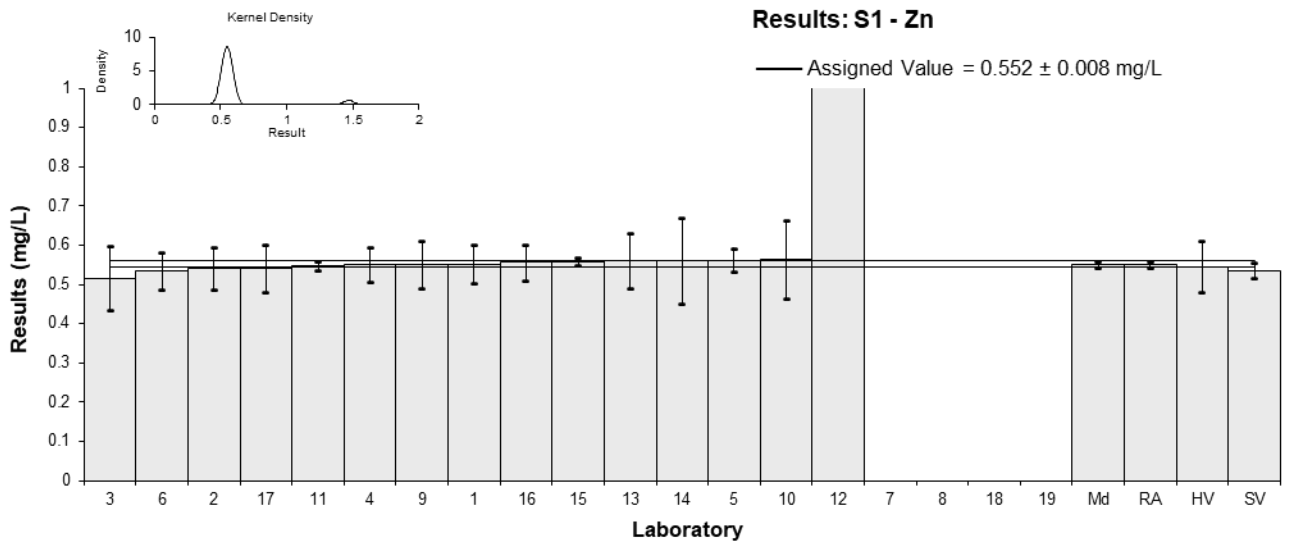
Participant Results

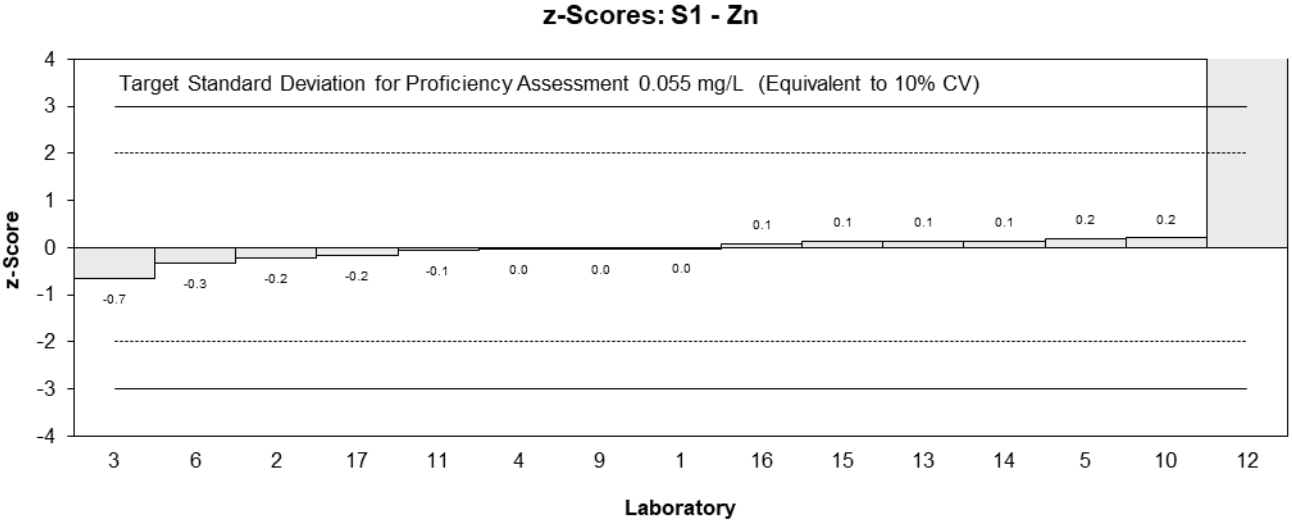
Lab. Code	Result	Uncertainty	z	E_n
1	0.551	0.049	-0.02	-0.02
2	0.54	0.054	-0.22	-0.22
3	0.516	0.082	-0.65	-0.44
4	0.550	0.0441	-0.04	-0.04
5	0.5623	0.03	0.19	0.33
6	0.53362	0.04729	-0.33	-0.38
7	NT	NT		
8	NT	NT		
9	0.55	0.0605	-0.04	-0.03
10	0.563	0.1	0.20	0.11
11	0.5481	0.0105	-0.07	-0.30
12*	1.47	0.441	16.63	2.08
13	0.56	0.07	0.14	0.11
14	0.56	0.11	0.14	0.07
15	0.559	0.0085	0.13	0.60
16	0.556	0.045	0.07	0.09
17	0.542	0.06	-0.18	-0.17
18	NT	NT		
19	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	0.552	0.008
Spike Value	0.536	0.021
Homogeneity Value	0.545	0.065
Robust Average	0.552	0.008
Median	0.551	0.009
Mean	0.61	
N	15	
Max	1.47	
Min	0.516	
Robust SD	0.013	
Robust CV	2.3%	


Kernel Density
Density
Result
Results: S1 - Zn
Assigned Value = 0.552 ± 0.008 mg/L
Results (mg/L)
Laboratory
3 6 2 17 11 4 9 1 16 15 13 14 5 10 12 7 8 18 19 Md RA HV SV


z-Scores: S1 - Zn
Target Standard Deviation for Proficiency Assessment 0.055 mg/L (Equivalent to 10% CV)
z-Score
-0.7 -0.3 -0.2 -0.2 -0.1 0.0 0.0 0.0 0.1 0.1 0.1 0.1 0.2 0.2
Laboratory
3 6 2 17 11 4 9 1 16 15 13 14 5 10 12

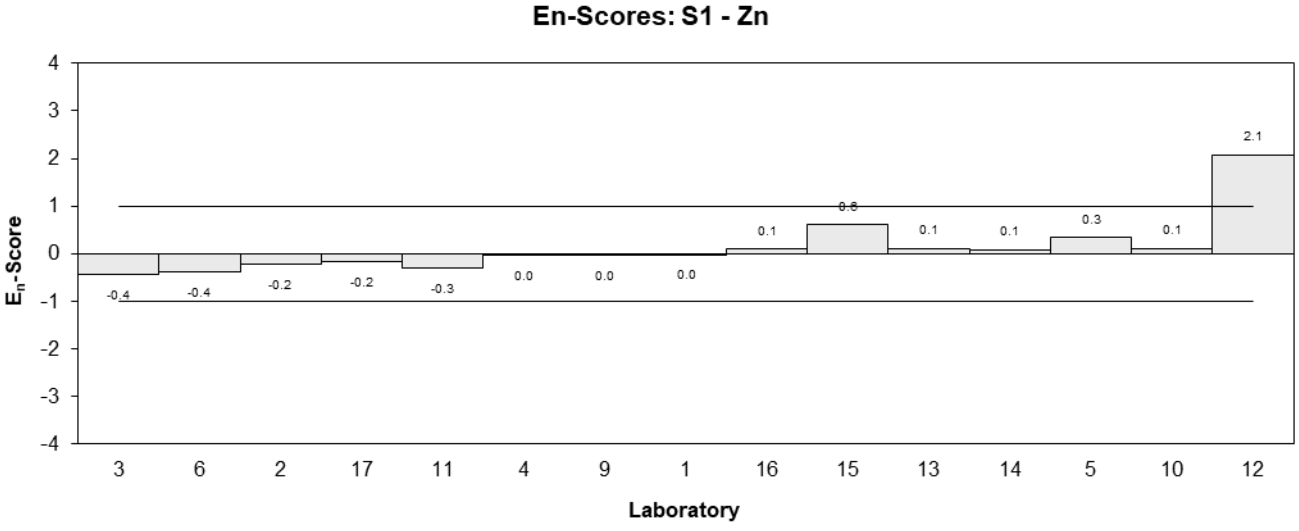

En-Scores: S1 - Zn
En-Score
-0.4 -0.4 -0.2 -0.2 -0.3 0.0 0.0 0.0 0.1 0.6 0.1 0.1 0.3 0.1 2.1
Laboratory
3 6 2 17 11 4 9 1 16 15 13 14 5 10 12

Figure 20

Table 24

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.05	0.008	-0.10	-0.06
2	0.057	0.009	1.29	0.70
3	0.047	0.0083	-0.69	-0.41
4	NT	NT		
5	0.051	0.003	0.10	0.13
6	0.0509	0.0078	0.08	0.05
7	NT	NT		
8	NT	NT		
9	0.05	0.0067	-0.10	-0.07
10	0.055	0.012	0.89	0.37
11	0.0495	0.0020	-0.20	-0.34
12**	0.41	0.082	71.19	4.38
13	0.049	0.021	-0.30	-0.07
14	0.045	0.009	-1.09	-0.59
15	0.050	0.0075	-0.10	-0.06
16	0.0494	0.0073	-0.22	-0.14
17	0.054	0.006	0.69	0.55
18	NT	NT		
19	NT	NT		

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	0.0505	0.0022
Spike Value	0.0498	0.0025
Homogeneity Value	0.0461	0.0055
Robust Average	0.0505	0.0022
Median	0.0500	0.0010
Mean	0.0506	
N	13	
Max	0.057	
Min	0.045	
Robust SD	0.0032	
Robust CV	6.4%	

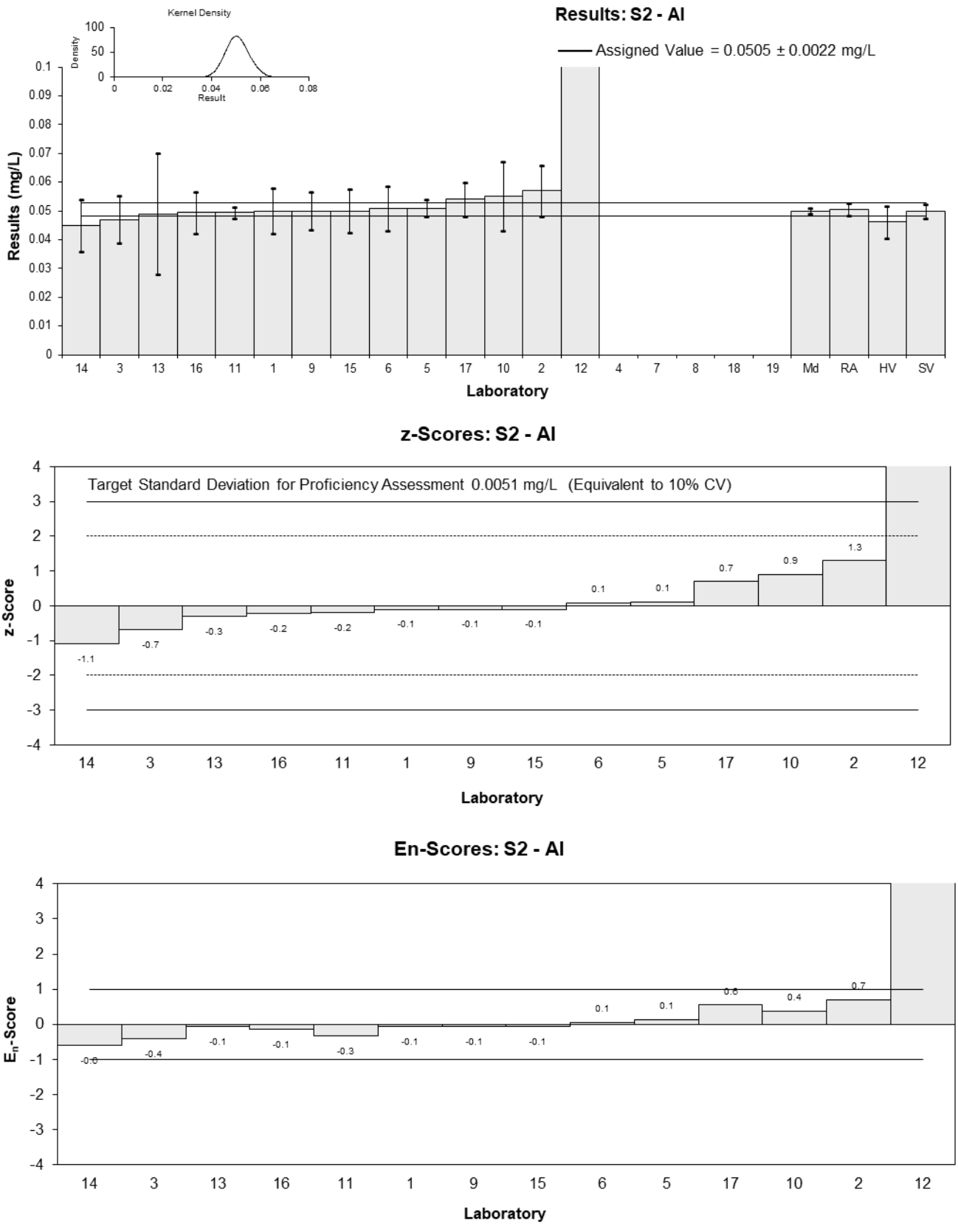

Results: S2 - Al
Assigned Value = 0.0505 ± 0.0022 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
14 3 13 16 11 1 9 15 6 5 17 10 2 12 4 7 8 18 19 Md RA HV SV
z-Scores: S2 - Al
Target Standard Deviation for Proficiency Assessment 0.0051 mg/L (Equivalent to 10% CV)
z-Score
-1.1 -0.7 -0.3 -0.2 -0.2 -0.1 -0.1 -0.1 0.1 0.1 0.7 0.9 1.3
Laboratory
14 3 13 16 11 1 9 15 6 5 17 10 2 12
En-Scores: S2 - Al
En-Score
-0.6 -0.4 -0.1 -0.1 -0.3 -0.1 -0.1 -0.1 0.1 0.1 0.6 0.4 0.7
Laboratory
14 3 13 16 11 1 9 15 6 5 17 10 2 12

Figure 21

Table 25

Sample Details

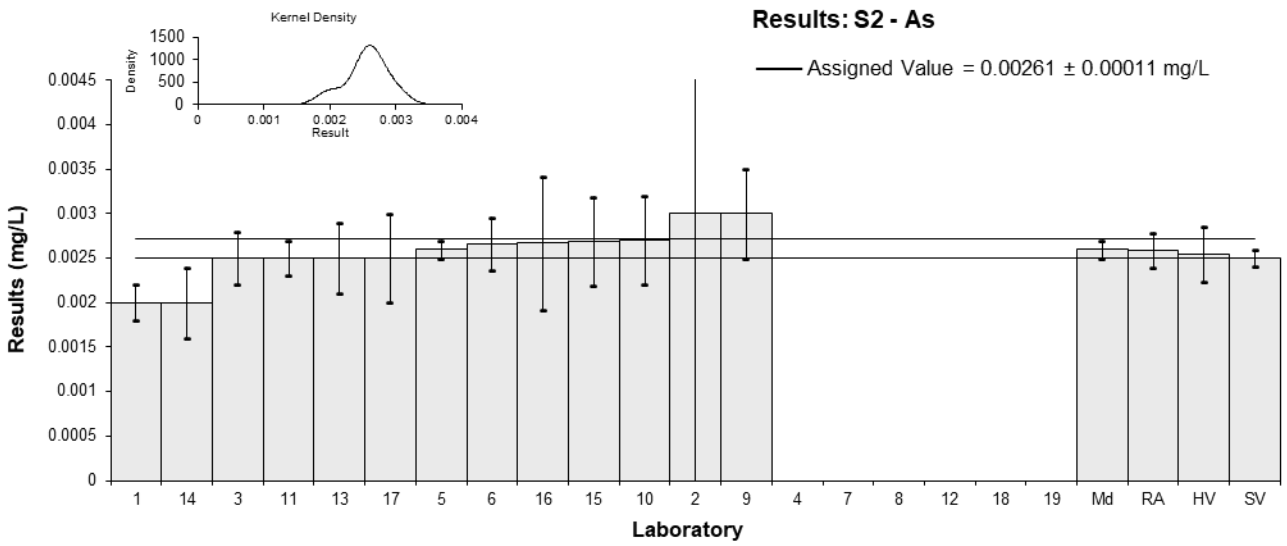
Sample No.	S2
Matrix	Potable Water
Analyte	As
Unit	mg/L

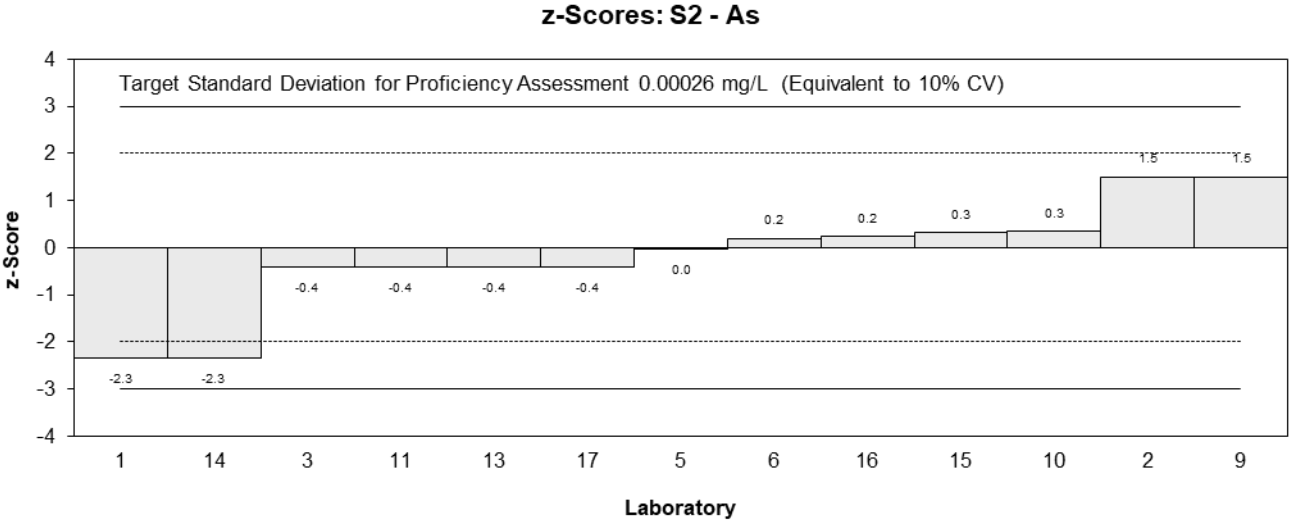
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.002	0.0002	-2.34	-2.67
2	0.003	0.005	1.49	0.08
3	0.0025	0.0003	-0.42	-0.34
4	NT	NT		
5	0.0026	0.0001	-0.04	-0.07
6	0.00266	0.00030	0.19	0.16
7	NT	NT		
8	NT	NT		
9	0.003	0.0005	1.49	0.76
10	0.0027	0.0005	0.34	0.18
11	0.0025	0.0002	-0.42	-0.48
12	<0.5	NR		
13	0.0025	0.0004	-0.42	-0.27
14	0.002	0.0004	-2.34	-1.47
15	0.00269	0.0005	0.31	0.16
16	0.00267	0.00075	0.23	0.08
17	0.0025	0.0005	-0.42	-0.21
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.00261	0.00011
Spike Value	0.00250	0.00009
Homogeneity Value	0.00255	0.00031
Robust Average	0.00259	0.00020
Median	0.00260	0.00010
Mean	0.00256	
N	13	
Max	0.003	
Min	0.002	
Robust SD	0.00029	
Robust CV	11%	


Results: S2 - As
Assigned Value = 0.00261 ± 0.00011 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
1 14 3 11 13 17 5 6 16 15 10 2 9 4 7 8 12 18 19 Md RA HV SV


z-Scores: S2 - As
Target Standard Deviation for Proficiency Assessment 0.00026 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
1 14 3 11 13 17 5 6 16 15 10 2 9
-2.3 -2.3 -0.4 -0.4 -0.4 -0.4 0.0 0.2 0.2 0.3 0.3 1.5 1.5

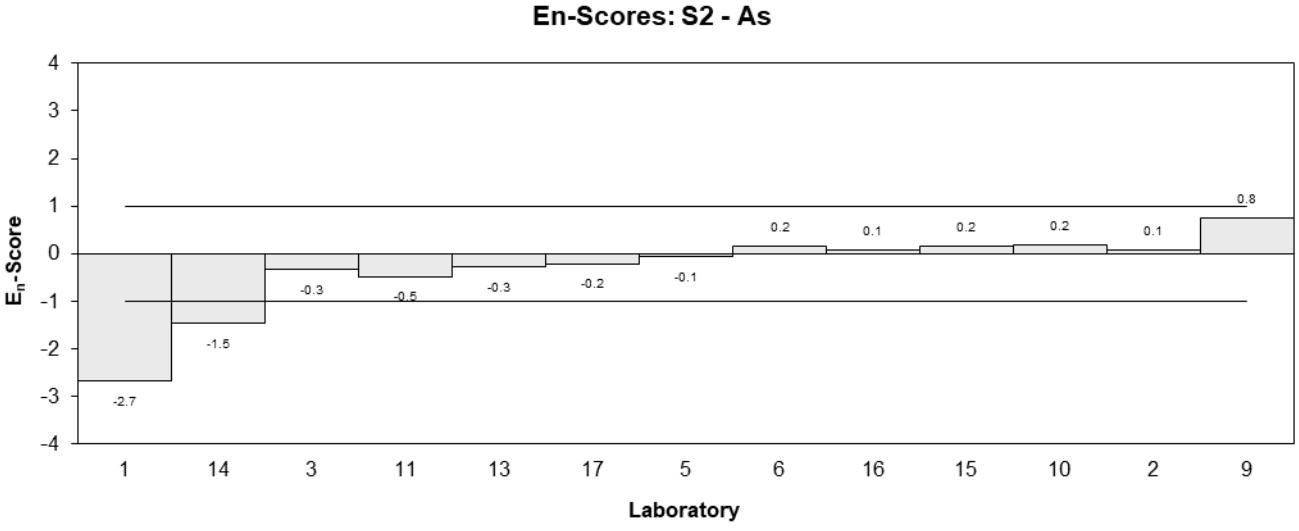

En-Scores: S2 - As
En-Score
Laboratory
1 14 3 11 13 17 5 6 16 15 10 2 9
-2.7 -1.5 -0.3 -0.5 -0.3 -0.2 -0.1 0.2 0.1 0.2 0.2 0.1 0.8

Figure 22

Table 26

Sample Details

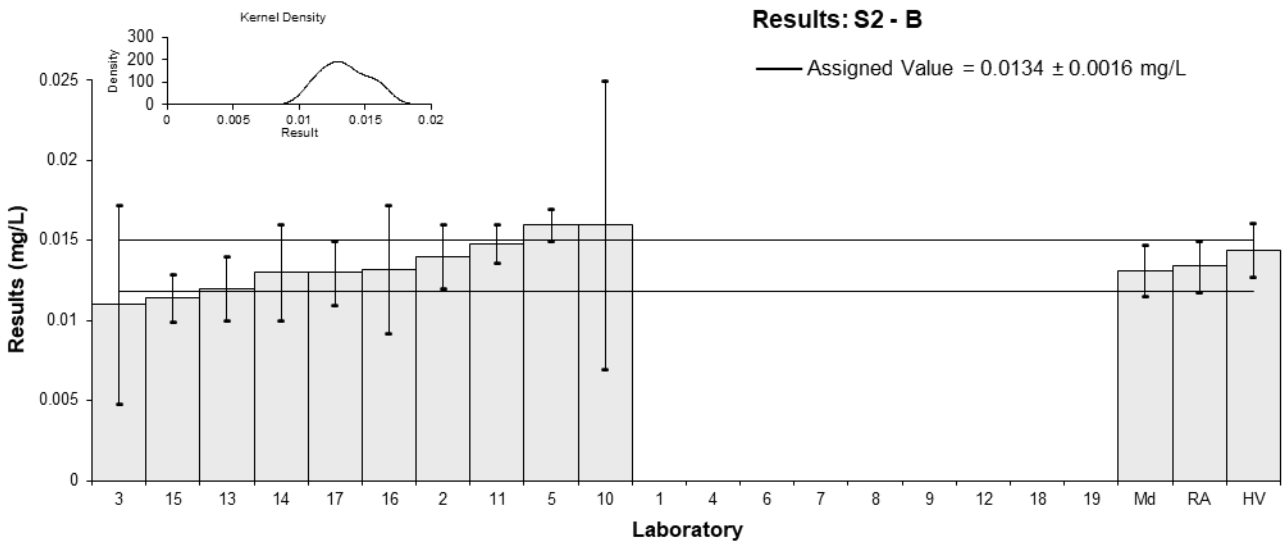
Sample No.	S2
Matrix	Potable Water
Analyte	B
Unit	mg/L

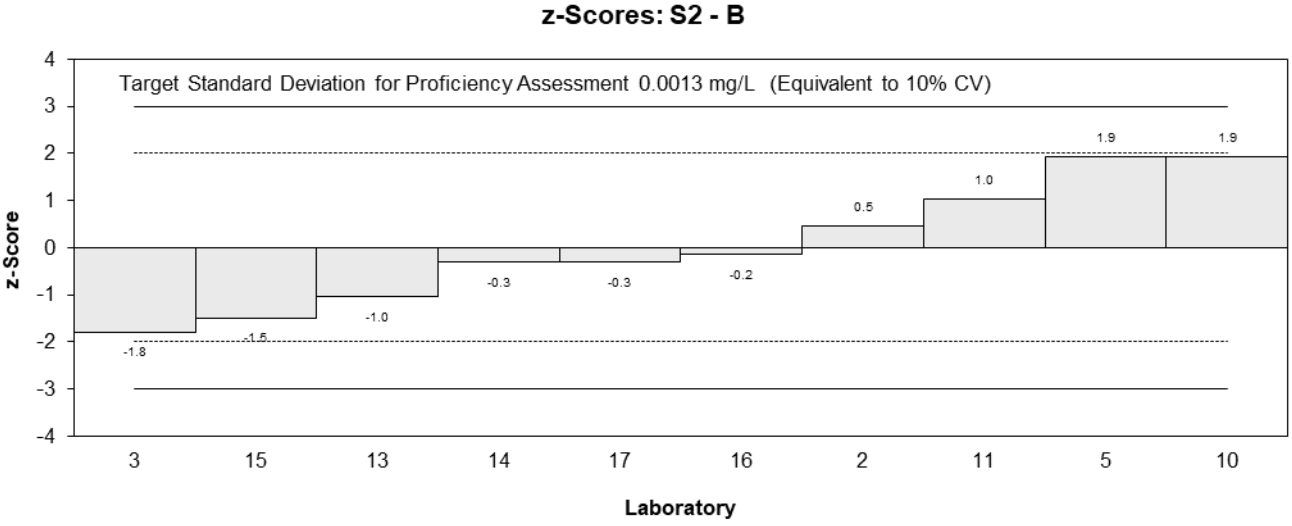
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	<0.05	NR		
2	0.014	0.002	0.45	0.23
3	0.011	0.0062	-1.79	-0.37
4	NT	NT		
5	0.016	0.001	1.94	1.38
6	<0.05	NR		
7	NT	NT		
8	NT	NT		
9	<0.02	NR		
10	0.016	0.009	1.94	0.28
11	0.0148	0.0012	1.04	0.70
12	<0.1	NR		
13	0.012	0.002	-1.04	-0.55
14	0.013	0.003	-0.30	-0.12
15	0.0114	0.0015	-1.49	-0.91
16	0.0132	0.0040	-0.15	-0.05
17	0.013	0.002	-0.30	-0.16
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.0134	0.0016
Spike Value	Not Spiked	
Homogeneity Value	0.0144	0.0017
Robust Average	0.0134	0.0016
Median	0.0131	0.0016
Mean	0.0134	
N	10	
Max	0.016	
Min	0.011	
Robust SD	0.0020	
Robust CV	15%	


Results: S2 - B
Kernel Density
Density
Result
Assigned Value = 0.0134 ± 0.0016 mg/L
Results (mg/L)
Laboratory
3 15 13 14 17 16 2 11 5 10 1 4 6 7 8 9 12 18 19 Md RA HV


z-Scores: S2 - B
Target Standard Deviation for Proficiency Assessment 0.0013 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
3 15 13 14 17 16 2 11 5 10
-1.8 -1.5 -1.0 -0.3 -0.3 -0.2 0.5 1.0 1.9 1.9

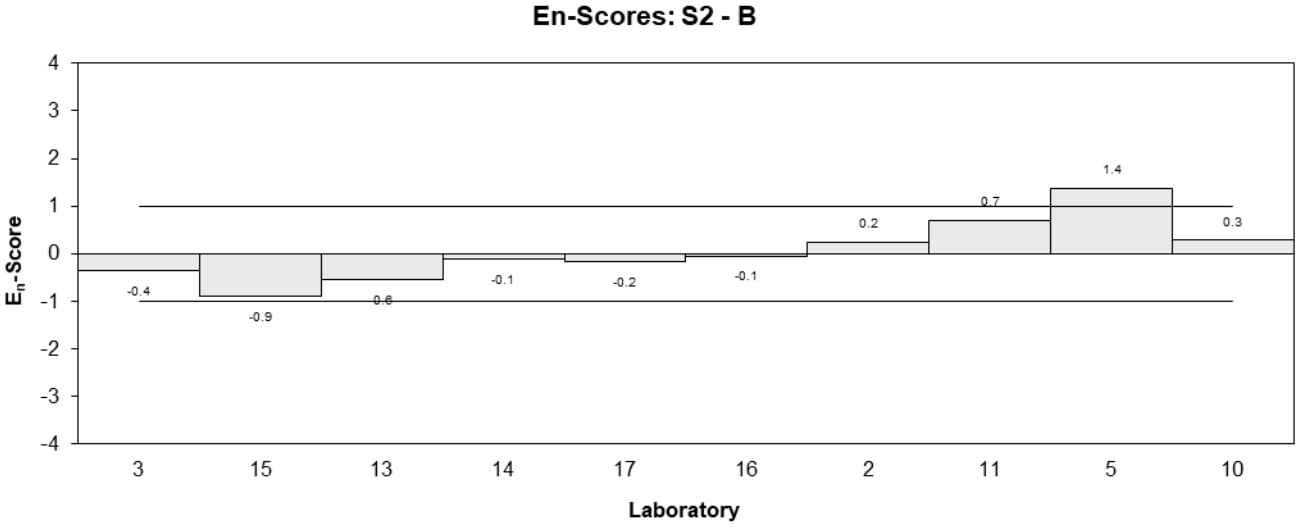

En-Scores: S2 - B
En-Score
Laboratory
3 15 13 14 17 16 2 11 5 10
-0.4 -0.9 -0.6 -0.1 -0.2 -0.1 0.2 0.7 1.4 0.3

Figure 23

Table 27

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.034	0.003	-0.81	-0.93
2	0.035	0.003	-0.54	-0.62
3	0.0377	0.0041	0.19	0.16
4	NT	NT		
5	0.0373	0.002	0.08	0.13
6	0.0378	0.0030	0.22	0.25
7	NT	NT		
8	NT	NT		
9	0.037	0.0048	0.00	0.00
10	0.0405	0.006	0.95	0.57
11	0.0379	0.0015	0.24	0.47
12	NT	NT		
13	0.036	0.010	-0.27	-0.10
14	0.035	0.007	-0.54	-0.28
15	0.0374	0.006	0.11	0.07
16	0.0368	0.0030	-0.05	-0.06
17	0.039	0.005	0.54	0.39
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.0370	0.0012
Spike Value	0.0369	0.0041
Homogeneity Value	0.0371	0.0045
Robust Average	0.0370	0.0012
Median	0.0373	0.0006
Mean	0.0370	
N	13	
Max	0.0405	
Min	0.034	
Robust SD	0.0018	
Robust CV	4.8%	

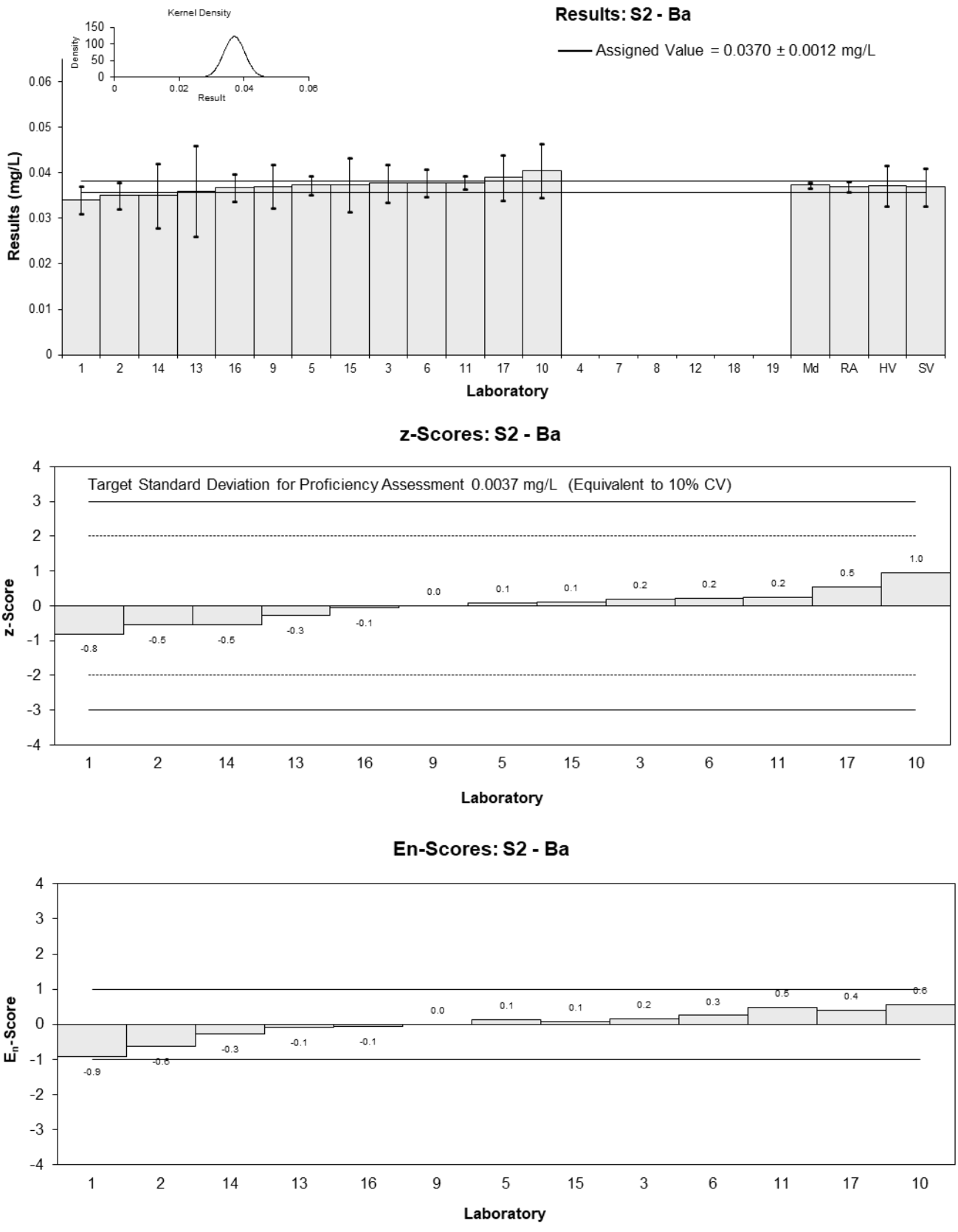

Results: S2 - Ba
Kernel Density
Density
Result
Assigned Value = 0.0370 ± 0.0012 mg/L
Results (mg/L)
Laboratory
1 2 14 13 16 9 5 15 3 6 11 17 10 4 7 8 12 18 19 Md RA HV SV
z-Scores: S2 - Ba
Target Standard Deviation for Proficiency Assessment 0.0037 mg/L (Equivalent to 10% CV)
z-Score
-0.8 -0.5 -0.5 -0.3 -0.1 0.0 0.1 0.1 0.2 0.2 0.2 0.5 1.0
Laboratory
1 2 14 13 16 9 5 15 3 6 11 17 10
En-Scores: S2 - Ba
En-Score
-0.9 -0.6 -0.3 -0.1 -0.1 0.0 0.1 0.1 0.2 0.3 0.5 0.4 0.6
Laboratory
1 2 14 13 16 9 5 15 3 6 11 17 10

Figure 24

Table 28

Sample Details

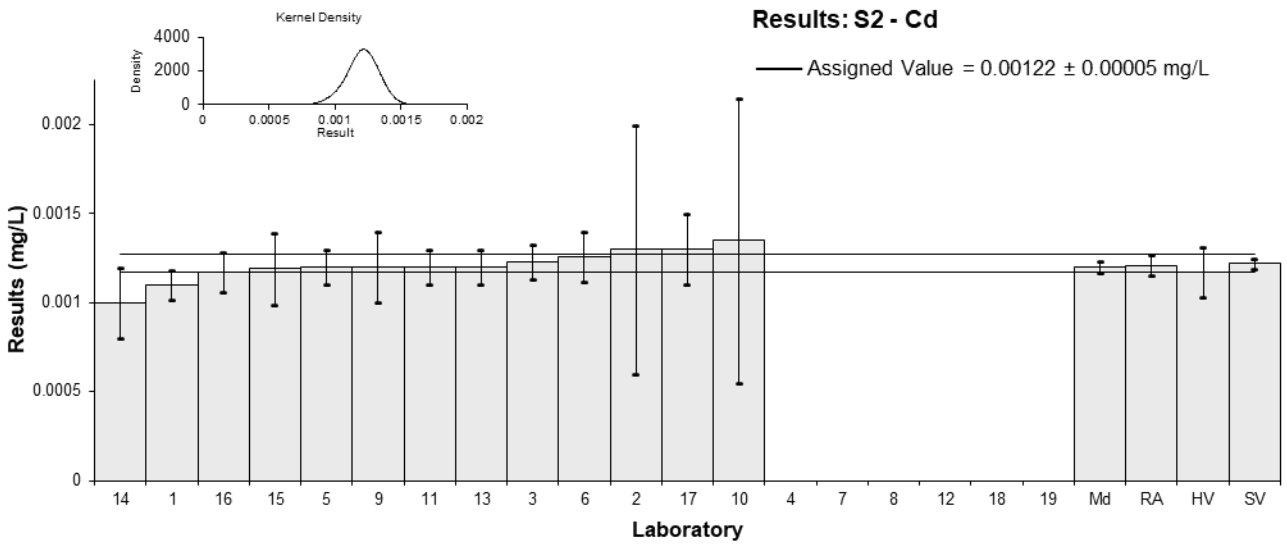
Sample No.	S2
Matrix	Potable Water
Analyte	Cd
Unit	mg/L

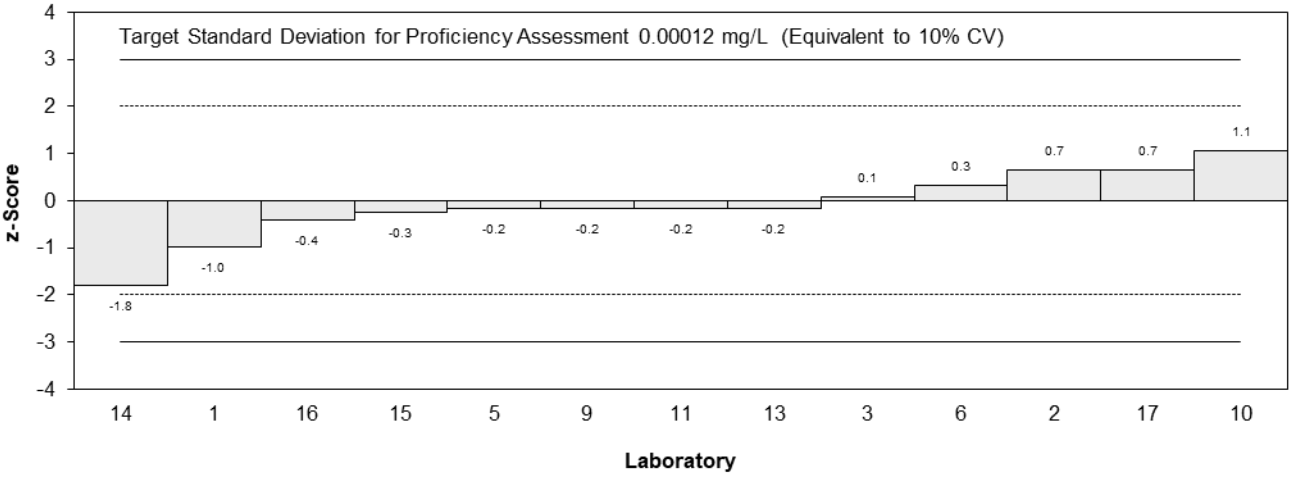
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.0011	0.00008	-0.98	-1.27
2	0.0013	0.0007	0.66	0.11
3	0.00123	0.0001	0.08	0.09
4	NT	NT		
5	0.0012	0.0001	-0.16	-0.18
6	0.00126	0.00014	0.33	0.27
7	NT	NT		
8	NT	NT		
9	0.0012	0.0002	-0.16	-0.10
10	0.00135	0.0008	1.07	0.16
11	0.0012	0.0001	-0.16	-0.18
12	<0.005	NR		
13	0.0012	0.0001	-0.16	-0.18
14	0.001	0.0002	-1.80	-1.07
15	0.00119	0.0002	-0.25	-0.15
16	0.00117	0.00011	-0.41	-0.41
17	0.0013	0.0002	0.66	0.39
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.00122	0.00005
Spike Value	0.00122	0.00003
Homogeneity Value	0.00117	0.00014
Robust Average	0.00121	0.00006
Median	0.00120	0.00003
Mean	0.00121	
N	13	
Max	0.00135	
Min	0.001	
Robust SD	0.000083	
Robust CV	6.8%	


Results: S2 - Cd
Assigned Value = 0.00122 ± 0.00005 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
14 1 16 15 5 9 11 13 3 6 2 17 10 4 7 8 12 18 19 Md RA HV SV


z-Scores: S2 - Cd
Target Standard Deviation for Proficiency Assessment 0.00012 mg/L (Equivalent to 10% CV)
z-Score
-1.8 -1.0 -0.4 -0.3 -0.2 -0.2 -0.2 -0.2 0.1 0.3 0.7 0.7 1.1
Laboratory
14 1 16 15 5 9 11 13 3 6 2 17 10

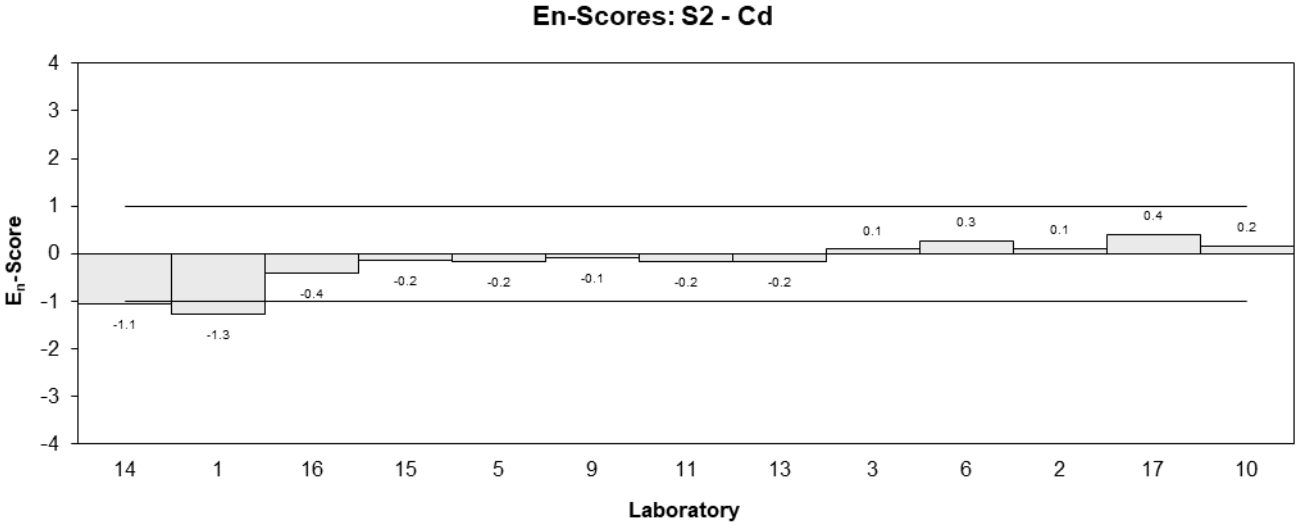

En-Scores: S2 - Cd
En-Score
-1.1 -1.3 -0.4 -0.2 -0.2 -0.1 -0.2 -0.2 0.1 0.3 0.1 0.4 0.2
Laboratory
14 1 16 15 5 9 11 13 3 6 2 17 10

Figure 25

Table 29

Sample Details

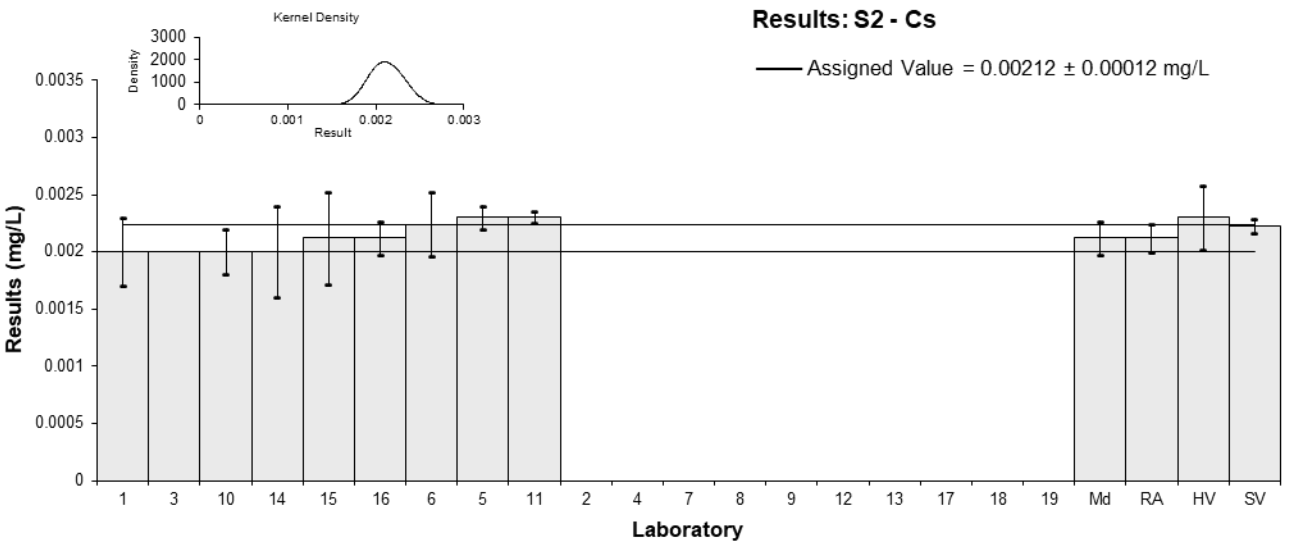
Sample No.	S2
Matrix	Potable Water
Analyte	Cs
Unit	mg/L

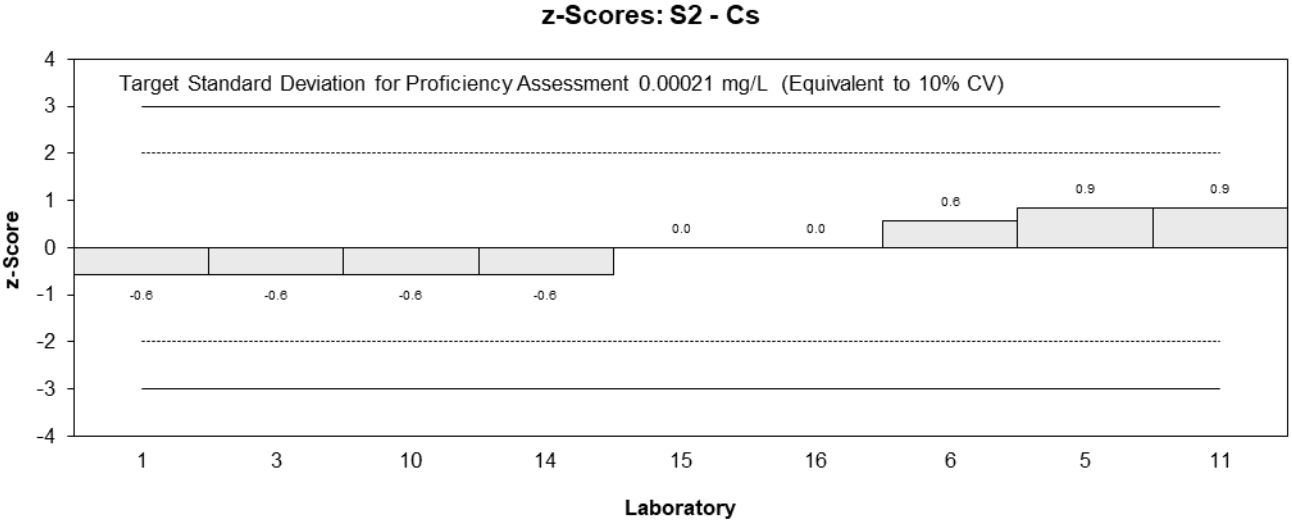
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.002	0.0003	-0.57	-0.37
2	NR	NR		
3	0.002	NR	-0.57	-1.00
4	NT	NT		
5	0.0023	0.0001	0.85	1.15
6	0.00224	0.00028	0.57	0.39
7	NT	NT		
8	NT	NT		
9	NR	NR		
10	0.002	0.0002	-0.57	-0.51
11	0.0023	0.00005	0.85	1.38
12	NT	NT		
13	NT	NT		
14	0.002	0.0004	-0.57	-0.29
15	0.00212	0.0004	0.00	0.00
16	0.00212	0.00015	0.00	0.00
17	NT	NT		
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.00212	0.00012
Spike Value	0.00223	0.00006
Homogeneity Value	0.00230	0.00028
Robust Average	0.00212	0.00012
Median	0.00212	0.00015
Mean	0.00212	
N	9	
Max	0.0023	
Min	0.002	
Robust SD	0.00015	
Robust CV	7%	


Kernel Density
Density
Result
Results: S2 - Cs
Assigned Value = 0.00212 ± 0.00012 mg/L
Results (mg/L)
Laboratory
1 3 10 14 15 16 6 5 11 2 4 7 8 9 12 13 17 18 19 Md RA HV SV


z-Scores: S2 - Cs
Target Standard Deviation for Proficiency Assessment 0.00021 mg/L (Equivalent to 10% CV)
z-Score
-0.6 -0.6 -0.6 -0.6 0.0 0.0 0.6 0.9 0.9
Laboratory
1 3 10 14 15 16 6 5 11

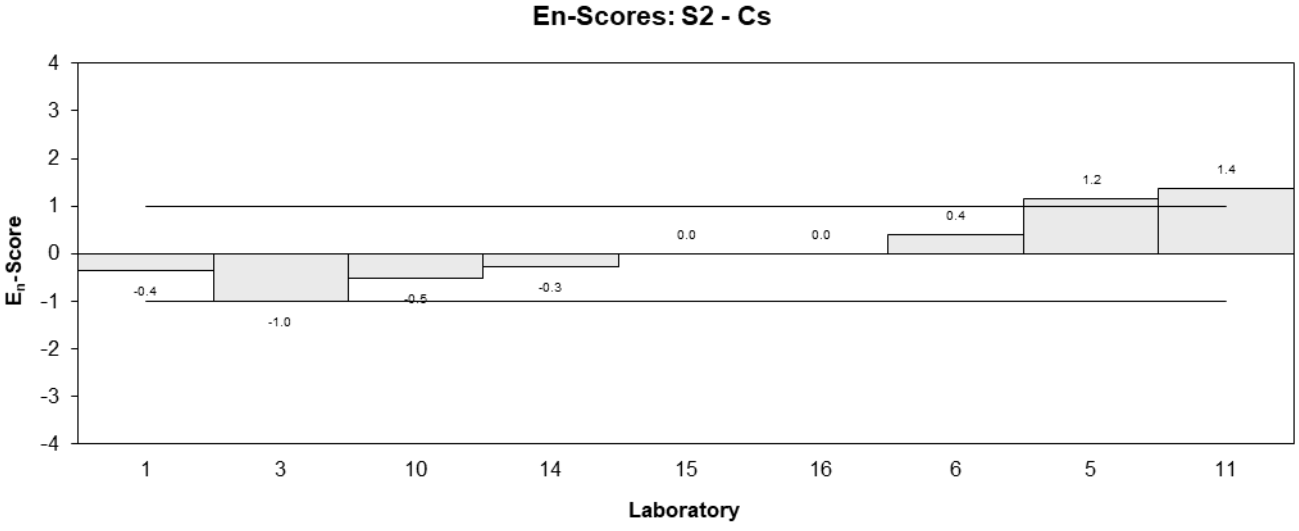

En-Scores: S2 - Cs
En-Score
-0.4 -1.0 -0.5 -0.3 0.0 0.0 0.4 1.2 1.4
Laboratory
1 3 10 14 15 16 6 5 11

Figure 26

Table 30

Sample Details

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

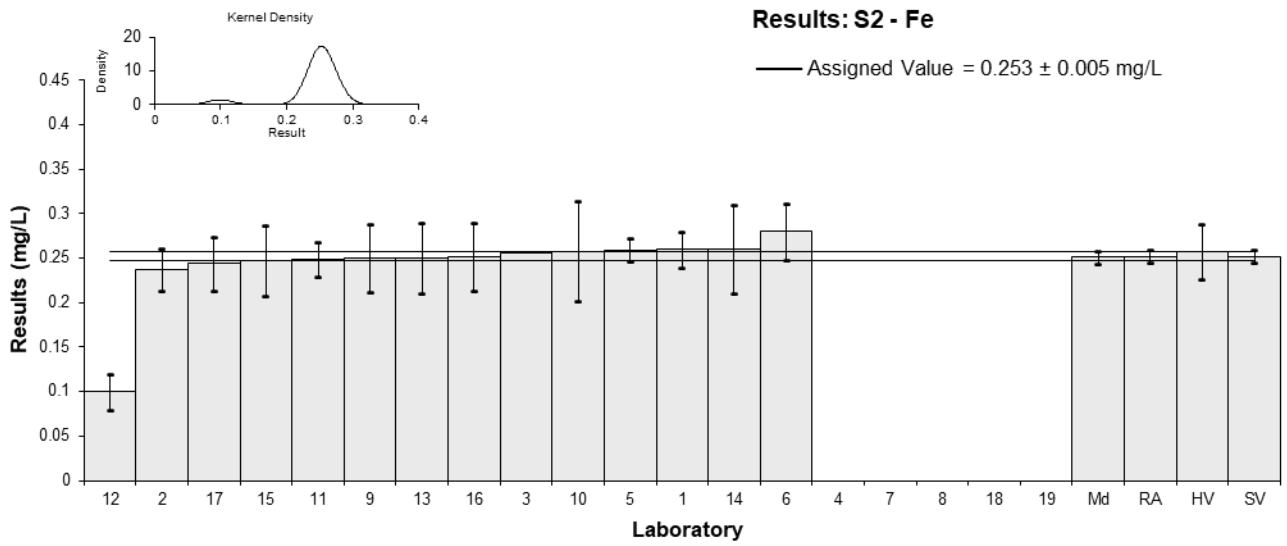
Participant Results

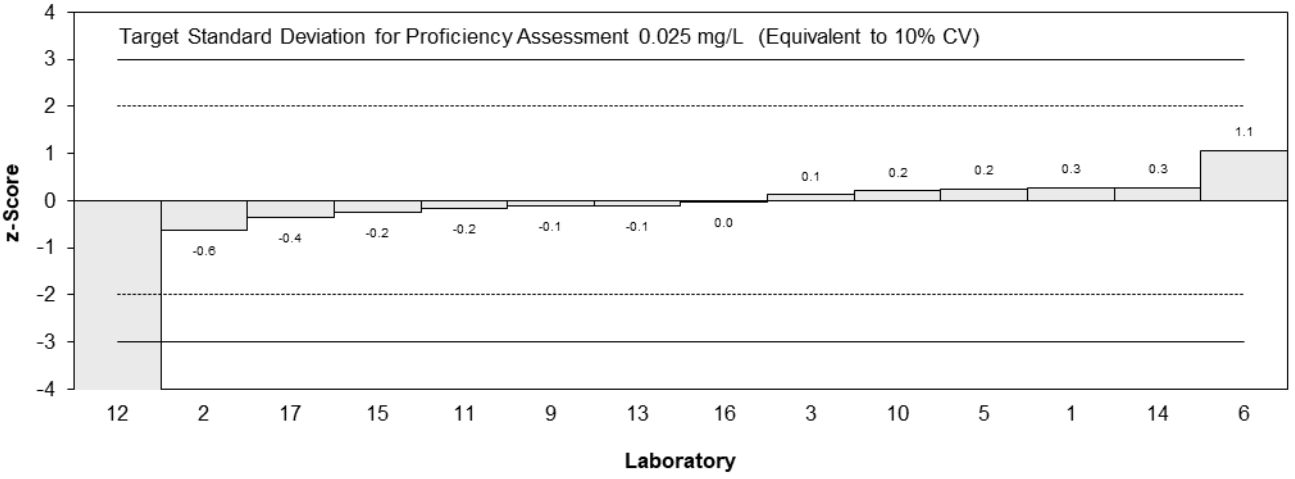
Lab. Code	Result	Uncertainty	z	E_n
1	0.26	0.02	0.28	0.34
2	0.237	0.0237	-0.63	-0.66
3	0.256	NR	0.12	0.60
4	NT	NT		
5	0.259	0.013	0.24	0.43
6	0.27979	0.03236	1.06	0.82
7	NT	NT		
8	NT	NT		
9	0.25	0.03825	-0.12	-0.08
10	0.258	0.056	0.20	0.09
11	0.2484	0.0197	-0.18	-0.23
12*	0.1	0.02	-6.05	-7.42
13	0.25	0.04	-0.12	-0.07
14	0.26	0.05	0.28	0.14
15	0.247	0.04	-0.24	-0.15
16	0.252	0.038	-0.04	-0.03
17	0.244	0.03	-0.36	-0.30
18	NT	NT		
19	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	0.253	0.005
Spike Value	0.252	0.007
Homogeneity Value	0.257	0.031
Robust Average	0.252	0.007
Median	0.251	0.007
Mean	0.243	
N	14	
Max	0.27979	
Min	0.1	
Robust SD	0.010	
Robust CV	4%	


Kernel Density
Density
Result
Results: S2 - Fe
Assigned Value = 0.253 ± 0.005 mg/L
Results (mg/L)
Laboratory
12 2 17 15 11 9 13 16 3 10 5 1 14 6 4 7 8 18 19 Md RA HV SV


z-Scores: S2 - Fe
Target Standard Deviation for Proficiency Assessment 0.025 mg/L (Equivalent to 10% CV)
z-Score
-0.6 -0.4 -0.2 -0.2 -0.1 -0.1 0.0 0.1 0.2 0.2 0.3 0.3 1.1
Laboratory
12 2 17 15 11 9 13 16 3 10 5 1 14 6

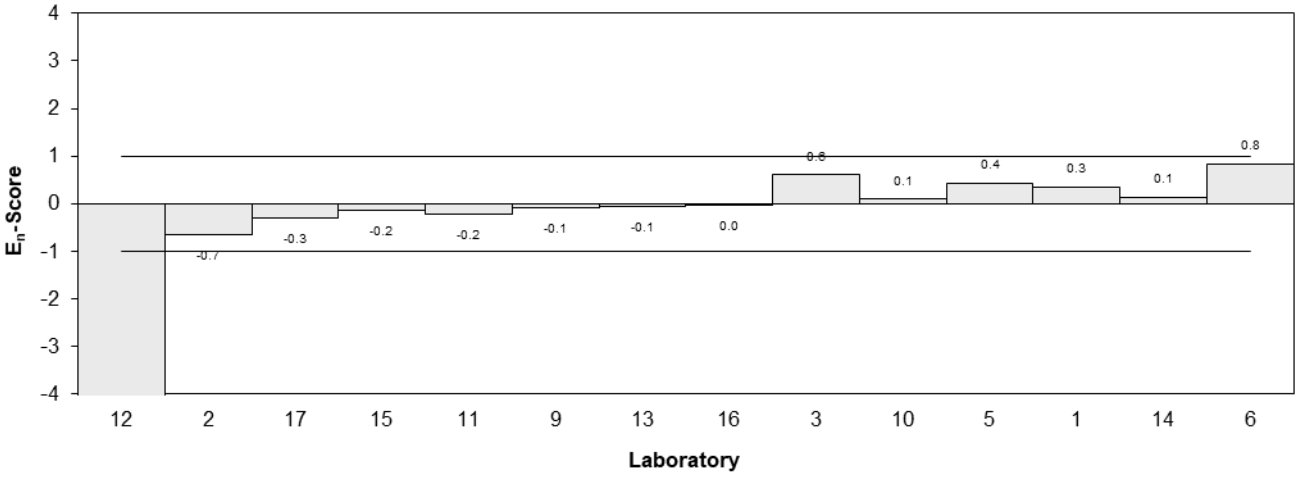

En-Scores: S2 - Fe
En-Score
-0.7 -0.3 -0.2 -0.2 -0.1 -0.1 0.0 0.6 0.1 0.4 0.3 0.1 0.8
Laboratory
12 2 17 15 11 9 13 16 3 10 5 1 14 6

Figure 27

Table 31

Sample Details

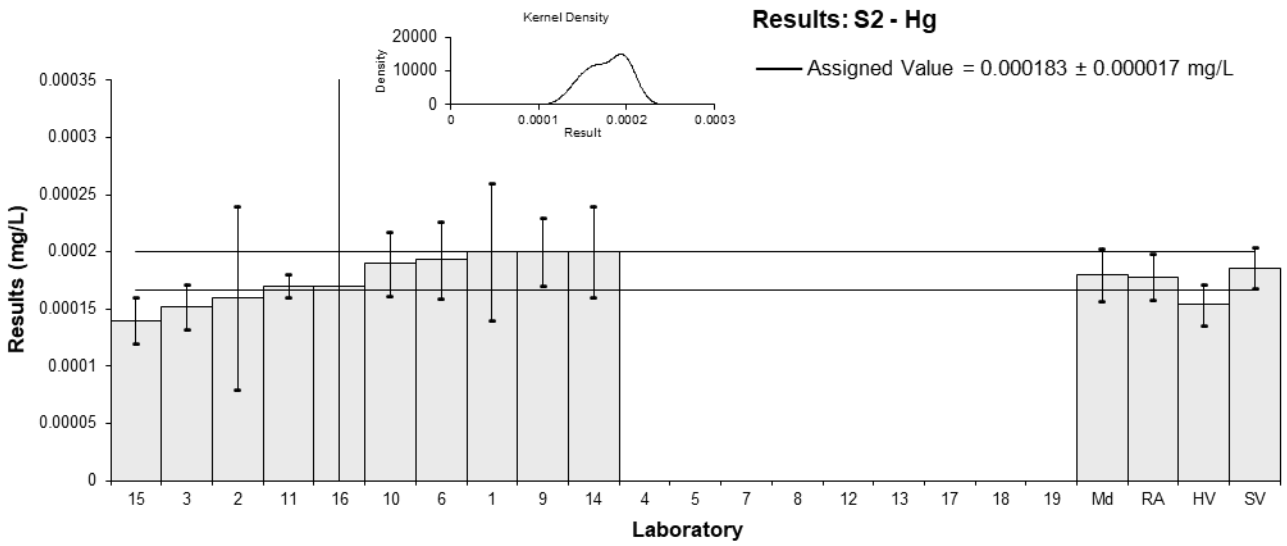
Sample No.	S2
Matrix	Potable Water
Analyte	Hg
Unit	mg/L

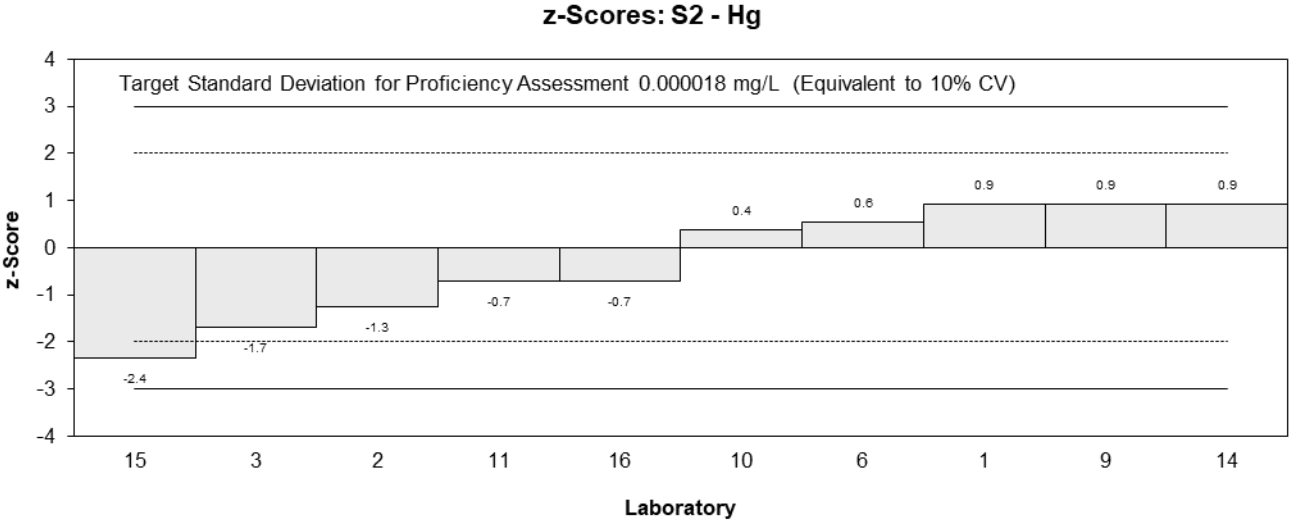
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.0002	0.00006	0.93	0.27
2	0.00016	0.00008	-1.26	-0.28
3	0.000152	0.00002	-1.69	-1.18
4	NT	NT		
5	NR	NR		
6	0.000193	0.000034	0.55	0.26
7	NT	NT		
8	NT	NT		
9	0.0002	0.00003	0.93	0.49
10	0.00019	0.000028	0.38	0.21
11	0.00017	0.00001	-0.71	-0.66
12	<0.25	NR		
13	NT	NT		
14	0.0002	0.00004	0.93	0.39
15	0.00014	0.00002	-2.35	-1.64
16	0.00017	0.00053	-0.71	-0.02
17	<0.0005	NR		
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.000183	0.000017
Spike Value	0.000186	0.000018
Homogeneity Value	0.000154	0.000018
Robust Average	0.000178	0.000020
Median	0.000180	0.000023
Mean	0.000178	
N	10	
Max	0.0002	
Min	0.00014	
Robust SD	0.000025	
Robust CV	14%	


Results: S2 - Hg
Assigned Value = 0.000183 ± 0.000017 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
15 3 2 11 16 10 6 1 9 14 4 5 7 8 12 13 17 18 19 Md RA HV SV


z-Scores: S2 - Hg
Target Standard Deviation for Proficiency Assessment 0.000018 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
15 3 2 11 16 10 6 1 9 14

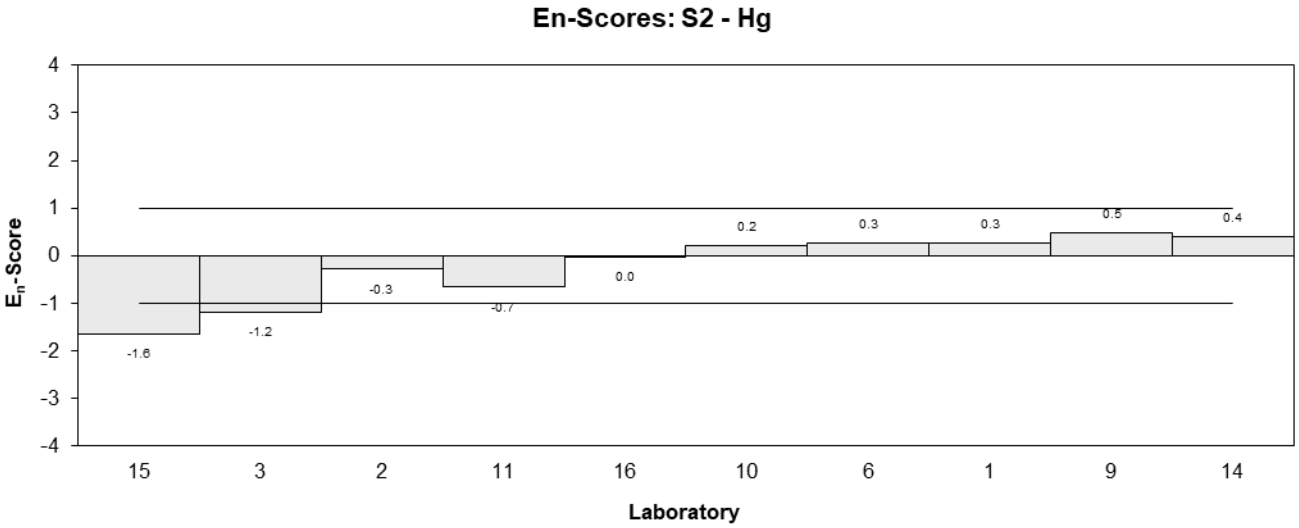

En-Scores: S2 - Hg
En-Score
Laboratory
15 3 2 11 16 10 6 1 9 14

Figure 28

Table 32

Sample Details

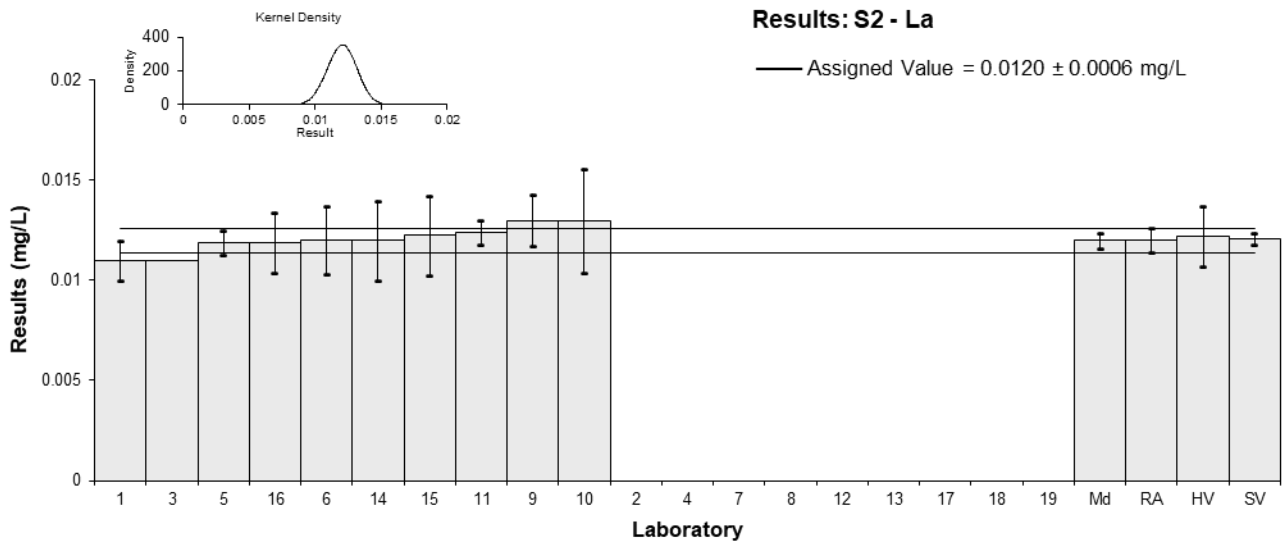
Sample No.	S2
Matrix	Potable Water
Analyte	La
Unit	mg/L

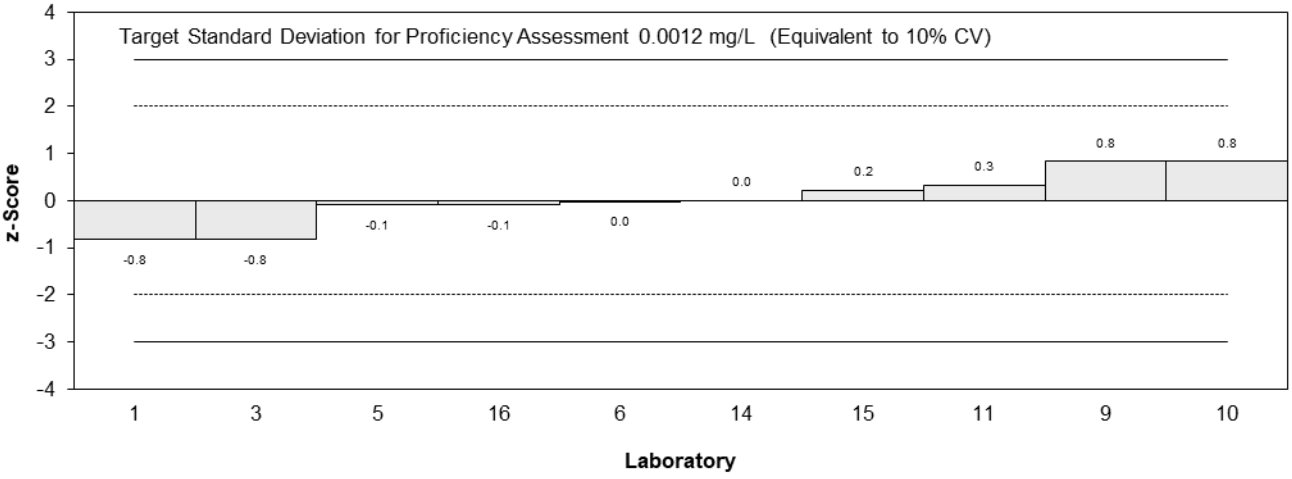
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.011	0.001	-0.83	-0.86
2	NR	NR		
3	0.011	NR	-0.83	-1.67
4	NT	NT		
5	0.0119	0.0006	-0.08	-0.12
6	0.01199	0.001697	-0.01	-0.01
7	NT	NT		
8	NT	NT		
9	0.013	0.0013	0.83	0.70
10	0.013	0.0026	0.83	0.37
11	0.0124	0.0006	0.33	0.47
12	NT	NT		
13	NT	NT		
14	0.012	0.002	0.00	0.00
15	0.01225	0.002	0.21	0.12
16	0.0119	0.0015	-0.08	-0.06
17	NT	NT		
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.0120	0.0006
Spike Value	0.0121	0.0003
Homogeneity Value	0.0122	0.0015
Robust Average	0.0120	0.0006
Median	0.0120	0.0004
Mean	0.0120	
N	10	
Max	0.013	
Min	0.011	
Robust SD	0.00078	
Robust CV	6.4%	


Kernel Density
Density
Result
Results: S2 - La
Assigned Value = 0.0120 ± 0.0006 mg/L
Results (mg/L)
Laboratory
1 3 5 16 6 14 15 11 9 10 2 4 7 8 12 13 17 18 19 Md RA HV SV


z-Scores: S2 - La
Target Standard Deviation for Proficiency Assessment 0.0012 mg/L (Equivalent to 10% CV)
z-Score
-0.8 -0.8 -0.1 -0.1 0.0 0.0 0.2 0.3 0.8 0.8
Laboratory
1 3 5 16 6 14 15 11 9 10

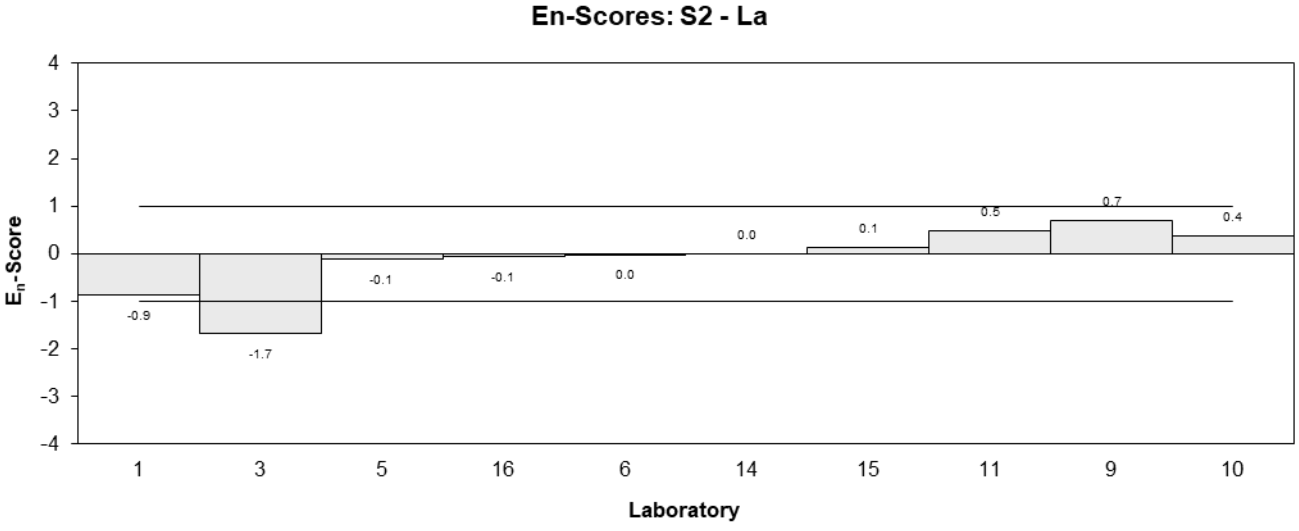

En-Scores: S2 - La
En-Score
-0.9 -1.7 -0.1 -0.1 0.0 0.0 0.1 0.5 0.7 0.4
Laboratory
1 3 5 16 6 14 15 11 9 10

Figure 29

Table 33

Sample Details

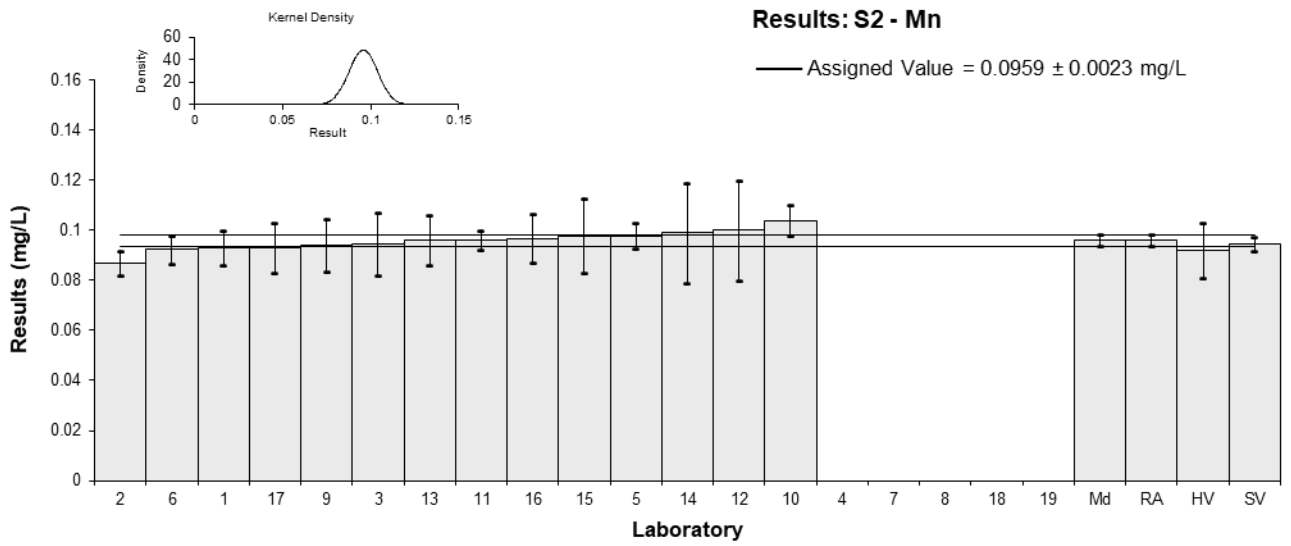
Sample No.	S2
Matrix	Potable Water
Analyte	Mn
Unit	mg/L

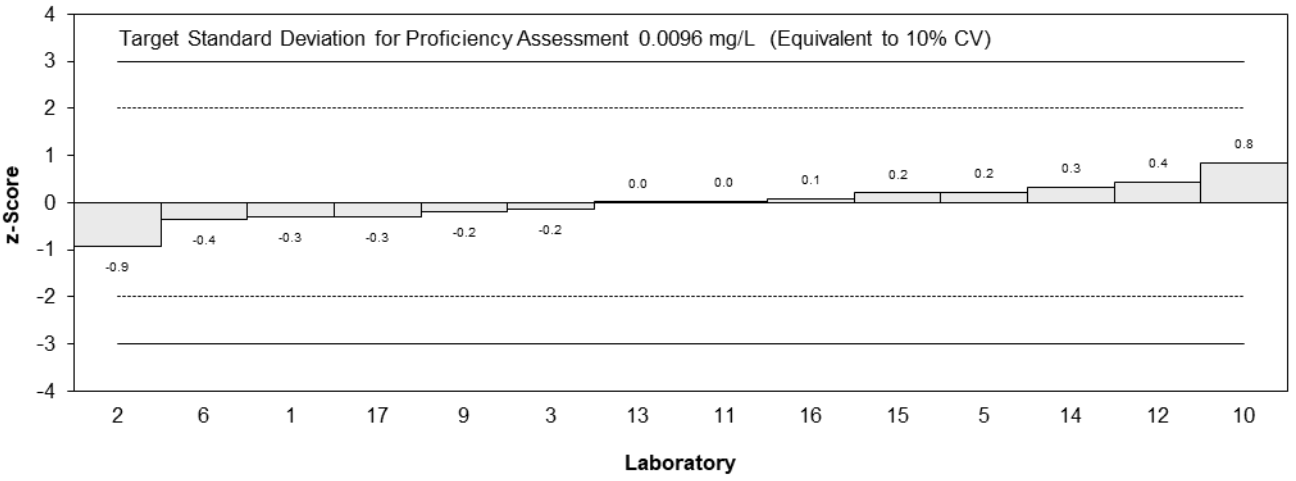
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.093	0.007	-0.30	-0.39
2	0.087	0.005	-0.93	-1.62
3	0.0945	0.0125	-0.15	-0.11
4	NT	NT		
5	0.0979	0.005	0.21	0.36
6	0.09246	0.00566	-0.36	-0.56
7	NT	NT		
8	NT	NT		
9	0.094	0.0106	-0.20	-0.18
10	0.104	0.006	0.84	1.26
11	0.0962	0.0040	0.03	0.07
12	0.1	0.02	0.43	0.20
13	0.096	0.010	0.01	0.01
14	0.099	0.02	0.32	0.15
15	0.0978	0.015	0.20	0.13
16	0.0968	0.0097	0.09	0.09
17	0.093	0.01	-0.30	-0.28
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.0959	0.0023
Spike Value	0.0945	0.0027
Homogeneity Value	0.092	0.011
Robust Average	0.0959	0.0023
Median	0.0961	0.0025
Mean	0.0958	
N	14	
Max	0.104	
Min	0.087	
Robust SD	0.0035	
Robust CV	3.7%	


Kernel Density
Density
Result
Results: S2 - Mn
Assigned Value = 0.0959 ± 0.0023 mg/L
Results (mg/L)
Laboratory
2 6 1 17 9 3 13 11 16 15 5 14 12 10 4 7 8 18 19 Md RA HV SV


z-Scores: S2 - Mn
Target Standard Deviation for Proficiency Assessment 0.0096 mg/L (Equivalent to 10% CV)
z-Score
-0.9 -0.4 -0.3 -0.3 -0.2 -0.2 0.0 0.0 0.1 0.2 0.2 0.3 0.4 0.8
Laboratory
2 6 1 17 9 3 13 11 16 15 5 14 12 10

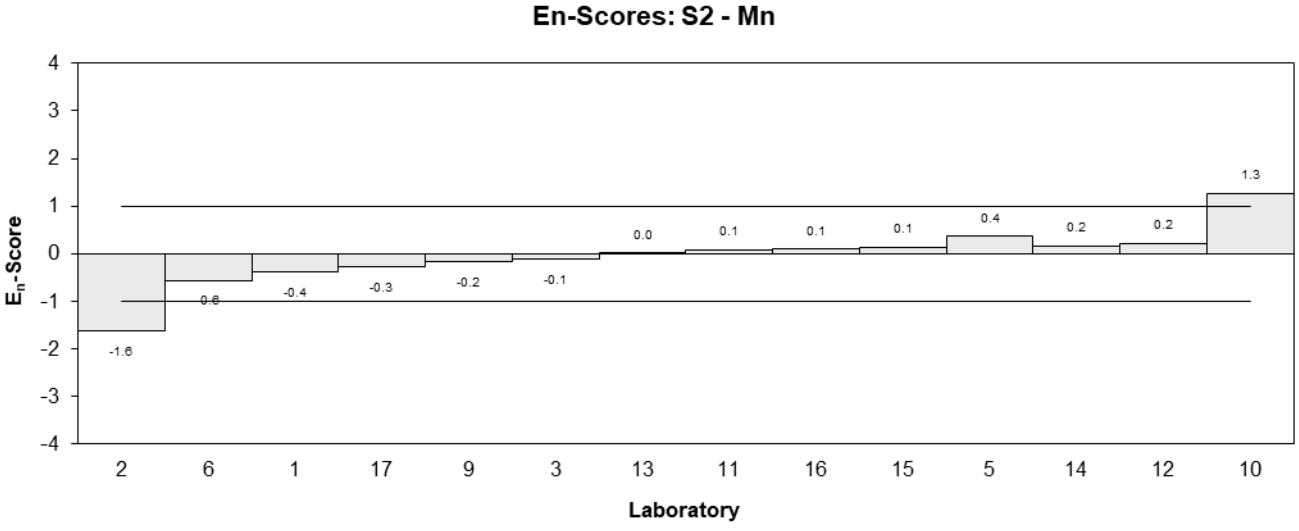

En-Scores: S2 - Mn
En-Score
-1.6 -0.6 -0.4 -0.3 -0.2 -0.1 0.0 0.1 0.1 0.1 0.4 0.2 0.2 1.3
Laboratory
2 6 1 17 9 3 13 11 16 15 5 14 12 10

Figure 30

Table 34

Sample Details

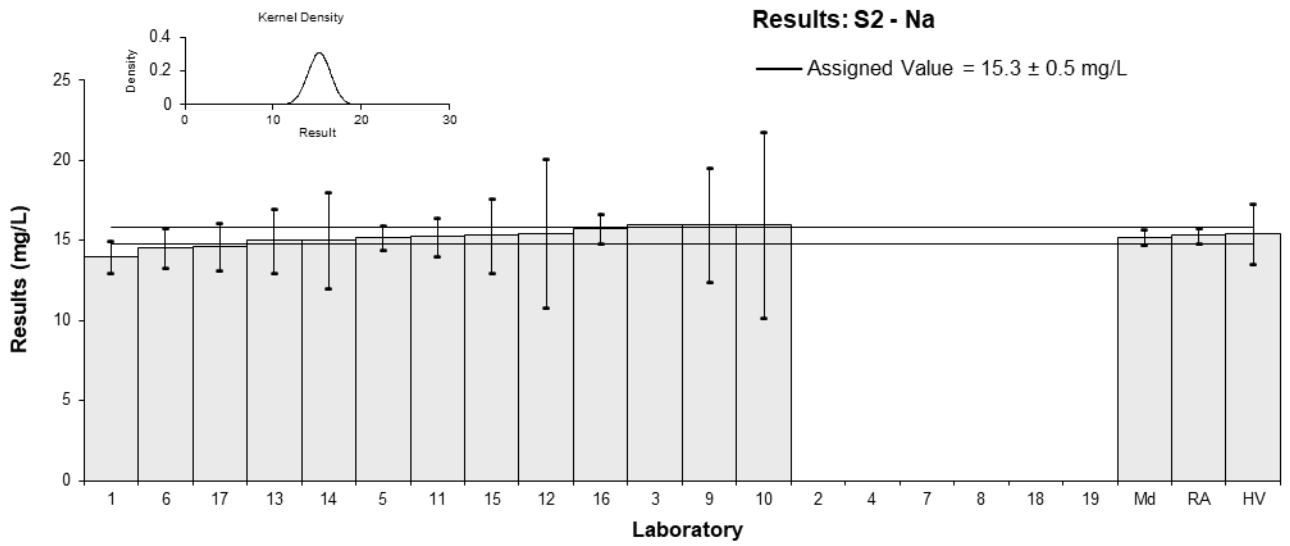
Sample No.	S2
Matrix	Potable Water
Analyte	Na
Unit	mg/L

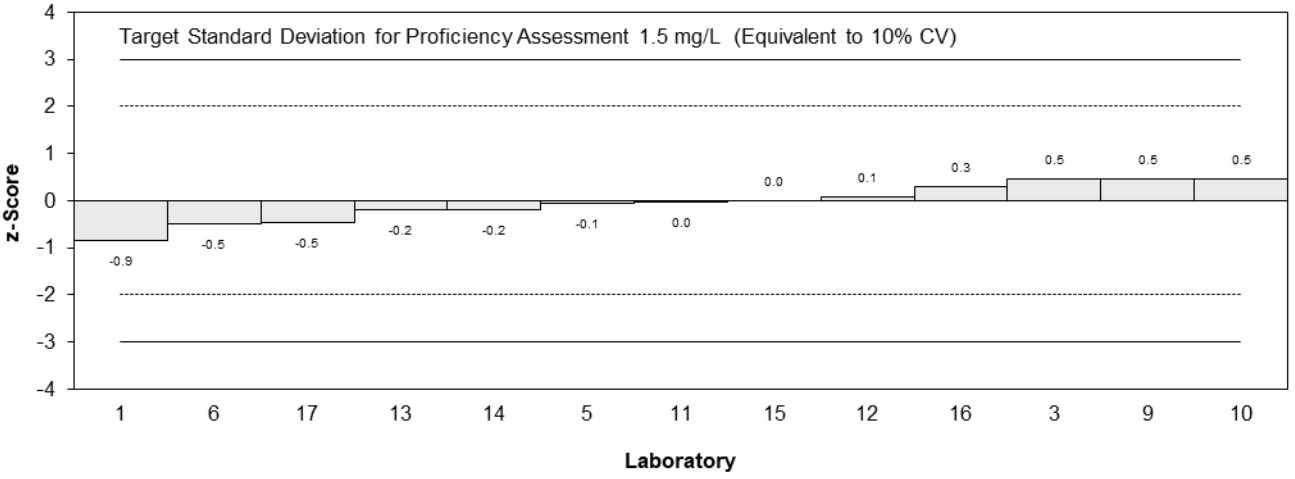
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	14	1	-0.85	-1.16
2	NR	NR		
3	16	NR	0.46	1.40
4	NT	NT		
5	15.189	0.76	-0.07	-0.12
6	14.5278	1.2454	-0.50	-0.58
7	NT	NT		
8	NT	NT		
9	16	3.552	0.46	0.20
10	16	5.81	0.46	0.12
11	15.24	1.22	-0.04	-0.05
12	15.445	4.6335	0.09	0.03
13	15	2	-0.20	-0.15
14	15	3	-0.20	-0.10
15	15.3	2.3	0.00	0.00
16	15.75	0.95	0.29	0.42
17	14.6	1.5	-0.46	-0.44
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	15.3	0.5
Spike Value	Not Spiked	
Homogeneity Value	15.4	1.9
Robust Average	15.3	0.5
Median	15.2	0.5
Mean	15.2	
N	13	
Max	16	
Min	14	
Robust SD	0.66	
Robust CV	4.3%	


Kernel Density
Density
Result
Results: S2 - Na
Assigned Value = 15.3 ± 0.5 mg/L
Results (mg/L)
Laboratory
1 6 17 13 14 5 11 15 12 16 3 9 10 2 4 7 8 18 19 Md RA HV


z-Scores: S2 - Na
Target Standard Deviation for Proficiency Assessment 1.5 mg/L (Equivalent to 10% CV)
z-Score
-0.9 -0.5 -0.5 -0.2 -0.2 -0.1 0.0 0.0 0.1 0.3 0.5 0.5 0.5
Laboratory
1 6 17 13 14 5 11 15 12 16 3 9 10

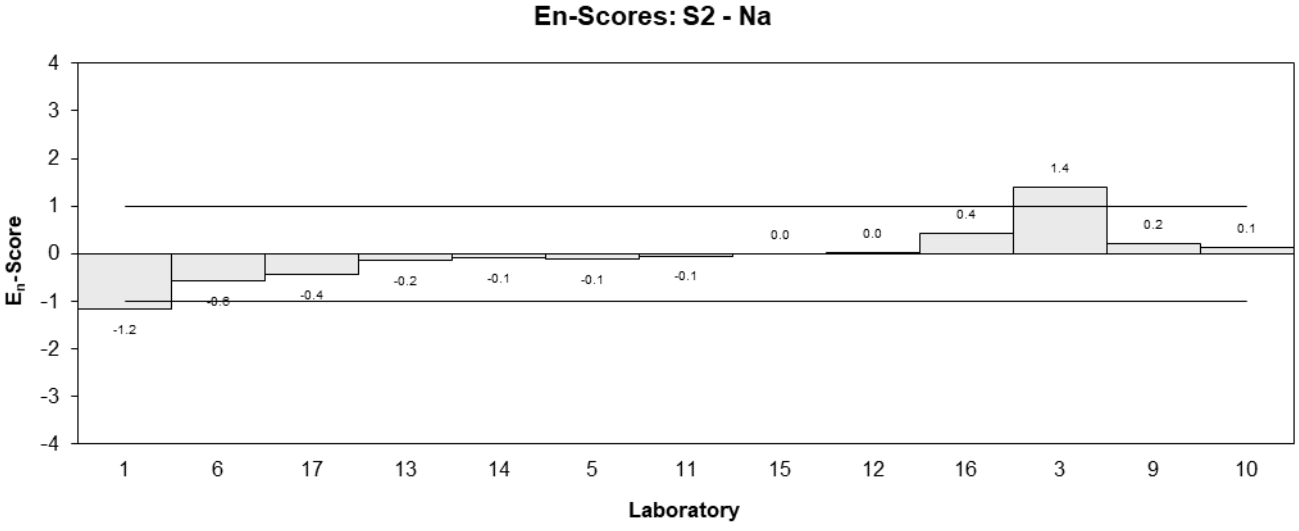

En-Scores: S2 - Na
En-Score
-1.2 -0.6 -0.4 -0.2 -0.1 -0.1 -0.1 0.0 0.0 0.4 1.4 0.2 0.1
Laboratory
1 6 17 13 14 5 11 15 12 16 3 9 10

Figure 31

Table 35

Sample Details

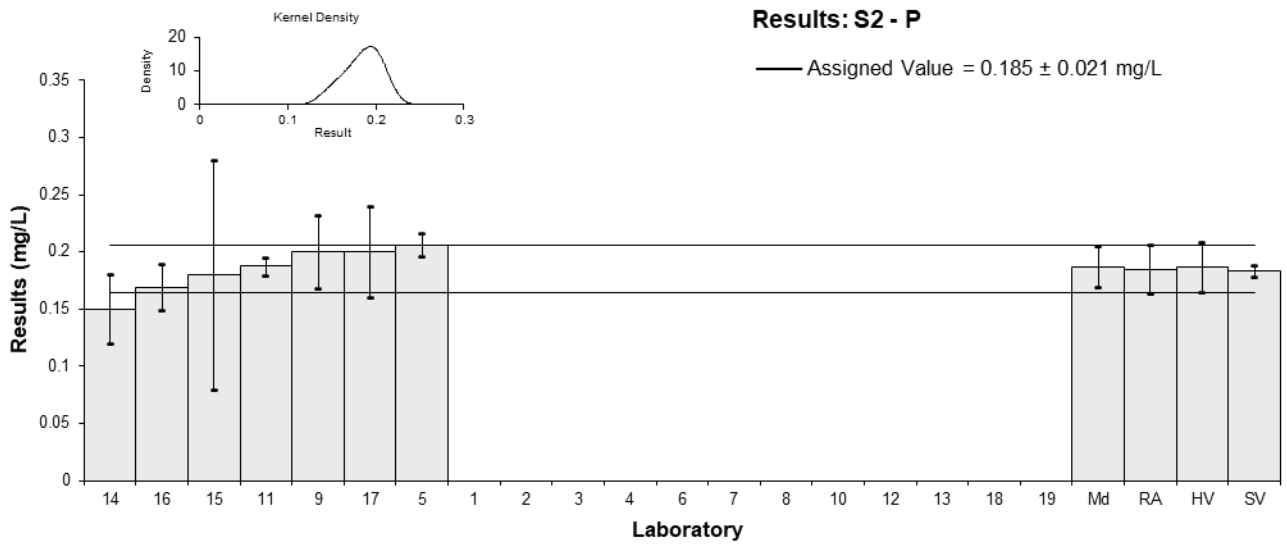
Sample No.	S2
Matrix	Potable Water
Analyte	P
Unit	mg/L

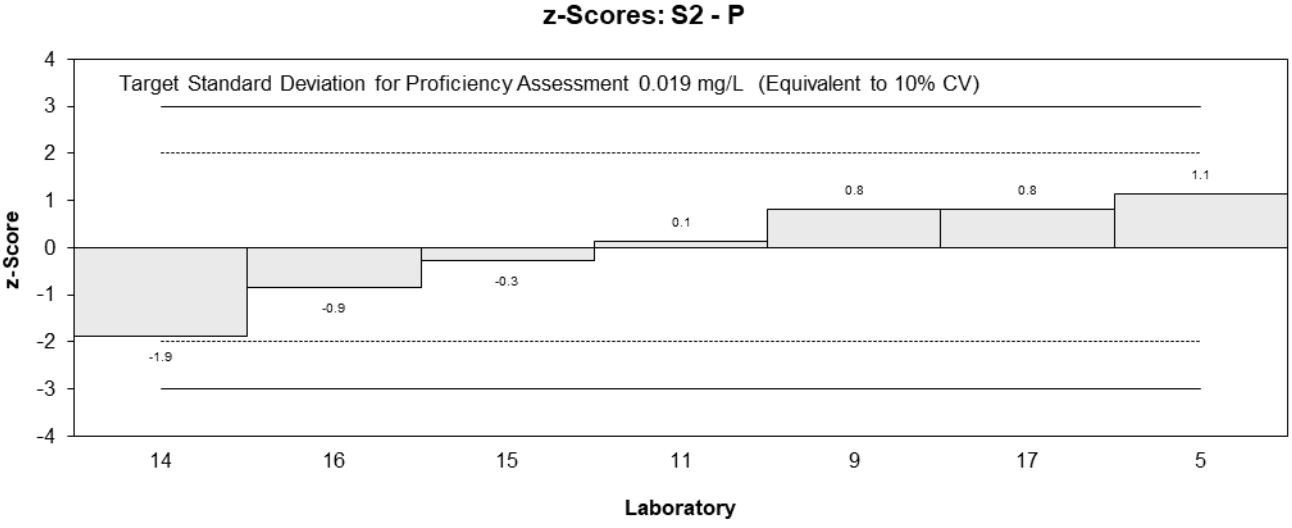
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	<1	NR		
2	NT	NT		
3	<1	NR		
4	NT	NT		
5	0.206	0.01	1.14	0.90
6	<1	NR		
7	NT	NT		
8	NT	NT		
9	0.2	0.0322	0.81	0.39
10	<1	0.1		
11	0.1874	0.0076	0.13	0.11
12	<0.25	NR		
13	NT	NT		
14	0.15	0.03	-1.89	-0.96
15	0.18	0.1	-0.27	-0.05
16	0.169	0.020	-0.86	-0.55
17	0.20	0.04	0.81	0.33
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.185	0.021
Spike Value	0.183	0.005
Homogeneity Value	0.187	0.022
Robust Average	0.185	0.021
Median	0.187	0.018
Mean	0.185	
N	7	
Max	0.206	
Min	0.15	
Robust SD	0.022	
Robust CV	12%	


Results: S2 - P
Assigned Value = 0.185 ± 0.021 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
14 16 15 11 9 17 5 1 2 3 4 6 7 8 10 12 13 18 19 Md RA HV SV


z-Scores: S2 - P
Target Standard Deviation for Proficiency Assessment 0.019 mg/L (Equivalent to 10% CV)
z-Score
-1.9
-0.9
-0.3
0.1
0.8
0.8
1.1
Laboratory
14 16 15 11 9 17 5

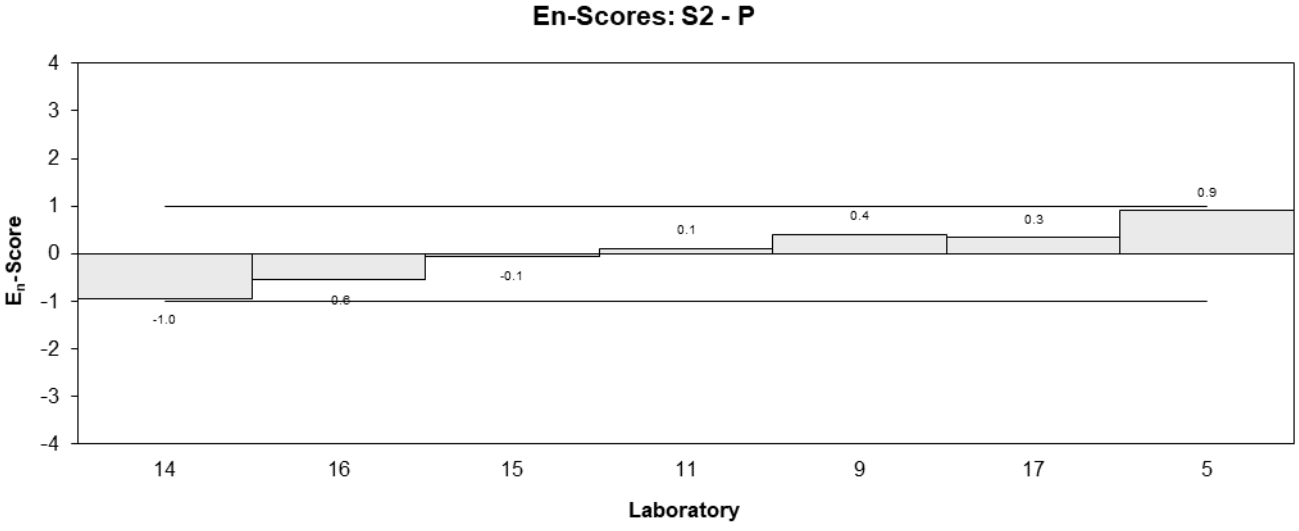

En-Scores: S2 - P
En-Score
-1.0
-0.6
-0.1
0.1
0.4
0.3
0.9
Laboratory
14 16 15 11 9 17 5

Figure 32

Table 36

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.010	0.0008	-0.38	-0.49
2	0.011	0.003	0.58	0.20
3	0.0107	0.0012	0.29	0.25
4	NT	NT		
5	0.0109	0.0005	0.48	0.93
6	0.01049	0.00061	0.09	0.14
7	NT	NT		
8	NT	NT		
9	0.010	0.00125	-0.38	-0.32
10	0.0108	0.001	0.38	0.39
11	0.0105	0.0002	0.10	0.35
12	<0.25	NR		
13	0.010	0.001	-0.38	-0.39
14	0.01	0.002	-0.38	-0.20
15	0.0104	0.002	0.00	0.00
16	0.01031	0.00063	-0.09	-0.14
17	0.010	0.0015	-0.38	-0.26
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.0104	0.0002
Spike Value	0.0105	0.0013
Homogeneity Value	0.0103	0.0012
Robust Average	0.0104	0.0003
Median	0.0104	0.0004
Mean	0.0104	
N	13	
Max	0.011	
Min	0.01	
Robust SD	0.00042	
Robust CV	4.1%	

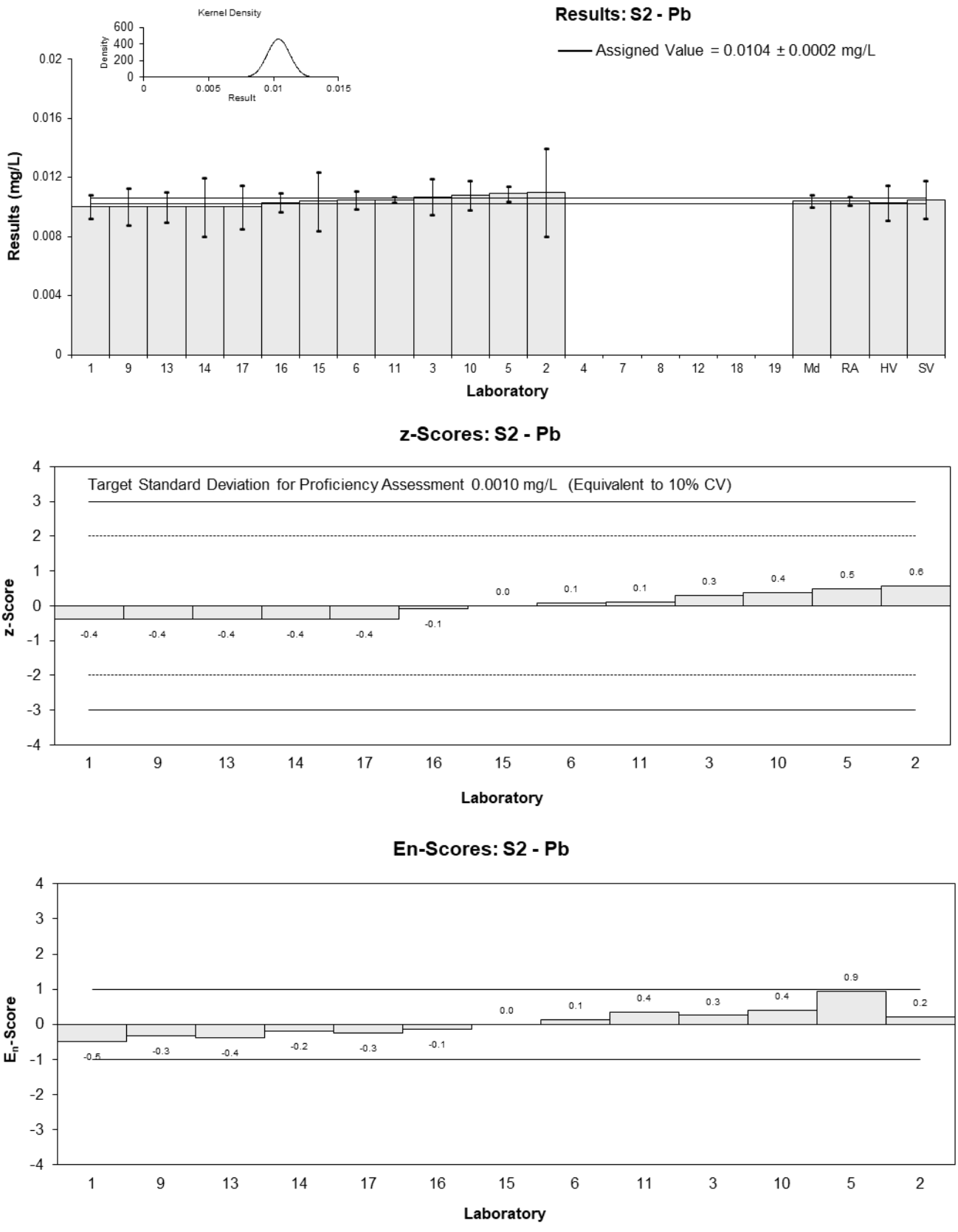

Results: S2 - Pb
Kernel Density
Density
Result
Assigned Value = 0.0104 ± 0.0002 mg/L
Results (mg/L)
Laboratory
1 9 13 14 17 16 15 6 11 3 10 5 2 4 7 8 12 18 19 Md RA HV SV
z-Scores: S2 - Pb
Target Standard Deviation for Proficiency Assessment 0.0010 mg/L (Equivalent to 10% CV)
z-Score
-0.4 -0.4 -0.4 -0.4 -0.4 -0.1 0.0 0.1 0.1 0.3 0.4 0.5 0.6
Laboratory
1 9 13 14 17 16 15 6 11 3 10 5 2
En-Scores: S2 - Pb
En-Score
-0.5 -0.3 -0.4 -0.2 -0.3 -0.1 0.0 0.1 0.4 0.3 0.4 0.9 0.2
Laboratory
1 9 13 14 17 16 15 6 11 3 10 5 2

Figure 33

Table 37

Sample Details

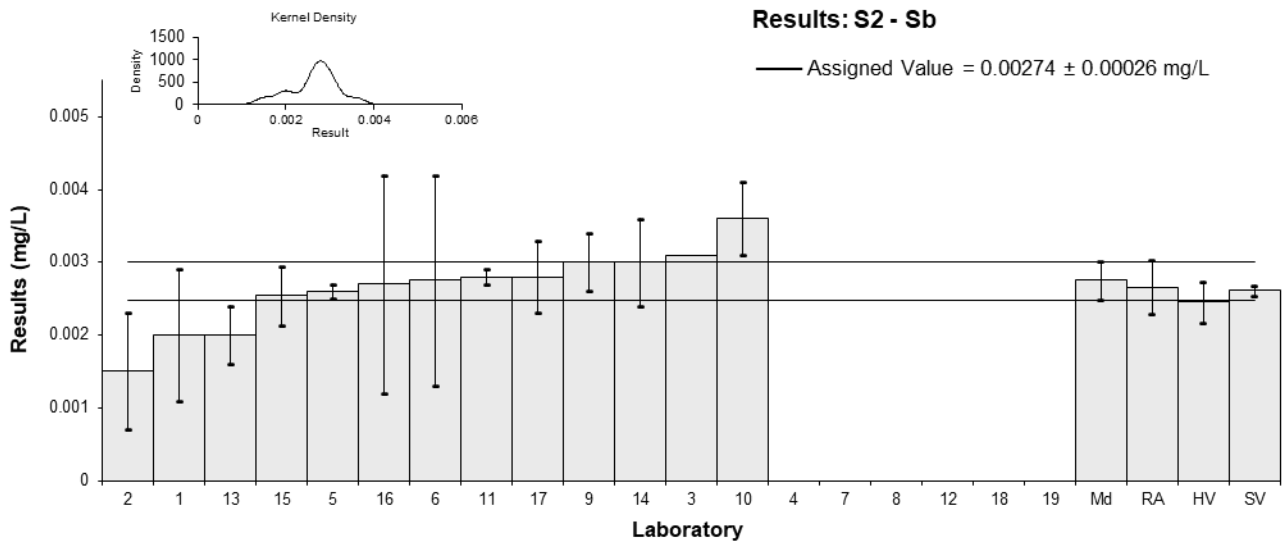
Sample No.	S2
Matrix	Potable Water
Analyte	Sb
Unit	mg/L

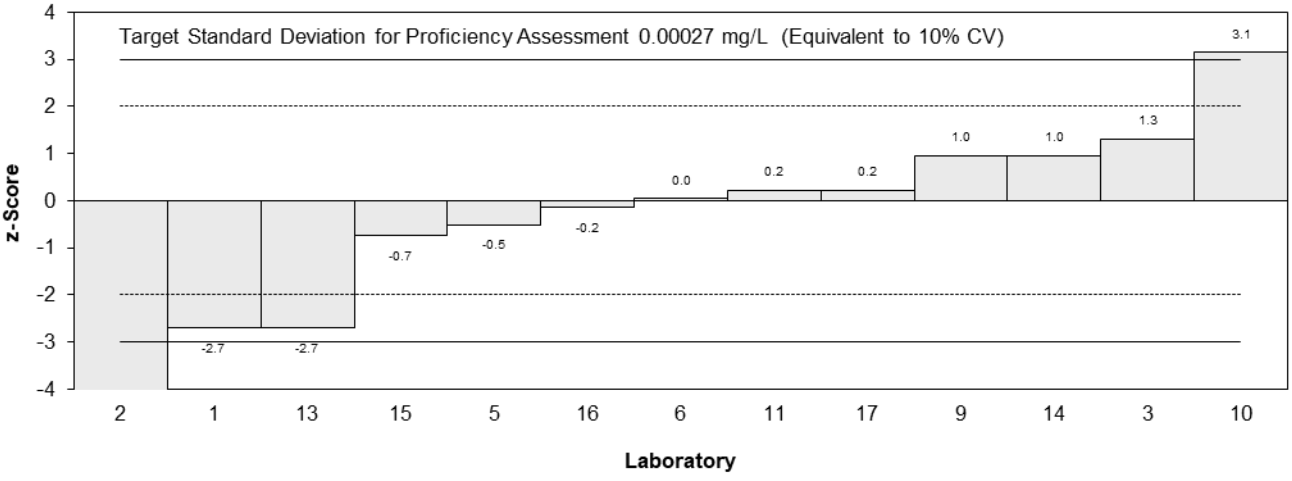
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.002	0.0009	-2.70	-0.79
2	0.0015	0.0008	-4.53	-1.47
3	0.0031	NR	1.31	1.38
4	NT	NT		
5	0.0026	0.0001	-0.51	-0.50
6	0.00275	0.00144	0.04	0.01
7	NT	NT		
8	NT	NT		
9	0.003	0.0004	0.95	0.54
10	0.0036	0.0005	3.14	1.53
11	0.0028	0.0001	0.22	0.22
12	<0.5	NR		
13	0.0020	0.0004	-2.70	-1.55
14	0.003	0.0006	0.95	0.40
15	0.00254	0.0004	-0.73	-0.42
16	0.0027	0.0015	-0.15	-0.03
17	0.0028	0.0005	0.22	0.11
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.00274	0.00026
Spike Value	0.00261	0.00007
Homogeneity Value	0.00245	0.00029
Robust Average	0.00266	0.00037
Median	0.00275	0.00026
Mean	0.00265	
N	13	
Max	0.0036	
Min	0.0015	
Robust SD	0.00053	
Robust CV	20%	


Kernel Density
Density
Result
Results: S2 - Sb
Assigned Value = 0.00274 ± 0.00026 mg/L
Results (mg/L)
Laboratory
2 1 13 15 5 16 6 11 17 9 14 3 10 4 7 8 12 18 19 Md RA HV SV


z-Scores: S2 - Sb
Target Standard Deviation for Proficiency Assessment 0.00027 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
2 1 13 15 5 16 6 11 17 9 14 3 10

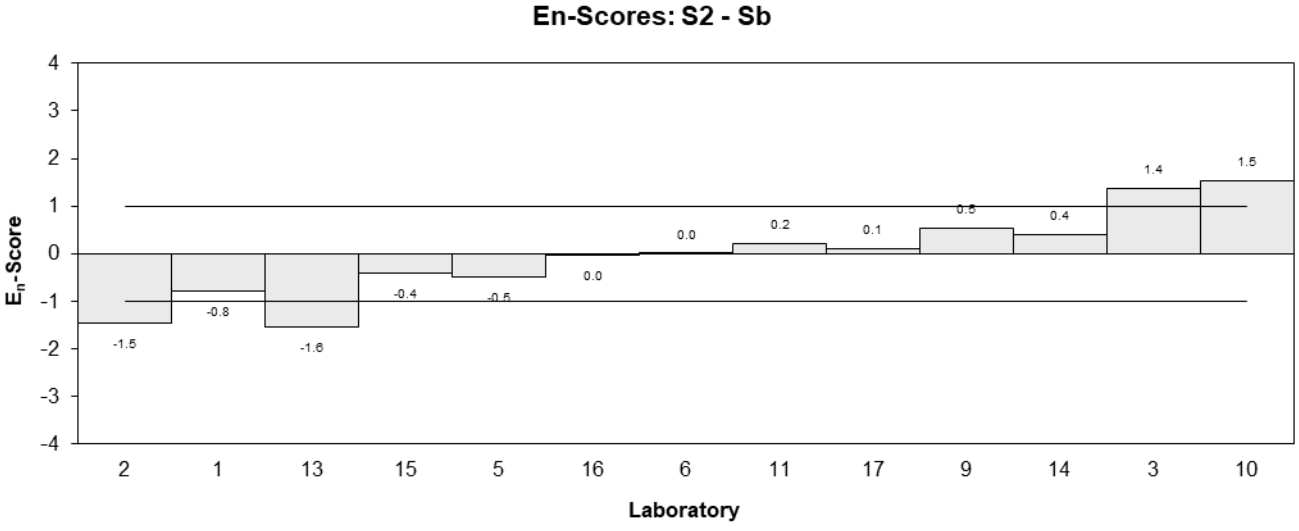

En-Scores: S2 - Sb
En-Score
Laboratory
2 1 13 15 5 16 6 11 17 9 14 3 10

Figure 34

Table 38

Sample Details

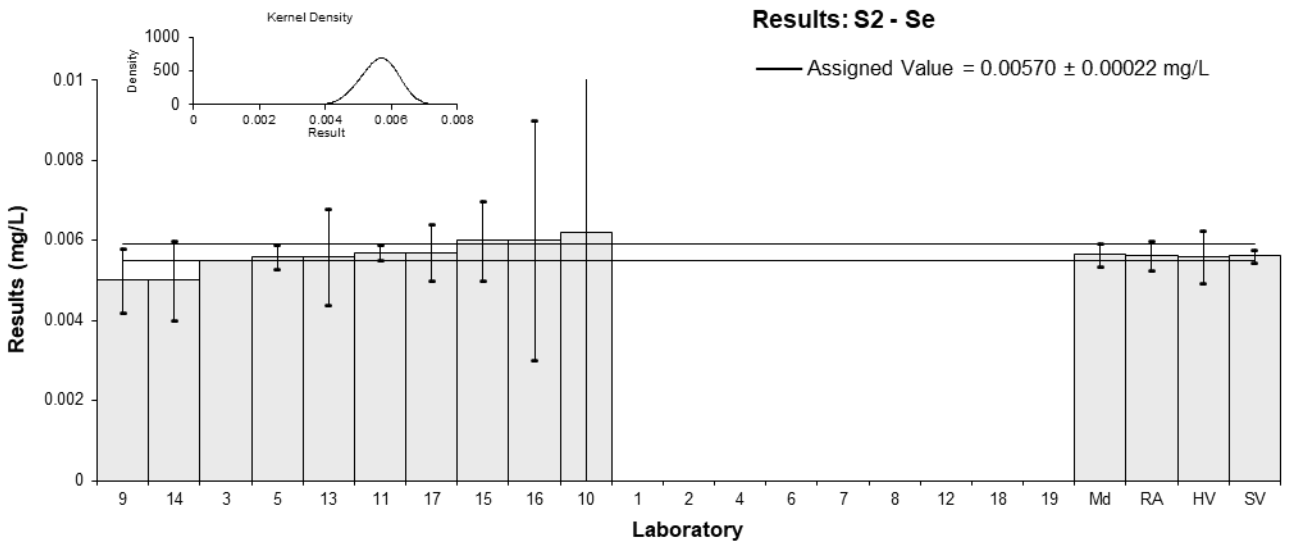
Sample No.	S2
Matrix	Potable Water
Analyte	Se
Unit	mg/L

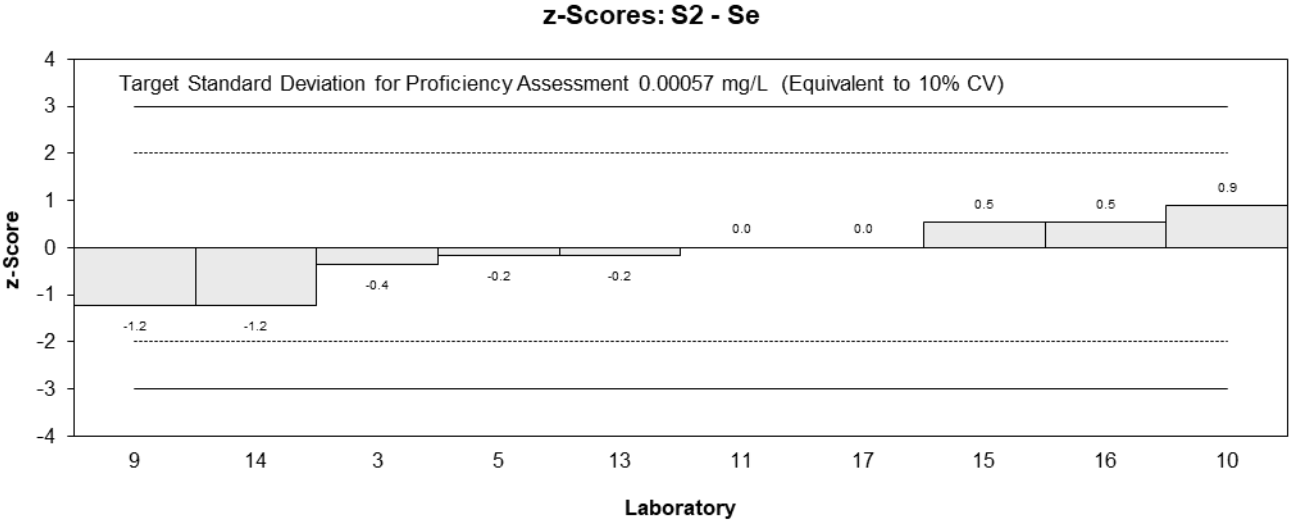
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	<0.01	NR		
2	<0.01	0.010		
3	0.0055	NR	-0.35	-0.91
4	NT	NT		
5	0.0056	0.0003	-0.18	-0.27
6	<0.01	NR		
7	NT	NT		
8	NT	NT		
9	0.005	0.0008	-1.23	-0.84
10	0.0062	0.0065	0.88	0.08
11	0.0057	0.0002	0.00	0.00
12	<2.5	NR		
13	0.0056	0.0012	-0.18	-0.08
14	0.005	0.001	-1.23	-0.68
15	0.006	0.001	0.53	0.29
16	0.0060	0.0030	0.53	0.10
17	0.0057	0.0007	0.00	0.00
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.00570	0.00022
Spike Value	0.00561	0.00016
Homogeneity Value	0.00559	0.00067
Robust Average	0.00563	0.00036
Median	0.00565	0.00029
Mean	0.00563	
N	10	
Max	0.0062	
Min	0.005	
Robust SD	0.00045	
Robust CV	8%	


Results: S2 - Se
Assigned Value = 0.00570 ± 0.00022 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
9 14 3 5 13 11 17 15 16 10 1 2 4 6 7 8 12 18 19 Md RA HV SV


z-Scores: S2 - Se
Target Standard Deviation for Proficiency Assessment 0.00057 mg/L (Equivalent to 10% CV)
z-Score
Laboratory
9 14 3 5 13 11 17 15 16 10
-1.2 -1.2 -0.4 -0.2 -0.2 0.0 0.0 0.5 0.5 0.9

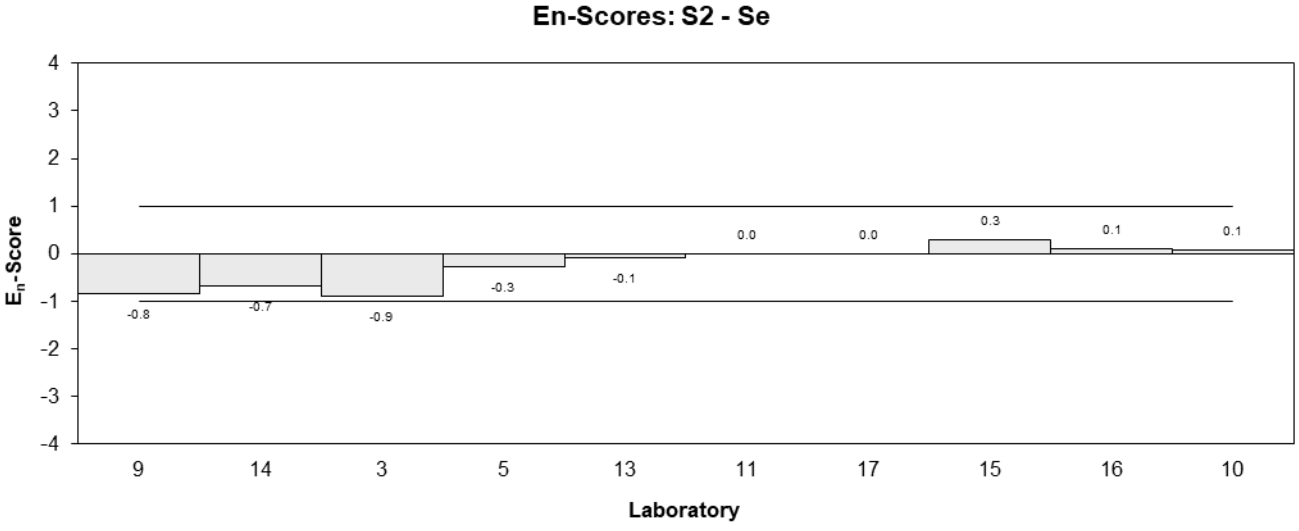

En-Scores: S2 - Se
En-Score
Laboratory
9 14 3 5 13 11 17 15 16 10
-0.8 -0.7 -0.9 -0.3 -0.1 0.0 0.0 0.3 0.1 0.1

Figure 35

Table 39

Sample Details

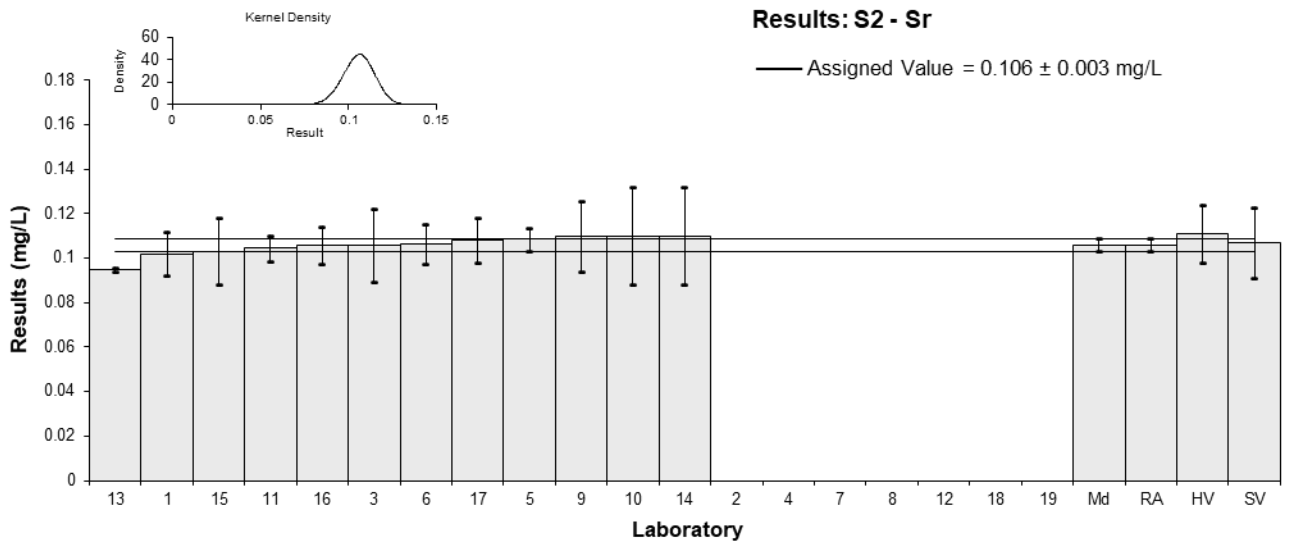
Sample No.	S2
Matrix	Potable Water
Analyte	Sr
Unit	mg/L

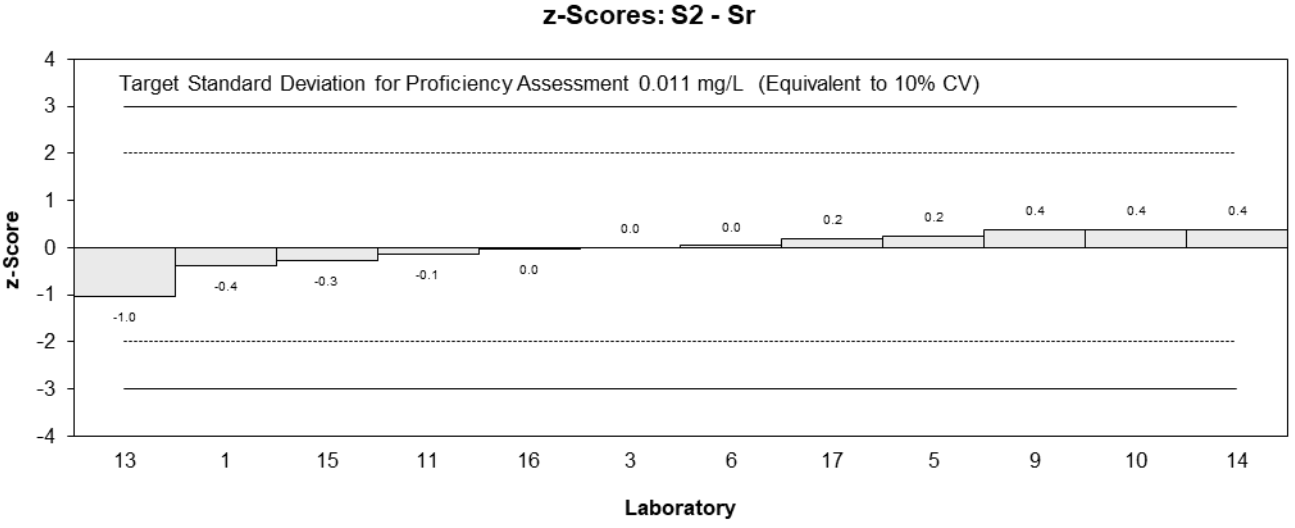
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.102	0.010	-0.38	-0.38
2	NR	NR		
3	0.106	0.0164	0.00	0.00
4	NT	NT		
5	0.1085	0.005	0.24	0.43
6	0.10643	0.00899	0.04	0.05
7	NT	NT		
8	NT	NT		
9	0.11	0.0157	0.38	0.25
10	0.11	0.022	0.38	0.18
11	0.1046	0.0057	-0.13	-0.22
12	NT	NT		
13	0.095	0.001	-1.04	-3.48
14	0.11	0.022	0.38	0.18
15	0.103	0.015	-0.28	-0.20
16	0.1057	0.0085	-0.03	-0.03
17	0.108	0.01	0.19	0.19
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.106	0.003
Spike Value	0.107	0.016
Homogeneity Value	0.111	0.013
Robust Average	0.106	0.003
Median	0.106	0.003
Mean	0.106	
N	12	
Max	0.11	
Min	0.095	
Robust SD	0.0036	
Robust CV	3.4%	


Kernel Density
Density
Result
Results: S2 - Sr
Assigned Value = 0.106 ± 0.003 mg/L
Results (mg/L)
Laboratory
13 1 15 11 16 3 6 17 5 9 10 14 2 4 7 8 12 18 19 Md RA HV SV


z-Scores: S2 - Sr
Target Standard Deviation for Proficiency Assessment 0.011 mg/L (Equivalent to 10% CV)
z-Score
-1.0 -0.4 -0.3 -0.1 0.0 0.0 0.0 0.2 0.2 0.4 0.4 0.4
Laboratory
13 1 15 11 16 3 6 17 5 9 10 14

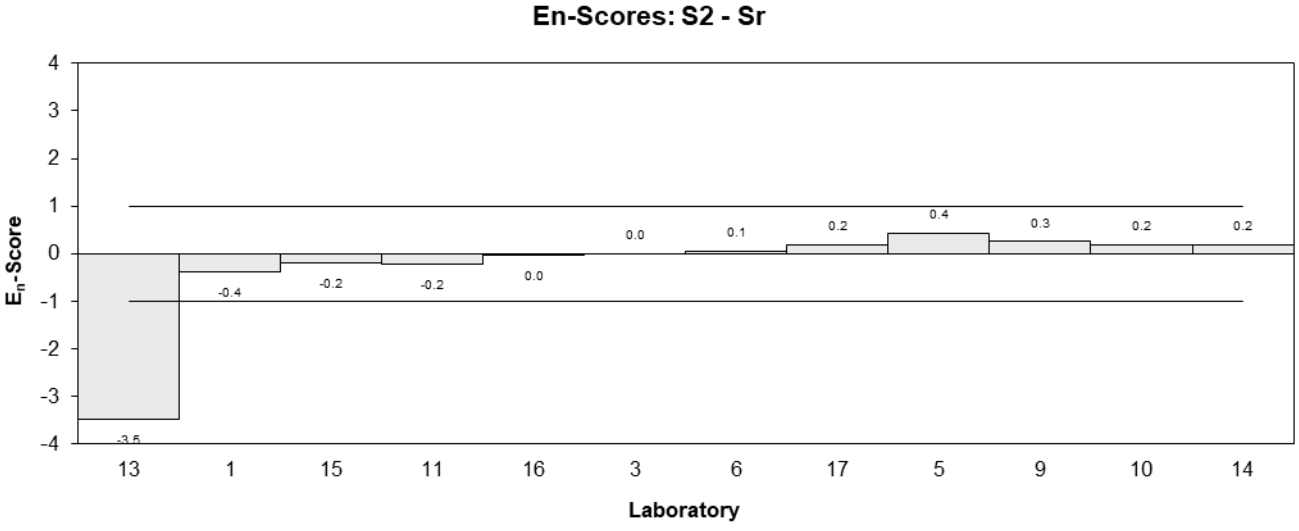

En-Scores: S2 - Sr
En-Score
-3.5 -0.4 -0.2 -0.2 0.0 0.0 0.1 0.2 0.4 0.3 0.2 0.2
Laboratory
13 1 15 11 16 3 6 17 5 9 10 14

Figure 36

Table 40

Sample Details

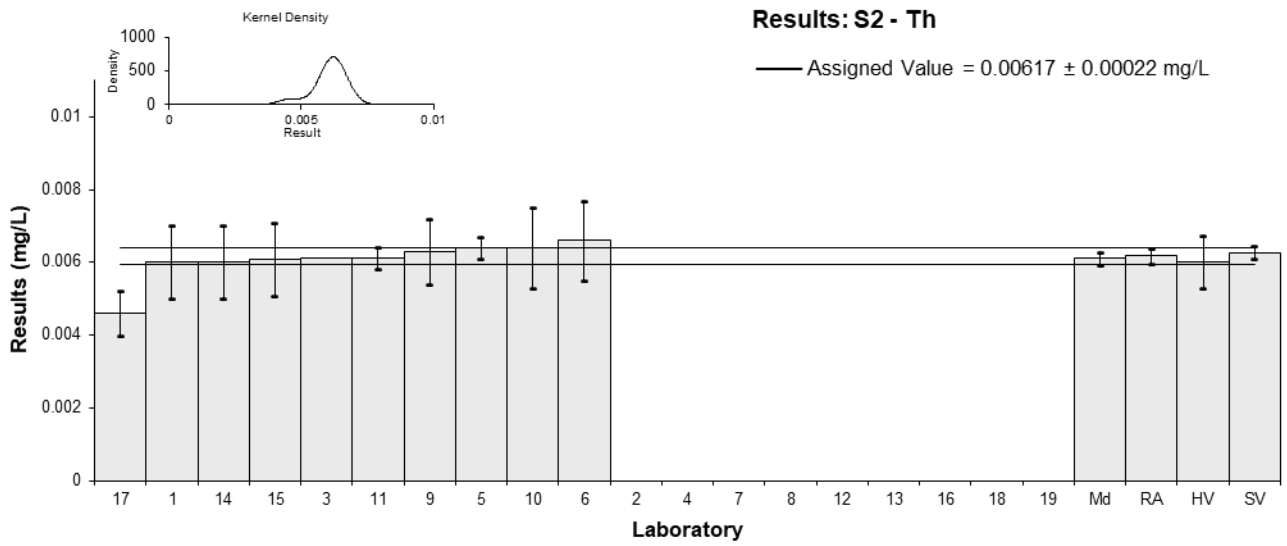
Sample No.	S2
Matrix	Potable Water
Analyte	Th
Unit	mg/L

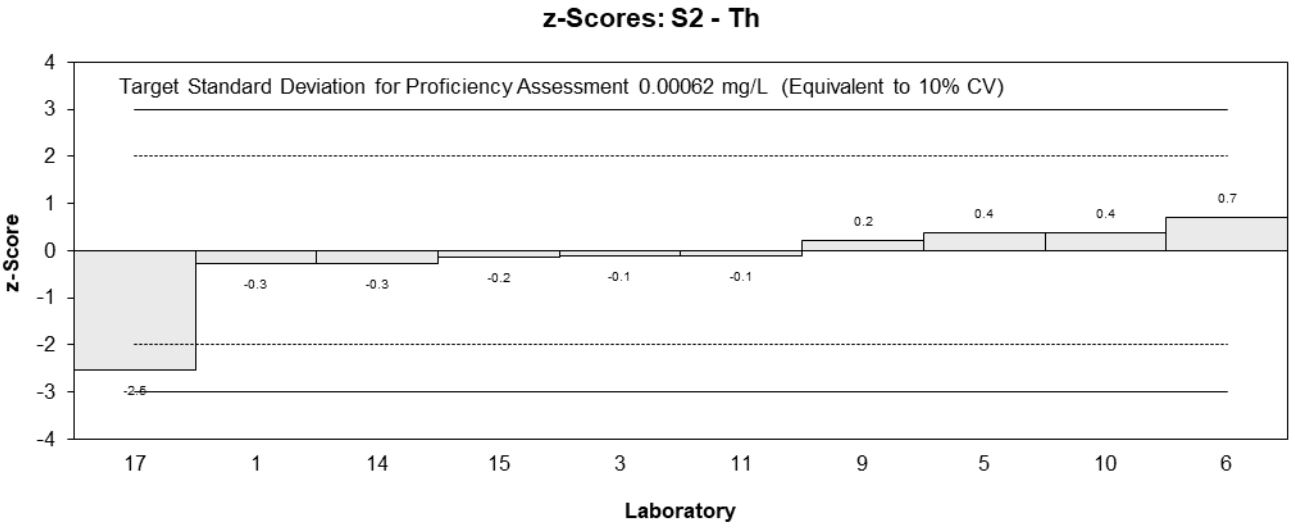
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.006	0.001	-0.28	-0.17
2	NR	NR		
3	0.0061	NR	-0.11	-0.32
4	NT	NT		
5	0.0064	0.0003	0.37	0.62
6	0.00660	0.00109	0.70	0.39
7	NT	NT		
8	NT	NT		
9	0.0063	0.0009	0.21	0.14
10	0.0064	0.0011	0.37	0.21
11	0.0061	0.0003	-0.11	-0.19
12	NT	NT		
13	NT	NT		
14	0.006	0.001	-0.28	-0.17
15	0.00608	0.001	-0.15	-0.09
16	NT	NT		
17	0.0046	0.0006	-2.54	-2.46
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.00617	0.00022
Spike Value	0.00627	0.00018
Homogeneity Value	0.00602	0.00072
Robust Average	0.00617	0.00022
Median	0.00610	0.00018
Mean	0.00606	
N	10	
Max	0.0066	
Min	0.0046	
Robust SD	0.00027	
Robust CV	4.4%	


Kernel Density
Density
1000
500
0
0
0.005
0.01
Result
Results: S2 - Th
Assigned Value = 0.00617 ± 0.00022 mg/L
Results (mg/L)
0.01
0.008
0.006
0.004
0.002
0
17 1 14 15 3 11 9 5 10 6 2 4 7 8 12 13 16 18 19 Md RA HV SV
Laboratory


z-Scores: S2 - Th
Target Standard Deviation for Proficiency Assessment 0.00062 mg/L (Equivalent to 10% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-0.3
-0.3
-0.2
-0.1
-0.1
0.2
0.4
0.4
0.7
-2.5
17 1 14 15 3 11 9 5 10 6
Laboratory

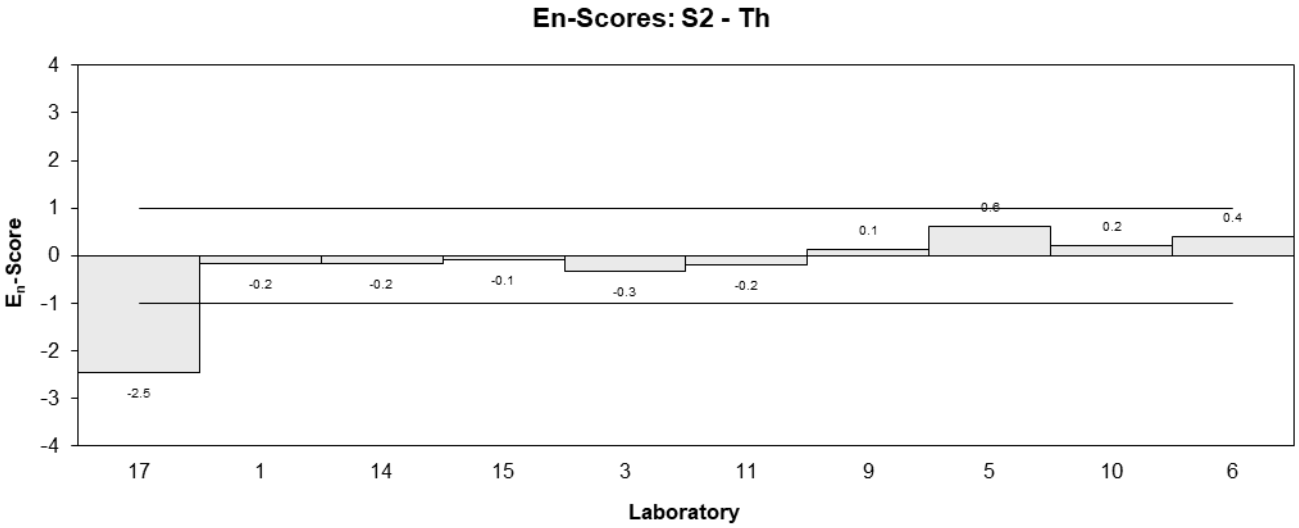

En-Scores: S2 - Th
En-Score
4
3
2
1
0
-1
-2
-3
-4
-0.2
-0.2
-0.1
-0.3
-0.2
0.1
0.6
0.2
0.4
-2.5
17 1 14 15 3 11 9 5 10 6
Laboratory

Figure 37

Table 41

Sample Details

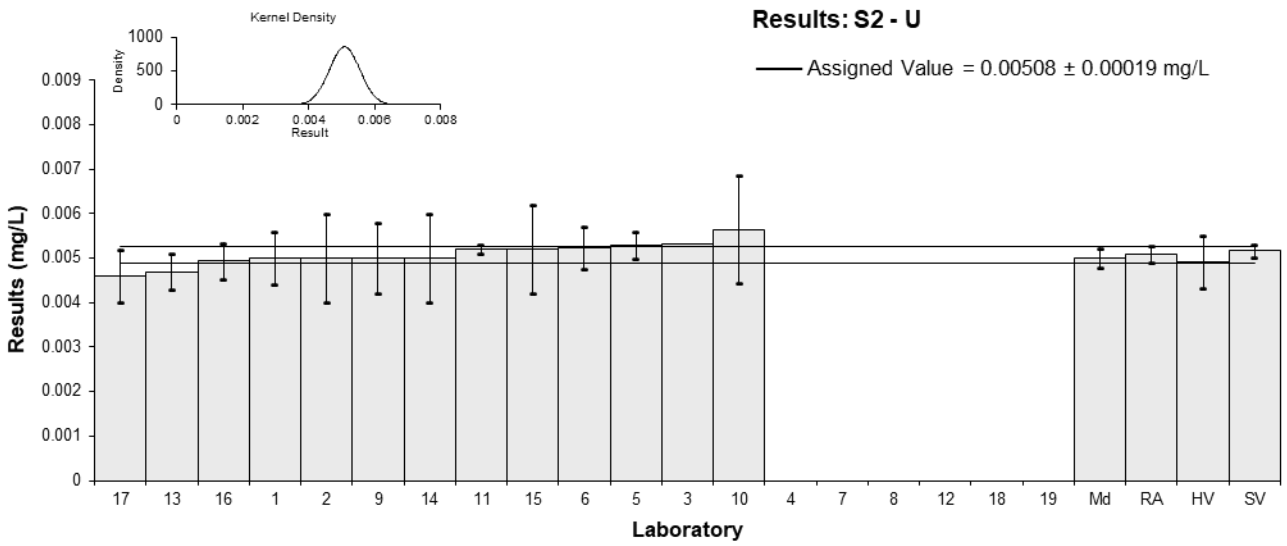
Sample No.	S2
Matrix	Potable Water
Analyte	U
Unit	mg/L

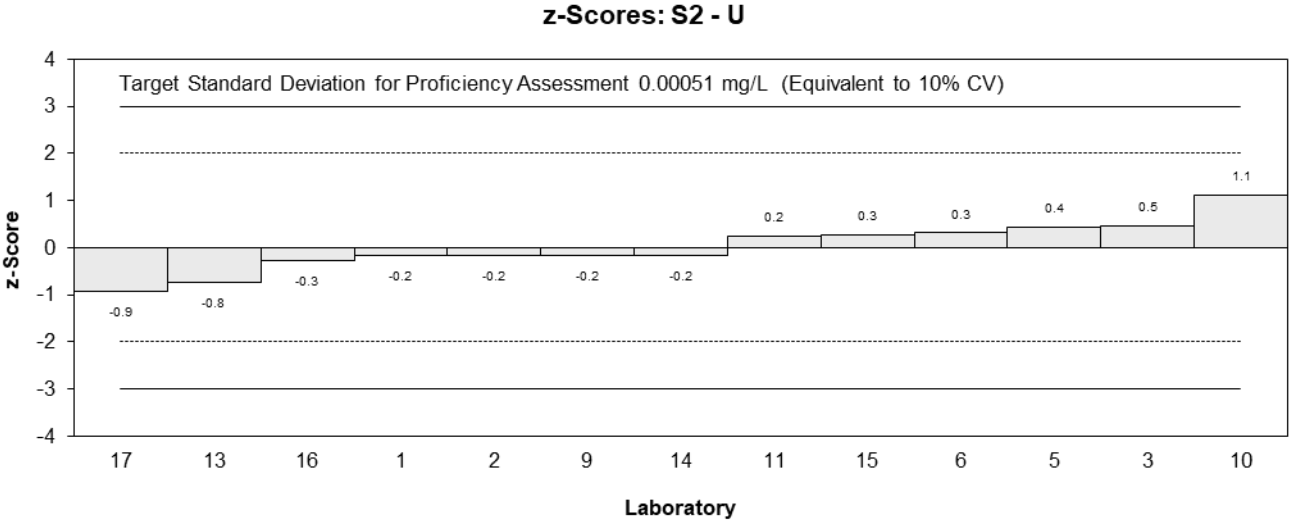
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.005	0.0006	-0.16	-0.13
2	0.005	0.001	-0.16	-0.08
3	0.00532	NR	0.47	1.26
4	NT	NT		
5	0.0053	0.0003	0.43	0.62
6	0.00524	0.00048	0.31	0.31
7	NT	NT		
8	NT	NT		
9	0.005	0.0008	-0.16	-0.10
10	0.00565	0.0012	1.12	0.47
11	0.0052	0.0001	0.24	0.56
12	NT	NT		
13	0.0047	0.0004	-0.75	-0.86
14	0.005	0.001	-0.16	-0.08
15	0.00521	0.001	0.26	0.13
16	0.00494	0.00040	-0.28	-0.32
17	0.0046	0.0006	-0.94	-0.76
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.00508	0.00019
Spike Value	0.00517	0.00015
Homogeneity Value	0.00492	0.00059
Robust Average	0.00508	0.00019
Median	0.00500	0.00022
Mean	0.00509	
N	13	
Max	0.00565	
Min	0.0046	
Robust SD	0.00027	
Robust CV	5.4%	


Kernel Density
Density
1000
500
0
0
0.002
0.004
0.006
0.008
Result
Results: S2 - U
Assigned Value = 0.00508 ± 0.00019 mg/L
Results (mg/L)
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
17 13 16 1 2 9 14 11 15 6 5 3 10 4 7 8 12 18 19 Md RA HV SV
Laboratory


z-Scores: S2 - U
Target Standard Deviation for Proficiency Assessment 0.00051 mg/L (Equivalent to 10% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-0.9
-0.8
-0.3
-0.2
-0.2
-0.2
-0.2
0.2
0.3
0.3
0.4
0.5
1.1
17 13 16 1 2 9 14 11 15 6 5 3 10
Laboratory

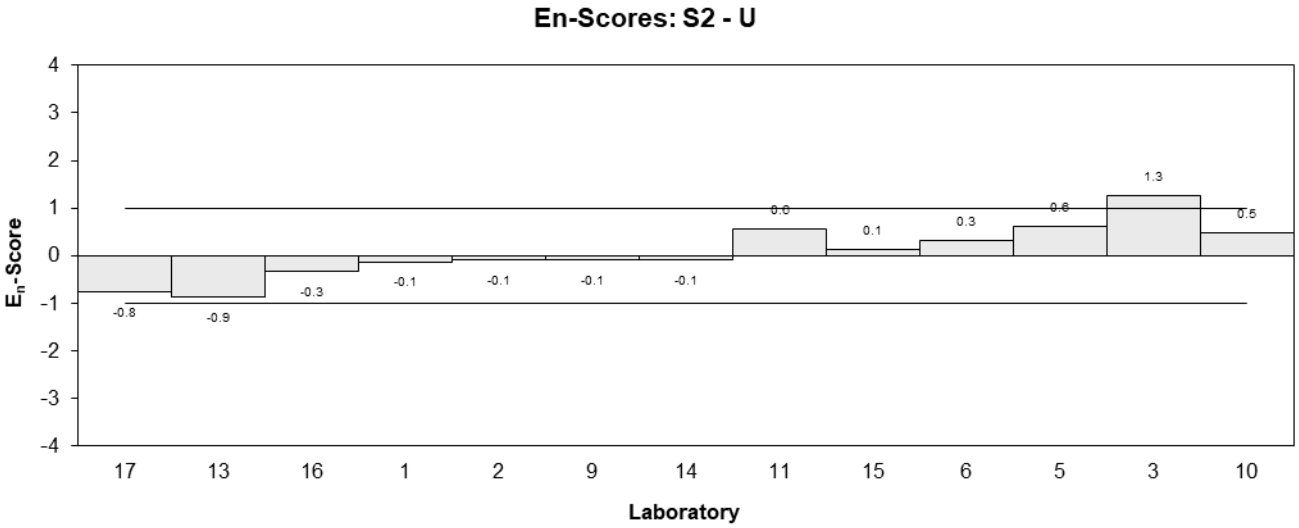

En-Scores: S2 - U
En-Score
4
3
2
1
0
-1
-2
-3
-4
-0.8
-0.9
-0.3
-0.1
-0.1
-0.1
-0.1
0.0
0.1
0.3
0.6
1.3
0.5
17 13 16 1 2 9 14 11 15 6 5 3 10
Laboratory

Figure 38

Table 42

Sample Details

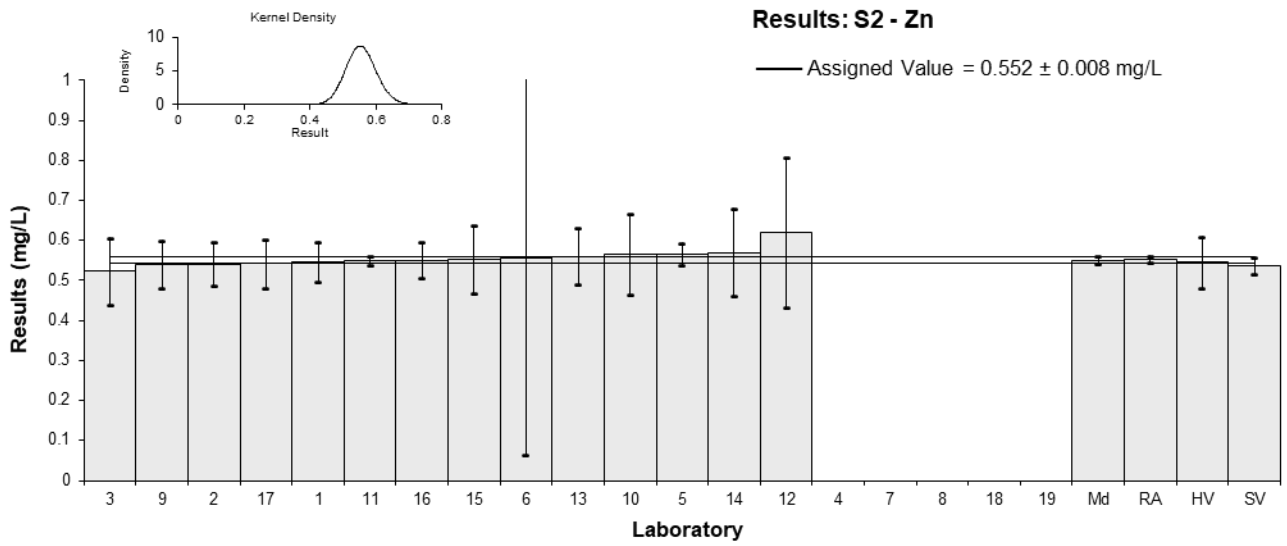
Sample No.	S2
Matrix	Potable Water
Analyte	Zn
Unit	mg/L

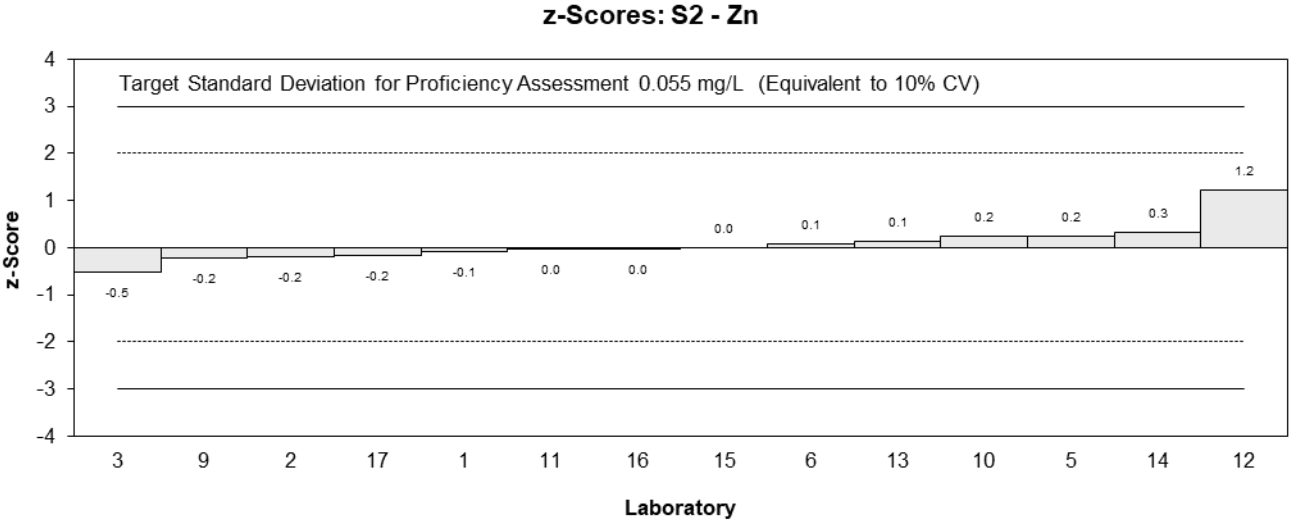
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.547	0.049	-0.09	-0.10
2	0.541	0.0541	-0.20	-0.20
3	0.523	0.084	-0.53	-0.34
4	NT	NT		
5	0.5651	0.028	0.24	0.45
6	0.55574	0.4924	0.07	0.01
7	NT	NT		
8	NT	NT		
9	0.54	0.0594	-0.22	-0.20
10	0.565	0.1	0.24	0.13
11	0.5497	0.0105	-0.04	-0.17
12	0.62	0.186	1.23	0.37
13	0.56	0.07	0.14	0.11
14	0.57	0.11	0.33	0.16
15	0.552	0.085	0.00	0.00
16	0.550	0.045	-0.04	-0.04
17	0.542	0.06	-0.18	-0.17
18	NT	NT		
19	NT	NT		

Statistics

Assigned Value	0.552	0.008
Spike Value	0.536	0.021
Homogeneity Value	0.545	0.065
Robust Average	0.553	0.009
Median	0.551	0.009
Mean	0.556	
N	14	
Max	0.62	
Min	0.523	
Robust SD	0.014	
Robust CV	2.6%	


Results: S2 - Zn
Assigned Value = 0.552 ± 0.008 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
3 9 2 17 1 11 16 15 6 13 10 5 14 12 4 7 8 18 19 Md RA HV SV


z-Scores: S2 - Zn
Target Standard Deviation for Proficiency Assessment 0.055 mg/L (Equivalent to 10% CV)
z-Score
-0.5 -0.2 -0.2 -0.2 -0.1 0.0 0.0 0.0 0.1 0.1 0.2 0.2 0.3 1.2
Laboratory
3 9 2 17 1 11 16 15 6 13 10 5 14 12

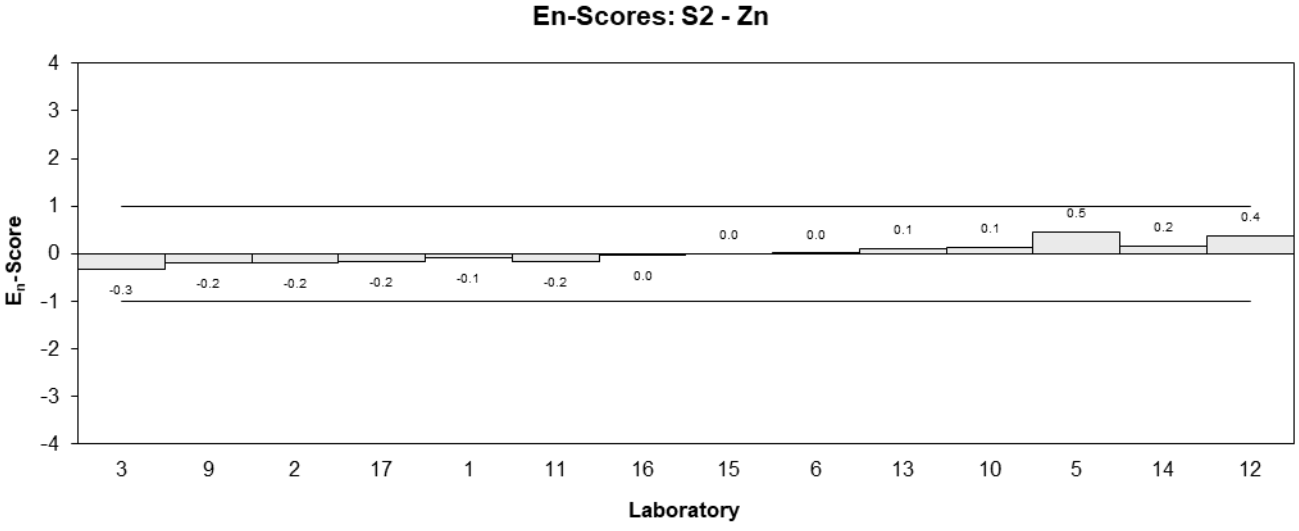

En-Scores: S2 - Zn
En-Score
-0.3 -0.2 -0.2 -0.2 -0.1 -0.2 0.0 0.0 0.0 0.1 0.1 0.5 0.2 0.4
Laboratory
3 9 2 17 1 11 16 15 6 13 10 5 14 12

Figure 39

Table 43

Sample Details

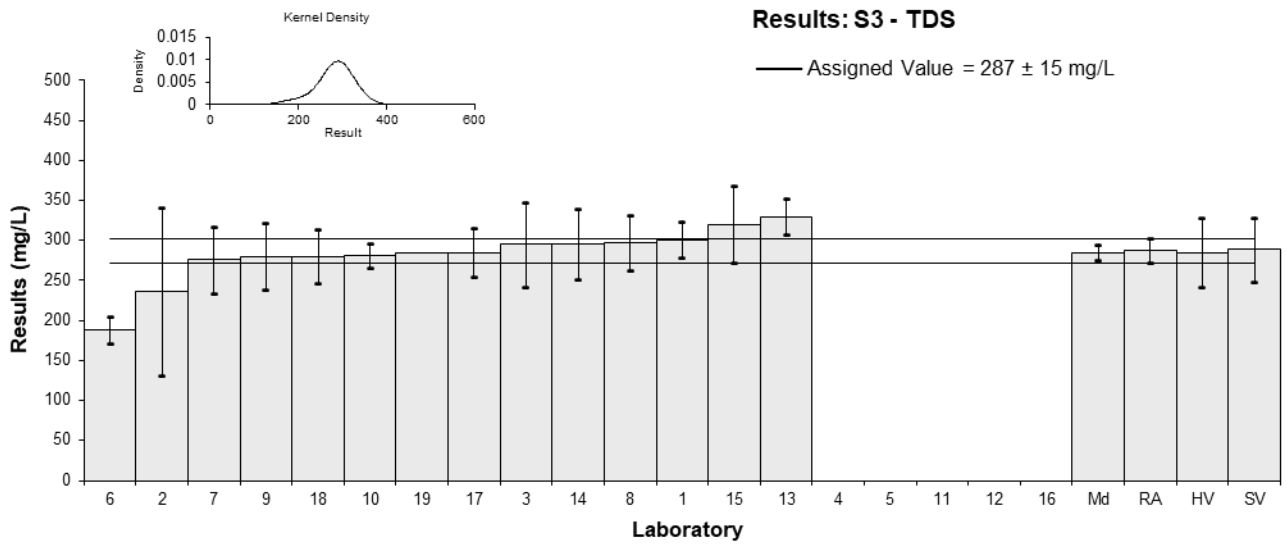
Sample No.	S3
Matrix	Potable Water
Analyte	TDS
Unit	mg/L

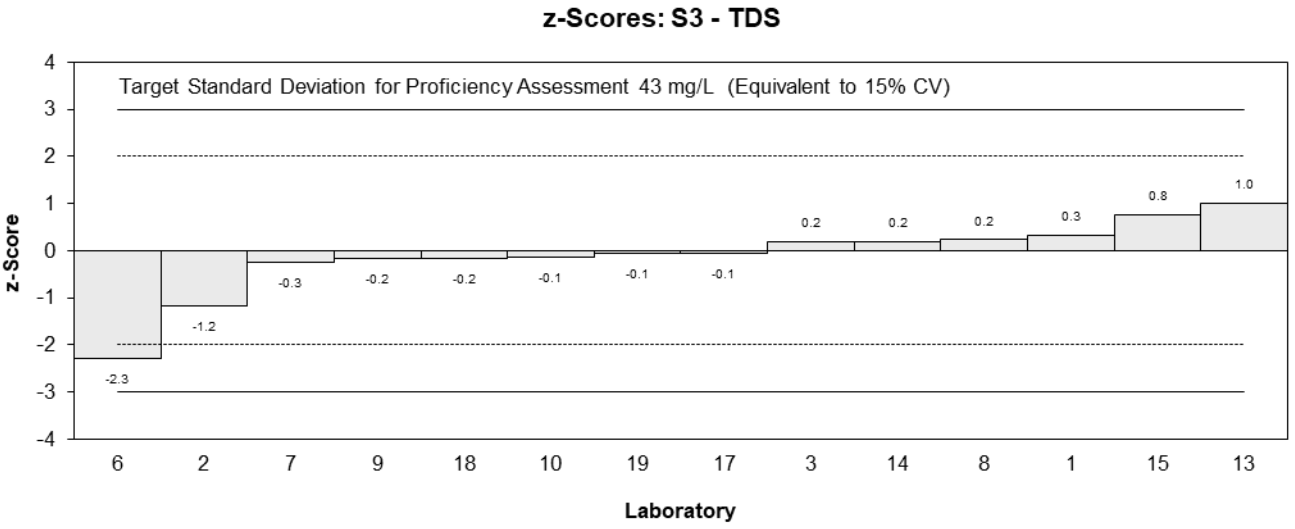
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	301	23	0.33	0.51
2	236	105	-1.18	-0.48
3	295	52.69	0.19	0.15
4	NT	NT		
5	NT	NT		
6	188	16.55	-2.30	-4.43
7	276	41.4	-0.26	-0.25
8	297	34	0.23	0.27
9	280	42	-0.16	-0.16
10	281	15.1	-0.14	-0.28
11	NT	NT		
12	NT	NT		
13	330	23	1.00	1.57
14	295	44	0.19	0.17
15	320	48	0.77	0.66
16	NT	NT		
17	285	30	-0.05	-0.06
18	280	33.88	-0.16	-0.19
19	284	NR	-0.07	-0.20

Statistics

Assigned Value	287	15
Spike Value	289	40
Homogeneity Value	285	43
Robust Average	287	15
Median	285	10
Mean	282	
N	14	
Max	330	
Min	188	
Robust SD	23	
Robust CV	7.9%	


Kernel Density
Density
0.015
0.01
0.005
0
0
200
400
600
Result
Results: S3 - TDS
Assigned Value = 287 ± 15 mg/L
Results (mg/L)
500
450
400
350
300
250
200
150
100
50
0
6 2 7 9 18 10 19 17 3 14 8 1 15 13 4 5 11 12 16 Md RA HV SV
Laboratory


z-Scores: S3 - TDS
Target Standard Deviation for Proficiency Assessment 43 mg/L (Equivalent to 15% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-2.3
-1.2
-0.3
-0.2
-0.2
-0.1
-0.1
-0.1
0.2
0.2
0.2
0.3
0.8
1.0
6 2 7 9 18 10 19 17 3 14 8 1 15 13
Laboratory

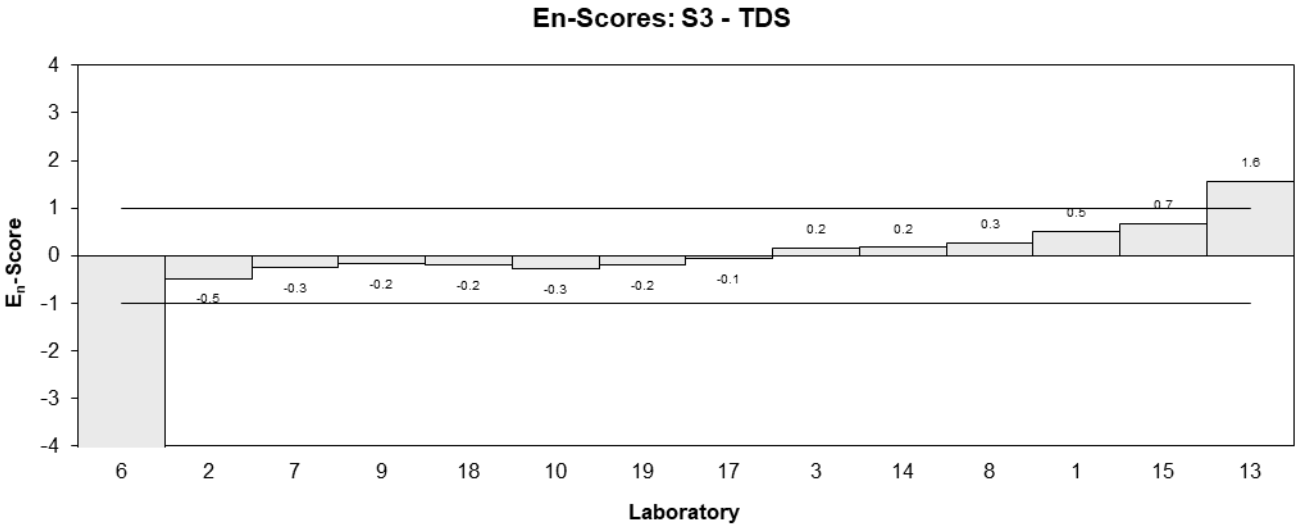

En-Scores: S3 - TDS
En-Score
4
3
2
1
0
-1
-2
-3
-4
-0.5
-0.3
-0.2
-0.2
-0.3
-0.2
-0.1
0.2
0.2
0.3
0.5
0.7
1.6
6 2 7 9 18 10 19 17 3 14 8 1 15 13
Laboratory

Figure 40

Table 44

Sample Details

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

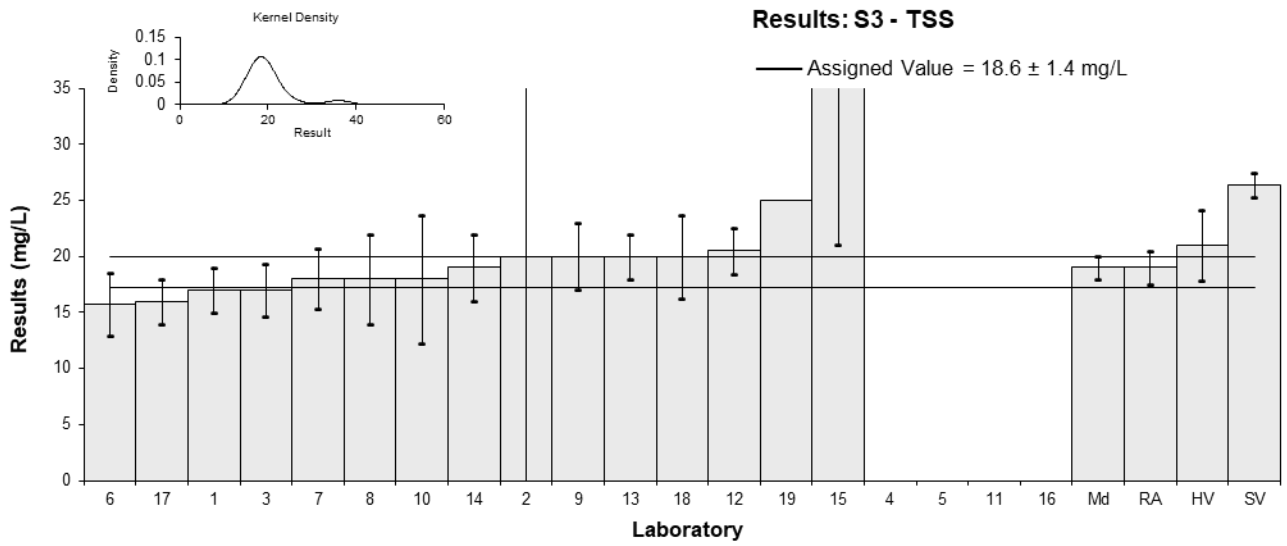
Participant Results

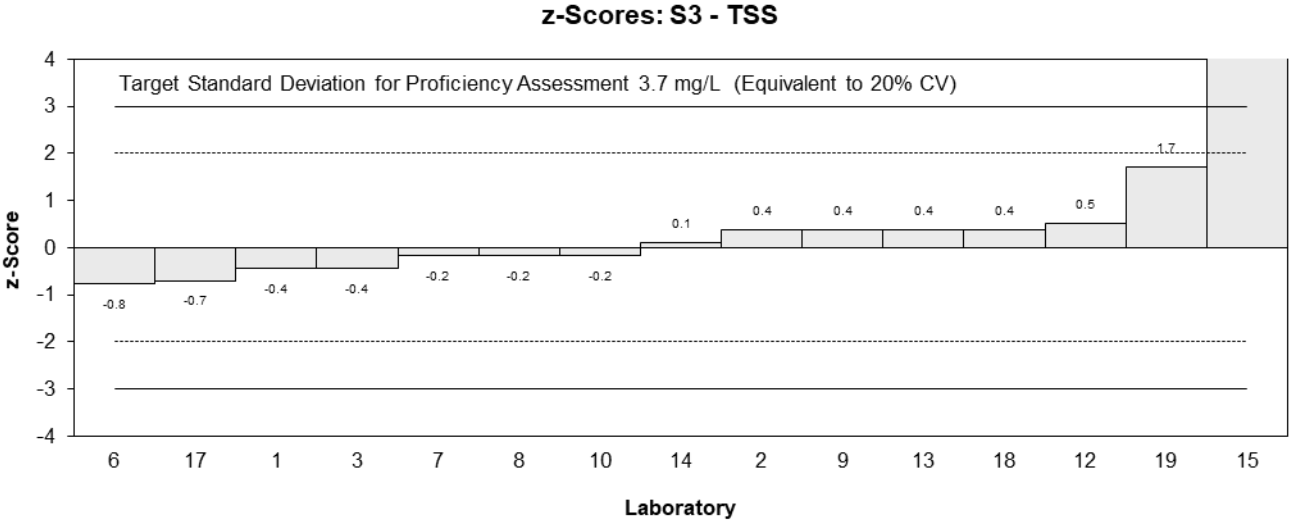
Lab. Code	Result	Uncertainty	z	E_n
1	17	2	-0.43	-0.66
2	20	88	0.38	0.02
3	17	2.35	-0.43	-0.58
4	NT	NT		
5	NT	NT		
6	15.75	2.78	-0.77	-0.92
7	18.0	2.70	-0.16	-0.20
8	18	4	-0.16	-0.14
9	20	3	0.38	0.42
10	18	5.7	-0.16	-0.10
11	NT	NT		
12	20.5	2.05	0.51	0.77
13	20	2	0.38	0.57
14	19	3	0.11	0.12
15*	36	15	4.68	1.15
16	NT	NT		
17	16	2.0	-0.70	-1.07
18	20	3.74	0.38	0.35
19	25	NR	1.72	4.57

* Outlier, see Section 4.2

Statistics

Assigned Value	18.6	1.4
Spike Value	26.4	1.1
Homogeneity Value	21.0	3.2
Robust Average	19.0	1.5
Median	19.0	1.0
Mean	20.0	
N	15	
Max	36	
Min	15.75	
Robust SD	2.4	
Robust CV	13%	


Results: S3 - TSS
Assigned Value = 18.6 ± 1.4 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
6 17 1 3 7 8 10 14 2 9 13 18 12 19 15 4 5 11 16 Md RA HV SV


z-Scores: S3 - TSS
Target Standard Deviation for Proficiency Assessment 3.7 mg/L (Equivalent to 20% CV)
z-Score
Laboratory
6 17 1 3 7 8 10 14 2 9 13 18 12 19 15

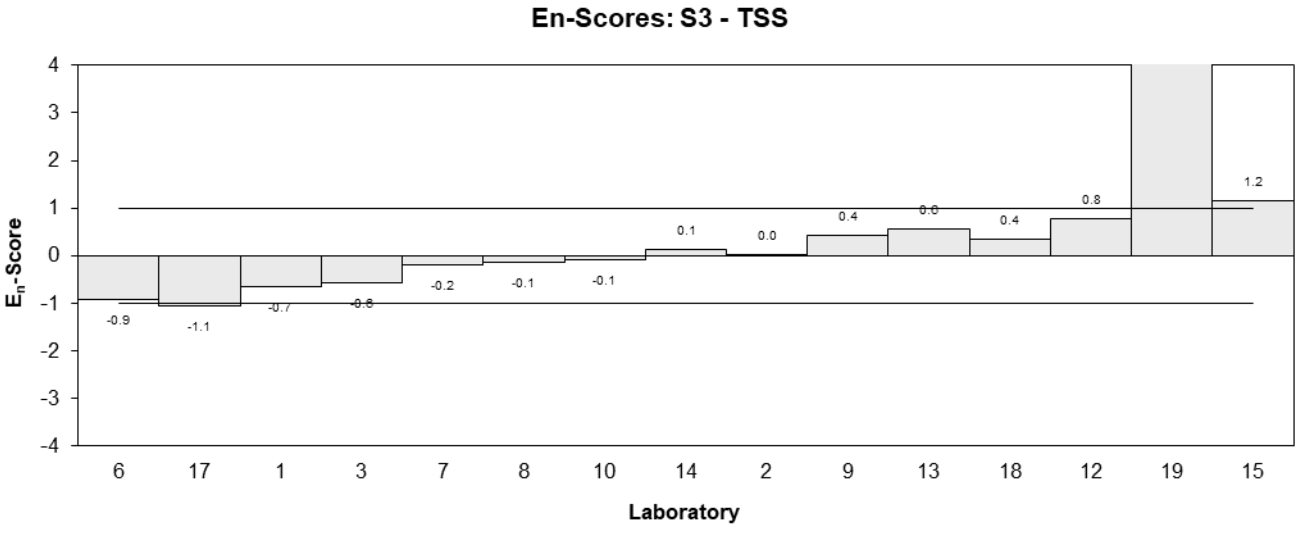

En-Scores: S3 - TSS
En-Score
Laboratory
6 17 1 3 7 8 10 14 2 9 13 18 12 19 15

Figure 41

Table 45

Sample Details

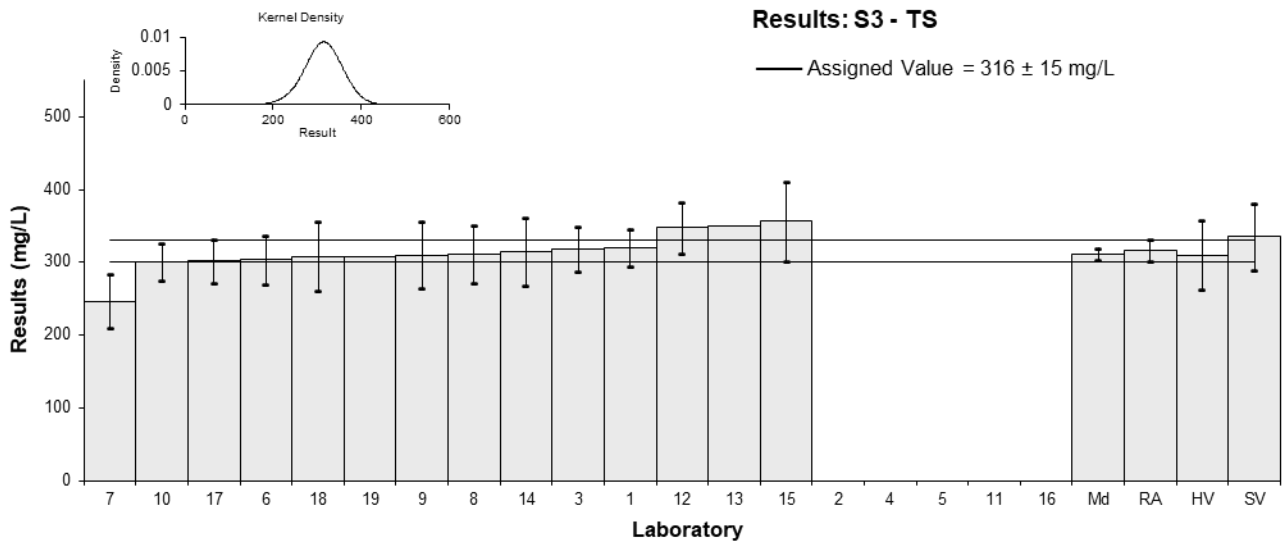
Sample No.	S3
Matrix	Potable Water
Analyte	TS
Unit	mg/L

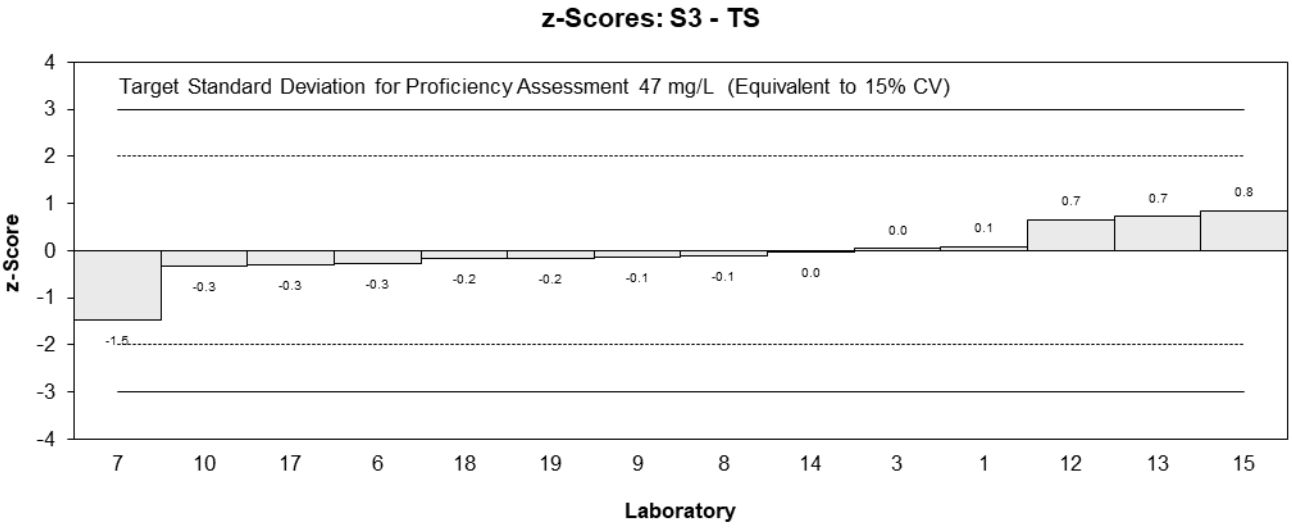
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	320	26	0.08	0.13
2	NR	NR		
3	318	30.1	0.04	0.06
4	NT	NT		
5	NT	NT		
6	303.25	33.49	-0.27	-0.35
7	246	36.9	-1.48	-1.76
8	311	39	-0.11	-0.12
9	310	46.5	-0.13	-0.12
10	300	25.6	-0.34	-0.54
11	NT	NT		
12	347.5	34.75	0.66	0.83
13	350	NR	0.72	2.27
14	314	47	-0.04	-0.04
15	356	54	0.84	0.71
16	NT	NT		
17	302	30	-0.30	-0.42
18	308	47.43	-0.17	-0.16
19	308	NR	-0.17	-0.53

Statistics

Assigned Value	316	15
Spike Value	335	46
Homogeneity Value	310	47
Robust Average	316	15
Median	311	8
Mean	314	
N	14	
Max	356	
Min	246	
Robust SD	23	
Robust CV	7.3%	


Kernel Density
Density
0.01
0.005
0
0
200
400
600
Result
Results: S3 - TS
Assigned Value = 316 ± 15 mg/L
Results (mg/L)
500
400
300
200
100
0
7 10 17 6 18 19 9 8 14 3 1 12 13 15 2 4 5 11 16 Md RA HV SV
Laboratory


z-Scores: S3 - TS
Target Standard Deviation for Proficiency Assessment 47 mg/L (Equivalent to 15% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-1.5
-0.3
-0.3
-0.3
-0.2
-0.2
-0.1
-0.1
0.0
0.0
0.1
0.7
0.7
0.8
7 10 17 6 18 19 9 8 14 3 1 12 13 15
Laboratory

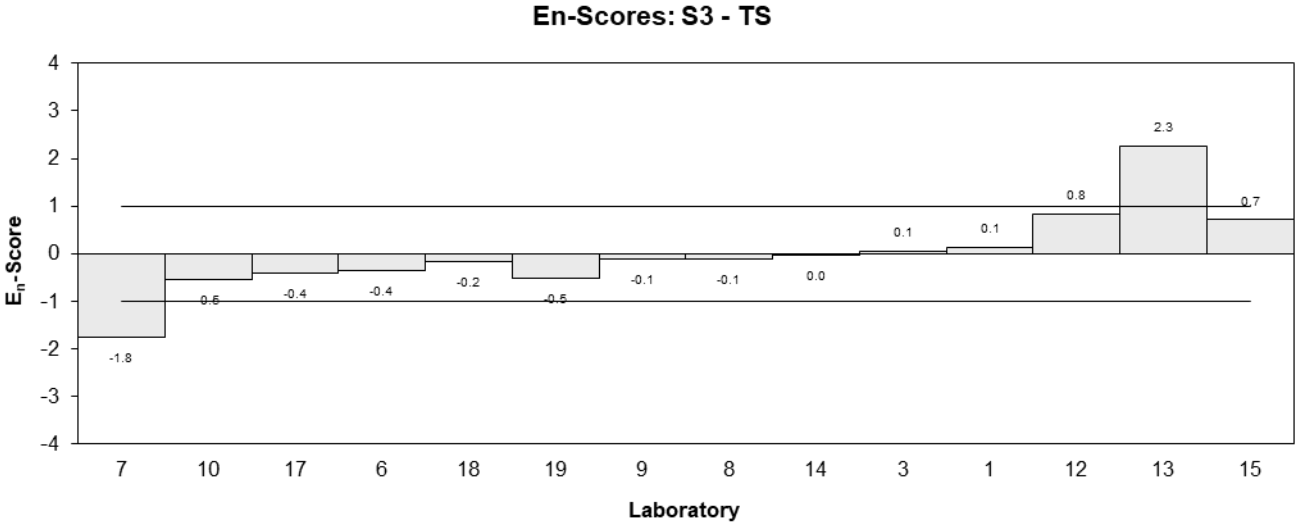

En-Scores: S3 - TS
En-Score
4
3
2
1
0
-1
-2
-3
-4
-1.8
-0.5
-0.4
-0.4
-0.2
-0.5
-0.1
-0.1
0.0
0.1
0.1
0.8
2.3
0.7
7 10 17 6 18 19 9 8 14 3 1 12 13 15
Laboratory

Figure 42

Table 46

Sample Details

Sample No.	S3
Matrix	Potable Water
Analyte	Turbidity
Unit	NTU

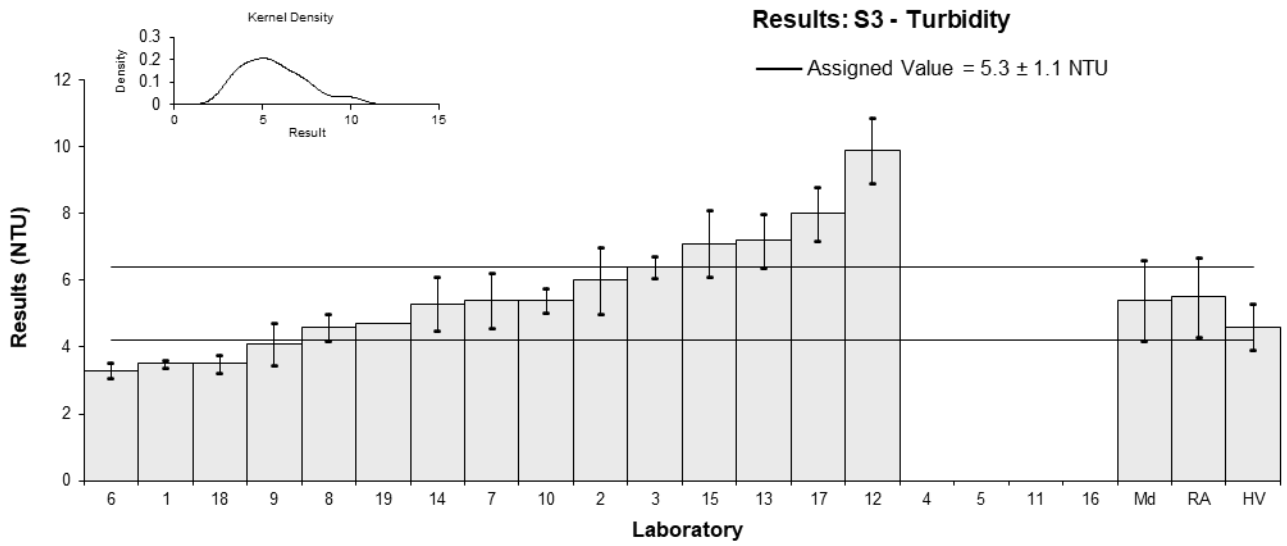
Participant Results

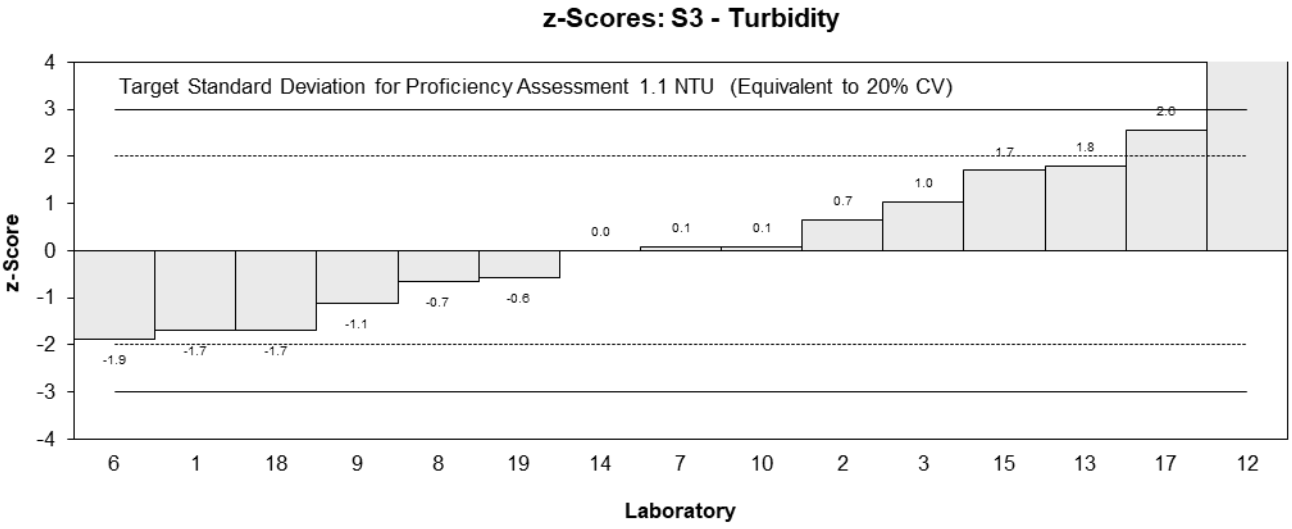
Lab. Code	Result	Uncertainty	z	E_n
1	3.5	0.1	-1.70	-1.63
2	6	1	0.66	0.47
3	6.4	0.31	1.04	0.96
4	NT	NT		
5	NT	NT		
6	3.30	0.24	-1.89	-1.78
7	5.4	0.81	0.09	0.07
8	4.59	0.41	-0.67	-0.60
9	4.1	0.62	-1.13	-0.95
10	5.4	0.38	0.09	0.09
11	NT	NT		
12*	9.9	0.99	4.34	3.11
13	7.2	0.8	1.79	1.40
14	5.3	0.8	0.00	0.00
15	7.10	1	1.70	1.21
16	NT	NT		
17	8.0	0.8	2.55	1.99
18	3.5	0.28	-1.70	-1.59
19	4.7	NR	-0.57	-0.55

* Outlier, see Section 4.2

Statistics

Assigned Value	5.3	1.1
Spike Value	Not Spiked	
Homogeneity Value	4.60	0.69
Robust Average	5.5	1.2
Median	5.4	1.2
Mean	5.63	
N	15	
Max	9.9	
Min	3.3	
Robust SD	1.8	
Robust CV	33%	


Results: S3 - Turbidity
Assigned Value = 5.3 ± 1.1 NTU
Kernel Density
Density
Result
Results (NTU)
Laboratory
6 1 18 9 8 19 14 7 10 2 3 15 13 17 12 4 5 11 16 Md RA HV


z-Scores: S3 - Turbidity
Target Standard Deviation for Proficiency Assessment 1.1 NTU (Equivalent to 20% CV)
z-Score
Laboratory
6 1 18 9 8 19 14 7 10 2 3 15 13 17 12
-1.9 -1.7 -1.7 -1.1 -0.7 -0.6 0.0 0.1 0.1 0.7 1.0 1.7 1.8 2.6

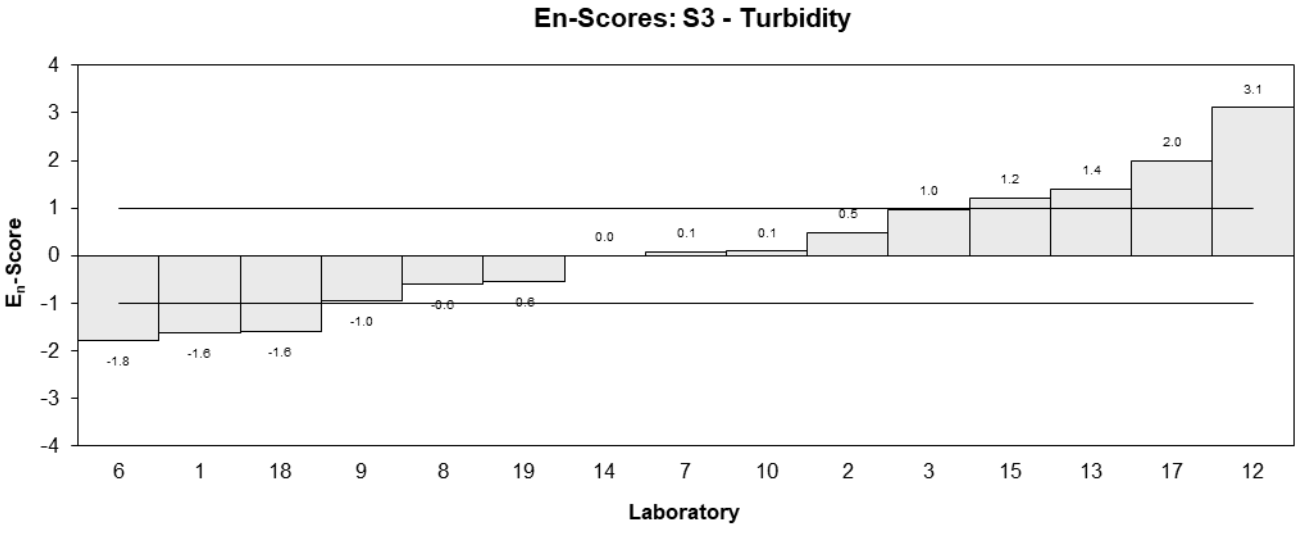

En-Scores: S3 - Turbidity
En-Score
Laboratory
6 1 18 9 8 19 14 7 10 2 3 15 13 17 12
-1.8 -1.6 -1.6 -1.0 -0.6 -0.6 0.0 0.1 0.1 0.5 1.0 1.2 1.4 2.0 3.1

Figure 43

6 DISCUSSION OF RESULTS

6.1 Assigned Value

Samples S1 and S2 were blind duplicates prepared from the same unfiltered potable water fortified with 28 elements. For Sample S1, participants were asked to report results for total: As, Be, Bi, Cd, Co, Cr, Cu, Fe, Hg, Li, Mo, Ni, Pb, Sb, Se, Sn, Tl, V and Zn, and for Sample S2 to report results for total: Al, As, B, Ba, Cd, Cs, Fe, Hg, La, Mn, Na, P, Pb, Sb, Se, Sr, Th, U and Zn. Th**e** concentration of common elements in both samples (As, Cd, Fe, Hg, Pb, Sb, Se, and Zn) was expected to be the same.

Sample S3 was potable water fortified with a High-Level Solids Standard. Participants were asked to report TDS, TS, TSS and turbidity.

Assigned values for the 26 non-repeated analytes were calculated as the robust averages of participants' results. The robust averages and their associated expanded uncertainties were calculated using the procedure described in ISO13528.[6] Extreme outliers and results less than 50% and more than 150% of the robust average were excluded prior to the calculation of each assigned value (see subchapters 4.2 and 4.3). Appendix 2 sets out the calculation of the robust average for Be in Sample S1 and its associated uncertainty.

Assigned values for the remaining 16 tests of As, Cd, Fe, Hg, Pb, Sb, Se, and Zn in S1 and S2 were calculated as the robust average of the combined results of both samples.

Spike Value where applicable, includes both the incurred value and the fortified value.

Traceability The assigned values are not traceable to any external reference; they are traceable to the consensus of participants' results derived from a variety of measurement methods and (presumably) a variety of calibrators. So, although expressed in SI units, the metrological traceability of the assigned values has not been established.

6.2 Measurement Uncertainty Reported by Participants

Participants were asked to report an estimate of the expanded measurement uncertainty associated with their results. Of 534 numerical results, 518 (97%) were reported with an expanded measurement uncertainty. The magnitude of these expanded uncertainties was within the range 0.83% to 13529% of the reported value. The participants used a wide variety of procedures to estimate the expanded measurement uncertainty. These are presented in Table 4.

Approaches to estimating measurement uncertainty include standard deviation of replicate analysis, Horwitz formula, long term reproducibility, professional judgement, bottom up approach, top down approach using precision and estimates 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 participants to check how reasonable their estimates of uncertainty are. Results and the expanded MU are presented in the bar charts for each analyte (Figures 2 to 43). As a simple rule of thumb, when the uncertainty estimate is smaller than uncertainty of the assigned value, or larger than the uncertainty of the assigned value plus twice the target standard deviation, then this should be reviewed as suspect. For example, 12 laboratories reported results for V in S1. The uncertainty of the assigned value estimated from the robust standard deviation of the 12 laboratories' results is 0.00024 mg/L (see equation 4, Appendix 2). Laboratory 11 might have under-estimated its expanded measurement uncertainties reported for V in S1 (0.0001 mg/L) as an uncertainty estimated from one measurement should not be smaller than the uncertainty estimated from 12 measurements. Alternatively, estimates of uncertainties for TSS in S3 larger than 8.8 mg/L (the uncertainty of the assigned value, 1.4 mg/L, plus the allowable variation from the

assigned value, the target standard deviation of 3.7 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 uncertainties reported by Laboratory 2 (88 mg/L) for TSS in S3 might have been over-estimated.

Laboratory 2 should review their procedure for estimating measurement uncertainty as some of their estimated uncertainties were over-estimated. Laboratory 11 should also review their procedure for estimating measurement uncertainty as some of their uncertainties were under-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 estimate the uncertainty of their measurement results.[10] An example of estimating measurement uncertainty using proficiency testing data only is given in Appendix 3.

Laboratories 2, 3, 10, 15 and 16 reported an estimate of expanded uncertainty for some measurement results equal to or larger than the results themselves.

In some cases, the results were reported with an inappropriate number of significant figures. The recommended format is to write 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 18.44 ± 3.4 mg/L, it is better to report 18.4 ± 3.4 mg/L or instead of 0.0023 ± 0.00048 mg/L, it is better to report 0.0023 ± 0.0005 mg/L.[9]

6.3 z-Score

The z-score compares participant's deviation from the assigned value with the target standard deviation set for proficiency assessment.

The target standard deviation defines acceptable performance in a proficiency test. Target standard deviations equivalent to 10% to 20% PCV were used to calculate z-scores. Unlike the standard deviation based on between-laboratory CV, setting the target standard deviation as a realistic, set value enables z-scores to be used as a fixed reference value point for assessment of laboratory performance, independent of group performance.

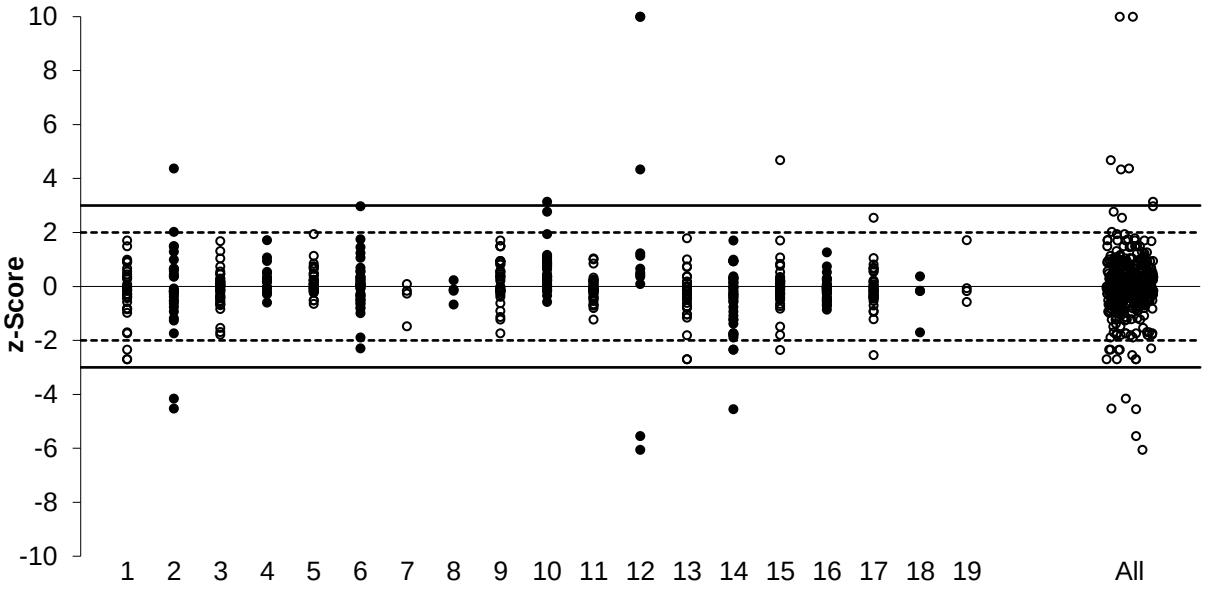
The between-laboratory coefficient of variation predicted by the Thompson-Horwitz equation[7] and the between-laboratory coefficient of variation resulted in this study are presented for comparison in Table 47.

The dispersal of participants' z-scores is presented in Figure 44 (by laboratory code) and in Figure 46 (by test). Of 534 results for which z-scores were calculated, 509 (95%) returned an acceptable score of $|z| \leq 2.0$ and 14 (3%) were questionable with a score of $2.0 < |z| < 3.0$. Participants with multiple z-scores larger than 2.0 or smaller than -2.0 should check for laboratory bias.

A summary of participants' performance is presented in Figure 47, and in Tables 48 and 49**.**

Laboratories **14** and **15** reported results for all 42 tests for which z-scores were calculated and returned 40 and 39 acceptable z-scores respectively.

All results reported by laboratories **3** (41), **9** (38), **11** (38), **16** (37), **5** (36), **4** (18), **7** (4), **8** (4), **18** (4) and **19** (4) returned acceptable z scores.



Scores of >10 or <-10 have been plotted as 10 or -10.

Figure 44 z-Score Dispersal by Laboratory

Table 47 Between-Laboratory CV of this study, Thompson/Horwitz CV, and Set Target CV

Sample	Test	Assigned value (mg/L)	Between-Laboratory CV*	Thompson/ Horwitz CV	Target SD (as CV)
S1	As	0.00261	10%	22%	10%
S1	Be	0.00309	5.2%	22%	10%
S1	Bi	0.00182	10%	22%	10%
S1	Cd	0.00122	6.9%	22%	10%
S1	Co	0.00121	14%	22%	10%
S1	Cr	0.00367	8.2%	22%	10%
S1	Cu	0.714	1.7%	17%	10%
S1	Fe	0.253	4.4%	20%	10%
S1	Hg	0.000183	15%	22%	10%
S1	Li	0.0220	6.8%	22%	10%
S1	Mo	0.00758	6.6%	22%	10%
S1	Ni	0.00772	3.8%	22%	10%
S1	Pb	0.0104	4%	22%	10%
S1	Sb	0.00274	19%	22%	10%
S1	Se	0.00570	5.9%	22%	10%
S1	Sn	0.00171	13%	22%	10%
S1	Tl	0.00121	4.1%	22%	10%
S1	V	0.00348	9.6%	22%	10%
S1	Zn	0.552	2.1%	17%	10%
S2	Al	0.0505	6.4%	22%	10%
S2	As	0.00261	11%	22%	10%
S2	B	0.0134	15%	22%	10%
S2	Ba	0.0370	4.8%	22%	10%
S2	Cd	0.00122	6.8%	22%	10%
S2	Cs	0.00212	7%	22%	10%
S2	Fe	0.253	4%	20%	10%
S2	Hg	0.000183	14%	22%	10%
S2	La	0.0120	6.4%	22%	10%
S2	Mn	0.0959	3.7%	22%	10%
S2	Na	15.3	4.3%	11%	10%
S2	P	0.185	12%	21%	10%
S2	Pb	0.0104	4.1%	22%	10%

Sample	Test	Assigned value (mg/L)	Between-Laboratory CV*	Thompson/ Horwitz CV	Target SD (as CV)
S2	Sb	0.00274	20%	22%	10%
S2	Se	0.00570	8%	22%	10%
S2	Sr	0.106	3.4%	22%	10%
S2	Th	0.00617	4.4%	22%	10%
S2	U	0.00508	5.4%	22%	10%
S2	Zn	0.552	2.6%	17%	10%
S3	TDS	287	7.9%	6.8%	15%
S3	TSS	18.6	11%	10%	20%
S3	TS	316	7.3%	6.7%	15%
S3	Turbidity	5.3 NTU	31%	12%	20%

*Robust between-laboratory CV outliers removed

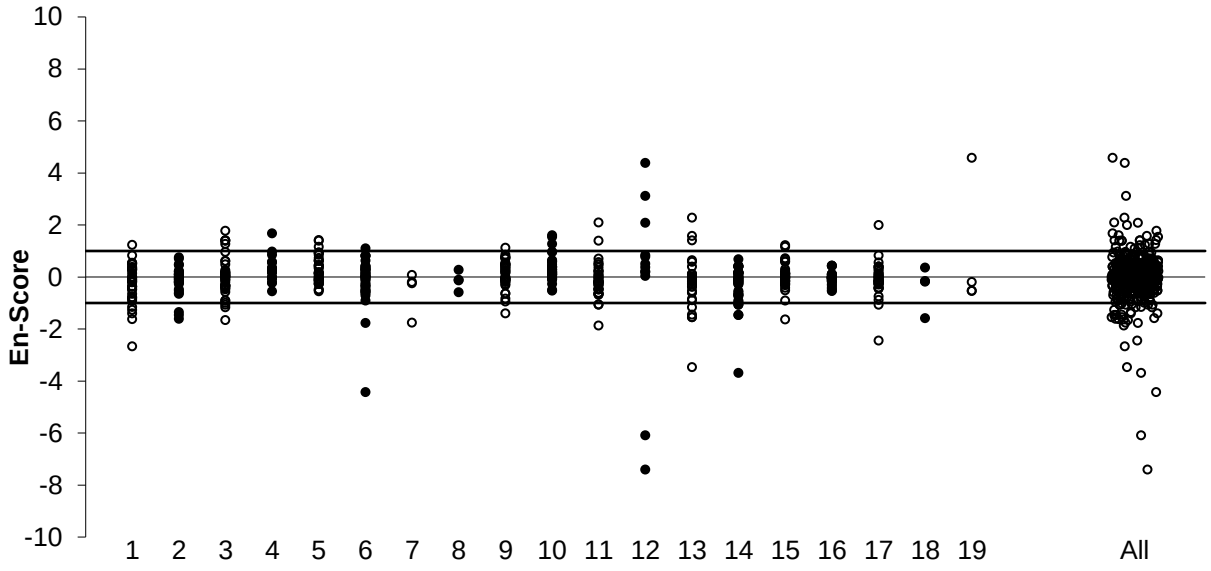
6.4 E_n-score

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

The dispersal of participants' E_n-scores is graphically presented in Figure 45. 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.

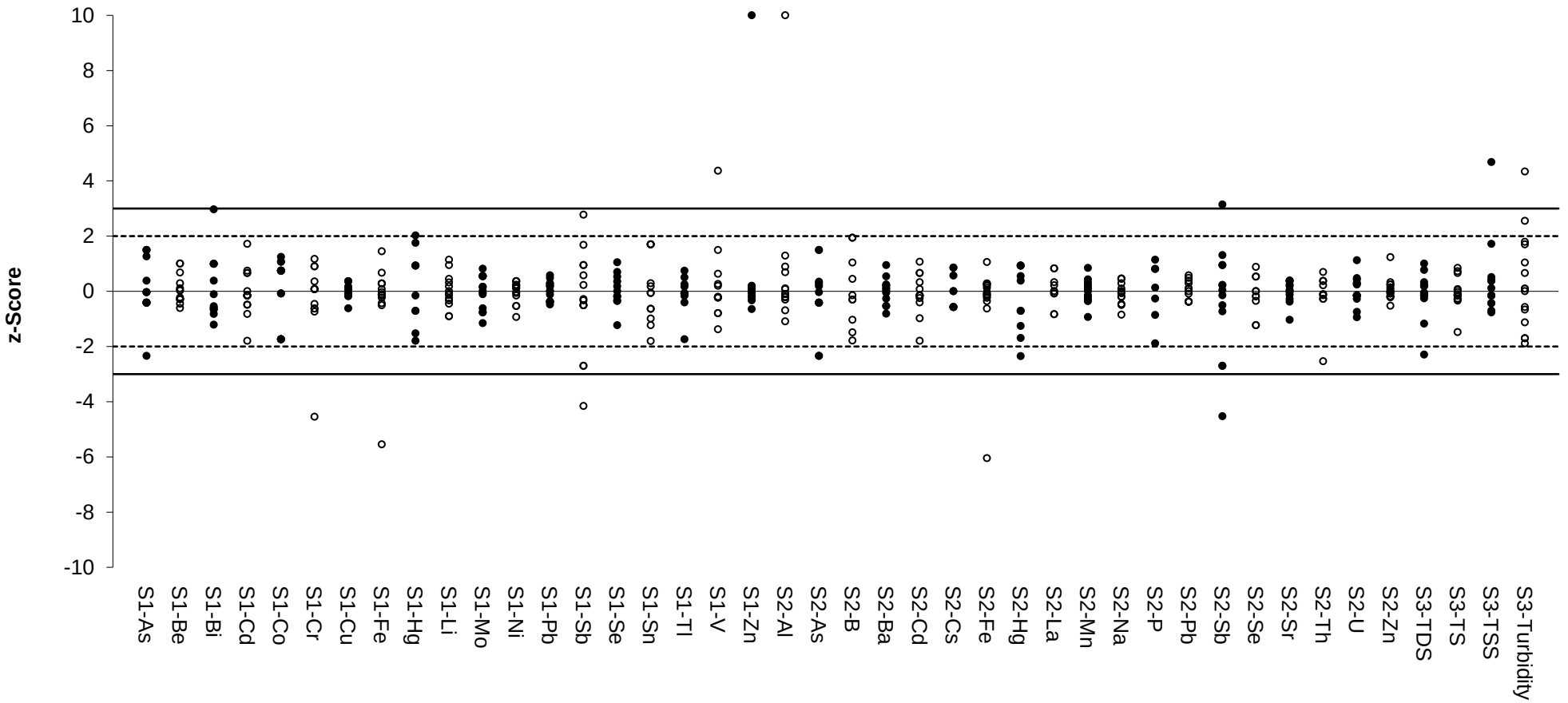
Of 534 results for which E_n-scores were calculated, 471 (88%) returned an acceptable score of $|E_n| < 1.0$, indicating agreement of the participants' results with the assigned values within their respective expanded measurement uncertainties.

Laboratory **15** had the highest number of acceptable E_n-scores at 39 out of 42 reported. All results reported by laboratories **16** (37) and **8** (4) returned acceptable E_n-scores.



Scores of >10 or < -10 have been plotted as 10 or -10.

Figure 45 E_n-Score Dispersal by Laboratory



Scores of >10 and <-10 have been plotted as 10 or -10.

Figure 46 z-Score Dispersal by Test

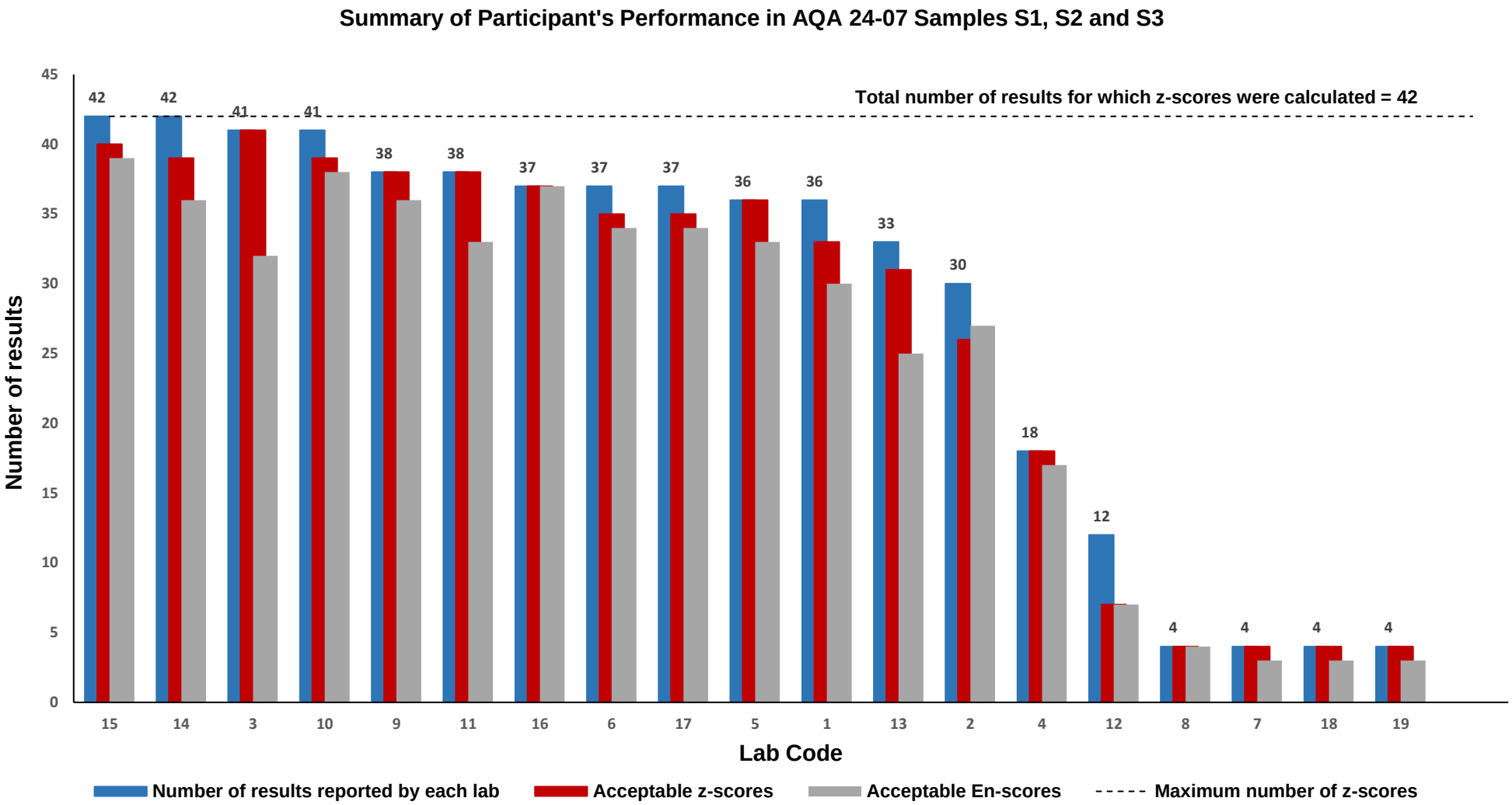


Figure 47: Summary of Participants Performance in AQA 24-07

Table 48 Summary of Participants' Results and Performance for S1

Lab Code	S1-As (mg/L)	S1-Be (mg/L)	S1-Bi (mg/L)	S1-Cd (mg/L)	S1-Co (mg/L)	S1-Cr (mg/L)	S1-Cu (mg/L)	S1-Fe (mg/L)	S1-Hg (mg/L)	S1-Li (mg/L)
AV	0.00261	0.00309	0.00182	0.00122	0.00121	0.00367	0.714	0.253	0.000183	0.022
HV	0.00255	0.00299	0.00164	0.00117	0.0013	0.00345	0.708	0.257	0.000154	0.0226
1	0.003	0.003	0.002	0.0012	0.001	0.004	0.714	0.27	0.0002	0.023
2	0.003	0.003	0.002	0.0012	0.001	<0.005	0.701	0.24	0.00022	NR
3	0.0025	0.0031	0.00170	0.00122	0.0013	0.0037	0.721	0.260	0.000155	0.0217
4	0.00260	0.00318	0.00171	0.00143	0.00134	0.00380	0.711	0.252	<0.0002	0.0241
5	0.0026	0.0033	0.0018	0.0013	0.0013	0.0037	0.7149	0.255	NR	0.022
6	0.00271	0.00295	0.00236	0.00112	0.00136	0.00344	0.7086	0.28958	0.000215	0.02127
7	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
8	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
9	0.003	0.003	NR	0.0012	0.001	0.004	0.67	0.26	0.0002	0.02
10	0.0026	0.0034	0.00189	0.00131	0.0013	0.0041	0.718	0.25	0.00018	0.0227
11	0.0025	0.0034	0.0017	0.0012	0.0012	0.0035	0.706	0.2471	0.00017	0.0214
12	<0.5	NT	NT	<0.005	<0.005	<0.005	0.74	0.1125	<0.25	0.0245
13	0.0025	0.0029	NT	0.0012	0.0013	0.0034	0.74	0.25	NT	NT
14	0.002	0.003	0.002	0.001	0.001	0.002	0.71	0.26	0.0002	0.021
15	0.0025	0.00312	0.00167	0.00116	0.00134	0.0037	0.726	0.25	0.00015	0.0224
16	0.00294	0.00302	0.00172	0.00116	0.00130	0.00344	0.715	0.242	0.00017	0.0218
17	0.0025	0.0031	0.0016	0.0013	0.0012	0.0037	0.703	0.249	<0.0005	0.020
18	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
19	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT

Shaded cells are results which returned a questionable or unacceptable z-score. AV = Assigned Value, HV = Homogeneity Value.

Table 48 Summary of Participants' Results and Performance for S1 (Continued)

Lab Code	S1-Mo (mg/L)	S1-Ni (mg/L)	S1-Pb (mg/L)	S1-Sb (mg/L)	S1-Se (mg/L)	S1-Sn (mg/L)	S1-Tl (mg/L)	S1-V (mg/L)	S1-Zn (mg/L)
AV	0.00758	0.00772	0.0104	0.00274	0.0057	0.00171	0.00121	0.00348	0.552
HV	0.00723	0.00762	0.0103	0.00245	0.00559	0.0015	0.00117	0.00322	0.545
1	0.008	0.008	0.010	0.002	<0.01	0.002	NT	<0.01	0.551
2	0.007	0.008	0.010	0.0016	<0.01	NR	0.0012	0.005	0.54
3	0.0080	0.0076	0.0106	0.0032	0.0055	0.0017	0.00123	0.0034	0.516
4	0.00799	0.00786	0.0106	0.00266	0.00559	0.00174	0.00127	0.00357	0.550
5	0.0075	0.0078	0.0109	0.0026	0.0056	0.0016	0.0013	0.0034	0.5623
6	0.00711	0.00781	0.01068	0.00260	<0.01	0.00154	0.001202	<0.01	0.53362
7	NT	NT	NT	NT	NT	NT	NT	NT	NT
8	NT	NT	NT	NT	NT	NT	NT	NT	NT
9	0.008	0.008	0.011	0.003	0.006	0.002	<0.001	0.004	0.55
10	0.0082	0.0079	0.0107	0.0035	0.0061	0.0017	0.00124	0.0037	0.563
11	0.0077	0.0073	0.0104	0.0028	0.0055	0.0015	0.0012	0.0032	0.5481
12	<0.05	<0.025	<0.25	<0.5	<2.5	NT	NT	<0.01	1.47
13	0.0067	0.0077	0.0099	0.0020	0.0058	0.0014	NT	0.0032	0.56
14	0.007	0.007	0.01	0.003	0.005	0.002	0.001	0.003	0.56
15	0.00754	0.00788	0.0104	0.00265	0.0059	0.0016	0.00116	0.00355	0.559
16	0.00759	0.00767	0.01028	0.0026	0.0057	0.00176	0.00119	0.00341	0.556
17	0.0077	0.0073	0.010	0.0029	0.0063	NT	0.0012	0.0034	0.542
18	NT	NT	NT	NT	NT	NT	NT	NT	NT
19	NT	NT	NT	NT	NT	NT	NT	NT	NT

Shaded cells are results which returned a questionable or unacceptable z-score. AV = Assigned Value, HV = Homogeneity Value.

Table 49 Summary of Participants' Results and Performance for S2 and S3

Lab Code	S2-Al (mg/L)	S2-As (mg/L)	S2-B (mg/L)	S2-Ba (mg/L)	S2-Cd (mg/L)	S2-Cs (mg/L)	S2-Fe (mg/L)	S2-Hg (mg/L)	S2-La (mg/L)	S2-Mn (mg/L)	S2-Na (mg/L)	S2-P (mg/L)
AV	0.0505	0.00261	0.0134	0.037	0.00122	0.00212	0.253	0.000183	0.012	0.0959	15.3	0.185
HV	0.0461	0.00255	0.0144	0.0371	0.00117	0.0023	0.257	0.000154	0.0122	0.092	15.4	0.187
1	0.05	0.002	<0.05	0.034	0.0011	0.002	0.26	0.0002	0.011	0.093	14	<1
2	0.057	0.003	0.014	0.035	0.0013	NR	0.237	0.00016	NR	0.087	NR	NT
3	0.047	0.0025	0.011	0.0377	0.00123	0.002	0.256	0.000152	0.011	0.0945	16	<1
4	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
5	0.051	0.0026	0.016	0.0373	0.0012	0.0023	0.259	NR	0.0119	0.0979	15.189	0.206
6	0.0509	0.00266	<0.05	0.0378	0.00126	0.00224	0.27979	0.000193	0.01199	0.09246	14.5278	<1
7	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
8	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
9	0.05	0.003	<0.02	0.037	0.0012	NR	0.25	0.0002	0.013	0.094	16	0.2
10	0.055	0.0027	0.016	0.0405	0.00135	0.002	0.258	0.00019	0.013	0.104	16	<1
11	0.0495	0.0025	0.0148	0.0379	0.0012	0.0023	0.2484	0.00017	0.0124	0.0962	15.24	0.1874
12	0.41	<0.5	<0.1	NT	<0.005	NT	0.1	<0.25	NT	0.1	15.445	<0.25
13	0.049	0.0025	0.012	0.036	0.0012	NT	0.25	NT	NT	0.096	15	NT
14	0.045	0.002	0.013	0.035	0.001	0.002	0.26	0.0002	0.012	0.099	15	0.15
15	0.050	0.00269	0.0114	0.0374	0.00119	0.00212	0.247	0.00014	0.01225	0.0978	15.3	0.18
16	0.0494	0.00267	0.0132	0.0368	0.00117	0.00212	0.252	0.00017	0.0119	0.0968	15.75	0.169
17	0.054	0.0025	0.013	0.039	0.0013	NT	0.244	<0.0005	NT	0.093	14.6	0.20
18	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
19	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT

Shaded cells are results which returned a questionable or unacceptable z-score. AV = Assigned Value, HV = Homogeneity Value.

Table 49 Summary of Participants' Results and Performance for S2 and S3 (Continued)

Lab Code	S2-Pb (mg/L)	S2-Sb (mg/L)	S2-Se (mg/L)	S2-Sr (mg/L)	S2-Th (mg/L)	S2-U (mg/L)	S2-Zn (mg/L)	S3-TDS (mg/L)	S3-TSS (mg/L)	S3-TS (mg/L)	S3-Turbidity (NTU)
AV	0.0104	0.00274	0.0057	0.106	0.00617	0.00508	0.552	287	18.6	316	5.3
HV	0.0103	0.00245	0.00559	0.111	0.00602	0.00492	0.545	285	21	310	4.6
1	0.010	0.002	<0.01	0.102	0.006	0.005	0.547	301	17	320	3.5
2	0.011	0.0015	<0.01	NR	NR	0.005	0.541	236	20	NR	6
3	0.0107	0.0031	0.0055	0.106	0.0061	0.00532	0.523	295	17	318	6.4
4	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
5	0.0109	0.0026	0.0056	0.1085	0.0064	0.0053	0.5651	NT	NT	NT	NT
6	0.01049	0.00275	<0.01	0.10643	0.00660	0.00524	0.55574	188	15.75	303.25	3.30
7	NT	NT	NT	NT	NT	NT	NT	276	18.0	246	5.4
8	NT	NT	NT	NT	NT	NT	NT	297	18	311	4.59
9	0.010	0.003	0.005	0.11	0.0063	0.005	0.54	280	20	310	4.1
10	0.0108	0.0036	0.0062	0.11	0.0064	0.00565	0.565	281	18	300	5.4
11	0.0105	0.0028	0.0057	0.1046	0.0061	0.0052	0.5497	NT	NT	NT	NT
12	<0.25	<0.5	<2.5	NT	NT	NT	0.62	NT	20.5	347.5	9.9
13	0.010	0.0020	0.0056	0.095	NT	0.0047	0.56	330	20	350	7.2
14	0.01	0.003	0.005	0.11	0.006	0.005	0.57	295	19	314	5.3
15	0.0104	0.00254	0.006	0.103	0.00608	0.00521	0.552	320	36	356	7.10
16	0.01031	0.0027	0.0060	0.1057	NT	0.00494	0.550	NT	NT	NT	NT
17	0.010	0.0028	0.0057	0.108	0.0046	0.0046	0.542	285	16	302	8.0
18	NT	NT	NT	NT	NT	NT	NT	280	20	308	3.5
19	NT	NT	NT	NT	NT	NT	NT	284	25	308	4.7

Shaded cells are results which returned a questionable or unacceptable z-score. AV = Assigned Value, HV = Homogeneity Value.

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 44 to 47.

Rounding of results and reporting results with an insufficient number of significant figures was still the main cause of unacceptable results. Analytical test results are rounded to avoid presenting a misleading impression of precision. However, most of the instrumental techniques used by participants in the present study should be capable of producing results with a reasonable degree of certainty to up to two significant figures at ppb level for most tests. 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. The level of analytes in the two studies were comparable. This suggests that change of unit is a source of confusion and/or that results could have been transferred from calculation spreadsheets that automatically apply the rounding rule. Laboratories 1, 13 and 14 should consider revising their calculation/reporting procedure.
Caution should be exercised when a rounding protocol is designed by a laboratory in order to avoid inadvertent loss of important information. According to Eurachem/CITAC Guide, "The reported result has to provide enough information in case a decision has to be made (e.g. when the result is close to the accepted guideline)."

Antimony was the analyte with the largest number of unacceptable results.

Participants were requested to analyse the drinking water samples for total elements. The method descriptions provided by participants are presented in Tables 1 and 2 and instrumental conditions are presented in Appendix 5.

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

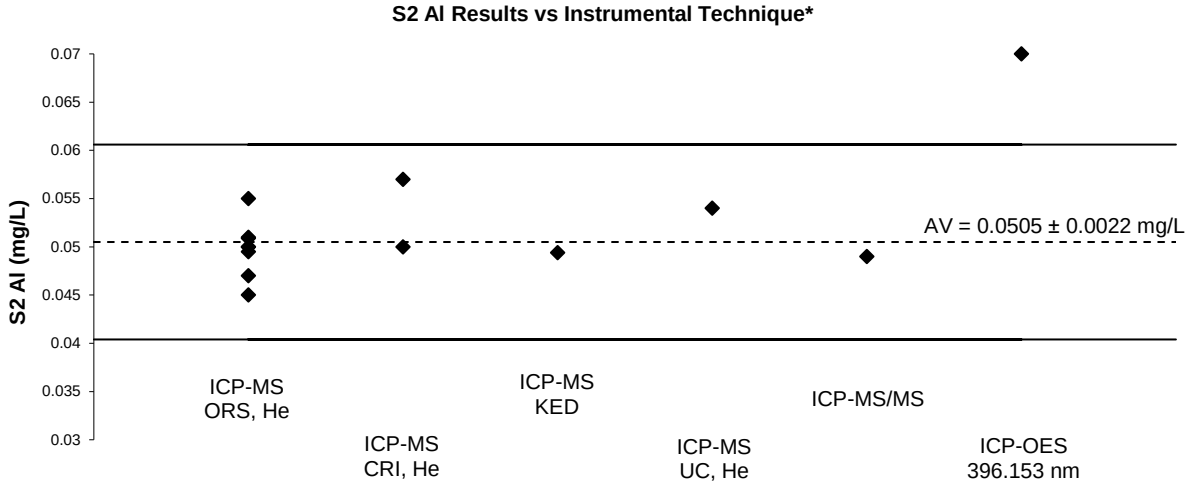
Individual Element Commentary

Aluminium level in S2 was 0.0505 mg/L. The majority of laboratories reported using ICP-MS in standard or collision mode. One laboratory used ICP-MS/MS in standard mode and one used ICP-OES with wavelength 396.153 nm. Contamination may explain the high unacceptable result from ICP-OES measurement. However, for Al measurements at low level by ICP-OES, it is better to use the wavelength 167.019 nm as it has better sensitivity (Figure 48).

Arsenic level in the potable water samples S1 and S2 was 0.00261 mg/L. Of the three questionable results reported for As in the two study samples, all were reported with only one significant figure (Tables 48 and 49). Laboratory 14 should review their preparation and/or reporting procedure as both results reported by them returned questionable z-scores (Figure 49). The instrumental techniques used by participants are presented in Figure 50. Most participants used ICP-MS in collision mode.

Cobalt in S1 was one of the analytes with a large between-laboratory CV (14%). Of 14 results reported for Co, four were reported with only one significant figure. There was no

evident relationship between participants' performance and instrumental technique used (Figure 51).



* Laboratory 12 result of 0.41 mg/L has been plotted as 0.07 mg/L. Horizontal lines on chart correspond to z-scores of 2 and -2.

Figure 48 S2-Al Participants' Results vs Instrumental Technique

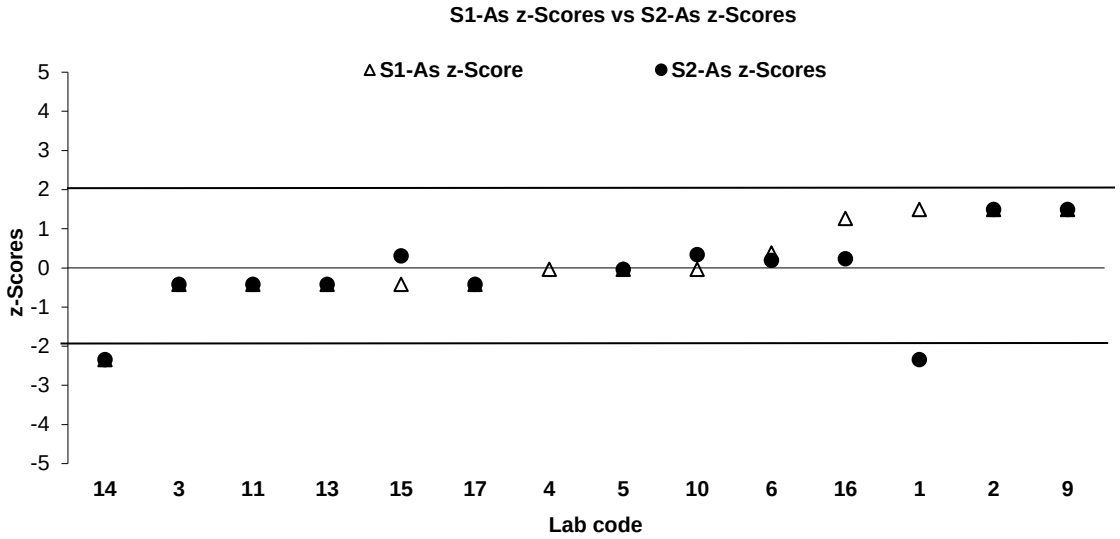


Figure 49 S1 and S2 S2-As Participants' Performance vs Laboratory Code Nr.

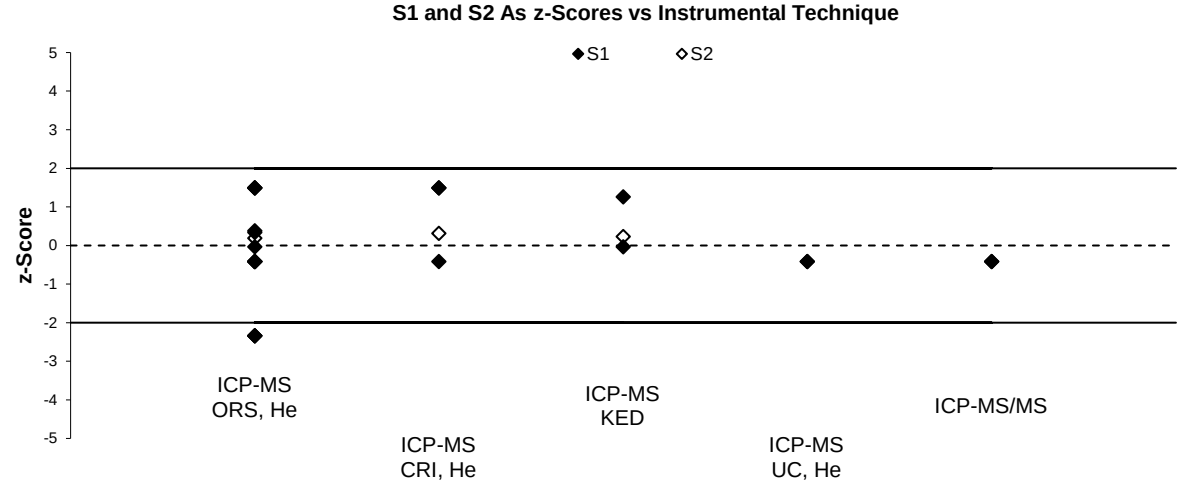
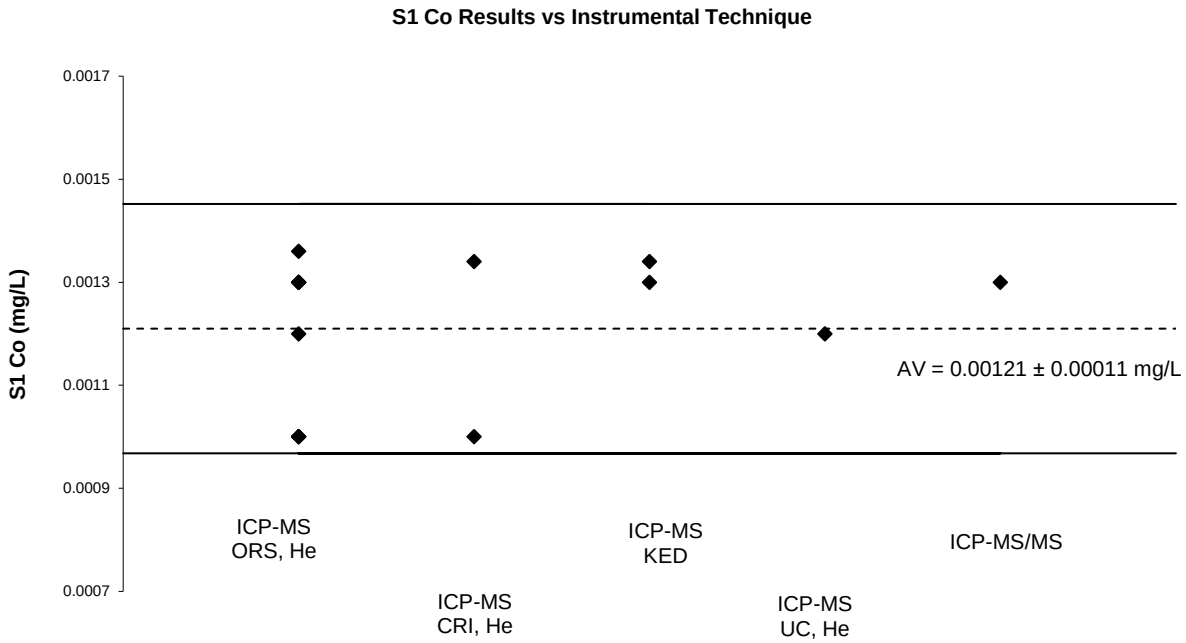


Figure 50 S1 and S2-As Participants' Performance vs Instrumental Technique



*Horizontal lines on chart correspond to z-scores of 2 and -2.

Figure 51 S1-Co Participants' Results vs Instrumental Technique

Mercury Although Hg level in S1 and S2 was the same at 0.000183 mg/L some laboratories reported an acceptable result in one sample and an unacceptable result in the other sample. For Laboratory 2, this is most likely an indication of a poor within-laboratory repeatability precision (Figure 52). For Laboratory 15 while they may have excellent within-laboratory precision as their reported results were in good agreement with each other, they should check for method or laboratories bias as both were low.

Plots of participants performance versus instrumental technique are presented in Figure 53. Most participants used ICP-MS in collision mode or CVAAS.

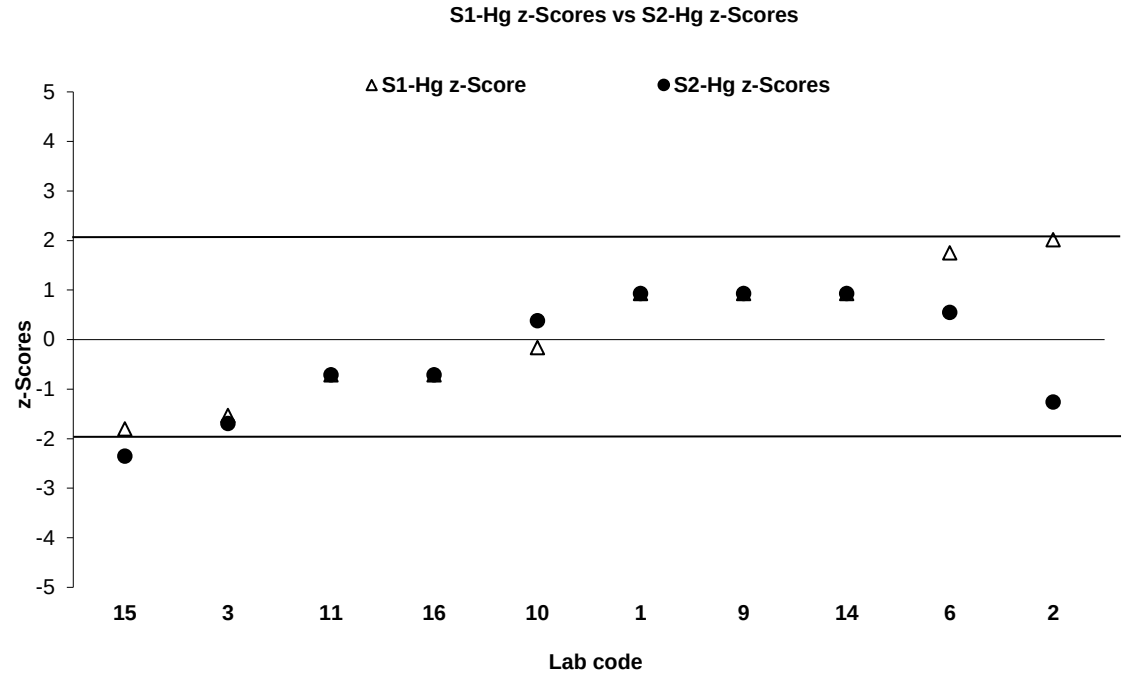


Figure 52 S1 and S2 S2-Hg Participants' Performance vs Laboratory Code Nr.

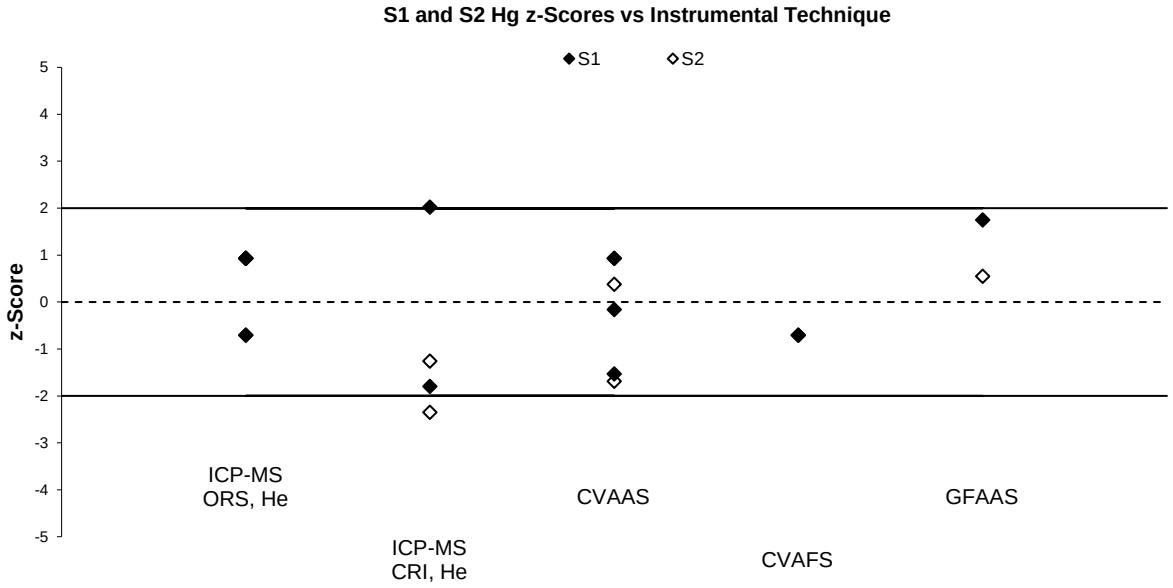
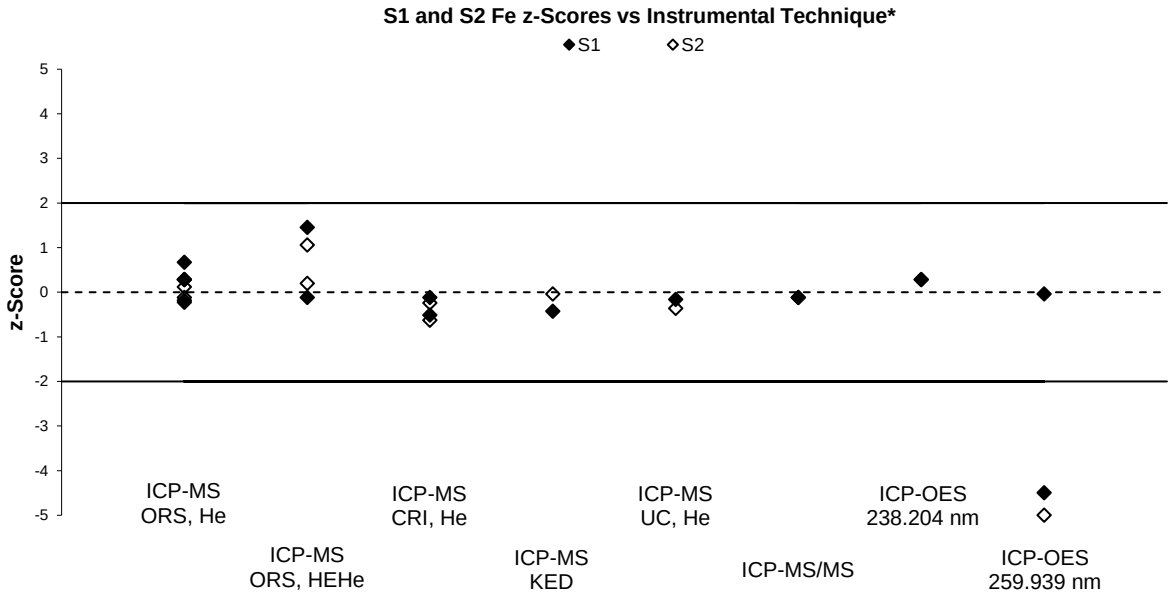


Figure 53 S1and S2-Hg Participants' Performance vs Instrumental Technique

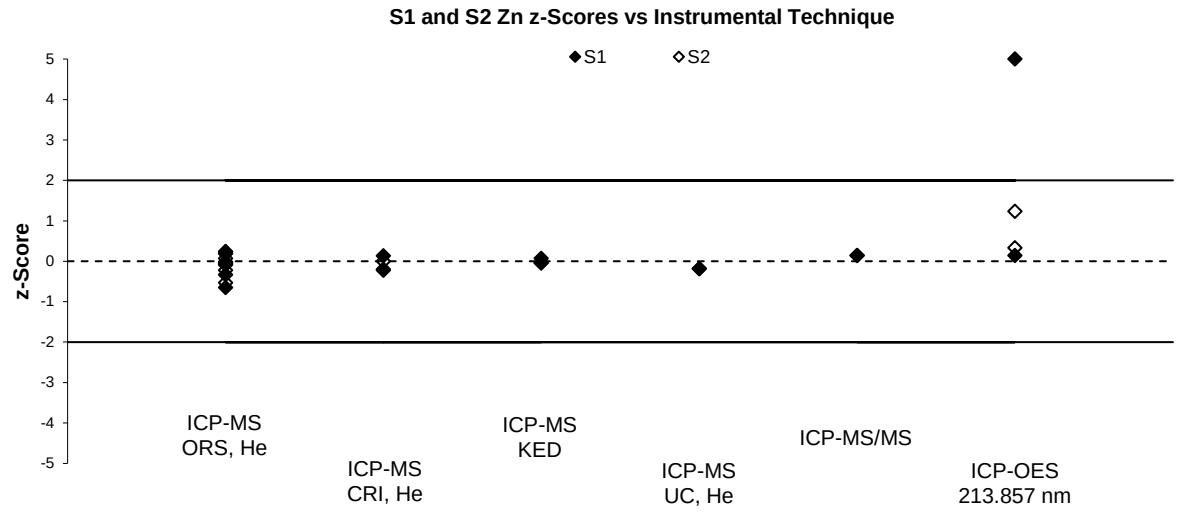
Iron and zinc are known to be ubiquitous in the environment; hence, special precautions (e.g. special gloves) are necessary in order to avoid contamination. Plots of participants' performance versus instrumental technique used are presented in Figures 54 and 55. while plots of participants' performance versus laboratory code number are presented in Figures 56 and 57.

Laboratory 12 should check the method used for Fe measurements. The results reported for Fe in the two identical test samples both returned unacceptable z-scores. Instrument blank contamination may explain the two low results. Sample contamination may also explain the high (unacceptable) result reported by Laboratory 12 for Zn.



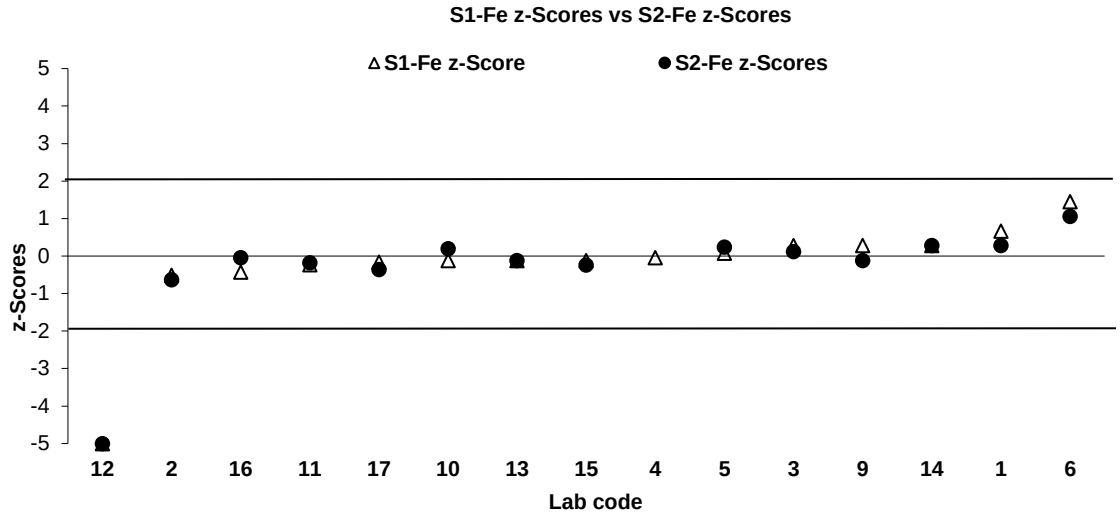
*Laboratory 12 z-scores for S1 (-5.55) and for S2 (-6.05) have been plotted as -4.5 and as -5 respectively.

Figure 54 S1 and S2-Fe Participants' Performance vs Instrumental Technique



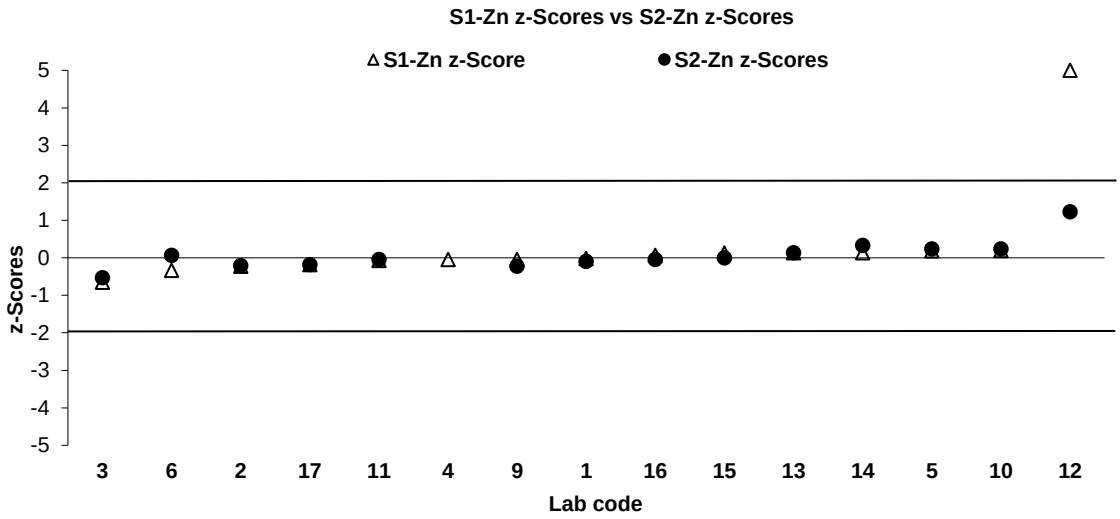
*Laboratory 12 z-score for S1 (16.63) plotted as 5.

Figure 55 S1 and S2-Zn Participants' Performance vs Instrumental Technique



*Laboratory 12 z-scores for S1 (-5.55) and for S2 (-6.05) have been plotted as -5.

Figure 56 S1 and S2-Fe Participants' Performance vs Lab Code Nr.



*Laboratory 12 z-score for S1 (16.63) plotted as 5.

Figure 57 S1 and S2-Zn Participants' Performance vs Lab Code Nr.

Antimony level in the two water samples was 0.00274 mg/L and challenged participants' analytical techniques. Of 13 laboratories who reported results in both test samples, 4 failed to perform acceptably (Figure 58).

For measurement of Sb in the two potable water samples, most participants used ICP-MS in collision mode (Figure 59).

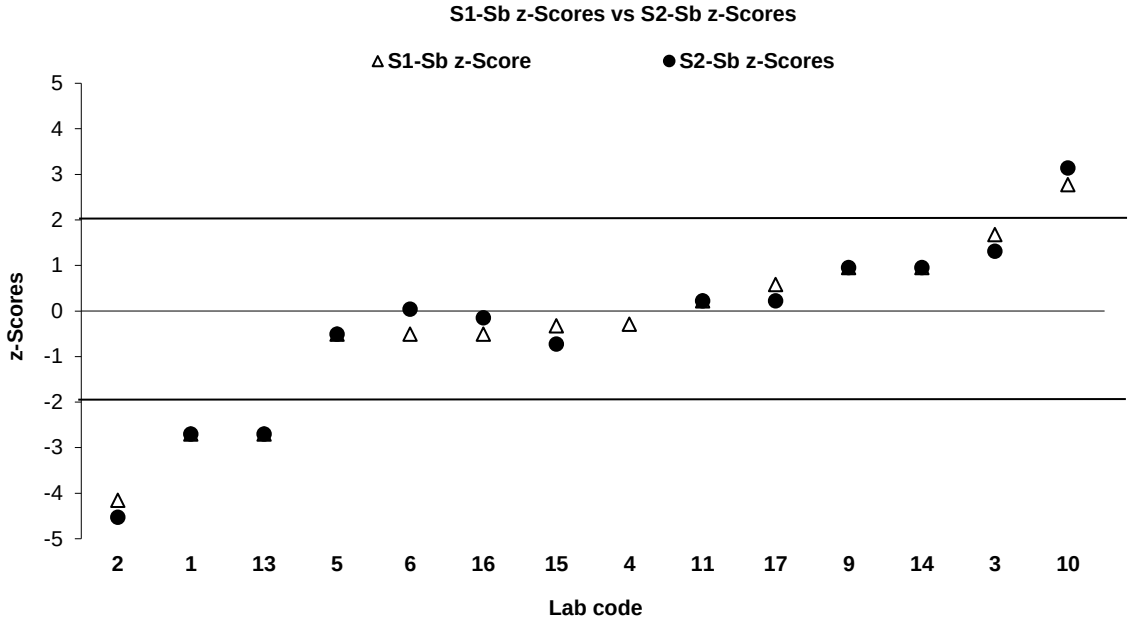


Figure 58 S1 and S2-Sb Participants' Performance vs Lab Code Nr.

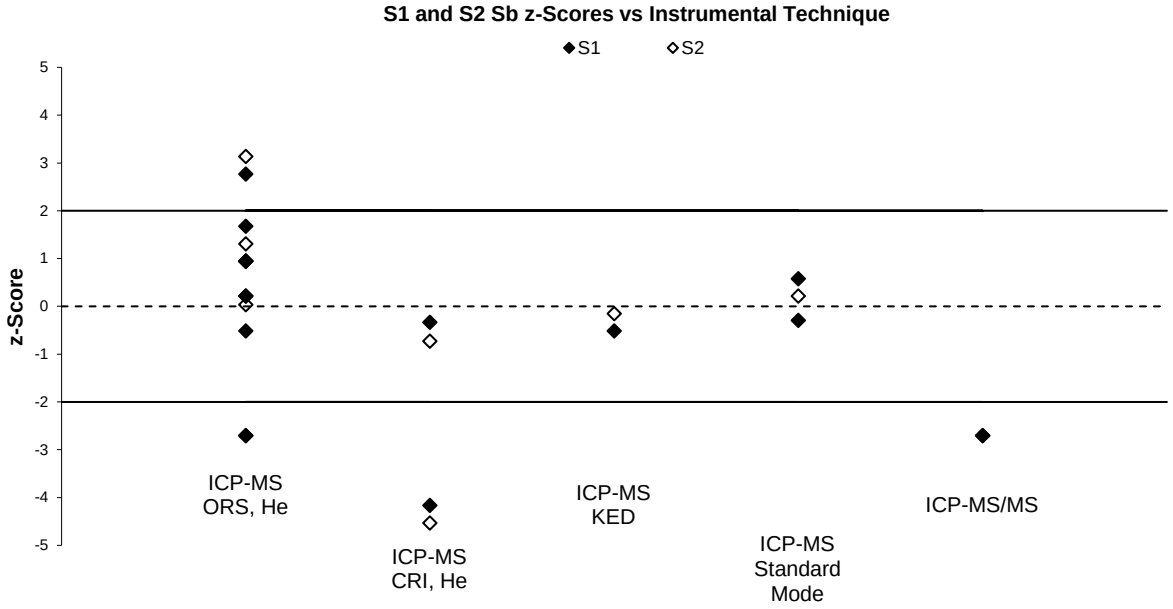


Figure 59 S1 and S2-Sb Participants' Performance vs Instrumental Technique

Selenium All participants who reported results for Se in S1 and S2 performed acceptably. Participants used 6 different instrumental techniques: ICP-MS in standard, collision, reaction, or MS/MS mode and with various collision/reaction gases: He, HEHe and NH_3 (Figure 60).

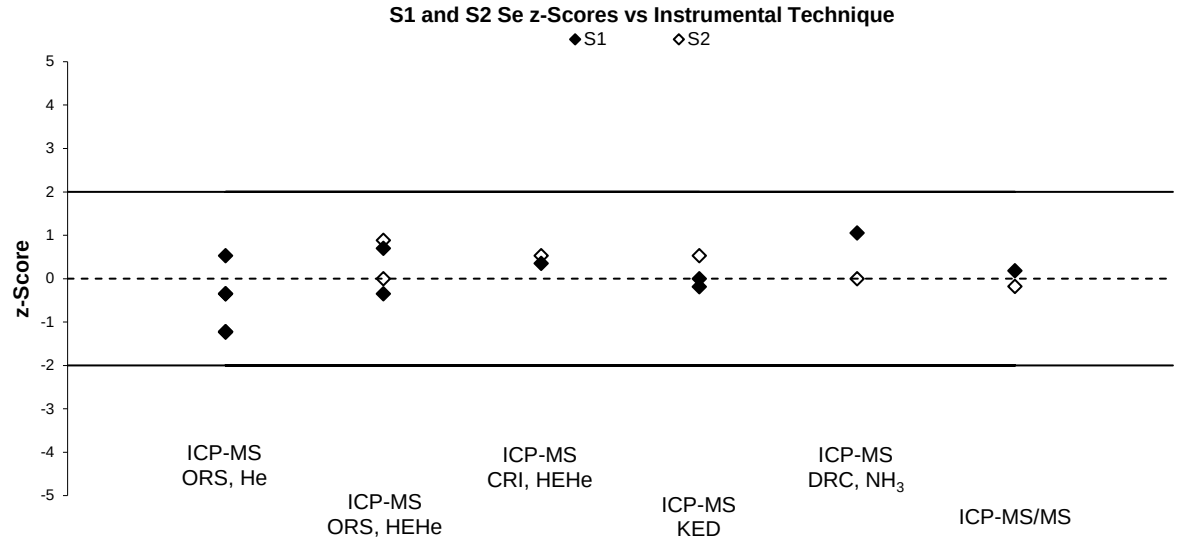


Figure 60 S1and S2-Se Participants' Performance vs Instrumental Technique

Solids and Turbidity The method description provided by participants is presented in Table 2. Most participants used APHA Method 2540 for solids and APHA Method 2130 for Turbidity.

Turbidity measurements challenged participating laboratories, as seen in the large between-laboratory CV of 31%. Laboratory 7 reported: *"As the sample had particles that settle quickly, the turbidity reading was taken as the highest number the instrument gave."* The result reported by them for Turbidity in S3 (5.4 NTU) was in an excellent agreement with the assigned value (5.3 NTU).

6.6 Participants' Within – Laboratory Repeatability

Sample S2 was the same fortified potable water used for Sample S1 preparation. The concentration of As, Cd, Fe, Hg, Pb, Sb, Se, and Zn in S2 was thus expected to be the same as in Sample S1. Scatter plots of z-scores in S1 and S2 for these tests are presented in Figure 61. 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.

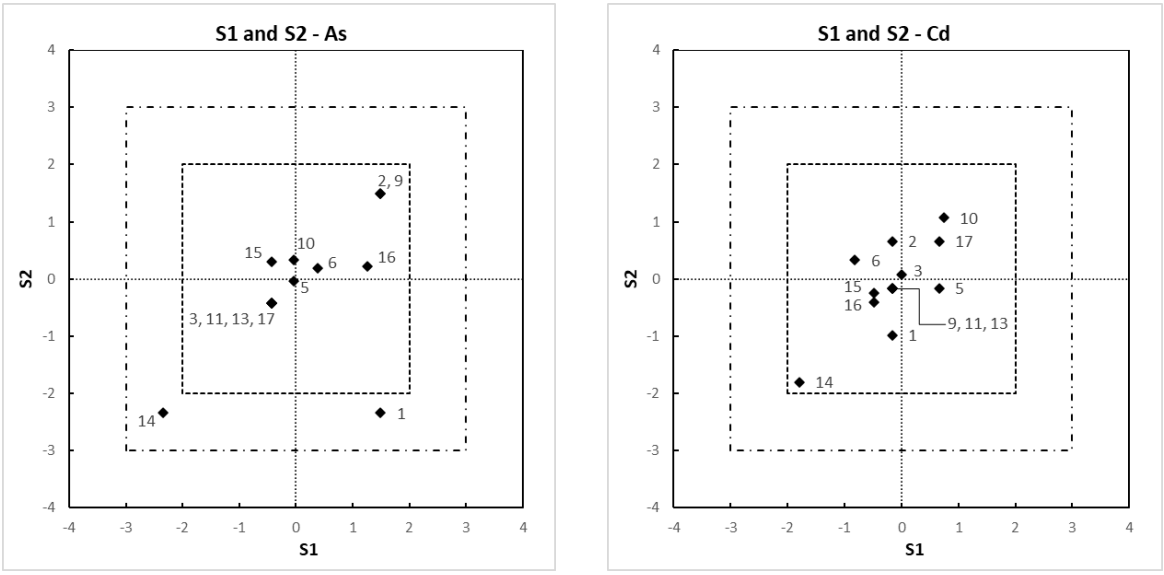
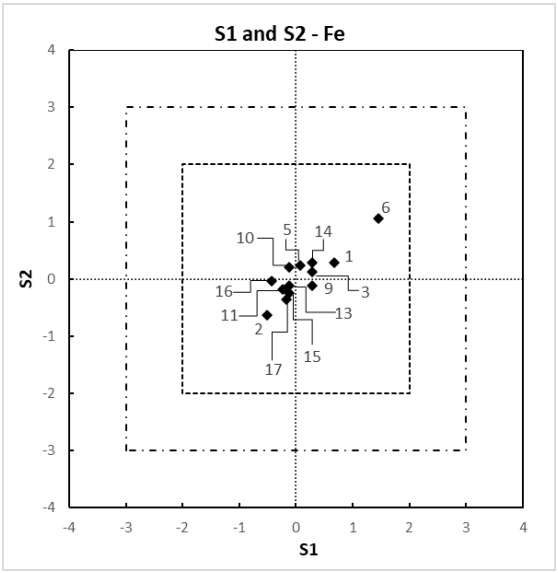
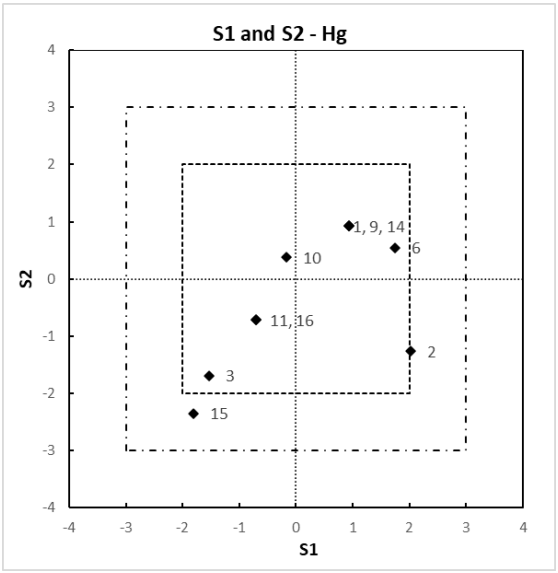
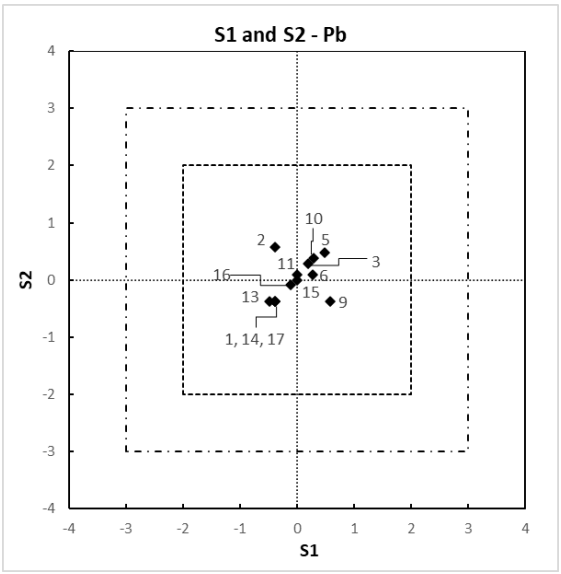


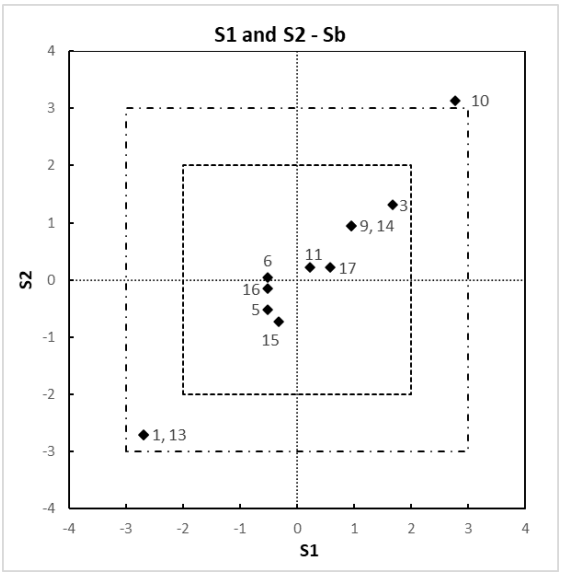
Figure 61 Scatter Plots of z-Scores for S1 and S2



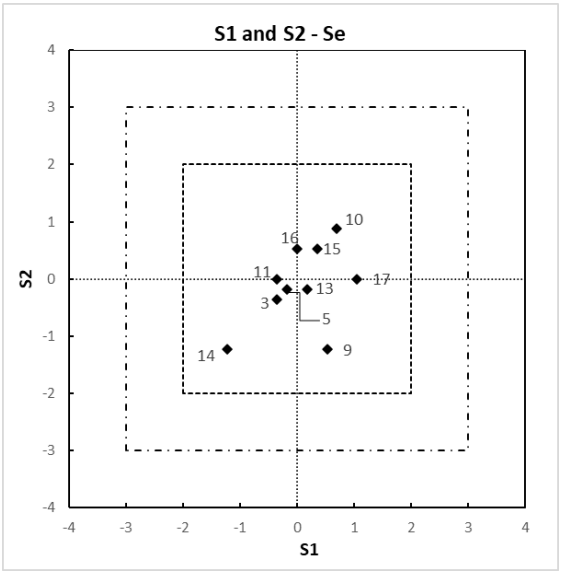


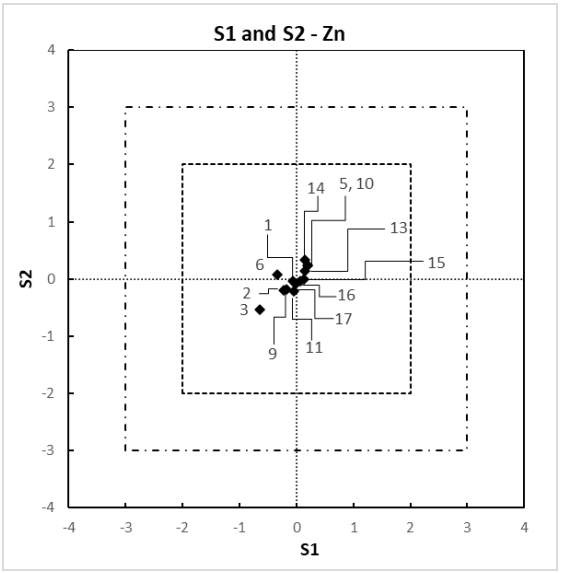
Laboratory 12 is off scale.





Laboratory 2 is off scale.





Laboratory 12 is off scale.

Figure 61 Scatter Plots of z-Scores for S1 and S2 (continued)

Results reported for the above elements and the expanded MU are presented in the bar charts for each of these analytes in both study samples (Figures 62 to 69). In some cases, the expanded measurement uncertainty in the two identical study samples was significantly different (e.g. uncertainties reported by Laboratory 10 for Cd, Laboratory 15 for Hg, Laboratory 10 for Se and by Laboratories 6 and 12 for Zn).

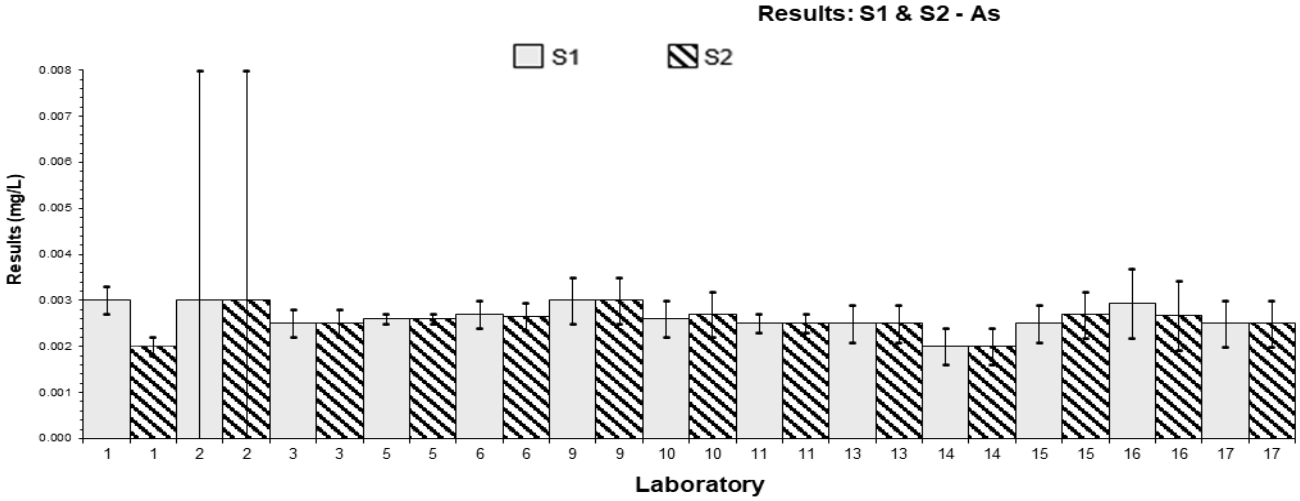


Figure 62 Bar Charts of Results for S1 and S2 – As

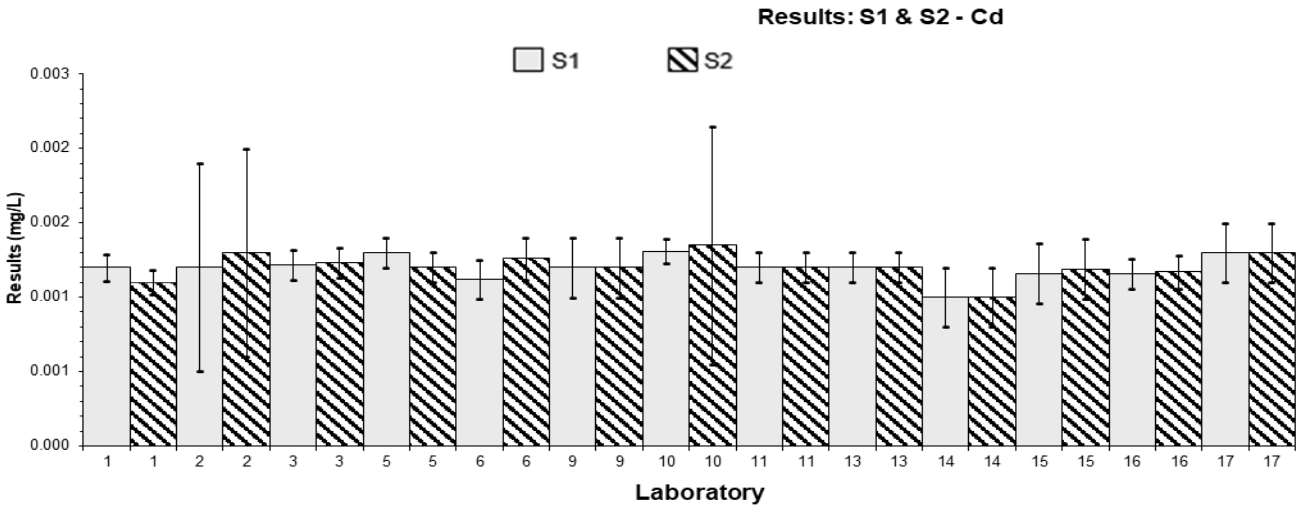


Figure 63 Bar Charts of Results for S1 and S2 – Cd

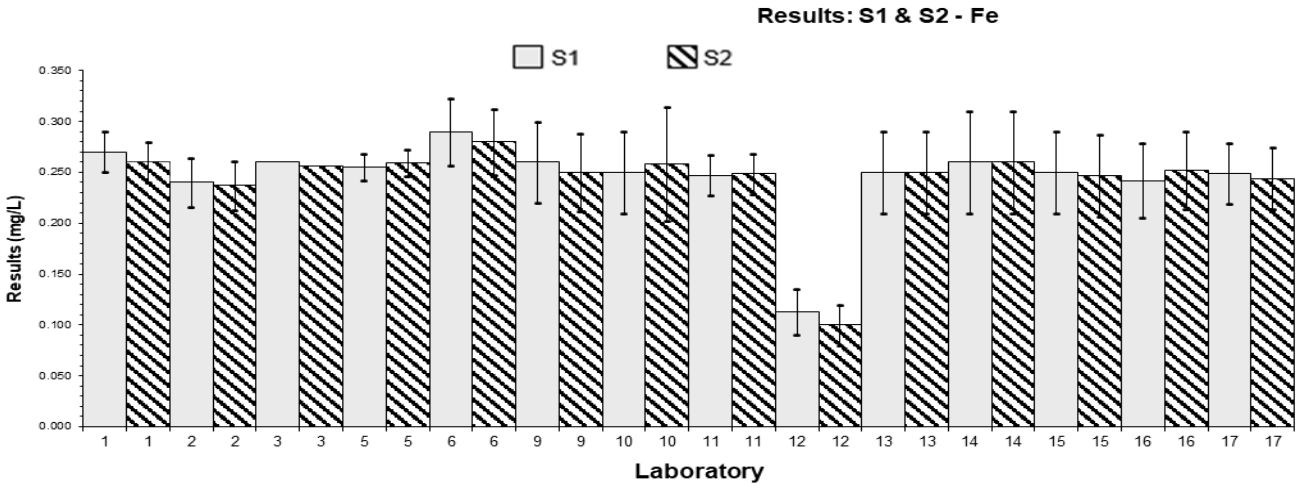


Figure 64 Bar Charts of Results for S1 and S2 – Fe

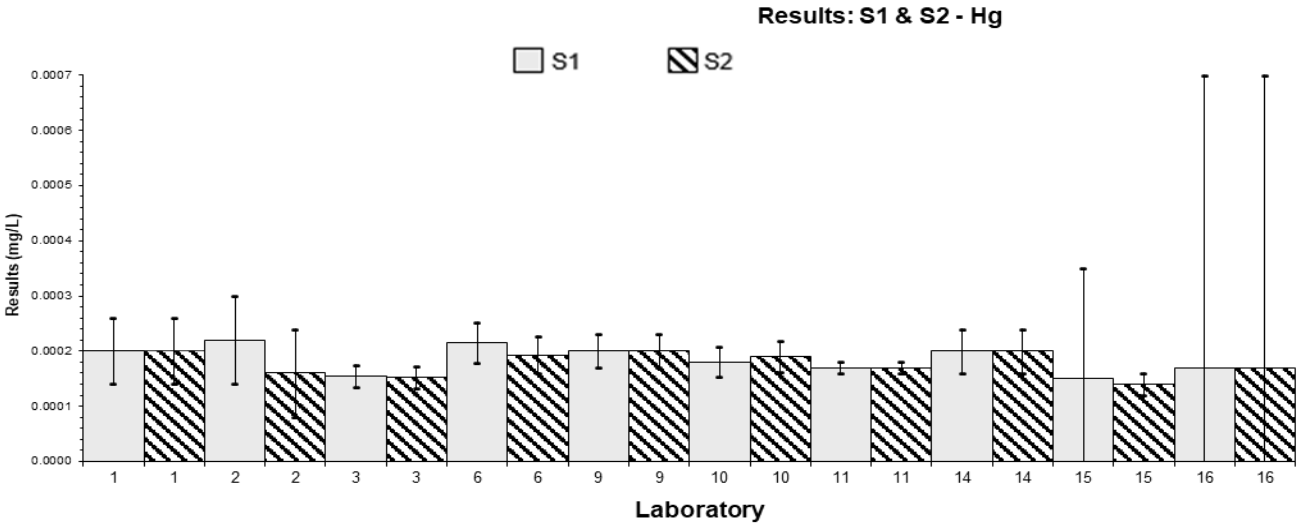


Figure 65 Bar Charts of Results for S1 and S2 – Hg

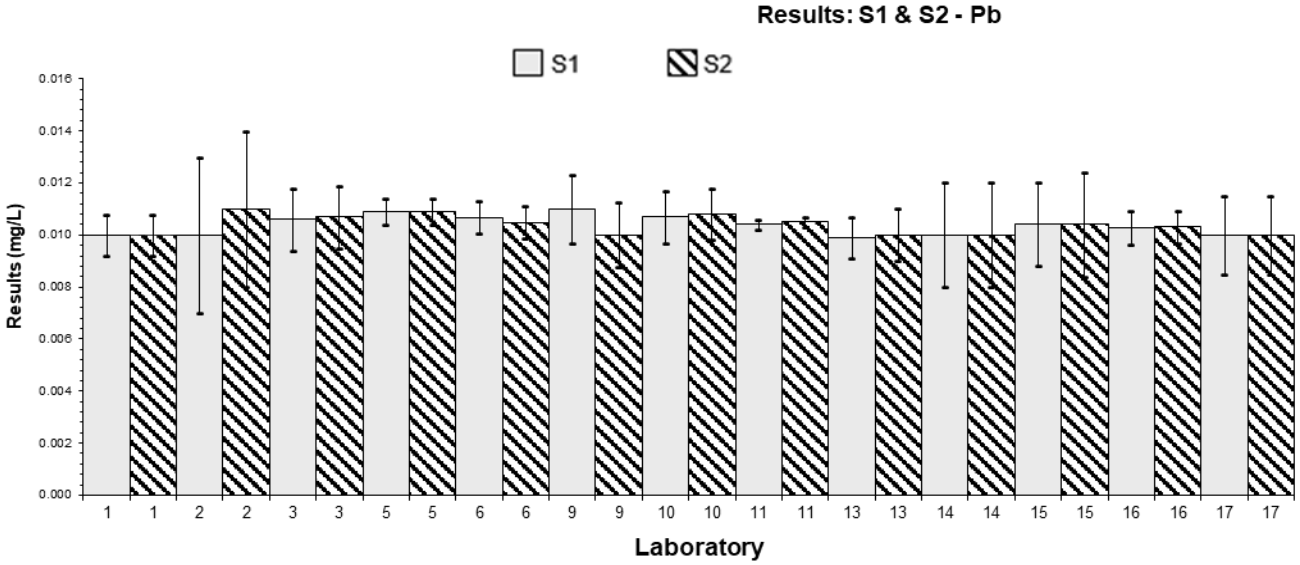


Figure 66 Bar Charts of Results for S1 and S2 – Pb

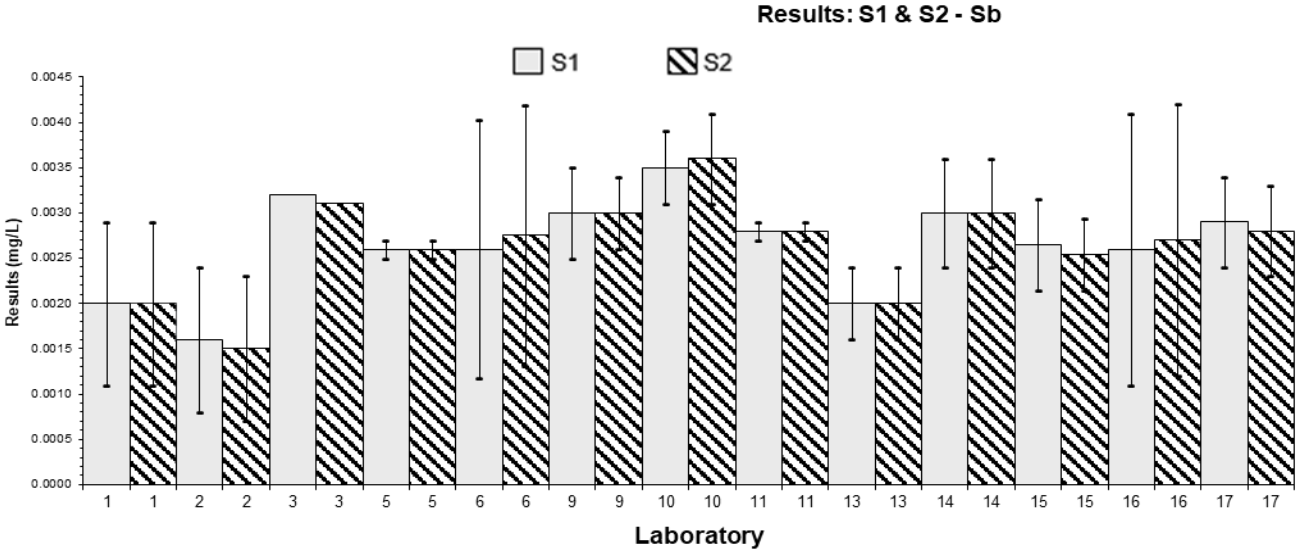


Figure 67 Bar Charts of Results for S1 and S2 – Sb

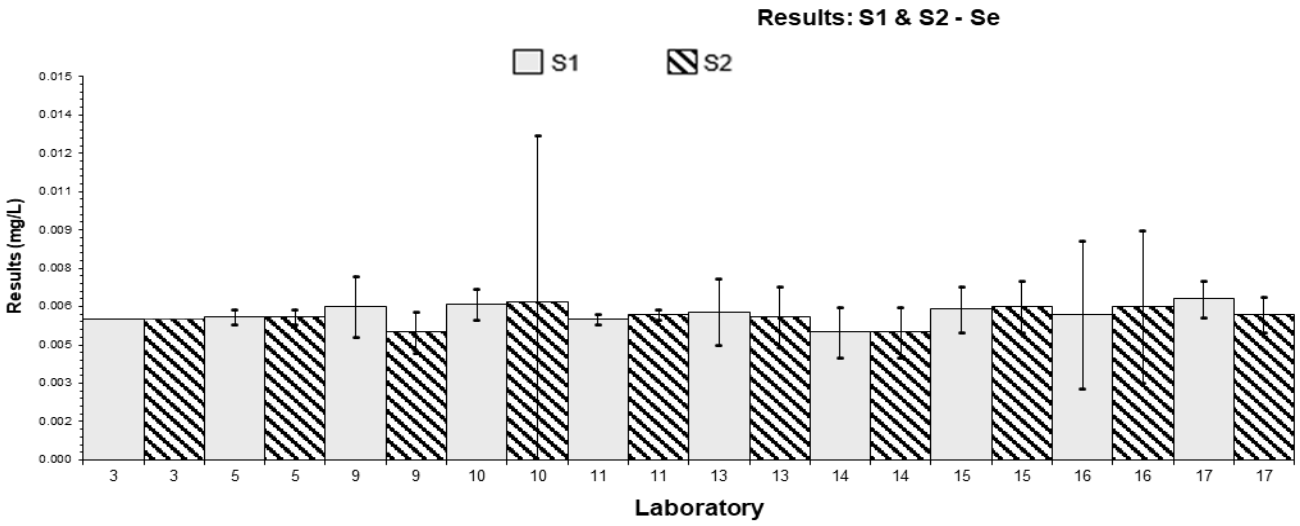


Figure 68 Bar Charts of Results for S1 and S2 – Se

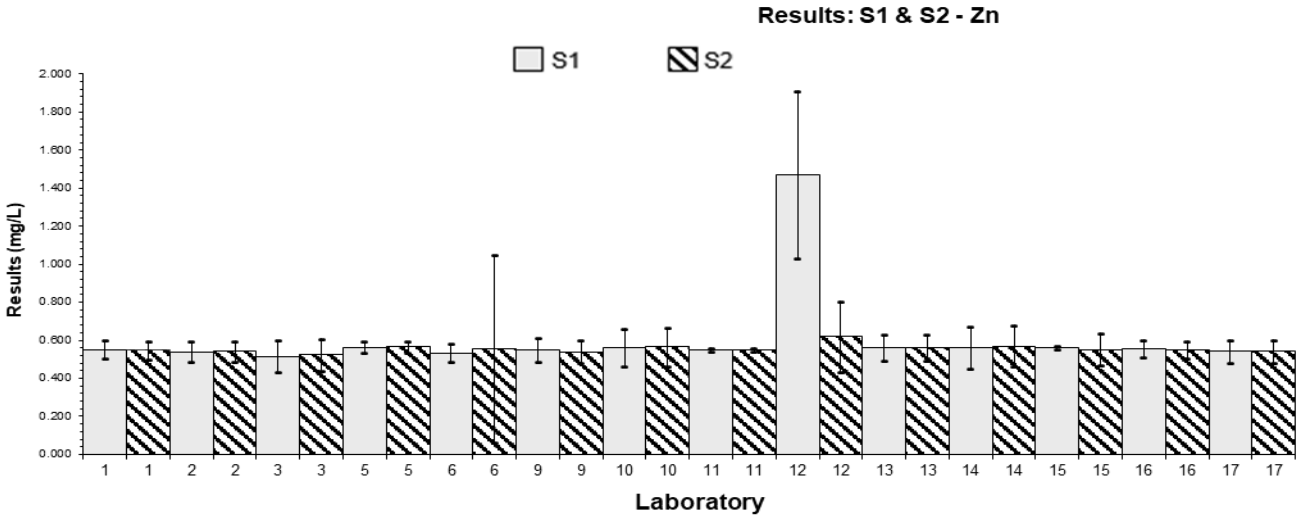


Figure 69 Bar Charts of Results for S1 and S2 – Zn

Laboratories with significant differences in the reported results or uncertainties should consider investigating their methods or procedures.

6.7 Comparison with Previous NMI Proficiency Tests of Metals in Water

AQA 24-07 is the seventh NMI proficiency test of metals in potable water. For most analytes, the same fixed target standard deviation was used in the present study as in previous studies of metals in water. This allowed for a comparison of participants' performance (z-score) over time and provided a benchmark for progressive improvement.

Laboratory capabilities in reporting realistic estimates of uncertainties for metals in potable water has improved over the last 7 years. On average, in the last three studies 88% of participants reported an acceptable E_n-score, an improvement from the 82% average of the first four studies (Figure 70).

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. Over time, laboratories should expect at least 95% of their scores to lie within the range $|z| \leq 2.0$. Scores in the range $2.0 < |z| < 3.0$ occasionally 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.

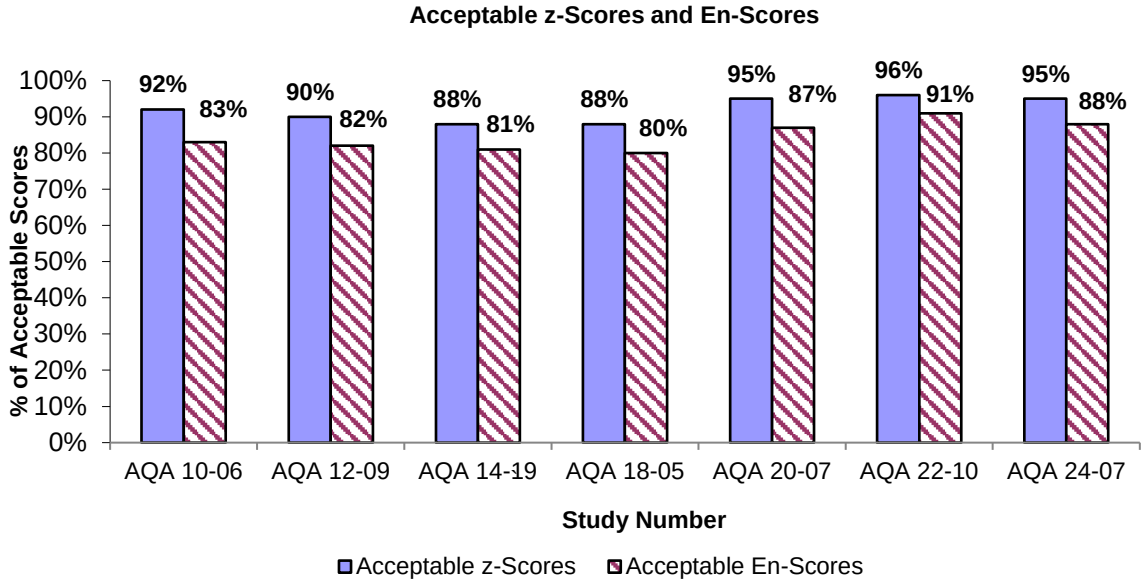


Figure 70 Participants' Performance in Metals in Potable Water Proficiency Studies

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 50).

Table 50 Control Samples Used by Participants

Lab. Code	Description of Control Samples
1	CRM
2	CRM-TMDW LOT 2319113
3	RM
4	CRM – TMDW-B-250 (Trace metals in drinking water std b)
6	Spiked Sample
7	Spiked Sample
8	CRM – Choice Analytical Multi-Analyte Solids Standard & Supelco Turbidity Calibration Standard
13	CRM
16	Spiked Sample
17	CRM-CWW-TM-B and C (metals)
18	RM

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'*[15]

7 REFERENCES

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

[1] ISO/IEC 17043, Conformity assessment – *General requirements for proficiency testing*.

[2] NMI, *Chemical Proficiency Testing Study Protocol*, viewed July 2024, <https://www.industry.gov.au>.

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[4] Thompson, M, Ellison, S. & Wood, R 2006, 'The international harmonized protocol for proficiency testing of (chemical) analytical laboratories', *Pure Appl. Chem*, vol 78, pp 145-196.

[5] National Health and Medical Research Council – *Australian Drinking Water Guidelines*, viewed July 2024, <https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines>.

[6] ISO 13528, *Statistical methods for use in proficiency testing by interlaboratory comparisons.*

[7] Thompson, M, Ellison, S 2000, 'Recent trends in inter-laboratory precision at ppb and sub-ppb concentrations in relation to fitness for purpose criteria in proficiency testing', *Analyst*, vol 125, pp 385-386.

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[9] Eurachem/CITAC Guide, *Quantifying uncertainty in analytical measurement*, 3rd edition, viewed July 2024, <https://www.eurachem.org>.

[10] Bertil, M, Näykki, T, Hovind, H & Krysell, M 2012, *Nordtest Report Handbook for Calculation of Measurement Uncertainty in Environmental Laboratories TR 537*, 4th Edition, Nordest Tekniikantie, Finland, Esopo.

[11] Hibbert, B 2007, *Quality Assurance for the Analytical Chemistry Laboratory*, Oxford University Press.

[12] ISO (2008), *Guide to the Expression of Uncertainty in Measurement (GUM)*, Geneva, Switzerland.

[13] Eurolab 2002, Technical Report No 1/2002 - *Measurement Uncertainty in Testing.*

[14] NMI, *Estimating Measurement Uncertainty for Chemists* – viewed July 2024, <https://www.industry.gov.au/client-services/training-and-assessment>.

[15] JCGM 200:2012, *International vocabulary of metrology – Basic and general concepts and associated terms* (VIM), 3rd edition.

[16] National Measurement Institute, Method Number NT2.47: Determination of Total Acid Extractable and Dissolved Elements in Waters

APPENDIX 1 - SAMPLE PREPARATION, ANALYSIS AND HOMOGENEITY TESTING

Sample Preparation

Samples S1 and S2 were the same potable water material acidified and then fortified for 28 elements.

Sample S3 was prepared by adding High-Level Solids Standard to known amount of potable water.

Sample Analysis and Homogeneity Testing

A partial homogeneity test was conducted for all analytes of interest in samples S1 and S2. Three bottles were analysed in duplicate, and the average of the results was reported as the homogeneity value.

Methodology for Total Elements

For analysis of both samples, a test portion of 7.5 mL was transferred to a 14 mL graduated polypropylene centrifuge tube, diluted to 10 mL with 2% HNO_3 and sent for instrumental analysis.[16]

Testing involved measurements using ICP-MS. The measurement instrument was calibrated using external standards for targeted analytes. A set of quality control samples consisting of blanks, blank matrix spike, duplicates and sample matrix spikes was carried out through the same set of procedures and analysed at the same time as the samples. A summary of the ion/s used for each analyte is given in Table 51.

Table 51 Instrumental Technique used for Total Elements

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	NA	1.33	137
Be	ICP-MS	Rh	NA	NA	1.33	NA	9
Bi	ICP-MS	Ir	ORS	He	1.33	NA	209
Cd	ICP-MS	Rh	ORS	He	1.33	1.33	111
Co	ICP-MS	Rh	ORS	He	1.33	NA	59
Cr	ICP-MS	Rh	ORS	He	1.33	NA	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
Li	ICP-MS	Rh	ORS	He	1.33	NA	7
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	1.33	121
Se	ICP-MS	Rh	ORS	HEHe	1.33	1.33	78
Sn	ICP-MS	Rh	ORS	He	1.33	NA	118
Sr	ICP-MS	Rh	ORS	He	NA	1.33	88
Th	ICP-MS	Rh	ORS	He	NA	1.33	232

Tl	ICP-MS	Rh	ORS	He	1.33	NA	205
U	ICP-MS	Ir	ORS	He	NA	1.33	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, TS, and Turbidity

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

APPENDIX 2 - ASSIGNED VALUE, Z-SCORE AND E_N-SCORE CALCULATION

The assigned value was calculated as the robust average using the procedure described in 'ISO 13528'[6], the uncertainty was estimated 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 52.

Table 52 Uncertainty of Assigned Value for Be in Sample S1

No. results (p)	14
Robust Average	0.00309 mg/L
$S_{rob\ av}$	0.00016 mg/L
$u_{rob\ av}$	0.000053 mg/L
k	2
$U_{rob\ av}$	0.00011 mg/L

The assigned value for Be in Sample S1 is **0.00309 ± 0.00011 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 page 10).

A worked example is set out below in Table 53.

Table 53 z-Score and E_n-score for Be result reported by Laboratory 3 in S1

Be Result mg/L	Assigned Value mg/L	Set Target Standard Deviation	z-Score	E_n-Score
0.0031±0.0005	0.00309±0.00011	10% as CV or 0.10x0.00309= =0.00031mg/L	$z = \frac{(0.0033 - 0.00309)}{0.00031}$ z = 0.03	$En = \frac{(0.0031 - 0.00309)}{\sqrt{0.0005^2 + 0.00011^2}}$ E_n= 0.02

APPENDIX 3 - USING PT DATA FOR UNCERTAINTY ESTIMATION

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 estimate the uncertainty of their measurement results.[10, 12] An example is given.

Between 2012 and 2024, NMI carried out 18 proficiency tests of metals in water. Some of these studies involved analyses of dissolved or total elements at low and high levels in potable, fresh (river), ground, and surface water, and for sea/saline water. Laboratory X submitted results in 13 of these PTs. All reported results returned acceptable z-scores. This data can be separated into two ranges of results: 0.0005 mg/L to 0.01 mg/L and 0.01 mg/L to 0.10 mg/L. The data for potable, fresh (river), ground, and surface water is presented and used as example for uncertainty calculation of Ni in these matrices (Tables 54 and 55).

Table 54 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 13-09	Fresh	0.0044 ± 0.0009	0.00409 ± 0.00017	15	7.9
AQA 15-18	Surface	0.002 ± 0.0003	0.00196 ± 0.00013	10	7.8
AQA 19-07	Fresh	0.0018 ± 0.0004	0.00187 ± 0.00009	10	5.3
AQA 21-09	River	0.0007 ± 0.0002	0.000756 ± 0.000059	8	8.9
AQA 22-10	Potable	0.007 ± 0.0011	0.00845 ± 0.00036	13	6.1
AQA 22-17	River	0.0035 ± 0.00027	0.00364 ± 0.00026	13	10
AQA 23-18	River	0.00565 ± 0.0007	0.00580 ± 0.00024	10	5.2
AQA 24-07	Potable	0.0073 ± 0.0009	0.00770 ± 0.00020	14	3.8
Average					6.9%*
$\boldsymbol{pooled\ s}\% = \sqrt{\frac{(\mathbf{15}-\mathbf{1})\times\mathbf{7.9^2}+(\mathbf{10}-\mathbf{1})\times\mathbf{7.8^2}+\cdots\ldots\ldots\ldots.+(\mathbf{14}-\mathbf{1})\times\mathbf{3.8^2})}{\mathbf{93}-\mathbf{8}}}$					7.1%

* The pooled standard deviation was used.

Table 55 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 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 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 18-05	Potable	0.017 ± 0.002	0.0172 ± 0.0010	16	8.7
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
Average					7.7%*
$\boldsymbol{pooled\ s}\% = \sqrt{\frac{(\mathbf{18}-\mathbf{1})\times\mathbf{6.7^2}+(\mathbf{18}-\mathbf{1})\times\mathbf{7.4^2}+\cdots\ldots\ldots\ldots.+(\mathbf{16}-\mathbf{1})\times\mathbf{6^2})}{\mathbf{152}-\mathbf{10}}}$					8.3%

*The pooled standard deviation was used.

The pooled standard deviation of the robust CV over these PT samples for each concentration range gives estimates of the relative standard uncertainty of 7.1% and 8.3% respectively. Using a coverage factor of two gives relative expanded uncertainties of 15% and 17% respectively, at a level of confidence of approximately 95%.

Table 56 sets out the expanded uncertainty for results of the measurement of Ni in potable, fresh (river), ground, and surface water over the ranges 0.0005 to 0.01 mg/L and 0.01 to 0.10 mg/L.

Table 56 Uncertainty of Ni Results Estimated Using PT Data.

Results mg/L	Uncertainty mg/L
0.00050	0.00008
0.00150	0.00023
0.0100	0.0015
0.075	0.013
0.150	0.026

The estimates of 15% and 17% relative passes the test of being reasonable, and the analysis of the 18 different PT samples over twelve years can be assumed to include all the relevant uncertainty components (different matrices, operators, reagents, calibrators etc.), and so complies with ISO 17025 requirements.[8]

APPENDIX 4 - ACRONYMS AND ABBREVIATIONS

APHA	American Public Health Association
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
DRC	Dynamic Reaction Cell
FIMS	Flow Injection Mercury System
GFAAS	Graphite Furnace Atomic Absorption Spectroscopy
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
k	Coverage Factor
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
NATA	National Association of Testing Authorities
NMI	National Measurement Institute (of Australia)
NR	Not Reported
NT	Not Tested
ORS	Octopole Reaction System
PCV	Performance Coefficient of Variation
PT	Proficiency Test
RA	Robust Average
RM	Reference Material
Robust CV	Robust Coefficient of Variation
Robust SD	Robust Standard Deviation
SI	The International System of Units
SS	Spiked Sample
SV	Spiked or Formulated Concentration of a PT Sample
Target SD	Target Standard Deviation
TDS	Total Dissolved Solids
TS	Total Solids
TSS	Total Suspended Solids
σ	Target Standard Deviation
UC	Universal Cell
USEPA or EPA	United States Environmental Protection Agency

APPENDIX 5 - INSTRUMENT DETAILS FOR TOTAL ELEMENTS

Table 57 Instrument Conditions Al

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	NA	He	NA	1	27 (m/z)
2	ICP-MS	Rh	CRI	He	NA	10	
3	ICP-MS	Sc	ORS	He	NA		27
5	ICP-MS	Rh			NA	1	27
6	ICP-MS	Sc,Ir,Rh	ORS	He	NA		27
9	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	NA	1	27
10	ICP-MS	Sc	ORS	He	NA	NA	27
11	ICP-MS	Sc	ORS	He	NA	1	27
12	ICP-OES-AV	Y			NA	1:10	396.153
13	ICP-MS/MS				NA		
14	ICP-MS	Rh	ORS	He	NA	1.25	
15	ICP-MS		CRI	He	NA		27
16	ICP-MS	Sc	KED	He	NA	1	27
17	ICP-MS	Sc	UC	He	NA	1	27

Table 58 Instrument Conditions As

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	NA	He	1	1	75 (m/z)
2	ICP-MS	Rh	CRI	He	10	10	
3	ICP-MS	Sc	ORS	He			75
4	ICP-MS	Rhodium	KED	He	1:1	NA	NA
5	ICP-MS	Rh			1	1	75
6	ICP-MS	Sc,Ir,Rh	ORS	He			75
9	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	1	75
10	ICP-MS	Rh	ORS	He	NA	NA	75
11	ICP-MS	Y	ORS	He	1	1	75
12	ICP-OES-AV	Y			1:10	1:10	188.979
13	ICP-MS/MS						
14	ICP-MS	Rh	ORS	He	1.25	1.25	75
15	ICP-MS		CRI	He			75
16	ICP-MS	Te	KED	He	1	1	75
17	ICP-MS	Ge	UC	He	1	1	75

Table 59 Instrument Conditions B

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	NA	He	NA	1	11 (m/z)
2	ICP-MS	Sc	CRI	Standard Mode	NA	10	
3	ICP-MS	Ir	ORS		NA		11
5	ICP-MS	Rh			NA	1	11
6	ICP-MS	Sc,Ir,Rh			NA		
9	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	NA	1	11
10	ICP-MS	Sc	ORS	He	NA	NA	11
11	ICP-MS	Sc	ORS	Standard Mode	NA	1	11
12	ICP-OES-AV	Y			NA	1:10	249.677
13	ICP-MS/MS				NA		
14	ICP-MS	Rh	ORS	He	NA	1.25	
15	ICP-MS				NA		11
16	ICP-MS	Sc	KED	He	NA	1	10
17	ICP-MS	Sc	NA	NA	NA	1	10

Table 60 Instrument Conditions Ba

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	NA	He	NA	1	137 (m/z)
2	ICP-MS	Rh	CRI	He	NA	10	
3	ICP-MS	Ir	ORS	He	NA		137
5	ICP-MS	Rh			NA	1	137
6	ICP-MS	Sc,Ir,Rh	ORS	He	NA		
7	NA	NA	NA	NA	NA	NA	NA
9	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	NA	1	137
10	ICP-MS	Rh	ORS	He	NA	NA	137
11	ICP-MS	Rh	ORS	He	NA	1	137
13	ICP-MS/MS				NA		
14	ICP-MS	Rh	ORS	He	NA	1.25	
15	ICP-MS		CRI	He	NA		137
16	ICP-MS	Tb	KED	He	NA	1	137
17	ICP-MS	Rh	NA	NA	NA	1	138

Table 61 Instrument Conditions Be

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	NA	He	1	NA	9 (m/z)
2	ICP-MS	Sc	CRI	Standard Mode	10	NA	
3	ICP-MS	Sc	ORS			NA	9
4	ICP-MS	Rhodium	NA	NA	1:1	NA	NA
5	ICP-MS	Rh			1	NA	9
6	ICP-MS	Sc,Ir,Rh	ORS			NA	9
9	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	NA	9
10	ICP-MS	Sc	ORS	He	NA	NA	9
11	ICP-MS	Sc	ORS	Standard Mode	1	NA	9
13	ICP-MS/MS					NA	
14	ICP-MS	Rh	ORS	He	1.25	NA	
15	ICP-MS					NA	9
16	ICP-MS	Sc	KED	He	1	NA	9
17	ICP-MS	Sc	NA	NA	1	NA	9

Table 62 Instrument Conditions Bi

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	NA	He	1	NA	209 (m/z)
2	ICP-MS	Ir	CRI	He	10	NA	
3	ICP-OES-AV		ORS			NA	
4	ICP-MS	Rhodium	NA	NA	1:1	NA	NA
5	ICP-MS	Rh			1	NA	209
6	ICP-MS	Sc,Ir,Rh	ORS			NA	
9	ICP-OES	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	NA	NA	NA	NA
10	ICP-MS	Ir	ORS	He	NA	NA	209
11	ICP-MS	Ir	ORS	He	1	NA	209
13	ICP-MS/MS					NA	
14	ICP-MS	Rh	ORS	He	1.25	NA	
15	ICP-MS		CRI	He		NA	209
16	ICP-MS	Tb	KED	He	1	NA	209
17	ICP-MS	Ir	NA	NA	1	NA	209

Table 63 Instrument Conditions Cd

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	NA	He	1	1	111 (m/z)
2	ICP-MS	Rh	CRI	He	10	10	
3	ICP-MS	Rh	ORS	He		NA	111
4	ICP-MS	Rhodium	NA	NA	1:1	NA	NA
5	ICP-MS	Rh			1	1	111
6	ICP-OES-AV	Eu			NA		315.885
9	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	1	111
10	ICP-MS	Rh	ORS	He	NA	NA	111
11	ICP-MS	Rh	ORS	He	1	1	111
12	ICP-OES-AV	Y			1:10	1:10	226.502
13	ICP-MS/MS						
14	ICP-MS	Rh	ORS	He	1.25	1.25	
15	ICP-MS		CRI	He			111
16	ICP-MS	Rh	KED	He	1	1	111
17	ICP-MS	Rh	NA	NA	1	1	111

Table 64 Instrument Conditions Co

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	NA	He	1	NA	59 (m/z)
2	ICP-MS	Rh	CRI	He	10	NA	
3	ICP-MS	Sc	ORS	He	NA		59
4	ICP-MS	Rhodium	KED	He	1:1	NA	NA
5	ICP-MS	Rh			1	NA	59
6	ICP-MS	Sc,Ir,Rh	ORS	He		NA	111
9	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	NA	59
10	ICP-MS	Rh	ORS	He	NA	NA	59
11	ICP-MS	Y	ORS	He	1	NA	59
12	ICP-OES-AV	Y			1:10	NA	228.616
13	ICP-MS/MS					NA	
14	ICP-MS	Rh	ORS	He	1.25	NA	
15	ICP-MS		CRI	He		NA	59
16	ICP-MS	Ga	KED	He	1	NA	59
17	ICP-MS	Ge	UC	He	1	NA	59

Table 65 Instrument Conditions Cr

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	NA	He	1	NA	52 (m/z)
2	ICP-MS	Rh	CRI	He	10	NA	
3	ICP-MS	Sc	ORS	He		NA	52
4	ICP-MS	Rhodium	KED	He	1:1	NA	NA
5	ICP-MS	Rh			1	NA	52
6	ICP-MS	Sc,Ir,Rh	ORS	He	NA		59
9	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	NA	52
10	ICP-MS	Sc	ORS	He	NA	NA	52
11	ICP-MS	Sc	ORS	He	1	NA	52
12	ICP-OES-AV	Y			1:10	NA	267.716
13	ICP-MS/MS					NA	
14	ICP-MS	Rh	ORS	He	1.25	NA	
15	ICP-MS		CRI	He		NA	52
16	ICP-MS	Sc	KED	He	1	NA	52
17	ICP-MS	Sc	UC	He	1	NA	52

Table 66 Instrument Conditions Cs

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	ir, Rh & Sc	NA	He	NA	1	133 (m/z)
5	ICP-MS	Rh			NA	1	133
6	ICP-MS	Sc,Ir,Rh	ORS	He		NA	52
9	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	NA	NA	NA
10	ICP-MS	Rh	ORS	He	NA	NA	133
11	ICP-MS	Rh	ORS	He	NA	1	133
13	ICP-MS/MS				NA		
14	ICP-MS	Rh	ORS	He	NA	1.25	
15	ICP-MS		CRI	He	NA		133
16	ICP-MS	Tb	KED	He	NA	1	133

Table 67 Instrument Conditions Cu

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	NA	He	1	NA	63 (m/z)
2	ICP-MS	Rh	CRI	He	10	NA	
3	ICP-MS	Sc	ORS	He		NA	53
4	ICP-MS	Rhodium	KED	He	1:4	NA	NA
5	ICP-MS	Rh			1	NA	63
6	ICP-MS	Sc,Ir,Rh	ORS	He		NA	63
9	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	NA	63
10	ICP-MS	Rh	ORS	He	NA	NA	63
11	ICP-MS	Y	ORS	He	1	NA	63
12	ICP-OES-AV	Y			1:10	NA	324.752
13	ICP-MS/MS					NA	
14	ICP-OES-AV	Y	NA	NA	2	NA	
15	ICP-MS		CRI	He		NA	63
16	ICP-MS	Ga	KED	He	1	NA	63
17	ICP-MS	Ge	UC	He	1	NA	63

Table 68 Instrument Conditions Fe

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	NA	He	1	1	56 (m/z)
2	ICP-MS	Rh	CRI	He	10	10	
3	ICP-MS	Sc	ORS	He	NA		56
4	ICP-OES-RV	YTTRIUM	NA	NA	1:1	NA	259.939
5	ICP-MS	Rh			1	1	57
6	ICP-MS	Sc,Ir,Rh	ORS	HEHe	NA		56
9	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	1	56
10	ICP-MS		ORS	HEHe	NA	NA	56
11	ICP-MS	Sc	ORS	He	1	1	56
12	ICP-OES-AV	Y			1:10	1:10	259.939
13	ICP-MS/MS						
14	ICP-OES-AV	Y	NA	NA	1.25	1.25	
15	ICP-MS		CRI	He			56
16	ICP-MS	Sc	KED	He	1	1	56
17	ICP-MS	Sc	UC	He	1	1	56

Table 69 Instrument Conditions Hg

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	CVAAS	NA	NA	NA	1	1	253 nm
2	ICP-MS	Ir	CRI	He	10	10	
3	CVAAS					NA	153
4	ICP-MS	Rhodium	NA	NA	1:1	NA	NA
6	GFAAS	-	NA	NA		NA	
9	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	1	201
10	CVAAS	N/A	ORS	He	NA	NA	253.7nm
11	ICP-MS	Ir	ORS	He	1	1	202
12	FIMS				1:10	1:10	194.168
13	ICP-MS/MS						
14	ICP-MS	Rh	ORS	He	1.25	1.25	
15	ICP-MS		CRI	He			202
16	Atomic Fluorescence	NA	NA	NA	5	5	254
17	ICP-MS	Ir	NA	NA	1	1	201

Table 70 Instrument Conditions La

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	NA	He	NA	1	139 (m/z)
3	ICP-MS	Rh	ORS	He	NA		139
5	ICP-MS	Rh			NA	1	139
6	ICP-MS	Sc,Ir,Rh	ORS	He	NA		
9	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	NA	1	139
10	ICP-MS	Rh	ORS	He	NA	NA	140
11	ICP-MS	Rh	ORS	He	NA	1	139
13	ICP-MS/MS				NA		
14	ICP-MS	Rh	ORS	He	NA	1.25	
15	ICP-MS		CRI	He	NA		139
16	ICP-MS	Tb	KED	He	NA	1	139

Table 71 Instrument Conditions Li

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	NA	He	1	NA	7 (m/z)
3	ICP-MS	Sc	ORS			NA	7
4	ICP-MS	Rhodium	NA	NA	1:1	NA	NA
5	ICP-MS	Rh			1	NA	7
6	ICP-MS	Sc,Ir,Rh	ORS	NA		NA	
9	ICP-OES	Cs,Y	NA	NA	1	NA	670.783
10	ICP-MS	Sc	ORS	He	NA	NA	7
11	ICP-MS	Sc	ORS	Standard Mode	1	NA	7
12	ICP-OES-AV	Y			1:10	NA	670.784
13	ICP-MS/MS					NA	
14	ICP-MS	Rh	ORS	He	1.25	NA	
15	ICP-MS					NA	7
16	ICP-MS	Sc	KED	He	1	NA	7
17	ICP-MS	Sc	NA	NA	1	NA	7

Table 72 Instrument Conditions Mn

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	NA	He	NA	1	55 (m/z)
2	ICP-MS	Rh	CRI	He	NA	10	
3	ICP-OES-AV	Eu	ORS		NA		
5	ICP-MS	Rh			NA	1	55
6	ICP-MS	Sc,Ir,Rh	ORS	He	NA		55
9	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	NA	1	55
10	ICP-MS	Sc	ORS	He	NA	NA	55
11	ICP-MS	Y	ORS	He	NA	1	55
12	ICP-OES-AV	Y			NA	1:10	257.61
13	ICP-MS/MS				NA		
14	ICP-OES-AV	Y	NA	NA	NA	2	
15	ICP-MS		CRI	He	NA		55
16	ICP-MS	Sc	KED	He	NA	1	55
17	ICP-MS	Sc	UC	He	NA	1	55

Table 73 Instrument Conditions Mo

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	NA	He	1	NA	95 (m/z)
2	ICP-MS	Rh	CRI	He	10	NA	
3	ICP-MS	Sc	ORS	He	NA		55
4	ICP-MS	Rhodium	NA	NA	1:1	NA	NA
5	ICP-MS	Rh			1	NA	95
6	ICP-MS	Sc,Ir,Rh	ORS	He		NA	95
9	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	NA	95
10	ICP-MS	Rh	ORS	He	NA	NA	95
11	ICP-MS	Rh	ORS	He	1	NA	95
12	ICP-OES-AV	Y			1:10	NA	203.301
13	ICP-MS/MS					NA	
14	ICP-MS	Rh	ORS	He	1.25	NA	
15	ICP-MS		CRI	He		NA	95
16	ICP-MS	Rh	KED	He	1	NA	98
17	ICP-MS	Rh	NA	NA	1	NA	95

Table 74 Instrument Conditions Na

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-OES	Eu & Cs	NA	NA	NA	1	330.237, 589.592nm
3	ICP-MS	Rh	ORS	He		NA	95
5	ICP-MS	Rh			NA	1	23
6	ICP-MS	Sc,Ir,Rh	ORS	He		NA	60
9	ICP-OES	Cs,Y	NA	NA	NA	1	588.995
10	ICP-OES-AV-buffer	Eu	N/A	N/A	NA	NA	589.592nm
11	ICP-MS	Sc	ORS	He	NA	1	23
12	ICP-OES-AV	Y			NA	1:10	589.592
13	ICP-MS/MS				NA		
14	ICP-OES-AV	Y	NA	NA	NA	2	
15	ICP-OES-AV				NA		589.5
16	ICP-MS	Sc	KED	He	NA	1	23
17	ICP-MS	Sc	UC	He	NA	1	23

Table 75 Instrument Conditions Ni

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICPMS	Ir, Rh & Sc	NA	He	1	NA	60 (m/z)
2	ICP-MS	Rh	CRI	He	10	NA	
3	ICP-MS	Sc	ORS	He		NA	60
4	ICP-MS	Rhodium	KED	He	1:1	NA	NA
5	ICP-MS	Rh			1	NA	60
6	ICP-OES-AV	Eu			NA		
9	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	NA	60
10	ICP-MS	Rh	ORS	He	NA	NA	60
11	ICP-MS	Y	ORS	He	1	NA	60
12	ICP-OES-AV	Y			1:10	NA	231.604
13	ICP-MS/MS					NA	
14	ICP-MS	Rh	ORS	He	1.25	NA	
15	ICP-MS		CRI	He		NA	60
16	ICP-MS	Ga	KED	He	1	NA	60
17	ICP-MS	Ge	UC	He	1	NA	60

Table 76 Instrument Conditions P

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-OES	Eu & Cs	NA	NA	NA	1	185.827 nm
3	ICP-OES-AV	Eu			NA		186
5	ICP-MS	Rh			NA	1	31
6	ICP-MS	Sc,Ir,Rh	ORS	He			208
9	ICP-OES	Cs,Y	NA	NA	NA	1	213.618
10	ICP-OES-AV-buffer	Eu	N/A	N/A	NA	NA	185.827nm
11	ICP-MS	Sc	ORS	HEHe	NA	1	31
12	ICP-OES-AV	Y			NA	1:10	178.221
13	ICP-MS/MS				NA		
14	ICP-OES-AV	Y	NA	NA	NA	2	
15	ICP-OES-AV				NA		177.4
16	ICP-MS	Sc	KED	He	NA	1	31
17	ICP-MS	Sc	UC	He	NA	1	31

Table 77 Instrument Conditions Pb

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICPMS	Ir, Rh & Sc	NA	He	1	1	208 (m/z)
2	ICP-MS	Ir	CRI	He	10	10	
3	ICP-MS	Ir	ORS	He			208
4	ICP-MS	Rhodium	NA	NA	1:1	NA	NA
5	ICP-MS	Rh			1	1	208
6	ICP-OES-AV	Eu			NA		
9	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	1	208
10	ICP-MS	Ir	ORS	He	NA	NA	208
11	ICP-MS	Ir	ORS	He	1	1	208
12	ICP-OES-AV	Y			1:10	1:10	220.353
13	ICP-MS/MS						
14	ICP-MS	Rh	ORS	He	1.25	1.25	
15	ICP-MS		CRI	He			sum of isotopes
16	ICP-MS	Tb	KED	He	1	1	206+207+208
17	ICP-MS	Ir	NA	NA	1	1	206+207+208

Table 78 Instrument Conditions Sb

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	NA	He	1	1	121 (m/z)
2	ICP-MS	Rh	CRI	He	10	10	
3	ICP-MS	Rh	ORS	He		NA	121
4	ICP-MS	Rhodium	NA	NA	1:1	NA	NA
5	ICP-MS	Rh			1	1	121
6	ICP-MS	Sc,Ir,Rh	ORS	He		NA	121
9	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	1	121
10	ICP-MS	Rh	ORS	He	NA	NA	121
11	ICP-MS	Rh	ORS	He	1	1	121
12	ICP-OES-AV	Y			1:10	1:10	206.386
13	ICP-MS/MS						
14	ICP-MS	Rh	ORS	He	1.25	1.25	
15	ICP-MS		CRI	He			12
16	ICP-MS	Rh	KED	He	1	1	121
17	ICP-MS	Rh	NA	NA	1	1	121

Table 79 Instrument Conditions Se

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	NA	He	1	1	78 (m/z)
2	ICP-MS	Rh	CRI	He	10	10	
3	ICP-MS	Sc	ORS	He			78
4	ICP-MS	Tellerium	KED	He	1:1	NA	NA
5	ICP-MS	Rh			1	1	80
6	ICP-MS	Sc,Ir,Rh	ORS	HEHe			78
9	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	1	78
10	ICP-MS	Rh	ORS	HEHe	NA	NA	78
11	ICP-MS	Y	ORS	HEHe	1	1	78
12	ICP-OES-AV	Y			1:10	1:10	196.026
13	ICP-MS/MS						
14	ICP-MS	Rh	ORS	He	1.25	1.25	
15	ICP-MS		CRI	HEHe			182
16	ICP-MS	Te	KED	He	1	1	82
17	ICP-MS	Rh	DRC	NH3	1	1	82

Table 80 Instrument Conditions Sn

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	NA	He	1	NA	188 (m/z)
3	ICP-MS	Th	ORS	He		NA	118
4	ICP-MS	Rhodium	NA	NA	1:1	NA	NA
5	ICP-MS	Rh			1	NA	118
6	ICP-MS	Sc,Ir,Rh	ORS	He		NA	118
9	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	NA	118
10	ICP-MS	Rh	ORS	He	NA	NA	118
11	ICP-MS	Rh	ORS	He	1	NA	118
13	ICP-MS/MS					NA	
14	ICP-MS	Rh	ORS	He	1.25	NA	
15	ICP-MS		CRI	He		NA	118
16	ICP-MS	Rh	KED	He	1	NA	120

Table 81 Instrument Conditions Sr

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	NA	He	NA	1	88 (m/z)
3	ICP-MS	Sc	ORS	He	NA		88
5	ICP-MS	Rh			NA	1	88
6	ICP-MS	Sc,Ir,Rh	ORS	He	NA		
9	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	NA	1	88
10	ICP-MS	Rh	ORS	He	NA	NA	88
11	ICP-MS	Y	ORS	He	NA	1	88
13	ICP-MS/MS				NA		
14	ICP-MS	Rh	ORS	He	NA	1.25	
15	ICP-MS		CRI	He	NA		88
16	ICP-MS	Rh	KED	He	NA	1	88
17	ICP-MS	Rh	NA	NA	NA	1	88

Table 82 Instrument Conditions Th

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	NA	He	NA	1	232 (m/z)
3	ICP-MS		ORS		NA		
5	ICP-MS	Rh			NA	1	232
6	ICP-MS	Sc,Ir,Rh	ORS	He	NA		
9	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	NA	1	232
10	ICP-MS	Ir	ORS	He	NA	NA	232
11	ICP-MS	Ir	ORS	He	NA	1	232
13	ICP-MS/MS				NA		
14	ICP-MS	Rh	ORS	He	NA	1.25	
15	ICP-MS		CRI	He	NA		232
16	ICP-MS	NA	NA	NA	NA	NA	NA
17	ICP-MS	Ir	NA	NA	NA	1	232

Table 83 Instrument Conditions Tl

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Ir	CRI	He	10	NA	
3	ICP-MS	Ir	ORS	He		NA	205
4	ICP-MS	Terbium	NA	NA	1:1	NA	NA
5	ICP-MS	Rh			1	NA	205
6	ICP-MS	Sc,Ir,Rh	ORS	He		NA	205
9	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	NA	205
10	ICP-MS	Ir	ORS	He	NA	NA	205
11	ICP-MS	Ir	ORS	He	1	NA	205
13	ICP-MS/MS					NA	
14	ICP-MS	Rh	ORS	He	1.25	NA	
15	ICP-MS		CRI	He		NA	205
16	ICP-MS	Tb	KED	He	1	NA	205
17	ICP-MS	Ir	NA	NA	1	NA	205

Table 84 Instrument Conditions U

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	NA	He	NA	1	238 (m/z)
2	ICP-MS	Ir	CRI	He	NA	10	
3	ICP-MS	Ir	ORS	He	NA		232
5	ICP-MS	Rh			NA	1	238
6	ICP-MS	Sc,Ir,Rh	ORS	He	NA		238
9	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	NA	1	238
10	ICP-MS	Ir	ORS	He	NA	NA	238
11	ICP-MS	Ir	ORS	He	NA	1	238
13	ICP-MS/MS				NA		
14	ICP-MS	Rh	ORS	He	NA	1.25	
15	ICP-MS		CRI	He	NA		238
16	ICP-MS	Tb	KED	He	NA	1	238
17	ICP-MS	Ir	NA	NA	NA	1	238

Table 85 Instrument Conditions V

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	NA	He	1	NA	51 (m/z)
2	ICP-MS	Rh	CRI	He	10	NA	
3	ICP-MS	Sc	ORS	He		NA	51
4	ICP-MS	Tellerium	KED	He	1:1	NA	NA
5	ICP-MS	Rh			1	NA	51
6	ICP-MS	Sc,Ir,Rh	ORS	He		NA	51
9	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	NA	51
10	ICP-MS	Sc	ORS	He	NA	NA	51
11	ICP-MS	Sc	ORS	He	1	NA	51
12	ICP-OES-AV	Y			1:10	NA	292.402
13	ICP-MS/MS					NA	
14	ICP-MS	Rh	ORS	He	1.25	NA	
15	ICP-MS		CRI	He		NA	51
16	ICP-MS	Sc	KED	He	1	NA	51
17	ICP-MS	Sc	UC	He	1	NA	51

Table 86 Instrument Conditions Zn

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1	ICP-MS	Ir, Rh & Sc	NA	He	1	1	64 (m/z)
2	ICP-MS	Rh	CRI	He	10	10	
3	ICP-MS	Sc	ORS	He			65
4	ICP-MS	Tellerium	KED	He	1:4	NA	NA
5	ICP-MS	Rh			1	1	66
6	ICP-MS	Sc,Ir,Rh	ORS	He			66
9	ICP-MS	Sc, Ga, Ge, Y, Rh, Ce, Ho, Ir	NA	He	1	1	66
10	ICP-MS	Rh	ORS	He	NA	NA	68
11	ICP-MS	Y	ORS	He	1	1	66
12	ICP-OES-AV	Y			1:10	1:10	213.857
13	ICP-MS/MS						
14	ICP-OES-AV	Y	NA	NA	2	2	
15	ICP-MS		CRI	He			66
16	ICP-MS	Te	KED	He	1	1	66
17	ICP-MS	Ge	UC	He	1	1	66

END OF REPORT