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National Measurement Institute

Proficiency Test Final Report AQA 23-11 Metals and Solids in Wastewater

November 2023

ACKNOWLEDGMENTS

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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, conducting 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 23-11, Trace Elements in Wastewater. The study focused on the measurement of total: Al, As, B, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, Hg, La, Li, Mg, Mn, Mo, Ni, P, Pb, S, Sb, Se, Sn, Sr, Th, Ti, Tl, U, V and Zn. Measurement of Total Dissolved Solids (TDS), Total Solids (TS), Total Suspended Solids (TSS) and Turbidity (NTU) were also included in the program.

The sample set consisted of three water samples.

Seventeen 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 513 z-scores, 471 (92%) returned a satisfactory score of $|z| \leq 2.0$.
Of 513 E_n-scores, 426 (83%) returned a satisfactory score of $|E_n| \leq 1.0$.

No laboratory received satisfactory z-scores or E_n scores for all analytes for which z-scores were calculated (40).

Laboratories 2, 5 and **13** reported results for 39 tests and returned satisfactory z-scores for 38 of them.

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

Low level Hg and Sb in S1 were the analytes that presented the most analytical difficulty to participating laboratories.

ICP-MS in collision mode was the preferred instrumental technique for measuring most of the elements of interest.

iii. *evaluate within laboratory precision-repeatability.*

Sample S2 was the same fortified trade wastewater used for Sample S1 preparation. The concentration of Se in S2 was expected to remain unchanged from that of Sample S1. In some cases, the Se results reported in the two identical study samples were significantly different.

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

On average, participants' performance in water has remained consistent over time.

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 513 numerical results, 503 (98%) were reported with an expanded measurement uncertainty. The magnitude of these expanded uncertainties was within the range 0.058% to 210% 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 from this study 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;
- allergens in food; and
- controlled drug assay.

AQA 23-11 is the 32nd NMI proficiency study of metals 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 trade wastewater;
- 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 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 40 tests were selected from those for which an investigation level is published in the Trade Waste Management Guidelines[5] and are commonly measured by water testing laboratories.

2.2 Participation

Seventeen laboratories participated and all submitted results.

The timetable of the study was:

Invitation issued:	13 June 2023
Samples dispatched:	3 July 2023
Results due:	31 July 2023
Interim report issued:	2 August 2023
Preliminary report issued	4 August 2023

2.3 Test Material Specification

Three samples were provided for analysis:

Samples S1 was autoclaved trade wastewater, preserved by adding 2% (v/w) HNO_3 and 0.01% (v/w) HCl, then spiked for 17 elements.

Sample S2 was Sample S1 further fortified for 10 elements.

Sample S3 was autoclaved trade wastewater spiked for TSS.

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 except for Li, Ti and Tl in S1, Mg, S in S2 and TS, TDS, TSS and Turbidity in S3.[1] 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 of the analytes assessed.

2.6 Stability of Analytes

No stability study was carried out for samples S1 and S2. 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 3 July 2023.

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:

- Participants are asked to report results in units of **µg/L**, except solids **(mg/L)** and turbidity **(NTU),** for the following:

SAMPLE S1 acidified wastewater		SAMPLE S2 acidified wastewater		SAMPLE S3 wastewater	
Test TOTAL	**Estimated Concentration Range (μg/L)**	**Test TOTAL**	**Estimated Concentration Range (μg/L)**	**Test**	**Estimated Concentration Range (mg/L)**
As	>1	Al	>50	TDS (dried at 103-105 °C)	NA
Be	>1	As	>10	TSS (dried at 103-105 °C)	>25
Bi	>1	B	>100	TS (dried at 103-105 °C)	NA
Cd	>1	Ba	>50	Turbidity (NTU)	NA
Cr	>1	Ca	>1000		
Cu	>10	Co	>1		
Hg	>0.25	Fe	>100		
Li	>1	La	>1		
Mo	>10	Mn	>25		
Ni	>1	Mg	>1000		
Pb	>1	P	>1000		
Sb	>1	Pb	>50		
Se	>1	S	NA		
Sn	>1	Se	>1		
Ti	>10	Sr	>50		
Tl	>1	Th	>10		
V	>10	U	>1		
Zn	>10	Zn	>50		

NA - the estimated concentration range is not available

- Report results using the electronic results sheet emailed to you:
- Report results as you would report to a client. For each analyte, report the expanded measurement uncertainty.
- Please send us all the requested details regarding the test method.
- Please return the completed results sheet by e-mail (proficiency@measurement.gov.au) , by 31 July 2023.

2.9 Interim Report and Provisional Report

An interim report was emailed to participants on 2 August 2023.

A Preliminary Report was issued on 4 August 2023. 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.

No data from the preliminary report has been changed in the present Final Report.

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	• Method 3120 - Metals by Plasma Emission Spectroscopy; Standard Methods for the Examination of Water and Wastewater, APHA, 23rd Edition 2017 • USEPA Method 200.7 Rev 4.4, Determination of Metals and Trace Elements in Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectroscopy	100	95	240	1	
2	USEPA Method 3005A	10	95	120	0.5	
3*	APHA Method 3030 E (Modified), 3120 B, 3125 B US EPA Method 245.7 (Hg)	10	100	60	0.5	
4*	US EPA 200.7, US EPA 200.8 and APHA section 3125, US EPA 245.1					
5*	3051A	20	170	15	1	1
6	APHA 3125, EPA 200.8	5	95	120	2	1
7		30	110	90	2	
8	In-house test method					
12	In House Method					
13	USEPA Method 3005A	10	95	120	0.2	0.5
14	USEPA SW846 and in house	10	95	120	0.5	
15	In-house method based on APHA 23rd Edition 3030E Nitric Acid Digestion	10	95	120	0.5	
16	In House W32 - APHA 3125					
17	APHA 3125; USEPA SW846 - 6020	10	98	120	0.5	

*Additional Information in Table 3

Table 2 Method References for Solids and Turbidity

Lab. Code	Method Reference
1*	turbidity: Standard Methods for the Examination of Water and Wastewater (APHA), 23rd edition 2017: TSD: Standard Methods for the Examination of Water and Wastewater, APHA, 23rd Edition, 2017 Method No. 2540-C Total dissolved solids dried at 180°C. Standard Methods for the Examination of Water and Wastewater, APHA, 22nd Edition 2012 Method 2540 D Total Suspended Solid dried at 103-105°C
2	APHA 2540C (TDS); APHA 2540D (TSS); APHA 2540B (TS); APHA 2130 (Turbidity)
4	APHA section 2540 C, 2540 B, 2540 D, and 2130
6	APHA METHOD 2540 C

Lab. Code	Method Reference
7	APHA
9*	QWI-EN.WA015,QWI-EN.WA025,QWI-EN.WAA055/WA030 AND QWI-EN.WA045
11	APHA 2540 B, C and D. APHA 2130 Turbidity A and B.
12	In House Method
13*	APHA
14*	APHA 2540C, 2540D, 2540B, 2130 and in house methodology
15	TSS - In-house method based on APHA 23rd Edition 2540 D TDS - In-house method based on APHA 23rd Edition 2540 C TS - In house method based on APHA 23rd Edition 2540 B Turbidity - In-house method based on APHA 23rd Edition 2130 B
16	In House W1 - Turbidity, W25 - TSS
17	Gravimetric APHA 2540C, APHA 2540 D, APHA 2540 B

*Additional Information in Table 3

3.2 Additional Information

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

Table 3 Additional Information

Lab Code	Additional Information
1	S3: TDS dried at 180°C
3	Total Elements: 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
4	Total Elements: Samples were not digested
5	Total Elements: Microwave digestion
9	S3: For the above results TDS dried at 180°C, TSS and TS dried at 103-105°C
13	S3: TDS was dried at 180 ± 5 °C.
14	S3: TDS performed at 180°C

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		Guide Document for Estimating MU
		Precision	Method Bias	
1	Top Down - precision and estimates of the method and laboratory bias	Control Samples - CRM Duplicate Analysis Instrument Calibration	CRM Instrument Calibration Recoveries of SS	ISO/GUM
2	Bottom Up (ISO/GUM, fish bone/ cause and effect diagram)	Control Samples Duplicate Analysis	CRM Instrument	Eurachem/CITAC Guide

Lab. Code	Approach to Estimating MU	Information Sources for MU Estimation		Guide Document for Estimating MU
		Precision	Method Bias	
		Instrument Calibration	Calibration Recoveries of SS	
3	Standard deviation of replicate analyses multiplied by 2 or 3	Control Samples - SS Duplicate Analysis Instrument Calibration	Instrument Calibration Recoveries of SS	Eurachem/CITAC Guide
4	Top Down - precision and estimates of the method and laboratory bias	Control Samples - CRM Duplicate Analysis	CRM Recoveries of SS	ASTM E2554-13
5	Top Down - precision and estimates of the method and laboratory bias	Control Samples - CRM Duplicate Analysis	CRM Recoveries of SS	NMI Uncertainty Course
6	Other	Control Samples - CRM Duplicate Analysis Instrument Calibration	CRM Instrument Calibration Laboratory Bias from PT Studies	Eurachem/CITAC Guide
7	Top Down - precision and estimates of the method and laboratory bias	Control Samples - CRM Duplicate Analysis	CRM Recoveries of SS	Nordtest Report TR537
8	Top Down - precision and estimates of the method and laboratory bias	Control Samples - CRM	CRM	Eurachem/CITAC Guide
9	Top Down - precision and estimates of the method and laboratory bias	Control Samples Duplicate Analysis Instrument Calibration	CRM Instrument Calibration Recoveries of SS	Eurachem/CITAC Guide
11	Bottom Up (ISO/GUM, fish bone/ cause and effect diagram)	Control Samples Duplicate Analysis Instrument Calibration	CRM Instrument Calibration Laboratory Bias from PT Studies	Eurachem 2000/ISO1993A
12	Standard deviation of replicate analyses multiplied by 2 or 3	Control Samples - RM Duplicate Analysis Instrument Calibration	CRM Instrument Calibration Recoveries of SS	NATA General Accreditation, Guidance, Estimating and Reporting MU (Replace TN 33)
13	Top Down - precision and estimates of the method and laboratory bias	Control Samples - CRM Duplicate Analysis Instrument Calibration	CRM Instrument Calibration	Eurachem/CITAC Guide
14	Top Down - precision and estimates of the method and laboratory bias	Control Samples - CRM	CRM Recoveries of SS	Eurachem/CITAC Guide
15	Top Down - precision and estimates of the method and laboratory bias	Control Samples - SS Duplicate Analysis	Recoveries of SS	NATA General Accreditation Guidance,

Lab. Code	Approach to Estimating MU	Information Sources for MU Estimation		Guide Document for Estimating MU
		Precision	Method Bias	
				Estimating and Reporting MU
16	Top Down - precision and estimates of the method and laboratory bias	Control Samples - CRM Duplicate Analysis	CRM	Nordtest Report TR537
17	Top Down - precision and estimates of the method and laboratory bias	Control Samples - RM Duplicate Analysis	CRM Instrument Calibration Laboratory Bias from PT Studies Recoveries of SS	Eurachem/CITAC Guide

[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.

Table 5 Participants' Comments

Participants' Comments	Study Co-ordinator's Response
Please add Ag silver to the next round. We usually do TDS at 180°C not 103-105°C as per APHA Method 2540 C. It would be good to have PT for total and dissolved metals.	Thank you for your feedback. Our next study will include Ag, TDS at 180°C and both total and dissolved elements.

4 PRESENTATION OF RESULTS AND STATISTICAL ANALYSIS

4.1 Results Summary

Participant results are listed in Tables 6 to 45 with resultant summary statistics: robust average, median, 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 41. An example chart with interpretation guide is shown in Figure 1.

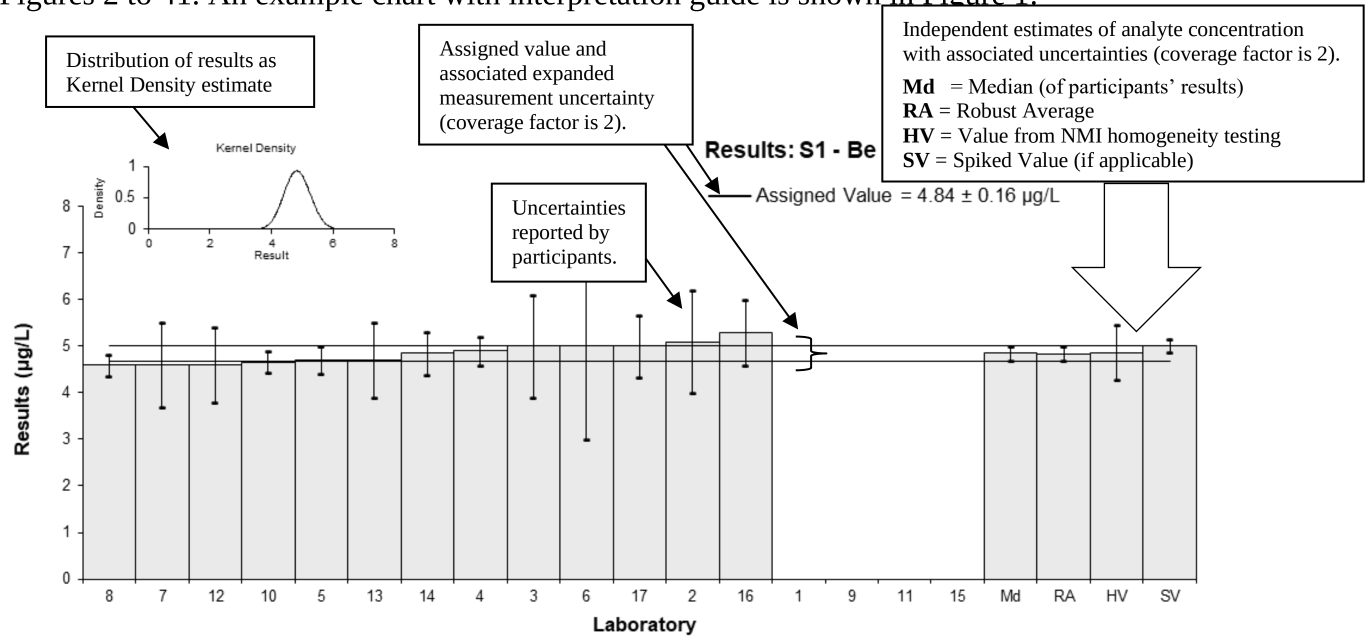


Figure 1 Guide to Presentation of Results

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 were obvious blunders, such as those with incorrect units, decimal errors, or results from different PT samples and were removed for calculation of summary statistics.[3, 4, 6]

4.3 Assigned Value

An example of the assigned value calculation using data from the present study is given in Appendix 2. The assigned value is defined as: 'the value attributed to a particular property of a proficiency test item.'[1] In this study, the property is the mass fraction of analyte. Assigned values were the robust average of participants' results, outliers removed; the expanded uncertainties were 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.

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

It is important to note that the PCV is a fixed value and is not the standard deviation of participants' results. The fixed value set for PCV is based on the existing regulation, the acceptance criteria indicated by the methods, the matrix, the concentration level of analyte and on experience from previous studies. It is backed up by mathematical models such as 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 participants' 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 participant's result;
- X is the study assigned value;
- σ is the target standard deviation.

A z-score with absolute value (|z|):

- $|z| \leq 2.0$ is satisfactory;
- $2.0 < |z| < 3.0$ is questionable;
- $|z| \geq 3.0$ is unsatisfactory.

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 study 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 ($|E_n|$):

- $|E_n| \leq 1.0$ is satisfactory;
- $|E_n| > 1.0$ is unsatisfactory.

4.8 Traceability and Measurement Uncertainty

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

5 TABLES AND FIGURES

Table 6

Sample Details

Sample No.	S1
Matrix	Wastewater
Analyte	As
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	<0.007	NR		
2	4.0	0.4	1.24	0.89
3	3.71	0.77	0.42	0.18
4	3.7	0.5	0.39	0.24
5	4	1	1.24	0.42
6	3	5	-1.57	-0.11
7	3.3	0.66	-0.73	-0.36
8*	11.5	1.2	22.30	6.43
9	NT	NT		
10	3.55	0.18	-0.03	-0.03
11	NT	NT		
12	4	1	1.24	0.42
13	3.4	0.4	-0.45	-0.32
14	3.609	0.51	0.14	0.08
15	NT	NT		
16	3.4	0.5	-0.45	-0.28
17	3	0.28	-1.57	-1.39

* Outlier, see Section 4.2

Statistics

Assigned Value	3.56	0.29
Spike Value	3.23	0.09
Homogeneity Value	3.47	0.42
Robust Average	3.61	0.31
Median	3.61	0.32
Mean	4.2	
N	13	
Max	11.5	
Min	3	
Robust SD	0.45	
Robust CV	12%	

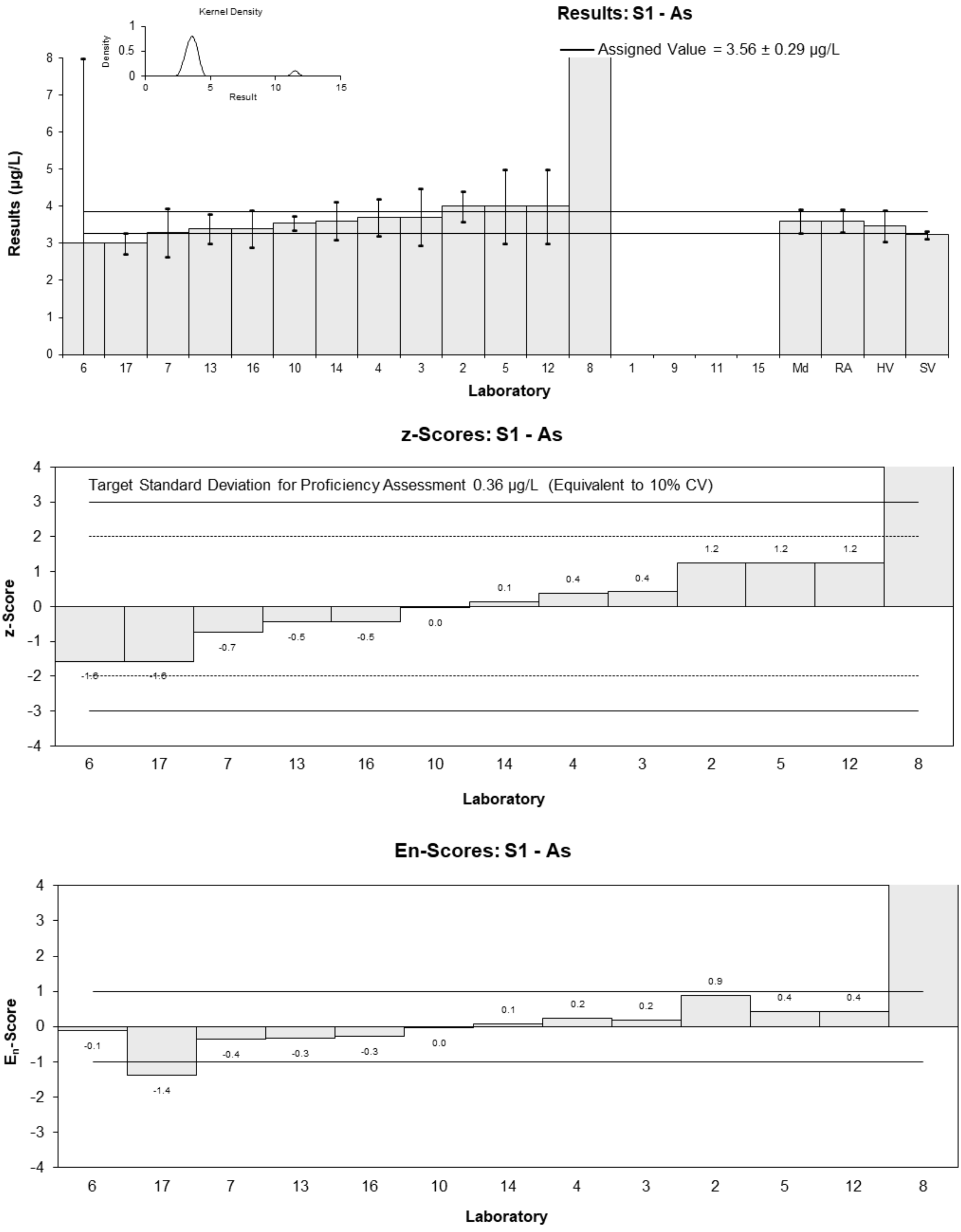

Results: S1 - As
Assigned Value = 3.56 ± 0.29 µg/L
Kernel Density
Density
Result
Results (µg/L)
Laboratory
6
17
7
13
16
10
14
4
3
2
5
12
8
1
9
11
15
Md
RA
HV
SV
z-Scores: S1 - As
Target Standard Deviation for Proficiency Assessment 0.36 µg/L (Equivalent to 10% CV)
z-Score
-1.6
-1.6
-0.7
-0.5
-0.5
0.0
0.1
0.4
0.4
1.2
1.2
1.2
Laboratory
En-Scores: S1 - As
En-Score
-0.1
-1.4
-0.4
-0.3
-0.3
0.0
0.1
0.2
0.2
0.9
0.4
0.4
Laboratory

Figure 2

Table 7

Sample Details

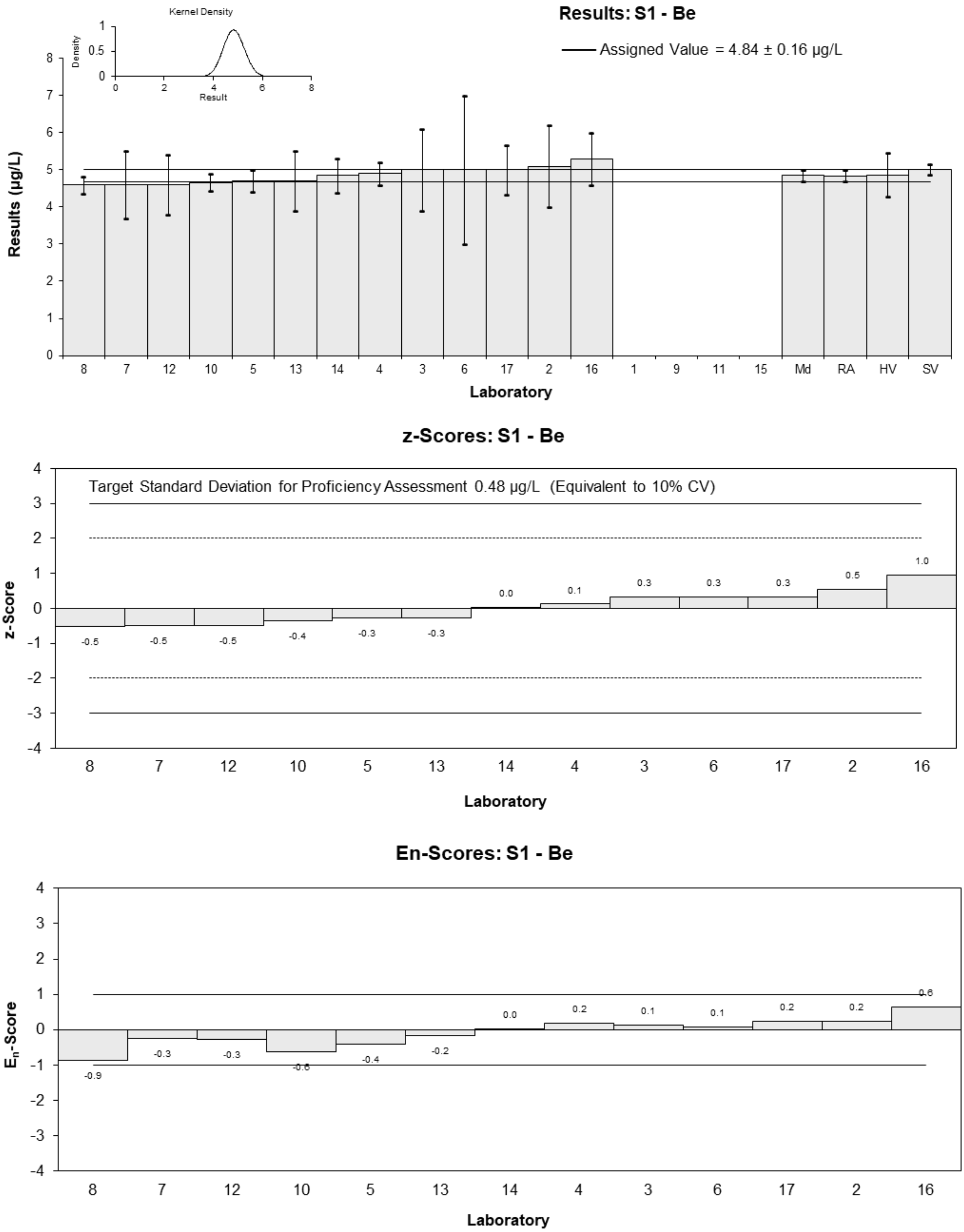
Sample No.	S1
Matrix	Wastewater
Analyte	Be
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	<0.006	NR		
2	5.1	1.1	0.54	0.23
3	5.0	1.1	0.33	0.14
4	4.9	0.3	0.12	0.18
5	4.7	0.3	-0.29	-0.41
6	5	2	0.33	0.08
7	4.6	0.92	-0.50	-0.26
8	4.59	0.24	-0.52	-0.87
9	NT	NT		
10	4.66	0.23	-0.37	-0.64
11	NT	NT		
12	4.6	0.8	-0.50	-0.29
13	4.7	0.8	-0.29	-0.17
14	4.854	0.46	0.03	0.03
15	NT	NT		
16	5.3	0.7	0.95	0.64
17	5	0.66	0.33	0.24

Statistics

Assigned Value	4.84	0.16
Spike Value	5.02	0.14
Homogeneity Value	4.87	0.58
Robust Average	4.84	0.16
Median	4.85	0.16
Mean	4.85	
N	13	
Max	5.3	
Min	4.59	
Robust SD	0.24	
Robust CV	4.9%	



Results: S1 - Be
Assigned Value = 4.84 ± 0.16 μg/L
Kernel Density
Density
Result
Results (μg/L)
Laboratory
8
7
12
10
5
13
14
4
3
6
17
2
16
1
9
11
15
Md
RA
HV
SV
z-Scores: S1 - Be
Target Standard Deviation for Proficiency Assessment 0.48 μg/L (Equivalent to 10% CV)
z-Score
-0.5
-0.5
-0.5
-0.4
-0.3
-0.3
0.0
0.1
0.3
0.3
0.3
0.5
1.0
Laboratory
En-Scores: S1 - Be
En-Score
-0.9
-0.3
-0.3
-0.6
-0.4
-0.2
0.0
0.2
0.1
0.1
0.2
0.2
0.6
Laboratory

Figure 3

Table 8

Sample Details

Sample No.	S1
Matrix	Wastewater
Analyte	Bi
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	5.62	1.1	1.29	0.55
3	5.0	1.5	0.04	0.01
4	NT	NT		
5	5.1	0.6	0.24	0.17
6	5	1	0.04	0.02
7	4.5	0.90	-0.96	-0.50
8	5.00	0.31	0.04	0.04
9	NT	NT		
10	4.74	0.24	-0.48	-0.57
11	NT	NT		
12	NT	NT		
13	4.90	0.70	-0.16	-0.10
14	7.265	1.114	4.59	1.96
15	NT	NT		
16	4.0	0.5	-1.97	-1.61
17	5	NR	0.04	0.06

Statistics

Assigned Value	4.98	0.35
Spike Value	5.07	0.14
Homogeneity Value	4.40	0.53
Robust Average	4.98	0.35
Median	5.00	0.11
Mean	5.10	
N	11	
Max	7.265	
Min	4	
Robust SD	0.47	
Robust CV	9.4%	

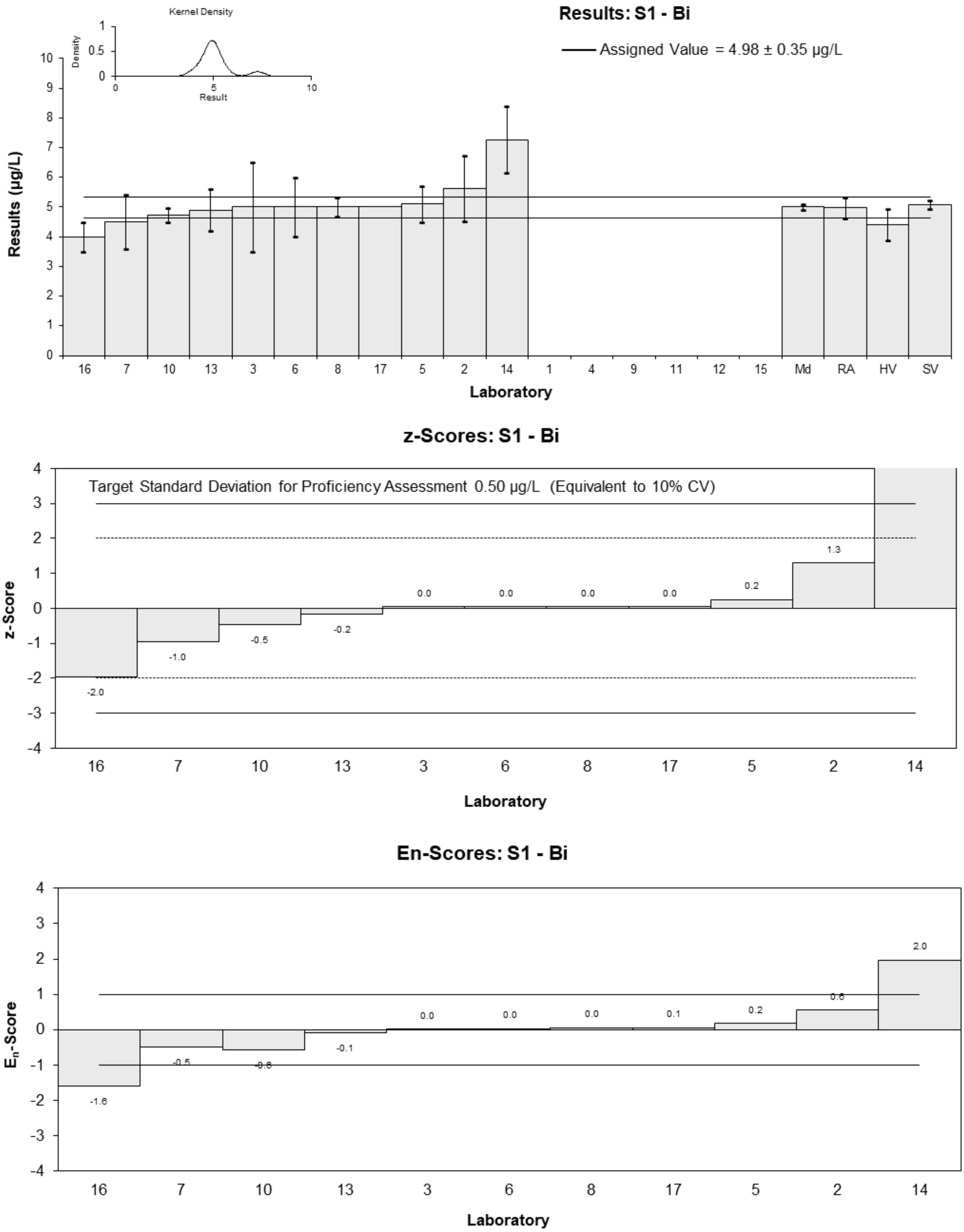

Results: S1 - Bi
Assigned Value = 4.98 ± 0.35 µg/L
Kernel Density
Density
Result
Results (µg/L)
Laboratory
16 7 10 13 3 6 8 17 5 2 14 1 4 9 11 12 15 Md RA HV SV
z-Scores: S1 - Bi
Target Standard Deviation for Proficiency Assessment 0.50 µg/L (Equivalent to 10% CV)
z-Score
-2.0 -1.0 -0.5 -0.2 0.0 0.0 0.0 0.0 0.2 1.3
16 7 10 13 3 6 8 17 5 2 14
Laboratory
En-Scores: S1 - Bi
E_n-Score
-1.6 -0.5 -0.6 -0.1 0.0 0.0 0.0 0.1 0.2 0.6 2.0
16 7 10 13 3 6 8 17 5 2 14
Laboratory

Figure 4

Table 9

Sample Details

Sample No.	S1
Matrix	Wastewater
Analyte	Cd
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1**	0.00476	0.0003	-9.99	-32.54
2	5.03	0.36	1.03	1.22
3	4.71	0.38	0.33	0.37
4	4.8	0.3	0.53	0.72
5	4.7	0.7	0.31	0.20
6	4.7	0.7	0.31	0.20
7	4.4	0.88	-0.35	-0.18
8	4.5	0.6	-0.13	-0.10
9	NT	NT		
10	4.47	0.22	-0.20	-0.35
11	NT	NT		
12	4.4	0.5	-0.35	-0.31
13	4.35	0.43	-0.46	-0.46
14	4.341	0.427	-0.48	-0.49
15	NT	NT		
16	4.6	0.6	0.09	0.06
17	4.5	0.39	-0.13	-0.14

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	4.56	0.14
Spike Value	4.72	0.13
Homogeneity Value	4.27	0.51
Robust Average	4.56	0.14
Median	4.50	0.15
Mean	4.58	
N	13	
Max	5.03	
Min	4.341	
Robust SD	0.20	
Robust CV	4.4%	

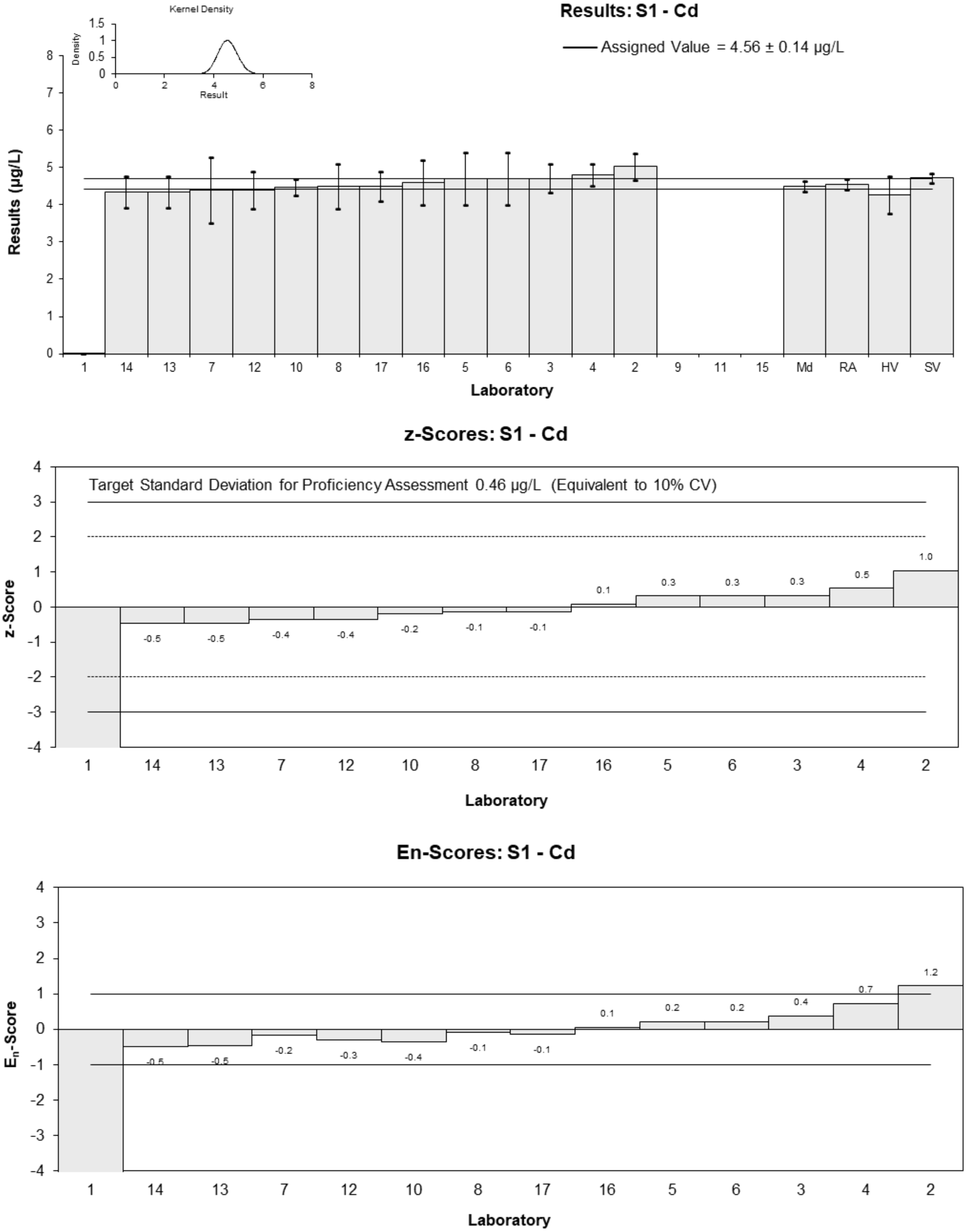

Results: S1 - Cd
Assigned Value = 4.56 ± 0.14 µg/L
Kernel Density
Density
Result
Results (µg/L)
Laboratory
1
14
13
7
12
10
8
17
16
5
6
3
4
2
9
11
15
Md
RA
HV
SV
z-Scores: S1 - Cd
Target Standard Deviation for Proficiency Assessment 0.46 µg/L (Equivalent to 10% CV)
z-Score
-0.5
-0.5
-0.4
-0.4
-0.2
-0.1
-0.1
0.1
0.3
0.3
0.3
0.5
1.0
Laboratory
En-Scores: S1 - Cd
En-Score
-0.5
-0.5
-0.2
-0.3
-0.4
-0.1
-0.1
0.1
0.2
0.2
0.4
0.7
1.2
Laboratory

Figure 5

Table 10

Sample Details

Sample No.	S1
Matrix	Wastewater
Analyte	Cr
Unit	µg/L

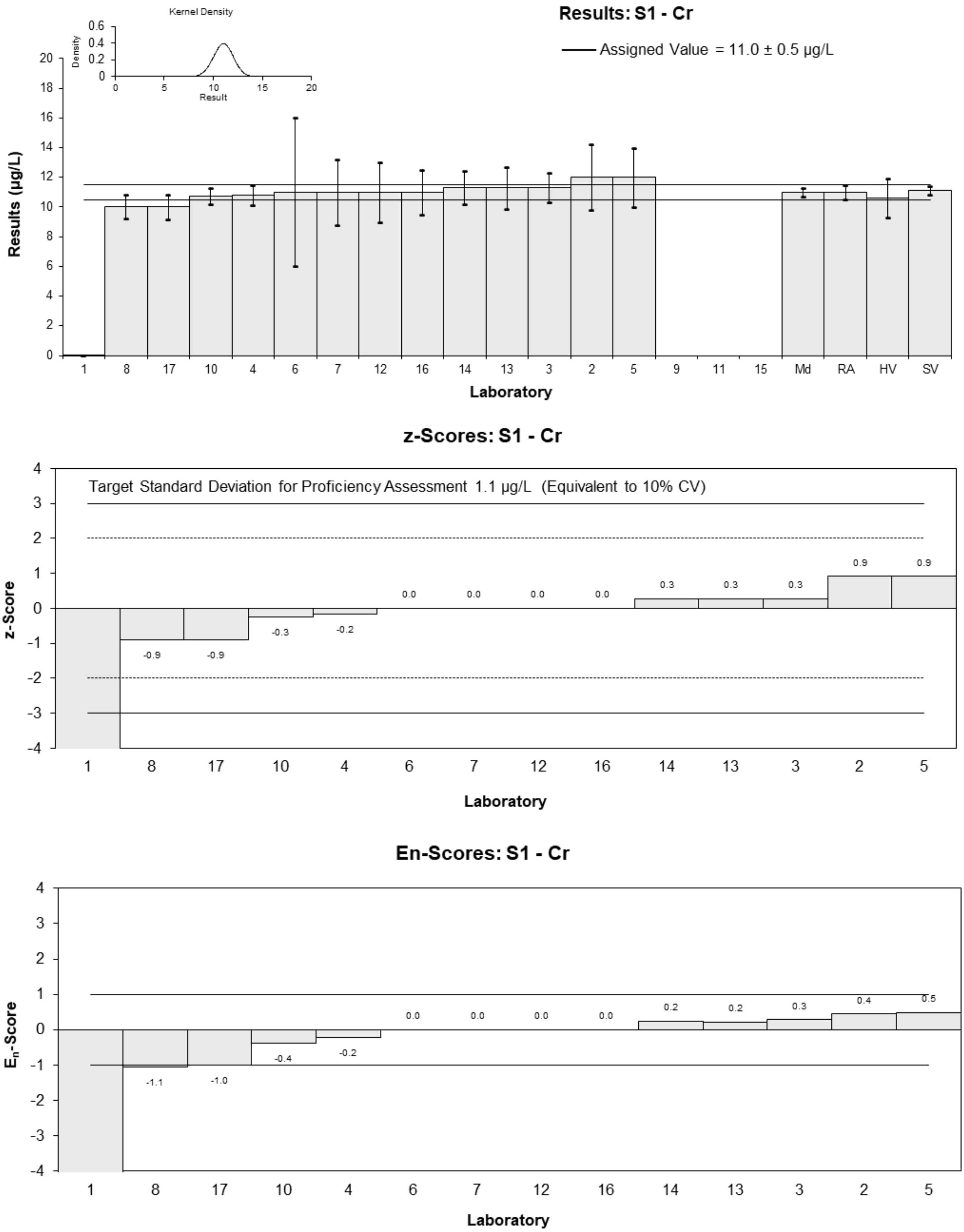
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1**	0.0118	0.0008	-9.99	-21.98
2	12.0	2.2	0.91	0.44
3	11.31	0.98	0.28	0.28
4	10.8	0.7	-0.18	-0.23
5	12	2	0.91	0.49
6	11	5	0.00	0.00
7	11	2.2	0.00	0.00
8	10.0	0.8	-0.91	-1.06
9	NT	NT		
10	10.71	0.54	-0.26	-0.39
11	NT	NT		
12	11	2	0.00	0.00
13	11.3	1.4	0.27	0.20
14	11.29	1.132	0.26	0.23
15	NT	NT		
16	11	1.5	0.00	0.00
17	10	0.85	-0.91	-1.01

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	11.0	0.5
Spike Value	11.1	0.3
Homogeneity Value	10.6	1.3
Robust Average	11.0	0.5
Median	11.0	0.3
Mean	11.0	
N	13	
Max	12	
Min	10	
Robust SD	0.68	
Robust CV	6.2%	



Results: S1 - Cr
Assigned Value = 11.0 ± 0.5 µg/L
Kernel Density
Density
Result
Results (µg/L)
Laboratory
1 8 17 10 4 6 7 12 16 14 13 3 2 5 9 11 15 Md RA HV SV
z-Scores: S1 - Cr
Target Standard Deviation for Proficiency Assessment 1.1 µg/L (Equivalent to 10% CV)
z-Score
-0.9 -0.9 -0.3 -0.2 0.0 0.0 0.0 0.0 0.3 0.3 0.3 0.9 0.9
1 8 17 10 4 6 7 12 16 14 13 3 2 5
Laboratory
En-Scores: S1 - Cr
E_n-Score
-1.1 -1.0 -0.4 -0.2 0.0 0.0 0.0 0.0 0.2 0.2 0.3 0.4 0.5
1 8 17 10 4 6 7 12 16 14 13 3 2 5
Laboratory

Figure 6

Table 11

Sample Details

Sample No.	S1
Matrix	Wastewater
Analyte	Cu
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1**	0.0442	0.0027	-9.99	-28.90
2	44.5	3.1	0.99	1.18
3	41.5	4.2	0.25	0.23
4	43	5	0.62	0.48
5	40	4	-0.12	-0.12
6	41	2	0.12	0.20
7	38	7.6	-0.62	-0.32
8	38.1	2.9	-0.59	-0.75
9	NT	NT		
10	39.72	1.99	-0.19	-0.32
11	NT	NT		
12	38	7	-0.62	-0.35
13	39.7	5.5	-0.20	-0.14
14	41.78	3.448	0.32	0.34
15	NT	NT		
16	41	5.0	0.12	0.10
17	41	3.9	0.12	0.12

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	40.5	1.4
Spike Value	40.2	4.4
Homogeneity Value	39.9	4.8
Robust Average	40.5	1.4
Median	41.0	1.3
Mean	40.6	
N	13	
Max	44.5	
Min	38	
Robust SD	2.0	
Robust CV	5%	

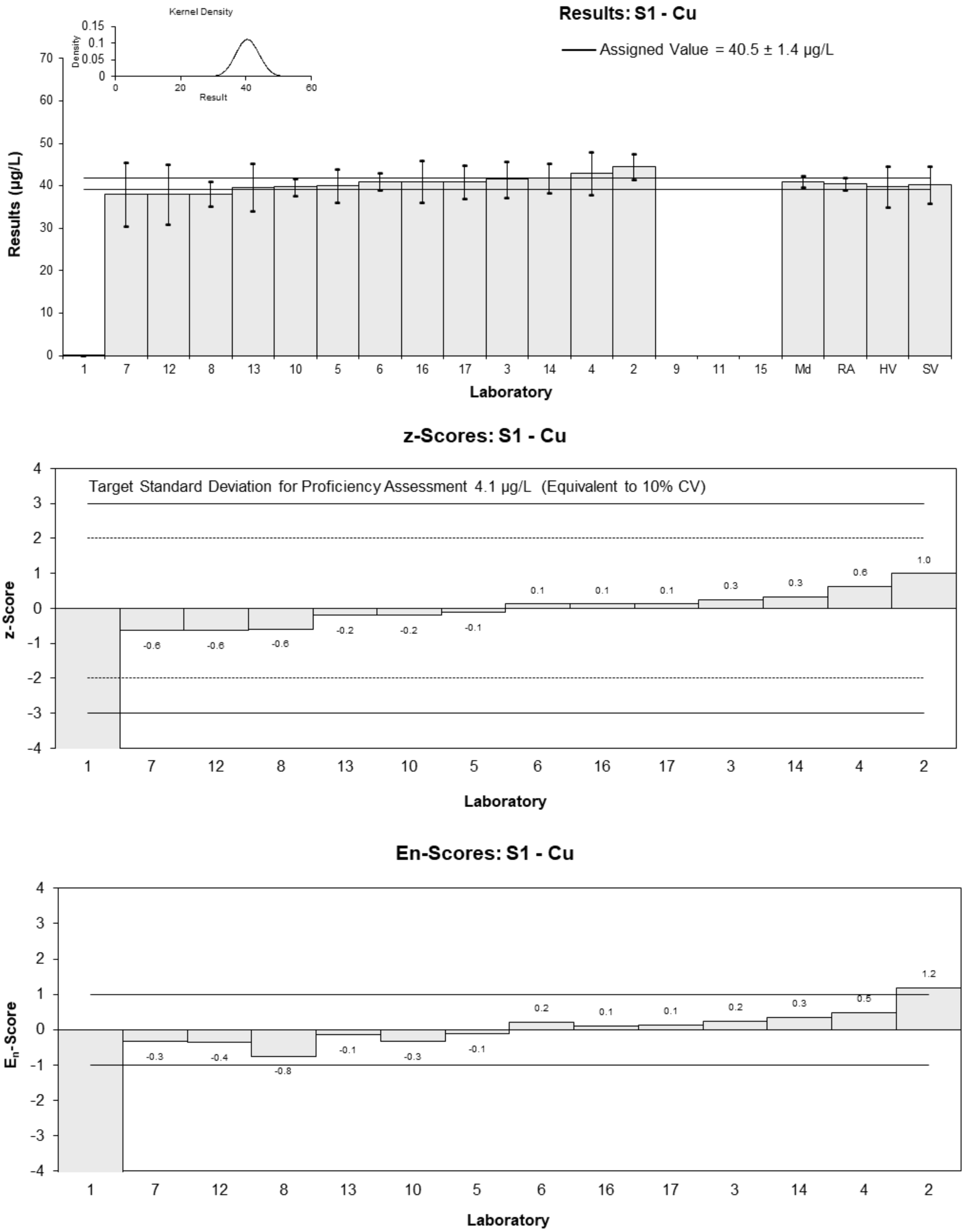

Kernel Density
Density
Result
Results: S1 - Cu
Assigned Value = 40.5 ± 1.4 µg/L
Results (µg/L)
Laboratory
1
7
12
8
13
10
5
6
16
17
3
14
4
2
9
11
15
Md
RA
HV
SV
z-Scores: S1 - Cu
Target Standard Deviation for Proficiency Assessment 4.1 µg/L (Equivalent to 10% CV)
z-Score
Laboratory
En-Scores: S1 - Cu
En-Score
Laboratory

Figure 7

Table 12

Sample Details

Sample No.	S1
Matrix	Wastewater
Analyte	Hg
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.344	0.0002	-0.80	-0.80
2	0.4	0.06	-0.12	-0.10
3	0.45	0.53	0.49	0.07
4	0.55	0.2	1.71	0.65
5	NT	NT		
6	0.52	0.08	1.34	0.95
7	NR	NR		
8	NT	NT		
9	NT	NT		
10	0.252	0.0126	-1.93	-1.88
11	NT	NT		
12	0.42	0.1	0.12	0.08
13	0.3	0.07	-1.34	-1.01
14	0.464	0.081	0.66	0.47
15	NT	NT		
16	<0.5	NR		
17	0.4	0.029	-0.12	-0.11

Statistics

Assigned Value	0.410	0.083
Spike Value	0.510	0.010
Homogeneity Value	0.500	0.060
Robust Average	0.410	0.083
Median	0.410	0.070
Mean	0.410	
N	10	
Max	0.55	
Min	0.252	
Robust SD	0.11	
Robust CV	26%	

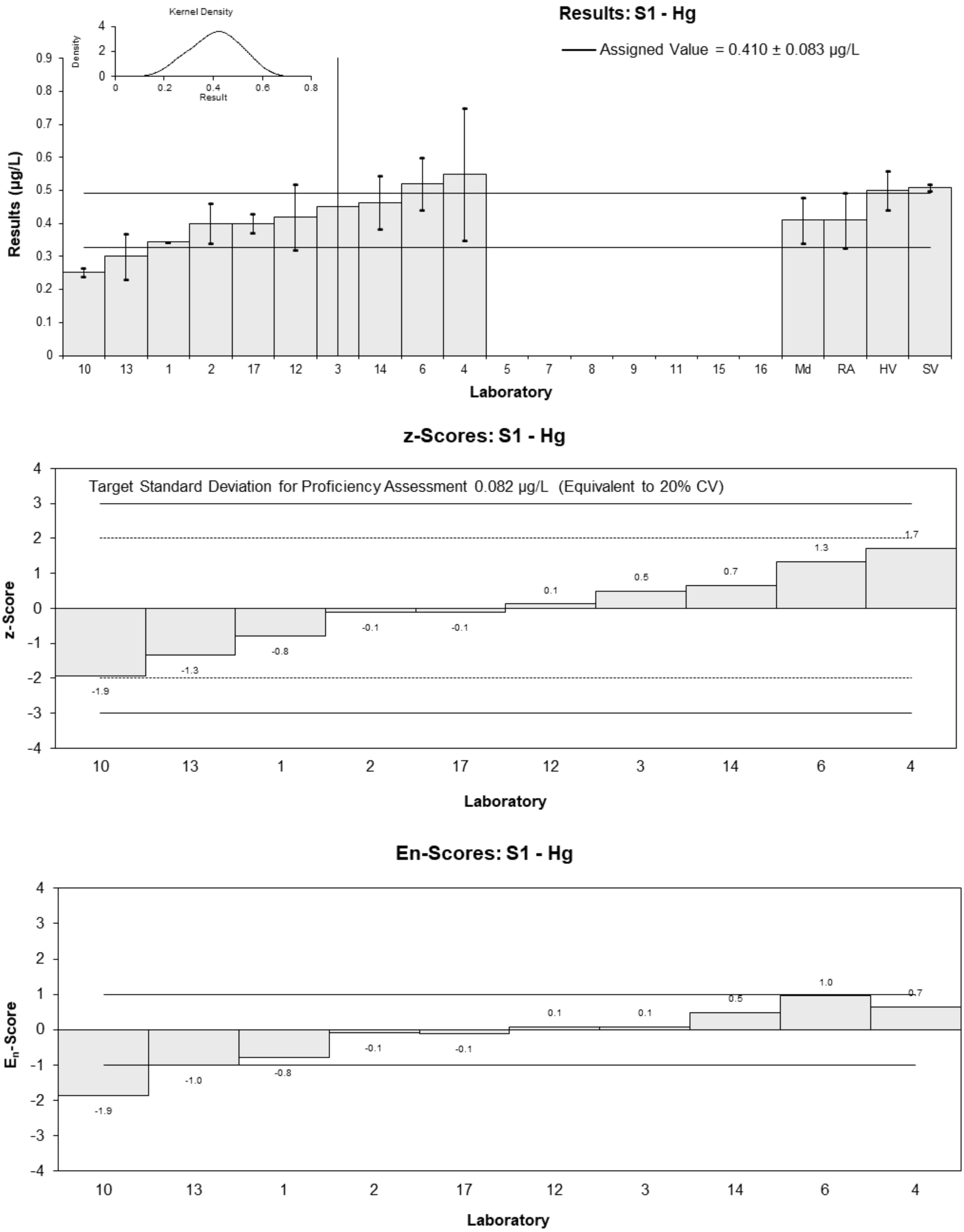

Results: S1 - Hg
Assigned Value = 0.410 ± 0.083 µg/L
Kernel Density
Density
Result
Results (µg/L)
Laboratory
10 13 1 2 17 12 3 14 6 4 5 7 8 9 11 15 16 Md RA HV SV
z-Scores: S1 - Hg
Target Standard Deviation for Proficiency Assessment 0.082 µg/L (Equivalent to 20% CV)
z-Score
-1.9 -1.3 -0.8 -0.1 -0.1 0.1 0.5 0.7 1.3 1.7
Laboratory
10 13 1 2 17 12 3 14 6 4
En-Scores: S1 - Hg
En-Score
-1.9 -1.0 -0.8 -0.1 -0.1 0.1 0.1 0.5 1.0 0.7
Laboratory
10 13 1 2 17 12 3 14 6 4

Figure 8

Table 13

Sample Details

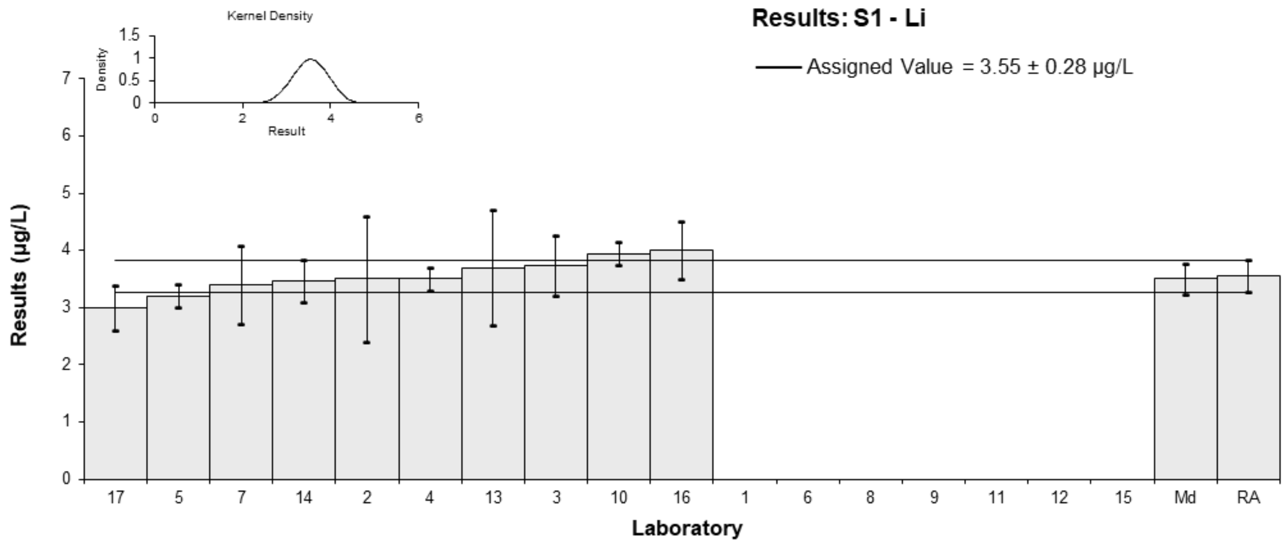
Sample No.	S1
Matrix	Wastewater
Analyte	Li
Unit	µg/L

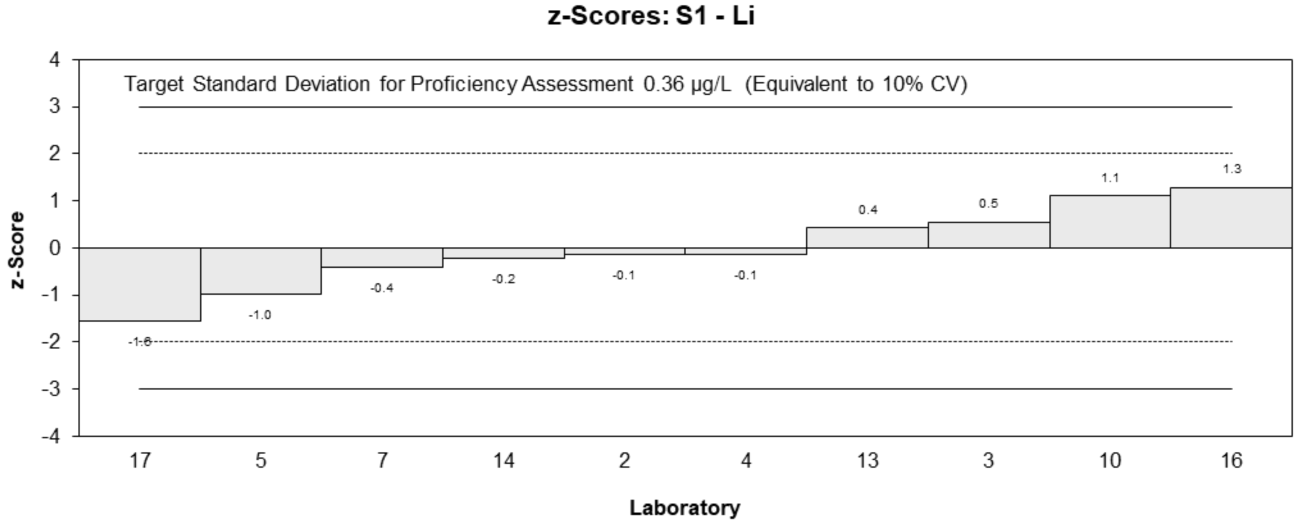
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	3.5	1.1	-0.14	-0.04
3	3.74	0.53	0.54	0.32
4	3.5	0.2	-0.14	-0.15
5	3.2	0.2	-0.99	-1.02
6	NT	NT		
7	3.4	0.68	-0.42	-0.20
8	NT	NT		
9	NT	NT		
10	3.94	0.20	1.10	1.13
11	NT	NT		
12	NT	NT		
13	3.7	1.0	0.42	0.14
14	3.469	0.373	-0.23	-0.17
15	NT	NT		
16	4.0	0.5	1.27	0.79
17	3	0.39	-1.55	-1.15

Statistics

Assigned Value	3.55	0.28
Spike Value	Not Spiked	
Robust Average	3.55	0.28
Median	3.50	0.26
Mean	3.54	
N	10	
Max	4	
Min	3	
Robust SD	0.35	
Robust CV	9.8%	


Results: S1 - Li
Assigned Value = 3.55 ± 0.28 µg/L
Kernel Density
Density
Result
Results (µg/L)
Laboratory
17
5
7
14
2
4
13
3
10
16
1
6
8
9
11
12
15
Md
RA


z-Scores: S1 - Li
Target Standard Deviation for Proficiency Assessment 0.36 µg/L (Equivalent to 10% CV)
z-Score
Laboratory
17
5
7
14
2
4
13
3
10
16
-1.6
-1.0
-0.4
-0.2
-0.1
-0.1
0.4
0.5
1.1
1.3

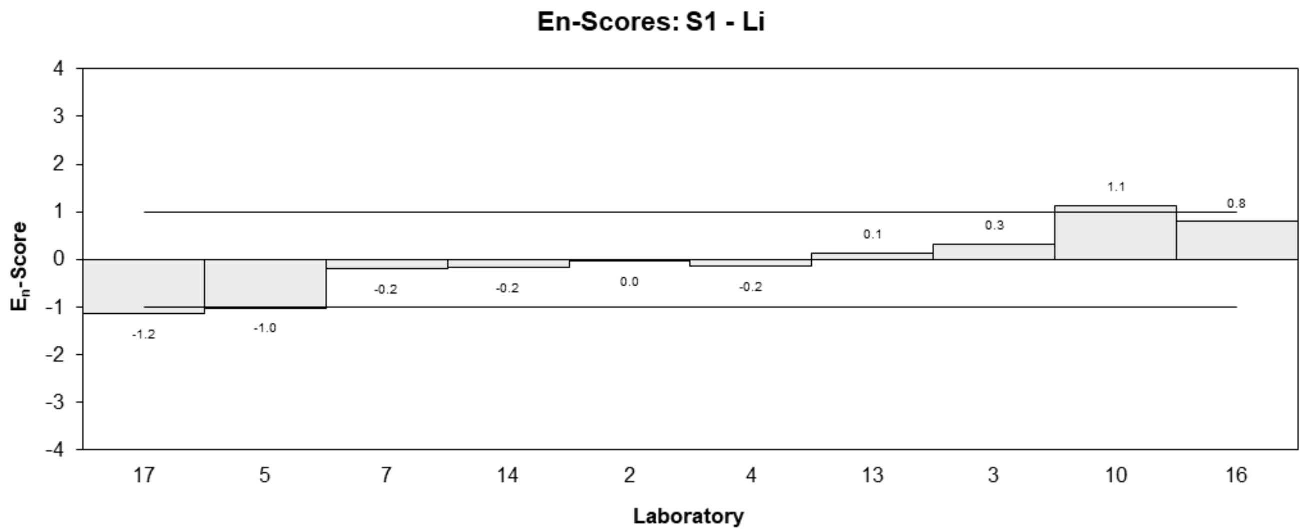

En-Scores: S1 - Li
En-Score
Laboratory
17
5
7
14
2
4
13
3
10
16
-1.2
-1.0
-0.2
-0.2
0.0
-0.2
0.1
0.3
1.1
0.8

Figure 9

Table 14

Sample Details

Sample No.	S1
Matrix	Wastewater
Analyte	Mo
Unit	µg/L

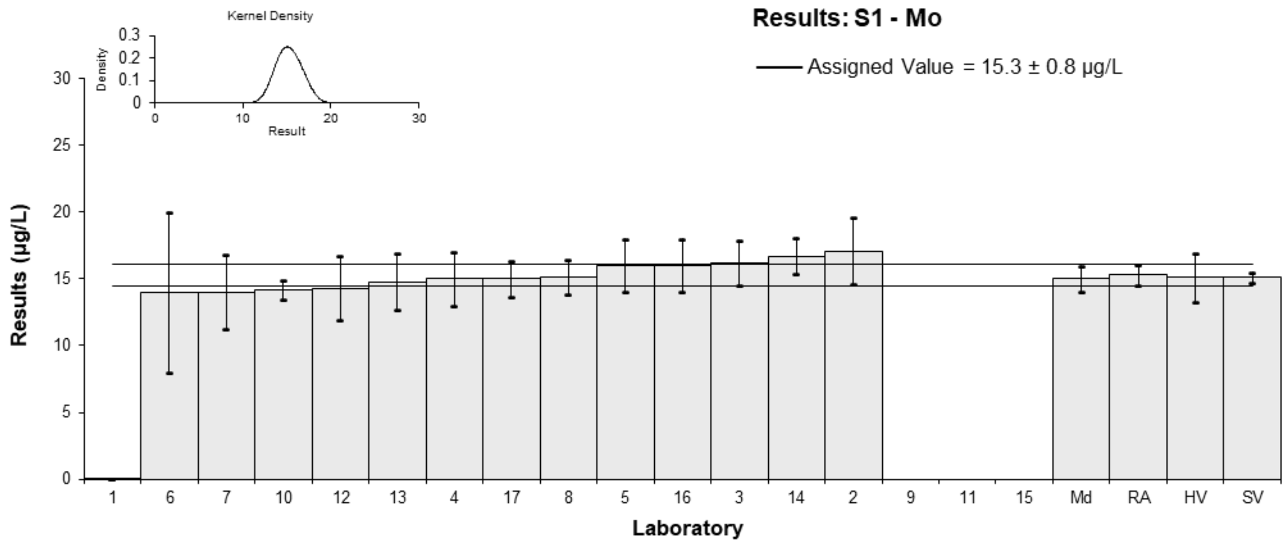
Participant Results

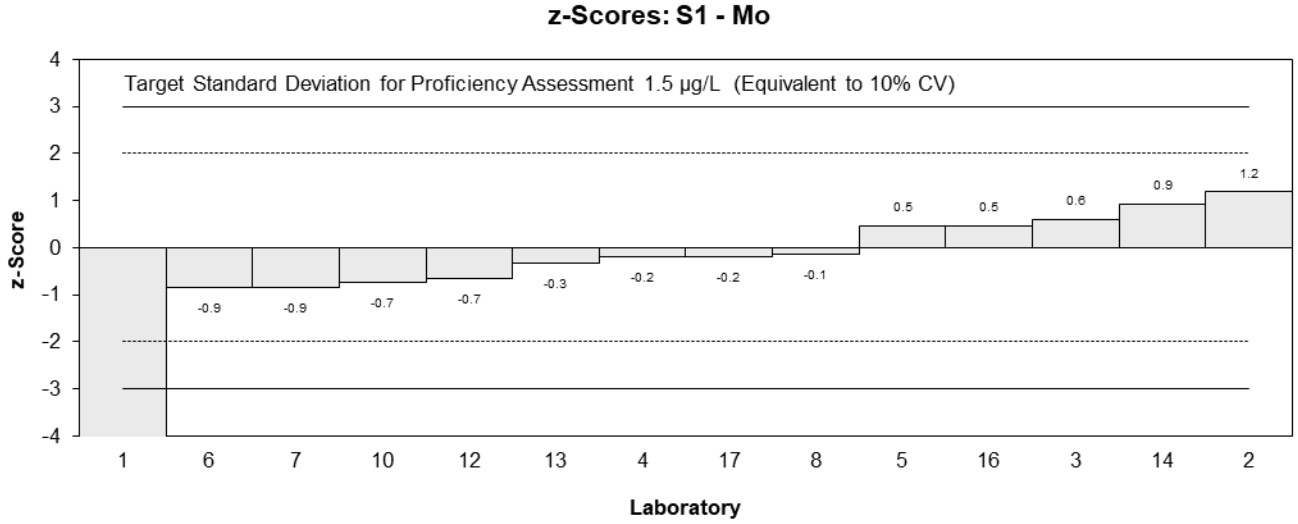
Lab. Code	Result	Uncertainty	z	E_n
1**	0.015	0.0011	-9.99	-19.11
2	17.1	2.5	1.18	0.69
3	16.2	1.7	0.59	0.48
4	15	2	-0.20	-0.14
5	16	2	0.46	0.32
6	14	6	-0.85	-0.21
7	14	2.8	-0.85	-0.45
8	15.1	1.3	-0.13	-0.13
9	NT	NT		
10	14.17	0.71	-0.74	-1.06
11	NT	NT		
12	14.3	2.4	-0.65	-0.40
13	14.8	2.1	-0.33	-0.22
14	16.72	1.36	0.93	0.90
15	NT	NT		
16	16	2.0	0.46	0.32
17	15	1.34	-0.20	-0.19

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	15.3	0.8
Spike Value	15.1	0.4
Homogeneity Value	15.1	1.8
Robust Average	15.3	0.8
Median	15.0	1.0
Mean	15.3	
N	13	
Max	17.1	
Min	14	
Robust SD	1.2	
Robust CV	7.7%	


Results: S1 - Mo
Assigned Value = 15.3 ± 0.8 µg/L
Kernel Density
Density
Result
Results (µg/L)
Laboratory
1
6
7
10
12
13
4
17
8
5
16
3
14
2
9
11
15
Md
RA
HV
SV


z-Scores: S1 - Mo
Target Standard Deviation for Proficiency Assessment 1.5 µg/L (Equivalent to 10% CV)
z-Score
Laboratory
-0.9
-0.9
-0.7
-0.7
-0.3
-0.2
-0.2
-0.1
0.5
0.5
0.6
0.9
1.2

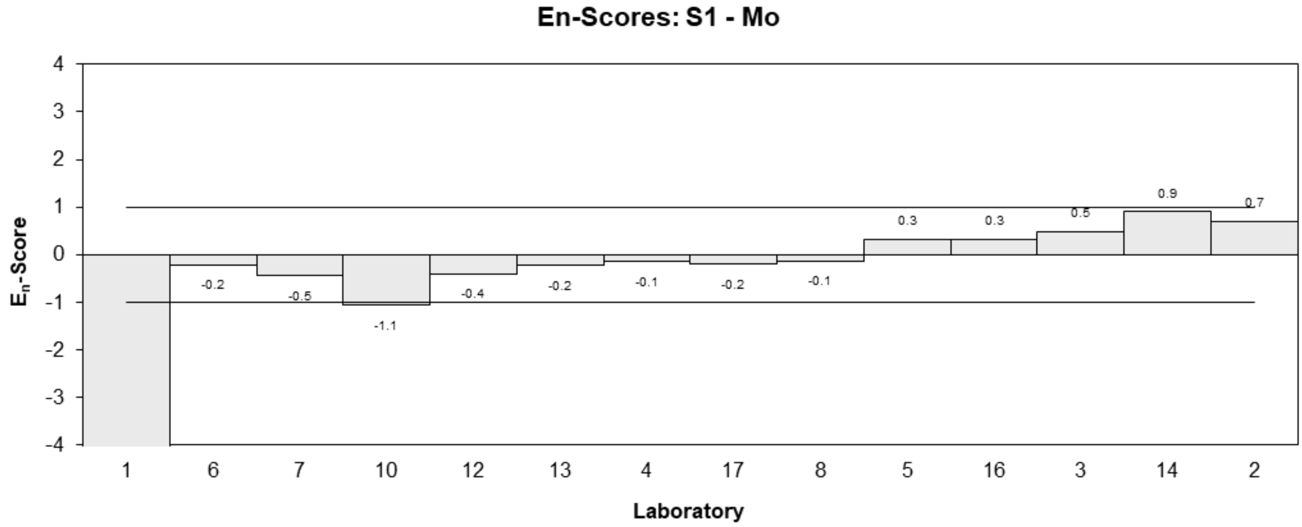

En-Scores: S1 - Mo
En-Score
Laboratory
-0.2
-0.5
-1.1
-0.4
-0.2
-0.1
-0.2
-0.1
0.3
0.3
0.5
0.9
0.7

Figure 10

Table 15

Sample Details

Sample No.	S1
Matrix	Wastewater
Analyte	Ni
Unit	µg/L

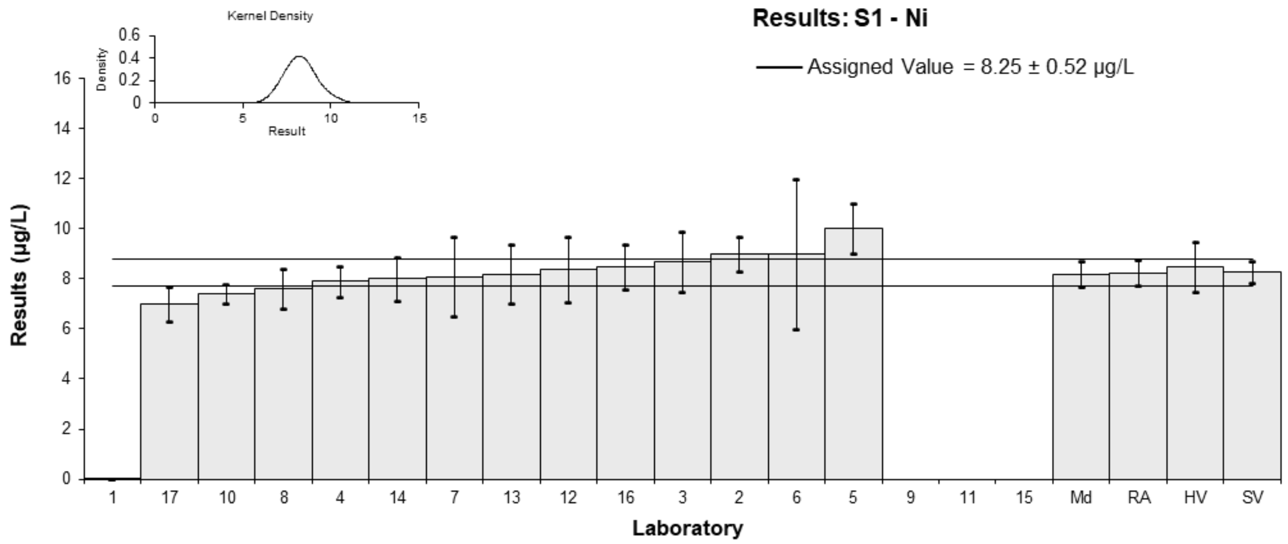
Participant Results

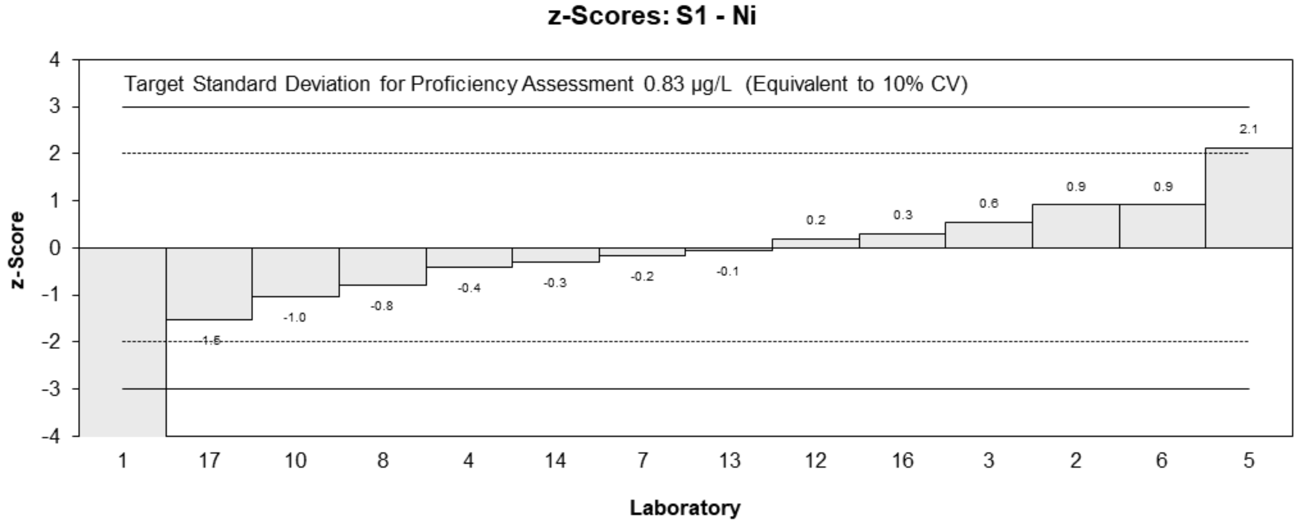
Lab. Code	Result	Uncertainty	z	E_n
1**	0.0085	0.0012	-9.99	-15.85
2	9.0	0.7	0.91	0.86
3	8.7	1.2	0.55	0.34
4	7.9	0.6	-0.42	-0.44
5	10	1	2.12	1.55
6	9	3	0.91	0.25
7	8.1	1.6	-0.18	-0.09
8	7.6	0.8	-0.79	-0.68
9	NT	NT		
10	7.40	0.37	-1.03	-1.33
11	NT	NT		
12	8.4	1.3	0.18	0.11
13	8.2	1.2	-0.06	-0.04
14	8.001	0.869	-0.30	-0.25
15	NT	NT		
16	8.5	0.9	0.30	0.24
17	7	0.68	-1.52	-1.46

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	8.25	0.52
Spike Value	8.28	0.42
Homogeneity Value	8.5	1.0
Robust Average	8.25	0.52
Median	8.20	0.51
Mean	8.29	
N	13	
Max	10	
Min	7	
Robust SD	0.76	
Robust CV	9.2%	


Results: S1 - Ni
Assigned Value = 8.25 ± 0.52 µg/L
Kernel Density
Density
Result
Results (µg/L)
Laboratory
1
17
10
8
4
14
7
13
12
16
3
2
6
5
9
11
15
Md
RA
HV
SV


z-Scores: S1 - Ni
Target Standard Deviation for Proficiency Assessment 0.83 µg/L (Equivalent to 10% CV)
z-Score
Laboratory
-1.5
-1.0
-0.8
-0.4
-0.3
-0.2
-0.1
0.2
0.3
0.6
0.9
0.9
2.1

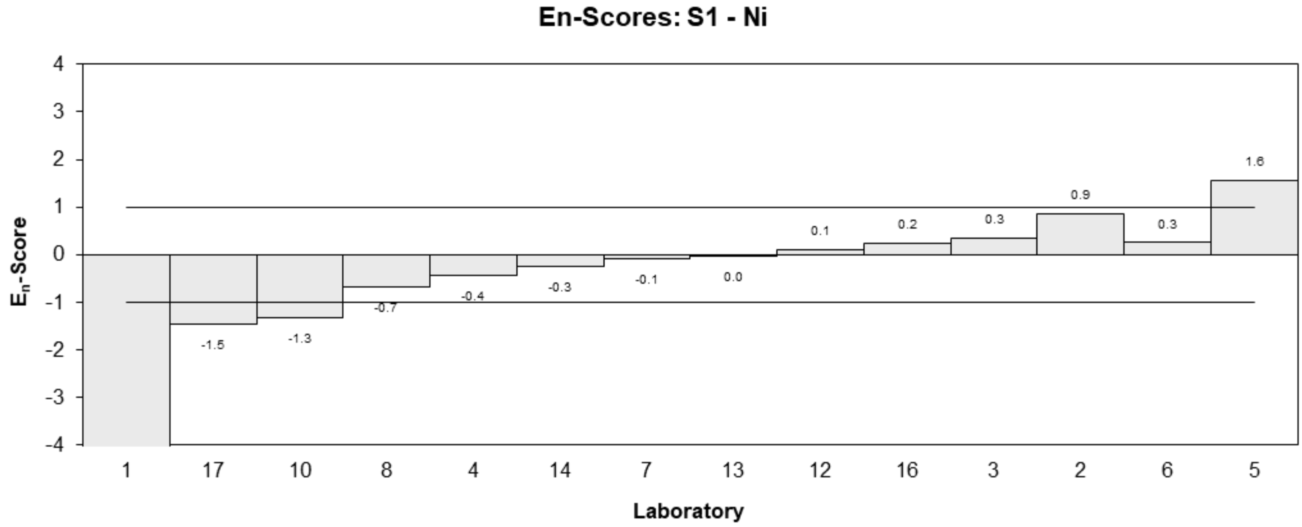

En-Scores: S1 - Ni
E_n-Score
Laboratory
-1.5
-1.3
-0.7
-0.4
-0.3
-0.1
0.0
0.1
0.2
0.3
0.9
0.3
1.6

Figure 11

Table 16

Sample Details

Sample No.	S1
Matrix	Wastewater
Analyte	Pb
Unit	µg/L

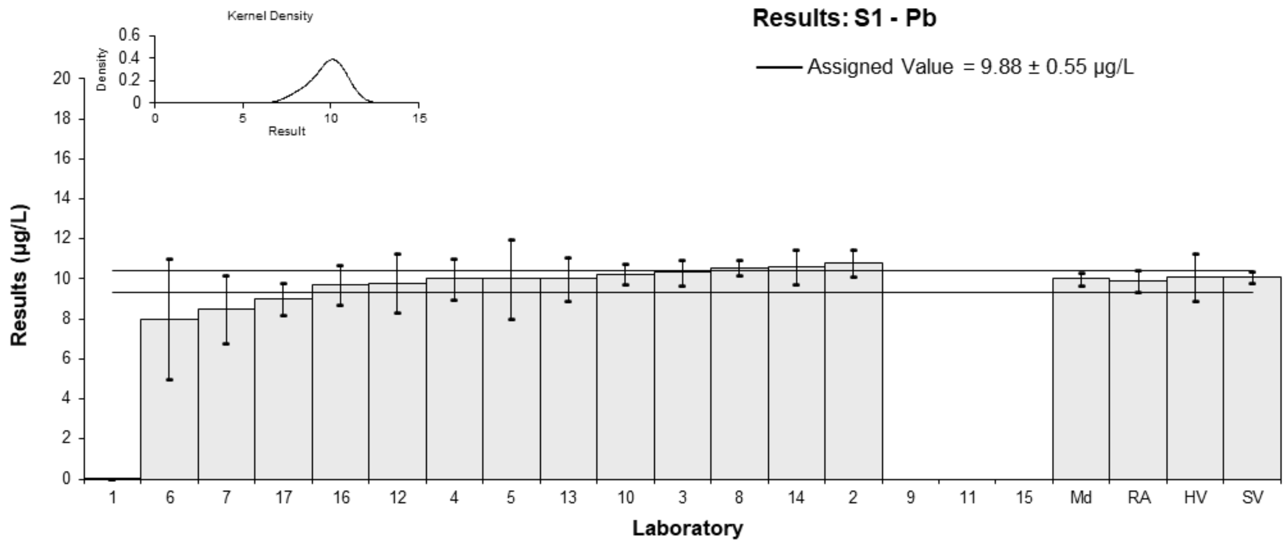
Participant Results

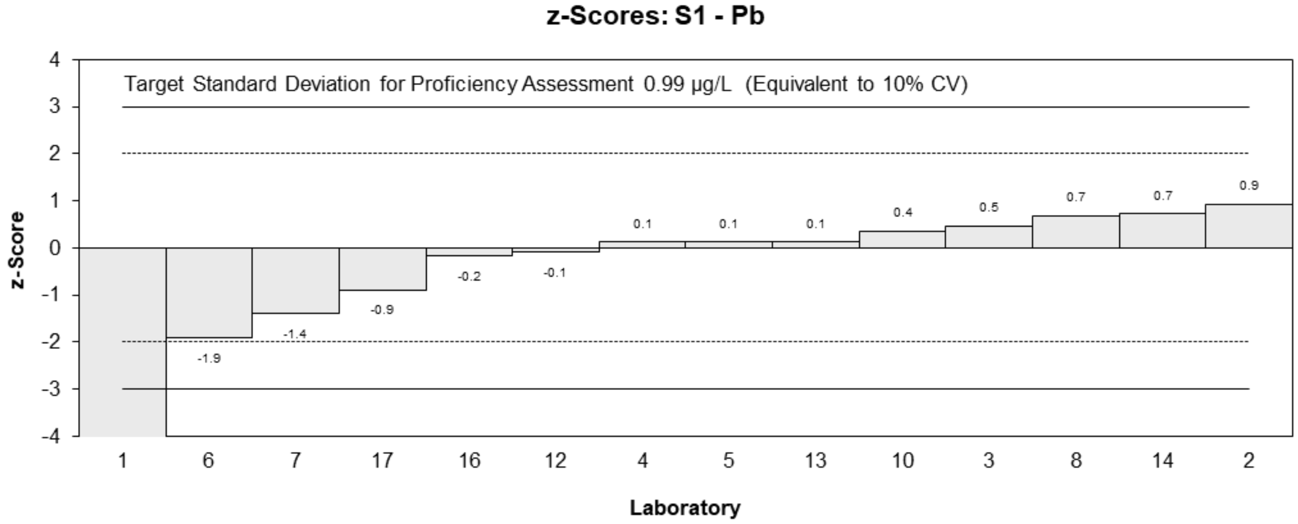
Lab. Code	Result	Uncertainty	z	E_n
1**	0.0099	0.0017	-9.99	-17.95
2	10.8	0.7	0.93	1.03
3	10.32	0.63	0.45	0.53
4	10	1	0.12	0.11
5	10	2	0.12	0.06
6	8	3	-1.90	-0.62
7	8.5	1.7	-1.40	-0.77
8	10.55	0.39	0.68	0.99
9	NT	NT		
10	10.23	0.51	0.35	0.47
11	NT	NT		
12	9.8	1.5	-0.08	-0.05
13	10.0	1.1	0.12	0.10
14	10.59	0.880	0.72	0.68
15	NT	NT		
16	9.7	1.0	-0.18	-0.16
17	9	0.78	-0.89	-0.92

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	9.88	0.55
Spike Value	10.1	0.3
Homogeneity Value	10.1	1.2
Robust Average	9.88	0.55
Median	10.0	0.3
Mean	9.81	
N	13	
Max	10.8	
Min	8	
Robust SD	0.79	
Robust CV	8%	


Kernel Density
Density
Result
Results: S1 - Pb
Assigned Value = 9.88 ± 0.55 µg/L
Results (µg/L)
Laboratory
1
6
7
17
16
12
4
5
13
10
3
8
14
2
9
11
15
Md
RA
HV
SV


z-Scores: S1 - Pb
Target Standard Deviation for Proficiency Assessment 0.99 µg/L (Equivalent to 10% CV)
z-Score
Laboratory
-1.9
-1.4
-0.9
-0.2
-0.1
0.1
0.1
0.1
0.4
0.5
0.7
0.7
0.9

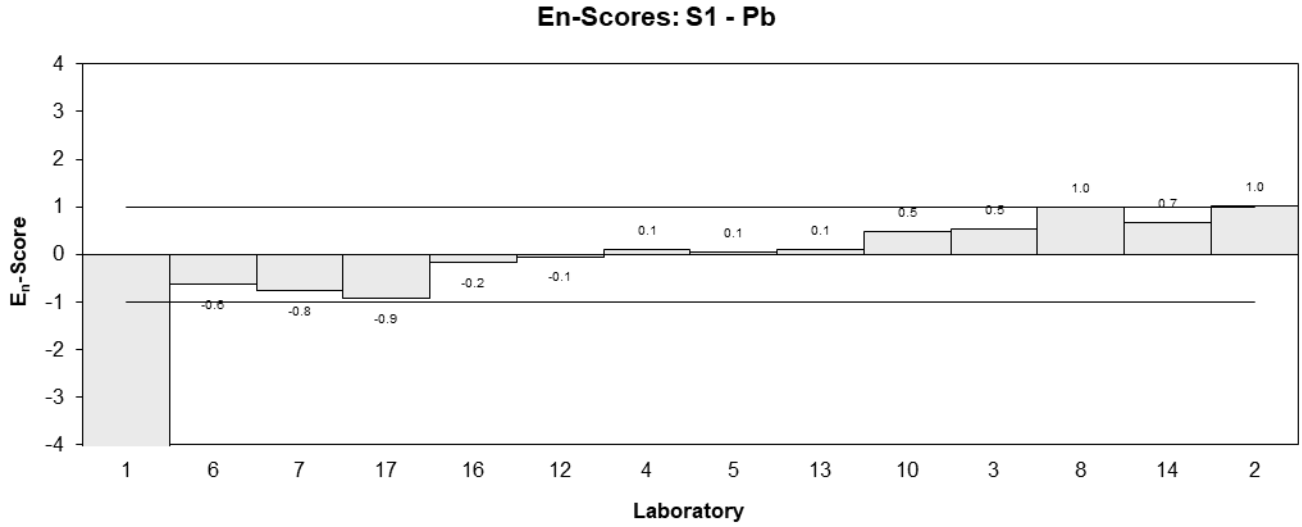

En-Scores: S1 - Pb
En-Score
Laboratory
-0.6
-0.8
-0.9
-0.2
-0.1
0.1
0.1
0.1
0.5
0.6
1.0
0.7
1.0

Figure 12

Table 17

Sample Details

Sample No.	S1
Matrix	Wastewater
Analyte	Sb
Unit	µg/L

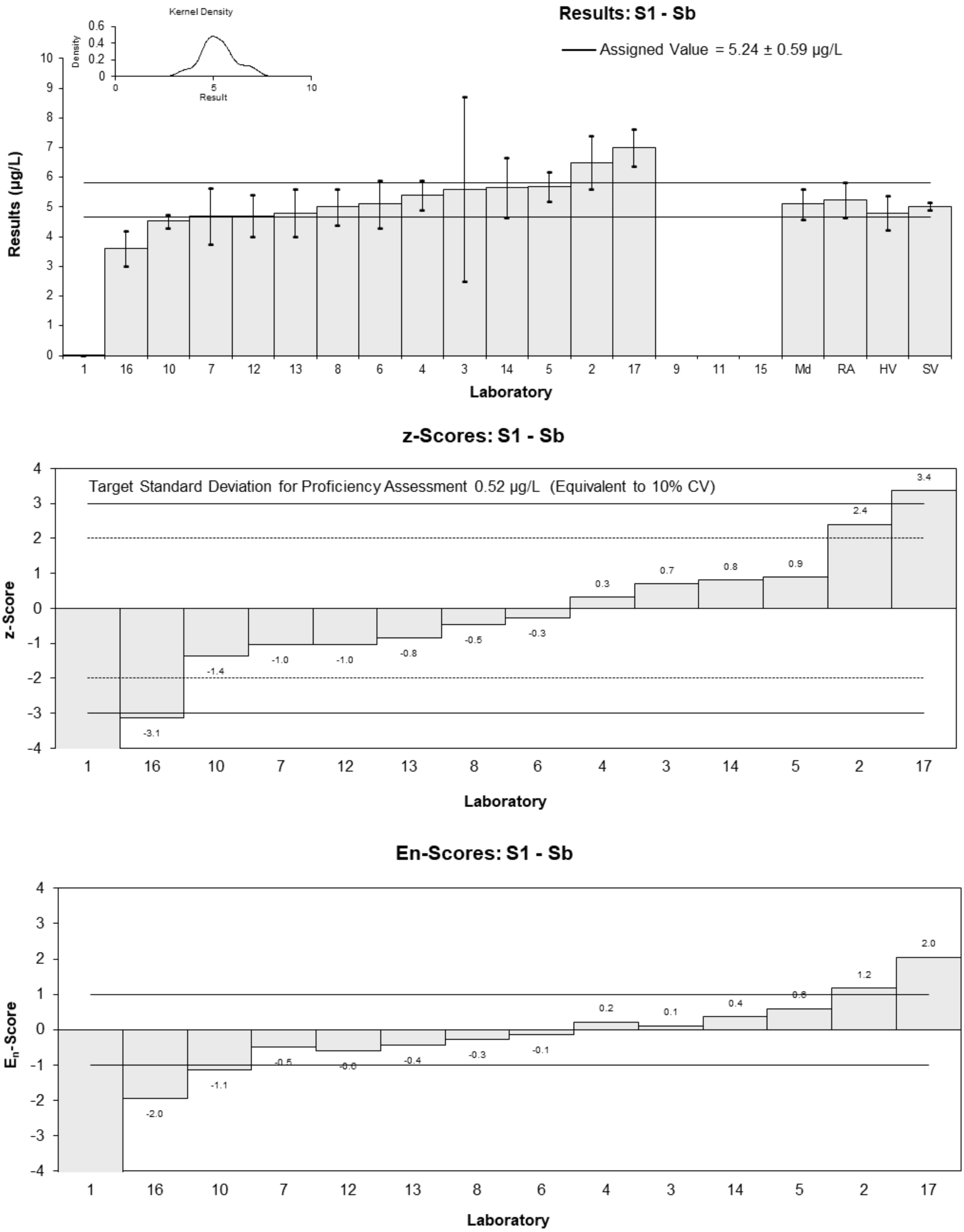
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1**	0.0078	0.0014	-9.99	-8.87
2	6.5	0.9	2.40	1.17
3	5.6	3.1	0.69	0.11
4	5.4	0.5	0.31	0.21
5	5.7	0.5	0.88	0.59
6	5.1	0.8	-0.27	-0.14
7	4.7	0.94	-1.03	-0.49
8	5.0	0.6	-0.46	-0.29
9	NT	NT		
10	4.52	0.23	-1.37	-1.14
11	NT	NT		
12	4.7	0.7	-1.03	-0.59
13	4.8	0.8	-0.84	-0.44
14	5.660	1.011	0.80	0.36
15	NT	NT		
16	3.6	0.6	-3.13	-1.95
17	7	0.63	3.36	2.04

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	5.24	0.59
Spike Value	5.03	0.14
Homogeneity Value	4.80	0.58
Robust Average	5.24	0.59
Median	5.10	0.51
Mean	5.25	
N	13	
Max	7	
Min	3.6	
Robust SD	0.85	
Robust CV	16%	



Results: S1 - Sb
Assigned Value = 5.24 ± 0.59 µg/L
Kernel Density
Density
Result
Results (µg/L)
Laboratory
1 16 10 7 12 13 8 6 4 3 14 5 2 17 9 11 15 Md RA HV SV
z-Scores: S1 - Sb
Target Standard Deviation for Proficiency Assessment 0.52 µg/L (Equivalent to 10% CV)
z-Score
-3.1 -1.4 -1.0 -1.0 -0.8 -0.5 -0.3 0.3 0.7 0.8 0.9 2.4 3.4
Laboratory
1 16 10 7 12 13 8 6 4 3 14 5 2 17
En-Scores: S1 - Sb
En-Score
-2.0 -1.1 -0.5 -0.4 -0.3 -0.1 0.2 0.1 0.4 1.2 2.0
Laboratory
1 16 10 7 12 13 8 6 4 3 14 5 2 17

Figure 13

Table 18

Sample Details

Sample No.	S1
Matrix	Wastewater
Analyte	Se
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	<0.01	NR		
2	3.9	0.41	0.66	0.38
3	3.8	1.9	0.38	0.07
4	3.5	1	-0.44	-0.14
5	3.9	1	0.66	0.22
6	<10	10		
7	2.9	0.58	-2.08	-1.01
8	NT	NT		
9	NT	NT		
10	2.73	0.14	-2.54	-1.86
11	NT	NT		
12	4	1	0.93	0.31
13	3.9	0.4	0.66	0.38
14	<10	NR		
15	NT	NT		
16	3.4	0.6	-0.71	-0.34
17	<10	NR		

Statistics

Assigned Value	3.66	0.48
Spike Value	3.43	0.10
Homogeneity Value	3.21	0.39
Robust Average	3.57	0.43
Median	3.80	0.25
Mean	3.56	
N	9	
Max	4	
Min	2.73	
Robust SD	0.51	
Robust CV	14%	

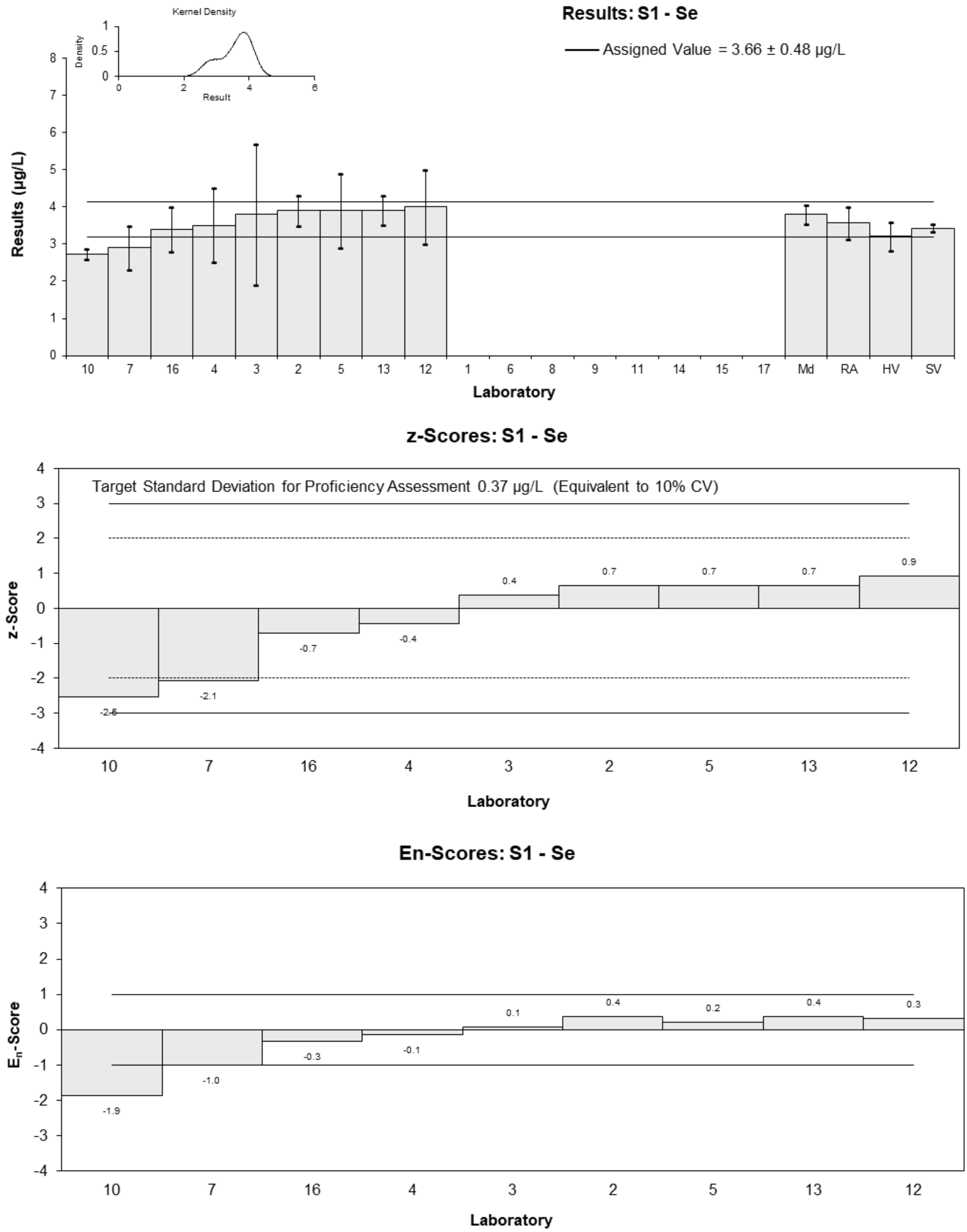

Results: S1 - Se
Assigned Value = 3.66 ± 0.48 µg/L
Kernel Density
Density
Result
Results (µg/L)
10 7 16 4 3 2 5 13 12 1 6 8 9 11 14 15 17 Md RA HV SV
Laboratory
z-Scores: S1 - Se
Target Standard Deviation for Proficiency Assessment 0.37 µg/L (Equivalent to 10% CV)
z-Score
-2.5 -2.1 -0.7 -0.4 0.4 0.7 0.7 0.7 0.9
10 7 16 4 3 2 5 13 12
Laboratory
En-Scores: S1 - Se
En-Score
-1.9 -1.0 -0.3 -0.1 0.1 0.4 0.2 0.4 0.3
10 7 16 4 3 2 5 13 12
Laboratory

Figure 14

Table 19

Sample Details

Sample No.	S1
Matrix	Wastewater
Analyte	Sn
Unit	µg/L

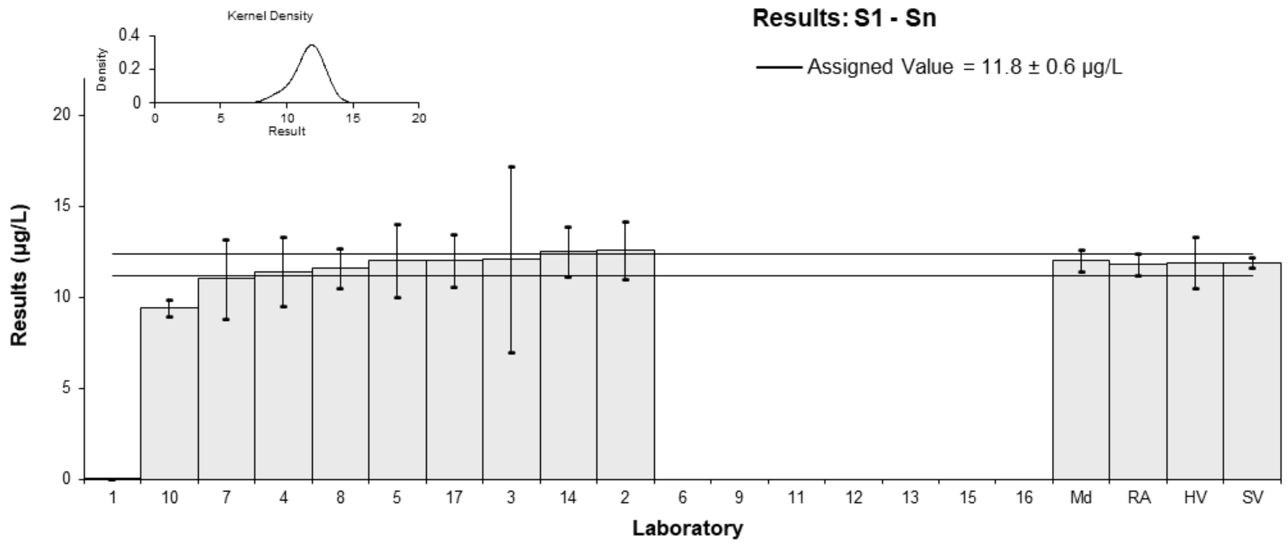
Participant Results

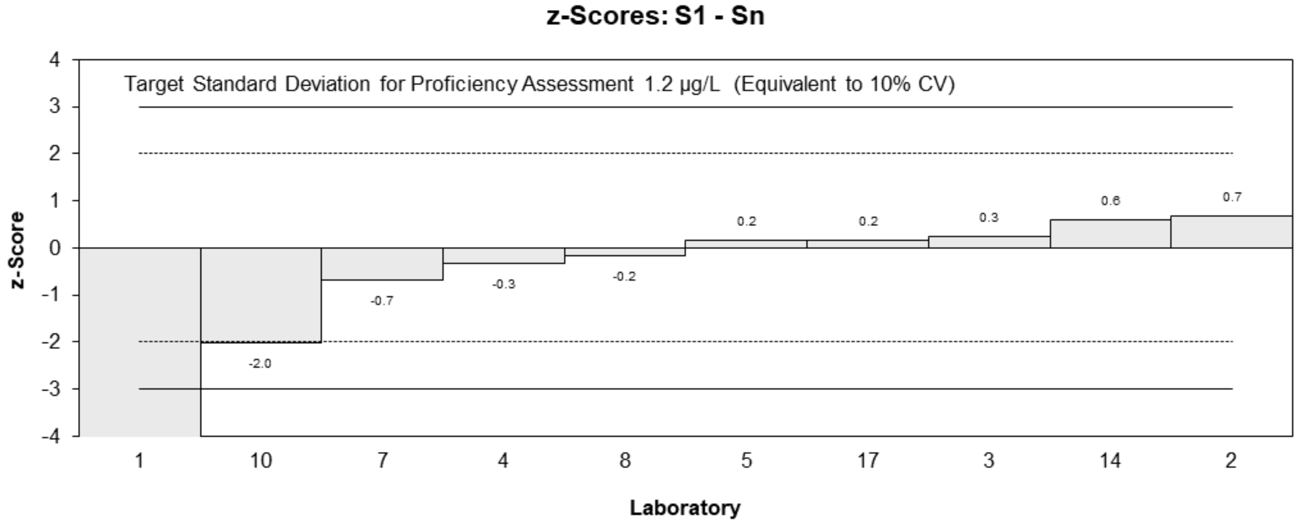
Lab. Code	Result	Uncertainty	z	E_n
1**	0.0102	0.0005	-9.99	-19.65
2	12.6	1.6	0.68	0.47
3	12.1	5.1	0.25	0.06
4	11.4	1.9	-0.34	-0.20
5	12	2	0.17	0.10
6	NT	NT		
7	11	2.2	-0.68	-0.35
8	11.6	1.1	-0.17	-0.16
9	NT	NT		
10	9.43	0.47	-2.01	-3.11
11	NT	NT		
12	NT	NT		
13	NT	NT		
14	12.50	1.37	0.59	0.47
15	NT	NT		
16	NT	NT		
17	12	1.44	0.17	0.13

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	11.8	0.6
Spike Value	11.9	0.3
Homogeneity Value	11.9	1.4
Robust Average	11.8	0.6
Median	12.0	0.6
Mean	11.6	
N	9	
Max	12.6	
Min	9.43	
Robust SD	0.75	
Robust CV	6.4%	


Results: S1 - Sn
Assigned Value = 11.8 ± 0.6 µg/L
Kernel Density
Density
Result
Results (µg/L)
Laboratory
1
10
7
4
8
5
17
3
14
2
6
9
11
12
13
15
16
Md
RA
HV
SV


z-Scores: S1 - Sn
Target Standard Deviation for Proficiency Assessment 1.2 µg/L (Equivalent to 10% CV)
z-Score
Laboratory
-2.0
-0.7
-0.3
-0.2
0.2
0.2
0.3
0.6
0.7
1
10
7
4
8
5
17
3
14
2

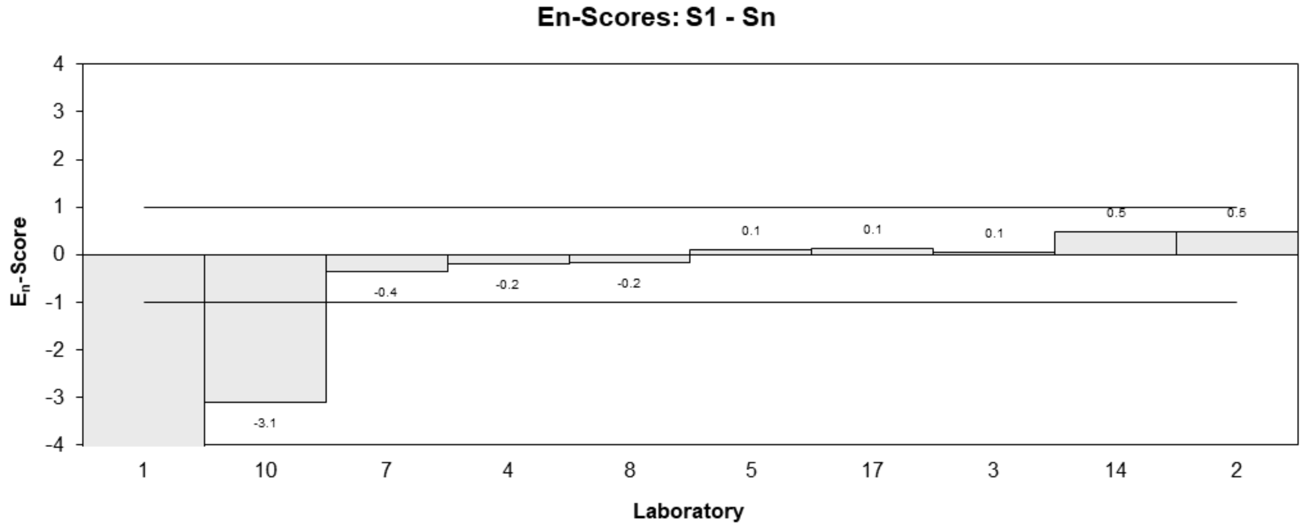

En-Scores: S1 - Sn
En-Score
Laboratory
-3.1
-0.4
-0.2
-0.2
0.1
0.1
0.1
0.5
0.5
1
10
7
4
8
5
17
3
14
2

Figure 15

Table 20

Sample Details

Sample No.	S1
Matrix	Wastewater
Analyte	Ti
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1**	0.0191	0.0019	-9.99	-15.45
2	22	2.8	0.95	0.62
3	18	NT	-1.04	-1.62
4	19	8	-0.55	-0.14
5	20	3	-0.05	-0.03
6	NT	NT		
7	21	4.2	0.45	0.20
8	26.9	2.2	3.38	2.66
9	NT	NT		
10	19.54	0.98	-0.28	-0.34
11	NT	NT		
12	NT	NT		
13	20	3	-0.05	-0.03
14	18.54	2.07	-0.78	-0.64
15	NT	NT		
16	NT	NT		
17	20	NR	-0.05	-0.08

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	20.1	1.3
Spike Value	20.1	0.6
Robust Average	20.1	1.3
Median	20.0	1.2
Mean	20.5	
N	10	
Max	26.9	
Min	18	
Robust SD	1.6	
Robust CV	8.1%	

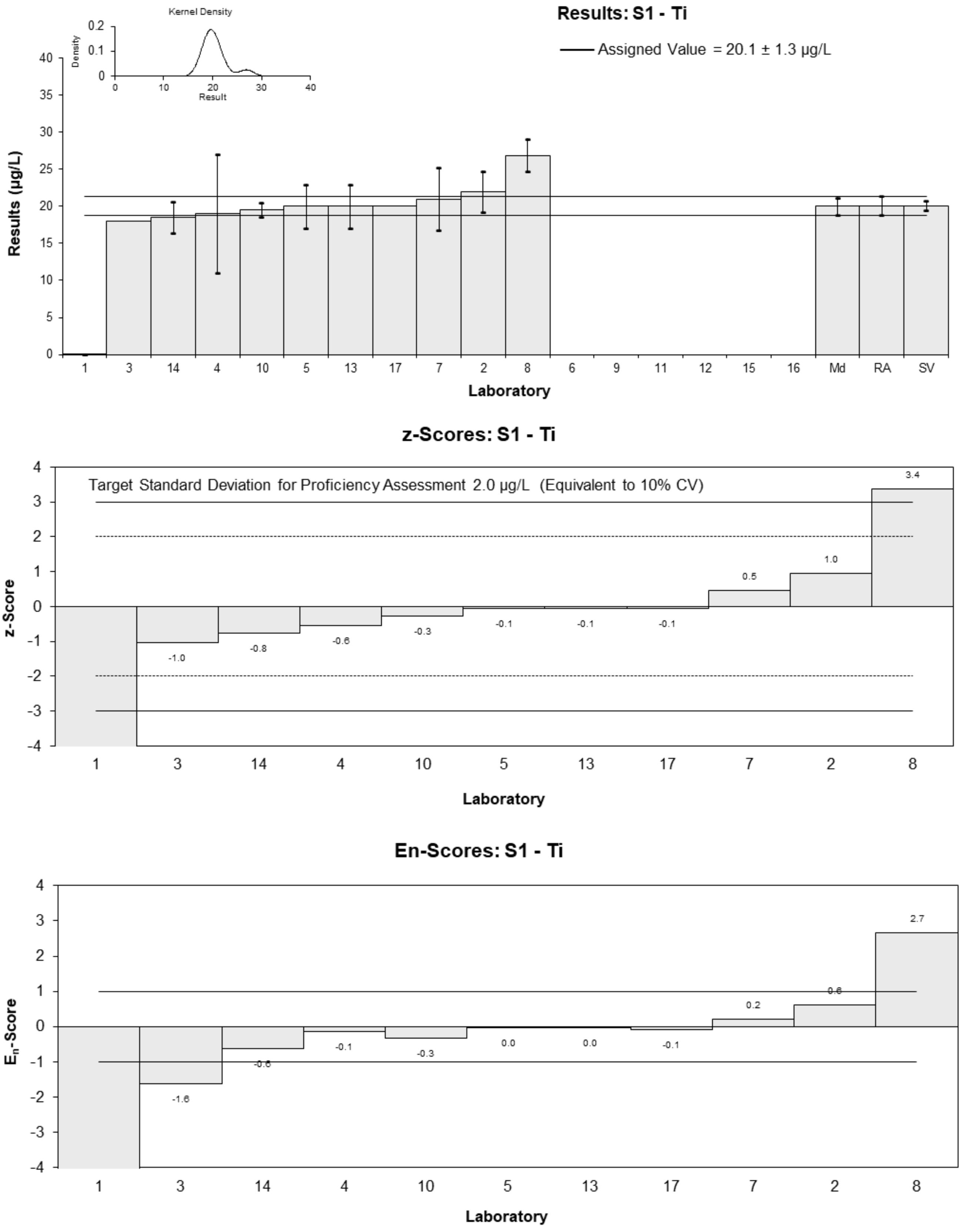

Results: S1 - Ti
Assigned Value = 20.1 ± 1.3 µg/L
Kernel Density
Density
Result
Results (µg/L)
Laboratory
1
3
14
4
10
5
13
17
7
2
8
6
9
11
12
15
16
Md
RA
SV
z-Scores: S1 - Ti
Target Standard Deviation for Proficiency Assessment 2.0 µg/L (Equivalent to 10% CV)
z-Score
En-Scores: S1 - Ti
En-Score

Figure 16

Table 21

Sample Details

Sample No.	S1
Matrix	Wastewater
Analyte	Tl
Unit	µg/L

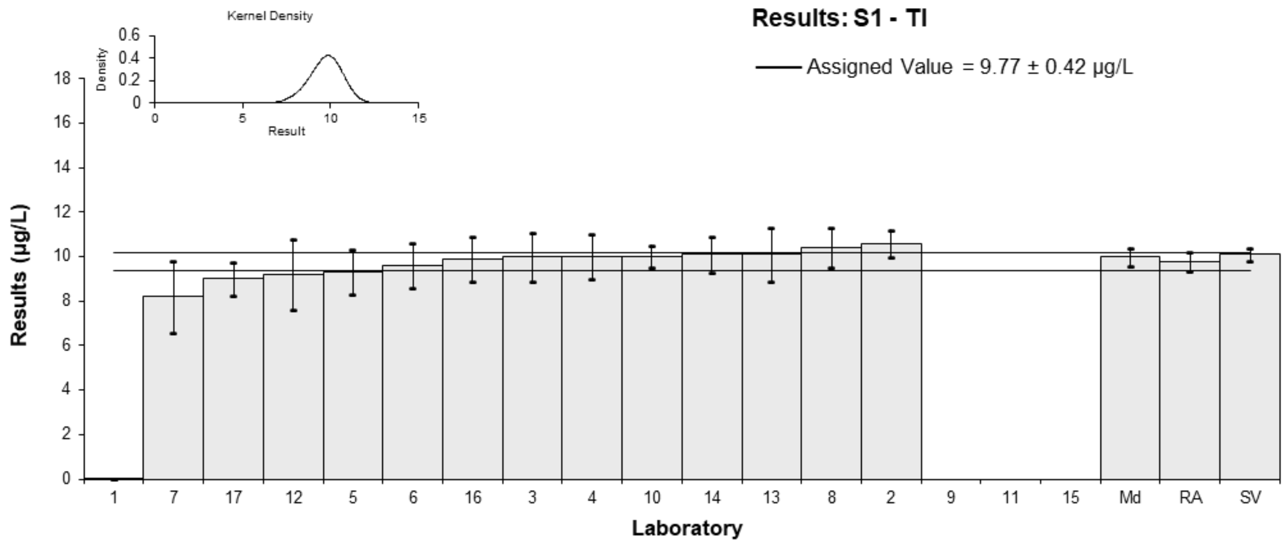
Participant Results

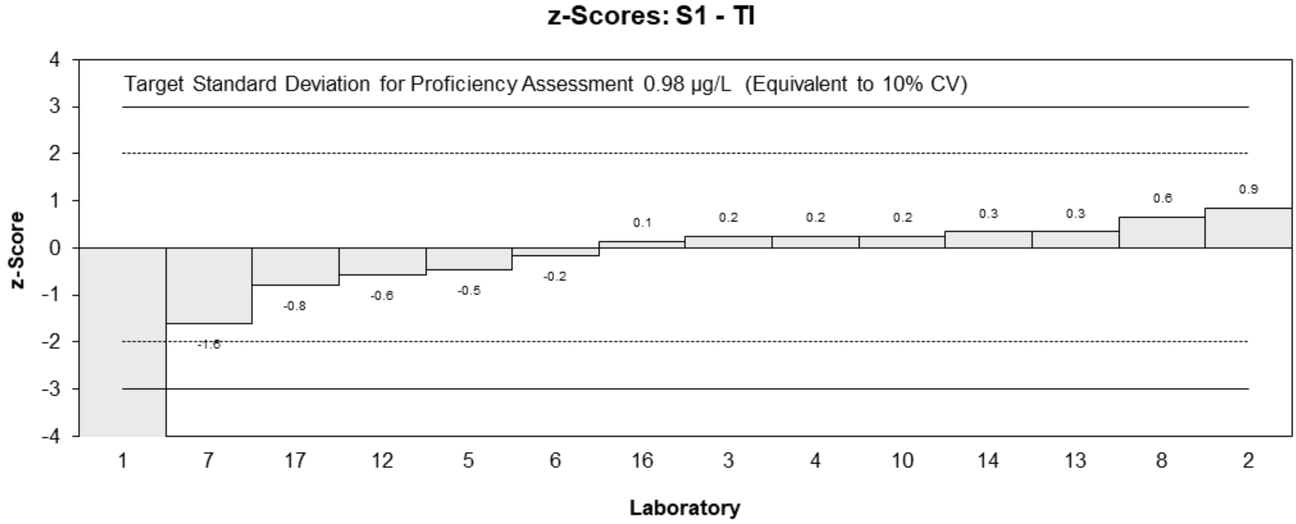
Lab. Code	Result	Uncertainty	z	E_n
1**	0.012	0.0016	-9.99	-23.23
2	10.6	0.6	0.85	1.13
3	10.0	1.1	0.24	0.20
4	10	1	0.24	0.21
5	9.3	1	-0.48	-0.43
6	9.6	1	-0.17	-0.16
7	8.2	1.6	-1.61	-0.95
8	10.4	0.9	0.64	0.63
9	NT	NT		
10	10	0.5	0.24	0.35
11	NT	NT		
12	9.2	1.6	-0.58	-0.34
13	10.1	1.2	0.34	0.26
14	10.098	0.802	0.34	0.36
15	NT	NT		
16	9.9	1.0	0.13	0.12
17	9	0.77	-0.79	-0.88

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	9.77	0.42
Spike Value	10.1	0.3
Robust Average	9.77	0.42
Median	10.0	0.4
Mean	9.72	
N	13	
Max	10.6	
Min	8.2	
Robust SD	0.61	
Robust CV	6.2%	


Results: S1 - Tl
Assigned Value = 9.77 ± 0.42 µg/L
Kernel Density
Density
Result
Results (µg/L)
Laboratory
1 7 17 12 5 6 16 3 4 10 14 13 8 2 9 11 15 Md RA SV


z-Scores: S1 - Tl
Target Standard Deviation for Proficiency Assessment 0.98 µg/L (Equivalent to 10% CV)
z-Score
Laboratory
1 7 17 12 5 6 16 3 4 10 14 13 8 2
-1.6 -0.8 -0.6 -0.5 -0.2 0.1 0.2 0.2 0.2 0.3 0.3 0.6 0.9

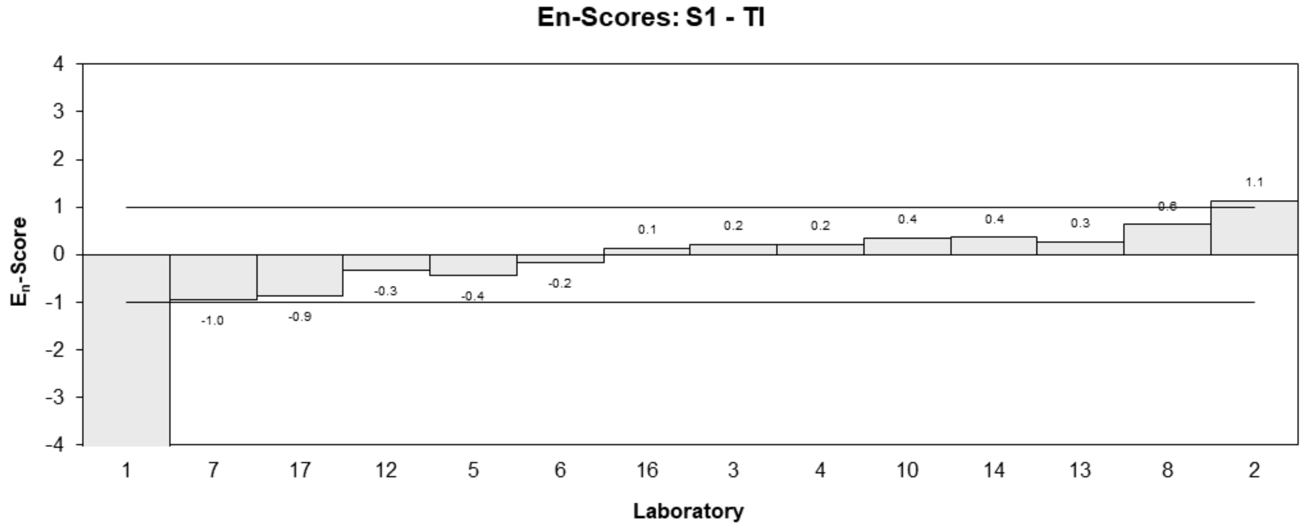

En-Scores: S1 - Tl
En-Score
Laboratory
1 7 17 12 5 6 16 3 4 10 14 13 8 2
-1.0 -0.9 -0.3 -0.4 -0.2 0.1 0.2 0.2 0.4 0.4 0.3 0.6 1.1

Figure 17

Table 22

Sample Details

Sample No.	S1
Matrix	Wastewater
Analyte	V
Unit	µg/L

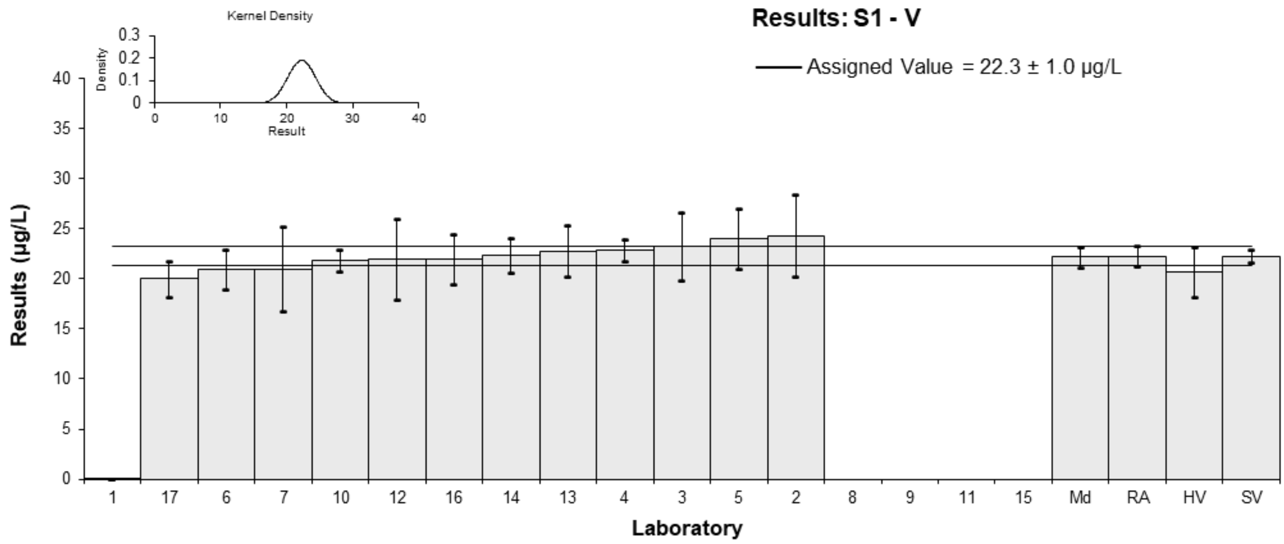
Participant Results

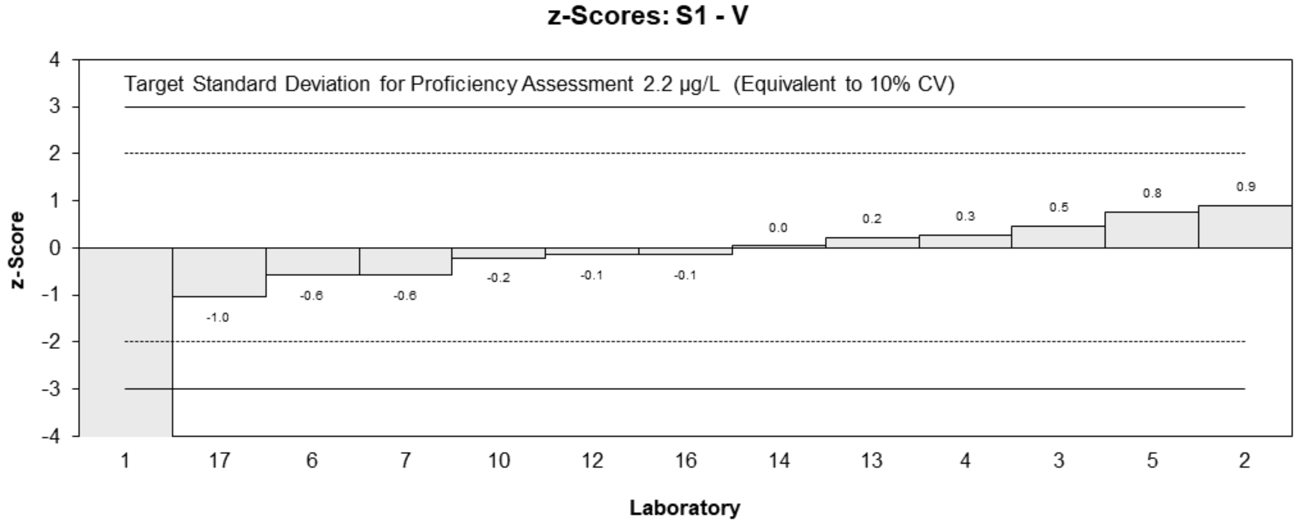
Lab. Code	Result	Uncertainty	z	E_n
1**	0.023	0.0012	-9.99	-22.28
2	24.3	4.1	0.90	0.47
3	23.3	3.4	0.45	0.28
4	22.9	1.1	0.27	0.40
5	24	3	0.76	0.54
6	21	2	-0.58	-0.58
7	21	4.2	-0.58	-0.30
8	NT	NT		
9	NT	NT		
10	21.84	1.09	-0.21	-0.31
11	NT	NT		
12	22	4	-0.13	-0.07
13	22.8	2.6	0.22	0.18
14	22.39	1.76	0.04	0.04
15	NT	NT		
16	22	2.5	-0.13	-0.11
17	20	1.77	-1.03	-1.13

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	22.3	1.0
Spike Value	22.3	0.6
Homogeneity Value	20.7	2.5
Robust Average	22.3	1.0
Median	22.2	1.0
Mean	22.3	
N	12	
Max	24.3	
Min	20	
Robust SD	1.4	
Robust CV	6.2%	


Results: S1 - V
Assigned Value = 22.3 ± 1.0 µg/L
Kernel Density
Density
Result
Results (µg/L)
Laboratory
1
17
6
7
10
12
16
14
13
4
3
5
2
8
9
11
15
Md
RA
HV
SV


z-Scores: S1 - V
Target Standard Deviation for Proficiency Assessment 2.2 µg/L (Equivalent to 10% CV)
z-Score
Laboratory
-1.0
-0.6
-0.6
-0.2
-0.1
-0.1
0.0
0.2
0.3
0.5
0.8
0.9

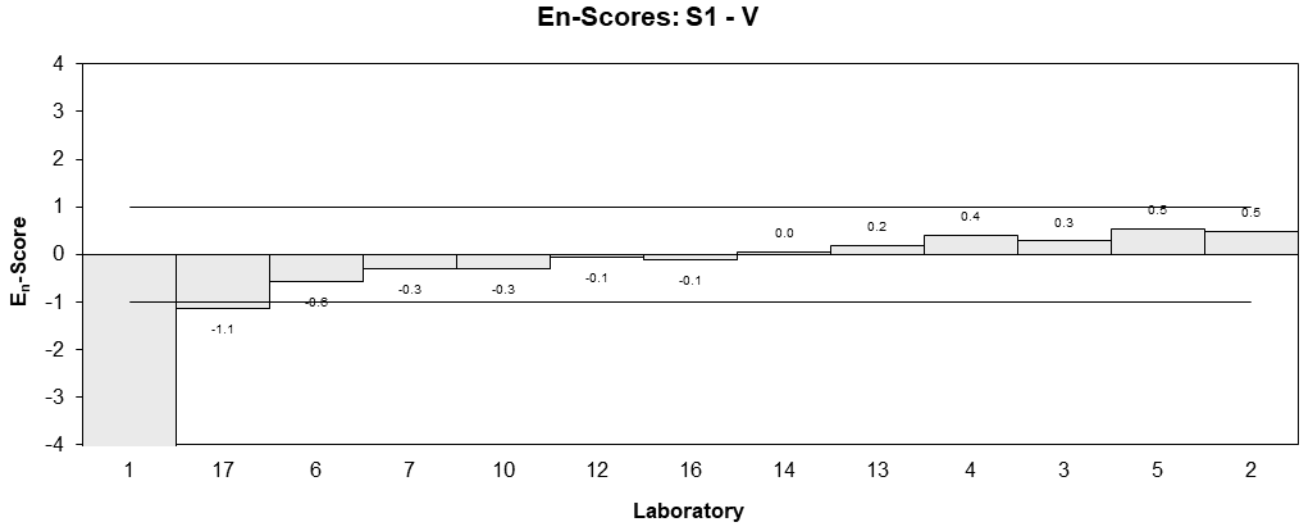

En-Scores: S1 - V
En-Score
Laboratory
-1.1
-0.6
-0.3
-0.3
-0.1
-0.1
0.0
0.2
0.4
0.3
0.5
0.5

Figure 18

Table 23

Sample Details

Sample No.	S1
Matrix	Wastewater
Analyte	Zn
Unit	µg/L

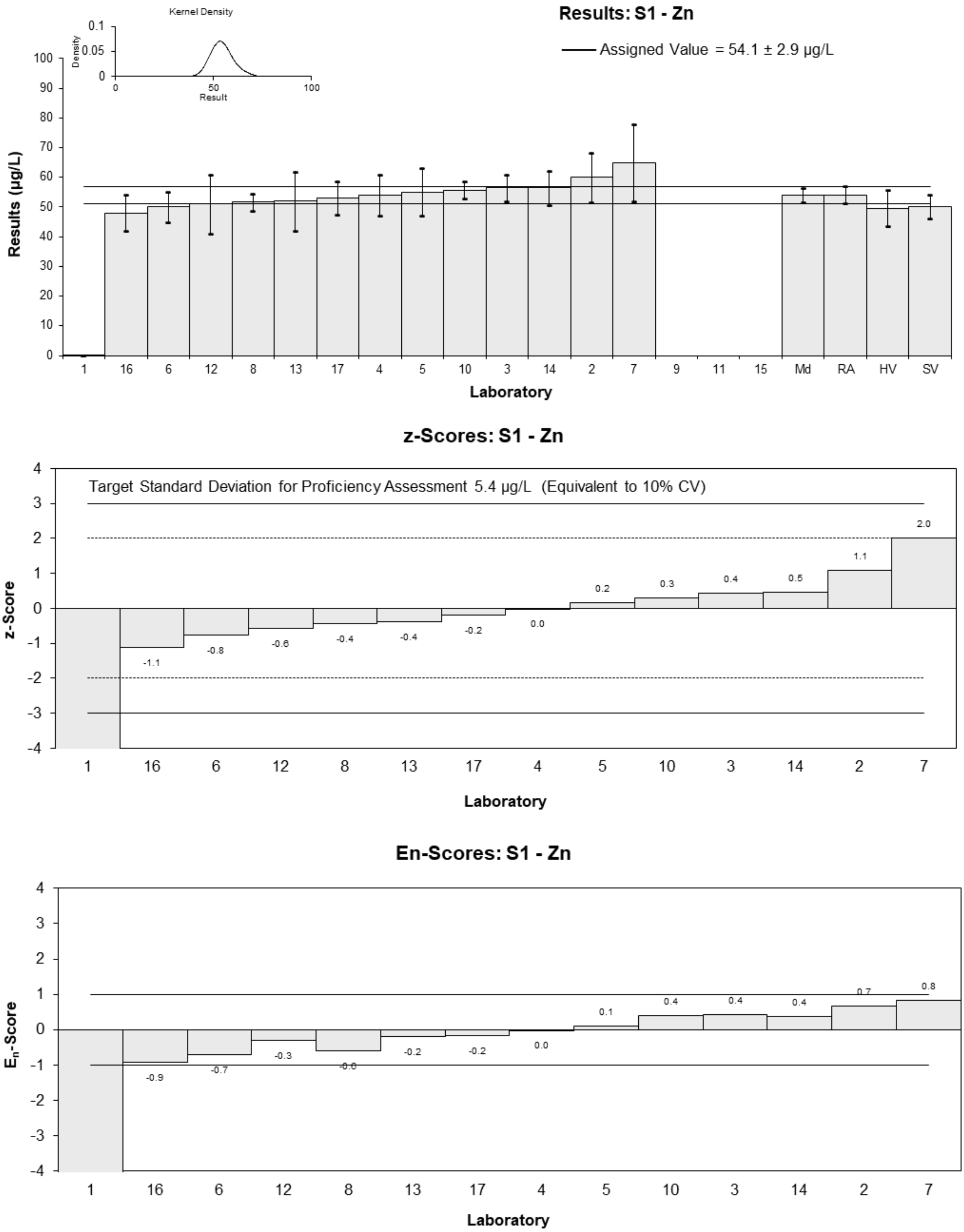
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1**	0.0564	0.0056	-9.99	-18.64
2	60	8.3	1.09	0.67
3	56.4	4.6	0.43	0.42
4	54	7	-0.02	-0.01
5	55	8	0.17	0.11
6	50	5	-0.76	-0.71
7	65	13	2.01	0.82
8	51.7	2.9	-0.44	-0.59
9	NT	NT		
10	55.74	2.78	0.30	0.41
11	NT	NT		
12	51	10	-0.57	-0.30
13	52	10	-0.39	-0.20
14	56.52	5.77	0.45	0.37
15	NT	NT		
16	48	6.0	-1.13	-0.92
17	53	5.72	-0.20	-0.17

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	54.1	2.9
Spike Value	50.0	4.0
Homogeneity Value	49.6	6.0
Robust Average	54.1	2.9
Median	54.0	2.5
Mean	54.5	
N	13	
Max	65	
Min	48	
Robust SD	4.2	
Robust CV	7.8%	



Results: S1 - Zn
Assigned Value = 54.1 ± 2.9 µg/L
Kernel Density
Density
Result
Results (µg/L)
Laboratory
1
16
6
12
8
13
17
4
5
10
3
14
2
7
9
11
15
Md
RA
HV
SV
z-Scores: S1 - Zn
Target Standard Deviation for Proficiency Assessment 5.4 µg/L (Equivalent to 10% CV)
z-Score
Laboratory
En-Scores: S1 - Zn
En-Score
Laboratory

Figure 19

Table 24

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1**	0.126	0.0730	-9.99	-18.81
2	110	4.11	-0.27	-0.41
3	117	17	0.35	0.22
4	125	18	1.06	0.63
5	98	16	-1.33	-0.88
6	119	9	0.53	0.55
7	120	24	0.62	0.28
8	NT	NT		
9	NT	NT		
10	108.82	5.44	-0.37	-0.52
11	NT	NT		
12	104	19	-0.80	-0.45
13	108	15	-0.44	-0.31
14	110.62	12.97	-0.21	-0.17
15	122	18.3	0.80	0.47
16	111	15	-0.18	-0.12
17	110	11.6	-0.27	-0.23

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	113	6
Spike Value	Not Spiked	
Homogeneity Value	99	12
Robust Average	113	6
Median	111	7
Mean	113	
N	13	
Max	125	
Min	98	
Robust SD	8.3	
Robust CV	7.3%	

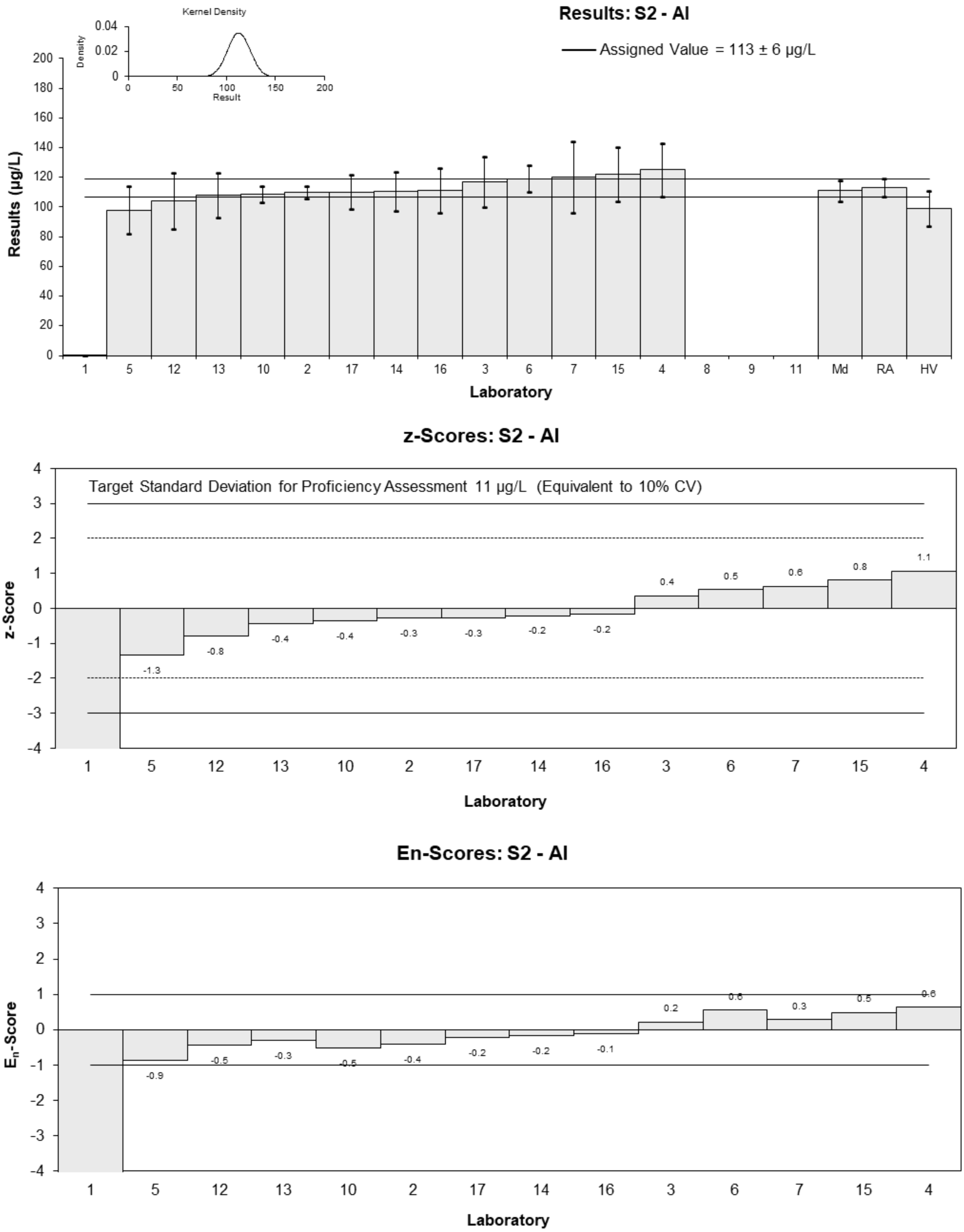

Results: S2 - Al
Assigned Value = 113 ± 6 µg/L
Kernel Density
Density
Result
Results (µg/L)
Laboratory
1
5
12
13
10
2
17
14
16
3
6
7
15
4
8
9
11
Md
RA
HV
z-Scores: S2 - Al
Target Standard Deviation for Proficiency Assessment 11 µg/L (Equivalent to 10% CV)
z-Score
-1.3
-0.8
-0.4
-0.4
-0.3
-0.3
-0.2
-0.2
0.4
0.5
0.6
0.8
1.1
Laboratory
En-Scores: S2 - Al
E_n-Score
-0.9
-0.5
-0.3
-0.5
-0.4
-0.2
-0.2
-0.1
0.2
0.6
0.3
0.5
0.6
Laboratory

Figure 20

Table 25

Sample Details

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

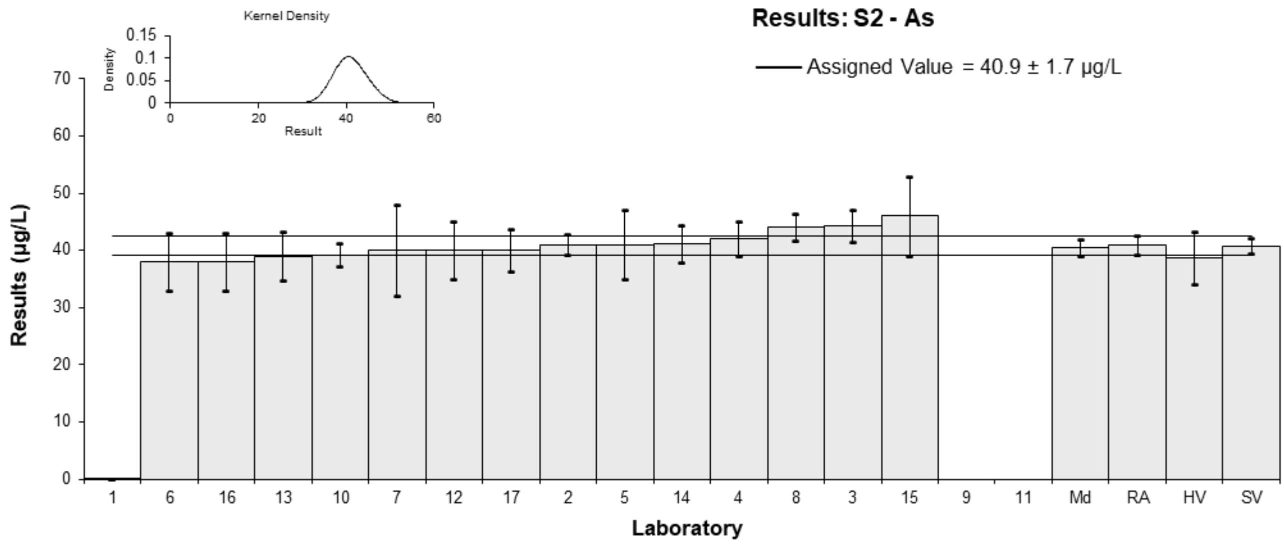
Participant Results

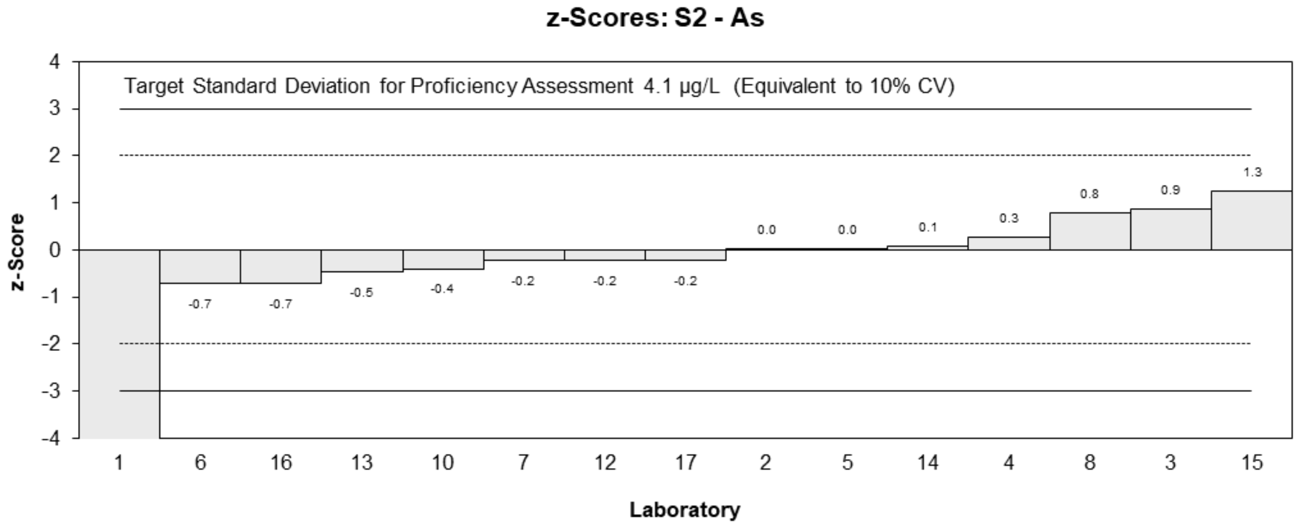
Lab. Code	Result	Uncertainty	z	E_n
1**	0.0427	0.0030	-9.99	-24.03
2	41	1.8	0.02	0.04
3	44.4	2.8	0.86	1.07
4	42	3	0.27	0.32
5	41	6	0.02	0.02
6	38	5	-0.71	-0.55
7	40	8.0	-0.22	-0.11
8	44.1	2.4	0.78	1.09
9	NT	NT		
10	39.25	1.96	-0.40	-0.64
11	NT	NT		
12	40	5	-0.22	-0.17
13	39.0	4.2	-0.46	-0.42
14	41.18	3.242	0.07	0.08
15	46	6.90	1.25	0.72
16	38	5.0	-0.71	-0.55
17	40	3.7	-0.22	-0.22

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	40.9	1.7
Spike Value	40.8	1.3
Homogeneity Value	38.6	4.6
Robust Average	40.9	1.7
Median	40.5	1.4
Mean	41.0	
N	14	
Max	46	
Min	38	
Robust SD	2.5	
Robust CV	6.1%	


Results: S2 - As
Assigned Value = 40.9 ± 1.7 µg/L
Kernel Density
Density
Result
Results (µg/L)
Laboratory
1 6 16 13 10 7 12 17 2 5 14 4 8 3 15 9 11 Md RA HV SV


z-Scores: S2 - As
Target Standard Deviation for Proficiency Assessment 4.1 µg/L (Equivalent to 10% CV)
z-Score
Laboratory
1 6 16 13 10 7 12 17 2 5 14 4 8 3 15
-0.7 -0.7 -0.5 -0.4 -0.2 -0.2 -0.2 0.0 0.0 0.1 0.3 0.8 0.9 1.3

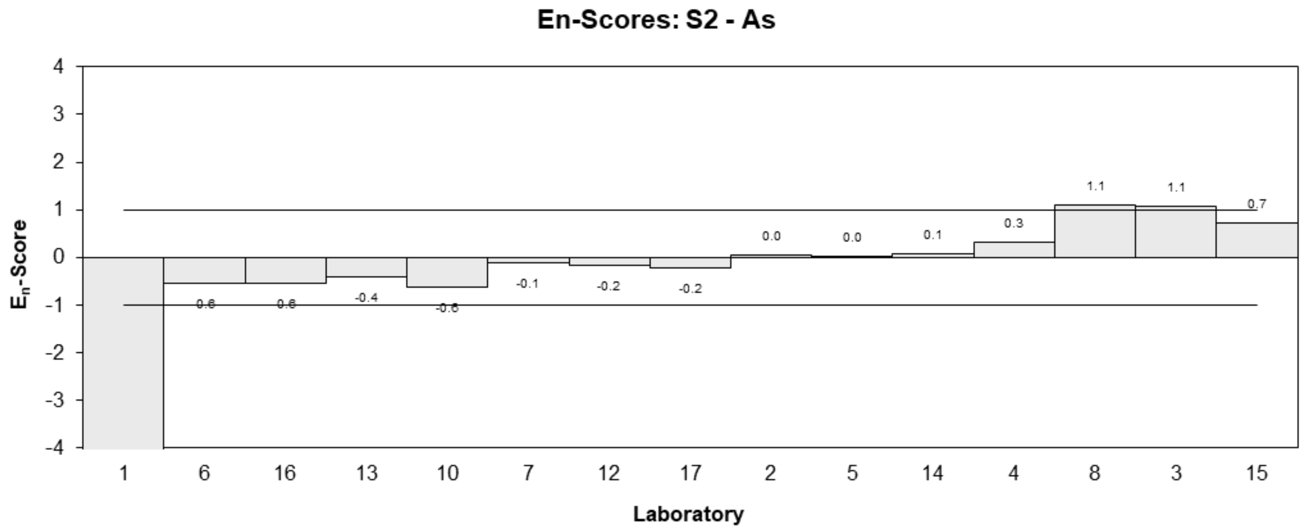

En-Scores: S2 - As
En-Score
Laboratory
1 6 16 13 10 7 12 17 2 5 14 4 8 3 15
-0.6 -0.6 -0.4 -0.6 -0.1 -0.2 -0.2 0.0 0.0 0.1 0.3 1.1 1.1 0.7

Figure 21

Table 26

Sample Details

Sample No.	S2
Matrix	Wastewater
Analyte	B
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1**	0.589	0.2533	-9.99	-14.69
2	540	65	-0.07	-0.05
3	607	86	1.16	0.67
4	480	83	-1.18	-0.70
5	610	160	1.21	0.40
6	501	50	-0.79	-0.69
7	560	112	0.29	0.14
8	538	27	-0.11	-0.13
9	NT	NT		
10	596.52	29.82	0.97	1.11
11	NT	NT		
12	NT	NT		
13	558	14	0.26	0.35
14	562.2	67.3	0.33	0.24
15	552	81.1	0.15	0.09
16	498	50	-0.85	-0.74
17	300	NR	-4.49	-6.59

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	544	37
Spike Value	Not Spiked	
Homogeneity Value	509	61
Robust Average	544	37
Median	552	46
Mean	531	
N	13	
Max	610	
Min	300	
Robust SD	53	
Robust CV	9.8%	

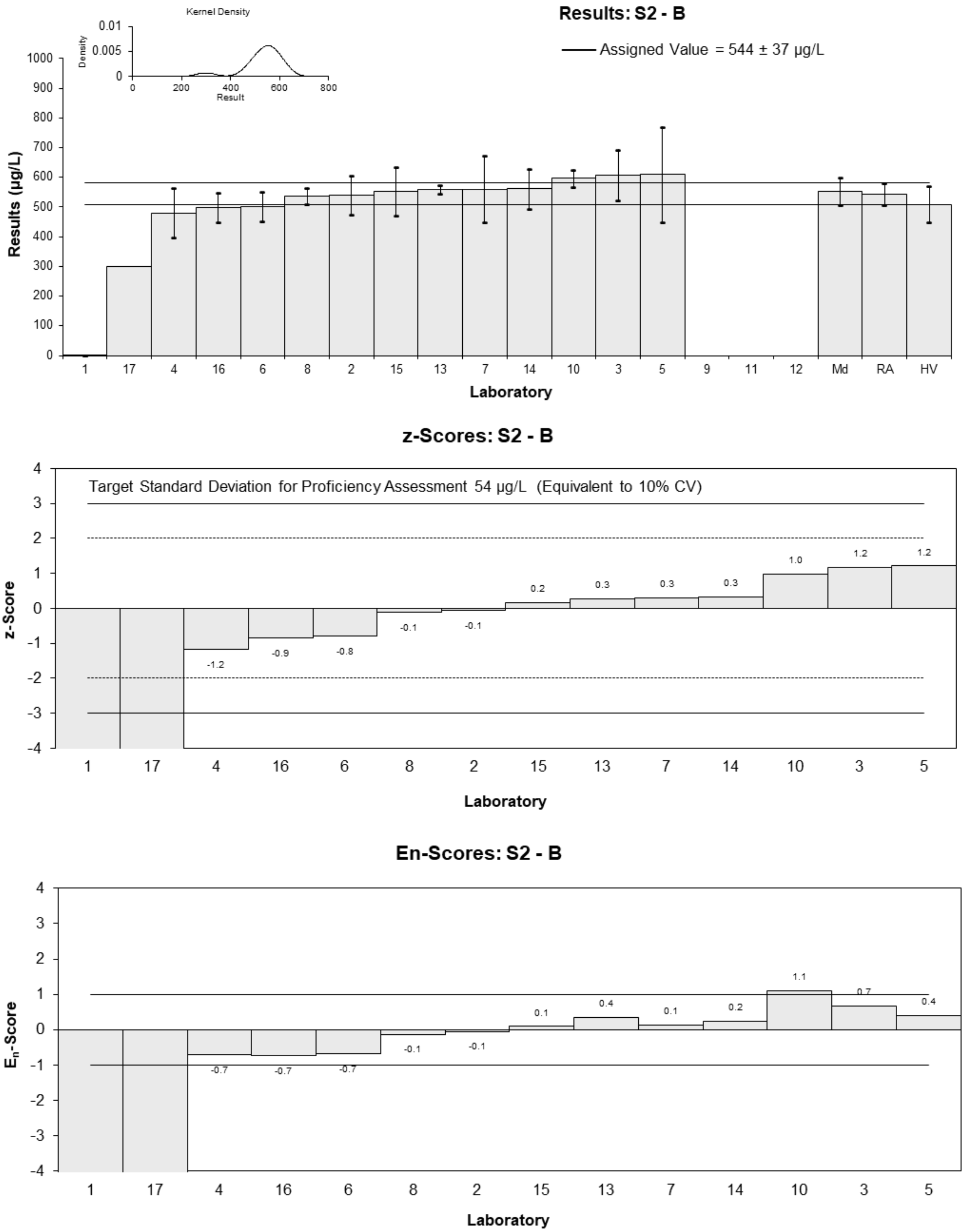

Results: S2 - B
Assigned Value = 544 ± 37 µg/L
Kernel Density
Density
Result
Results (µg/L)
Laboratory
z-Scores: S2 - B
Target Standard Deviation for Proficiency Assessment 54 µg/L (Equivalent to 10% CV)
z-Score
Laboratory
En-Scores: S2 - B
En-Score
Laboratory

Figure 22

Table 27

Sample Details

Sample No.	S2
Matrix	Wastewater
Analyte	Ba
Unit	µg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1**	0.0818	0.0343	-9.99	-37.80
2	74	5	-0.22	-0.32
3	82.5	6.7	0.90	0.97
4	79	8	0.44	0.40
5	80	7	0.57	0.59
6	75	3	-0.09	-0.19
7	75	15	-0.09	-0.05
8	75.6	3.7	-0.01	-0.02
9	NT	NT		
10	71.53	3.58	-0.55	-1.02
11	NT	NT		
12	73	10	-0.36	-0.26
13	73.1	9.2	-0.34	-0.28
14	76.97	7.22	0.17	0.17
15	75	11.3	-0.09	-0.06
16	75	8.0	-0.09	-0.08
17	77	7.0	0.17	0.18

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	75.7	2.0
Spike Value	70.3	6.1
Homogeneity Value	67.5	8.1
Robust Average	75.7	2.0
Median	75.0	1.9
Mean	75.9	
N	14	
Max	82.5	
Min	71.53	
Robust SD	3.0	
Robust CV	3.9%	

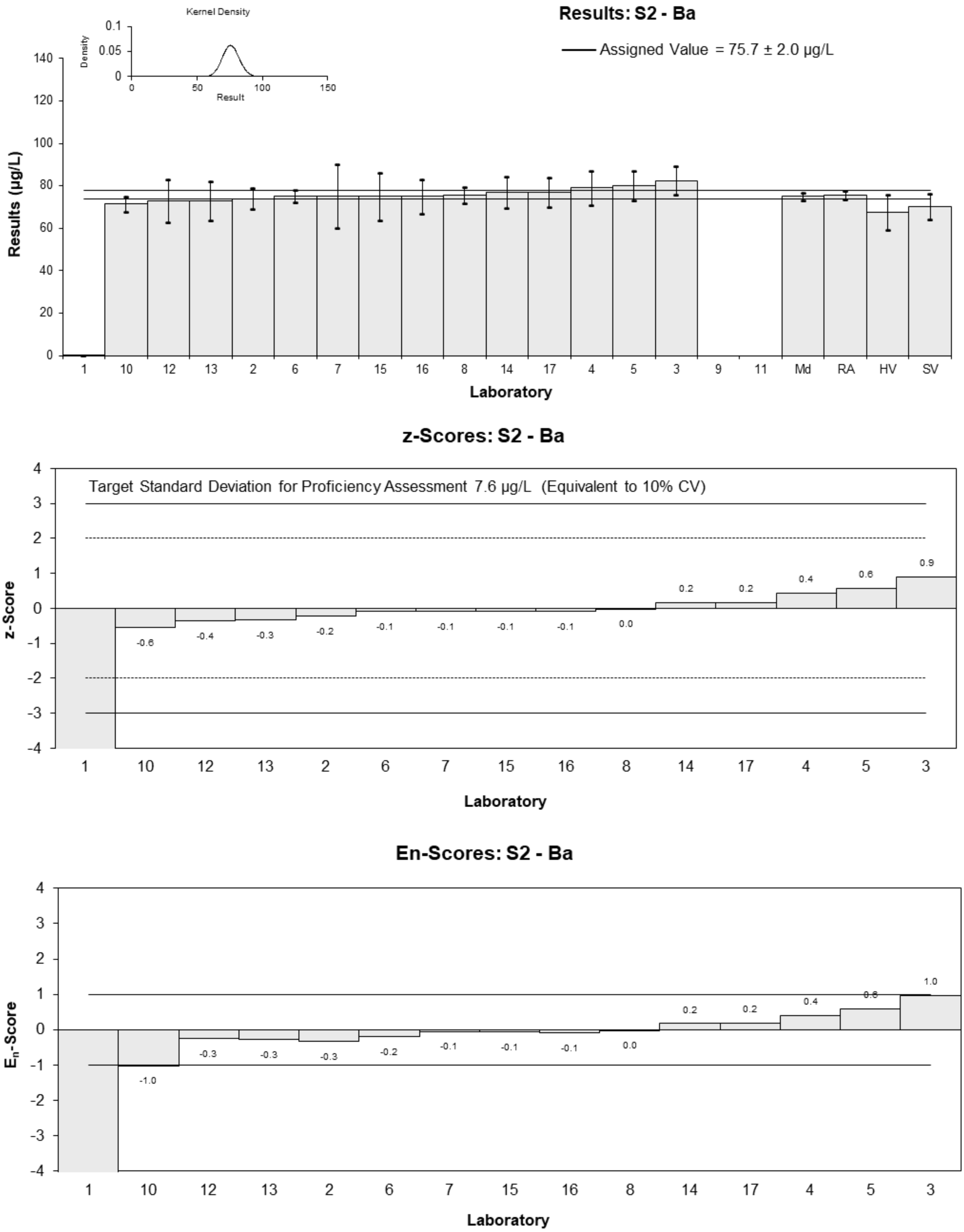

Results: S2 - Ba
Assigned Value = 75.7 ± 2.0 µg/L
Kernel Density
Density
Result
Results (µg/L)
Laboratory
1
10
12
13
2
6
7
15
16
8
14
17
4
5
3
9
11
Md
RA
HV
SV
z-Scores: S2 - Ba
Target Standard Deviation for Proficiency Assessment 7.6 µg/L (Equivalent to 10% CV)
z-Score
-0.6
-0.4
-0.3
-0.2
-0.1
-0.1
-0.1
-0.1
0.0
0.2
0.2
0.4
0.6
0.9
En-Scores: S2 - Ba
En-Score
-1.0
-0.3
-0.3
-0.3
-0.2
-0.1
-0.1
-0.1
0.0
0.2
0.2
0.4
0.6
1.0

Figure 23

Table 28

Sample Details

Sample No.	S2
Matrix	Wastewater
Analyte	Ca
Unit	µg/L

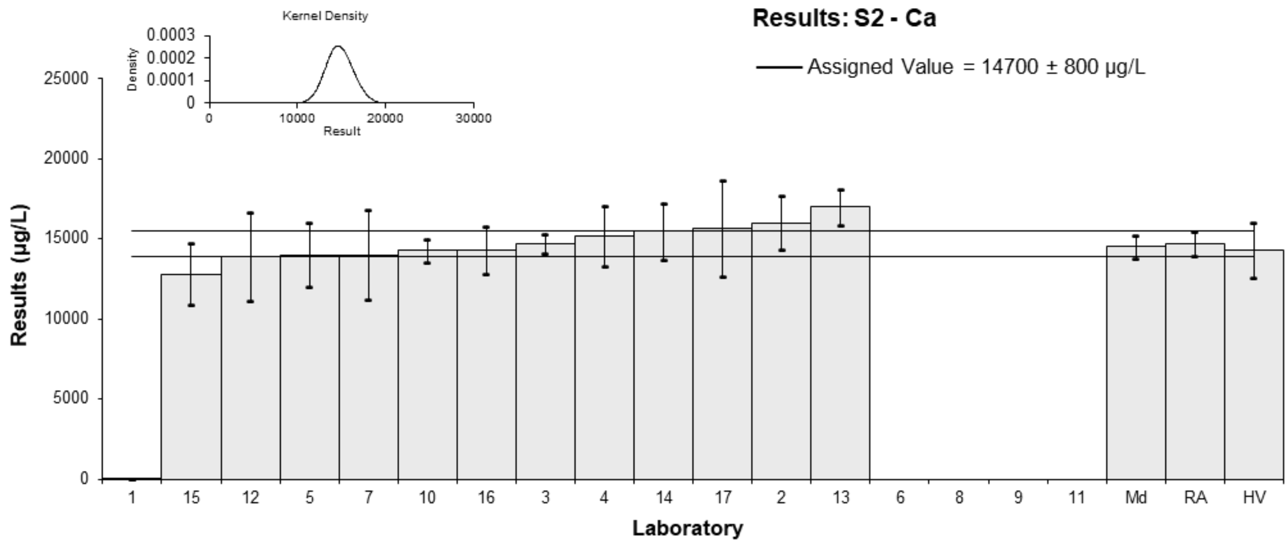
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1**	14.7	5.88	-9.99	-18.36
2	16000	1682	0.88	0.70
3	14710	590	0.01	0.01
4	15200	1900	0.34	0.24
5	14000	2000	-0.48	-0.32
6	NT	NT		
7	14000	2800	-0.48	-0.24
8	NT	NT		
9	NT	NT		
10	14268	713	-0.29	-0.40
11	NT	NT		
12	13900	2800	-0.54	-0.27
13	17000	1100	1.56	1.69
14	15470	1780	0.52	0.39
15	12800	1920	-1.29	-0.91
16	14310	1500	-0.27	-0.23
17	15640	2984	0.64	0.30

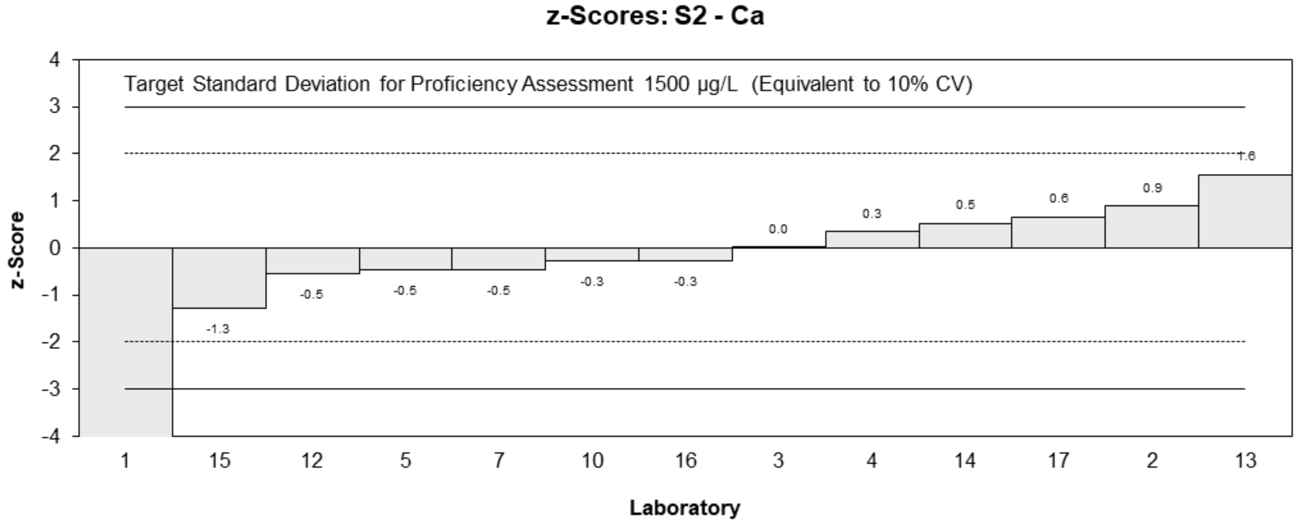
** Extreme Outlier, see Section 4.2

Statistics

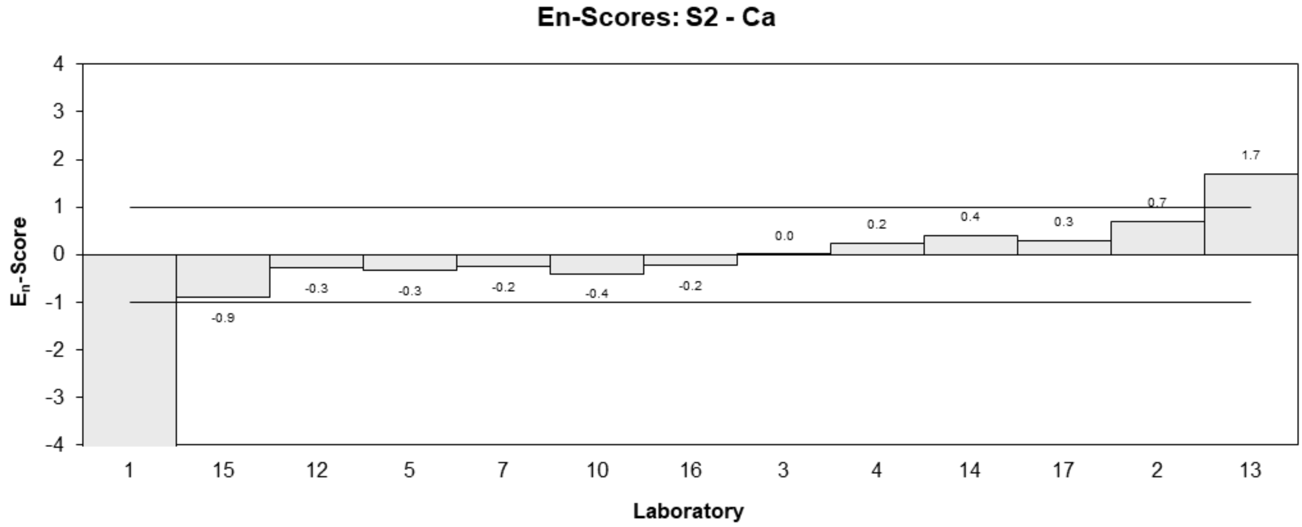
Assigned Value	14700	800
Spike Value	Not Spiked	
Homogeneity Value	14300	1700
Robust Average	14700	800
Median	14500	700
Mean	14800	
N	12	
Max	17000	
Min	12800	
Robust SD	1100	
Robust CV	7.8%	



Results: S2 - Ca
Assigned Value = 14700 ± 800 µg/L
Kernel Density
Density
Result
Results (µg/L)
Laboratory



z-Scores: S2 - Ca
Target Standard Deviation for Proficiency Assessment 1500 µg/L (Equivalent to 10% CV)
z-Score
Laboratory



En-Scores: S2 - Ca
En-Score
Laboratory

Figure 24

Table 29

Sample Details

Sample No.	S2
Matrix	Wastewater
Analyte	Co
Unit	µg/L

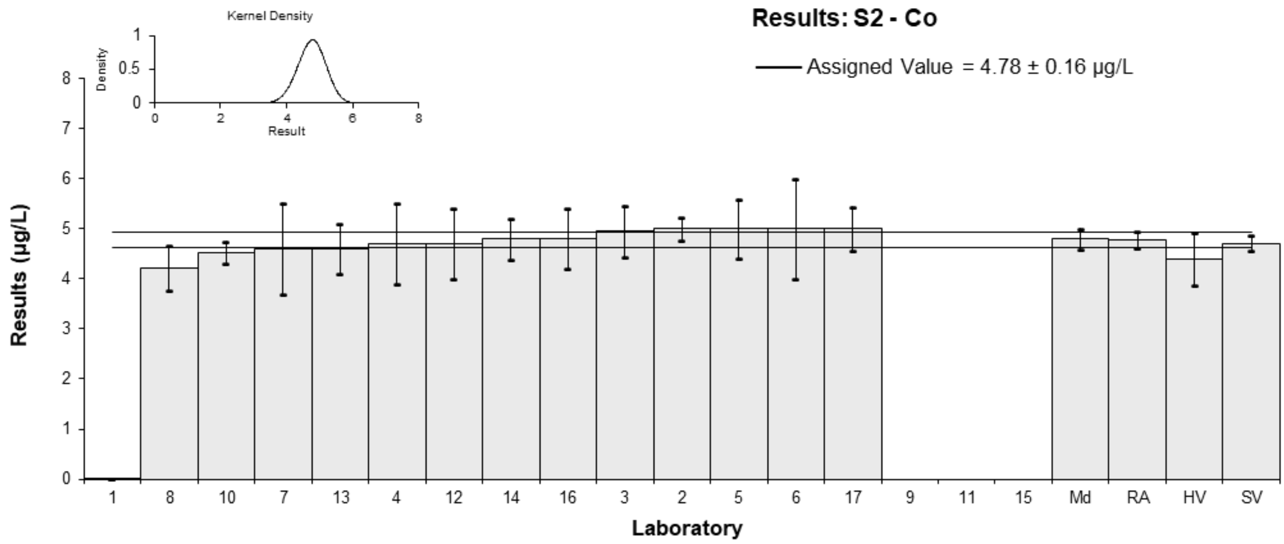
Participant Results

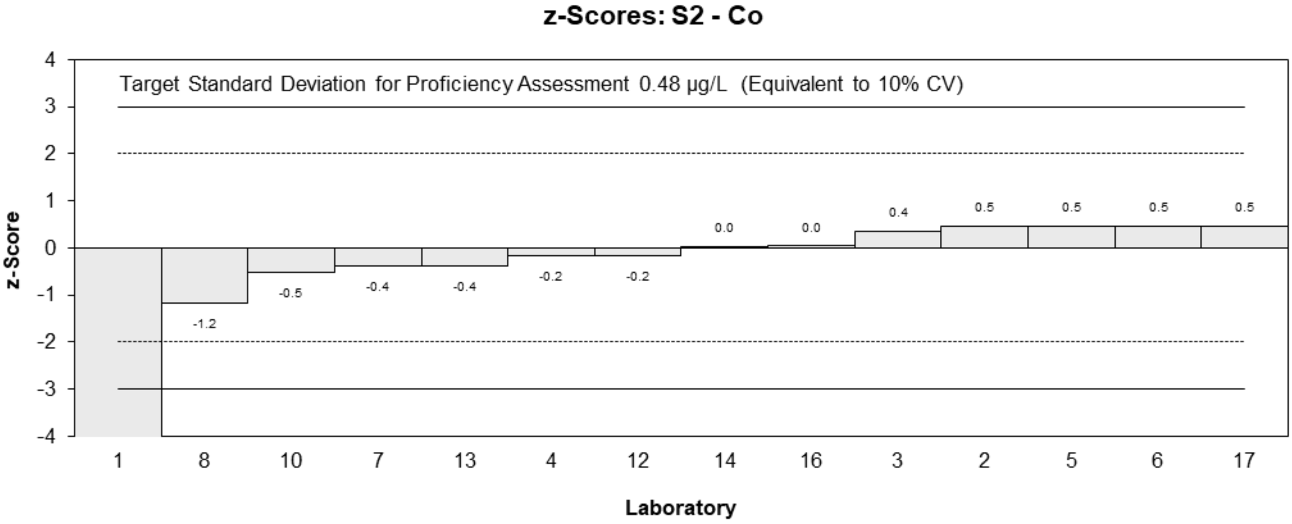
Lab. Code	Result	Uncertainty	z	E_n
1**	0.0045	0.0005	-9.99	-29.85
2	5	0.22	0.46	0.81
3	4.95	0.52	0.36	0.31
4	4.7	0.8	-0.17	-0.10
5	5	0.6	0.46	0.35
6	5	1	0.46	0.22
7	4.6	0.92	-0.38	-0.19
8	4.22	0.44	-1.17	-1.20
9	NT	NT		
10	4.53	0.22	-0.52	-0.92
11	NT	NT		
12	4.7	0.7	-0.17	-0.11
13	4.6	0.5	-0.38	-0.34
14	4.796	0.4	0.03	0.04
15	<10	NR		
16	4.8	0.6	0.04	0.03
17	5	0.44	0.46	0.47

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	4.78	0.16
Spike Value	4.71	0.15
Homogeneity Value	4.40	0.53
Robust Average	4.78	0.16
Median	4.80	0.20
Mean	4.76	
N	13	
Max	5	
Min	4.22	
Robust SD	0.23	
Robust CV	4.8%	


Results: S2 - Co
Assigned Value = 4.78 ± 0.16 µg/L
Kernel Density
Density
Result
Results (µg/L)
Laboratory
1
8
10
7
13
4
12
14
16
3
2
5
6
17
9
11
15
Md
RA
HV
SV


z-Scores: S2 - Co
Target Standard Deviation for Proficiency Assessment 0.48 µg/L (Equivalent to 10% CV)
z-Score
Laboratory
-1.2
-0.5
-0.4
-0.4
-0.2
-0.2
0.0
0.0
0.4
0.5
0.5
0.5
0.5

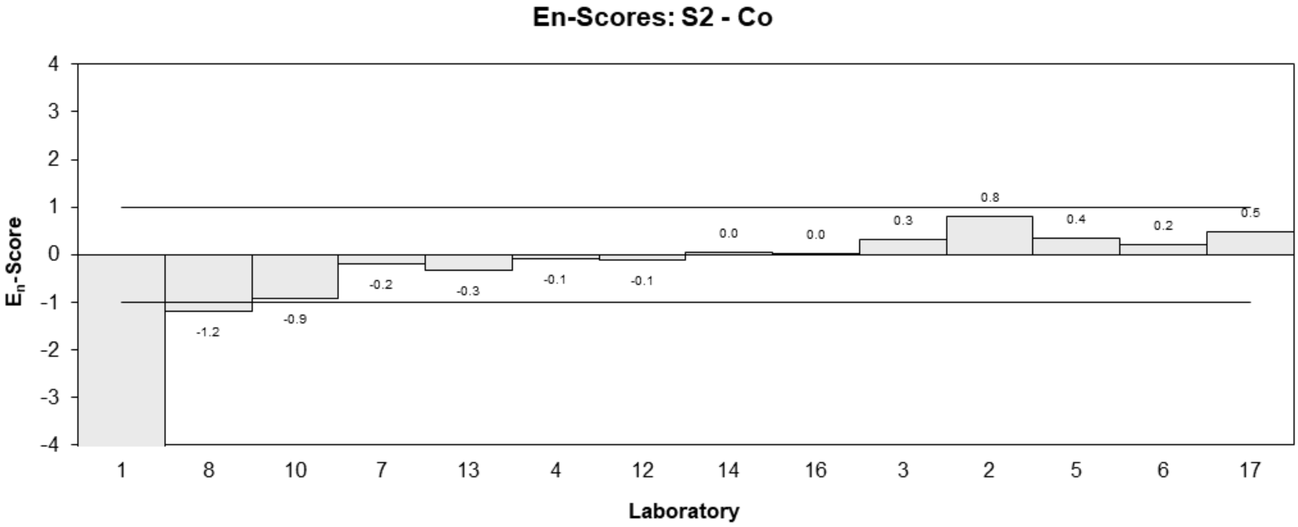

En-Scores: S2 - Co
En-Score
Laboratory
-1.2
-0.9
-0.2
-0.3
-0.1
-0.1
0.0
0.0
0.3
0.8
0.4
0.2
0.5

Figure 25

Table 30

Sample Details

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

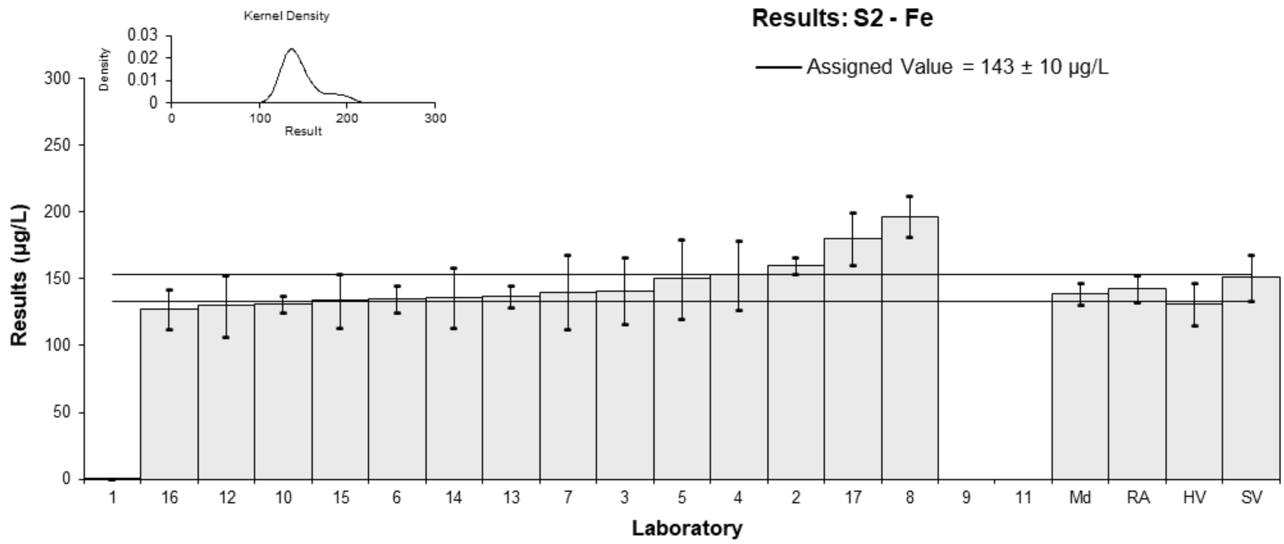
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1**	0.141	0.0564	-9.99	-14.29
2	160	6.3	1.19	1.44
3	141	25	-0.14	-0.07
4	153	26	0.70	0.36
5	150	30	0.49	0.22
6	135	10	-0.56	-0.57
7	140	28	-0.21	-0.10
8	197	15	3.78	3.00
9	NT	NT		
10	131.07	6.55	-0.83	-1.00
11	NT	NT		
12	130	23	-0.91	-0.52
13	137	8	-0.42	-0.47
14	135.8	22.6	-0.50	-0.29
15	134	20.1	-0.63	-0.40
16	127	15	-1.12	-0.89
17	180	19.8	2.59	1.67

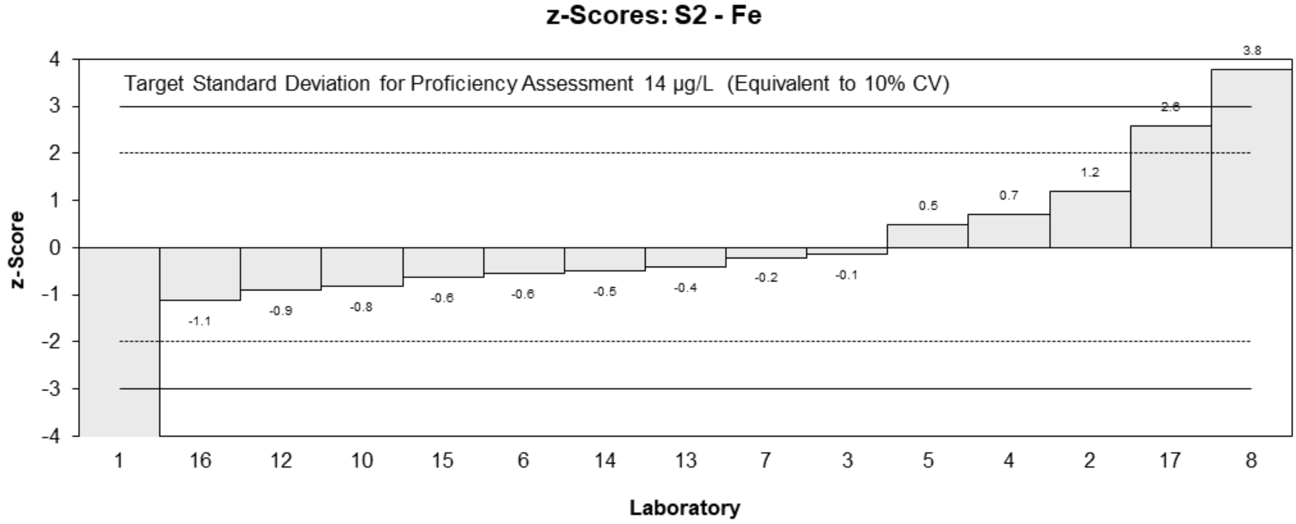
** Extreme Outlier, see Section 4.2

Statistics

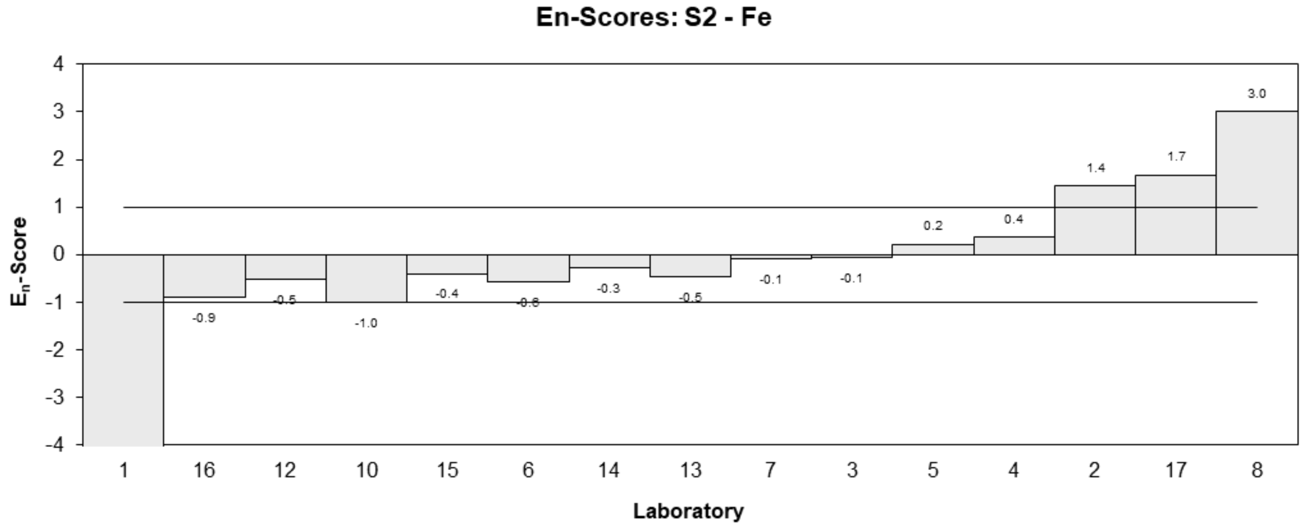
Assigned Value	143	10
Spike Value	151	17
Homogeneity Value	131	16
Robust Average	143	10
Median	139	8
Mean	146	
N	14	
Max	197	
Min	127	
Robust SD	15	
Robust CV	10%	



Results: S2 - Fe
Assigned Value = 143 ± 10 µg/L
Kernel Density
Density
Result
Results (µg/L)
Laboratory
1
16
12
10
15
6
14
13
7
3
5
4
2
17
8
9
11
Md
RA
HV
SV



z-Scores: S2 - Fe
Target Standard Deviation for Proficiency Assessment 14 µg/L (Equivalent to 10% CV)
z-Score
Laboratory
-1.1
-0.9
-0.8
-0.6
-0.6
-0.5
-0.4
-0.2
-0.1
0.5
0.7
1.2
2.6
3.8



En-Scores: S2 - Fe
E_n-Score
Laboratory
-0.9
-0.5
-1.0
-0.4
-0.6
-0.3
-0.5
-0.1
-0.1
0.2
0.4
1.4
1.7
3.0

Figure 26

Table 31

Sample Details

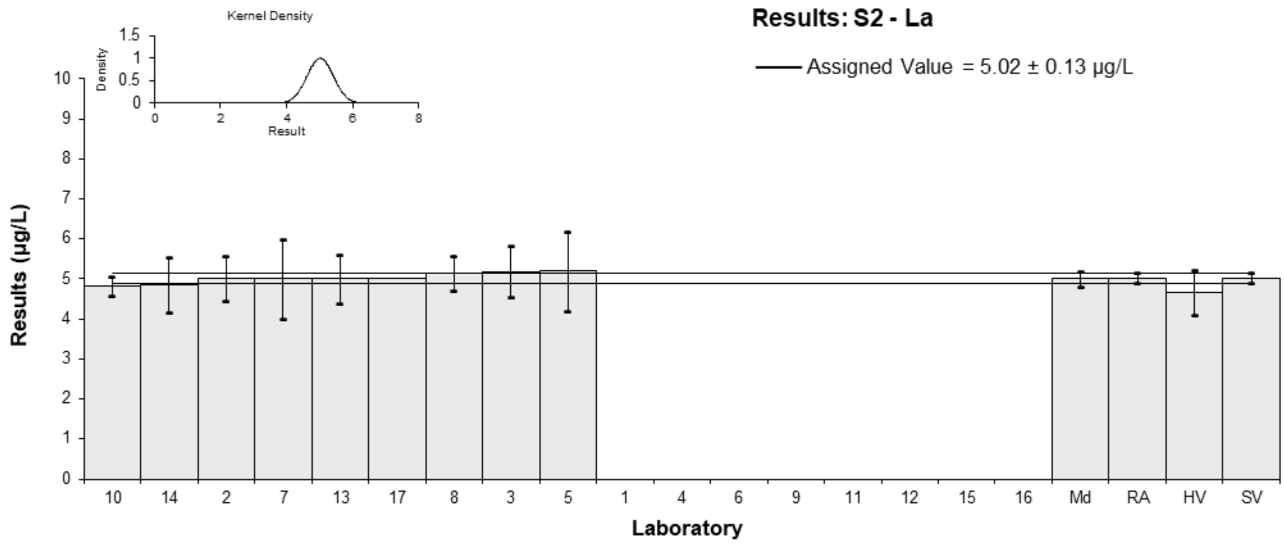
Sample No.	S2
Matrix	Wastewater
Analyte	La
Unit	µg/L

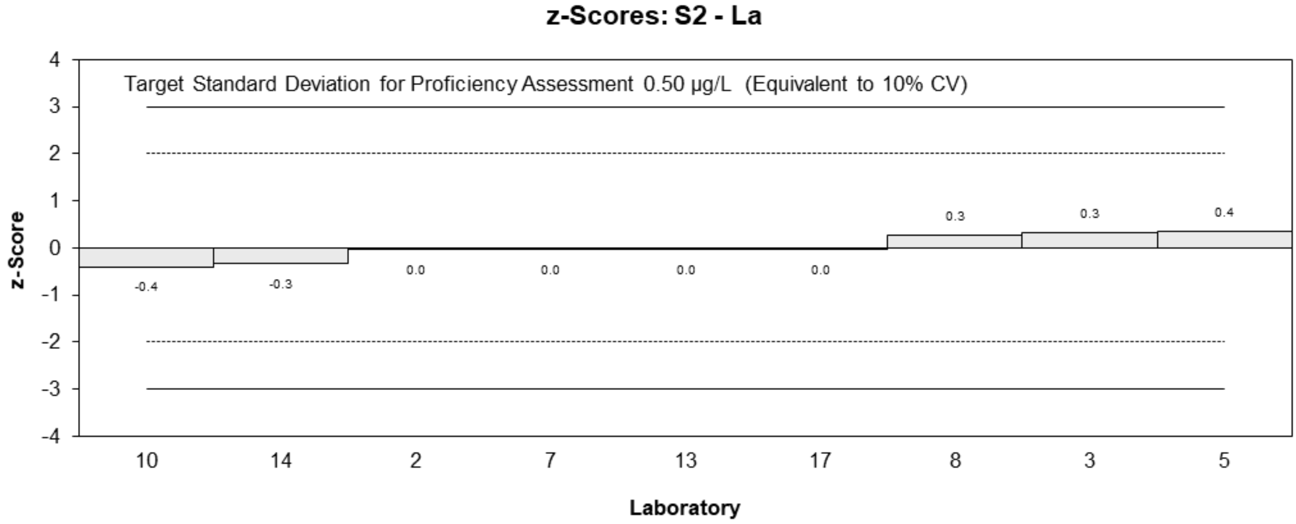
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	5	0.56	-0.04	-0.03
3	5.18	0.64	0.32	0.24
4	NT	NT		
5	5.2	1	0.36	0.18
6	NT	NT		
7	5.0	1.0	-0.04	-0.02
8	5.15	0.44	0.26	0.28
9	NT	NT		
10	4.82	0.24	-0.40	-0.73
11	NT	NT		
12	NT	NT		
13	5	0.6	-0.04	-0.03
14	4.848	0.687	-0.34	-0.25
15	NT	NT		
16	NT	NT		
17	5	NR	-0.04	-0.15

Statistics

Assigned Value	5.02	0.13
Spike Value	5.03	0.14
Homogeneity Value	4.67	0.56
Robust Average	5.02	0.13
Median	5.00	0.19
Mean	5.02	
N	9	
Max	5.2	
Min	4.82	
Robust SD	0.15	
Robust CV	3.1%	


Results: S2 - La
Assigned Value = 5.02 ± 0.13 µg/L
Kernel Density
Density
Result
Results (µg/L)
Laboratory
10
14
2
7
13
17
8
3
5
1
4
6
9
11
12
15
16
Md
RA
HV
SV


z-Scores: S2 - La
Target Standard Deviation for Proficiency Assessment 0.50 µg/L (Equivalent to 10% CV)
z-Score
Laboratory
-0.4
-0.3
0.0
0.0
0.0
0.0
0.3
0.3
0.4
10
14
2
7
13
17
8
3
5

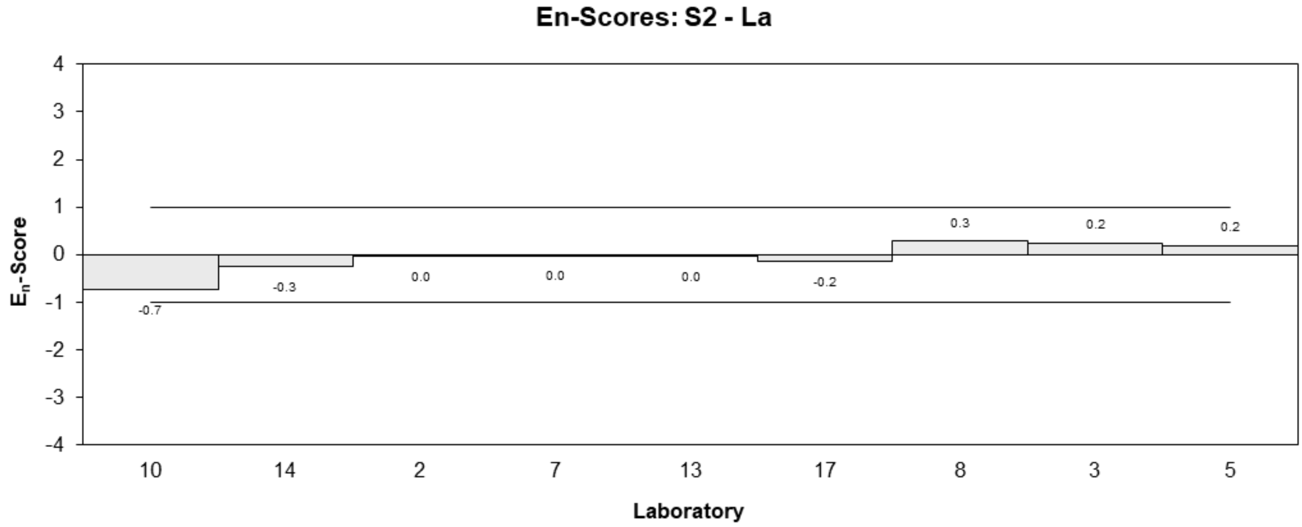

En-Scores: S2 - La
En-Score
Laboratory
-0.7
-0.3
0.0
0.0
0.0
-0.2
0.3
0.2
0.2
10
14
2
7
13
17
8
3
5

Figure 27

Table 32

Sample Details

Sample No.	S2
Matrix	Wastewater
Analyte	Mg
Unit	µg/L

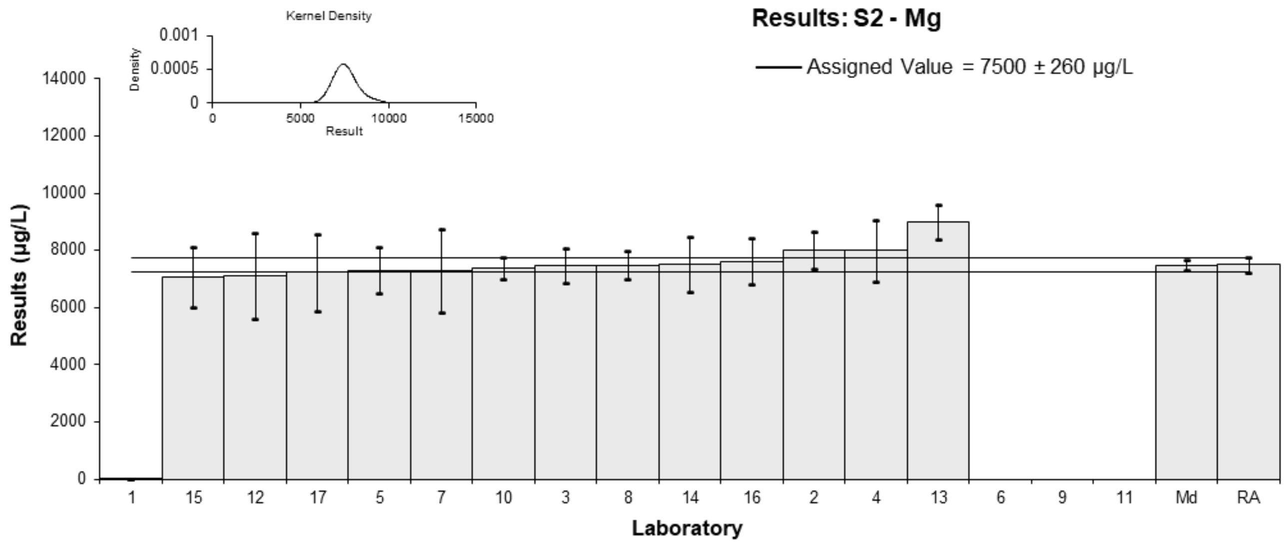
Participant Results

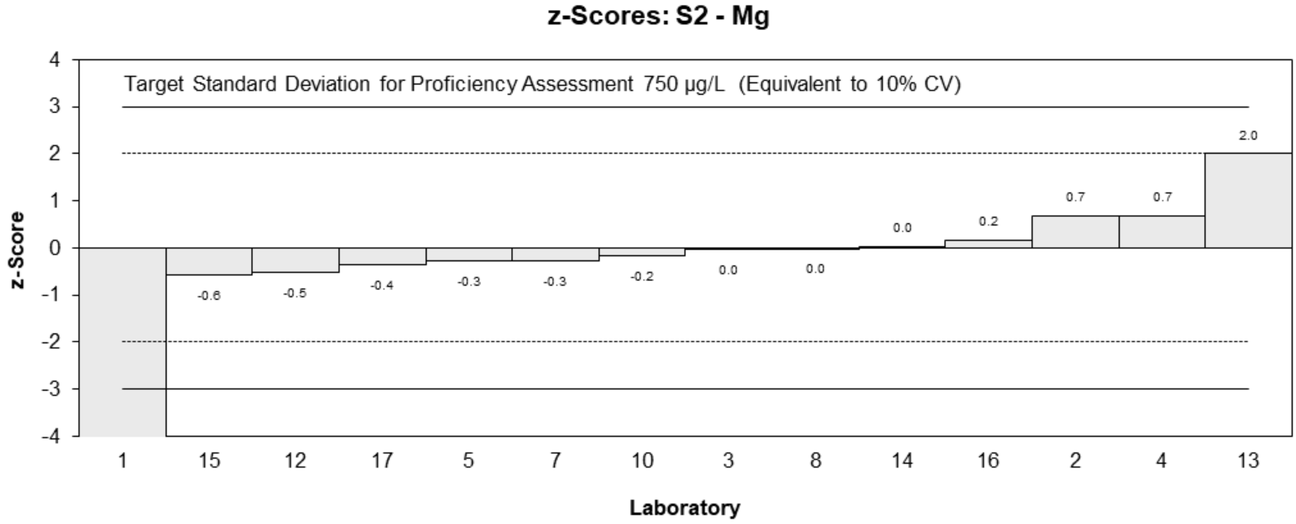
Lab. Code	Result	Uncertainty	z	E_n
1**	7.88	3.0732	-9.99	-28.81
2	8000	662	0.67	0.70
3	7480	600	-0.03	-0.03
4	8000	1080	0.67	0.45
5	7300	800	-0.27	-0.24
6	NT	NT		
7	7300	1460	-0.27	-0.13
8	7490	480	-0.01	-0.02
9	NT	NT		
10	7374	368	-0.17	-0.28
11	NT	NT		
12	7110	1500	-0.52	-0.26
13	9000	600	2.00	2.29
14	7517	953	0.02	0.02
15	7070	1061	-0.57	-0.39
16	7620	800	0.16	0.14
17	7225	1326	-0.37	-0.20

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	7500	260
Spike Value	Not Spiked	
Robust Average	7500	260
Median	7480	190
Mean	7580	
N	13	
Max	9000	
Min	7070	
Robust SD	380	
Robust CV	5.1%	


Results: S2 - Mg
Assigned Value = 7500 ± 260 µg/L
Kernel Density
Density
Result
Results (µg/L)
Laboratory
1
15
12
17
5
7
10
3
8
14
16
2
4
13
6
9
11
Md
RA


z-Scores: S2 - Mg
Target Standard Deviation for Proficiency Assessment 750 µg/L (Equivalent to 10% CV)
z-Score
Laboratory
-0.6
-0.5
-0.4
-0.3
-0.3
-0.2
0.0
0.0
0.0
0.2
0.7
0.7
2.0

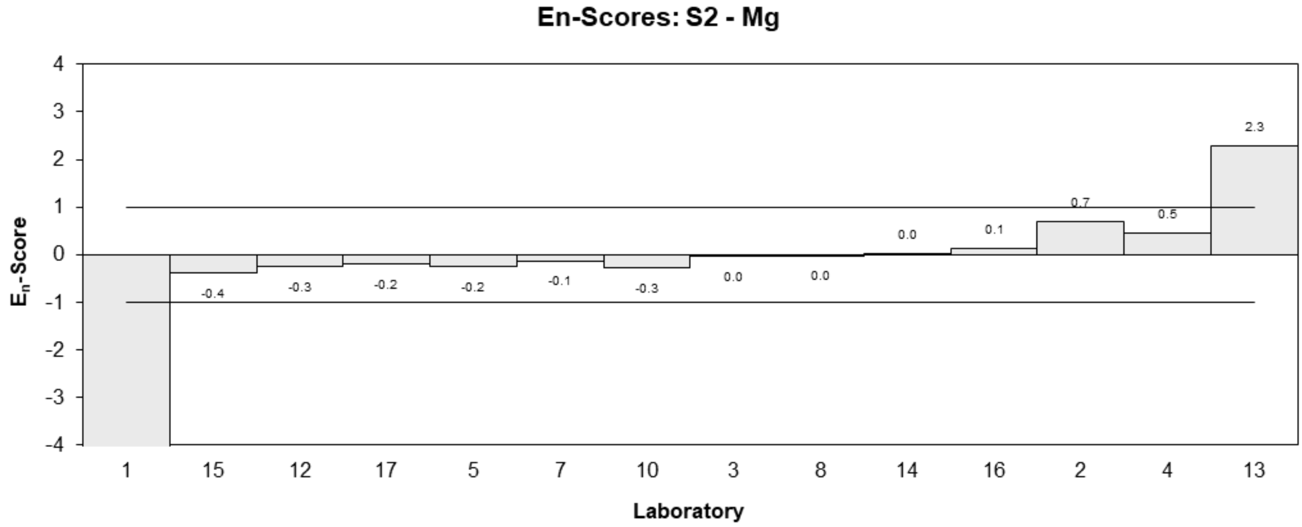

En-Scores: S2 - Mg
E_n-Score
Laboratory
-0.4
-0.3
-0.2
-0.2
-0.1
-0.3
0.0
0.0
0.0
0.1
0.7
0.5
2.3

Figure 28

Table 33

Sample Details

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

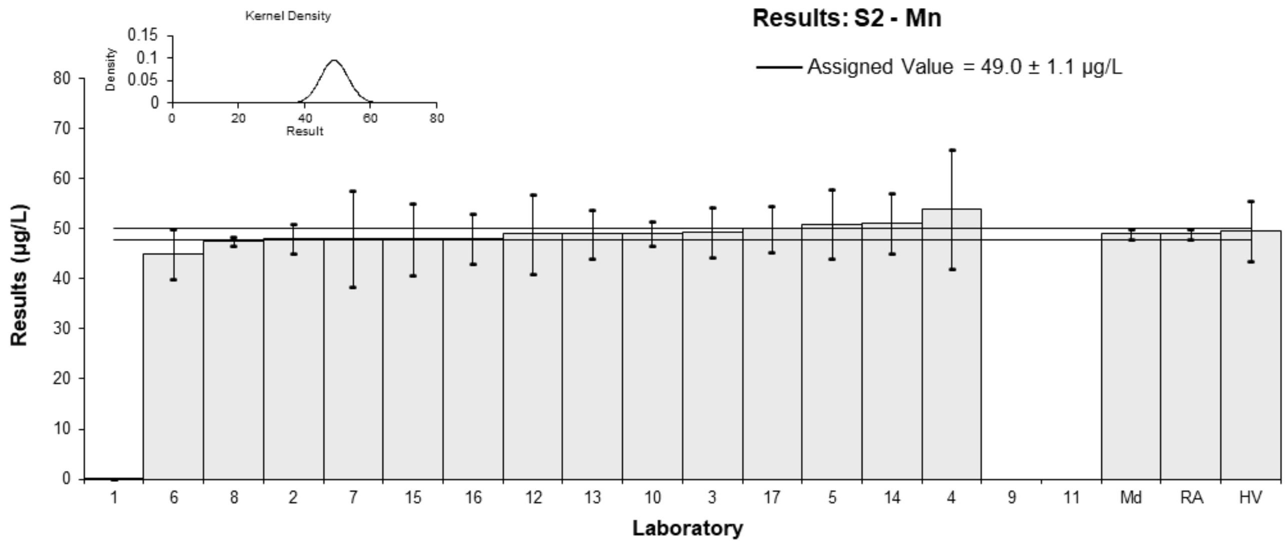
Participant Results

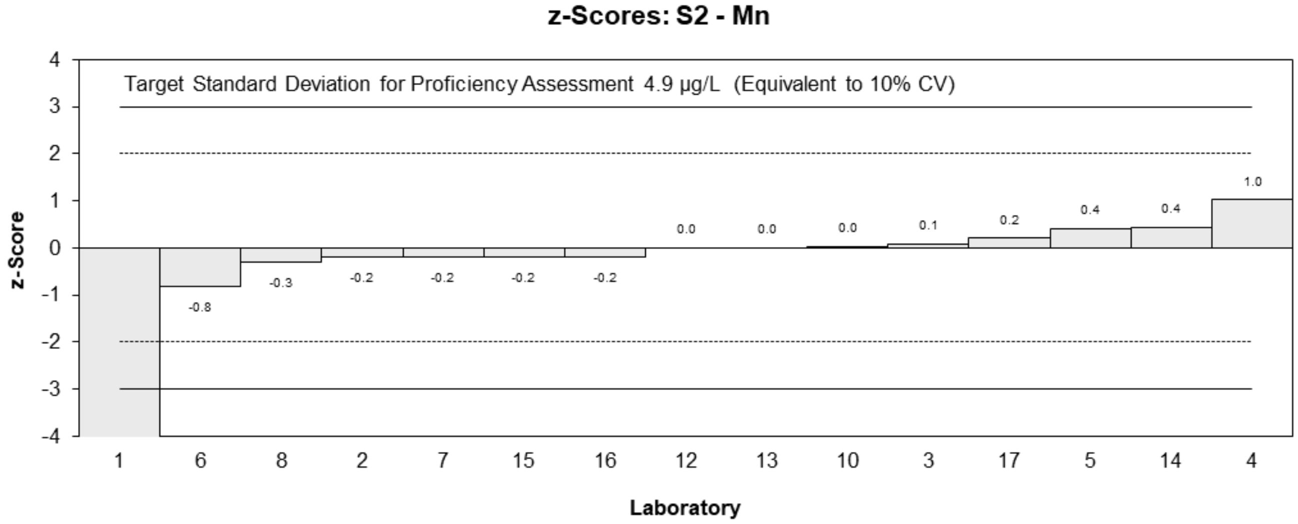
Lab. Code	Result	Uncertainty	z	E_n
1**	0.0511	0.0051	-9.99	-44.50
2	48	3	-0.20	-0.31
3	49.4	5.0	0.08	0.08
4	54	12	1.02	0.41
5	51	7	0.41	0.28
6	45	5	-0.82	-0.78
7	48	9.6	-0.20	-0.10
8	47.5	0.9	-0.31	-1.06
9	NT	NT		
10	49.08	2.5	0.02	0.03
11	NT	NT		
12	49	8	0.00	0.00
13	49.0	4.9	0.00	0.00
14	51.15	6.01	0.44	0.35
15	48	7.20	-0.20	-0.14
16	48	5.0	-0.20	-0.20
17	50	4.71	0.20	0.21

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	49.0	1.1
Spike Value	Not Spiked	
Homogeneity Value	49.6	6.0
Robust Average	49.0	1.1
Median	49.0	1.0
Mean	49.1	
N	14	
Max	54	
Min	45	
Robust SD	1.7	
Robust CV	3.4%	


Results: S2 - Mn
Assigned Value = 49.0 ± 1.1 µg/L
Kernel Density
Density
Result
Results (µg/L)
Laboratory
1
6
8
2
7
15
16
12
13
10
3
17
5
14
4
9
11
Md
RA
HV


z-Scores: S2 - Mn
Target Standard Deviation for Proficiency Assessment 4.9 µg/L (Equivalent to 10% CV)
z-Score
Laboratory
1
6
8
2
7
15
16
12
13
10
3
17
5
14
4
-0.8
-0.3
-0.2
-0.2
-0.2
-0.2
0.0
0.0
0.0
0.1
0.2
0.4
0.4
1.0

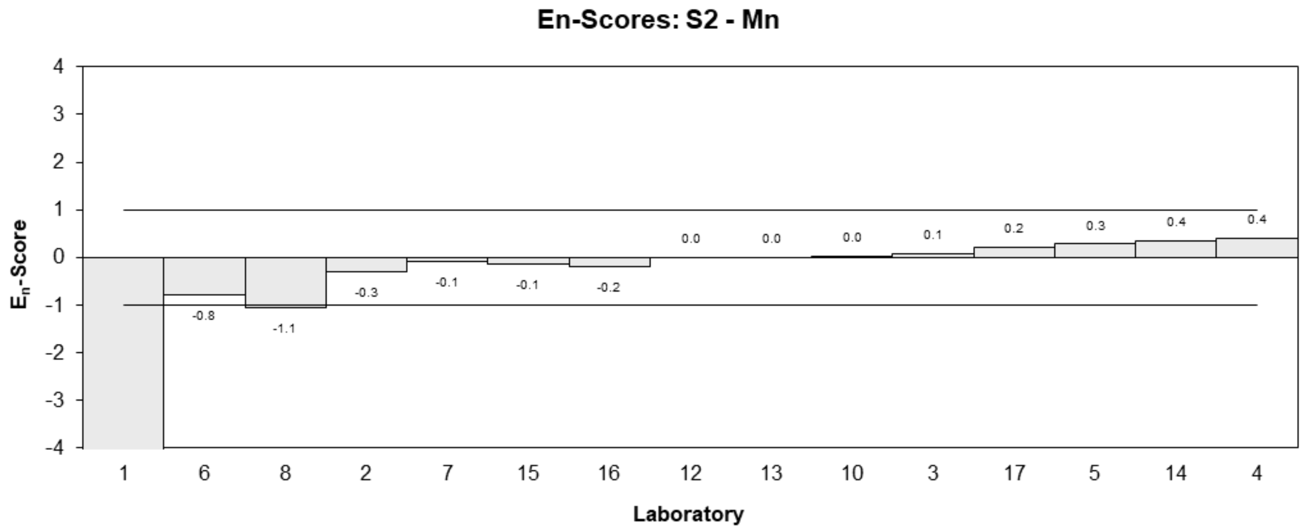

En-Scores: S2 - Mn
En-Score
Laboratory
1
6
8
2
7
15
16
12
13
10
3
17
5
14
4
-0.8
-1.1
-0.3
-0.1
-0.1
-0.2
0.0
0.0
0.0
0.1
0.2
0.3
0.4
0.4

Figure 29

Table 34

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	3000	224	0.45	0.51
3	2930	240	0.21	0.22
4	3100	560	0.80	0.40
5	2800	300	-0.24	-0.22
6	NT	NT		
7	2600	520	-0.94	-0.51
8	NT	NT		
9	NT	NT		
10	2809	140	-0.21	-0.33
11	NT	NT		
12	NT	NT		
13	3000	300	0.45	0.40
14	2907.3	300	0.13	0.12
15	NT	NT		
16	2770	300	-0.35	-0.31
17	2790	NR	-0.28	-0.67

Statistics

Assigned Value	2870	120
Spike Value	Not Spiked	
Homogeneity Value	2680	320
Robust Average	2870	120
Median	2860	90
Mean	2870	
N	10	
Max	3100	
Min	2600	
Robust SD	160	
Robust CV	5.4%	

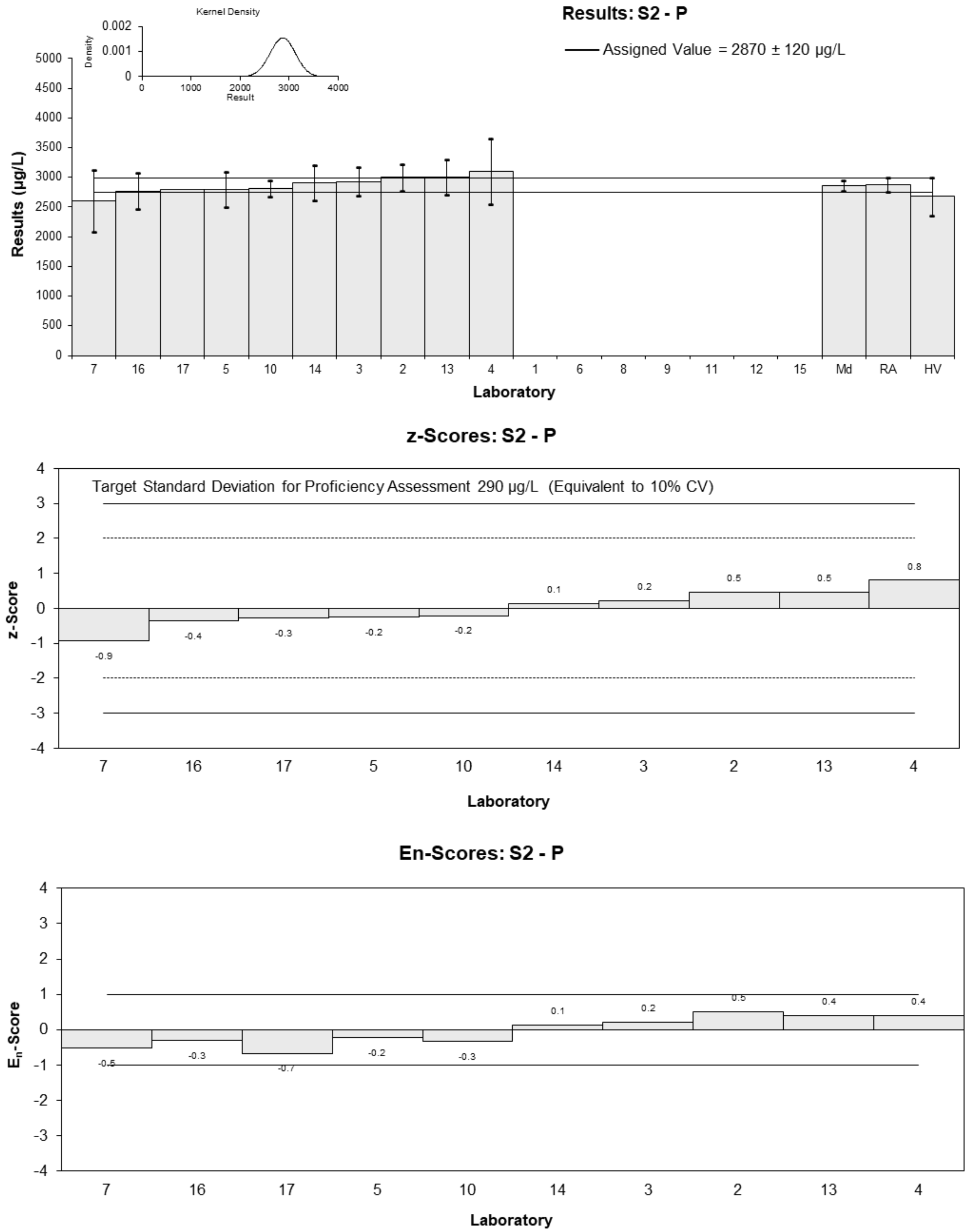

Results: S2 - P
Assigned Value = 2870 ± 120 µg/L
Kernel Density
Density
Result
Results (µg/L)
7 16 17 5 10 14 3 2 13 4 1 6 8 9 11 12 15 Md RA HV
Laboratory
z-Scores: S2 - P
Target Standard Deviation for Proficiency Assessment 290 µg/L (Equivalent to 10% CV)
z-Score
-0.9 -0.4 -0.3 -0.2 -0.2 0.1 0.2 0.5 0.5 0.8
7 16 17 5 10 14 3 2 13 4
Laboratory
En-Scores: S2 - P
En-Score
-0.5 -0.3 -0.7 -0.2 -0.3 0.1 0.2 0.5 0.4 0.4
7 16 17 5 10 14 3 2 13 4
Laboratory

Figure 30

Table 35

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1**	0.146	0.0248	-9.99	-29.77
2	144	6.1	-0.34	-0.63
3	154.9	9.3	0.40	0.56
4	155	9	0.40	0.58
5	150	25	0.07	0.04
6	144	14.4	-0.34	-0.33
7	140	28	-0.60	-0.32
8	159	9	0.67	0.97
9	NT	NT		
10	145.67	7.3	-0.22	-0.38
11	NT	NT		
12	154	23	0.34	0.21
13	153	17	0.27	0.23
14	151.2	12.1	0.15	0.17
15	136	20.4	-0.87	-0.62
16	145	15	-0.27	-0.25
17	149	13.0	0.00	0.00

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	149	5
Spike Value	150	4
Homogeneity Value	148	18
Robust Average	149	5
Median	150	5
Mean	149	
N	14	
Max	159	
Min	136	
Robust SD	6.9	
Robust CV	4.7%	

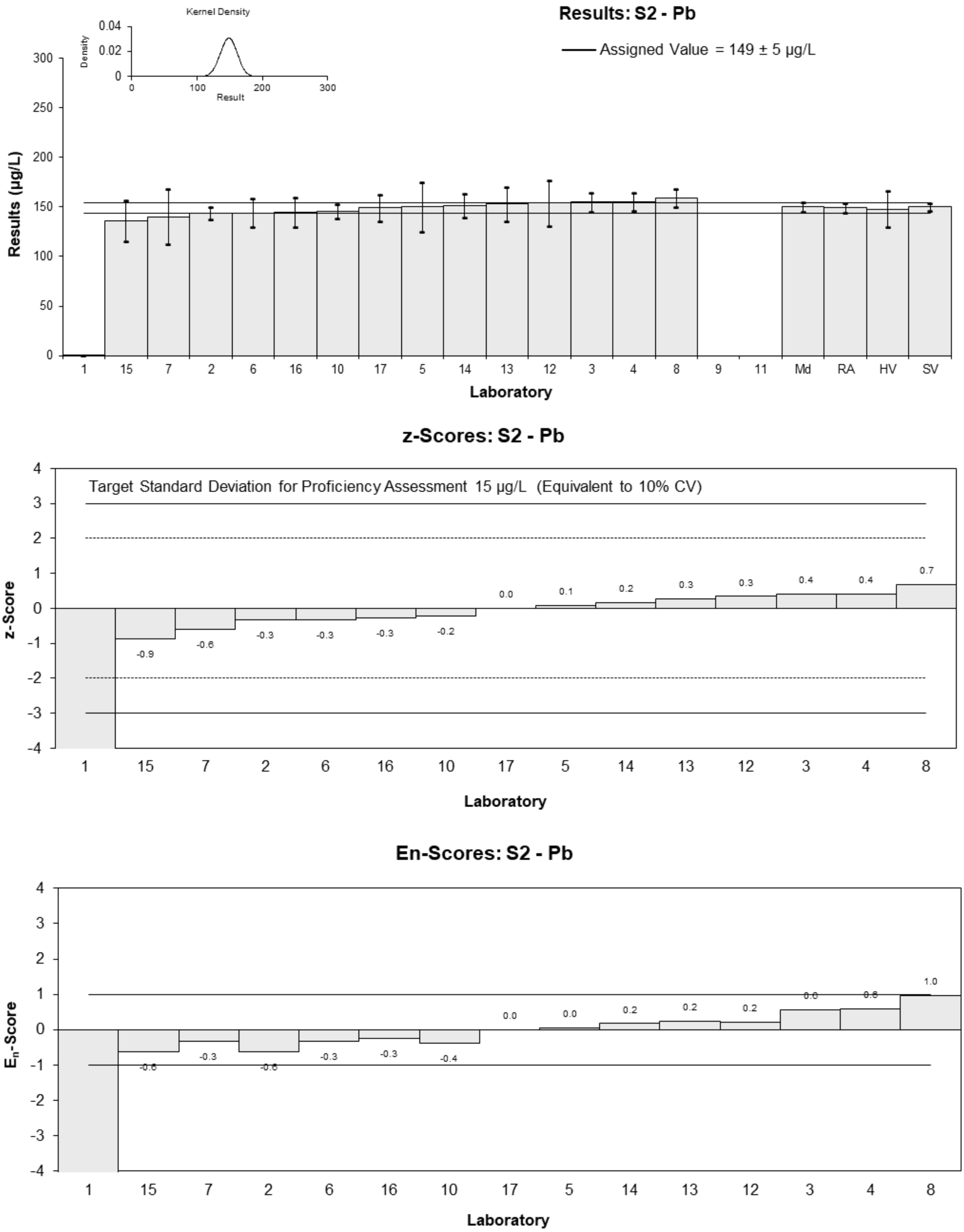

Results: S2 - Pb
Assigned Value = 149 ± 5 µg/L
Kernel Density
Density
Result
Results (µg/L)
Laboratory
1
15
7
2
6
16
10
17
5
14
13
12
3
4
8
9
11
Md
RA
HV
SV
z-Scores: S2 - Pb
Target Standard Deviation for Proficiency Assessment 15 µg/L (Equivalent to 10% CV)
z-Score
-0.9
-0.6
-0.3
-0.3
-0.3
-0.2
0.0
0.1
0.2
0.3
0.3
0.4
0.4
0.7
Laboratory
En-Scores: S2 - Pb
E_n-Score
-0.6
-0.3
-0.6
-0.3
-0.3
-0.4
0.0
0.0
0.2
0.2
0.2
0.6
0.6
1.0
Laboratory

Figure 31

Table 36

Sample Details

Sample No.	S2
Matrix	Wastewater
Analyte	S
Unit	µg/L

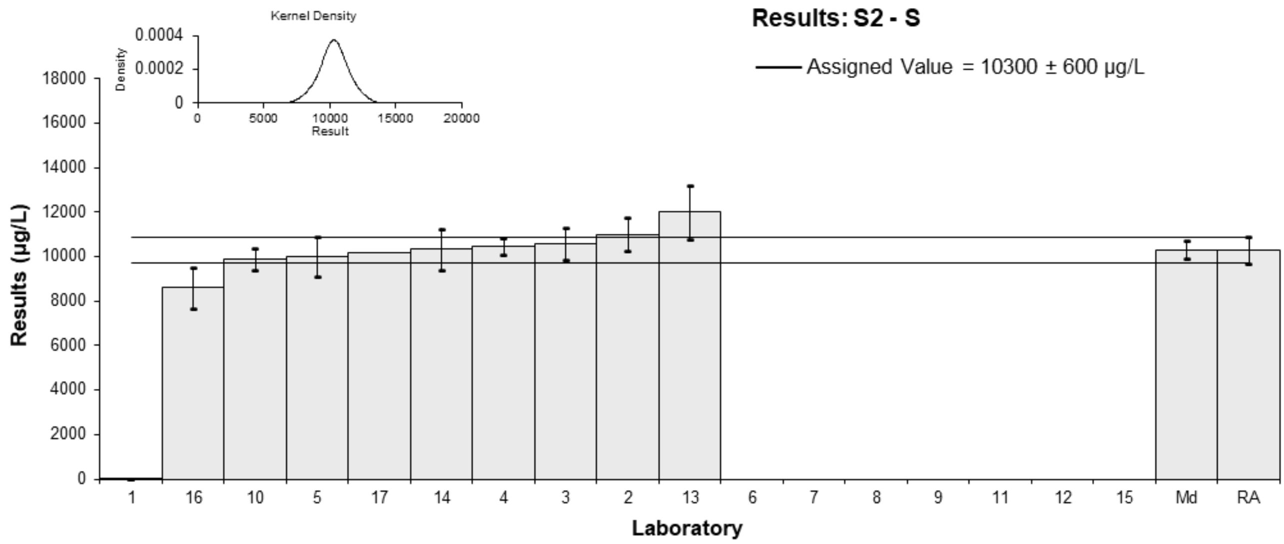
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1**	10.0859	1.2103	-9.99	-17.15
2	11000	748	0.68	0.73
3	10560	720	0.25	0.28
4	10470	360	0.17	0.24
5	10000	900	-0.29	-0.28
6	NT	NT		
7	NR	NR		
8	NT	NT		
9	NT	NT		
10	9867	490	-0.42	-0.56
11	NT	NT		
12	NT	NT		
13	12000	1200	1.65	1.27
14	10325	935	0.02	0.02
15	NT	NT		
16	8600	900	-1.65	-1.57
17	10179	NR	-0.12	-0.20

** Extreme Outlier, see Section 4.2

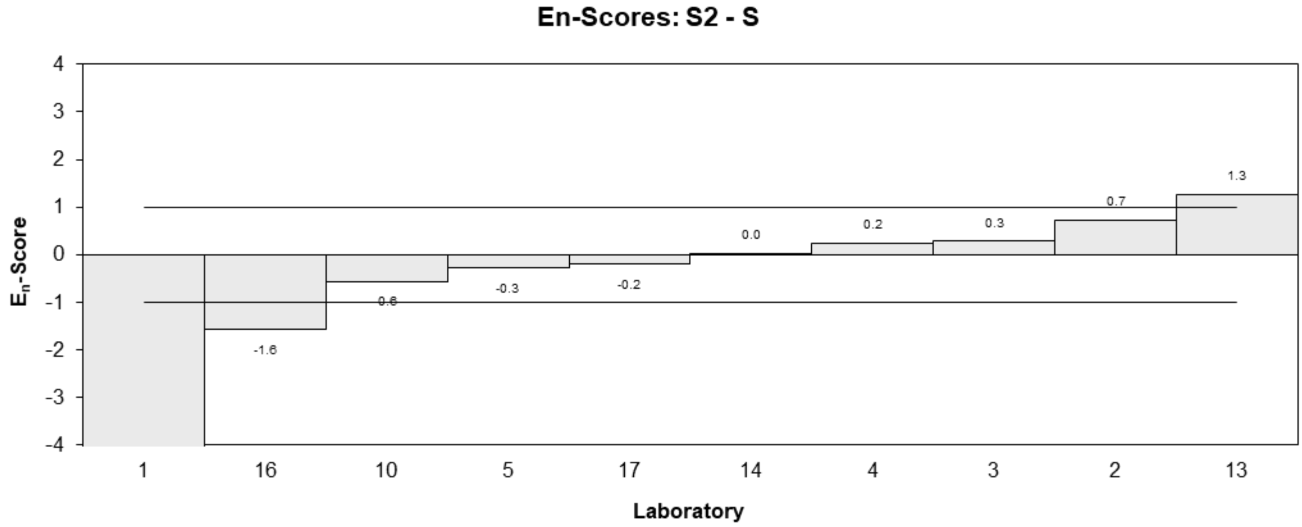
Statistics

Assigned Value	10300	600
Spike Value	Not Spiked	
Robust Average	10300	600
Median	10300	400
Mean	10300	
N	9	
Max	12000	
Min	8600	
Robust SD	710	
Robust CV	6.9%	



Results: S2 - S
Assigned Value = 10300 ± 600 µg/L
Kernel Density
Density
Result
Results (µg/L)
Laboratory
1
16
10
5
17
14
4
3
2
13
6
7
8
9
11
12
15
Md
RA

z-Scores: S2 - S
Target Standard Deviation for Proficiency Assessment 1000 µg/L (Equivalent to 10% CV)
z-Score
Laboratory
-1.7
-0.4
-0.3
-0.1
0.0
0.2
0.3
0.7
1.7



En-Scores: S2 - S
E_n-Score
Laboratory
-1.6
-0.6
-0.3
-0.2
0.0
0.2
0.3
0.7
1.3

Figure 32

Table 37

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	<0.01	NR		
2	<10	0.7		
3	3.7	1.9	0.11	0.02
4	3.5	1	-0.44	-0.14
5	4	1	0.93	0.31
6	<10	10		
7	3.1	0.62	-1.53	-0.71
8	NT	NT		
9	NT	NT		
10	3.034	0.15	-1.71	-1.24
11	NT	NT		
12	3	1	-1.80	-0.60
13	5.1	0.7	3.93	1.70
14	<10.0	NR		
15	<10	NR		
16	4.5	0.6	2.30	1.09
17	<10	NR		

Statistics

Assigned Value	3.66	0.48
Spike Value	3.43	0.10
Homogeneity Value	3.18	0.38
Robust Average	3.72	0.72
Median	3.60	0.70
Mean	3.74	
N	8	
Max	5.1	
Min	3	
Robust SD	0.81	
Robust CV	22%	

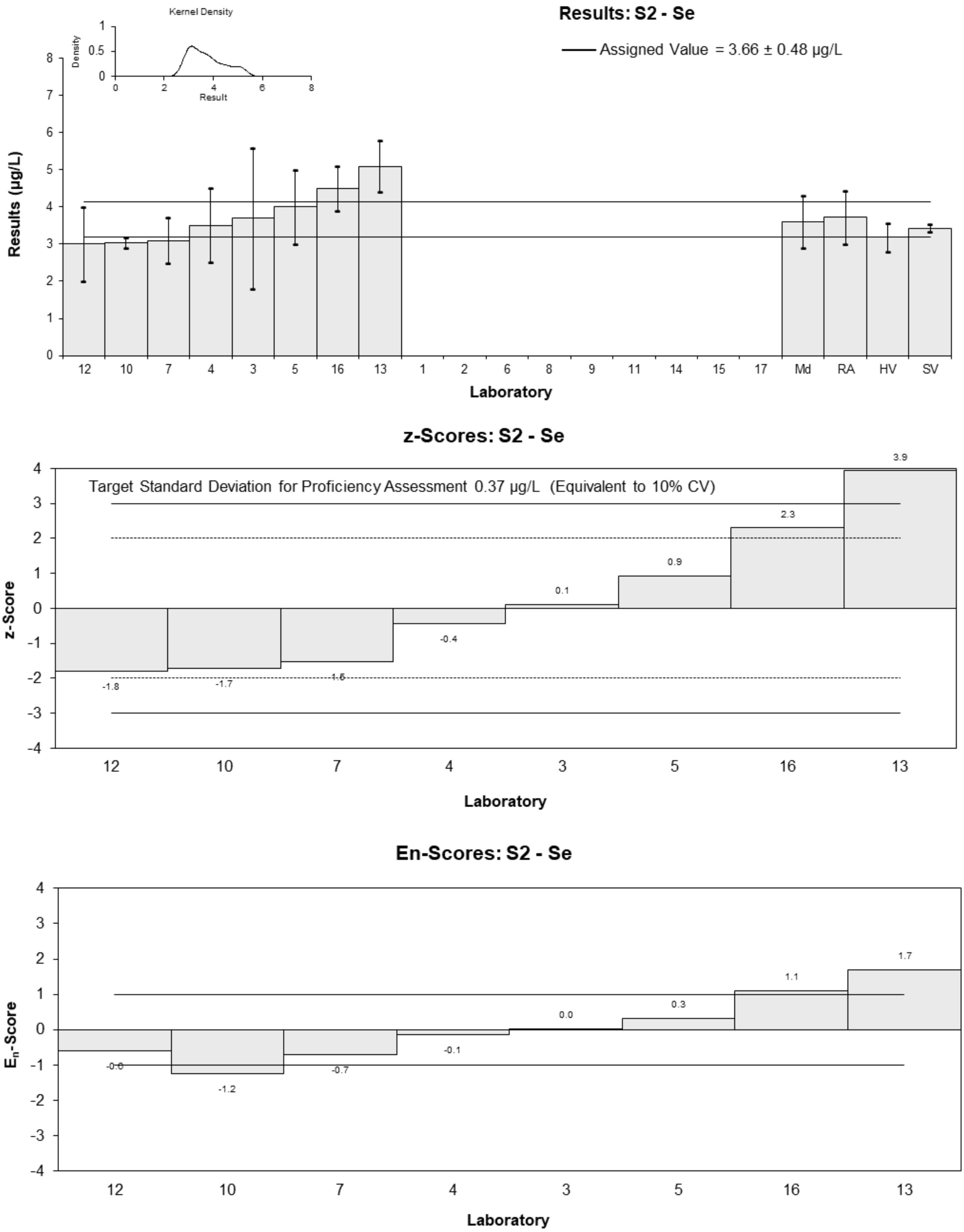

Results: S2 - Se
Assigned Value = 3.66 ± 0.48 µg/L
Kernel Density
Density
Result
Results (µg/L)
Laboratory
12 10 7 4 3 5 16 13 1 2 6 8 9 11 14 15 17 Md RA HV SV
z-Scores: S2 - Se
Target Standard Deviation for Proficiency Assessment 0.37 µg/L (Equivalent to 10% CV)
z-Score
-1.8 -1.7 -1.5 -0.4 0.1 0.9 2.3 3.9
12 10 7 4 3 5 16 13
Laboratory
En-Scores: S2 - Se
En-Score
-0.6 -1.2 -0.7 -0.1 0.0 0.3 1.1 1.7
12 10 7 4 3 5 16 13
Laboratory

Figure 33

Table 38

Sample Details

Sample No.	S2
Matrix	Wastewater
Analyte	Sr
Unit	µg/L

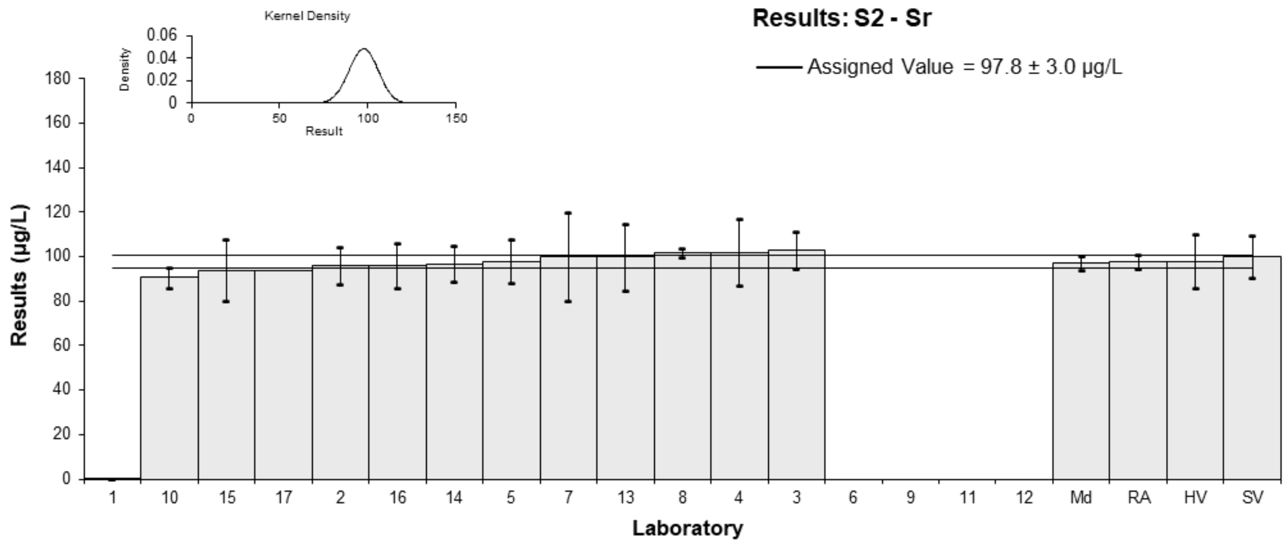
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1**	0.0939	0.0066	-9.99	-32.57
2	96	8.3	-0.18	-0.20
3	103.0	8.3	0.53	0.59
4	102	15	0.43	0.27
5	98	10	0.02	0.02
6	NT	NT		
7	100	20	0.22	0.11
8	101.8	1.8	0.41	1.14
9	NT	NT		
10	90.59	4.5	-0.74	-1.33
11	NT	NT		
12	NT	NT		
13	100	15	0.22	0.14
14	96.89	8.19	-0.09	-0.10
15	94	14.1	-0.39	-0.26
16	96	10	-0.18	-0.17
17	94	NR	-0.39	-1.27

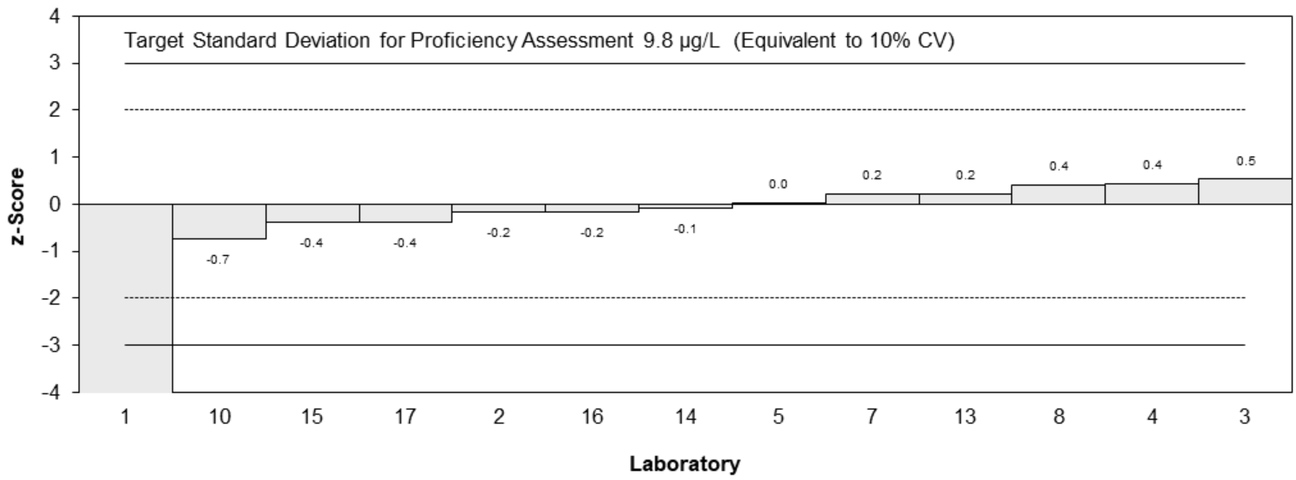
** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	97.8	3.0
Spike Value	99.9	9.4
Homogeneity Value	98	12
Robust Average	97.8	3.0
Median	97.4	3.2
Mean	97.7	
N	12	
Max	103	
Min	90.59	
Robust SD	4.1	
Robust CV	4.2%	



z-Scores: S2 - Sr



En-Scores: S2 - Sr

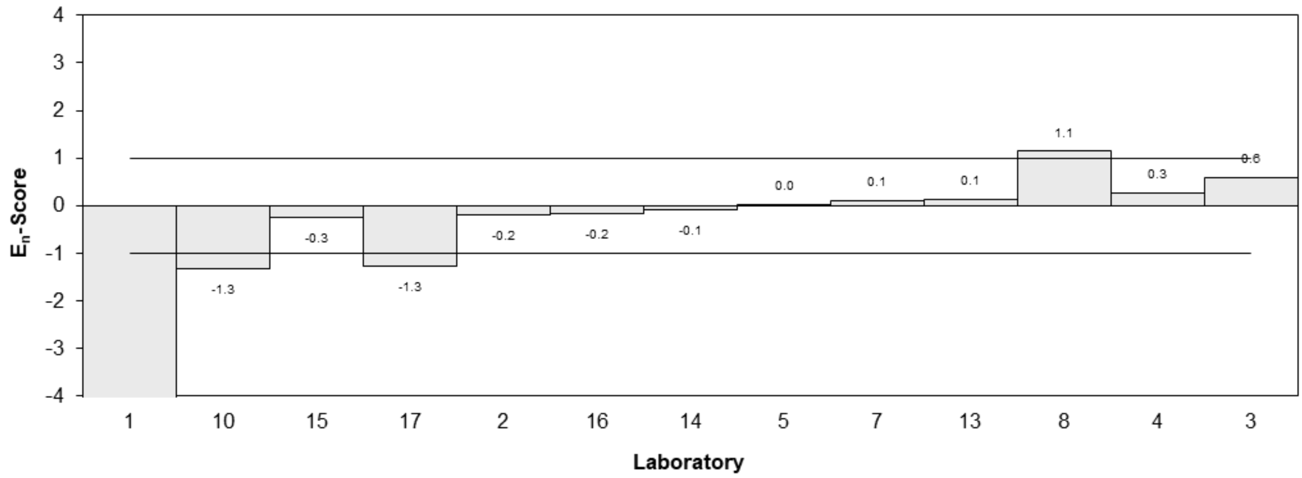


Figure 34

Table 39

Sample Details

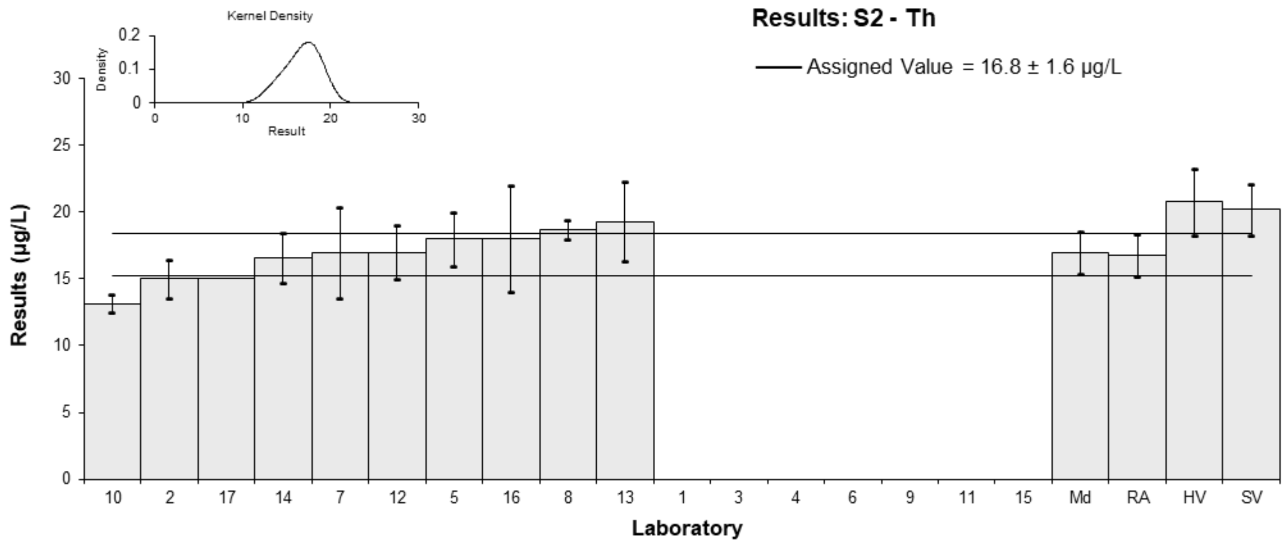
Sample No.	S2
Matrix	Wastewater
Analyte	Th
Unit	µg/L

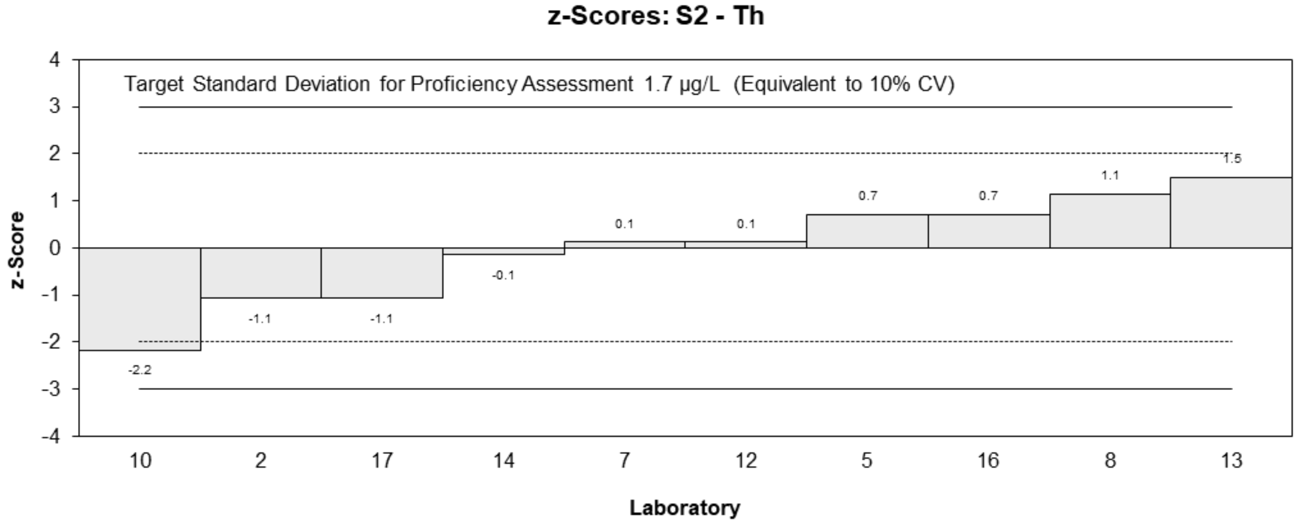
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	15	1.44	-1.07	-0.84
3	NT	NT		
4	NT	NT		
5	18	2	0.71	0.47
6	NT	NT		
7	17	3.4	0.12	0.05
8	18.7	0.7	1.13	1.09
9	NT	NT		
10	13.16	0.66	-2.17	-2.10
11	NT	NT		
12	17	2	0.12	0.08
13	19.3	3.0	1.49	0.74
14	16.56	1.89	-0.14	-0.10
15	NT	NT		
16	18	4.0	0.71	0.28
17	15	NR	-1.07	-1.13

Statistics

Assigned Value	16.8	1.6
Spike Value	20.2	1.9
Homogeneity Value	20.8	2.5
Robust Average	16.8	1.6
Median	17.0	1.6
Mean	16.8	
N	10	
Max	19.3	
Min	13.16	
Robust SD	2.0	
Robust CV	12%	


Results: S2 - Th
Assigned Value = 16.8 ± 1.6 µg/L
Kernel Density
Density
Result
Results (µg/L)
Laboratory
10
2
17
14
7
12
5
16
8
13
1
3
4
6
9
11
15
Md
RA
HV
SV


z-Scores: S2 - Th
Target Standard Deviation for Proficiency Assessment 1.7 µg/L (Equivalent to 10% CV)
z-Score
Laboratory
-2.2
-1.1
-1.1
-0.1
0.1
0.1
0.7
0.7
1.1
1.5
10
2
17
14
7
12
5
16
8
13

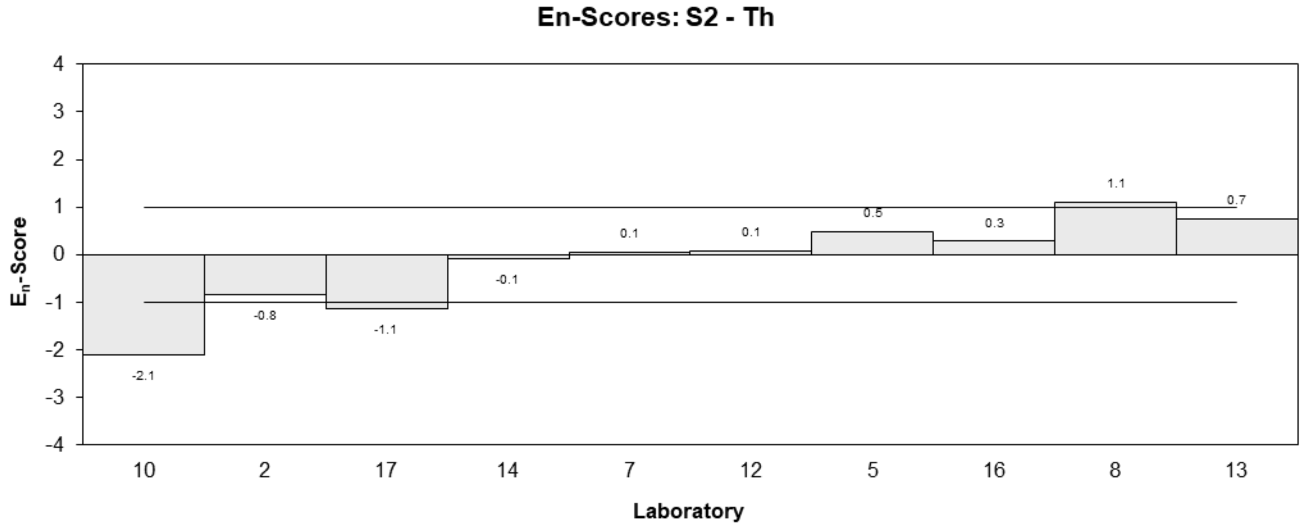

En-Scores: S2 - Th
En-Score
Laboratory
-2.1
-0.8
-1.1
-0.1
0.1
0.1
0.5
0.3
1.1
0.7
10
2
17
14
7
12
5
16
8
13

Figure 35

Table 40

Sample Details

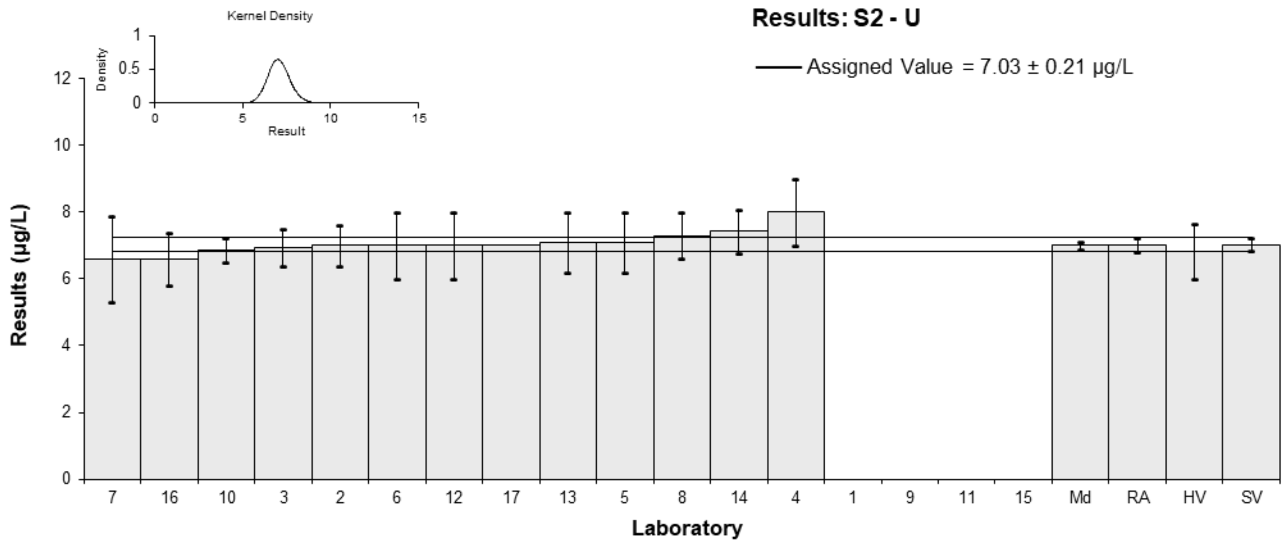
Sample No.	S2
Matrix	Wastewater
Analyte	U
Unit	µg/L

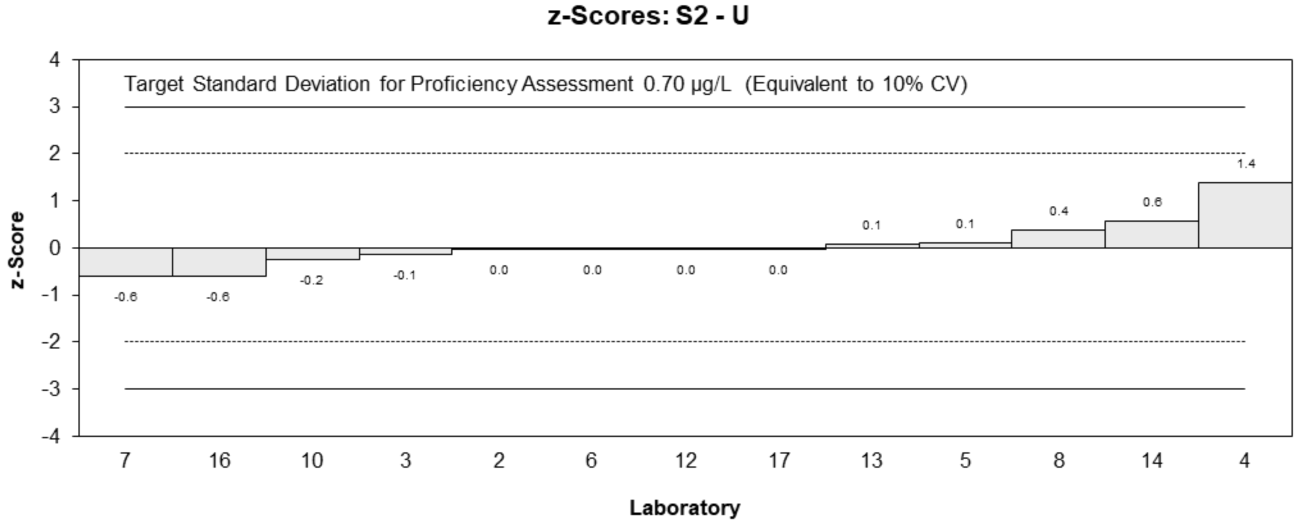
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	7	0.6	-0.04	-0.05
3	6.93	0.56	-0.14	-0.17
4	8	1	1.38	0.95
5	7.1	0.9	0.10	0.08
6	7	1	-0.04	-0.03
7	6.6	1.3	-0.61	-0.33
8	7.3	0.7	0.38	0.37
9	NT	NT		
10	6.86	0.35	-0.24	-0.42
11	NT	NT		
12	7	1	-0.04	-0.03
13	7.09	0.90	0.09	0.06
14	7.425	0.663	0.56	0.57
15	NT	NT		
16	6.6	0.8	-0.61	-0.52
17	7	NR	-0.04	-0.14

Statistics

Assigned Value	7.03	0.21
Spike Value	7.03	0.20
Homogeneity Value	6.82	0.82
Robust Average	7.03	0.21
Median	7.00	0.10
Mean	7.07	
N	13	
Max	8	
Min	6.6	
Robust SD	0.30	
Robust CV	4.3%	


Results: S2 - U
Assigned Value = 7.03 ± 0.21 µg/L
Kernel Density
Density
Result
Results (µg/L)
Laboratory
7
16
10
3
2
6
12
17
13
5
8
14
4
1
9
11
15
Md
RA
HV
SV


z-Scores: S2 - U
Target Standard Deviation for Proficiency Assessment 0.70 µg/L (Equivalent to 10% CV)
z-Score
Laboratory
-0.6
-0.6
-0.2
-0.1
0.0
0.0
0.0
0.0
0.1
0.1
0.4
0.6
1.4

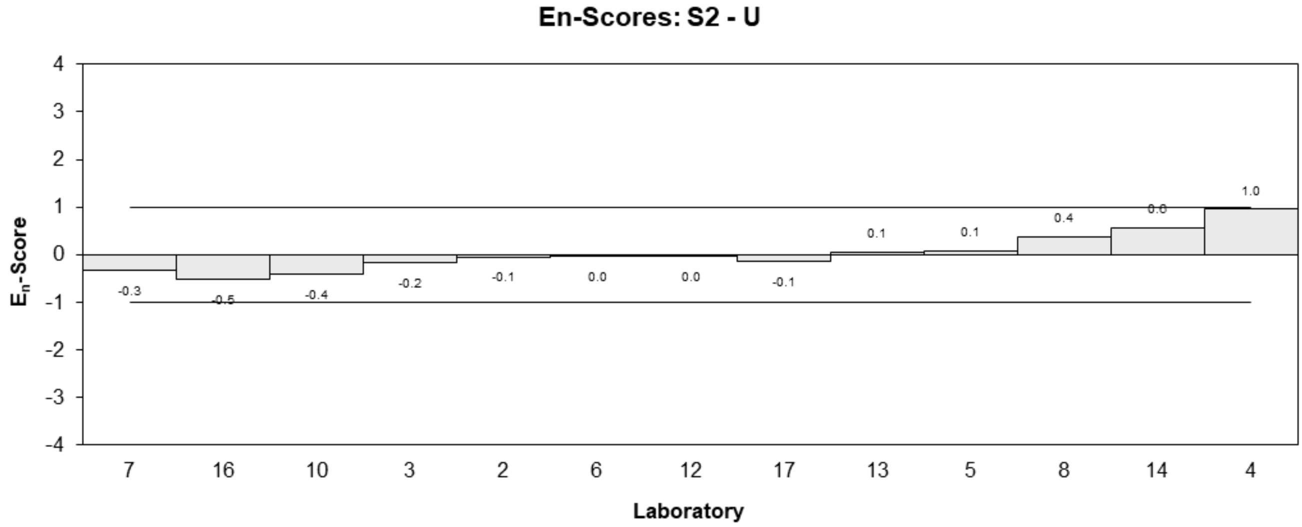

En-Scores: S2 - U
En-Score
Laboratory
-0.3
-0.5
-0.4
-0.2
-0.1
0.0
0.0
-0.1
0.1
0.1
0.4
0.6
1.0

Figure 36

Table 41

Sample Details

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

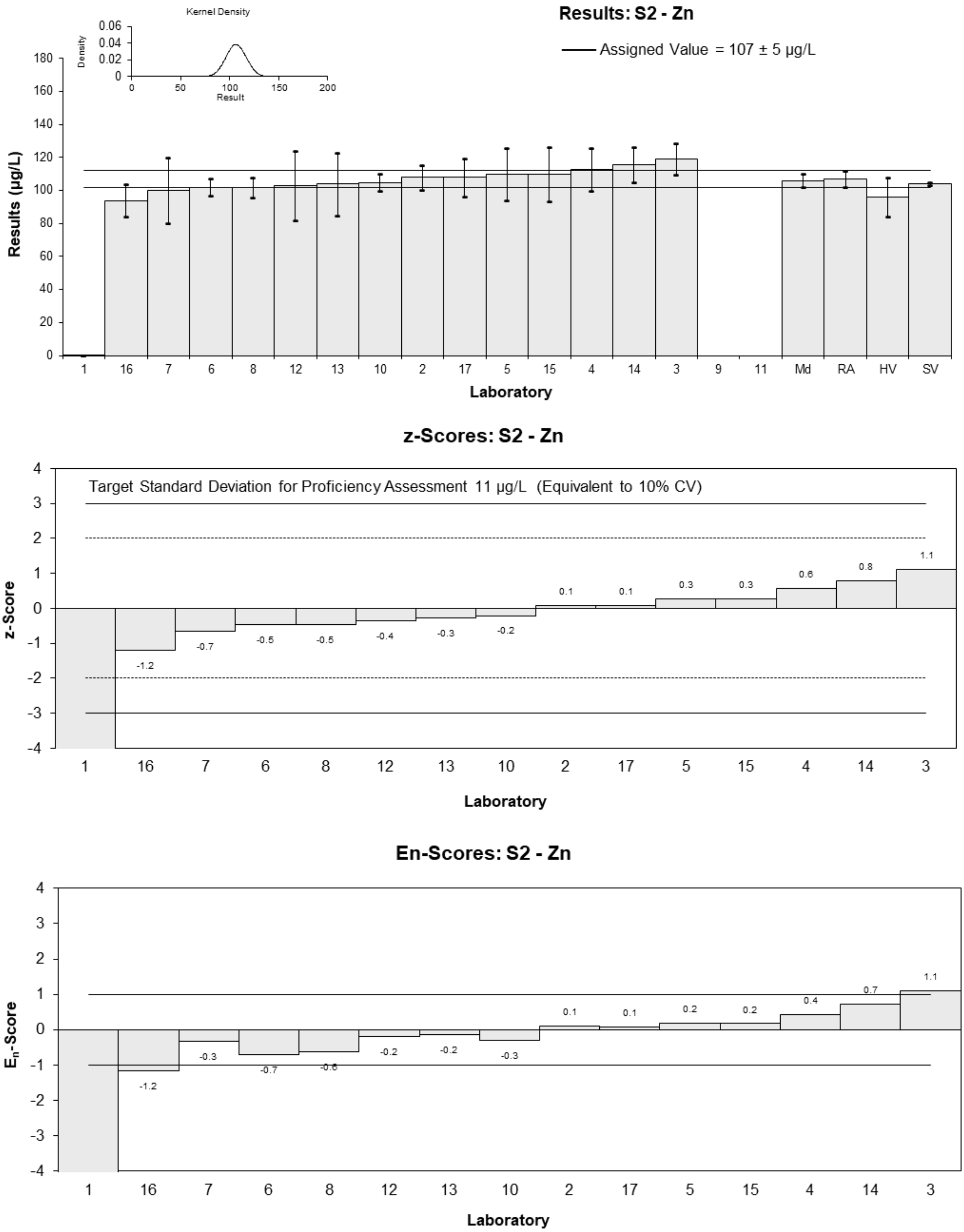
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1**	0.111	0.0111	-9.99	-21.38
2	108	7.43	0.09	0.11
3	118.9	9.6	1.11	1.10
4	113	13	0.56	0.43
5	110	16	0.28	0.18
6	102	5	-0.47	-0.71
7	100	20	-0.65	-0.34
8	102	6	-0.47	-0.64
9	NT	NT		
10	104.78	5.23	-0.21	-0.31
11	NT	NT		
12	103	21	-0.37	-0.19
13	104	19	-0.28	-0.15
14	115.5	10.6	0.79	0.73
15	110	16.5	0.28	0.17
16	94	10	-1.21	-1.16
17	108	11.6	0.09	0.08

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	107	5
Spike Value	104	1
Homogeneity Value	96	12
Robust Average	107	5
Median	106	4
Mean	107	
N	14	
Max	118.9	
Min	94	
Robust SD	6.8	
Robust CV	6.3%	



Results: S2 - Zn
Assigned Value = 107 ± 5 µg/L
Kernel Density
Density
Result
Results (µg/L)
Laboratory
1 16 7 6 8 12 13 10 2 17 5 15 4 14 3 9 11 Md RA HV SV
z-Scores: S2 - Zn
Target Standard Deviation for Proficiency Assessment 11 µg/L (Equivalent to 10% CV)
z-Score
-1.2 -0.7 -0.5 -0.5 -0.4 -0.3 -0.2 0.1 0.1 0.3 0.3 0.6 0.8 1.1
Laboratory
1 16 7 6 8 12 13 10 2 17 5 15 4 14 3
En-Scores: S2 - Zn
En-Score
-1.2 -0.3 -0.7 -0.6 -0.2 -0.2 -0.3 0.1 0.1 0.2 0.2 0.4 0.7 1.1
Laboratory
1 16 7 6 8 12 13 10 2 17 5 15 4 14 3

Figure 37

Table 42

Sample Details

Sample No.	S3
Matrix	Wastewater
Analyte	TDS
Unit	mg/L

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	662.5	60	-1.18	-1.36
2	727	35	-0.32	-0.56
3	NT	NT		
4	770	49	0.25	0.35
5	730	73	-0.28	-0.27
6	800	105	0.65	0.45
7	730	110	-0.28	-0.19
8	NT	NT		
9	765	114.75	0.19	0.12
10	NT	NT		
11	718	87.1	-0.44	-0.36
12	728	73	-0.31	-0.30
13	784	61	0.44	0.50
14	809.67	65.02	0.78	0.84
15	770	115.5	0.25	0.16
16	737	75	-0.19	-0.18
17	750	138	-0.01	-0.01

Statistics

Assigned Value	751	25
Spike Value	Not Spiked	
Robust Average	751	25
Median	744	23
Mean	749	
N	14	
Max	809.67	
Min	662.5	
Robust SD	37	
Robust CV	4.9%	

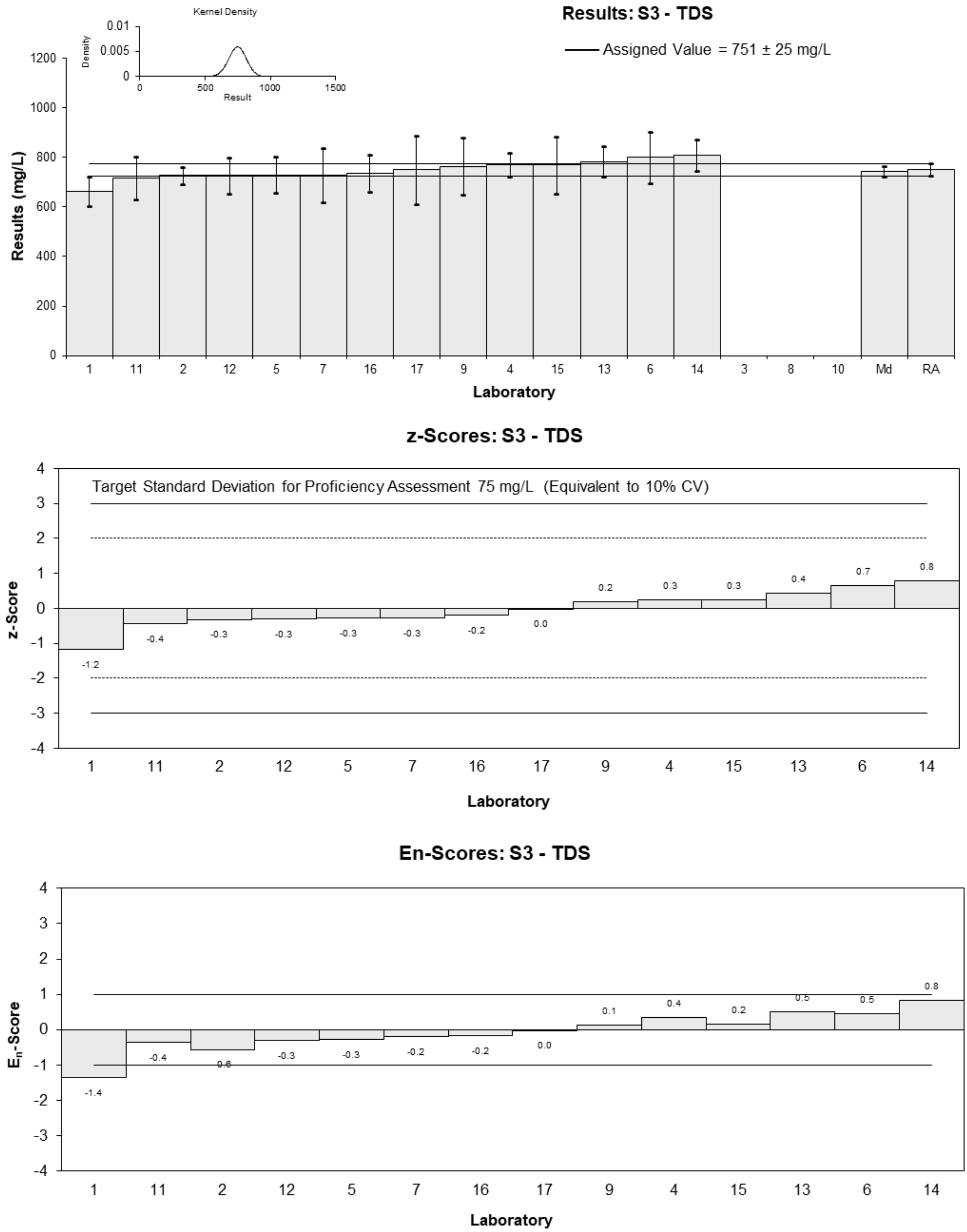

Results: S3 - TDS
Assigned Value = 751 ± 25 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
1
11
2
12
5
7
16
17
9
4
15
13
6
14
3
8
10
Md
RA
z-Scores: S3 - TDS
Target Standard Deviation for Proficiency Assessment 75 mg/L (Equivalent to 10% CV)
z-Score
-1.2
-0.4
-0.3
-0.3
-0.3
-0.3
-0.2
0.0
0.2
0.3
0.3
0.4
0.7
0.8
En-Scores: S3 - TDS
E_n-Score
-1.4
-0.4
-0.6
-0.3
-0.3
-0.2
-0.2
0.0
0.1
0.4
0.2
0.5
0.5
0.8

Figure 38

Table 43

Sample Details

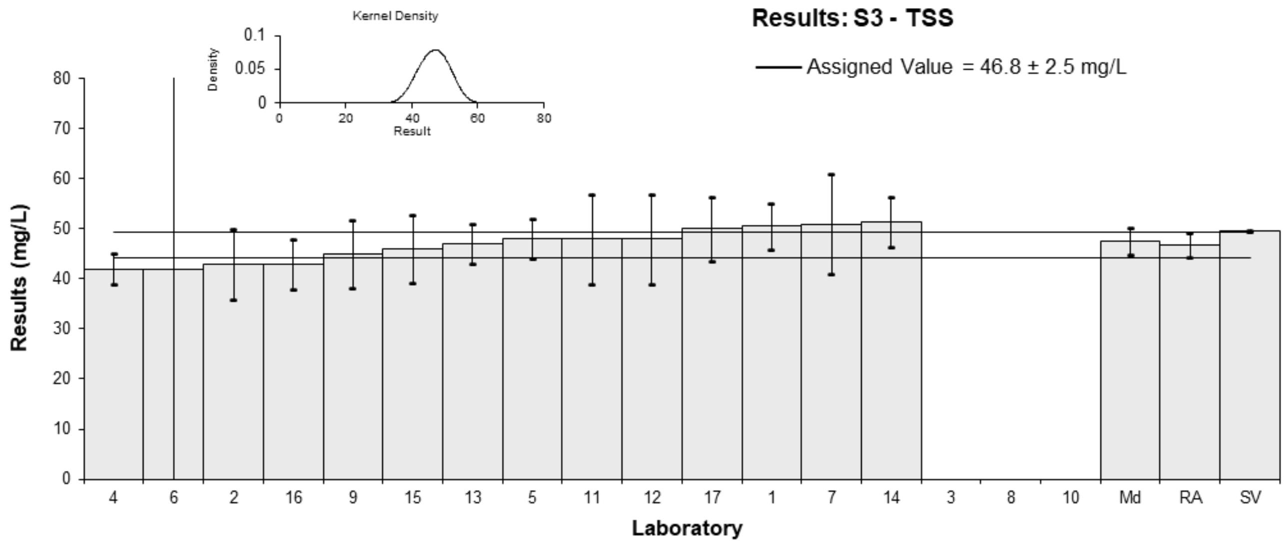
Sample No.	S3
Matrix	Wastewater
Analyte	TSS
Unit	mg/L

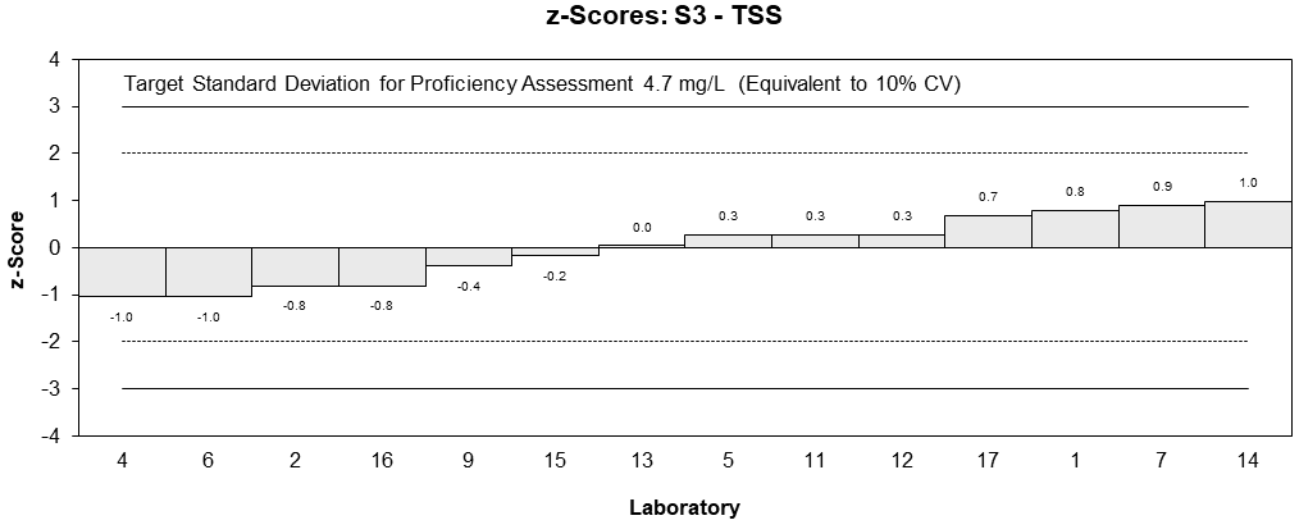
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	50.5	4.5	0.79	0.72
2	43	7	-0.81	-0.51
3	NT	NT		
4	42	3	-1.03	-1.23
5	48	4	0.26	0.25
6	42	88	-1.03	-0.05
7	51	10	0.90	0.41
8	NT	NT		
9	45	6.75	-0.38	-0.25
10	NT	NT		
11	48	8.98	0.26	0.13
12	48	9	0.26	0.13
13	47	4	0.04	0.04
14	51.4	5.12	0.98	0.81
15	46	6.9	-0.17	-0.11
16	43	5.0	-0.81	-0.68
17	50	6.4	0.68	0.47

Statistics

Assigned Value	46.8	2.5
Spike Value	49.6	0.2
Robust Average	46.8	2.5
Median	47.5	2.7
Mean	46.8	
N	14	
Max	51.4	
Min	42	
Robust SD	3.8	
Robust CV	8.1%	


Results: S3 - TSS
Assigned Value = 46.8 ± 2.5 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
4 6 2 16 9 15 13 5 11 12 17 1 7 14 3 8 10 Md RA SV


z-Scores: S3 - TSS
Target Standard Deviation for Proficiency Assessment 4.7 mg/L (Equivalent to 10% CV)
z-Score
-1.0 -1.0 -0.8 -0.8 -0.4 -0.2 0.0 0.3 0.3 0.3 0.7 0.8 0.9 1.0
4 6 2 16 9 15 13 5 11 12 17 1 7 14
Laboratory

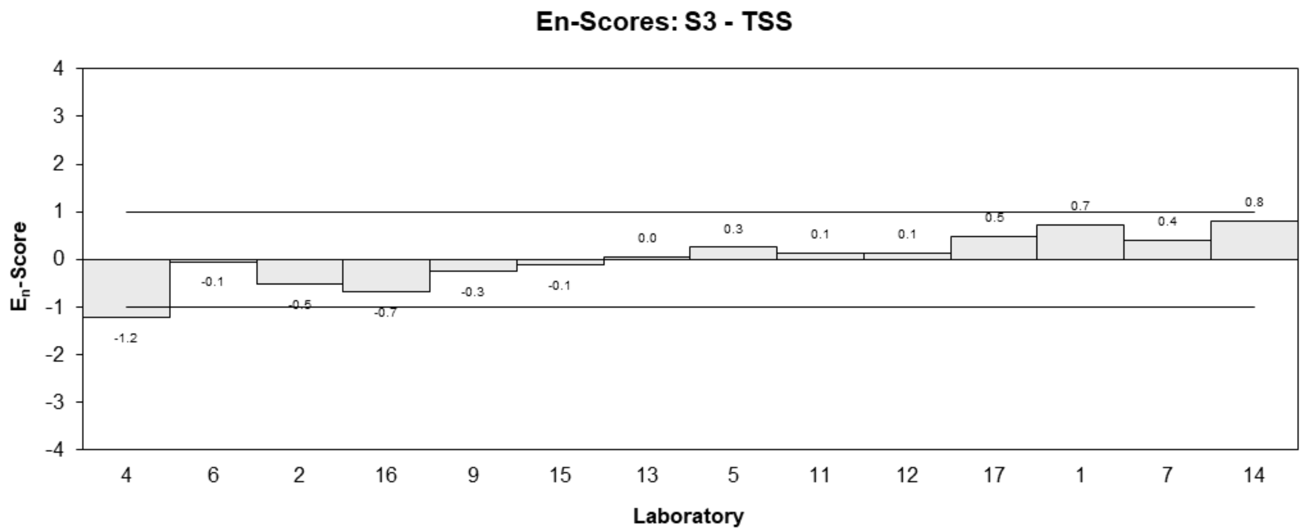

En-Scores: S3 - TSS
En-Score
-1.2 -0.1 -0.5 -0.7 -0.3 -0.1 0.0 0.3 0.1 0.1 0.5 0.7 0.4 0.8
4 6 2 16 9 15 13 5 11 12 17 1 7 14
Laboratory

Figure 39

Table 44

Sample Details

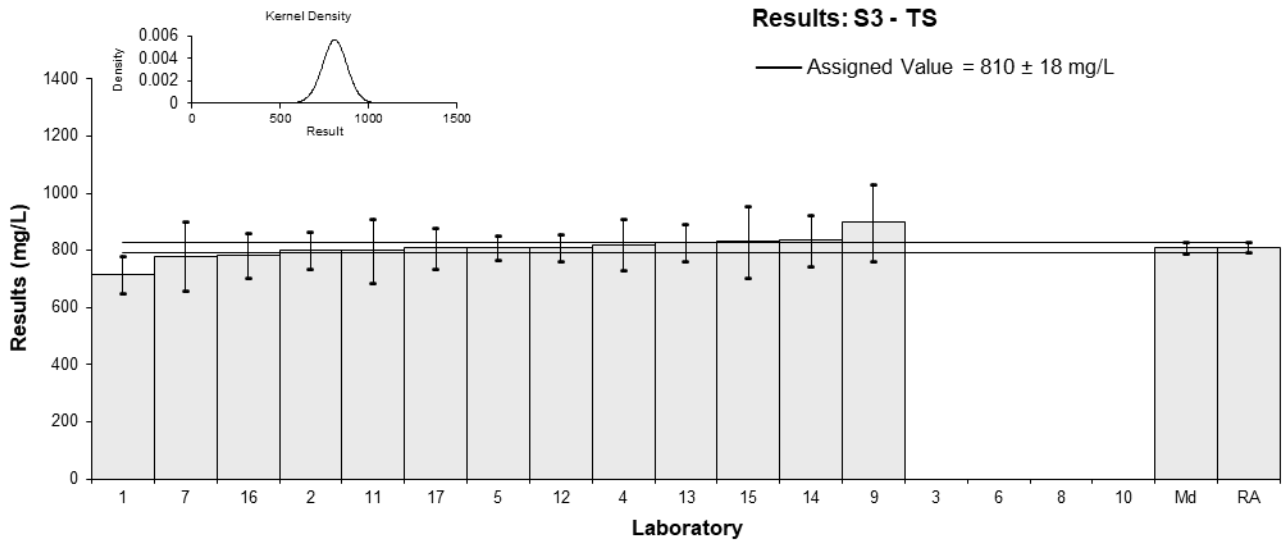
Sample No.	S3
Matrix	Wastewater
Analyte	TS
Unit	mg/L

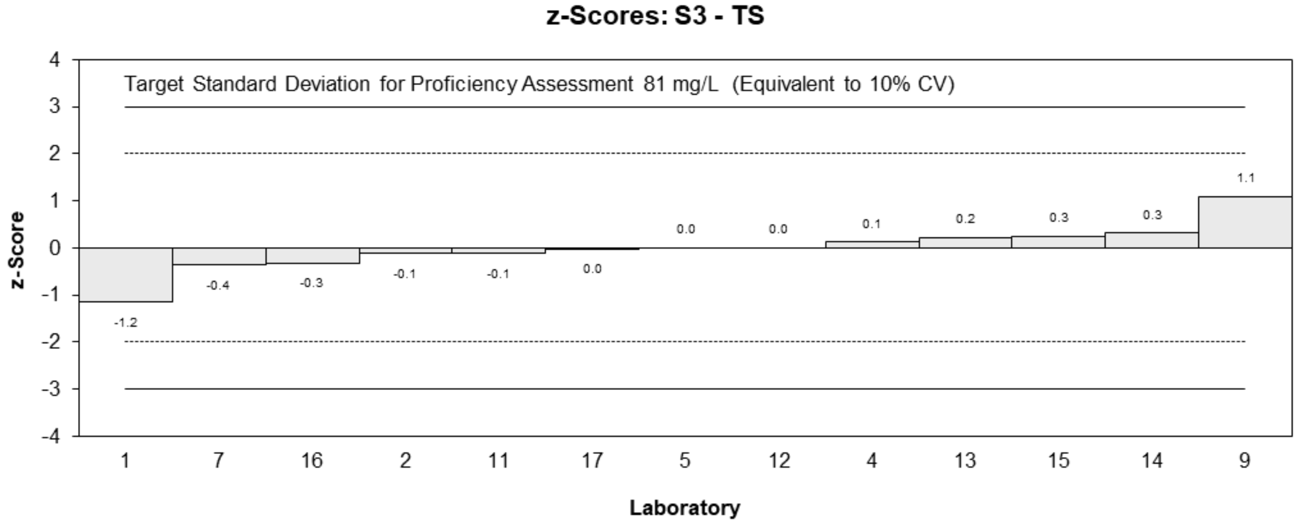
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	716	65	-1.16	-1.39
2	800	63.6	-0.12	-0.15
3	NT	NT		
4	820	90	0.12	0.11
5	810	44	0.00	0.00
6	NT	NT		
7	780	120	-0.37	-0.25
8	NT	NT		
9	898	134.75	1.09	0.65
10	NT	NT		
11	800	112	-0.12	-0.09
12	810	49	0.00	0.00
13	828	66	0.22	0.26
14	835	91.3	0.31	0.27
15	830	124.5	0.25	0.16
16	784	78	-0.32	-0.32
17	808	72.3	-0.02	-0.03

Statistics

Assigned Value	810	18
Spike Value	Not Spiked	
Robust Average	810	18
Median	810	19
Mean	809	
N	13	
Max	898	
Min	716	
Robust SD	26	
Robust CV	3.2%	


Results: S3 - TS
Assigned Value = 810 ± 18 mg/L
Kernel Density
Density
Result
Results (mg/L)
Laboratory
1 7 16 2 11 17 5 12 4 13 15 14 9 3 6 8 10 Md RA


z-Scores: S3 - TS
Target Standard Deviation for Proficiency Assessment 81 mg/L (Equivalent to 10% CV)
z-Score
-1.2 -0.4 -0.3 -0.1 -0.1 0.0 0.0 0.0 0.1 0.2 0.3 0.3 1.1
1 7 16 2 11 17 5 12 4 13 15 14 9
Laboratory

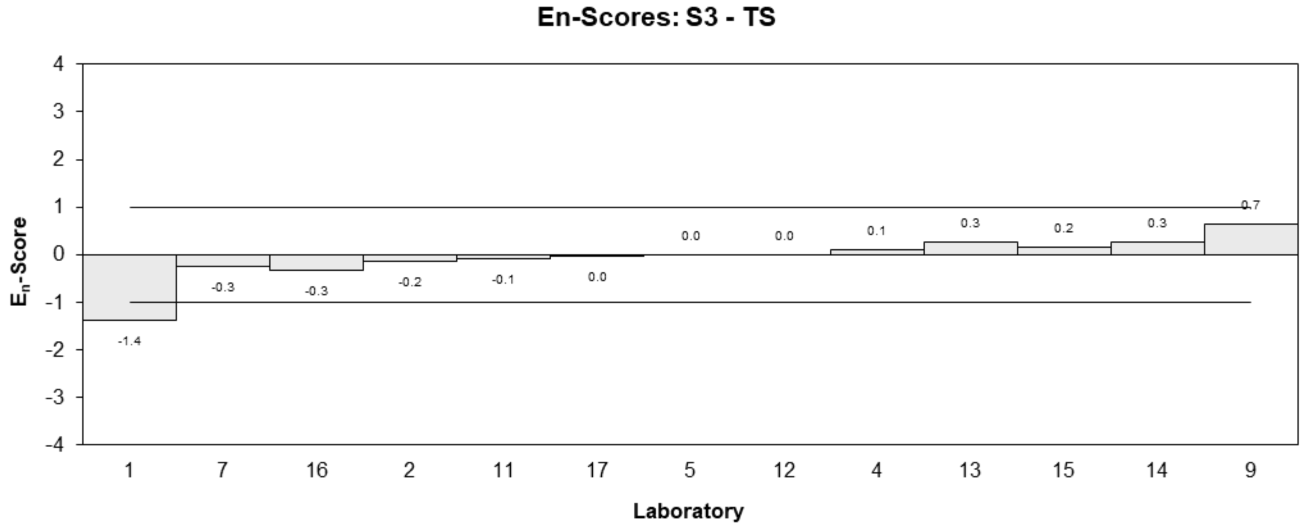

En-Scores: S3 - TS
En-Score
-1.4 -0.3 -0.3 -0.2 -0.1 0.0 0.0 0.0 0.1 0.3 0.2 0.3 0.7
1 7 16 2 11 17 5 12 4 13 15 14 9
Laboratory

Figure 40

Table 45

Sample Details

Sample No.	S3
Matrix	Wastewater
Analyte	Turbidity
Unit	NTU

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	23.9	1.2	1.57	1.99
2	19	1.2	0.22	0.28
3	NT	NT		
4	17.8	3	-0.11	-0.10
5	13	2	-1.43	-1.59
6	18	2	-0.05	-0.06
7	19	3.8	0.22	0.17
8	NT	NT		
9	12	1.8	-1.70	-1.96
10	NT	NT		
11	18	1.46	-0.05	-0.07
12	23	3	1.32	1.21
13	16.0	0.3	-0.60	-0.84
14	16.3	0.8	-0.52	-0.70
15	18	2.7	-0.05	-0.05
16	23.6	2.5	1.48	1.50
17	17.4	0.76	-0.22	-0.30

Statistics

Assigned Value	18.2	2.6
Spike Value	Not Spiked	
Robust Average	18.2	2.6
Median	18.0	1.3
Mean	18.2	
N	14	
Max	23.9	
Min	12	
Robust SD	3.9	
Robust CV	22%	

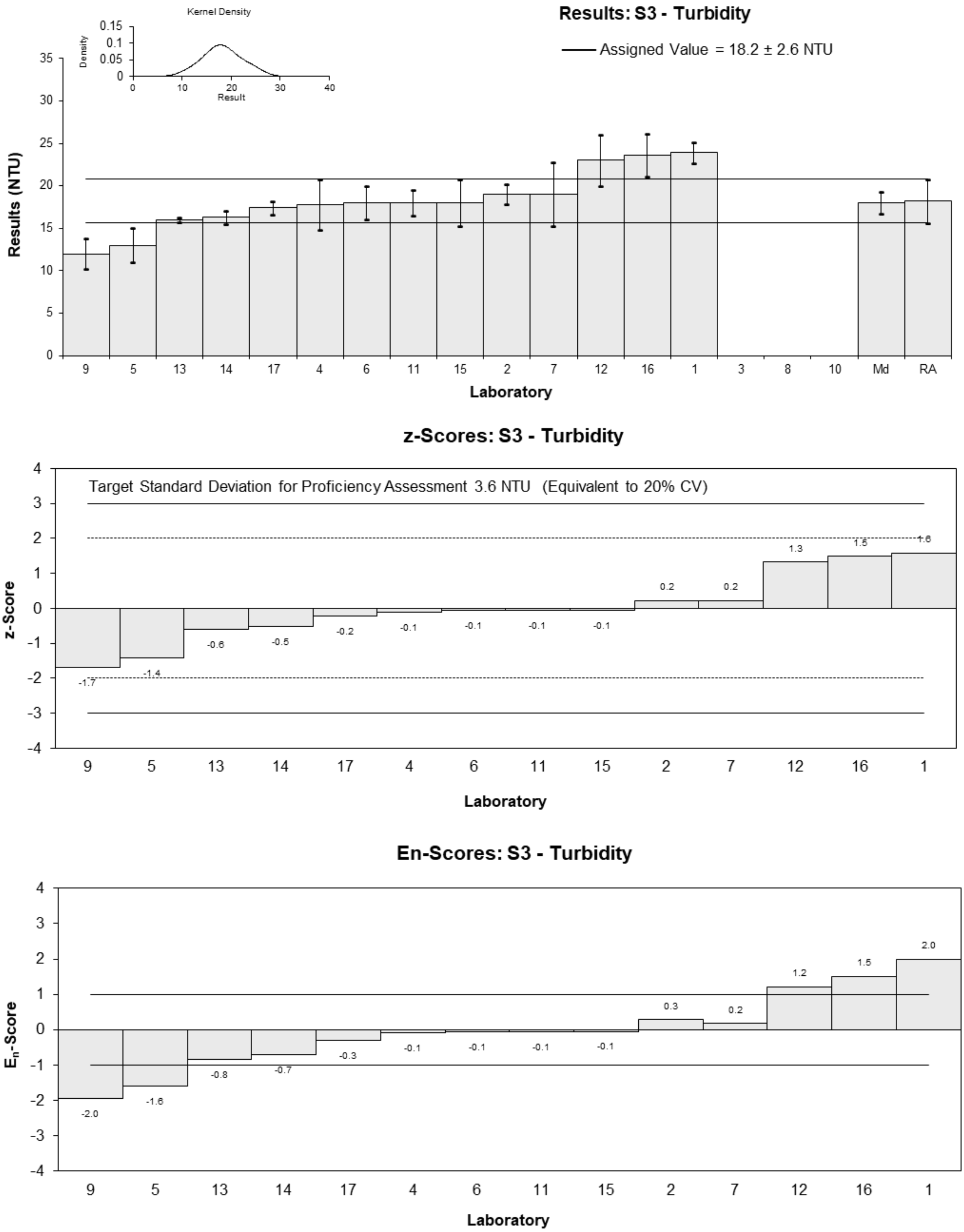

Results: S3 - Turbidity
Assigned Value = 18.2 ± 2.6 NTU
Kernel Density
Density
Result
Results (NTU)
Laboratory
9
5
13
14
17
4
6
11
15
2
7
12
16
1
3
8
10
Md
RA
z-Scores: S3 - Turbidity
Target Standard Deviation for Proficiency Assessment 3.6 NTU (Equivalent to 20% CV)
z-Score
-1.7
-1.4
-0.6
-0.5
-0.2
-0.1
-0.1
-0.1
-0.1
0.2
0.2
1.3
1.5
1.6
En-Scores: S3 - Turbidity
En-Score
-2.0
-1.6
-0.8
-0.7
-0.3
-0.1
-0.1
-0.1
-0.1
0.3
0.2
1.2
1.5
2.0

Figure 41

6 DISCUSSION OF RESULTS

6.1 Assigned Value

Sample S1 was autoclaved and acidified trade wastewater to which a known amount of the elemental standard solutions were added.

Sample S2 was the same fortified wastewater used for Sample S1 preparation, further fortified for As, Ba, Co, Fe, La, Pb, Sr, Th, U and Zn. The concentration of Se in S2 was expected to remain unchanged from that of Sample S1.

For Sample S1, participants were asked to report results for total As, Be, Bi, Cd, Cr, Cu, Hg, Li, Mo, Ni, Pb, Sb, Se, Sn, Ti, Tl, V and Zn, and for Sample S2 to report results for total Al, As, B, Ba, Ca, Co, Fe, La, Mn, Mg, P, Pb, S, Se, Sr, Th, U and Zn. The samples were chilled prior to dispatch.

Sample S3 was wastewater fortified with a known amount of suspended solid. Participants were asked to report TS, TDS, TSS and turbidity.

Assigned Values for the 40 tests were the robust average of participants' results. The robust averages used as assigned values and their associated expanded uncertainties were calculated using the procedure described in 'ISO13528:2015(E), Statistical methods for use in proficiency testing by interlaboratory comparisons'. Results less than 50% and more than 150% of the robust average were removed before calculation of each assigned value.[6] Appendix 2 sets out the calculation of the robust average and assigned value for Be in Sample S1 and its associated uncertainty.

The assigned value for Se in S1 and S2 was calculated as the robust average of the combined average of the results reported by participants for both samples.

Spike Value for some analytes, included both the incurred value and the fortified value.

Assigned values, spike values and homogeneity values were in agreement with each other within their estimates of uncertainty for all elements of interest.

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, for which the traceability to SI has not been confirmed. 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 513 numerical results, 503 (98%) were reported with an expanded measurement uncertainty, indicating that the majority of laboratories have addressed this requirement of AS ISO 17025.[8] The magnitude of these expanded uncertainties was within the range 0.058% to 210 % 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.[10 – 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 (Figure 2 to 41). 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, 13 laboratories reported results for Pb in S1. The uncertainty of the assigned value estimated from the robust standard deviation of the 13 laboratories' results is 0.55 µg/L (see equation 4, Appendix 2). If Laboratory 8 result is coming from one measurement, then they might have under-estimated their expanded measurement uncertainties reported for Pb in S1 (0.39 µg/L) as an uncertainty estimated from one measurement should not be smaller than the uncertainty estimated from 13 measurements. Alternatively, estimates of uncertainties for Se in S1 and S2 (for example) larger than 1.2 µg/L (the uncertainty of the assigned value, 0.48 µg/L plus the allowable variation from the assigned value, the target standard deviation of 0.366 µg/L, multiplied by 2, the coverage factor for a confidence interval of 95%), should also be viewed as suspect. For example, the expanded measurement uncertainties reported by laboratory 3 for Se in S1 and S2 (1.9 µg/L) might have been over-estimated.

Laboratory 10 may need to review their procedure for estimating measurement uncertainty as most of their estimated 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 and 6 attached an estimate of the expanded measurement uncertainty to Se result which was reported as "less than". An estimate of uncertainty expressed as a value cannot be attached to a result expressed as a range.[9]

Laboratories 3 and 6 reported an estimate of expanded uncertainty for some measurement results 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 µg/L, it is better to report 18.4 ± 3.4 µg/L or instead of 0.0023 ± 0.00048 µg/L, it is better to report 0.0023 ± 0.0005 µg/L.[9]

6.3 z-Score

The z-score compares the participant's deviation from the assigned value with the target standard deviation set for proficiency assessment. The target standard deviation defines satisfactory performance in a proficiency test. Target standard deviations equivalent to 10%, and 20% CV were used to calculate z-scores. Unlike the standard deviation based on between laboratories CV, setting the target standard deviation as a realistic value enables z-scores to be used as reference value points for assessment of laboratory performance, independent of group performance.

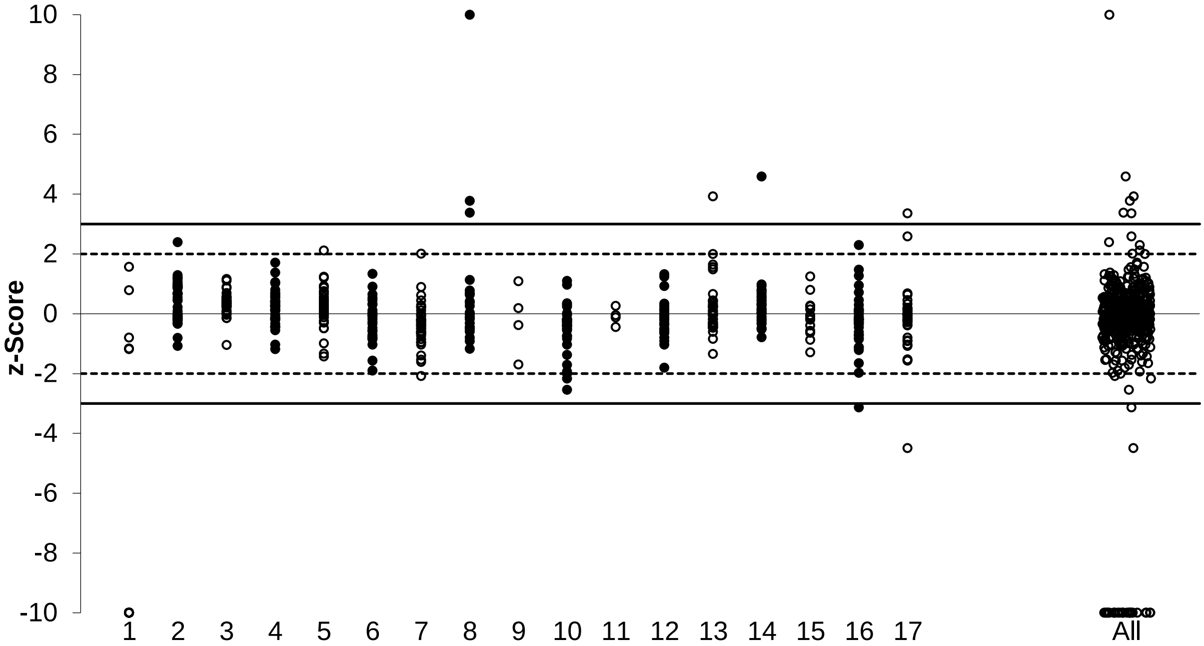
The between laboratories coefficient of variation predicted by the Thompson equation[7] and the between laboratories coefficient of variation resulted in this study are presented for comparison in Table 46. The dispersal of participants' z-scores is presented in Figure 42 (by laboratory code) and in Figure 44 (by test). Of 513 results for which z-scores were calculated, 471 (92%) returned a satisfactory score of $|z| \le 2.0$ and 9 (2%) 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. Summary of participants' performance is presented in Figure 45**.**

No laboratories reported results for all 40 tests.

Laboratories 2, 5 and **13** reported results for 39 tests and returned satisfactory z-scores for 38 of them.

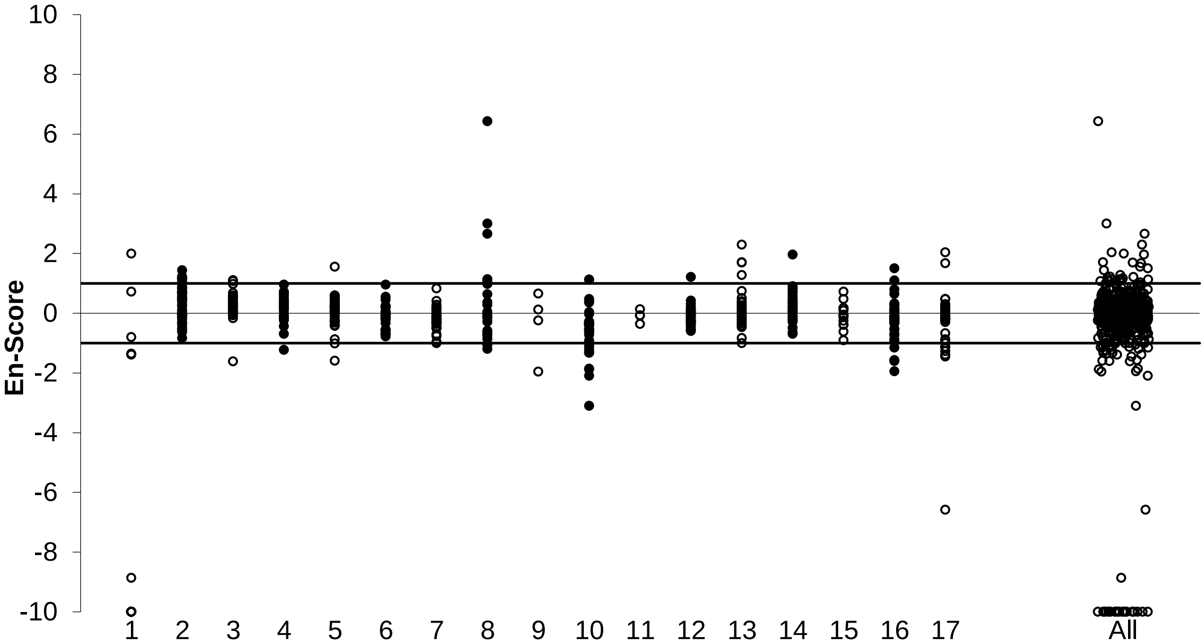
Laboratory 4 reported results for 37 tests and returned satisfactory z-scores for all of them.

All results reported by **Laboratories 3** (35), **12** (31), **6** (27), **15** (15), **11** (4) and **9** (4) returned satisfactory z scores.



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

Figure 42 z-Score Dispersal by Laboratory



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

Figure 43 E_n-Score Dispersal by Laboratory

6.4 E_n-score

En-score can be interpreted only in conjunction with z-scores. The E_n-score indicates how closely a result agrees with the assigned value considering the respective uncertainties. An unsatisfactory En 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 42. 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.

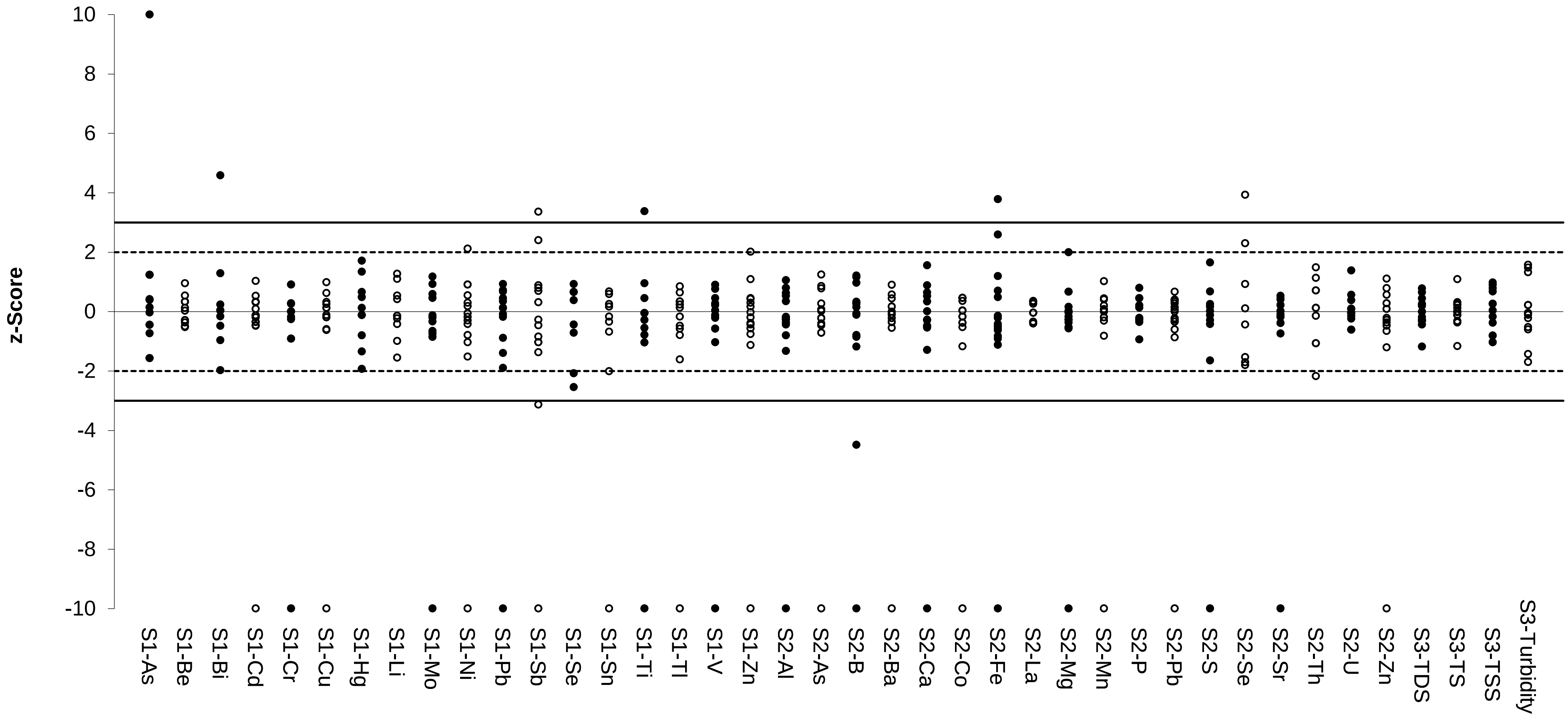
Of 513 results for which E_n-scores were calculated, 426 (83%) returned a satisfactory score of $|E_n| \leq 1.0$ indicating agreement of the participants' results with the assigned values within their respective expanded measurement uncertainties.

All results reported by **Laboratories 6** (27), **15** (15) and **11** (4) returned satisfactory E_n scores.

Table 46 Between Laboratories CV of this study, Thompson CV and Set Target CV

Sample	Test	Assigned value (µg/L)	Between Laboratories CV*	Thompson/ Horwitz CV	Target SD (as CV)
S1	As	3.56	11%	22%	10%
S1	Be	4.84	4.9%	22%	10%
S1	Bi	4.98	9.4%	22%	10%
S1	Cd	4.56	4.4%	22%	10%
S1	Cr	11	6.2%	22%	10%
S1	Cu	40.5	5%	22%	10%
S1	Hg	0.41	26%	22%	20%
S1	Li	3.55	9.8%	22%	10%
S1	Mo	15.3	7.7%	22%	10%
S1	Ni	8.25	9.2%	22%	10%
S1	Pb	9.88	8%	22%	10%
S1	Sb	5.24	16%	22%	10%
S1	Se	3.66	14%	22%	10%
S1	Sn	11.8	6.4%	22%	10%
S1	Ti	20.1	8.1%	22%	10%
S1	Tl	9.77	6.2%	22%	10%
S1	V	22.3	6.2%	22%	10%
S1	Zn	54.1	7.8%	22%	10%
S2	Al	113	7.3%	22%	10%
S2	As	40.9	6.1%	22%	10%
S2	B	544	9.8%	18%	10%
S2	Ba	75.7	3.9%	22%	10%
S2	Ca	14700	7.8%	11%	10%
S2	Co	4.78	4.8%	22%	10%
S2	Fe	143	11%	21%	10%
S2	La	5.02	3.1%	22%	10%
S2	Mg	7500	5.1%	12%	10%
S2	Mn	49	3.4%	22%	10%
S2	P	2870	5.4%	14%	10%
S2	Pb	149	4.7%	21%	10%
S2	S	10300	6.9%	11%	10%
S2	Se	3.66	22%	22%	10%
S2	Sr	97.8	4.2%	22%	10%
S2	Th	16.8	12%	22%	10%
S2	U	7.03	4.3%	22%	10%
S2	Zn	107	6.3%	22%	10%
S3	TDS	751 mg/L	4.9%	5.9%	10%
S3	TSS	46.8 mg/L	8.1%	9%	10%
S3	TS	810 mg/L	3.2%	5.8%	10%
S3	Turbidity	18.2 NTU	22%	10%	20%

*Robust between -laboratory CV outliers removed



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

Figure 44 z-Score Dispersal by Test

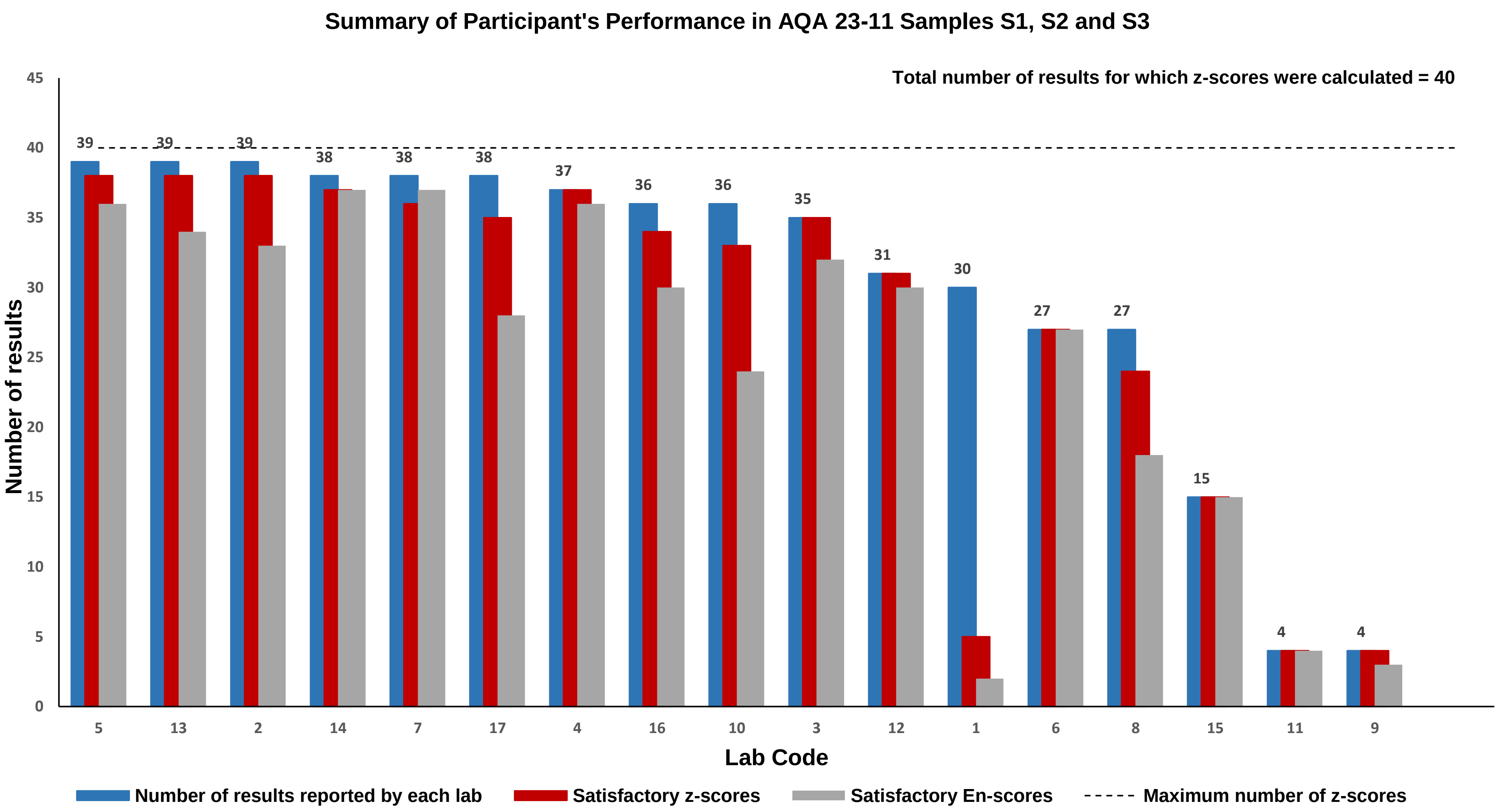


Figure 45: Summary of Participants Performance in AQA 23-11

Table 47 Summary of Participants' Results and Performance for S1.

Lab Code	As (µg/L)	Be (µg/L)	Bi (µg/L)	Cd (µg/L)	Cr (µg/L)	Cu (µg/L)	Hg (µg/L)	Li (µg/L)	Mo (µg/L)	Ni (µg/L)	Pb (µg/L)	Sb (µg/L)	Se (µg/L)	Sn (µg/L)	Ti (µg/L)	Tl (µg/L)	V (µg/L)	Zn (µg/L)
A.V.	3.56	4.84	4.98	4.56	11.0	40.5	0.410	3.55	15.3	8.25	9.88	5.24	3.66	11.8	20.1	9.77	22.3	54.1
H.V.	3.47	4.87	4.40	4.27	10.6	39.9	0.500	NA	15.1	8.5	10.1	4.80	3.21	11.9	NA	NA	20.7	49.6
1	<0.007	<0.006	NT	0.00476	0.0118	0.0442	0.344	NT	0.015	0.0085	0.0099	0.0078	<0.01	0.0102	0.0191	0.012	0.023	0.0564
2	4.0	5.1	5.62	5.03	12.0	44.5	0.4	3.5	17.1	9.0	10.8	6.5	3.9	12.6	22	10.6	24.3	60
3	3.71	5.0	5.0	4.71	11.31	41.5	0.45	3.74	16.2	8.7	10.32	5.6	3.8	12.1	18	10.0	23.3	56.4
4	3.7	4.9	NT	4.8	10.8	43	0.55	3.5	15	7.9	10	5.4	3.5	11.4	19	10	22.9	54
5	4	4.7	5.1	4.7	12	40	NT	3.2	16	10	10	5.7	3.9	12	20	9.3	24	55
6	3	5	5	4.7	11	41	0.52	NT	14	9	8	5.1	<10	NT	NT	9.6	21	50
7	3.3	4.6	4.5	4.4	11	38	NR	3.4	14	8.1	8.5	4.7	2.9	11	21	8.2	21	65
8	11.5	4.59	5.00	4.5	10.0	38.1	NT	NT	15.1	7.6	10.55	5.0	NT	11.6	26.9	10.4	NT	51.7
9	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
10	3.55	4.66	4.74	4.47	10.71	39.72	0.252	3.94	14.17	7.40	10.23	4.52	2.73	9.43	19.54	10	21.84	55.74
11	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
12	4	4.6	NT	4.4	11	38	0.42	NT	14.3	8.4	9.8	4.7	4	NT	NT	9.2	22	51
13	3.4	4.7	4.90	4.35	11.3	39.7	0.3	3.7	14.8	8.2	10.0	4.8	3.9	NT	20	10.1	22.8	52
14	3.609	4.854	7.265	4.341	11.29	41.78	0.464	3.469	16.72	8.001	10.59	5.660	<10	12.50	18.54	10.098	22.39	56.52
15	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
16	3.4	5.3	4.0	4.6	11	41	<0.5	4.0	16	8.5	9.7	3.6	3.4	NT	NT	9.9	22	48
17	3	5	5	4.5	10	41	0.4	3	15	7	9	7	<10	12	20	9	20	53

Shaded cells are results which returned a questionable or unsatisfactory z-score. A.V. = Assigned Value, H.V. = Homogeneity Value; NA = Not Available

Table 48 Summary of Participants' Results and Performance for S2 and S3

Lab Code	S2-Al (µg/L)	S2-As (µg/L)	S2-B (µg/L)	S2-Ba (µg/L)	S2-Ca (µg/L)	S2-Co (µg/L)	S2-Fe (µg/L)	S2-La (µg/L)	S2-Mg (µg/L)	S2-Mn (µg/L)	S2-P (µg/L)
A.V.	113	40.9	544	75.7	14700	4.78	143	5.02	7500	49.0	2870
H.V.	99	38.6	509	67.5	14300	4.40	131	4.67	NA	49.6	2680
1	0.126	0.0427	0.589	0.0818	14.7	0.0045	0.141	NT	7.88	0.0511	NT
2	110	41	540	74	16000	5	160	5	8000	48	3000
3	117	44.4	607	82.5	14710	4.95	141	5.18	7480	49.4	2930
4	125	42	480	79	15200	4.7	153	NT	8000	54	3100
5	98	41	610	80	14000	5	150	5.2	7300	51	2800
6	119	38	501	75	NT	5	135	NT	NT	45	NT
7	120	40	560	75	14000	4.6	140	5.0	7300	48	2600
8	NT	44.1	538	75.6	NT	4.22	197	5.15	7490	47.5	NT
9	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
10	108.82	39.25	596.52	71.53	14268	4.53	131.07	4.82	7374	49.08	2809
11	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
12	104	40	NT	73	13900	4.7	130	NT	7110	49	NT
13	108	39.0	558	73.1	17000	4.6	137	5	9000	49.0	3000
14	110.62	41.18	562.2	76.97	15470	4.796	135.8	4.848	7517	51.15	2907.3
15	122	46	552	75	12800	<10	134	NT	7070	48	NT
16	111	38	498	75	14310	4.8	127	NT	7620	48	2770
17	110	40	300	77	15640	5	180	5	7225	50	2790

Shaded cells are results which returned a questionable or unsatisfactory z-score. A.V. = Assigned Value, H.V. = Homogeneity Value; NA = Not Available

Table 48 Summary of Participants' Results and Performance for S2 and S3 (Continued)

Lab Code	S2-Pb (µg/L)	S2-S (µg/L)	S2-Se (µg/L)	S2-Sr (µg/L)	S2-Th (µg/L)	S2-U (µg/L)	S2-Zn (µg/L)	S3-TDS (mg/L)	S3-TS (mg/L)	S3-TSS (mg/L)	S3-Turbidity (NTU)
A.V.	149	10300	3.66	97.8	16.8	7.03	107	751	810	46.8	18.2
H.V.	148	NA	3.18	98	20.8	6.82	96	NA	NA	NA	NA
1	0.146	10.0859	<0.01	0.0939	NT	NT	0.111	662.5	716	50.5	23.9
2	144	11000	<10	96	15	7	108	727	800	43	19
3	154.9	10560	3.7	103.0	NT	6.93	118.9	NT	NT	NT	NT
4	155	10470	3.5	102	NT	8	113	770	820	42	17.8
5	150	10000	4	98	18	7.1	110	730	810	48	13
6	144	NT	<10	NT	NT	7	102	800	NT	42	18
7	140	NR	3.1	100	17	6.6	100	730	780	51	19
8	159	NT	NT	101.8	18.7	7.3	102	NT	NT	NT	NT
9	NT	NT	NT	NT	NT	NT	NT	765	898	45	12
10	145.67	9867	3.034	90.59	13.16	6.86	104.78	NT	NT	NT	NT
11	NT	NT	NT	NT	NT	NT	NT	718	800	48	18
12	154	NT	3	NT	17	7	103	728	810	48	23
13	153	12000	5.1	100	19.3	7.09	104	784	828	47	16.0
14	151.2	10325	<10.0	96.89	16.56	7.425	115.5	809.67	835	51.4	16.3
15	136	NT	<10	94	NT	NT	110	770	830	46	18
16	145	8600	4.5	96	18	6.6	94	737	784	43	23.6
17	149	10179	<10	94	15	7	108	750	808	50	17.4

Shaded cells are results which returned a questionable or unsatisfactory z-score. A.V. = Assigned Value, H.V. = Homogeneity Value; NA = Not Available

6.5 Participants' Results and Analytical Methods

A summary of participants' results, and performance is presented in Tables 47 and 48 as well as in Figures 42 to 45.

Sb in S1 was the analyte with the largest number of unsatisfactory results.

Laboratory 1 correctly measured Cd, Cr, Cu, Mo, Ni, Pb, Sn, Ti, V and Zn in S1 and Al, As, B, Ba, Ca, Co, Fe, Mg, Mn, Pb, S, Sr and Zn in S2 but reported results in the wrong units.

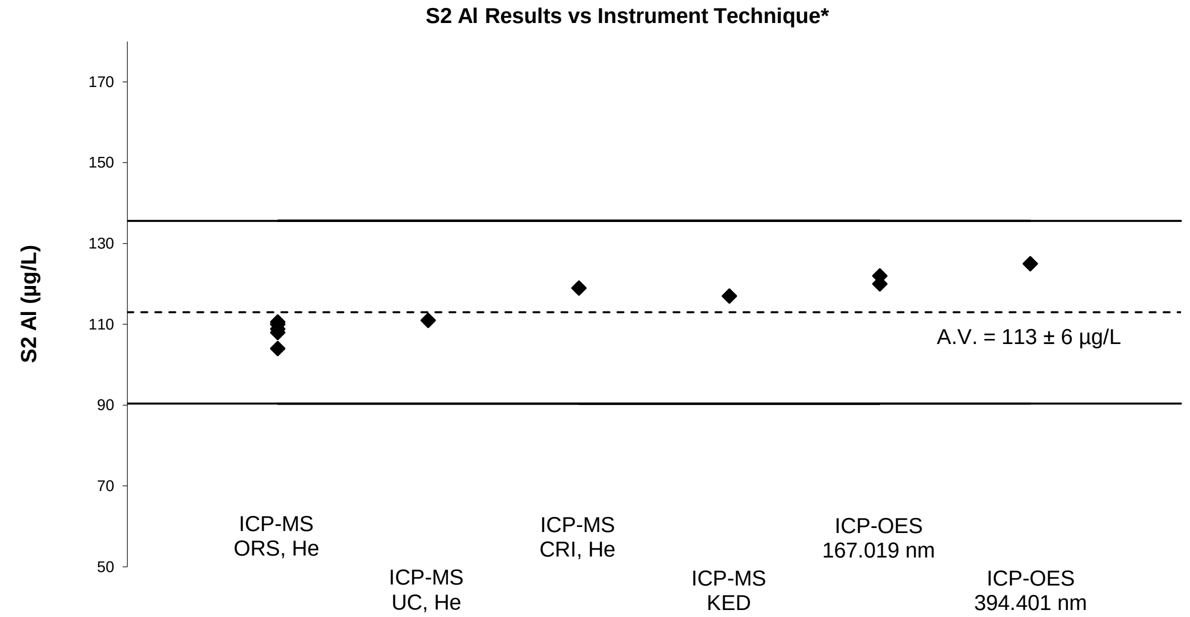
Participants were requested to analyse the wastewater samples for total elements. The method descriptions provided by participants are presented in Tables 1 and 3 and instrumental conditions are presented in Appendix 5.

No relationship was evident between participants' performance and the digestion procedure used for total elements in samples S1 and S2. 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 meth od used by the testing laboratory. Thus, these results should not be construed as an evaluation of a particular instrument.

Participants used a wide variety of instrumental techniques, collision/reaction cells and cell gases. Most laboratories reported using ICP-MS with a collision/reaction cell, some used ICP-OES and some only ICP-MS. One participant reported using GFAAS. Plots of participants' results and performance versus instrumental techniques used are presented in Figures 46 to 54.

Individual Element Commentary

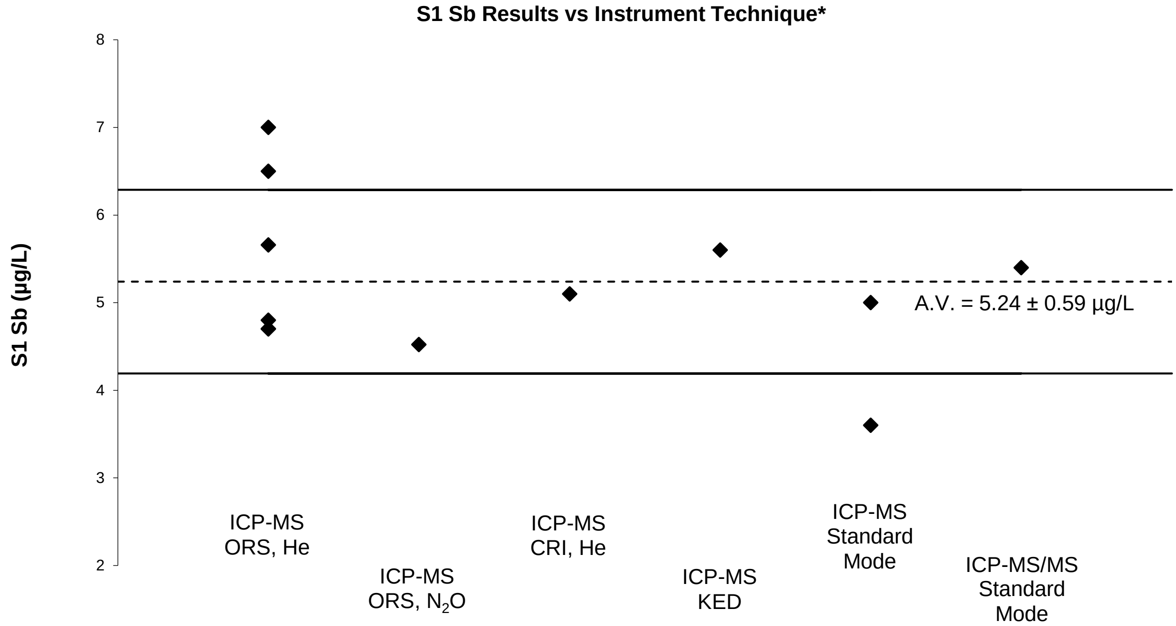
Aluminium level in S2 was 113 µg/L. Three participants used ICP-OES with wavelengths of 167 nm (2) or 394 nm (1). Nine laboratories reported using ICP-MS in collision mode. All instrumental techniques produced satisfactory results (Figure 46).



*The result from Laboratory 1 was excluded. Horizontal lines on charts correspond to z-scores of 2 and -2.

Figure 46 S2-Al Participants' Results vs Instrumental Technique

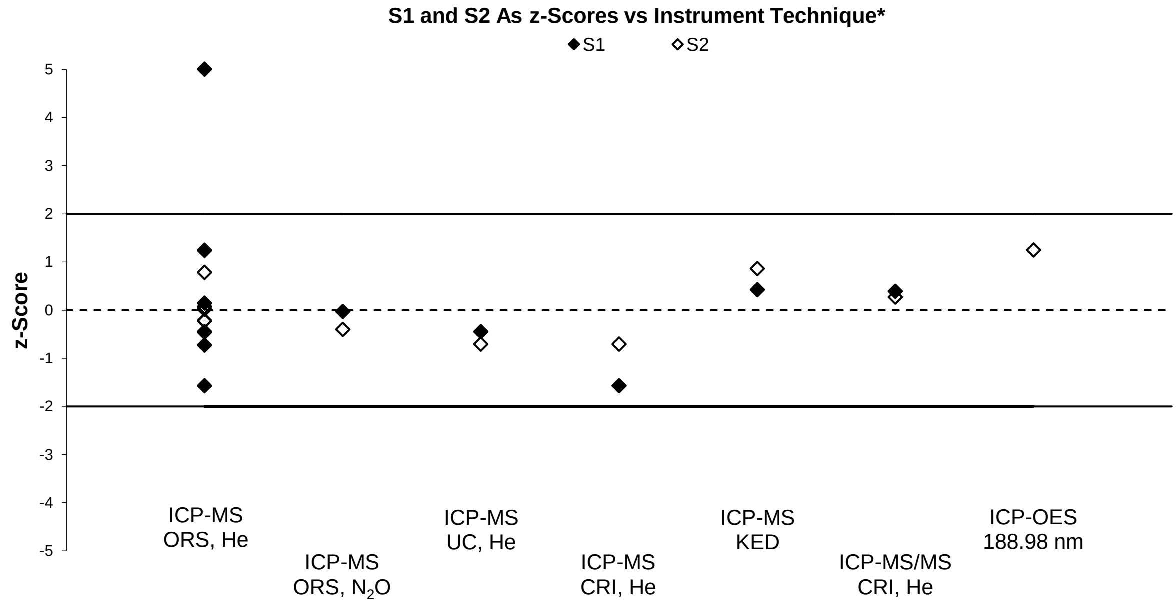
Antimony in S1 was the analyte with the largest number of unsatisfactory z-scores. Most participants used ICP-MS in collision mode for Sb measurements (Figure 47).



*The result from Laboratory 1 was excluded. Horizontal lines on charts correspond to z-scores of 2 and -2.

Figure 47 S1-Sb Participants' Results vs Instrumental Technique

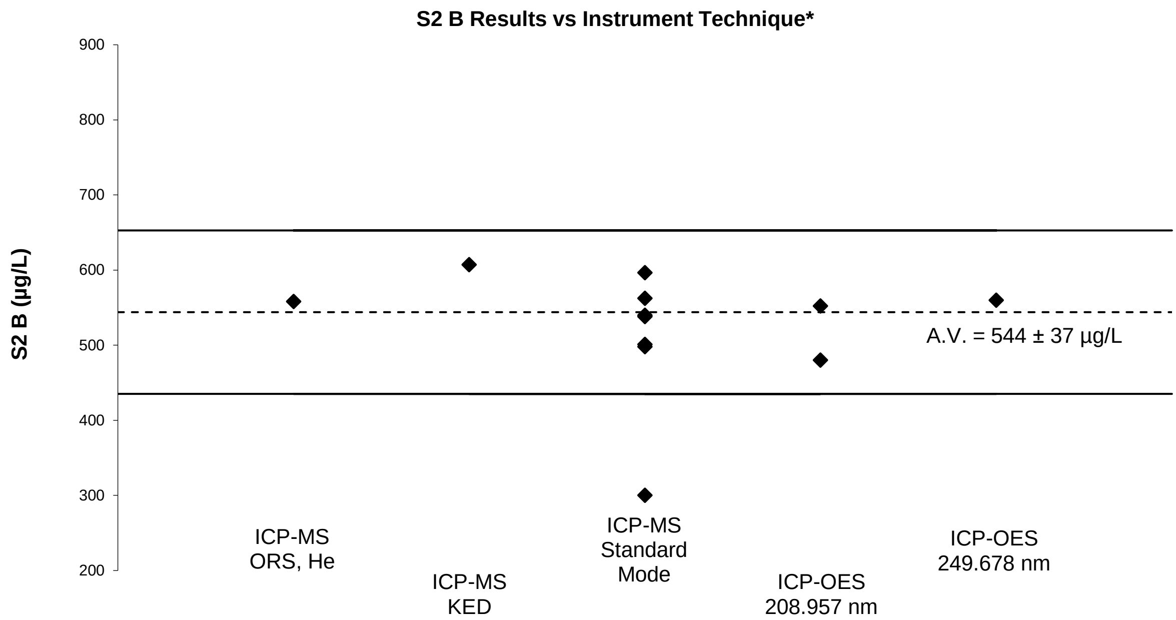
Arsenic level in Sample S1 was 3.56 µg/L, whereas in S2 it was 11 times higher at 40.9 µg/L. All reported results for As in S1 and S2 retuned satisfactory z-scores except for one in S1. The instrumental techniques used by participants are presented in Figure 48. One laboratory used ICP-OES with a vapour generator accessory and a wavelength of 188.98 nm.



*The results from Laboratory 1 were excluded. z-Score large than 5 has been plotted as 5. Horizontal lines on charts correspond to z-scores of 2 and -2.

Figure 48 S1 and S2-As Participants' Performance vs Instrumental Technique

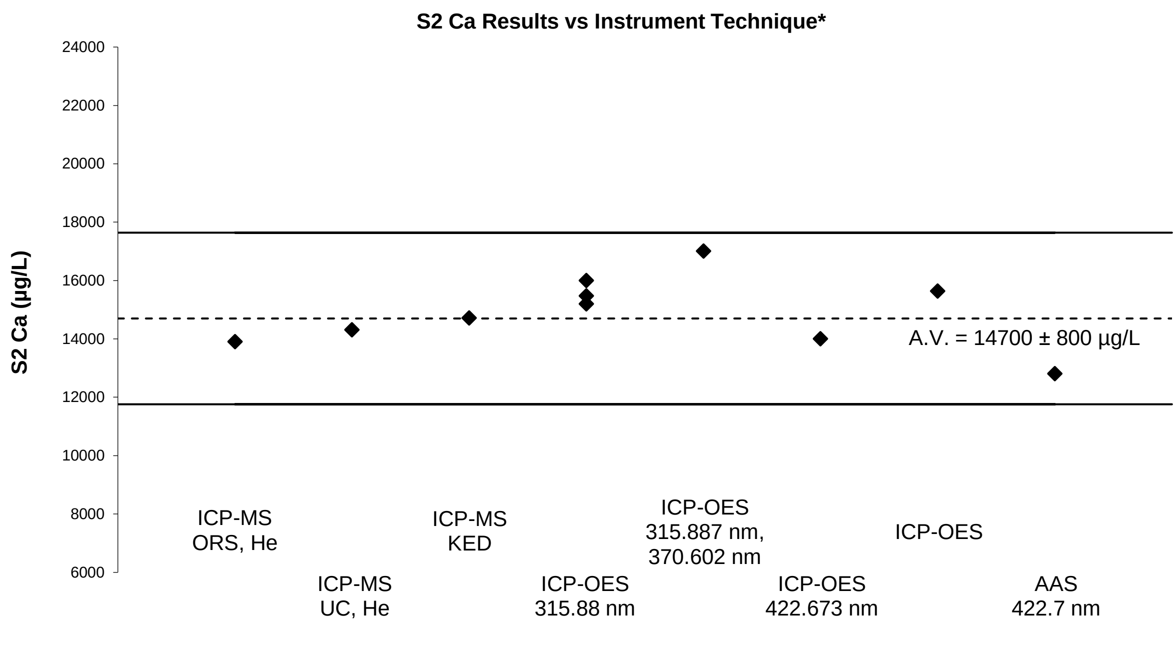
Boron level in Sample S2 was 544 µg/L and did not challenge participants' analytical techniques. ICP-MS in standard mode was the most popular instrumental technique used by participants for B measurements (Figure 49).



*The result from Laboratory 1 was excluded. Horizontal lines on charts correspond to z-scores of 2 and -2.

Figure 49 S2-B Participants' Results vs Instrumental Technique

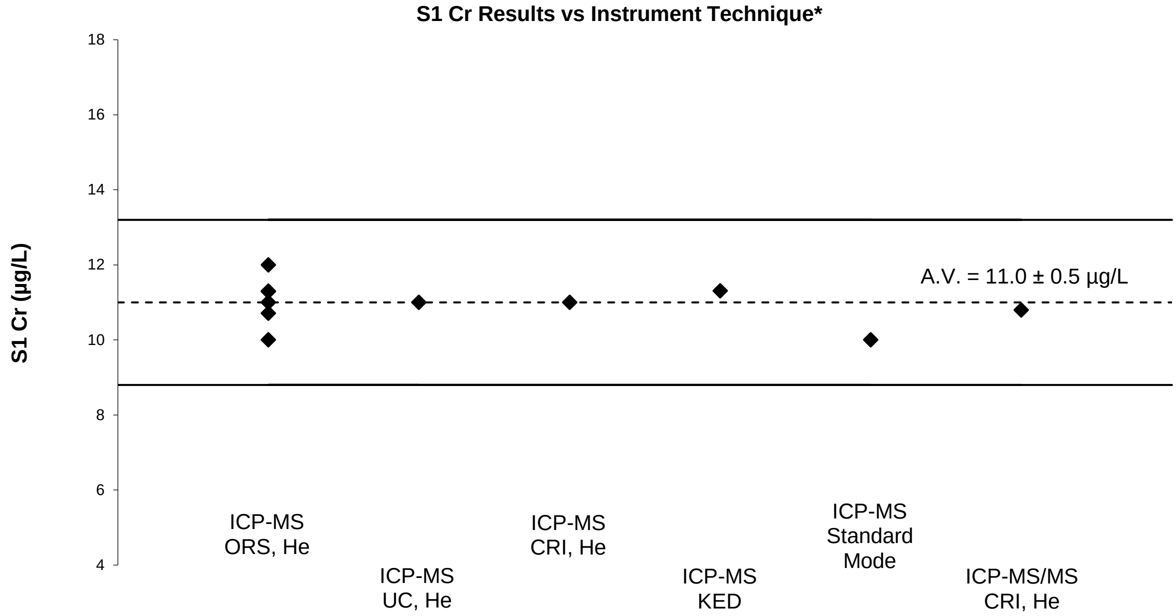
Calcium level in the wastewater sample S2 was 14700 µg/L. Participants used a wide variety of instrumental techniques: three used ICP-OES with wavelength 315 nm, two laboratories reported using ICP-OES or AAS with the wavelength 422 nm, and 3 ICP-MS in collision mode. One participant used ICP-OES and both wavelengths 315 nm and 370 nm (Figure 50).



*The result from Laboratory 1 was excluded. Horizontal lines on charts correspond to z-scores of 2 and -2.

Figure 50 S2-Ca Participants' Results vs Instrumental Technique

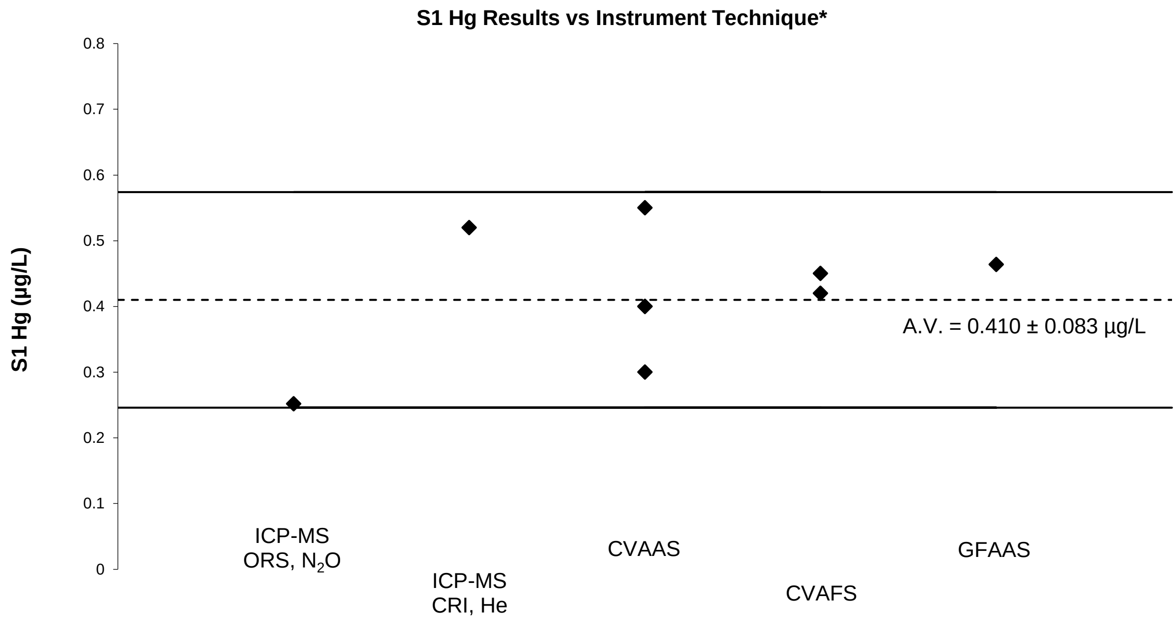
Chromium in S1 was one of the elements that least challenged participants' analytical techniques. The between laboratory-CV was 6%, much smaller than the 22% predicted by Thomson and Horwitz equation. For measurement of Cr in S1, all participants but one used ICP-MS in collision mode.



*The result from Laboratory 1 was excluded. Horizontal lines on charts correspond to z-scores of 2 and -2.

Figure 51 S1-Cr Participants' Results vs Instrumental Technique

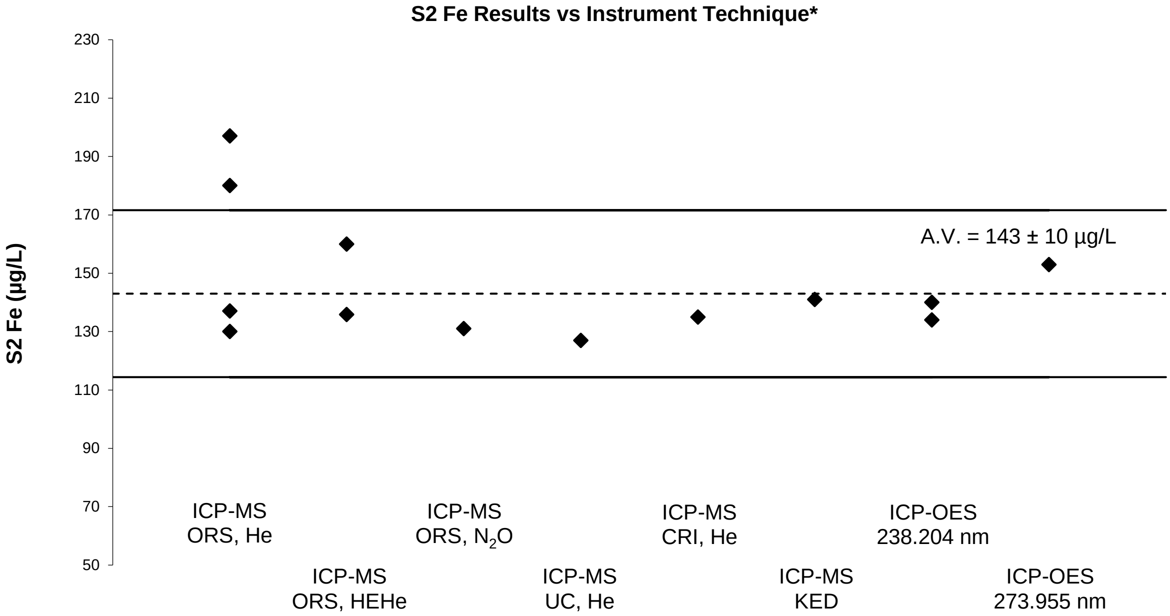
Mercury level in S1 was low at 0.410 µg/L. Participants used various instrumental techniques, including ICP-MS in collision or reaction mode, CVAAS, CVAFS or GFAAS (Figure 51). The reported results were variable with a large between laboratory CV of 26%, larger than that predicted by Thomson and Horwitz (22%).



*The result from Laboratory 1 was excluded. Horizontal lines on charts correspond to z-scores of 2 and -2.

Figure 52 S1-Hg Participants' Results vs Instrumental Technique

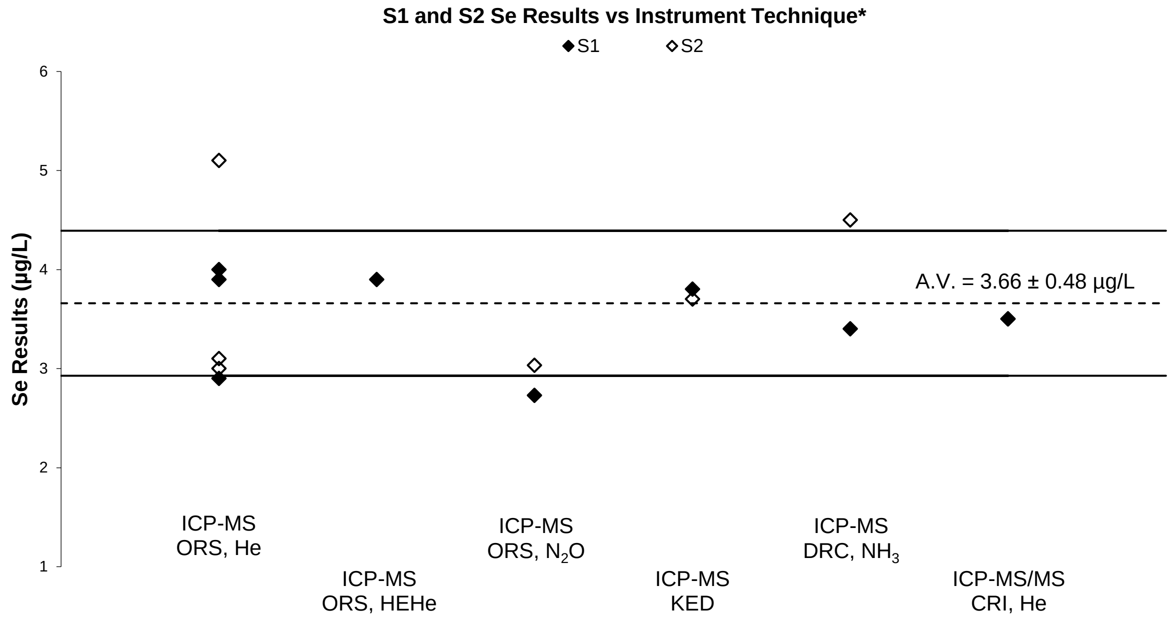
Iron is known to be ubiquitous in the environment; hence, special precautions are necessary to avoid contamination. Plots of participants' results reported for Fe versus measurement technique used are presented in Figure 53.



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

Figure 53 S1-Fe Participants' Results vs Instrumental Technique

Selenium level in S1 and S2 was similar, 3.66 µg/L. Participants used 5 different instrumental techniques: ICP-MS in collision, reaction or MS/MS mode and with various collision/reaction gases: He, HEHe, N_2O and NH_3 (see Figure 54).



*The result from Laboratory 1 was excluded. Horizontal lines on charts correspond to z-scores of 2 and -2.

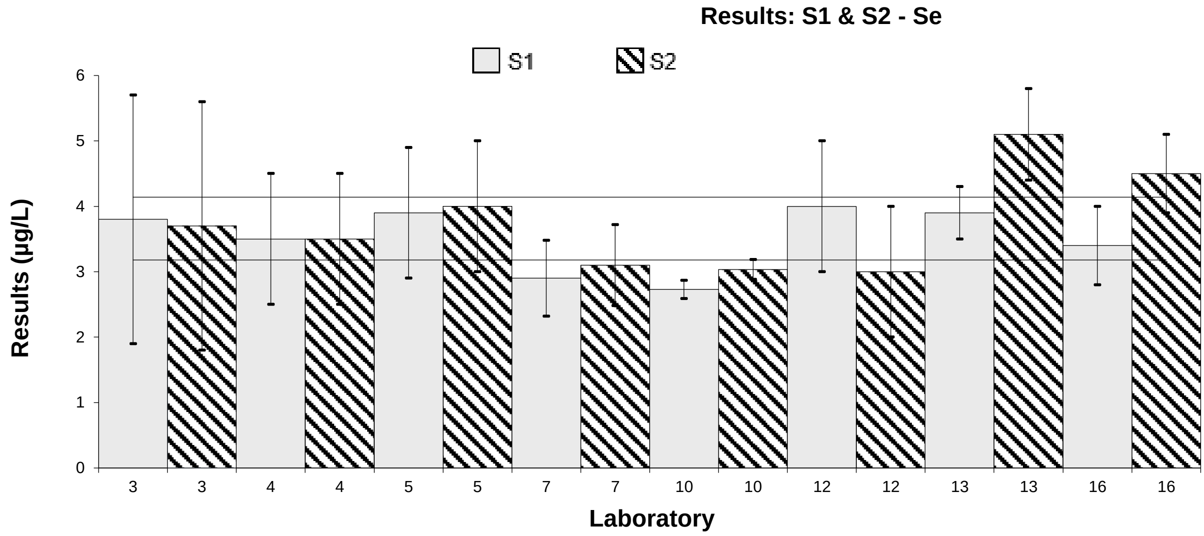
Figure 54 S1 and S2-Se Participants' Results vs Instrumental Technique

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.

6.6 Participants' Within – Laboratory Repeatability

Sample S2 was the same fortified trade wastewater used for Sample S1 preparation, further fortified for: As, Ba, Co, Fe, La, Pb, Sr, Th, U and Zn. The concentration of Se in S2 was expected to remain unchanged from that of Sample S1.

Eight laboratories reported Se results in both study samples. Laboratory 2 correctly measured Se in S1 but reported a result of <10 µg/L for Se in S2. Results reported for Se and the expanded MU in both study samples are presented in the bar charts in Figure 55. In some cases, the results reported for Se in the two identical study samples are significantly different. The results reported by Laboratories 7 and 10 returned satisfactory z-scores in S2 but not in S1, while the results reported by Laboratories 13 and 16 returned a satisfactory z-score in S1 but not in S2.



Horizontal line on the chart represent the assigned value and associated expanded measurement uncertainty (coverage factor k = 2).

Figure 55 Bar Charts of Results for S1 and S2 – Se

Scatter plots of z-scores in Samples S1 and S2 for Se are presented in Figure 56. Points close to the diagonal axis represent excellent repeatability, and points close to zero represent excellent repeatability and accuracy.

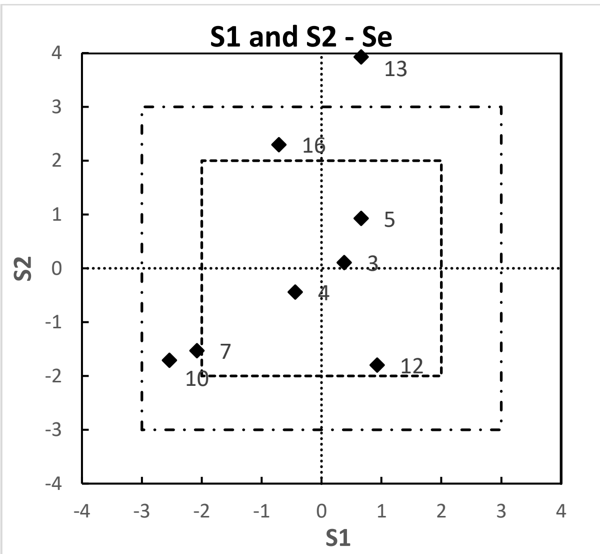


Figure 56 Scatter Plots of z-Scores for Se in S1 and S2

6.7 Comparison with Previous NMI Proficiency Tests of Metals in Water

AQA 23-11 is the 32nd NMI proficiency study of metals in water. Participants' performance in the measurement of trace elements in water (river water, seawater, wastewater and potable water) over the last ten years is presented in Figure 57. Over this period, the average proportion of satisfactory scores was 91% for z-scores and 83% for En-scores.

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.

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 49).

Table 49 Control Samples Used by Participants

Lab. Code	Description of Control Samples
4	CWW-TMA, CWW-TMC
6	CRM-TMDW LOT 2231242
8	VHG-163936-01-02, lot no. 10016262-1 VHG-Z22-W000571, lot no. 1276704
13	Choice Analytical High Purity CRMs
16	CWW-TM-B and CWW-TM-C (metals)

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'*[14]

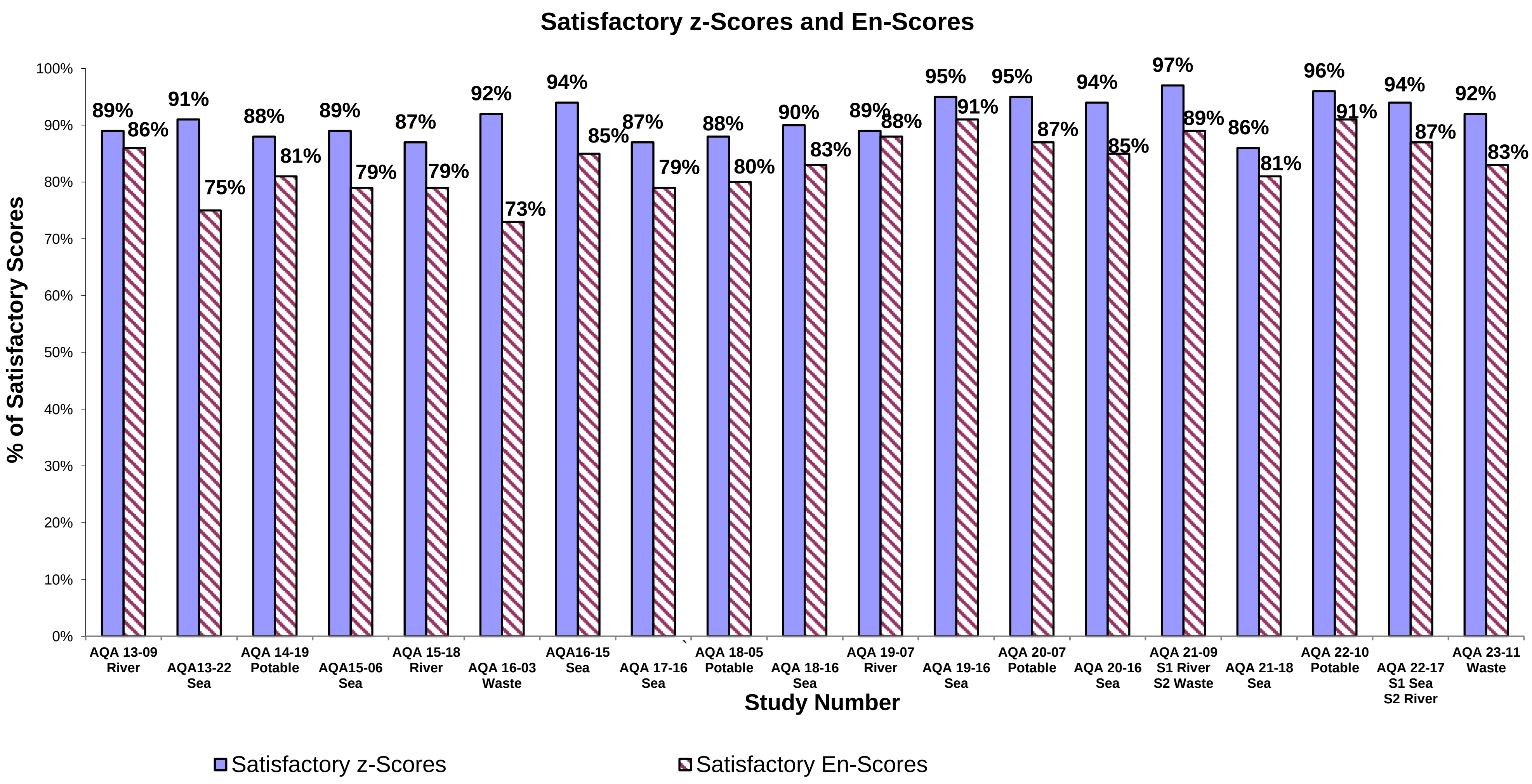


Figure 57 Participants' Performance in Metals in Water over last 10 years

7 REFERENCES

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

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APPENDIX 1 - SAMPLE PREPARATION, ANALYSIS AND HOMOGENEITY TESTING

Sample Preparation

Sample S1 was prepared using trade wastewater from Sydney Water. Approximately 9.7 L of autoclaved wastewater was acidified and then further fortified for 17 elements.

Sample S2 was prepared from 5.6 L of Sample S1, further fortified for 10 elements.

Sample S3 was prepared from autoclaved trade wastewater. Approximately 15 L of wastewater were spiked with total suspended solids.

Sample Analysis and Homogeneity Testing

A partial homogeneity test was conducted for all analytes of interest in samples S1 and S2, except for Li, Ti and Tl in S1 and Mg and S in S2. Three bottles were analysed in duplicate for both samples 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 30 mL was transferred to a 50 mL tube. The samples were digested using 2 mL nitric acid and 1 mL hydrochloric acid on a hot block at 95°C ± 5°C for 1.5 hours before ICP-MS determination.

The measurement instrument was calibrated using external standards for targeted analytes. A set of quality control samples consisting of blanks, blank matrix spike, QC material (MIX 14, AQA 22-17 S1), 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 50.

Table 50 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	4.4	27
As	ICP-MS	Rh	ORS	He	4.4	4.4	75
B	ICP-MS	Rh	NA	NA	NA	4.4	11
Ba	ICP-MS	Rh	ORS	He	NA	4.4	138
Be	ICP-MS	Rh	NA	NA	4.4	NA	9
Bi	ICP-MS	Ir	ORS	He	4.4	NA	209
Ca	ICP-MS	Rh	ORS	He	NA	4.4	43
Cd	ICP-MS	Rh	NA	NA	4.4	NA	111
Co	ICP-MS	Rh	ORS	He	NA	4.4	59
Cr	ICP-MS	Rh	ORS	He	4.4	NA	52
Cu	ICP-MS	Rh	ORS	He	4.4	NA	63
Fe	ICP-MS	Rh	NA	NA	NA	4.4	56
Hg	ICP-MS	Rh	NA	NA	4.4	NA	202
La	ICP-MS	Rh	ORS	He	NA	4.4	139
Mn	ICP-MS	Rh	ORS	He	NA	4.4	55
Mo	ICP-MS	Rh	ORS	He	4.4	NA	95
Ni	ICP-MS	Rh	ORS	He	4.4	NA	60
P	ICP-MS	Ir	ORS	HEHe	NA	4.4	31
Pb	ICP-MS	Ir	NA	NA	4.4	4.4	Average of 206, 207, 208
Sb	ICP-MS	Ir	ORS	He	4.4	NA	121
Se	ICP-MS	Rh	ORS	HEHe	4.4	4.4	78
Sn	ICP-MS	Rh	NA	NA	4.4	NA	118
Sr	ICP-MS	Rh	ORS	He	NA	4.4	88

Th	ICP-MS	Rh	ORS	He	NA	4.4	232
U	ICP-MS	Ir	NA	NA	NA	4.4	238
V	ICP-MS	Rh	ORS	He	4.4	NA	51
Zn	ICP-MS	Rh	ORS	He	4.4	4.4	64

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

The assigned value was calculated as the robust average using the procedure described in 'ISO13528:2015(E), Statistical methods for use in proficiency testing by inter-laboratory comparisons – Annex C'.[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 51.

Table 51 Uncertainty of Assigned Value for Be in Sample S1

No. results (p)	13
Robust Average	4.84 µg/L
$S_{rob\ av}$	0.23 µg/L
$u_{rob\ av}$	0.08 µg/L
k	2
$U_{rob\ av}$	0.16 µg/L

The assigned value for Be in Sample S1 is **4.84 ± 0.16 µg/L.**

z-Score and E_n-score

For each participant's result a z-score and E_n-score are calculated according to Equation 2 and Equation 3 respectively (see page 10).

A worked example is set out below in Table 52.

Table 52 z-Score and E_n-score for Be result reported by Laboratory 10 in S1

Be Result µg/L	Assigned Value µg/L	Set Target Standard Deviation	z-Score	E_n-Score
4.66 ± 0.23	4.84 ± 0.16	10% as CV or 0.10 x 4.84= =0.48 µg/L	$z = \frac{(4.66 - 4.84)}{0.48}$ z = -0.37	$En = \frac{(4.66 - 4.84)}{\sqrt{0.23^2 + 0.16^2}}$ E_n= -0.64

APPENDIX 3 - USING PT DATA FOR UNCERTAINTY ESTIMATION

When a laboratory has successfully participated in at least 6 proficiency testing studies, the standard deviation from proficiency testing studies can be used to estimate the uncertainty of their measurement results.[10, 12] Between 2007 and 2023, NMI carried out 32 proficiency tests of metals in water. These studies involved analyses of dissolved or total elements at low and high levels in potable, fresh (river), saline water, ground water and wastewater. Laboratory X participated and submitted satisfactory results in 24 of these PTs. This data can be separated into two ranges of results: 0.0005 to 0.01 mg/L and 0.01 to 0.10 mg/L. Results are presented in Tables 53 and 54.

Table 53 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	Robust CV of all results (%)	Number of Results
AQA 11-07	Fresh	0.0015 ± 0.0003	0.00100 ± 0.00001	24	15
	Fresh	0.0039 ± 0.00078	0.00306 ± 0.00016	18	19
	Fresh	0.0039 ± 0.00078	0.00306 ± 0.00016	9.6	19
AQA 12-20	Saline	0.0039 ± 0.0008	0.00370 ± 0.00028	13	19
AQA 13-09	Fresh	0.0044 ± 0.0009	0.00409 ± 0.00017	7.9	15
AQA 13-22	Saline	0.00170 ± 0.00034	0.00165 ± 0.00014	13	14
	Saline	0.00384 ± 0.00077	0.00378 ± 0.00012	13	14
AQA 15-06	Sea	0.00180 ±0.0004	0.00177 ± 0.00021	28	12
	Sea	0.00172 ± 0.0004	0.00177 ± 0.00021	28	11
AQA 15-18	Surface	0.002 ± 0.0003	0.00196 ± 0.00013	7.8	10
AQA 16-03	Waste	0.0041 ± 0.0008	0.00398 ± 0.00031	8.6	9
AQA 16-15	Sea	0.0070 ± 0.0010	0.00652 ± 0.00038	9.4	16
AQA 17-16	Sea	0.0015 ± 0.0003	0.00143 ± 0.00029	22	10
AQA 18-16	Sea	0.0022 ± 0.0005	0.00206 ± 0.00015	11	14
AQA 19-07	Fresh	0.0018 ± 0.0004	0.00187 ± 0.00009	5.3	10
AQA 19-16	Sea	0.0021 ± 0.0004	0.00168 ± 0.00037	25	8
AQA 20-16	Sea	0.0013 ± 0.0003	0.00178 ± 0.00034	24	10
AQA 21-09	River	0.0007 ± 0.0002	0.000756 ± 0.000059	8.9	8
AQA 21-18	Saline	0.0029 ± 0.0006	0.00298 ± 0.00031	13	6
AQA 22-10	Potable	0.007 ± 0.0011	0.00845 ± 0.00036	6.1	13
AQA 22-17	Sea	0.0028 ± 0.00056	0.00286 ± 0.00027	12	15
AQA 22-17	River	0.0035 ± 0.00027	0.00364 ± 0.00026	10	13
AQA 23-11	Waste	0.0085 ± 0.0009	0.00825 ± 0.0052	9.2	13
Average				14**	

* Expanded uncertainty at 95% confidence level. ** The mean value of Robust CV was used.

Table 54 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	Robust CV of all results (%)	Number of Results
AQA 11-17	Waste	0.10 ± 0.009	0.099 ± 0.001	2	15
	Waste	0.10 ± 0.009	0.098 ± 0.001	2	15
AQA 12-09	Potable	0.047 ± 0.007	0.045 ± 0.002	6.7	19
	Potable	0.055 ± 0.008	0.053 ± 0.002	7.4	19
AQA 12-20	Saline	0.0415 ± 0.0083	0.0384 ± 0.0021	11	22
AQA 13-09	Fresh	0.0393 ± 0.0040	0.0361 ± 0.0010	4.8	16
	Fresh	0.0258 ± 0.0030	0.0272 ± 0.0025	15	15
AQA 14-08	Ground	0.019 ± 0.004	0.0191 ± 0.0007	7.9	13

Table 54 Laboratory X Reported Results for Ni at 0.01 to 0.10 mg/L Level (continued)

Study No.	Sample	Laboratory result* mg/L	Assigned value mg/L	Robust CV of all results (%)	Number of Results
AQA 14-19	Potable	0.019 ± 0.004	0.0183 ± 0.0013	11	14
AQA 15-18	Surface	0.036 ± 0.0035	0.0336 ± 0.0013	5.1	13
AQA 16-03	Waste	0.042 ± 0.0045	0.0352 ± 0.0050	19	11
AQA 16-15	Sea	0.0456 ± 0.0060	0.0409 ± 0.0029	12	17
AQA 17-16	Sea	0.0116 ± 0.0012	0.0101 ± 0.0023	27	9
AQA 18-05	Potable	0.017 ± 0.002	0.0172 ± 0.0010	8.7	16
AQA 18-16	Sea	0.015 ± 0.0030	0.0138 ± 0.0014	15	15
AQA 19-07	Fresh	0.029 ± 0.0035	0.0283 ± 0.0009	4.3	11
AQA 20-07	Potable	0.010 ± 0.002	0.0106 ± 0.0004	6	16
AQA 21-09	Waste	0.014 ± 0.0021	0.0143 ± 0.0006	8.1	21
Average				9.6**	

*Expanded uncertainty at 95% confidence level. **The mean value of Robust CV was used

Taking the average of the robust CVs over these PT samples for each concentration range gives estimates of the relative standard uncertainty of 14% and 9.6% respectively. Using a coverage factor of two gives relative expanded uncertainties of 28% and 20% respectively, at a level of confidence of 95% level.

Table 55 sets out the expanded uncertainty for results of the measurement of Ni in fresh, saline, waste or potable water over the ranges 0.0005 – 0.01 mg/L and 0.01 – 0.10 mg/L.

Table 55 Uncertainty of Ni results estimated using PT data.

Results mg/L	Uncertainty mg/L
0.00050	0.00014
0.00100	0.00028
0.0100	0.0020
0.100	0.020
0.150	0.030

The estimates of 28% and 20% relative passes the test of being reasonable, and the analysis of the forty-one different PT samples over ten years can be assumed to include all the relevant uncertainty components (different matrices, operators, reagents, calibrators etc.), and so complies with ISO 17025.[8]

APPENDIX 4 - ACRONYMS AND ABBREVIATIONS

APHA	American Public Health Association
ASNZS	Standards Australia and Standards New Zealand
CITAC	Cooperation on International Traceability in Analytical Chemistry
CRI	Collision Reaction Interface
CRM	Certified Reference Material
CV	Coefficient of Variation
CVAAS	Cold Vapour-Atomic Absorption Spectrometry
CVAFS	Cold Vapour-Atomic Fluorescence Spectroscopy
DRC	Dynamic Reaction Cell
GUM	Guide to the Expression of Uncertainty in Measurement
HEHe	High Energy He Mode
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-AV-buffer	Inductively Coupled Plasma - Optical Emission Spectrometry- axial view with buffer
ISO	International Organisation for Standardisation
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
NIST	National Institute of Standards and Technology
NMI	National Measurement Institute (of Australia)
NR	Not Reported
NT	Not Tested
ORS	Octopole Reaction System
PCV	Performance Coefficient of Variation
PT	Proficiency Test
RM	Reference Material
Robust CV	Robust Coefficient of Variation
Robust SD	Robust Standard Deviation
S.V.	Spiked or Formulated Concentration of a PT Sample
SI	The International System of Units
s^2_{sam}	Sampling Variance
s_a/σ	Analytical Standard Deviation Divided by the Target Standard Deviation
SRM	Standard Reference Material (Trademark of NIST)
Target SD	Target Standard Deviation
σ	Target Standard Deviation
UC	Universal Cell
USEPA	United States Environmental Protection Agency

APPENDIX 5 - INSTRUMENT DETAILS FOR TOTAL ELEMENTS

Table 56 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							
2	ICP-MS	Sc	ORS	He	NA		27
3	ICP-MS	Sc	KED	He	NA	1	27
4	ICP-OES-AV-buffer	Y	NA	NA	NA	1	394.401
5					NA		
6	ICP-MS	Sc	CRI	He	10	10	
7	ICP-OES-AV	Y	NA	NA	NA	2	167.019
8					NA		
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh			NA		
11					NA		
12	ICP-MS	Sc45	ORS	He	NA	1	27(m/z)
13	ICP-MS	Ir, Rh & Sc	ORS	He	NA	1	27 (m/z)
14	ICP-MS	Sc, Ir, Rh	ORS	He	NA		27
15	ICP-OES-AV				NA	neat	167.019
16	ICP-MS	Sc	UC	He	NA	1	27
17	ICP-MS	Sc	ORS	He	NA		27

Table 57 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							
2	ICP-MS	Ir	ORS	He			75
3	ICP-MS	Te	KED	He	1	1	75
4	ICP-MS/MS	Ge	CRI	He	1	1	75
5							
6	ICP-MS	As	CRI	He	10	10	
7	ICP-MS	Rh	ORS	He	1.25	1.25	75
8	ICP-MS	VIS (Sc, Y, Rh, In, Tb)	ORS	He	1	1	75
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh					
11							
12	ICP-MS	Ge72	ORS	He	1	1	75(m/z)
13	ICP-MS	Ir, Rh & Sc	ORS	He	1	1	75 (m/z)
14	ICP-MS	Sc,Ir,Rh	ORS	He			75
15	ICP-OES-AV					neat	188.98
16	ICP-MS	Ge	UC	He	1	1	75
17	ICP-MS	Sc	ORS	He			75

Table 58 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							
2	ICP-MS	Sc	ORS		NA		11
3	ICP-MS	Sc	KED	He	NA	1	10
4	ICP-OES-AV-buffer	Y	NA	NA	NA	1	208.957
5					NA		
6	ICP-MS	Sc	NA		10	10	
7	ICP-OES-AV	Y	NA	NA	NA	2	249.678
8	ICP-MS	VIS (Sc, Y, Rh, In, Tb)			NA	10	11
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh			NA		
11					NA		
12	NA				NA		
13	ICP-MS	Ir, Rh & Sc	ORS	He	NA	1	11 (m/z)
14	ICP-MS	Sc,Ir,Rh			NA		
15	ICP-OES-AV				NA	neat	208.956
16	ICP-MS	Sc	NA	NA	NA	1	10
17	ICP-MS	Ir	ORS		NA		11

Table 59 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							
2	ICP-MS	Ir	ORS	He	NA		137
3	ICP-MS	Tb	KED	He	NA	1	137
4	ICP-OES-AV-buffer	Y	NA	NA	NA	1	455.403
5					NA		
6	ICP-MS	Ir	CRI	He	10	10	
7	ICP-MS	Rh	ORS	He	NA	1.25	134
8	ICP-MS	VIS (Sc, Y, Rh, In, Tb)			NA	1	137
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh			NA		
11					NA		
12	ICP-MS	In115	ORS	He	NA	1	137(m/z)
13	ICP-MS	Ir, Rh & Sc	ORS	He	NA	1	137 (m/z)
14	ICP-MS	Sc,Ir,Rh	ORS	He	NA		
15	ICP-OES-AV				NA	neat	455.403
16	ICP-MS	Rh	NA	NA	NA	1	138
17	ICP-MS	Ir	ORS	He	NA		137

Table 60 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							
2	ICP-MS	Sc	ORS			NA	9
3	ICP-MS	Sc	KED	He	1	NA	9
4	ICP-MS/MS	Sc	CRI	standard mode	1	NA	9
5						NA	
6	ICP-MS	Sc	NA		10	10	
7	ICP-MS	Rh	ORS	He	1.25	NA	9
8	ICP-MS	VIS (Sc, Y, Rh, In, Tb)			1	NA	9
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh				NA	
11						NA	
12	ICP-MS	Sc45	NA	NA	1	NA	9(m/z)
13	ICP-MS	Ir, Rh & Sc	ORS	He	1	NA	9 (m/z)
14	ICP-MS	Sc,Ir,Rh	ORS			NA	9
15						NA	
16	ICP-MS	Sc	NA	NA	1	NA	9
17	ICP-MS	Sc	ORS			NA	9
18							
19	ICP-MS	Sc	ORS			NA	9
20	ICP-MS	Sc	KED	He	1	NA	9

Table 61 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							
2	ICP-MS	Rh	ORS	He		NA	209
3	ICP-MS	Tb	KED	He	1	NA	209
4	NA						NT
5						NA	
6	ICP-MS	Ir	CRI	He	10	10	
7	ICP-MS	Rh	ORS	He	NA	1.25	209
8	ICP-MS	VIS (Sc, Y, Rh, In, Tb)			1	NA	209
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh				NA	
11						NA	
12	NA					NA	
13	ICP-MS	Ir, Rh & Sc	ORS	He	1	NA	209 (m/z)
14	ICP-MS	Sc,Ir,Rh	ORS			NA	
15						NA	
16	ICP-MS	Ir	NA	NA	1	NA	209
17	ICP-OES-AV		ORS			NA	
18							
19	ICP-MS	Rh	ORS	He		NA	209
20	ICP-MS	Tb	KED	He	1	NA	209

Table 62 Instrument Conditions Ca

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							
2	ICP-OES-AV-buffer	Eu			NA		315.887nm
3	ICP-MS	Sc	KED	He	NA	1	43
4	ICP-OES-AV-buffer	Y	NA	NA	NA	1	315.887
5					NA		
6	ICP-MS	Sc	CRI	He	10	10	
7	ICP-OES-AV	Y	NA	NA	NA	2	422.673
8					NA		
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh			NA		
11					NA		
12	ICP-MS	Sc45	ORS	He	NA	1	44(m/z)
13	ICP-OES	Eu & Cs	NA	NA	NA	1	315.887, 370.602nm
14	ICP-OES-AV	Eu			NA		315.885
15	AAS				NA	10	422.7
16	ICP-MS	Sc	UC	He	NA	1	44
17	ICP-OES-AV	Eu		He	NA		

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							
2	ICP-MS	Ir	ORS	He		NA	111
3	ICP-MS	Rh	KED	He	1	NA	111
4	ICP-MS/MS	In		standard mode	1	NA	111
5						NA	
6	ICP-MS	Ir	CRI	He	10	10	
7	ICP-MS	Rh	ORS	He	1.25	1.25	111
8	ICP-MS	VIS (Sc, Y, Rh, In, Tb)			1	NA	111
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh				NA	
11						NA	
12	ICP-MS	Rh103	ORS	He	1	NA	111(m/z)
13	ICP-MS	Ir, Rh & Sc	ORS	He	1	NA	111 (m/z)
14	ICP-MS	Sc,Ir,Rh	ORS	He		NA	111
15	ICP-OES-AV					NA	
16	ICP-MS	Rh	NA	NA	1	NA	111
17	ICP-MS	Rh	ORS	He		NA	111

Table 64 Instrument Conditions Co

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1							
2	ICP-MS	Ir	ORS	He	NA		59
3	ICP-MS	Ga	KED	He	NA	1	59
4	ICP-MS/MS	Ge	CRI	He	NA	1	59
5					NA		
6	ICP-MS	Rh	CRI	He	10	10	
7	ICP-MS	Rh	ORS	He	1.25	NA	59
8	ICP-MS	VIS (Sc, Y, Rh, In, Tb)			NA	1	59
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh			NA		
11					NA		
12	ICP-MS	Ge72	ORS	He	NA	1	59(m/z)
13	ICP-MS	Ir, Rh & Sc	ORS	He	NA	1	59 (m/z)
14	ICP-MS	Sc,Ir,Rh	ORS	He	NA		59
15	ICP-OES-AV				NA	neat	231.16
16	ICP-MS	Ge	UC	He	NA	1	59
17	ICP-MS	Sc	ORS	He	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							
2	ICP-MS	Sc	ORS	He		NA	52
3	ICP-MS	Sc	KED	He	1	NA	52
4	ICP-MS/MS	Ge	CRI	He	1	NA	52
5						NA	
6	ICP-MS	Rh	CRI	He	10	10	
7	ICP-MS	Rh	ORS	He	1.25	NA	52
8	ICP-MS	VIS (Sc, Y, Rh, In, Tb)			1	NA	52
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh				NA	
11						NA	
12	ICP-MS	Ge72	ORS	He	1	NA	52(m/z)
13	ICP-MS	Ir, Rh & Sc	ORS	He	1	NA	52 (m/z)
14	ICP-MS	Sc,Ir,Rh	ORS	He		NA	52
15						NA	
16	ICP-MS	Sc	UC	He	1	NA	52
17	ICP-MS	Sc	ORS	He		NA	52

Table 66 Instrument Conditions Cu

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1							
2	ICP-MS	Ir	ORS	He		NA	63
3	ICP-MS	Ga	KED	He	1	NA	63
4	ICP-MS/MS	Ge	CRI	He	1	NA	63
5						NA	
6	ICP-MS	Rh	CRI	He	10	10	
7	ICP-OES-AV	y	NA	NA	2	NA	267.716
8	ICP-MS	VIS (Sc, Y, Rh, In, Tb)			1	NA	63
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh				NA	
11						NA	
12	ICP-MS	Rh103	ORS	He	1	NA	65(m/z)
13	ICP-MS	Ir, Rh & Sc	ORS	He	1	NA	63 (m/z)
14	ICP-MS	Sc,Ir,Rh	ORS	He		NA	63
15						NA	
16	ICP-MS	Ge	UC	He	1	NA	63
17	ICP-MS	Sc	ORS	He		NA	53

Table 67 Instrument Conditions Fe

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1							
2	ICP-MS	Sc	ORS	HEHe	NA		56
3	ICP-MS	Sc	KED	He	NA	1	56
4	ICP-OES-AV-buffer	Y	NA	NA	NA	1	273.955
5					NA		
6	ICP-MS	Rh	CRI	He	10	10	
7	ICP-OES-AV	Y	NA	NA	2	2	238.204
8	ICP-MS	VIS (Sc, Y, Rh, In, Tb)	ORS	He	NA	1	56
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh			NA		
11					NA		
12	ICP-MS	Ge72	ORS	He	NA	1	56(m/z)
13	ICP-MS	Ir, Rh & Sc	ORS	He	NA	1	56 (m/z)
14	ICP-MS	Sc,Ir,Rh	ORS	HEHe	NA		56
15	ICP-OES-AV				NA	neat	238.204
16	ICP-MS	Sc	UC	He	NA	1	56
17	ICP-MS	Sc	ORS	He	NA		56

Table 68 Instrument Conditions Hg

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
1							
2	CVAAS					NA	253.7nm
3	CVAFS	NA	NA	NA	5	NA	253.7
4	CVAAS	NA	NA	NA	2	2	253.7nm
5						NA	
6	ICP-MS	Ir	CRI	He	10	10	
7						NA	
8						NA	
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh				NA	
11						NA	
12	CVAFS		NA	NA	1.25	NA	254(nm)
13	CETAC	NA	NA	NA	1	NA	253 nm
14	GFAAS	-	NA	NA		NA	
15						NA	
16	ICP-MS	Ir	NA	NA	1	NA	201
17	CVAAS					NA	153

Table 69 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							
2	ICP-MS	Ir	ORS		NA		140
3	ICP-MS	Tb	KED	He	NA	1	139
4	NA				NA		NT
5					NA		
6	NA						
7	ICP-MS	Rh	ORS	He	NA	1.25	139
8	ICP-MS	VIS (Sc, Y, Rh, In, Tb)			NA	1	139
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh			NA		
11					NA		
12	NA				NA		
13	ICP-MS	Ir, Rh & Sc	NA	He	NA	1	139 (m/z)
14	ICP-MS	Sc,Ir,Rh	ORS	He	NA		
15	NT				NA		NT
16					NA		
17	ICP-MS	Rh	ORS	He	NA		139

Table 70 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							
2	ICP-MS	Sc	ORS			NA	7
3	ICP-MS	Sc	KED	He	1	NA	7
4	ICP-MS/MS	Sc		standard mode	1	NA	7
5						NA	
6	NA						
7	ICP-MS	Rh	ORS	He	1.25	NA	7
8						NA	
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh				NA	
11						NA	
12	NA					NA	
13	ICP-MS	Ir, Rh & Sc	ORS	He	1	NA	7 (m/z)
14	ICP-MS	Sc,Ir,Rh	ORS	NA		NA	
15						NA	
16	ICP-MS	Sc	NA	NA	1	NA	7
17	ICP-MS	Sc	ORS			NA	7

Table 71 Instrument Conditions Mg

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							
2	ICP-OES-AV-buffer	Eu			NA		383.829nm
3	ICP-MS	Sc	KED	He	NA	10	25
4	ICP-OES-AV-buffer	Y		NA	NA	1	285.213
5					NA		
6	ICP-MS	Sc	CRI	He	10	10	
7	ICP-OES-AV	Y	NA	NA	NA	2	279.078
8	ICP-MS	VIS (Sc, Y, Rh, In, Tb)			NA	10	24
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh			NA		
11					NA		
12	ICP-MS	Sc45	ORS	He	NA	1	24(m/z)
13	ICP-OES	Eu & Cs	NA	NA	NA	1	383.830 (nm)
14	ICP-OES-AV	Eu			NA		383.83
15	AAS				NA	10	285.2
16	ICP-MS	Sc	UC	He	NA	1	25
17	ICP-OES-AV	Eu	ORS		NA		

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							
2	ICP-MS	Sc	ORS	He	NA		55
3	ICP-MS	Sc	KED	He	NA	1	55
4	ICP-MS/MS	Ge	CRI	He	NA	1	257.61
5					NA		
6	ICP-MS	Rh	CRI	He	10	10	
7	ICP-OES-AV	Y	NA	NA	NA	2	257.61
8	ICP-MS	VIS (Sc, Y, Rh, In, Tb)			NA	1	55
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh			NA		
11					NA		
12	ICP-MS	Ge72	ORS	He	NA	1	55(m/z)
13	ICP-MS	Ir, Rh & Sc	ORS	He	NA	1	55 (m/z)
14	ICP-MS	Sc,Ir,Rh	ORS	He	NA		55
15	ICP-OES-AV				NA	neat	294.921
16	ICP-MS	Sc	UC	He	NA	1	55
17	ICP-MS	Sc	ORS	He	NA		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							
2	ICP-MS	Ir	ORS	He		NA	95
3	ICP-MS	Rh	KED	He	1	NA	98
4	ICP-MS/MS	Y		standard mode	1	NA	95
5						NA	
6	ICP-MS	Rh	CRI	He	10	10	
7	ICP-MS	Rh	ORS	He	1.25	NA	95
8	ICP-MS	VIS (Sc, Y, Rh, In, Tb)			1	NA	98
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh				NA	
11						NA	
12	ICP-MS	Rh103	ORS	He	1	NA	95(m/z)
13	ICP-MS	Ir, Rh & Sc	ORS	He	1	NA	95 (m/z)
14	ICP-MS	Sc,Ir,Rh	ORS	He		NA	95
15						NA	
16	ICP-MS	Rh	NA	NA	1	NA	95
17	ICP-MS	Rh	ORS	He		NA	95

Table 74 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							
2	ICP-MS	Ir	ORS	He		NA	60
3	ICP-MS	Ga	KED	He	1	NA	60
4	ICP-MS/MS	Ge	CRI	He	1	NA	60
5						NA	
6	ICP-MS	Rh	CRI	He	10	10	
7	ICP-MS	Rh	ORS	He	1.25	NA	60
8	ICP-MS	VIS (Sc, Y, Rh, In, Tb)			1	NA	60
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh				NA	
11						NA	
12	ICP-MS	Ge72	ORS	He	1	NA	60(m/z)
13	ICP-MS	Ir, Rh & Sc	ORS	He	1	NA	60 (m/z)
14	ICP-MS	Sc,Ir,Rh	ORS	He		NA	60
15						NA	
16	ICP-MS	Ge	UC	He	1	NA	60
17	ICP-MS	Sc	ORS	He		NA	60

Table 75 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							
2	ICP-OES-AV-buffer	Eu			NA		185.827nm
3	ICP-MS	Sc	KED	He	NA	1	31
4	ICP-OES-AV-buffer	Y		NA	NA		178.221
5					NA		
6	NA						
7	ICP-OES-AV	Y	NA	NA	NA	2	213.618
8					NA		
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh			NA		
11					NA		
12	NA				NA		
13	ICP-OES	Eu & Cs	NA	NA	NA	1	185.827 (nm)
14	ICP-OES-AV	Eu			NA		
15	NT				NA		NT
16	ICP-MS	Sc	UC	He	NA	1	31
17	ICP-OES-AV	Eu			NA		186

Table 76 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							
2	ICP-MS	Rh	ORS	He			208
3	ICP-MS	Tb	KED	He	1	1	206+207+208
4	ICP-MS/MS	Ir		standard mode	1	1	207
5							
6	ICP-MS	Ir	CRI	He	10	10	
7	ICP-MS	Rh	ORS	He	1.25	NA	208
8	ICP-MS	VIS (Sc, Y, Rh, In, Tb)			1	1	208
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh					
11							
12	ICP-MS	Lu175	ORS	He	1	1	208(m/z)
13	ICP-MS	Ir, Rh & Sc	ORS	He	1	1	208 (m/z)
14	ICP-MS	Sc,Ir,Rh	ORS	He			208
15	ICP-OES-AV					neat	220.353
16	ICP-MS	Ir	NA	NA	1	1	206+207+208
17	ICP-MS	Ir	ORS	He			208

Table 77 Instrument Conditions S

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							
2	ICP-OES-AV-buffer				NA		181.972nm
3	ICP-OES-RV	NA	NA	NA	NA	1	182
4	ICP-OES-AV-buffer	Y		NA	NA	1	181.975
5					NA		
6	NA						
7					NA		
8					NA		
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh			NA		
11					NA		
12	NA				NA		
13	ICP-OES	Eu & Cs	NA	NA	NA	1	178.165,181.972nm
14	ICP-OES-AV	Eu			NA		
15	NT				NA		
16	ICP-MS	Sc	NA	NA	NA	1	34
17	ICP-OES-AV	Eu	ORS	He	NA		

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							
2	ICP-MS	Ir	ORS	He		NA	121
3	ICP-MS	Rh	KED	He	1	NA	121
4	ICP-MS/MS	In		standard mode	1	NA	121
5						NA	
6	ICP-MS	Ir	CRI	He	10	10	
7	ICP-MS	Rh	ORS	He	1.25	1.25	121
8	ICP-MS	VIS (Sc, Y, Rh, In, Tb)			1	NA	121
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh				NA	
11						NA	
12	ICP-MS	In115	ORS	He	1	NA	121(m/z)
13	ICP-MS	Ir, Rh & Sc	ORS	He	1	NA	121 (m/z)
14	ICP-MS	Sc,Ir,Rh	ORS	He		NA	121
15						NA	
16	ICP-MS	Rh	NA	NA	1	NA	121
17	ICP-MS	Rh	ORS	He		NA	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							
2	ICP-MS	Ir	ORS	HEHe			78
3	ICP-MS	Te	KED	He	1	1	82
4	ICP-MS/MS	Ge	CRI	He	1	1	78
5							
6	ICP-MS	Rh	CRI	He	10	10	
7	ICP-MS	Rh	ORS	He	1.25	NA	77
8							
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh					
11							
12	ICP-MS	Ge72	ORS	He	1	1	78(m/z)
13	ICP-MS	Ir, Rh & Sc	ORS	He	1	1	78 (m/z)
14	ICP-MS	Sc,Ir,Rh	ORS	HEHe			78
15	ICP-OES-AV					neat	196.026
16	ICP-MS	Rh	DRC	NH3	1	1	82
17	ICP-MS	Sc	ORS	He			78

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							
2	ICP-MS	Ir	ORS	He		NA	118
3	ICP-MS	Rh	KED	He	1	NA	120
4	ICP-MS/MS	In		standard mode	1	NA	118
5						NA	
6	NA						
7	ICP-MS	Rh	ORS	He	1.25	1.25	118
8	ICP-MS	VIS (Sc, Y, Rh, In, Tb)	ORS	He	1	NA	118
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh				NA	
11						NA	
12	NA					NA	
13	NT	NT	NT	NT	NT	NA	NT
14	ICP-MS	Sc,Ir,Rh	ORS	He		NA	118
15						NA	
16						NA	
17	ICP-MS	Th	ORS	He		NA	118

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							
2	ICP-MS	Ir	ORS	He	NA		88
3	ICP-MS	Rh	KED	He	NA	1	88
4	ICP-OES-AV-buffer	Y			NA	1	421.552
5					NA		
6	NA						
7	ICP-OES-AV	Y	NA	NA	NA	2	421.552
8	ICP-MS	VIS (Sc, Y, Rh, In, Tb)			NA	1	88
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh			NA		
11					NA		
12	NA				NA		
13	ICP-MS	Ir, Rh & Sc	ORS	He	NA	1	88 (m/z)
14	ICP-MS	Sc,Ir,Rh	ORS	He	NA		
15	ICP-OES-AV				NA	neat	407.771
16	ICP-MS	Rh	NA	NA	NA	1	88
17	ICP-MS	Sc	ORS	He	NA		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							
2	ICP-MS	Rh	ORS	He	NA		232
3	NA	NA	NA	NA	NA	NA	NA
4	NA						NT
5					NA		
6	NA						
7	ICP-MS	Rh	ORS	He	NA	1.25	232
8	ICP-MS	VIS (Sc, Y, Rh, In, Tb)			NA	1	232
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh			NA		
11					NA		
12	ICP-MS	Lu175	ORS	He	NA	1	232(m/z)
13	ICP-MS	Ir, Rh & Sc	ORS	He	NA	1	232 (m/z)
14	ICP-MS	Sc,Ir,Rh	ORS	He	NA		
15	NT				NA		NT
16	ICP-MS	Ir	NA	NA	NA	1	232
17	ORS	He		NA	118		

Table 83 Instrument Conditions Ti

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							
2	ICP-MS	Sc	ORS	He		NA	47
3	ICP-OES-RV	NA	NA	NA	1	NA	338
4	ICP-OES-AV-buffer	Y		NA	1	NA	336.121
5						NA	
6	NA						
7	ICP-MS	Rh	ORS	He	NA	1.25	49
8	ICP-MS	VIS (Sc, Y, Rh, In, Tb)			1	NA	47
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh				NA	
11						NA	
12	NA					NA	
13	ICP-MS	Ir, Rh & Sc	ORS	He	1	NA	47 (m/z)
14	ICP-MS	Sc,Ir,Rh	ORS	He		NA	
15						NA	
16						NA	
17	ICP-MS		ORS			NA	

Table 84 Instrument Conditions Tl

Laboratory Code	**Instrument**	**Internal standard**	**Reaction Cell**	**Reaction Gas**	**S1 Final Dilution Factor**	**S2 Final Dilution Factor**	**Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)**
1							
2	ICP-MS	Rh	ORS	He		NA	205
3	ICP-MS	Tb	KED	He	1	NA	205
4	ICP-MS/MS	Ir		standard mode	1	NA	203
5						NA	
6	ICP-MS	Ir	CRI	He	10	10	
7	ICP-MS	Rh	ORS	He	1.25	NA	205
8	ICP-MS	VIS (Sc, Y, Rh, In, Tb)			1	NA	205
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh				NA	
11						NA	
12	ICP-MS	Tb159	ORS	He	1	NA	205(m/z)
13	ICP-MS	Ir, Rh & Sc	ORS	He	1	NA	205 (m/z)
14	ICP-MS	Sc,Ir,Rh	ORS	He		NA	205
15						NA	
16	ICP-MS	Ir	NA	NA	1	NA	205
17	ICP-MS	Ir	ORS	He		NA	205

Table 85 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							
2	ICP-MS	Rh	ORS	He	NA		238
3	ICP-MS	Tb	KED	He	NA	1	238
4	ICP-MS/MS	Ir		standard mode	NA	5	238
5					NA		
6	ICP-MS	Ir	CRI	He	10	10	
7	ICP-MS	Rh	ORS	He	NA	1.25	238
8	ICP-MS	VIS (Sc, Y, Rh, In, Tb)			NA	1	238
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh			NA		
11					NA		
12	ICP-MS	Lu175	ORS	He	NA	1	238(m/z)
13	ICP-MS	Ir, Rh & Sc	ORS	He	NA	1	238 (m/z)
14	ICP-MS	Sc,Ir,Rh	ORS	He	NA		238
15	NT				NA		NT
16	ICP-MS	Ir	NA	NA	NA	1	238
17	ICP-MS	Ir	ORS	He	NA		232

Table 86 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							
2	ICP-MS	Sc	ORS	He		NA	51
3	ICP-MS	Sc	KED	He	1	NA	51
4	ICP-MS/MS	Ge	CRI	He	1	NA	51
5						NA	
6	ICP-MS	Rh	CRI	He	10	10	
7	ICP-MS	Rh	ORS	He	1.25	NA	51
8						NA	
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh				NA	
11						NA	
12	ICP-MS	Ge72	ORS	He	1	NA	51(m/z)
13	ICP-MS	Ir, Rh & Sc	ORS	He	1	NA	51 (m/z)
14	ICP-MS	Sc,Ir,Rh	ORS	He		NA	51
15						NA	
16	ICP-MS	Sc	UC	He	1	NA	51
17	ICP-MS	Sc	ORS	He		NA	51

Table 87 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							
2	ICP-MS	Ir	ORS	He			68
3	ICP-MS	Te	KED	He	1	1	66
4	ICP-OES-AV-buffer	Y			1	1	213.857
5							
6	ICP-MS	Rh	CRI	He	10	10	
7	ICP-OES-AV	Y	NA	NA	2	2	213.857
8	ICP-MS	VIS (Sc, Y, Rh, In, Tb)			1	1	66
9	NA	NA	NA	NA	NA	NA	NA
10	ICP-MS	Rh					
11							
12	ICP-MS	Rh103	ORS	He	1	1	66(m/z)
13	ICP-MS	Ir, Rh & Sc	ORS	He	1	1	64 (m/z)
14	ICP-MS	Sc,Ir,Rh	ORS	He			66
15	ICP-OES-AV					neat	206.2
16	ICP-MS	Ge	UC	He	1	1	66
17	ICP-MS	Sc	ORS	He			65

END OF REPORT