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Proficiency Test Final Report AQA 26-04 Metals, Nutrients, and Exchangeable Bases in Soil

June 2026

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SUMMARY

This report presents the results of the proficiency test AQA 26-04 Metals, Nutrients, and Exchangeable Bases in Soil. The study focused on the measurement of the following acid extractable elements: Ag, Al, As, B, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, Ga, Hg, K, La, Li, Mg, Mn, Mo, Na, Ni, P, Pb, Rb, S, Sb, Se, Sn, Sr, Th, U, V and Zn. Measurement of total P, P buffer index (with Colwell P)- PBI_{+ColP}, calcium chloride-extractable B, total carbon (TC), total organic carbon (TOC), total nitrogen (TN), Colwell K, Colwell P, EC, pH of 1:5 soil / 0.01 M $CaCl_2$ extract, exchangeable bases (Ca^{2+}, K^+, Mg^{2+}, Na^+) - 1M NH_4Cl extract and moisture content was also included in the program.

The sample set consisted of one dried soil sample, one moist sediment sample, and one dried agricultural soil sample. The assigned values were the robust average of participants' results. The associated uncertainties were evaluated from the robust standard deviation of the participants' results.

Twenty-eight laboratories enrolled and 26 reported results. The outcomes of the study were assessed against the aims as follows, to:

i. assess laboratory capabilities in measuring metals, nutrients, and exchangeable bases in soil.

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

Of 1002 z-scores, 956 (95%) returned an acceptable score of $|z| \leq 2.0$.

Of 1002 E_n-scores, 848 (85%) were acceptable with $|E_n| < 1.0$.

No laboratory reported results for all 60 tests for which a z-score was calculated.

Laboratory 17 returned both the highest number of acceptable z-scores and the highest number of acceptable E_n-scores (55 out of 55 reported).

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

Measurement of boron in Sample S2 challenged participants' analytical techniques. Caution should be exercised when using ICP-OES at the wavelength of 249.7 nm for boron measurements in soil samples high in Fe. The Fe emission line at 249.771 nm directly overlaps with the B line at 249.7 nm, causing interference.

Seven participants reported results for Colwell P in Sample S3, and all agreed with each other. Discrete analyser was the preferred instrumental technique.

iii. compare the performance of participant laboratories with their past performance.

Despite different matrices, analytes, and analyte concentrations, on average participants' performance remained consistent over time.

iv. develop the practical application of measurement uncertainty and provide participants with information that will be useful in evaluating their uncertainties.

Of 1039 numerical results, 975 (94%) were reported with an expanded measurement uncertainty. The magnitude of these expanded uncertainties was within the range 0.033% to 225% of the reported value.

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

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

1 INTRODUCTION

1.1 NMIA Proficiency Testing Program

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

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

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

AQA 26-04 is the 38th NMIA proficiency study of inorganic analytes in soil.

1.2 Study Aims

The aims of the study were to:

- assess laboratory capabilities in measuring metals, nutrients, and exchangeable bases in soil;
- evaluate the laboratories' methods used in determination of inorganic analytes;
- compare the performance of participant laboratories with their past performance;
- develop the practical application of measurement uncertainty and provide participants with information that will be useful in evaluating their uncertainties; and
- produce materials that can be used in method validation and as control samples.

1.3 Study Conduct

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

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

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

2 STUDY INFORMATION

2.1 Selection of Matrices and Inorganic Analytes

The 67 tests over the three samples were selected from those for which an investigation level is published in the Guidelines on the Investigation Levels for Soil and Groundwater, promulgated by the National Environmental Protection Council (NEPC), [5] and from analytes commonly measured in soil.

2.2 Participation

28 laboratories participated and 26 submitted results.

The timetable of the study was:

Invitations issued:	09 February 2026
Samples dispatched:	02 March 2026
Results due:	27 March 2026
Interim report issued:	31 March 2026
Preliminary report issued	08 April 2026

2.3 Test Material Specification

Three samples were provided for analysis:

Sample S1 was 30 g of dried soil.

Sample S2 was 35 g of moist sediment.

Sample S3 was 75 g of dried agricultural soil.

2.4 Laboratory Code

All participant laboratories were assigned a confidential code number.

2.5 Sample Preparation, Analysis and Homogeneity Testing

Test samples from previous studies have been demonstrated to be sufficiently homogeneous for the evaluation of participants' performance. As the same preparation procedure was followed as in the previous studies only a partial homogeneity test was conducted for samples S1 and S3, with the exception of B in Sample S1, and of the agricultural tests in S3. A full homogeneity test of the moist sediment Sample S2 was conducted for all acid extractable elements and the moisture content except for La and Rb.

The results of the partial homogeneity testing and full homogeneity testing for these samples are reported in the present study as the homogeneity value. The preparation, analysis and homogeneity testing of the study samples are described in Appendix 1.

2.6 Stability of Analytes

No stability study was carried out for the present study. Stability studies conducted for the previous proficiency tests of inorganic analytes in soil and sediment found no significant changes in any of the analytes' concentration.

2.7 Sample Storage, Dispatch and Receipt

Sample S2, the moist sediment sample, was stored refrigerated prior to dispatch, whilst all other test samples were stored at room temperature.

The samples were dispatched by courier on 2 March 2026.

The following items were packaged with the samples:

- a covering letter which included a description of the test samples and instructions for participants; and
- a form to confirm the receipt and condition of the samples.

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

2.8 Instructions to Participants

Participants were instructed as follows:

- Quantitatively analyse the samples using your normal test method.
- Please store samples S1 and S3 at room temperature.
- Sample S2, the moist sample, should be thoroughly mixed before removing a test portion. To avoid loss of moisture, do not leave the sample uncovered; store this sample refrigerated.
- For Sample S3 for determination of calcium chloride – extractable B, exchangeable bases (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}) - 1M NH_4Cl extract and of P buffer index (with Colwell P)- PBI $_{+ColP}$, participants are asked to use the methods defined by Rayment, G.E. and David, J. L in "Soil Chemical Methods-Australasia".
- These samples are an attempt to mime the real samples encountered by a laboratory in its routine activities. Please use appropriate Good Laboratory Practice when handling them, including safety aspects.
- For S1 report results for acid extractable elements on as received basis in units of mg/kg.
- For S2 report results for moisture content in % (g/100g). For acid extractable elements in S2 results are to be reported on dry weight basis (corrected for moisture content) and in units of mg/kg.
- For S3 report results on as received basis in units of cmol(+)/kg for exchangeable bases (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}) - 1M NH_4Cl extract. For all other tests, except pH and EC (µS/cm), report on as received basis in units of mg/kg.

SAMPLE S1		**SAMPLE S2**		**SAMPLE S3**	
Test acid extractable	**Approximate Conc. Range *(as received basis)* mg/kg***	**Test acid extractable**	**Approximate Conc. Range *(dry weight basis)* mg/kg***	**Test**	**Approximate Conc. Range *(as received basis)* mg/kg***
Ag	0.5-20	As	5-200	Ba (acid extractable)	5-200
Al	1000-40000	B	0.5-20	Ca (acid extractable)	50-2000
As	0.5-20	Ba	5-200	Calcium Chloride Extractable B[1]	Not Available
B	0.5-20	Be	0.05-2	Colwell K	Not Available
Bi	0.5-20	Cd	0.05-2	Colwell P	Not Available
Ca	1000-40000	Co	5-200	EC (1:5 0.01 M $CaCl_2$)	Not Available
Cr	5-200	Cr	5-200	Exchangeable Ca (1M NH4Cl Extract)[2]	Not Available
Cu	5-200	Cu	5-200	Exchangeable K (1M NH4Cl Extract)[2]	Not Available
Fe	1000-40000	Ga	0.5-20	Exchangeable Mg (1M NH4Cl Extract)[2]	Not Available
Hg	0.05-2	La	0.5-20	Exchangeable Na (1M NH4Cl Extract)[2]	Not Available
Li	0.5-20	Mn	50-2000	Fe (acid extractable)	1000-40000
Mn	50-2000	Na	5-200	K (acid extractable)	50-2000
Mo	0.5-20	Ni	5-200	Mg (acid extractable)	50-2000
Ni	0.5-20	P	50-2000	Na (acid extractable)	5-200
Pb	5-200	Pb	5-200	P (acid extractable)	50-2000
Sb	5-200	Rb	0.5-20	P (total)	Not Available
Se	0.5-20	Se	0.05-2	P buffer index (with Colwell P) - PBI+ColP[3]	Not Available
Sn	0.5-20	Sn	0.05-2	pH (1:5 0.01 M $CaCl_2$)	Not Available
Th	0.5-20	Sr	5-200	S (acid extractable)	50-2000
U	0.5-20	V	5-200	Sr (acid extractable)	5-200
V	0.5-20	Zn	50-2000	Total Carbon	1000-40000
Zn	5-200	Moisture Content	5-50%	Total Nitrogen	1000-40000
				Total Organic Carbon	1000-40000

*Please note these are real samples and the given values are estimates; [1]Method 12C; [2]Method 15A1; [3]Method 9I2 as defined by Rayment, G.E. and David, J. L in "Soil Chemical Methods-Australasia".

- 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.
- Return the completed results sheet by email (proficiency@measurement.gov.au), by 20 March 2026.

The results due date was later extended to 27 March 2026 due to a request from a participating laboratory.

2.9 Interim and Preliminary Reports

An Interim Report was emailed to participants on 31 March 2026.

A Preliminary Report was issued on 8 April 2026. This report included: a summary of the results reported by laboratories, assigned values, performance coefficient of variations, z-scores and E_n-scores for each analyte tested by participants.

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

3 PARTICIPANT LABORATORY INFORMATION

3.1 Test Method Summaries

Summaries of test methods are transcribed in Tables 1 to 10. The instruments and settings reported by participants are presented in Appendix 5. Some responses may be modified so the participant cannot be identified.

Table 1 Methodology for Acid Extractable Elements

Lab. Code	Method Reference	Staggered Digestion	Sample Mass (g)	Temp. (°C)	Time (min)	Vol. HNO_3 (mL)	Vol. HCl (mL)	Vol. HNO_3 (1:1) (mL)	Vol. HCl (1:1) (mL)	Vol. H_2O_2 (mL)	Other
2	In House Method referencing APHA 3125	No	0.4	120	60	2.5	7.5				
3	In-house Method	Yes	0.5	95	120	1	3				
4	USEPA 3010		2	95-105	60	4	12				
5	US EPA 3050B		0.5	95	120	3	3				
6	In-House Method	No	2	105	60	0.4	1.2				
8	200.2 Revision 2.8	Yes	1	95 ± 5	60	2	10			2	
9			1.034	90	120	9	3				
10	EPA (Environmental Protection Agency) 1994 Method 200.8		2	109°	60	800	400				1200
11	USEPA Method 6010c, USEPA Methods 7471B, 7470A, 7471B	No	1	90-98	90	3	3				
12		Yes	1	95	2			2	10	2	
13	In House		1	112.5	120	7.5	2.5				
14	US EPA 200.2	NA	1	95	50	2	2				10 (H_2O)
15	USEPA Method 3050	Yes	3	95	120	10	5	10		6	
16	US EPA 200.2	No	0.5	95	30	1	1				
17	Acid Digestion of sediment,sludges and soil-USEPA 3050		1	95	90	3	3				
18	USEPA Method 6010c, USEPA Methods 7471B, 7470A, 7471B	No	1	90-98	90	3	3				
19	In-House Method	No	2	95 - 105	60	4	12				4 (H_2O)
20	US EPA 200.2		1	98	90	2 or 3 mL	0.5 or 3 mL				
21	USEPA method 200.2 Revision 2.8	Yes		95	60			2		2	10 (HCl 1:4)
24	EPA Method 200.7	No	0.5	95	120	2mL	2mL				10mL (H_2O)
25	Internal Method, Reverse Aqua Regia	No	1	110	65	3.5	1.5				
26	In-house Method	No	2	95 - 105	60	4	12				
27	US EPA 3050B		1	98	150	5	5				
28	Based on US EPA 3051A, 6020b.	No	0.16	180	30	3	1				

Table 2 Methodology for Total Carbon

Lab. Code	Method Reference	Total Carbon Test Method	Total Carbon Measurement Technique
2	In house Method	High Temperature Oxidation	LECO
7	6B2b	High Temperature Oxidation	LECO Trumac
8	Rayment & Lyons 6B3	High Temperature Oxidation	Eltra Csi
17	Rayment G.E and Lyons D.J Soil Chemical Methods	High Temperature Oxidation	Non-Dipersive Infra-Red Detector
19	In-House Method	High Temperature Oxidation	Infrared Dectection
26	In-house Method	High Temperature Oxidation	Combustion/infrared
27		High Temperature Oxidation	

Table 3 Methodology for Total Organic Carbon

Lab. Code	Method Reference	Total Organic Carbon Test Method	Total Organic Carbon Measurement Technique	Additional Information
2		High Temperature Oxidation	LECO	Sample digested with sulfurous acid prior to analysis on LECO
7	6B3	High Temperature Oxidation	LECO Trumac	
8	Rayment & Lyons 6B3	High Temperature Oxidation	Eltra Csi	
11		Chemical treatment/Combustion	Infra-Red Detector	
15	6B1	Dichromate/H2SO4 digestion	Da (wavelength)	
17	Rayment G.E and Lyons D.J Soil Chemical Methods	High Temperature Oxidation	Non-Dipersive Infra-Red Detector	Samples are acid treated for the removal of Inorganic Carbon.
18	AS1289.4.1.1	Chemical Oxidation (Ag2SO4 added)	Titration	
19	In-House Method	High Temperature Oxidation	Infrared Dectection	
21	Australian Standard AS 1289.4.1.1	Chemical Oxidation (Ag2SO4 added)	calculation from titration of Organic Matter	
26	In-house Method	Other	Combustion/acidification/infrared	Total organic carbon calculated as the difference between total and inorganic carbon
27		High Temperature Oxidation		

Table 4 Methodology for Colwell K and Colwell P

Lab. Code	Method Reference	Sample Mass (g)	Extraction Solution 0.5 M $NaHCO_3$ Volume (mL)	Shake time (hours)	Final Dilution Factor (Colwell K)	Final Dilution Factor (Colwell P)	Measurement Technique (Colwell K)	Measurement Technique (Colwell P)	Additional Information
2	Colwell P 9B2, Colwell K 18A1	0.4	40	16	3280	328	ICPMS	FIA (wavelength)	
7	9B2	1	100	17				FIA (wavelength)	880nm
8	Rayment & Lyons 9B1 & 18A1	1	100	16	100	100	ICP-OES (wavelength)	UV-Vis (wavelength)	
11	9B1	1	100		500	125	ICP-OES-AV-buffer (wavelength)	DA (wavelength)	
15	9B1	1	100	16		100		DA (wavelength)	
25	9B2	0.5	50	16	NT	100	NT	DA (wavelength)	0.5M NaHCO3, 2.5ppm polyacrylamide, adjusted to pH 8.50 with NaOH. (Shared with Olsen-P)
27	Method 9B1: George E. Rayment and David J. Lyons	1.2	120	16				DA (wavelength)	

Table 5 Methodology for P Buffer Index – PBI_{+ColP}

Lab. Code	Method Reference*	Sample Mass (g)	Extraction Solution (P equilibrating Solution) Volume (mL)	Shake time (hours)	Instrument	Final Dilution Factor	Wavelength (nm) / Absorbance (nm)
2	9I2	2	20	16	ICP-OES	10	213.617
27	9I2	2	20	17	ICP-OES	100	213.617

*9I2 as defined by Rayment, G.E. and David, J. L. in “Soil Chemical Methods-Australasia”.

Table 6 Methodology for Total P

Lab. Code	Method
8	Total P by APHA 4500 Norg-D with Jirka modification followed by DA finish
15	Total P by Kjeldahl digestion and DA
21	Total P by Kjeldahl digestion and DA

Table 7 Methodology for Calcium Chloride Extractable B

Lab. Code	Method Reference*	Sample Mass (g)	Extraction Solution (0.01 M $CaCl_2$) Volume (mL)	Reflux Time (hours)	Instrument	Final Dilution Factor	Wavelength (nm) / Absorbance (nm)
2	12C	5	20	1	ICP-OES	2	208.889
8	12C	10	20	0.16	ICP-OES	2	249.773
11	12C	10	20		ICP-OES-AV-buffer	2	208.956
17	12C	10	20		ICP-OES	2	208.9
21	12C	10	20mL of 0.01M CaCl2	0hr 10min	ICP-OES-AV-equation	2	250
27	12C	2	20	0.167	ICP-OES	100	249.68

*12C as defined by Rayment, G.E. and David, J. L. in “Soil Chemical Methods-Australasia”.

Table 8 Methodology for Total Nitrogen

Lab. Code	Method Reference (eg USEPA No.)	Test Method	TN = TKN	TN = TKN + NOx	Measurement Method	Instrument
2	In house Method - Dumas combustion	Combustion			Dumas -High temperature combustion	LECO
4	APHA4500-Norg-B,C,D. (4-123)(TKN)	Distillation	No	Yes	Colorimetric - phenate method	DA
7	7A5	Combustion			Dumas -High temperature combustion	LECO
8	APHA 22nd edition 4500 Norg A & D with Jirka Modification-Jirka et al. (1976)	Digestion	No	Yes	Colorimetric - phenate method	DA
12	APHA 4500 - Norg A &D	Digestion	No	Yes	Colorimetric - salicylate method	DA
15	APHA Method 4500-N Org D	Digestion	Yes	Yes	Colorimetric - salicylate method	DA
17	Rayment G.E and Lyons D.J Chemical methods-Australasia	Combustion	No	No	Dumas -High temperature combustion	LECO
18	APHA-23rd Edition 4500-Inorg-D	Digestion	No	Yes	Colorimetric - salicylate method	DA
21	APHA 4500 -NOrg. A & D	Digestion	No	Yes	Colorimetric - salicylate method	DA
27		Combustion			Dumas -High temperature combustion	LECO

Table 9 Methodology for Exchangeable Bases

Lab. Code	Method Reference	Sample Mass (g)	Shake Time (hours)	Extraction Solution	Extraction Solution Volume (mL)
2	15A1	1	1	1M NH_4Cl	20
7	15A1	2	1	1M NH_4Cl	40
8	15A1	2.5	1	1M NH_4Cl	50
11	15A1	2.5	1	1M NH_4Cl	50
12	15A1	2.5	1	1M NH_4Cl	50
15	15A1	2	1	1M NH_4Cl	40
17	15A1	2.5	1	1M NH_4Cl	50
18	15A1			1M NH_4Cl	
19	15A1	5	1	1M NH_4Cl	100
21	15A1			1M NH_4Cl	
26	15A1	5	1	1M NH_4Cl	100
27	15A1	2	1	1M NH_4Cl	10

*15A1 as defined by Rayment, G.E. and David, J. L. in “Soil Chemical Methods-Australasia”.

3.2 Additional Information

Participants had the option to report additional information for each sample analysed. These are transcribed in Table 10.

Table 10 Additional Information

Lab. Code	Additional Information
20	S2 - Lab does not report moisture content. Analysis is carried out on a dried portion of soil.
23	S2 - Results are reporting as received basis.

3.3 Basis of Participants' Measurement Uncertainty Evaluation

Participants were requested to provide information about the basis of their uncertainty evaluation (Tables 11 and 12).

Table 11 Basis of Uncertainty Evaluation

Lab. Code	Approach to Evaluating MU	Information Sources for MU Evaluation[a]		Guide Document for Evaluation MU
		Precision	Method Bias	
2	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Control Samples - Reference Material / Ex PT Sample	CRM	Nordtest Report TR537
3	Standard deviation of replicate analyses multiplied by 2 or 3 k = 2	Control Samples - Reference Material / Ex PT Sample Duplicate Analysis	CRM Laboratory Bias from PT Studies	Eurachem/CITAC Guide
4	Bottom Up (ISO/GUM, fish bone/ cause and effect diagram) Coverage factor not reported	Control Samples - CRM Duplicate Analysis Instrument Calibration	Instrument Calibration	ISO/GUM
5	SD of replicate analyses x 2 x 100/85 x 100/mean Coverage factor not reported	Control Samples	CRM Instrument Calibration	
6	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Control Samples - CRM	CRM Instrument Calibration	ISO/GUM
7	Top Down - reproducibility (standard deviation) from PT studies used directly Coverage factor not reported	Control Samples - Reference Material / Ex PT Sample	CRM	Nordtest Report TR537
8	Top Down - precision and evaluations of the method and laboratory bias k = 2	Control Samples - CRM Duplicate Analysis Instrument Calibration	CRM Instrument Calibration	Eurachem/CITAC Guide
9	Standard deviation of replicate analyses multiplied by 2 or 3 k = 2	Standard deviation from PT studies only		ISO/GUM
10	Standard deviation of replicate analyses multiplied by 2 or 3 Coverage factor not reported	Duplicate Analysis	Recoveries of SS	
11	Top Down - precision and evaluations of the method and laboratory bias k = 2	Control Samples - SS		Eurachem/CITAC Guide
12	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Control Samples	CRM Recoveries of SS	Eurachem/CITAC Guide
13	Standard deviation of replicate analyses multiplied by 2 or 3 Coverage factor not reported	Control Samples - Reference Material / Ex PT Sample Duplicate Analysis	CRM Recoveries of SS	NATA General Accreditation, Guidance, Estimating and Reporting MU (Replace TN 33)
14	Standard deviation of replicate analyses multiplied by 2 or 3 Coverage factor not reported	Control Samples Duplicate Analysis	CRM Instrument Calibration Laboratory Bias from PT Studies	Eurachem/CITAC Guide

Lab. Code	Approach to Evaluating MU	Information Sources for MU Evaluation[a]		Guide Document for Evaluation MU
		Precision	Method Bias	
15	Top Down - precision and evaluations of the method and laboratory bias k = 2	Control Samples - SS Duplicate Analysis	Instrument Calibration Laboratory Bias from PT Studies Recoveries of SS	In-house QA/QC plan
16	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Control Samples Duplicate Analysis	Laboratory Bias from PT Studies	Other
17	Top Down - precision and evaluations of the method and laboratory bias k = 2	Control Samples	Recoveries of SS	ISO/GUM
18	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Duplicate Analysis	Recoveries of SS	Eurachem/CITAC Guide
19*	Other Coverage factor not reported	Control Samples - CRM	CRM	Other
20*	Professional judgement k = 2	Control Samples Duplicate Analysis Instrument Calibration	CRM Instrument Calibration Recoveries of SS	
21	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Control Samples - CRM Duplicate Analysis		Eurachem/CITAC Guide
23	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Control Samples - SS Instrument Calibration	Instrument Calibration Recoveries of SS	Eurachem/CITAC Guide
24	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Control Samples - CRM	CRM	ISO/GUM
25	Other Coverage factor not reported	Standard deviation from PT studies only		Eurachem/CITAC Guide
		Control Samples - Reference Material / Ex PT Sample Duplicate Analysis Instrument Calibration	Instrument Calibration Variation in Sample Moisture Content Standard Purity	
26	Top Down - precision and evaluations of the method and laboratory bias k = 2	Control Samples Duplicate Analysis Instrument Calibration	CRM Instrument Calibration Laboratory Bias from PT Studies Recoveries of SS	ASTM E2554-13
27	Top Down - reproducibility (standard deviation) from PT studies used directly Coverage factor not reported	Standard deviation from PT studies only		Eurachem/CITAC Guide
		Control Samples Duplicate Analysis	CRM Laboratory Bias from PT Studies	
28	Top Down - precision and evaluations of the method and laboratory bias k = 2	Control Samples - SS	Recoveries of SS	Eurachem/CITAC Guide

*Additional information in Table 12. [a] CRM = Certified Reference Material, PT = Proficiency testing, SS =Spiked samples.

Table 12 Additional Information for Basis of Uncertainty Evaluation

Lab Code	Additional Information
19	Estimation of MU from within-laboratory data on bias and precision has been calculated by using the procedures outlined in ASTM E2554-13 Standard Practice for Estimating and Monitoring the Uncertainty of Test Results of a Test Method Using Control Chart Techniques
20	The laboratory does not test many soils and mostly only tests for lead apart from rare occasions and so does not have sufficient data for uncertainty estimations. The uncertainty quoted is based on the acceptance criteria for lead which is within 20% of expected value for controls.

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

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

No comments were made in the current study.

4 PRESENTATION OF RESULTS AND STATISTICAL ANALYSIS

4.1 Results Summary

Participant results are listed in Tables 13 to 79 with resultant summary statistics. Bar charts of results and performance scores are presented in Figures 2 to 68. An example chart with interpretation guide is shown in Figure 1.

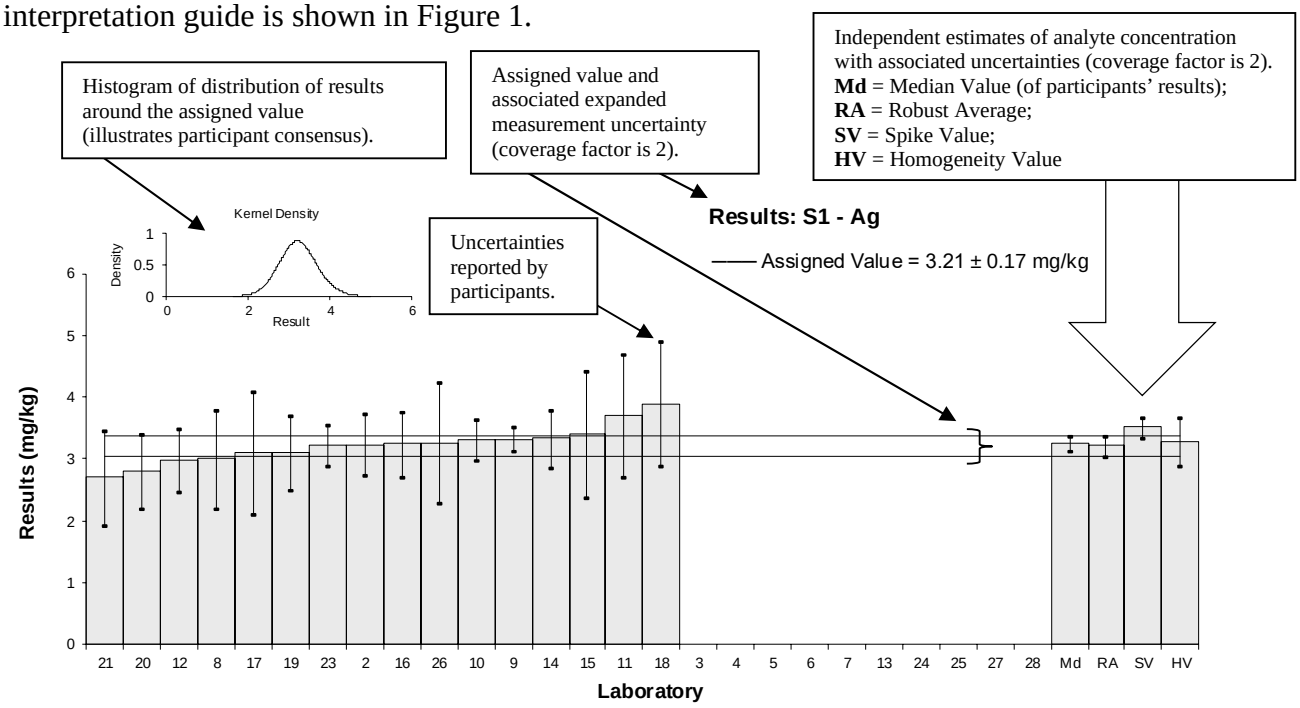


Figure 1 Guide to Presentation of Results

4.2 Outliers and Extreme Outliers

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

4.3 Assigned Value

An example of the assigned value calculation using data from the present study is given in Appendix 2. The assigned value is defined as: 'the value attributed to a particular property or characteristic of a proficiency test item.'[1] In this PT study, the property is the mass fraction of analyte. Assigned values were the robust average of participants' results, outliers and extreme outliers removed; the expanded uncertainties were evaluated from the associated robust standard deviations.[4, 6]

4.4 Robust Average and Robust Between-Laboratory Coefficient of Variation

The robust averages and associated expanded uncertainties, and robust CVs (a measure of the variability of participants' results) were calculated as described in ISO 13528.[6] The Robust CVs as presented in the Section 5 Statistics Tables are the robust between-laboratory CV including outliers but excluding extreme outliers. Everywhere else in the report, the robust between-laboratory CV refers to the robust CV calculated with both outliers and extreme outliers removed.

4.5 Standard Deviation for Proficiency Assessment

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

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

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

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

4.6 z-Score

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

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

Where:

z is z-score;
χ is participant's result;
X is the assigned value;
σ is the SDPA from Equation 1

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

- $|z| \leq 2.0$ is acceptable;
- $2.0 < |z| < 3.0$ is questionable;
- $|z| \geq 3.0$ is not acceptable.

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 assessing laboratory performance. E_n-score includes measurement uncertainty and is calculated according to Equation 3 below:

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

Where:

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

An E_n-score with absolute value ($|E_n|$):

- $|E_n| < 1.0$ is acceptable;
- $|E_n| \geq 1.0$ is not acceptable.

4.8 Traceability and Measurement Uncertainty

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

5 TABLES AND FIGURES

Table 13

Sample Details

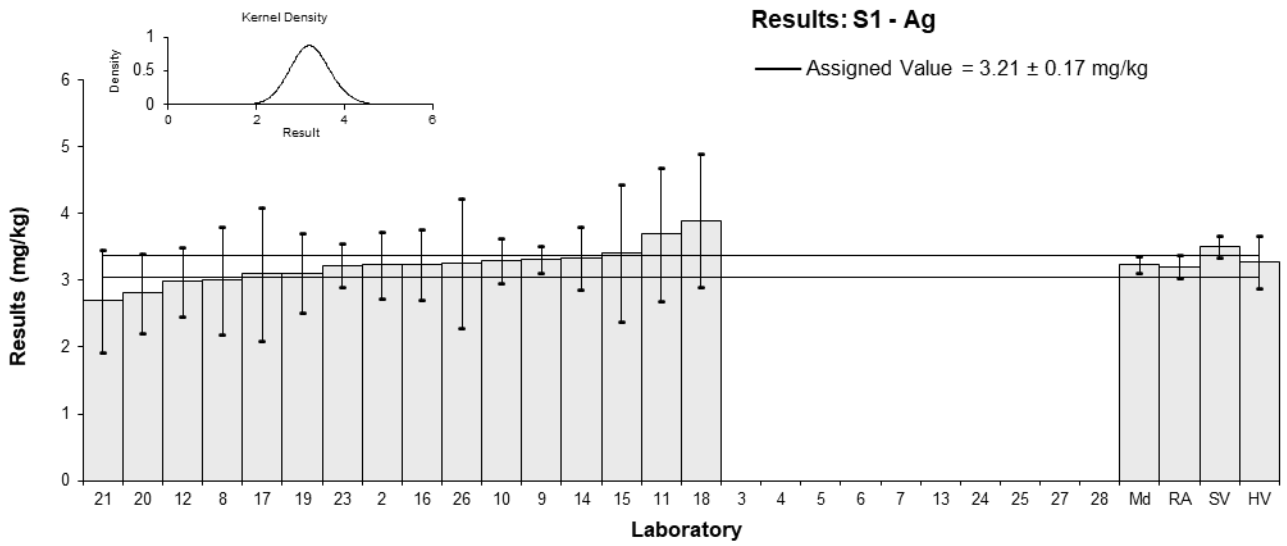
Sample No.	S1
Matrix	Soil
Analyte	Ag
Unit	mg/kg

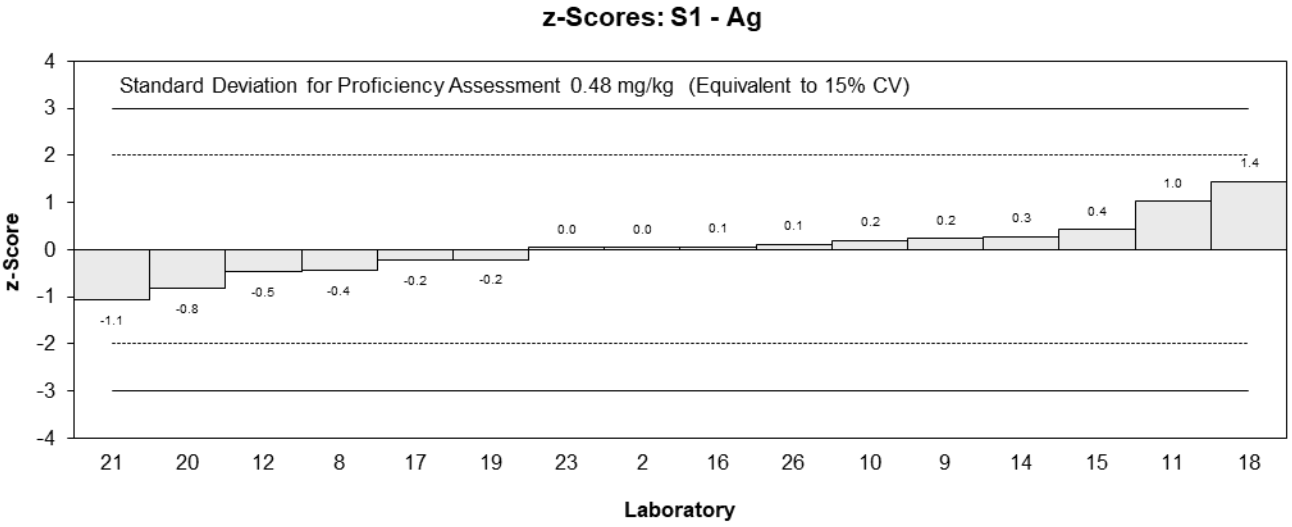
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	3.23	0.5	0.04	0.04
3	NR	NR		
4	NT	NT		
5	NT	NT		
6	<5	NR		
7	NT	NT		
8	3.0	0.8	-0.44	-0.26
9	3.32	0.2	0.23	0.42
10	3.3	0.33	0.19	0.24
11	3.7	1	1.02	0.48
12	2.981	0.512	-0.48	-0.42
13	NT	NT		
14	3.34	0.47	0.27	0.26
15	3.41	1.023	0.42	0.19
16	3.24	0.52	0.06	0.05
17	3.1	1	-0.23	-0.11
18	3.9	1	1.43	0.68
19	3.11	0.60	-0.21	-0.16
20	2.81	0.6	-0.83	-0.64
21	2.7	0.77	-1.06	-0.65
23	3.229	0.323	0.04	0.05
24	NT	NT		
25	NT	NT		
26	3.26	0.978	0.10	0.05
27	NR	NR		
28	NT	NT		

Statistics

Assigned Value	3.21	0.17
Spike Value	3.51	0.17
Homogeneity Value	3.28	0.39
Robust Average	3.21	0.17
Median	3.24	0.12
Mean	3.23	
N	16	
Max	3.9	
Min	2.7	
Robust SD	0.27	
Robust CV	8.4%	


Kernel Density
Density
Result
Results: S1 - Ag
Assigned Value = 3.21 ± 0.17 mg/kg
Results (mg/kg)
21 20 12 8 17 19 23 2 16 26 10 9 14 15 11 18 3 4 5 6 7 13 24 25 27 28 Md RA SV HV
Laboratory


z-Scores: S1 - Ag
Standard Deviation for Proficiency Assessment 0.48 mg/kg (Equivalent to 15% CV)
z-Score
-1.1 -0.8 -0.5 -0.4 -0.2 -0.2 0.0 0.0 0.1 0.1 0.2 0.2 0.3 0.4 1.0 1.4
21 20 12 8 17 19 23 2 16 26 10 9 14 15 11 18
Laboratory

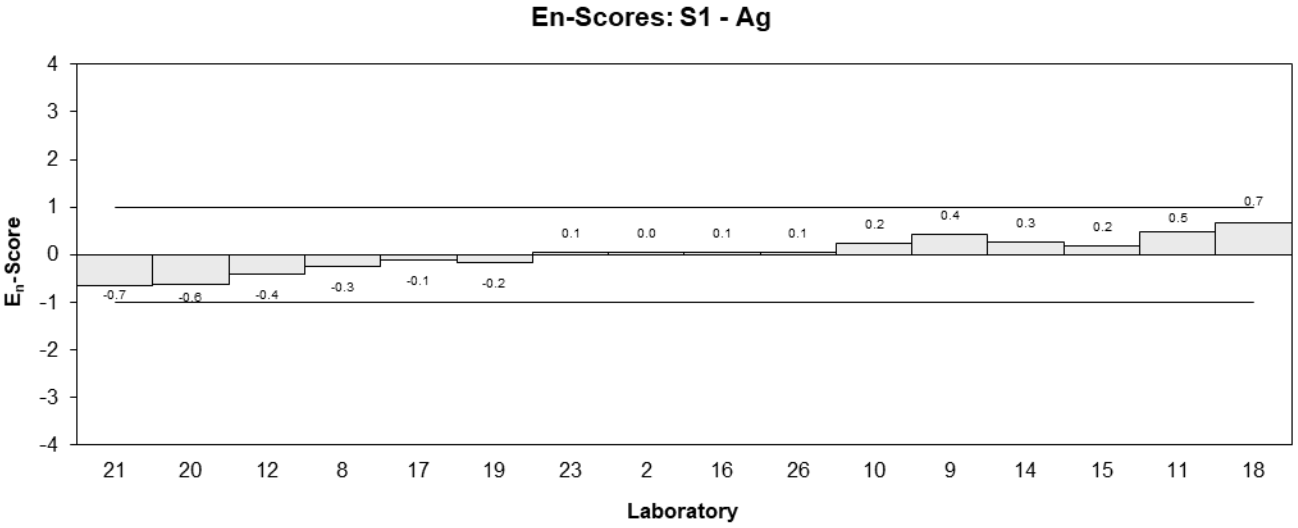

En-Scores: S1 - Ag
En-Score
-0.7 -0.6 -0.4 -0.3 -0.1 -0.2 0.1 0.0 0.1 0.1 0.2 0.4 0.3 0.2 0.5 0.7
21 20 12 8 17 19 23 2 16 26 10 9 14 15 11 18
Laboratory

Figure 2

Table 14

Sample Details

Sample No.	S1
Matrix	Soil
Analyte	Al
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	8040	800	-0.46	-0.60
3	9000	450	0.29	0.50
4	NT	NT		
5	8230	2470	-0.31	-0.16
6	9490	1900	0.66	0.43
7	NT	NT		
8	6580	1030	-1.58	-1.73
9	7684	2.5	-0.73	-1.63
10	10200	1020	1.21	1.34
11	9300	2000	0.52	0.32
12	8717	1195.4	0.07	0.07
13	10100	2500	1.14	0.57
14	9000	1100	0.29	0.30
15	8093	2428	-0.41	-0.22
16	6490	1400	-1.65	-1.41
17	8000	2000	-0.49	-0.30
18	8100	2000	-0.41	-0.25
19	8412	1291	-0.17	-0.15
20	8120	1600	-0.39	-0.30
21	7980	1570	-0.50	-0.39
23*	15458.169	1545.817	5.27	4.14
24	11000	3100	1.83	0.75
25	NT	NT		
26	9090	2730	0.36	0.16
27	9305	NR	0.52	1.16
28	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	8630	580
Spike Value	Not Spiked	
Homogeneity Value	8100	970
Robust Average	8710	610
Median	8560	450
Mean	8930	
N	22	
Max	15458.169	
Min	6490	
Robust SD	1200	
Robust CV	13%	

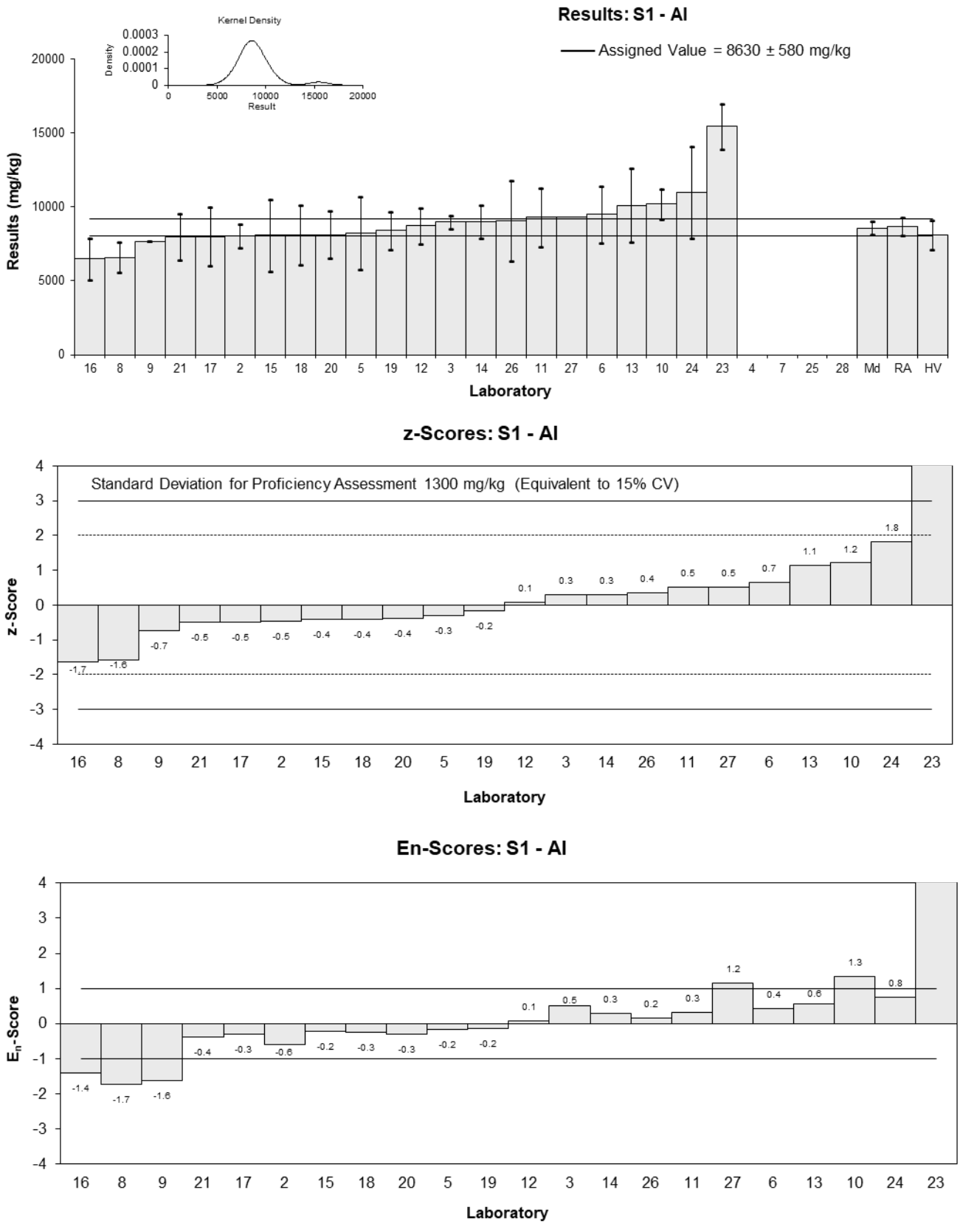

Results: S1 - Al
Assigned Value = 8630 ± 580 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
16 8 9 21 17 2 15 18 20 5 19 12 3 14 26 11 27 6 13 10 24 23 4 7 25 28 Md RA HV
z-Scores: S1 - Al
Standard Deviation for Proficiency Assessment 1300 mg/kg (Equivalent to 15% CV)
z-Score
-1.7 -1.6 -0.7 -0.5 -0.5 -0.5 -0.4 -0.4 -0.4 -0.3 -0.2 0.1 0.3 0.3 0.4 0.5 0.5 0.7 1.1 1.2 1.8
16 8 9 21 17 2 15 18 20 5 19 12 3 14 26 11 27 6 13 10 24 23
Laboratory
En-Scores: S1 - Al
En-Score
-1.4 -1.7 -1.6 -0.4 -0.3 -0.6 -0.2 -0.3 -0.3 -0.2 -0.2 0.1 0.5 0.3 0.2 0.3 1.2 0.4 0.6 1.3 0.8
16 8 9 21 17 2 15 18 20 5 19 12 3 14 26 11 27 6 13 10 24 23
Laboratory

Figure 3

Table 15

Sample Details

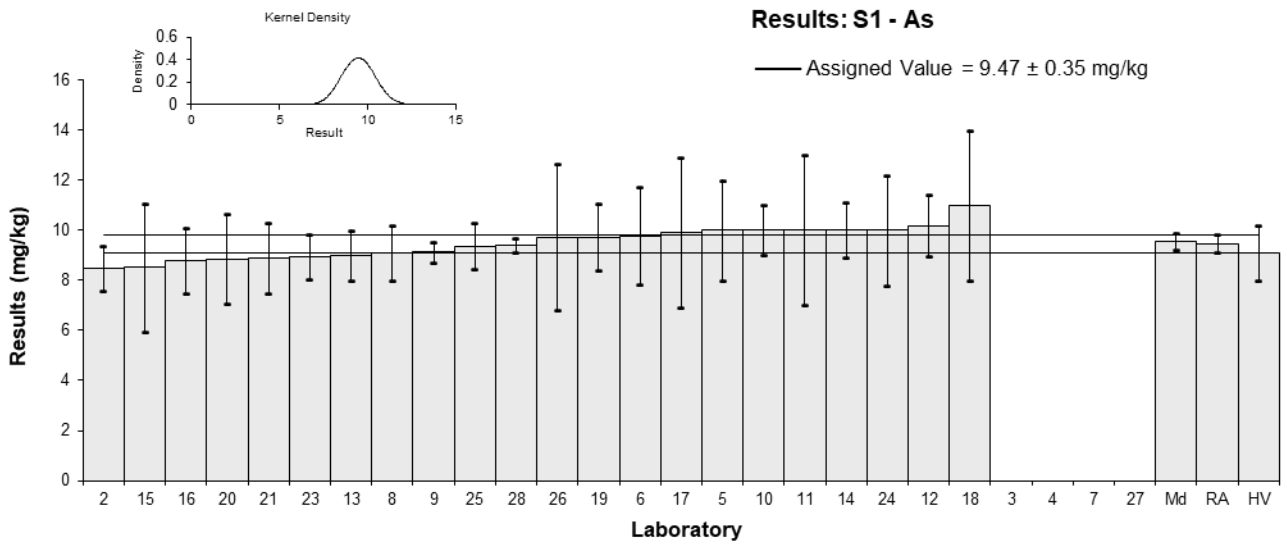
Sample No.	S1
Matrix	Soil
Analyte	As
Unit	mg/kg

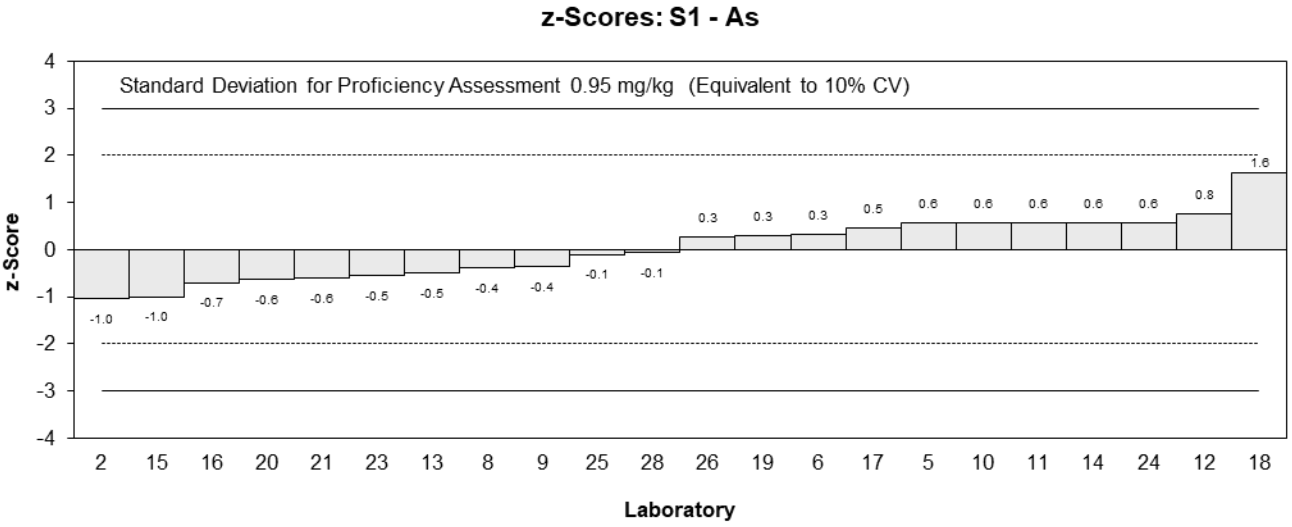
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	8.49	0.9	-1.03	-1.01
3	< 10	NR		
4	NT	NT		
5	10	2	0.56	0.26
6	9.77	1.95	0.32	0.15
7	NT	NT		
8	9.1	1.1	-0.39	-0.32
9	9.14	0.4	-0.35	-0.62
10	10.0	1	0.56	0.50
11	10	3	0.56	0.18
12	10.191	1.234	0.76	0.56
13	9	1	-0.50	-0.44
14	10.0	1.1	0.56	0.46
15	8.52	2.556	-1.00	-0.37
16	8.81	1.3	-0.70	-0.49
17	9.9	3	0.45	0.14
18	11	3	1.62	0.51
19	9.74	1.34	0.29	0.19
20	8.86	1.8	-0.64	-0.33
21	8.9	1.41	-0.60	-0.39
23	8.955	0.896	-0.54	-0.54
24	10	2.2	0.56	0.24
25	9.38	0.9	-0.10	-0.09
26	9.73	2.92	0.27	0.09
27	<15	NR		
28	9.4	0.3	-0.07	-0.15

Statistics

Assigned Value	9.47	0.35
Spike Value	Not Spiked	
Homogeneity Value	9.1	1.1
Robust Average	9.47	0.35
Median	9.57	0.34
Mean	9.49	
N	22	
Max	11	
Min	8.49	
Robust SD	0.66	
Robust CV	6.9%	


Kernel Density
Density
Result
Results: S1 - As
Assigned Value = 9.47 ± 0.35 mg/kg
Results (mg/kg)
Laboratory
2 15 16 20 21 23 13 8 9 25 28 26 19 6 17 5 10 11 14 24 12 18 3 4 7 27 Md RA HV


z-Scores: S1 - As
Standard Deviation for Proficiency Assessment 0.95 mg/kg (Equivalent to 10% CV)
z-Score
Laboratory
2 15 16 20 21 23 13 8 9 25 28 26 19 6 17 5 10 11 14 24 12 18
-1.0 -1.0 -0.7 -0.6 -0.6 -0.5 -0.5 -0.4 -0.4 -0.1 -0.1 0.3 0.3 0.3 0.5 0.6 0.6 0.6 0.6 0.6 0.8 1.6

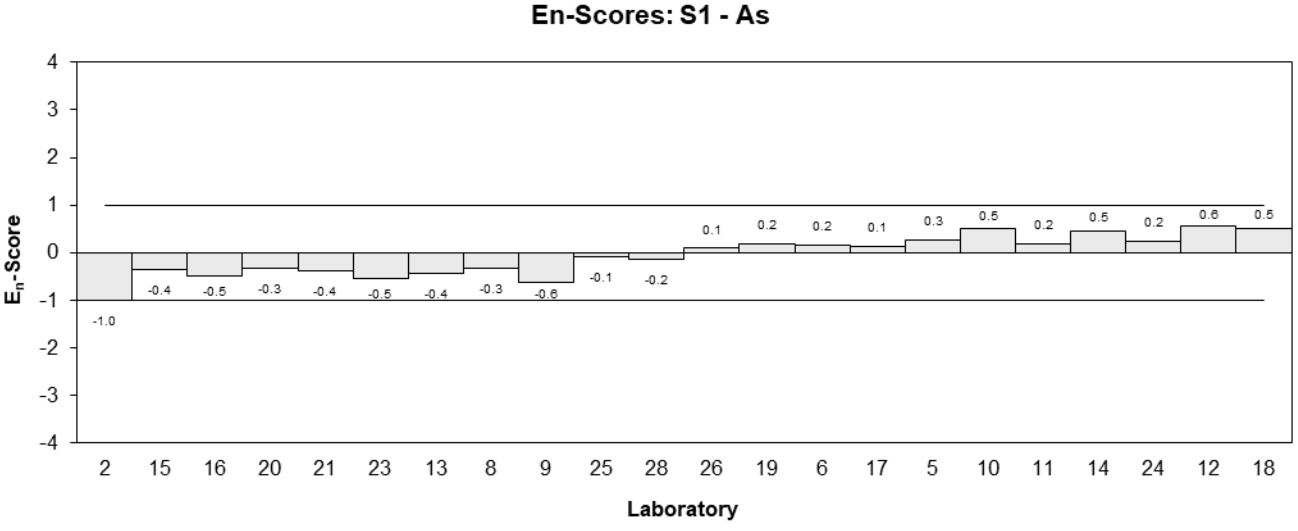

En-Scores: S1 - As
En-Score
Laboratory
2 15 16 20 21 23 13 8 9 25 28 26 19 6 17 5 10 11 14 24 12 18
-1.0 -0.4 -0.5 -0.3 -0.4 -0.5 -0.4 -0.3 -0.6 -0.1 -0.2 0.1 0.2 0.2 0.1 0.3 0.5 0.2 0.5 0.2 0.6 0.5

Figure 4

Table 16

Sample Details

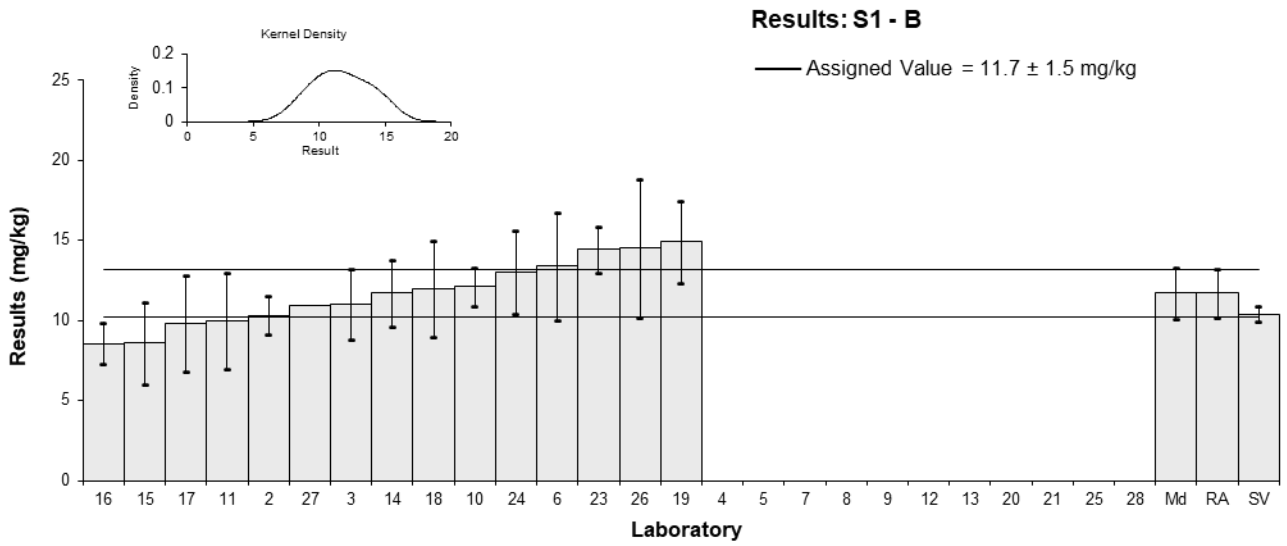
Sample No.	S1
Matrix	Soil
Analyte	B
Unit	mg/kg

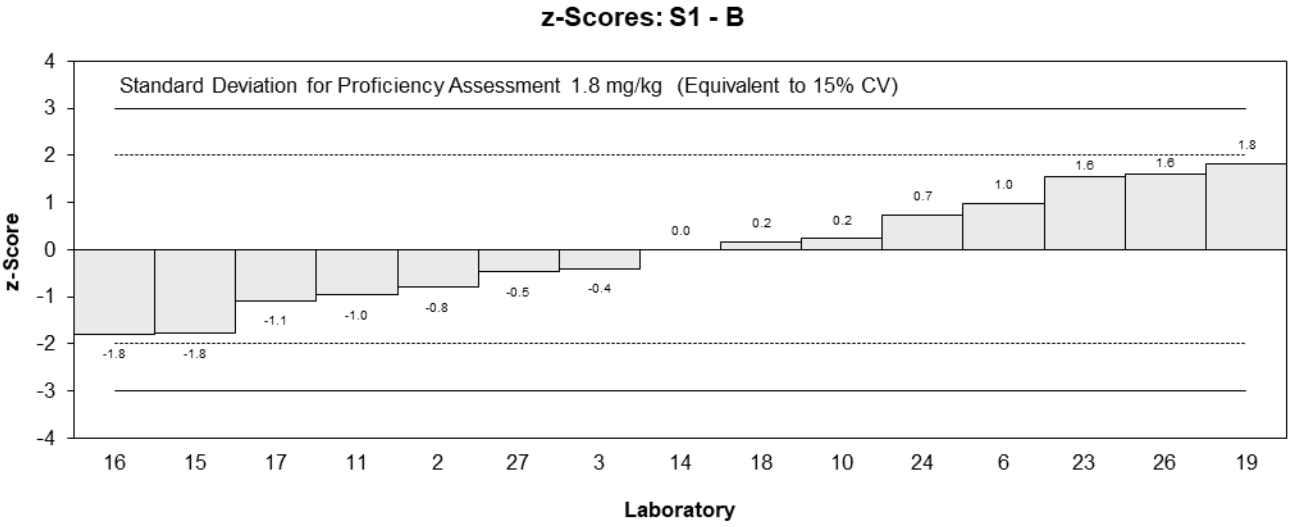
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	10.3	1.2	-0.80	-0.73
3	11	2.2	-0.40	-0.26
4	NT	NT		
5	NT	NT		
6	13.4	3.35	0.97	0.46
7	NT	NT		
8	<50	NR		
9	NT	NT		
10	12.1	1.21	0.23	0.21
11	10	3	-0.97	-0.51
12	<50	NR		
13	NT	NT		
14	11.7	2.1	0.00	0.00
15	8.58	2.574	-1.78	-1.05
16	8.56	1.3	-1.79	-1.58
17	9.8	3	-1.08	-0.57
18	12	3	0.17	0.09
19	14.9	2.6	1.82	1.07
20	NT	NT		
21	<50	NR		
23	14.442	1.444	1.56	1.32
24	13	2.6	0.74	0.43
25	NT	NT		
26	14.5	4.35	1.60	0.61
27	10.9	NR	-0.46	-0.53
28	NT	NT		

Statistics

Assigned Value	11.7	1.5
Spike Value	10.4	0.5
Robust Average	11.7	1.5
Median	11.7	1.6
Mean	11.7	
N	15	
Max	14.9	
Min	8.56	
Robust SD	2.3	
Robust CV	20%	


Results: S1 - B
Assigned Value = 11.7 ± 1.5 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
16 15 17 11 2 27 3 14 18 10 24 6 23 26 19 4 5 7 8 9 12 13 20 21 25 28 Md RA SV


z-Scores: S1 - B
Standard Deviation for Proficiency Assessment 1.8 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
16 15 17 11 2 27 3 14 18 10 24 6 23 26 19
-1.8 -1.8 -1.1 -1.0 -0.8 -0.5 -0.4 0.0 0.2 0.2 0.7 1.0 1.6 1.6 1.8

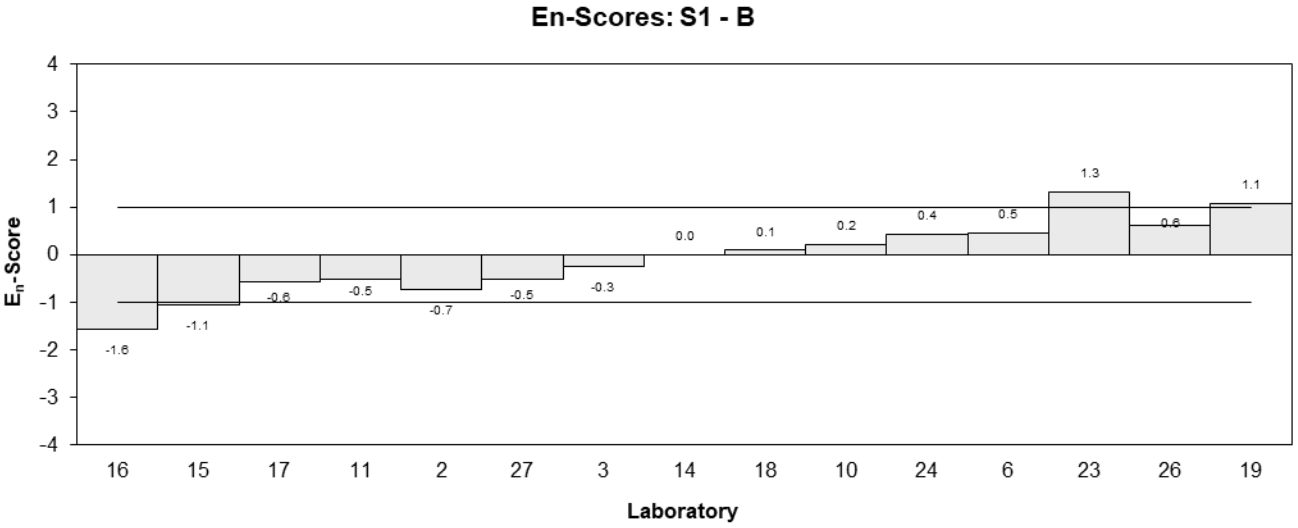

En-Scores: S1 - B
En-Score
Laboratory
16 15 17 11 2 27 3 14 18 10 24 6 23 26 19
-1.6 -1.1 -0.6 -0.5 -0.7 -0.5 -0.3 0.0 0.1 0.2 0.4 0.5 1.3 0.6 1.1

Figure 5

Table 17

Sample Details

Sample No.	S1
Matrix	Soil
Analyte	Bi
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	0.82	0.1	-0.74	-0.76
3	NR	NR		
4	NT	NT		
5	NT	NT		
6	<10	NR		
7	NT	NT		
8	0.9	0.3	-0.17	-0.07
9	NT	NT		
10	0.94	0.094	0.12	0.13
11	<1	NR		
12	1.069	0.229	1.05	0.59
13	NT	NT		
14	0.95	0.14	0.20	0.16
15*	4.10	1.230	22.95	2.58
16	0.887	0.28	-0.26	-0.12
17	<1	NR		
18	<1	NR		
19	< 10	NR		
20	<8	NR		
21	0.8	0.13	-0.89	-0.77
23	NT	NT		
24	NT	NT		
25	1.02	0.1	0.70	0.71
26	< 10	3.33		
27	NT	NT		
28	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	0.923	0.092
Spike Value	1.00	0.05
Homogeneity Value	0.93	0.11
Robust Average	0.95	0.11
Median	0.940	0.099
Mean	1.28	
N	9	
Max	4.10	
Min	0.8	
Robust SD	0.13	
Robust CV	13%	

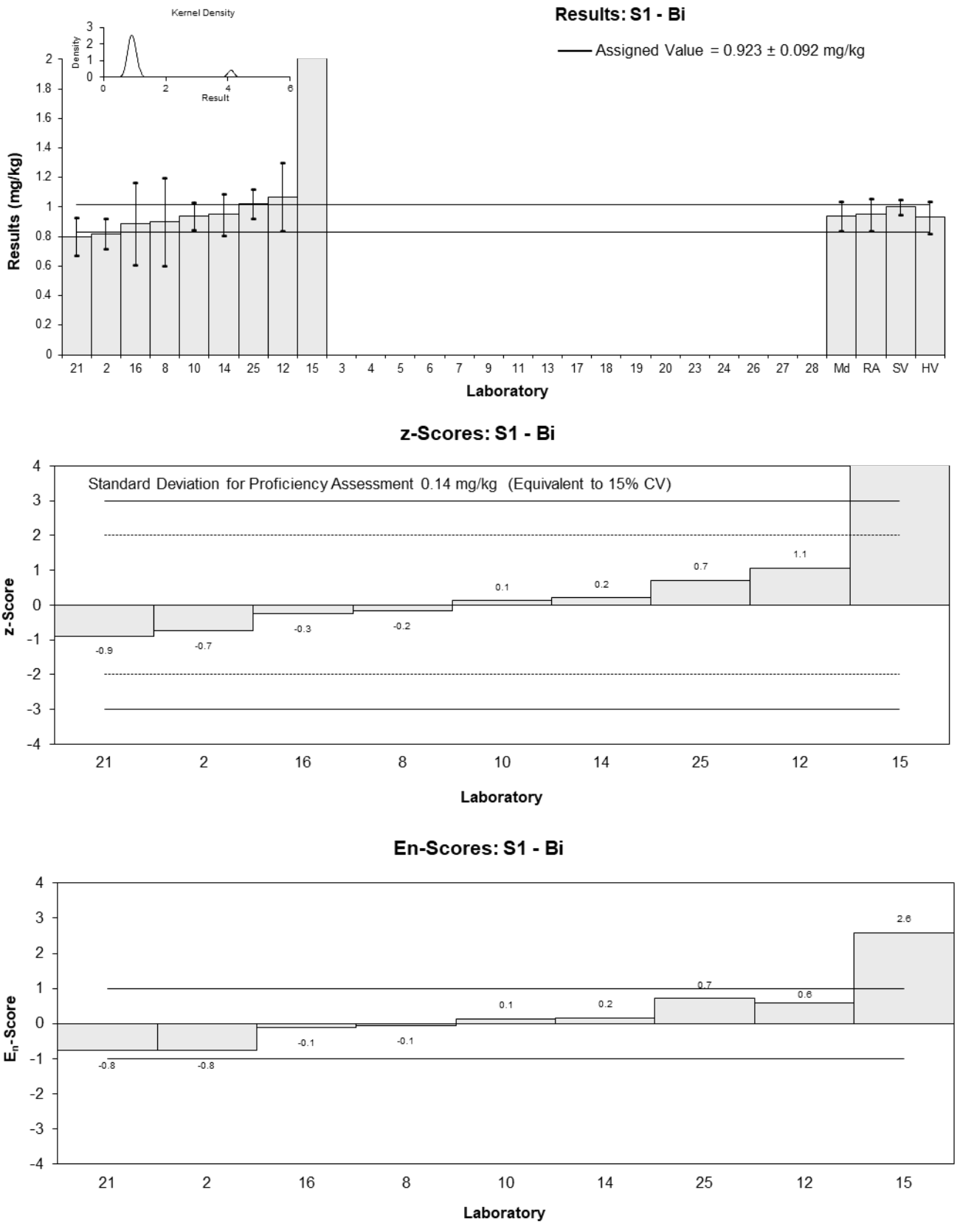

Results: S1 - Bi
Assigned Value = 0.923 ± 0.092 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
21 2 16 8 10 14 25 12 15 3 4 5 6 7 9 11 13 17 18 19 20 23 24 26 27 28 Md RA SV HV
z-Scores: S1 - Bi
Standard Deviation for Proficiency Assessment 0.14 mg/kg (Equivalent to 15% CV)
z-Score
-0.9 -0.7 -0.3 -0.2 0.1 0.2 0.7 1.1
Laboratory
21 2 16 8 10 14 25 12 15
En-Scores: S1 - Bi
En-Score
-0.8 -0.8 -0.1 -0.1 0.1 0.2 0.7 0.6 2.6
Laboratory
21 2 16 8 10 14 25 12 15

Figure 6

Table 18

Sample Details

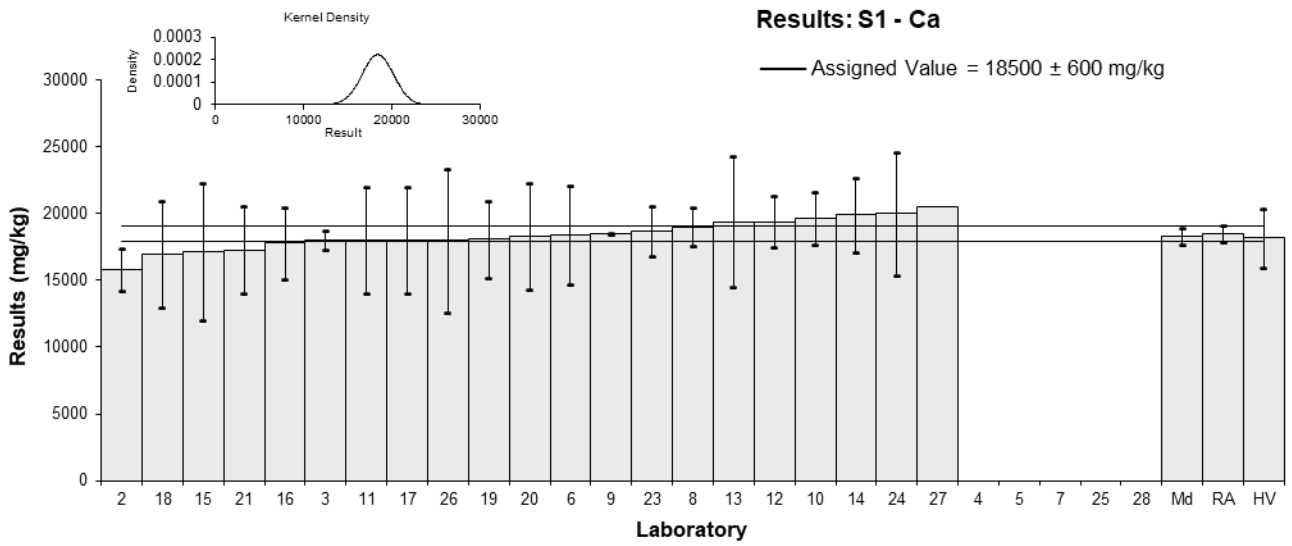
Sample No.	S1
Matrix	Soil
Analyte	Ca
Unit	mg/kg

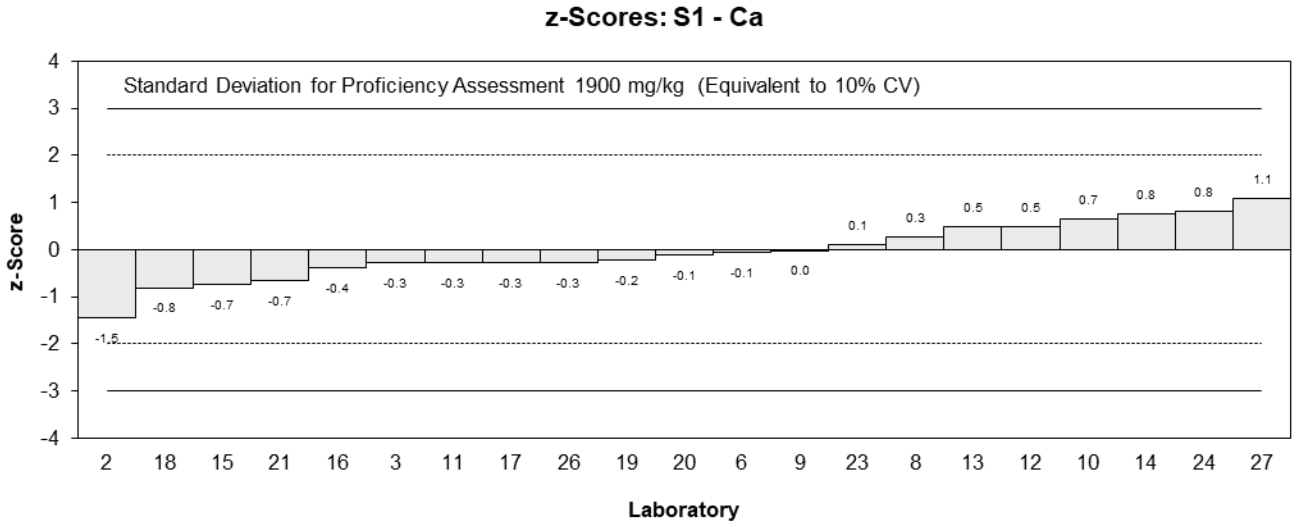
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	15800	1580	-1.46	-1.60
3	18000	740	-0.27	-0.52
4	NT	NT		
5	NT	NT		
6	18400	3680	-0.05	-0.03
7	NT	NT		
8	19000	1430	0.27	0.32
9	18469	42	-0.02	-0.05
10	19700	1970	0.65	0.58
11	18000	4000	-0.27	-0.12
12	19402	1946	0.49	0.44
13	19400	4900	0.49	0.18
14	19900	2800	0.76	0.49
15	17129	5139	-0.74	-0.26
16	17800	2700	-0.38	-0.25
17	18000	4000	-0.27	-0.12
18	17000	4000	-0.81	-0.37
19	18072	2840	-0.23	-0.15
20	18300	4000	-0.11	-0.05
21	17300	3300	-0.65	-0.36
23	18701.785	1870.179	0.11	0.10
24	20000	4600	0.81	0.32
25	NT	NT		
26	18000	5400	-0.27	-0.09
27	20500	NR	1.08	3.33
28	NT	NT		

Statistics

Assigned Value	18500	600
Spike Value	Not Spiked	
Homogeneity Value	18200	2200
Robust Average	18500	600
Median	18300	600
Mean	18400	
N	21	
Max	20500	
Min	15800	
Robust SD	1200	
Robust CV	6.3%	


Results: S1 - Ca
Assigned Value = 18500 ± 600 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
2 18 15 21 16 3 11 17 26 19 20 6 9 23 8 13 12 10 14 24 27 4 5 7 25 28 Md RA HV


z-Scores: S1 - Ca
Standard Deviation for Proficiency Assessment 1900 mg/kg (Equivalent to 10% CV)
z-Score
Laboratory
2 18 15 21 16 3 11 17 26 19 20 6 9 23 8 13 12 10 14 24 27
-1.5 -0.8 -0.7 -0.7 -0.4 -0.3 -0.3 -0.3 -0.3 -0.2 -0.1 -0.1 0.0 0.1 0.3 0.5 0.5 0.7 0.8 0.8 1.1

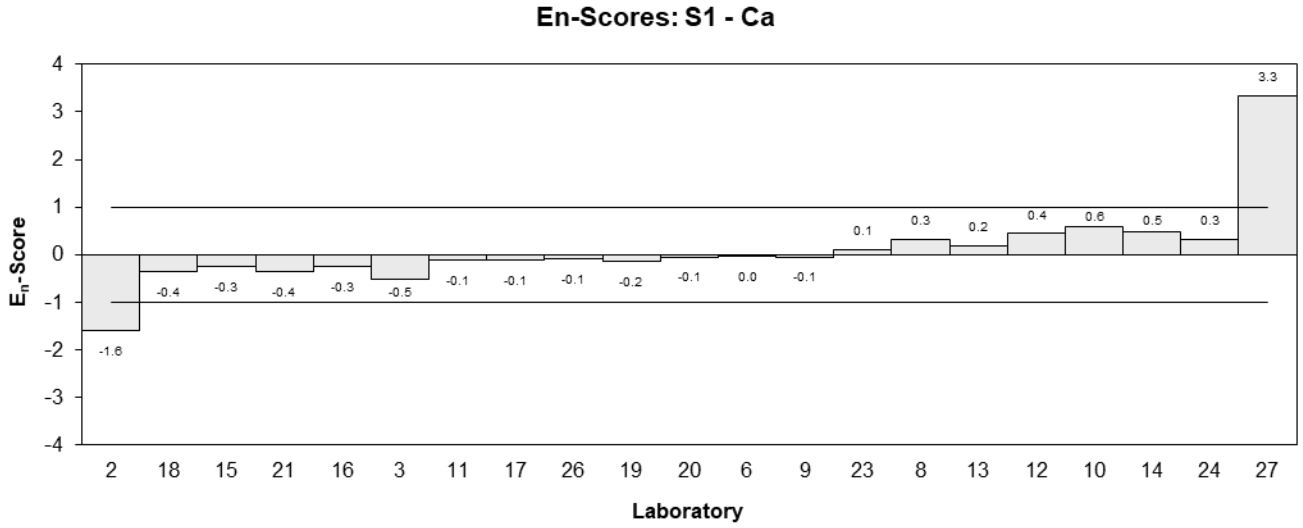

En-Scores: S1 - Ca
En-Score
Laboratory
2 18 15 21 16 3 11 17 26 19 20 6 9 23 8 13 12 10 14 24 27
-1.6 -0.4 -0.3 -0.4 -0.3 -0.5 -0.1 -0.1 -0.1 -0.2 -0.1 0.0 -0.1 0.1 0.3 0.2 0.4 0.6 0.5 0.3 3.3

Figure 7

Table 19

Sample Details

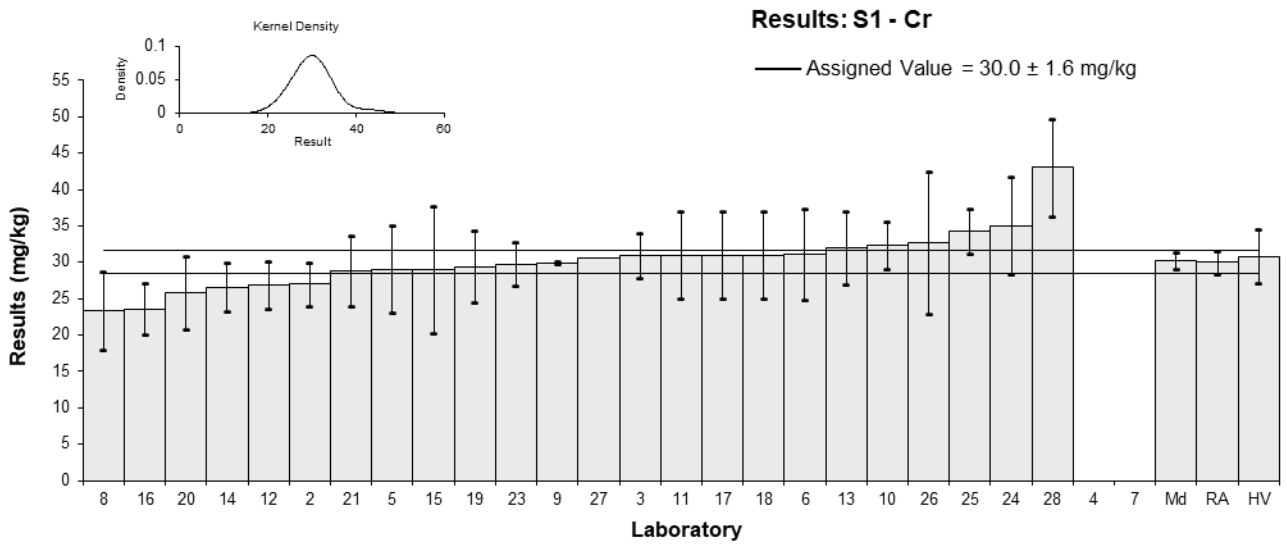
Sample No.	S1
Matrix	Soil
Analyte	Cr
Unit	mg/kg

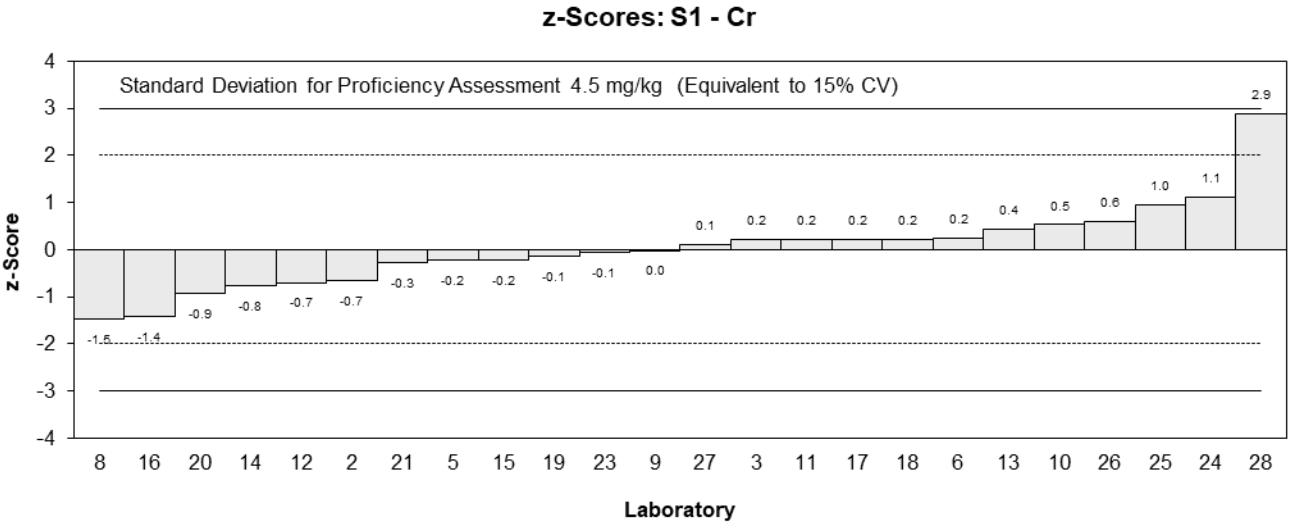
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	27.0	3.0	-0.67	-0.88
3	31	3.1	0.22	0.29
4	NT	NT		
5	29	6	-0.22	-0.16
6	31.1	6.23	0.24	0.17
7	NT	NT		
8	23.4	5.4	-1.47	-1.17
9	29.94	0.2	-0.01	-0.04
10	32.4	3.24	0.53	0.66
11	31	6	0.22	0.16
12	26.870	3.338	-0.70	-0.85
13	32	5	0.44	0.38
14	26.6	3.3	-0.76	-0.93
15	29.01	8.703	-0.22	-0.11
16	23.6	3.5	-1.42	-1.66
17	31	6	0.22	0.16
18	31	6	0.22	0.16
19	29.4	4.9	-0.13	-0.12
20	25.8	5	-0.93	-0.80
21	28.8	4.89	-0.27	-0.23
23	29.765	2.977	-0.05	-0.07
24	35	6.7	1.11	0.73
25	34.28	3	0.95	1.26
26	32.7	9.81	0.60	0.27
27	30.5	NR	0.11	0.31
28	43	6.7	2.89	1.89

Statistics

Assigned Value	30.0	1.6
Spike Value	Not Spiked	
Homogeneity Value	30.8	3.7
Robust Average	30.0	1.6
Median	30.2	1.2
Mean	30.2	
N	24	
Max	43	
Min	23.4	
Robust SD	3.2	
Robust CV	11%	


Results: S1 - Cr
Assigned Value = 30.0 ± 1.6 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
8 16 20 14 12 2 21 5 15 19 23 9 27 3 11 17 18 6 13 10 26 25 24 28 4 7 Md RA HV


z-Scores: S1 - Cr
Standard Deviation for Proficiency Assessment 4.5 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
8 16 20 14 12 2 21 5 15 19 23 9 27 3 11 17 18 6 13 10 26 25 24 28
-1.5 -1.4 -0.9 -0.8 -0.7 -0.7 -0.3 -0.2 -0.2 -0.1 -0.1 0.0 0.1 0.2 0.2 0.2 0.2 0.2 0.4 0.5 0.6 1.0 1.1 2.9

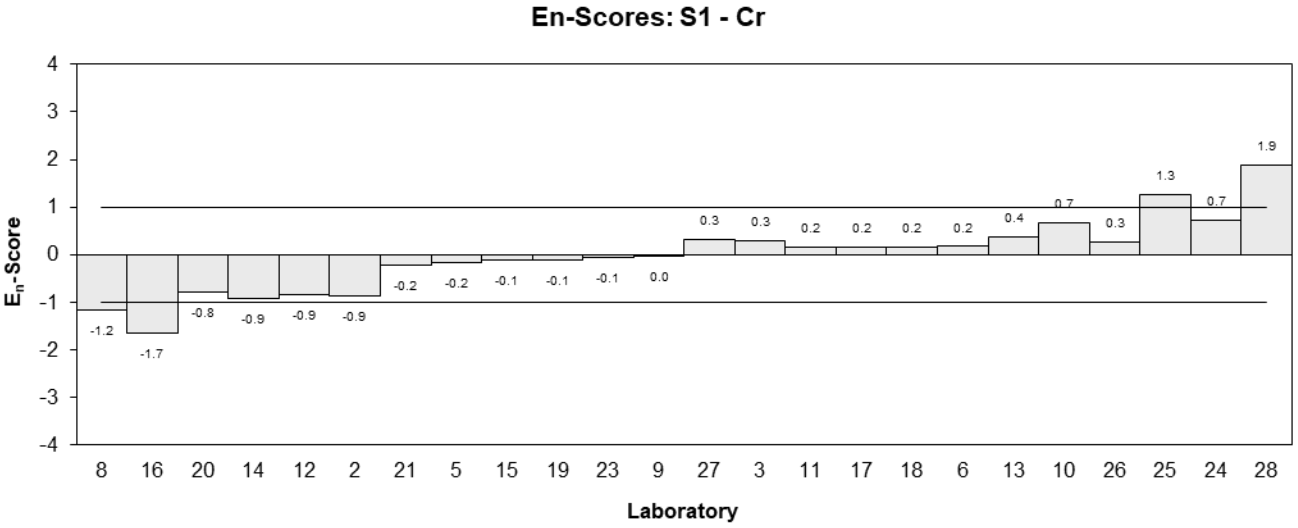

En-Scores: S1 - Cr
En-Score
Laboratory
8 16 20 14 12 2 21 5 15 19 23 9 27 3 11 17 18 6 13 10 26 25 24 28
-1.2 -1.7 -0.8 -0.9 -0.9 -0.9 -0.2 -0.2 -0.1 -0.1 -0.1 0.0 0.3 0.3 0.2 0.2 0.2 0.2 0.4 0.7 0.3 1.3 0.7 1.9

Figure 8

Table 20

Sample Details

Sample No.	S1
Matrix	Soil
Analyte	Cu
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	26.4	2.7	-0.47	-0.43
3	27	2.7	-0.25	-0.23
4	NT	NT		
5	27	5	-0.25	-0.14
6	26.5	5.29	-0.43	-0.22
7	NT	NT		
8	23.9	3.6	-1.37	-0.99
9*	84.38	7.5	20.46	7.45
10	28.5	2.85	0.29	0.26
11	31	6	1.19	0.54
12	27.024	3.665	-0.24	-0.17
13	27	4	-0.25	-0.17
14	28.5	4.0	0.29	0.19
15	29.47	8.841	0.64	0.20
16	24.2	3.6	-1.26	-0.91
17	29	6	0.47	0.21
18	31	6	1.19	0.54
19	26.4	3.9	-0.47	-0.32
20	30.7	6	1.08	0.49
21	25.8	3.95	-0.69	-0.46
23	24.836	2.484	-1.03	-1.02
24	31	8.4	1.19	0.39
25	29.95	3	0.81	0.69
26	26.7	8.01	-0.36	-0.12
27	26.5	NR	-0.43	-0.92
28	28	2.5	0.11	0.11

* Outlier, see Section 4.2

Statistics

Assigned Value	27.7	1.3
Spike Value	Not Spiked	
Homogeneity Value	27.2	3.3
Robust Average	27.8	1.3
Median	27.0	1.1
Mean	30.0	
N	24	
Max	84.38	
Min	23.9	
Robust SD	2.5	
Robust CV	9.1%	

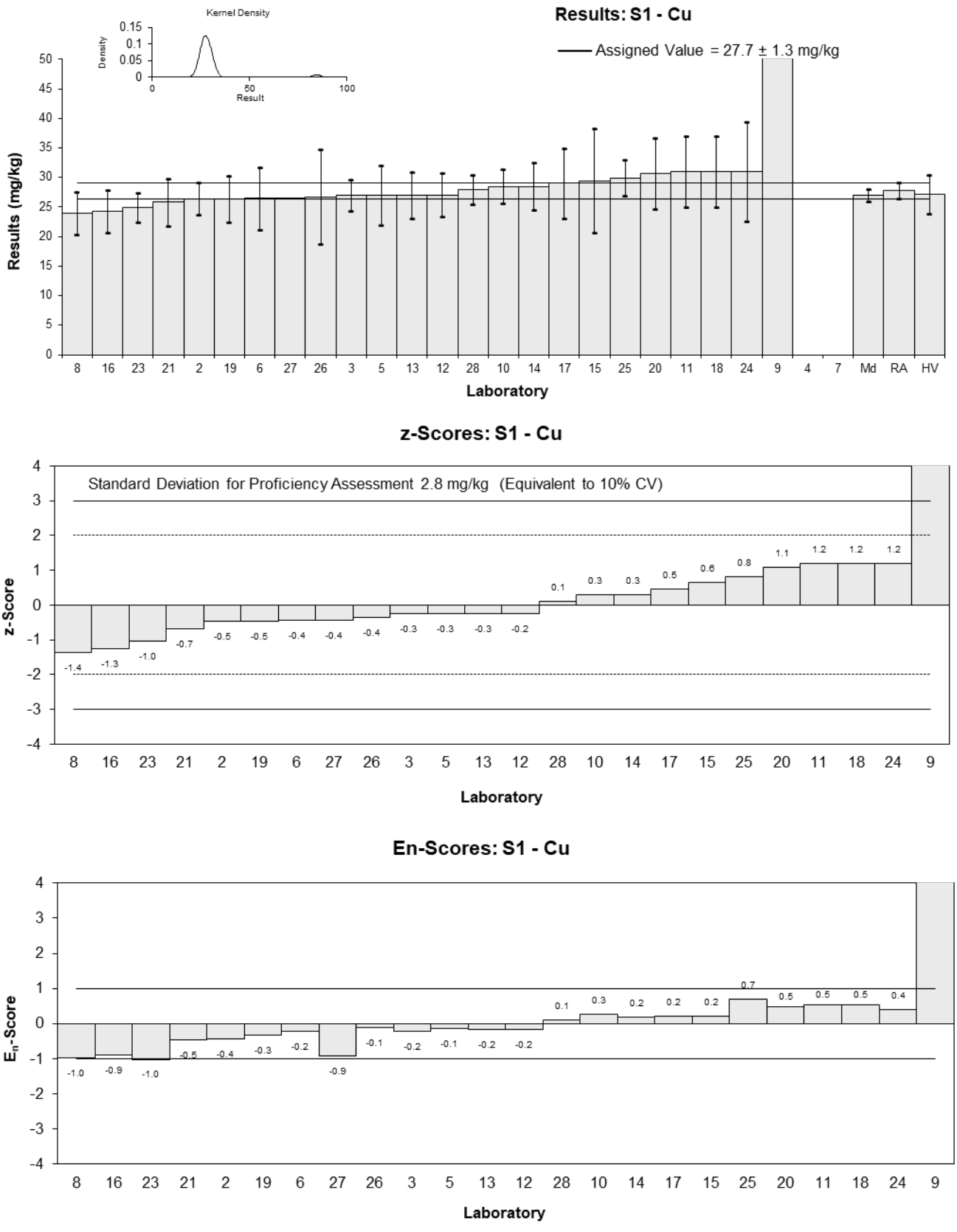

Kernel Density
Density
Result
Results: S1 - Cu
Assigned Value = 27.7 ± 1.3 mg/kg
Results (mg/kg)
Laboratory
z-Scores: S1 - Cu
Standard Deviation for Proficiency Assessment 2.8 mg/kg (Equivalent to 10% CV)
z-Score
Laboratory
En-Scores: S1 - Cu
En-Score
Laboratory

Figure 9

Table 21

Sample Details

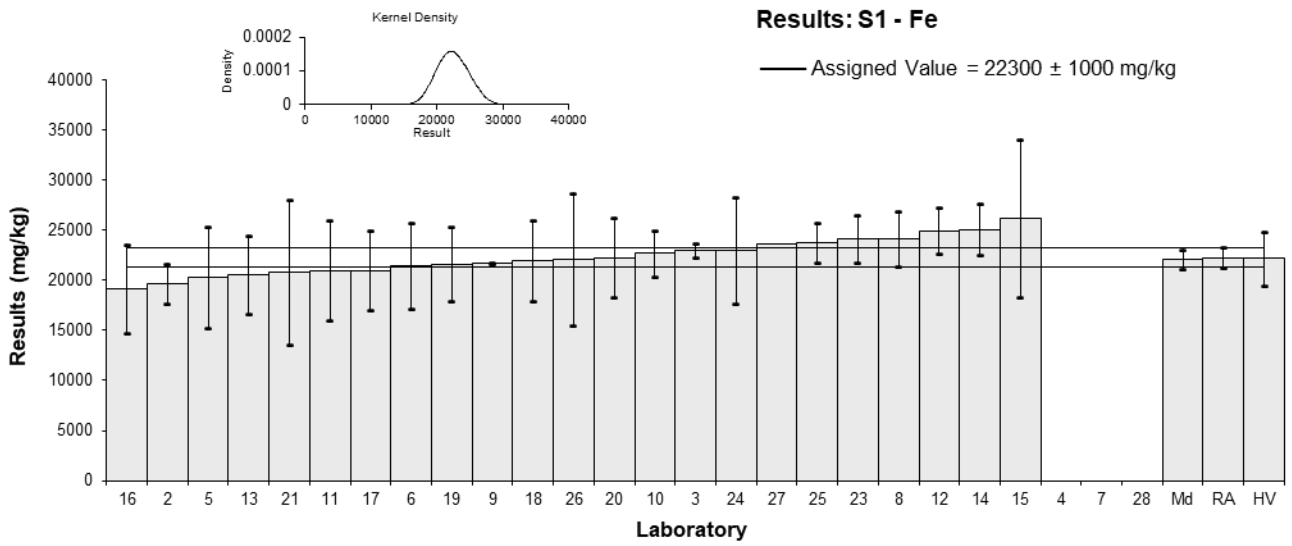
Sample No.	S1
Matrix	Soil
Analyte	Fe
Unit	mg/kg

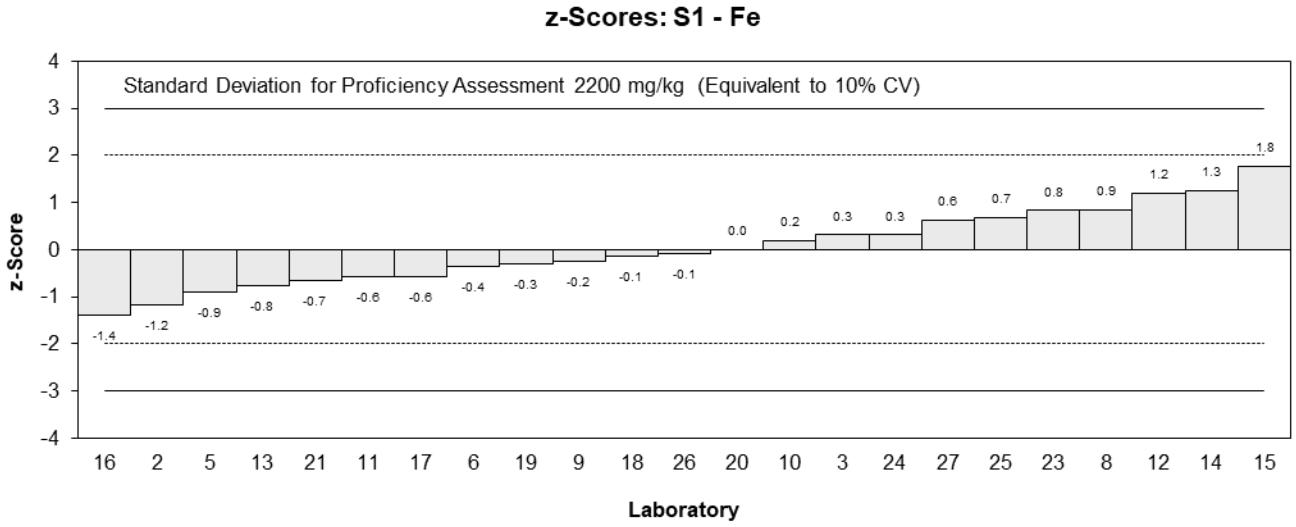
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	19700	1970	-1.17	-1.18
3	23000	680	0.31	0.58
4	NT	NT		
5	20300	5075	-0.90	-0.39
6	21500	4300	-0.36	-0.18
7	NT	NT		
8	24200	2760	0.85	0.65
9	21768	81	-0.24	-0.53
10	22700	2270	0.18	0.16
11	21000	5000	-0.58	-0.25
12	24978	2319	1.20	1.06
13	20600	3900	-0.76	-0.42
14	25100	2600	1.26	1.01
15	26255	7876	1.77	0.50
16	19200	4400	-1.39	-0.69
17	21000	4000	-0.58	-0.32
18	22000	4000	-0.13	-0.07
19	21632	3712	-0.30	-0.17
20	22300	4000	0.00	0.00
21	20800	7238	-0.67	-0.21
23	24149.220	2414.922	0.83	0.71
24	23000	5300	0.31	0.13
25	23821	2000	0.68	0.68
26	22100	6630	-0.09	-0.03
27	23700	NR	0.63	1.40
28	NT	NT		

Statistics

Assigned Value	22300	1000
Spike Value	Not Spiked	
Homogeneity Value	22200	2700
Robust Average	22300	1000
Median	22100	1000
Mean	22400	
N	23	
Max	26255	
Min	19200	
Robust SD	2000	
Robust CV	8.7%	


Kernel Density
Density
Result
Results: S1 - Fe
Assigned Value = 22300 ± 1000 mg/kg
Results (mg/kg)
Laboratory
16 2 5 13 21 11 17 6 19 9 18 26 20 10 3 24 27 25 23 8 12 14 15 4 7 28 Md RA HV


z-Scores: S1 - Fe
Standard Deviation for Proficiency Assessment 2200 mg/kg (Equivalent to 10% CV)
z-Score
Laboratory
16 2 5 13 21 11 17 6 19 9 18 26 20 10 3 24 27 25 23 8 12 14 15

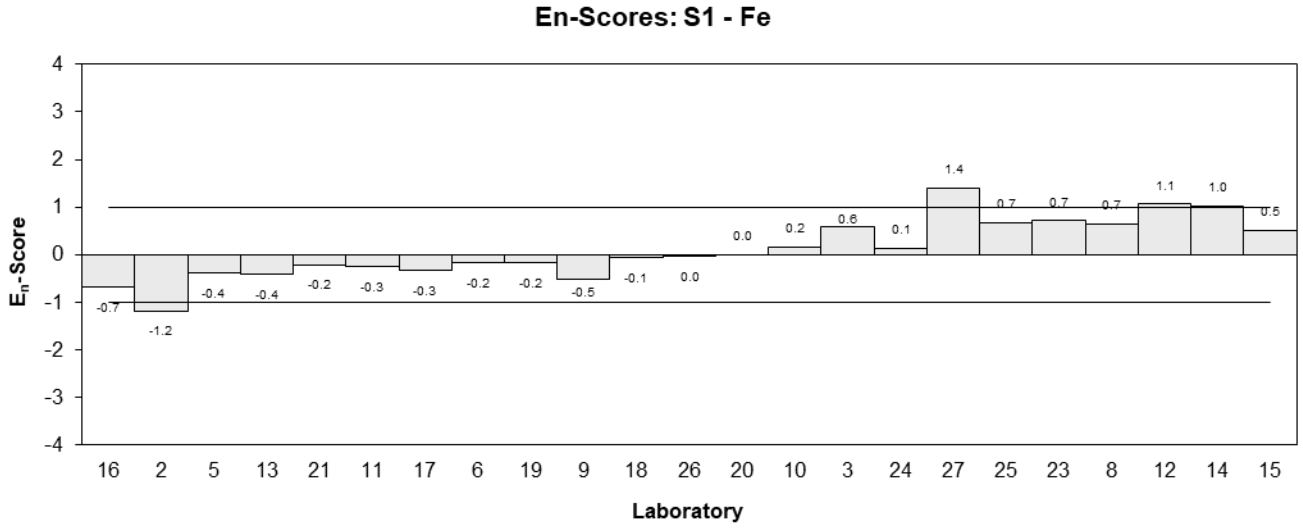

En-Scores: S1 - Fe
En-Score
Laboratory
16 2 5 13 21 11 17 6 19 9 18 26 20 10 3 24 27 25 23 8 12 14 15

Figure 10

Table 22

Sample Details

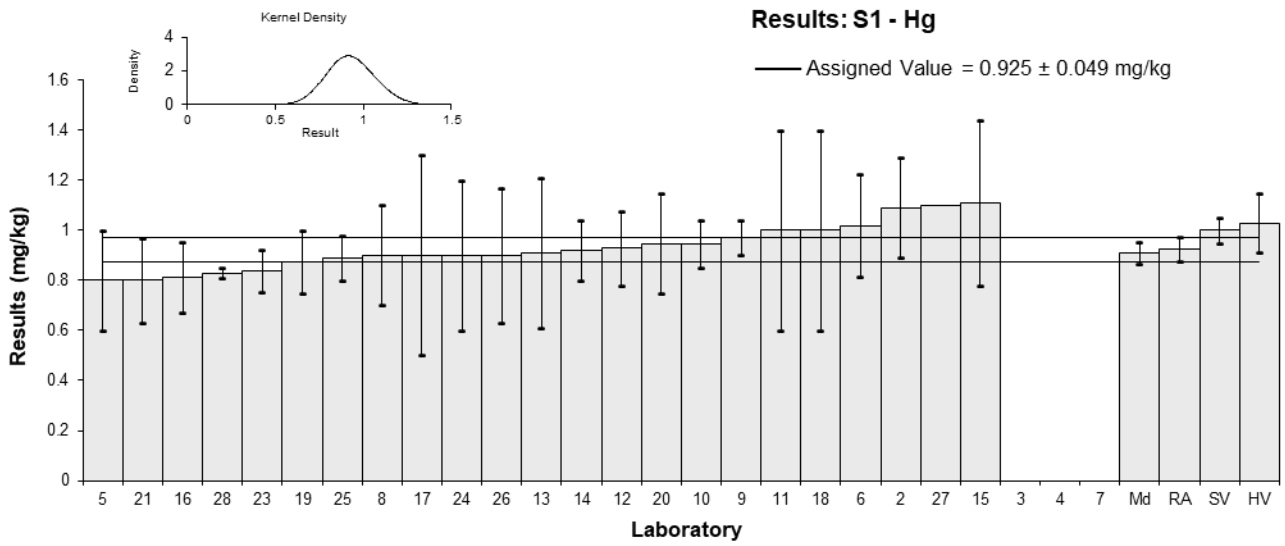
Sample No.	S1
Matrix	Soil
Analyte	Hg
Unit	mg/kg

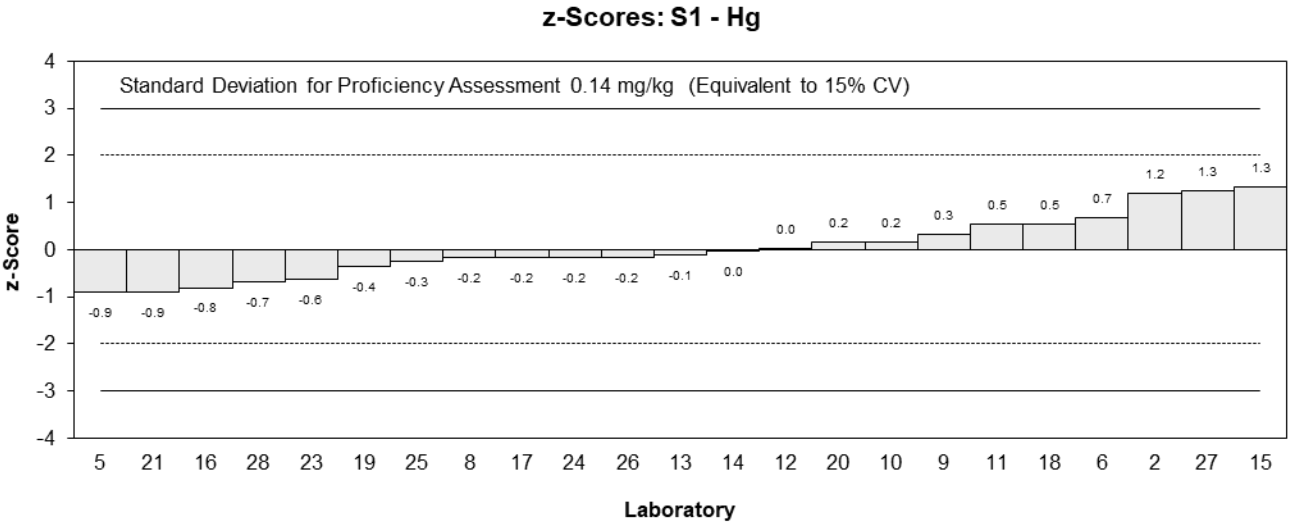
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	1.09	0.2	1.19	0.80
3	< 5	NR		
4	NT	NT		
5	0.8	0.2	-0.90	-0.61
6	1.02	0.204	0.68	0.45
7	NT	NT		
8	0.9	0.2	-0.18	-0.12
9	0.97	0.07	0.32	0.53
10	0.948	0.0948	0.17	0.22
11	1	0.4	0.54	0.19
12	0.928	0.147	0.02	0.02
13	0.91	0.3	-0.11	-0.05
14	0.92	0.12	-0.04	-0.04
15	1.11	0.333	1.33	0.55
16	0.812	0.14	-0.81	-0.76
17	0.9	0.4	-0.18	-0.06
18	1	0.4	0.54	0.19
19	0.874	0.126	-0.37	-0.38
20	0.946	0.2	0.15	0.10
21	0.8	0.17	-0.90	-0.71
23	0.838	0.084	-0.63	-0.89
24	0.9	0.3	-0.18	-0.08
25	0.8886	0.09	-0.26	-0.36
26	0.9	0.27	-0.18	-0.09
27	1.10	NR	1.26	3.57
28	0.83	0.02	-0.68	-1.80

Statistics

Assigned Value	0.925	0.049
Spike Value	1.00	0.05
Homogeneity Value	1.03	0.12
Robust Average	0.925	0.049
Median	0.910	0.046
Mean	0.930	
N	23	
Max	1.11	
Min	0.8	
Robust SD	0.094	
Robust CV	10%	


Results: S1 - Hg
Assigned Value = 0.925 ± 0.049 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
5 21 16 28 23 19 25 8 17 24 26 13 14 12 20 10 9 11 18 6 2 27 15 3 4 7 Md RA SV HV


z-Scores: S1 - Hg
Standard Deviation for Proficiency Assessment 0.14 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
5 21 16 28 23 19 25 8 17 24 26 13 14 12 20 10 9 11 18 6 2 27 15
-0.9 -0.9 -0.8 -0.7 -0.6 -0.4 -0.3 -0.2 -0.2 -0.2 -0.2 -0.1 0.0 0.0 0.2 0.2 0.3 0.5 0.5 0.7 1.2 1.3 1.3

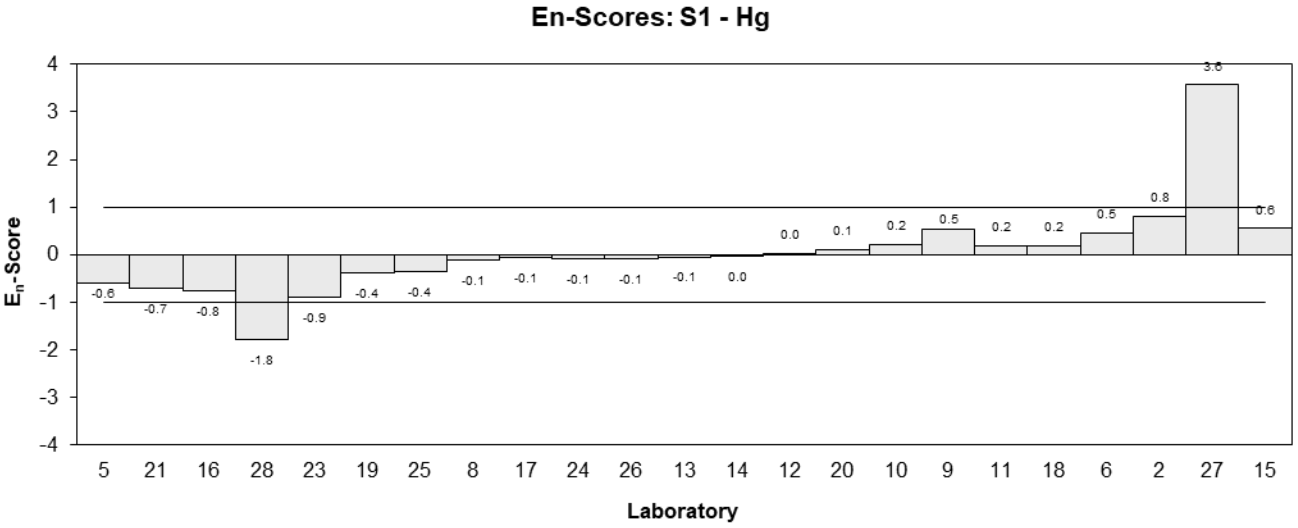

En-Scores: S1 - Hg
En-Score
Laboratory
5 21 16 28 23 19 25 8 17 24 26 13 14 12 20 10 9 11 18 6 2 27 15
-0.6 -0.7 -0.8 -1.8 -0.9 -0.4 -0.4 -0.1 -0.1 -0.1 -0.1 -0.1 0.0 0.0 0.1 0.2 0.5 0.2 0.2 0.5 0.8 3.6 0.6

Figure 11

Table 23

Sample Details

Sample No.	S1
Matrix	Soil
Analyte	Li
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	18.3	2.0	1.01	0.91
3	17	1.7	0.46	0.46
4	NT	NT		
5	NT	NT		
6	15.3	3.07	-0.25	-0.17
7	NT	NT		
8	9.7	2.4	-2.60	-2.11
9	NT	NT		
10	17.3	1.73	0.59	0.58
11	19	5	1.30	0.59
12	11.370	1.846	-1.90	-1.81
13	NT	NT		
14	16.2	2.0	0.13	0.11
15	16.57	4.971	0.28	0.13
16	12.6	2.5	-1.38	-1.09
17	18	4	0.88	0.48
18	22	4	2.56	1.40
19	16.5	3.2	0.25	0.17
20	14.8	3	-0.46	-0.32
21	12.1	2.73	-1.59	-1.18
23	15.312	1.531	-0.25	-0.26
24	NT	NT		
25	NT	NT		
26	16.9	5.07	0.42	0.19
27	17.0	NR	0.46	0.65
28	NT	NT		

Statistics

Assigned Value	15.9	1.7
Spike Value	Not Spiked	
Homogeneity Value	14.5	1.7
Robust Average	15.9	1.7
Median	16.5	1.2
Mean	15.9	
N	18	
Max	22	
Min	9.7	
Robust SD	2.9	
Robust CV	18%	

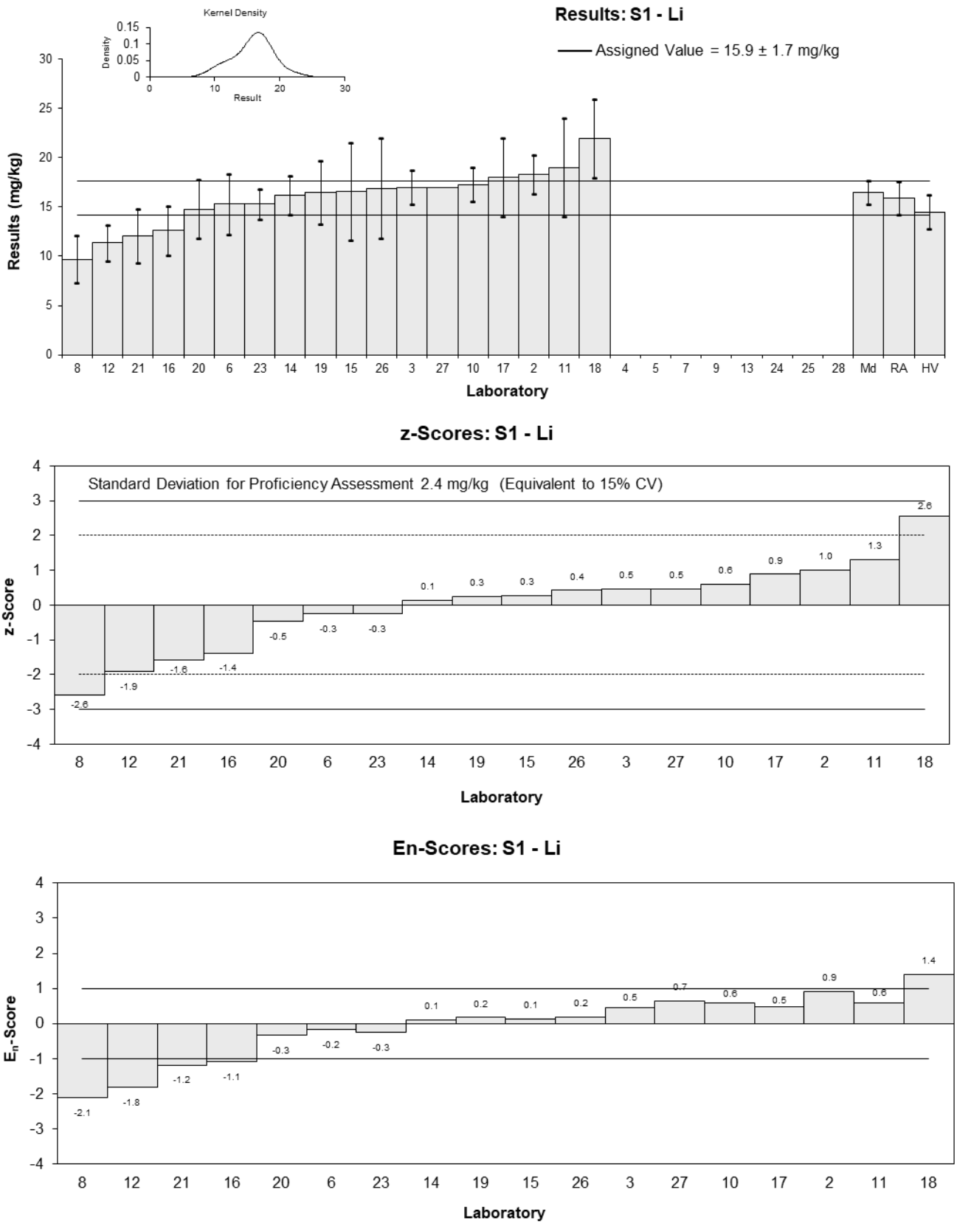

Results: S1 - Li
Assigned Value = 15.9 ± 1.7 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
8 12 21 16 20 6 23 14 19 15 26 3 27 10 17 2 11 18 4 5 7 9 13 24 25 28 Md RA HV
z-Scores: S1 - Li
Standard Deviation for Proficiency Assessment 2.4 mg/kg (Equivalent to 15% CV)
z-Score
-2.6 -1.9 -1.6 -1.4 -0.5 -0.3 -0.3 0.1 0.3 0.3 0.4 0.5 0.5 0.6 0.9 1.0 1.3 2.6
8 12 21 16 20 6 23 14 19 15 26 3 27 10 17 2 11 18
Laboratory
En-Scores: S1 - Li
En-Score
-2.1 -1.8 -1.2 -1.1 -0.3 -0.2 -0.3 0.1 0.2 0.1 0.2 0.5 0.7 0.6 0.5 0.9 0.6 1.4
8 12 21 16 20 6 23 14 19 15 26 3 27 10 17 2 11 18
Laboratory

Figure 12

Table 24

Sample Details

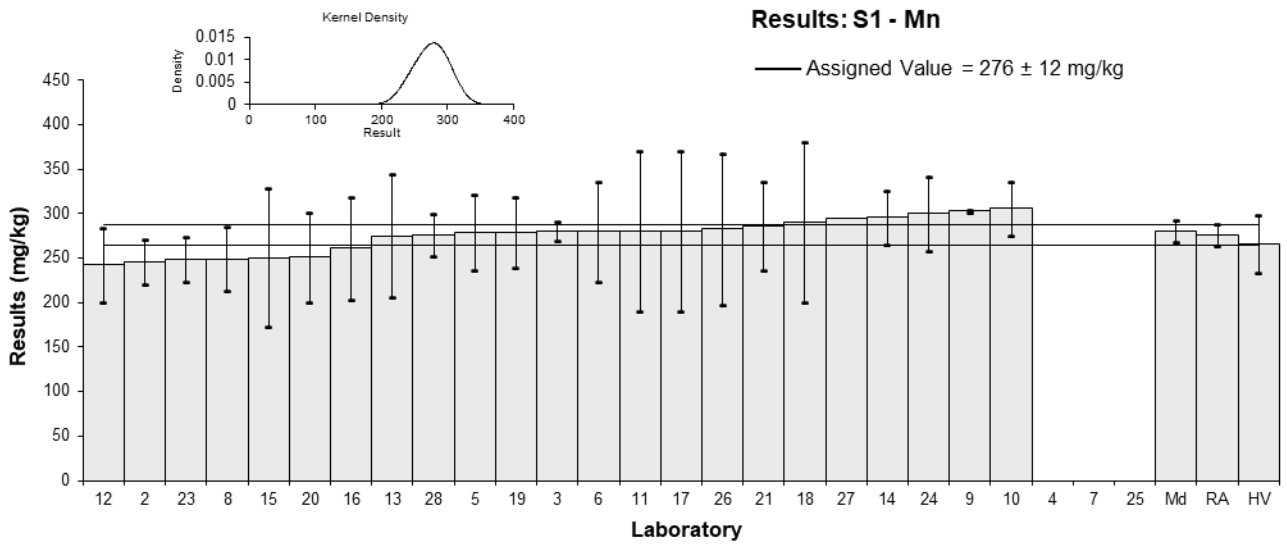
Sample No.	S1
Matrix	Soil
Analyte	Mn
Unit	mg/kg

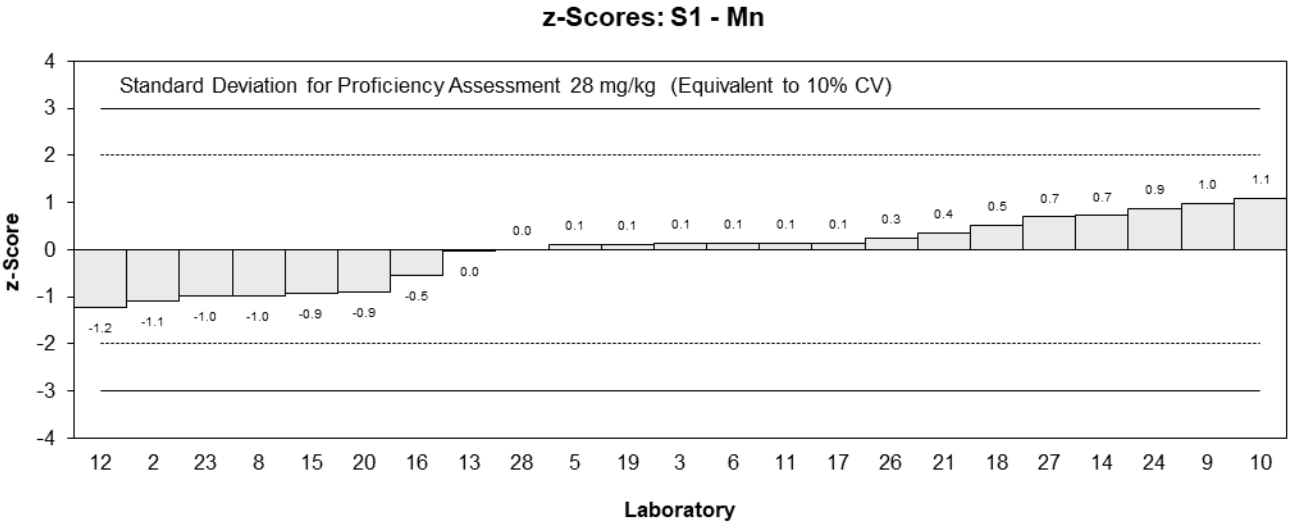
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	246	25	-1.09	-1.08
3	280	11	0.14	0.25
4	NT	NT		
5	279	42	0.11	0.07
6	280	55.9	0.14	0.07
7	NT	NT		
8	249	36	-0.98	-0.71
9	303	1.25	0.98	2.24
10	306	30.6	1.09	0.91
11	280	90	0.14	0.04
12	242.327	42.249	-1.22	-0.77
13	275	69	-0.04	-0.01
14	296	30	0.72	0.62
15	250.63	77.695	-0.92	-0.32
16	261	57	-0.54	-0.26
17	280	90	0.14	0.04
18	290	90	0.51	0.15
19	279	40	0.11	0.07
20	251	50	-0.91	-0.49
21	286	49.9	0.36	0.19
23	248.734	24.873	-0.99	-0.99
24	300	42	0.87	0.55
25	NT	NT		
26	283	84.9	0.25	0.08
27	295	NR	0.69	1.58
28	276	24	0.00	0.00

Statistics

Assigned Value	276	12
Spike Value	Not Spiked	
Homogeneity Value	266	32
Robust Average	276	12
Median	280	12
Mean	276	
N	23	
Max	306	
Min	242.327	
Robust SD	22	
Robust CV	8%	


Kernel Density
Density
0.015
0.01
0.005
0
0
100
200
300
400
Result
Results: S1 - Mn
Assigned Value = 276 ± 12 mg/kg
Results (mg/kg)
450
400
350
300
250
200
150
100
50
0
12 2 23 8 15 20 16 13 28 5 19 3 6 11 17 26 21 18 27 14 24 9 10 4 7 25 Md RA HV
Laboratory


z-Scores: S1 - Mn
Standard Deviation for Proficiency Assessment 28 mg/kg (Equivalent to 10% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-1.2 -1.1 -1.0 -1.0 -0.9 -0.9 -0.5 0.0 0.0 0.1 0.1 0.1 0.1 0.1 0.1 0.3 0.4 0.5 0.7 0.7 0.9 1.0 1.1
12 2 23 8 15 20 16 13 28 5 19 3 6 11 17 26 21 18 27 14 24 9 10
Laboratory

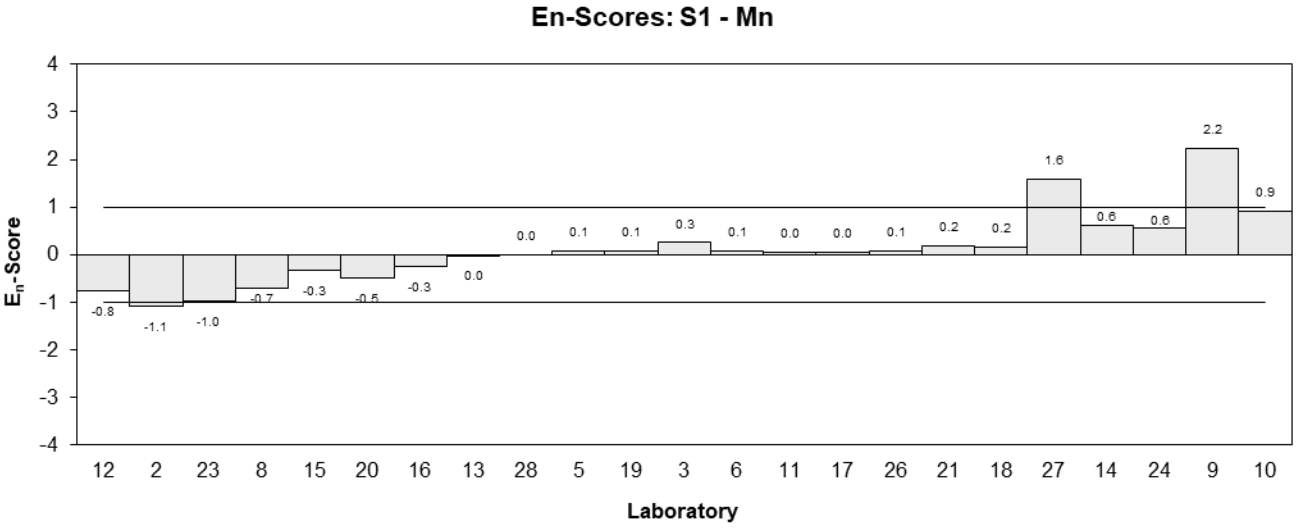

En-Scores: S1 - Mn
En-Score
4
3
2
1
0
-1
-2
-3
-4
-0.8 -1.1 -1.0 -0.7 -0.3 -0.5 -0.3 0.0 0.0 0.1 0.1 0.3 0.1 0.0 0.0 0.1 0.2 0.2 1.6 0.6 0.6 2.2 0.9
12 2 23 8 15 20 16 13 28 5 19 3 6 11 17 26 21 18 27 14 24 9 10
Laboratory

Figure 13

Table 25

Sample Details

Sample No.	S1
Matrix	Soil
Analyte	Mo
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	1.29	0.2	0.08	0.08
3	1.2	0.072	-0.28	-0.44
4	NT	NT		
5	NT	NT		
6	<10	NR		
7	NT	NT		
8	1.1	0.1	-0.67	-0.99
9	1.27	0.15	0.00	0.00
10	1.40	0.14	0.51	0.66
11	1.6	1	1.30	0.33
12	1.352	0.247	0.32	0.29
13	1	0.5	-1.06	-0.52
14	1.41	0.20	0.55	0.57
15	1.77	0.566	1.97	0.86
16	1.03	0.15	-0.94	-1.17
17	1	0.4	-1.06	-0.64
18	1.1	0.4	-0.67	-0.40
19	< 5	NR		
20	<2	NR		
21	1.2	0.19	-0.28	-0.30
23	1.428	0.143	0.62	0.79
24	NR	NR		
25	1.33	0.1	0.24	0.35
26	< 5	1.5		
27	<5	NR		
28	NT	NT		

Statistics

Assigned Value	1.27	0.14
Spike Value	Not Spiked	
Homogeneity Value	1.34	0.16
Robust Average	1.27	0.14
Median	1.28	0.13
Mean	1.28	
N	16	
Max	1.77	
Min	1	
Robust SD	0.22	
Robust CV	17%	

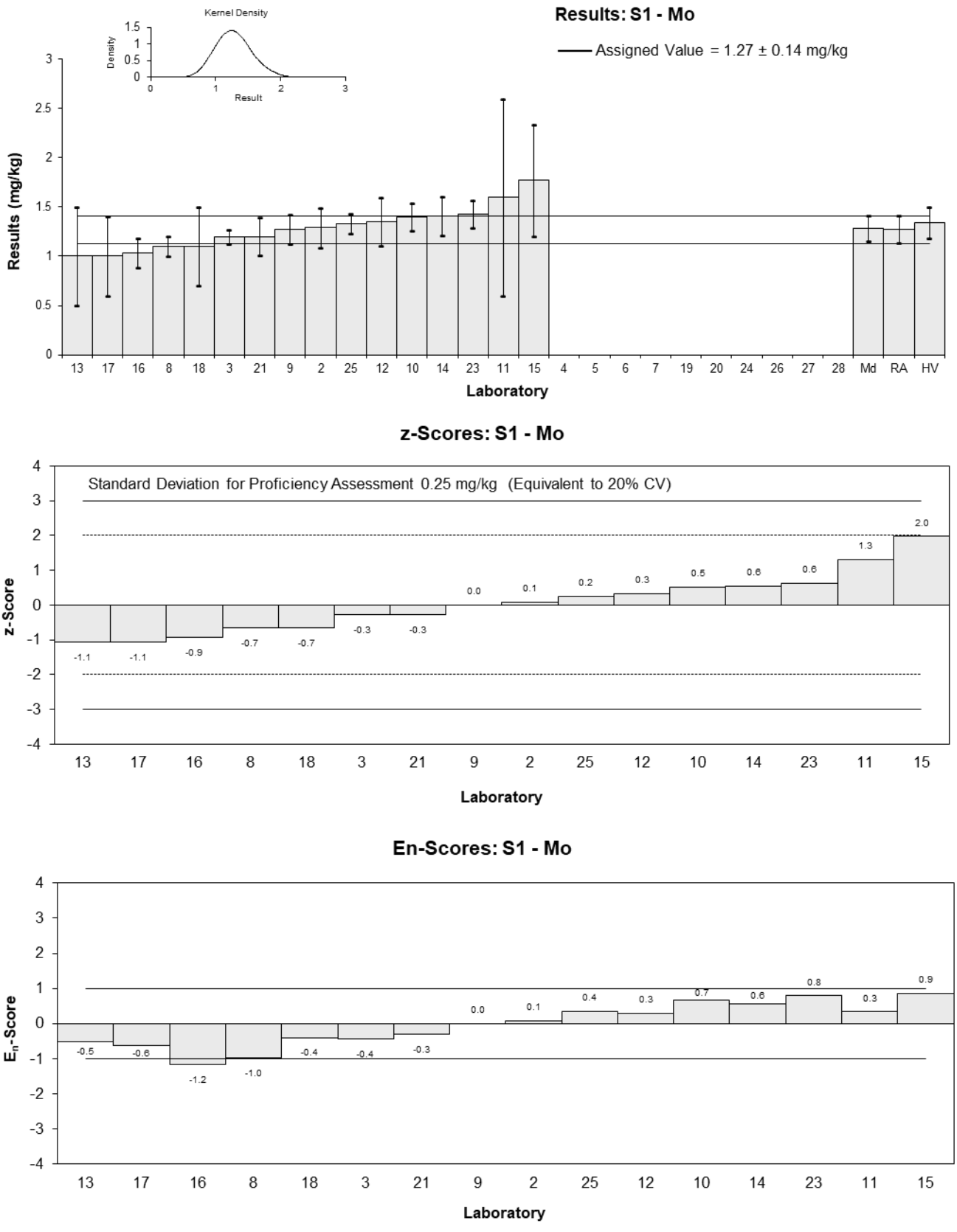

Results: S1 - Mo
Assigned Value = 1.27 ± 0.14 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
13 17 16 8 18 3 21 9 2 25 12 10 14 23 11 15 4 5 6 7 19 20 24 26 27 28 Md RA HV
z-Scores: S1 - Mo
Standard Deviation for Proficiency Assessment 0.25 mg/kg (Equivalent to 20% CV)
z-Score
-1.1 -1.1 -0.9 -0.7 -0.7 -0.3 -0.3 0.0 0.1 0.2 0.3 0.5 0.6 0.6 1.3 2.0
13 17 16 8 18 3 21 9 2 25 12 10 14 23 11 15
Laboratory
En-Scores: S1 - Mo
En-Score
-0.5 -0.6 -1.2 -1.0 -0.4 -0.4 -0.3 0.0 0.1 0.4 0.3 0.7 0.6 0.8 0.3 0.9
13 17 16 8 18 3 21 9 2 25 12 10 14 23 11 15
Laboratory

Figure 14

Table 26

Sample Details

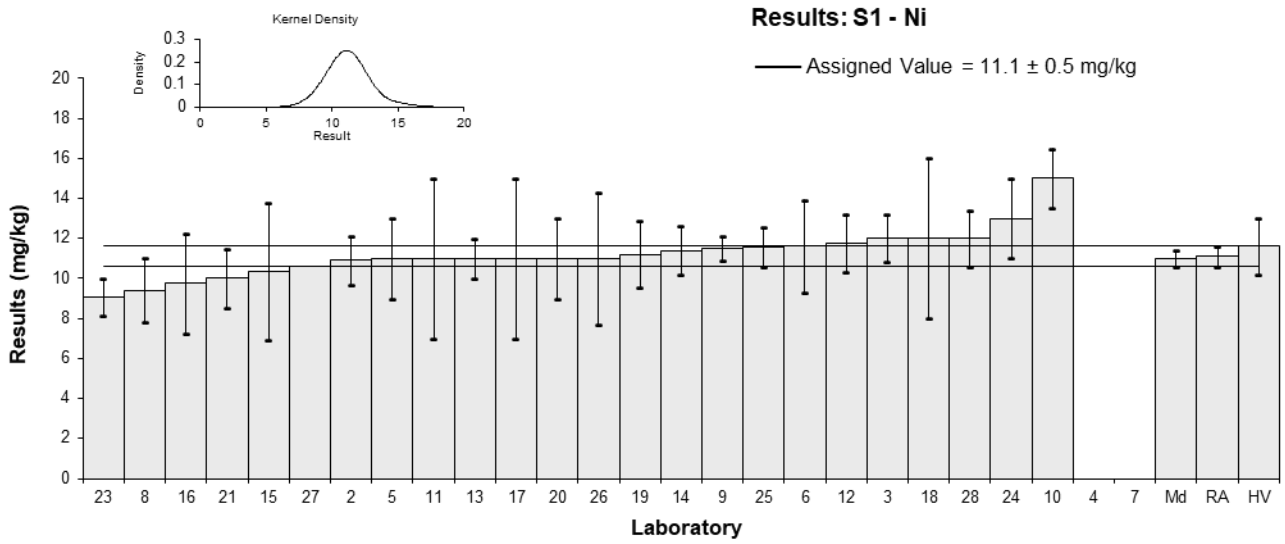
Sample No.	S1
Matrix	Soil
Analyte	Ni
Unit	mg/kg

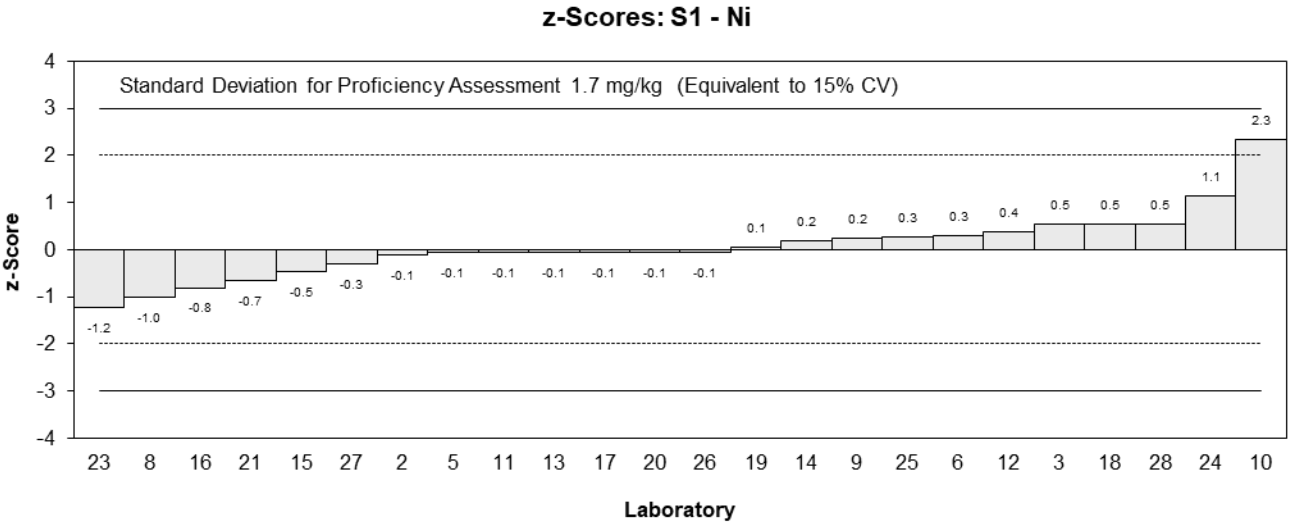
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	10.9	1.2	-0.12	-0.15
3	12	1.2	0.54	0.69
4	NT	NT		
5	11	2	-0.06	-0.05
6	11.6	2.32	0.30	0.21
7	NT	NT		
8	9.4	1.6	-1.02	-1.01
9	11.50	0.6	0.24	0.51
10	15.0	1.5	2.34	2.47
11	11	4	-0.06	-0.02
12	11.757	1.469	0.39	0.42
13	11	1	-0.06	-0.09
14	11.4	1.2	0.18	0.23
15	10.34	3.412	-0.46	-0.22
16	9.75	2.5	-0.81	-0.53
17	11	4	-0.06	-0.02
18	12	4	0.54	0.22
19	11.2	1.65	0.06	0.06
20	11	2	-0.06	-0.05
21	10	1.48	-0.66	-0.70
23	9.070	0.907	-1.22	-1.96
24	13	2	1.14	0.92
25	11.55	1	0.27	0.40
26	11	3.3	-0.06	-0.03
27	10.6	NR	-0.30	-1.00
28	12	1.4	0.54	0.61

Statistics

Assigned Value	11.1	0.5
Spike Value	Not Spiked	
Homogeneity Value	11.6	1.4
Robust Average	11.1	0.5
Median	11.0	0.4
Mean	11.2	
N	24	
Max	15.0	
Min	9.070	
Robust SD	0.92	
Robust CV	8.3%	


Results: S1 - Ni
Assigned Value = 11.1 ± 0.5 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
23 8 16 21 15 27 2 5 11 13 17 20 26 19 14 9 25 6 12 3 18 28 24 10 4 7 Md RA HV


z-Scores: S1 - Ni
Standard Deviation for Proficiency Assessment 1.7 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
23 8 16 21 15 27 2 5 11 13 17 20 26 19 14 9 25 6 12 3 18 28 24 10
-1.2 -1.0 -0.8 -0.7 -0.5 -0.3 -0.1 -0.1 -0.1 -0.1 -0.1 -0.1 -0.1 0.1 0.2 0.2 0.3 0.3 0.4 0.5 0.5 0.5 1.1 2.3

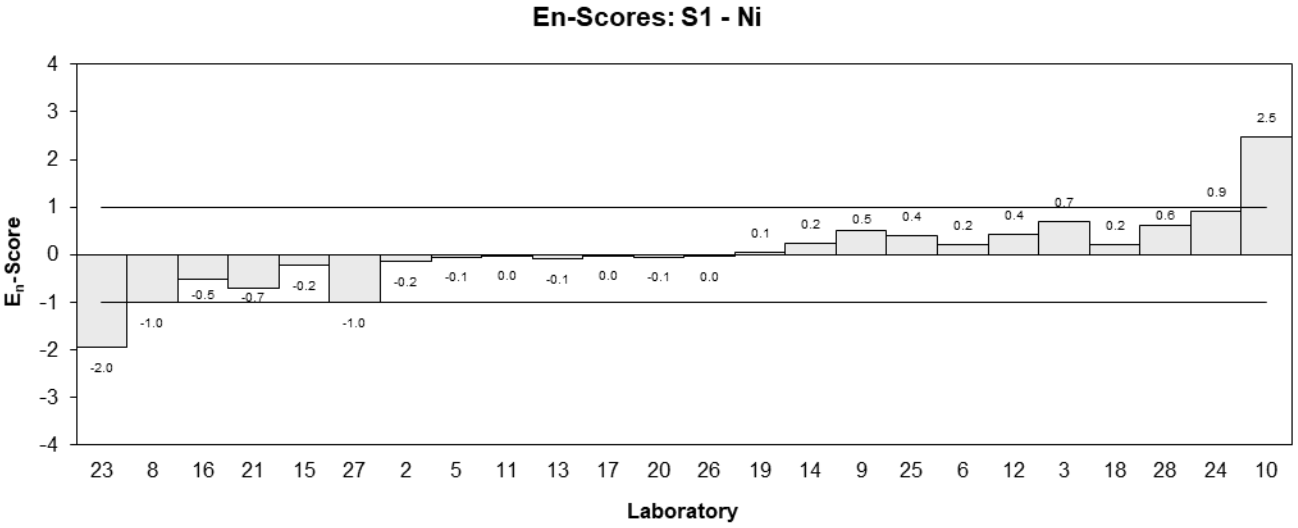

En-Scores: S1 - Ni
En-Score
Laboratory
23 8 16 21 15 27 2 5 11 13 17 20 26 19 14 9 25 6 12 3 18 28 24 10
-2.0 -1.0 -0.5 -0.7 -0.2 -1.0 -0.2 -0.1 0.0 -0.1 0.0 -0.1 0.0 0.1 0.2 0.5 0.4 0.2 0.4 0.7 0.2 0.6 0.9 2.5

Figure 15

Table 27

Sample Details

Sample No.	S1
Matrix	Soil
Analyte	Pb
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	105	10	-0.95	-1.02
3	120	12	0.34	0.32
4	NT	NT		
5	125	19	0.78	0.46
6	118	23.7	0.17	0.08
7	NT	NT		
8	111	14	-0.43	-0.34
9	120.55	3.7	0.39	0.84
10	131	13.1	1.29	1.10
11	110	40	-0.52	-0.15
12	117.31	14.962	0.11	0.08
13	106	12	-0.86	-0.79
14	115	14	-0.09	-0.07
15	114.60	38.964	-0.12	-0.04
16	117	18	0.09	0.05
17	110	40	-0.52	-0.15
18	120	40	0.34	0.10
19	112	14	-0.34	-0.27
20	115	20	-0.09	-0.05
21	120	20.3	0.34	0.19
23	118.121	11.812	0.18	0.17
24	130	23	1.21	0.60
25	129.3	10	1.15	1.23
26	115	34.5	-0.09	-0.03
27	109	NR	-0.60	-1.75
28	108	5	-0.69	-1.25

Statistics

Assigned Value	116	4
Spike Value	Not Spiked	
Homogeneity Value	120	14
Robust Average	116	4
Median	116	3
Mean	117	
N	24	
Max	131	
Min	105	
Robust SD	7.5	
Robust CV	6.4%	

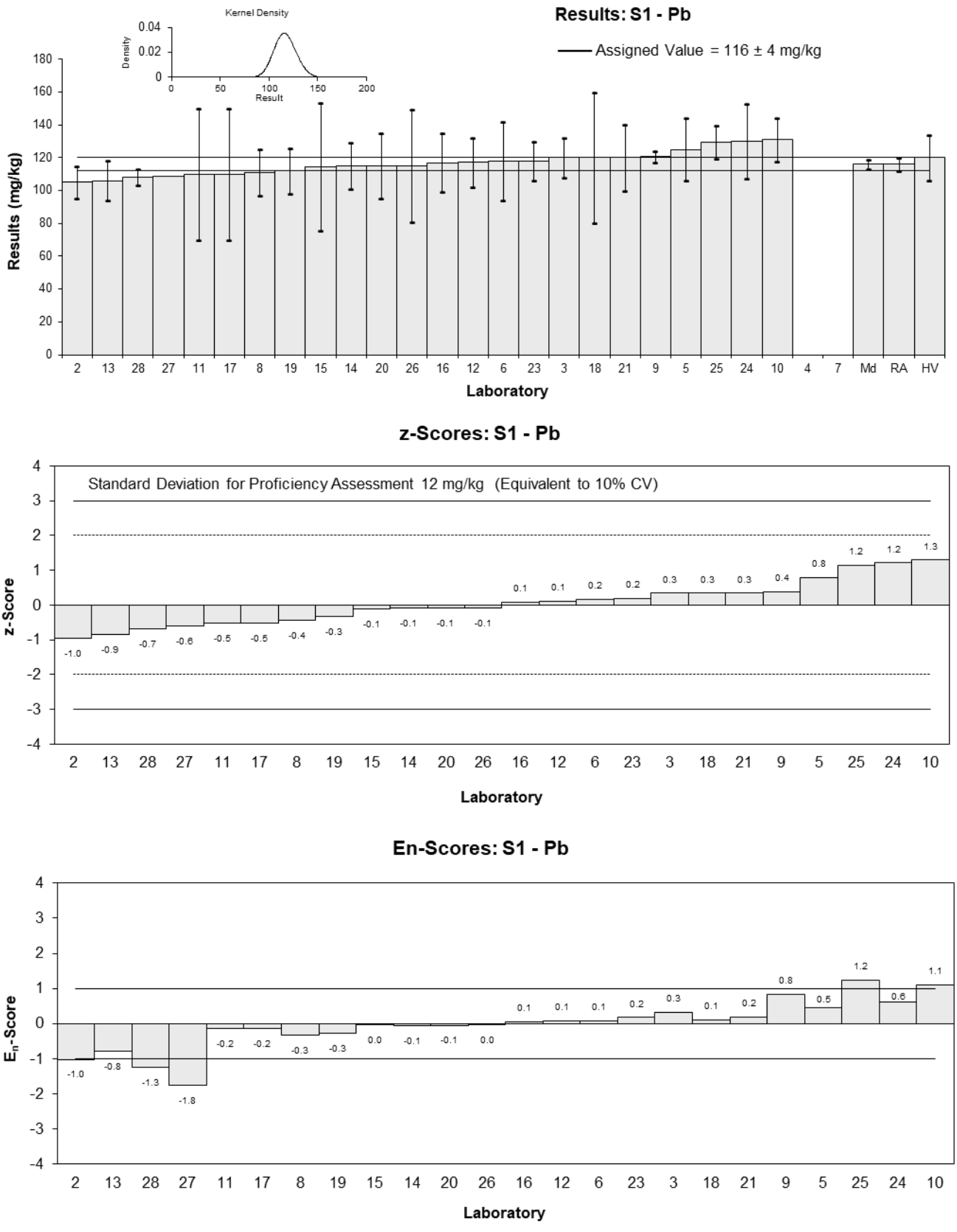

Results: S1 - Pb
Assigned Value = 116 ± 4 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
2 13 28 27 11 17 8 19 15 14 20 26 16 12 6 23 3 18 21 9 5 25 24 10 4 7 Md RA HV
z-Scores: S1 - Pb
Standard Deviation for Proficiency Assessment 12 mg/kg (Equivalent to 10% CV)
z-Score
-1.0 -0.9 -0.7 -0.6 -0.5 -0.5 -0.4 -0.3 -0.1 -0.1 -0.1 -0.1 0.1 0.1 0.2 0.2 0.3 0.3 0.3 0.4 0.8 1.2 1.2 1.3
2 13 28 27 11 17 8 19 15 14 20 26 16 12 6 23 3 18 21 9 5 25 24 10
Laboratory
En-Scores: S1 - Pb
En-Score
-1.0 -0.8 -1.3 -1.8 -0.2 -0.2 -0.3 -0.3 0.0 -0.1 -0.1 0.0 0.1 0.1 0.1 0.2 0.3 0.1 0.2 0.8 0.5 1.2 0.6 1.1
2 13 28 27 11 17 8 19 15 14 20 26 16 12 6 23 3 18 21 9 5 25 24 10
Laboratory

Figure 16

Table 28

Sample Details

Sample No.	S1
Matrix	Soil
Analyte	Sb
Unit	mg/kg

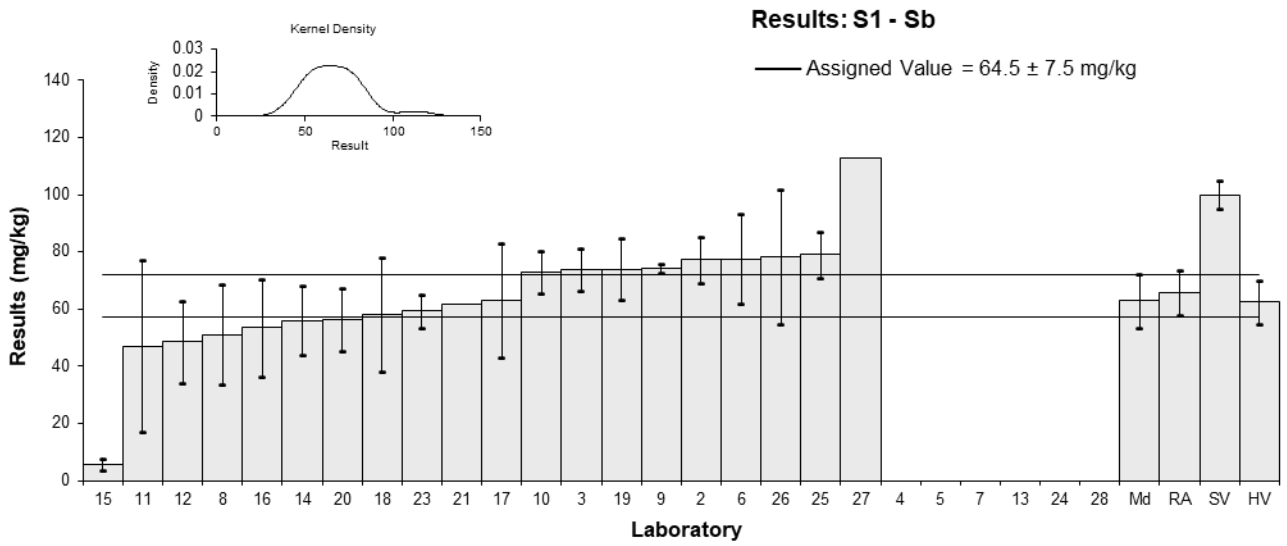
Participant Results

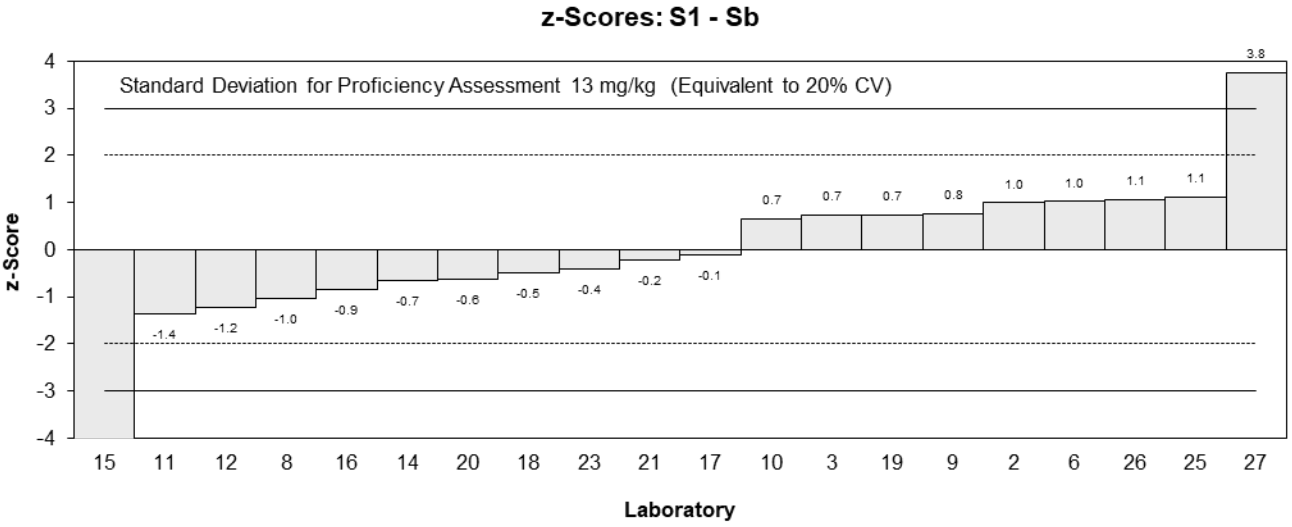
Lab. Code	Result	Uncertainty	z	E_n
2	77.3	8.0	0.99	1.17
3	74	7.4	0.74	0.90
4	NT	NT		
5	NT	NT		
6	77.6	15.5	1.02	0.76
7	NT	NT		
8	51.1	17.6	-1.04	-0.70
9	74.27	1.5	0.76	1.28
10	73.0	7.3	0.66	0.81
11	47	30	-1.36	-0.57
12	48.503	14.398	-1.24	-0.99
13	NT	NT		
14	56	12	-0.66	-0.60
15**	5.67	1.985	-4.56	-7.58
16	53.4	17	-0.86	-0.60
17	63	20	-0.12	-0.07
18	58	20	-0.50	-0.30
19	74	10.6	0.74	0.73
20	56.2	11	-0.64	-0.62
21	61.5	NR	-0.23	-0.40
23	59.225	5.923	-0.41	-0.55
24	NT	NT		
25	78.99	8	1.12	1.32
26	78.2	23.5	1.06	0.56
27*	113	NR	3.76	6.47
28	NT	NT		

* Outlier, ** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	64.5	7.5
Spike Value	100.0	4.9
Homogeneity Value	62.4	7.5
Robust Average	65.7	7.8
Median	63.0	9.4
Mean	67.1	
N	19	
Max	113	
Min	47	
Robust SD	14	
Robust CV	21%	


Results: S1 - Sb
Kernel Density
Density
Result
Assigned Value = 64.5 ± 7.5 mg/kg
Results (mg/kg)
Laboratory
15 11 12 8 16 14 20 18 23 21 17 10 3 19 9 2 6 26 25 27 4 5 7 13 24 28 Md RA SV HV


z-Scores: S1 - Sb
Standard Deviation for Proficiency Assessment 13 mg/kg (Equivalent to 20% CV)
z-Score
Laboratory
15 11 12 8 16 14 20 18 23 21 17 10 3 19 9 2 6 26 25 27

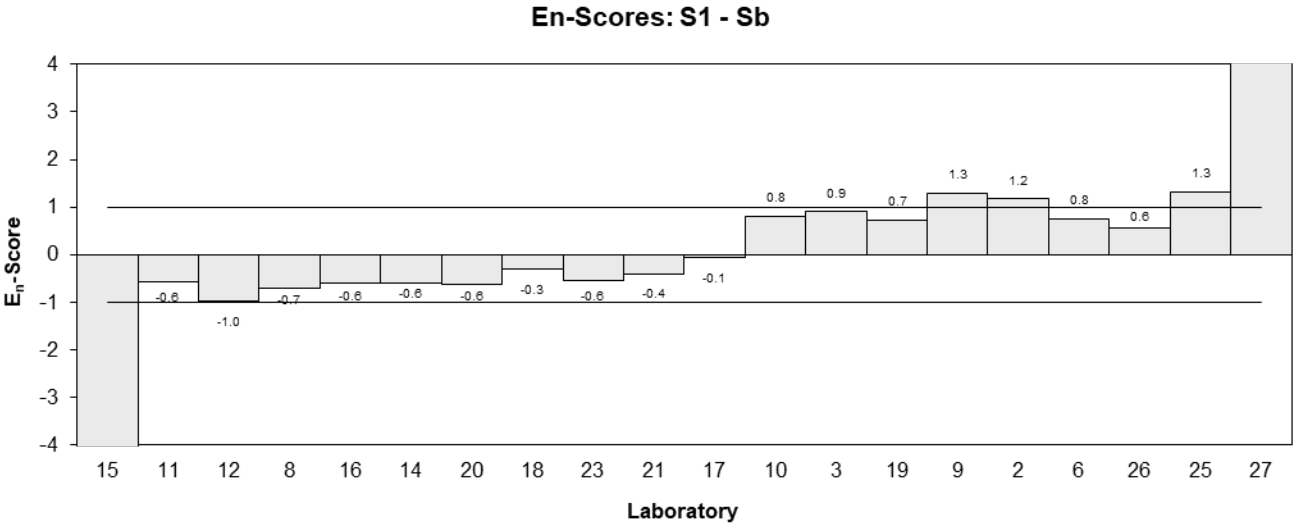

En-Scores: S1 - Sb
En-Score
Laboratory
15 11 12 8 16 14 20 18 23 21 17 10 3 19 9 2 6 26 25 27

Figure 17

Table 29

Sample Details

Sample No.	S1
Matrix	Soil
Analyte	Se
Unit	mg/kg

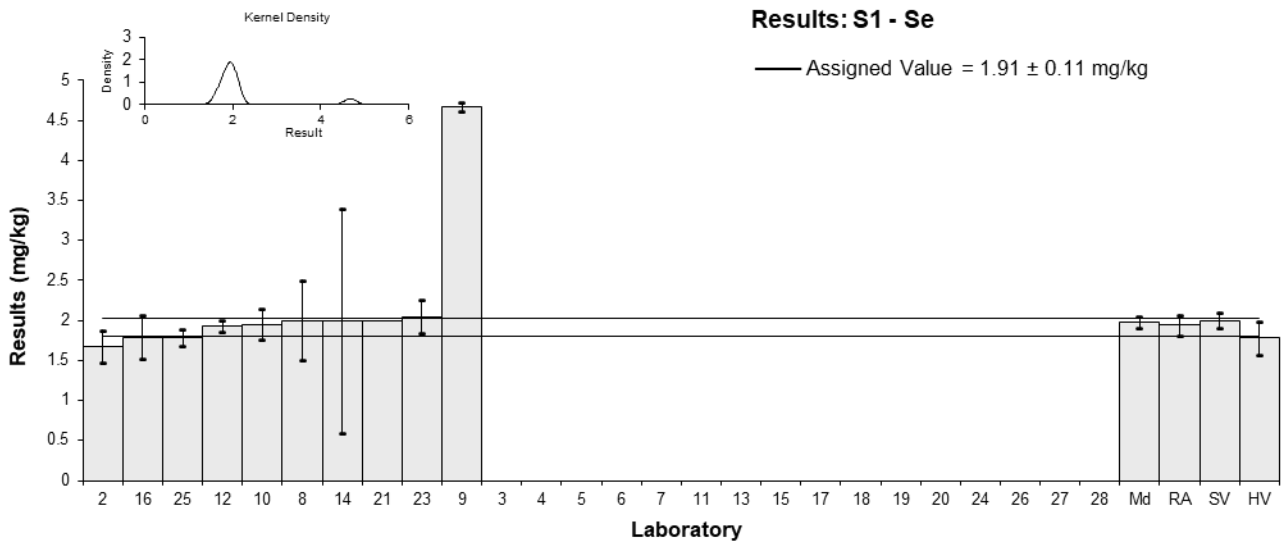
Participant Results

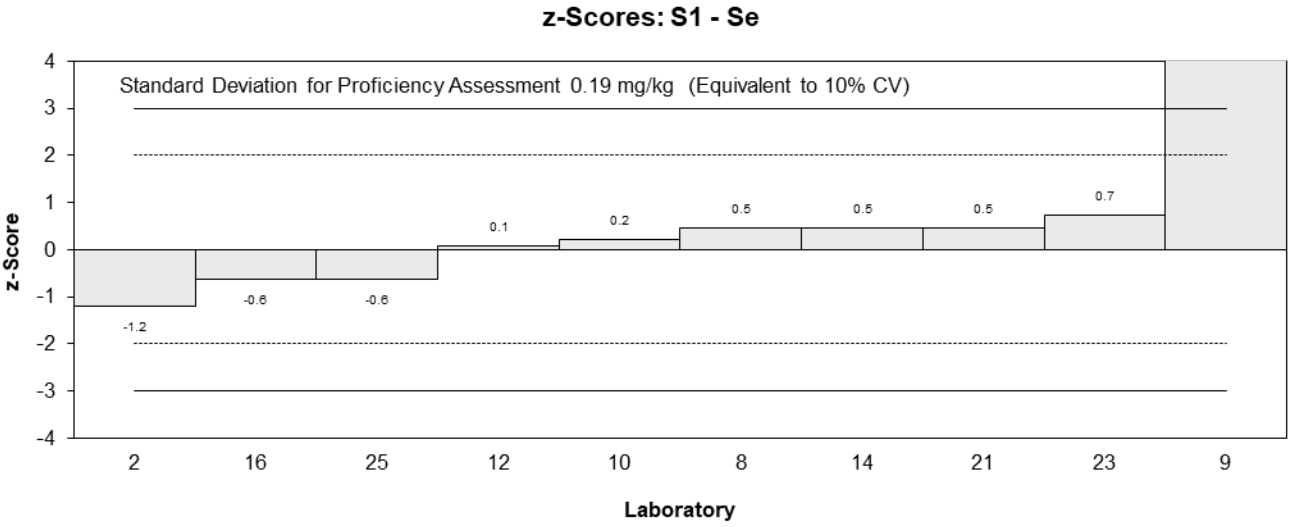
Lab. Code	Result	Uncertainty	z	E_n
2	1.68	0.2	-1.20	-1.01
3	< 10	NR		
4	NT	NT		
5	NT	NT		
6	<2	NR		
7	NT	NT		
8	2	0.5	0.47	0.18
9*	4.67	0.05	14.45	22.84
10	1.95	0.195	0.21	0.18
11	<2	NR		
12	1.928	0.070	0.09	0.14
13	<5	NR		
14	2.0	1.4	0.47	0.06
15	<2	<2		
16	1.79	0.27	-0.63	-0.41
17	<2	NR		
18	<2	NR		
19	< 2	NR		
20	<8	NR		
21	2	NR	0.47	0.82
23	2.049	0.205	0.73	0.60
24	NR	NR		
25	1.79	0.1	-0.63	-0.81
26	< 2	0.6		
27	<100	NR		
28	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	1.91	0.11
Spike Value	2.00	0.10
Homogeneity Value	1.78	0.21
Robust Average	1.94	0.13
Median	1.98	0.07
Mean	2.19	
N	10	
Max	4.67	
Min	1.68	
Robust SD	0.16	
Robust CV	8.5%	


Kernel Density
Density
Result
Results: S1 - Se
Assigned Value = 1.91 ± 0.11 mg/kg
Results (mg/kg)
Laboratory
2 16 25 12 10 8 14 21 23 9 3 4 5 6 7 11 13 15 17 18 19 20 24 26 27 28 Md RA SV HV


z-Scores: S1 - Se
Standard Deviation for Proficiency Assessment 0.19 mg/kg (Equivalent to 10% CV)
z-Score
-1.2
-0.6
-0.6
0.1
0.2
0.5
0.5
0.5
0.7
Laboratory
2 16 25 12 10 8 14 21 23 9

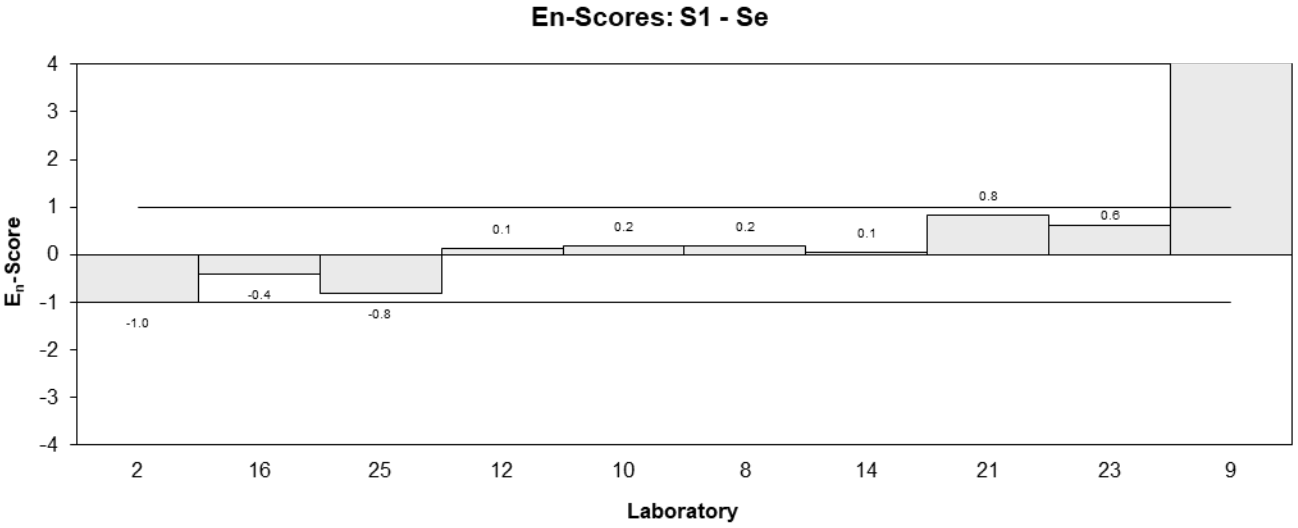

En-Scores: S1 - Se
En-Score
-1.0
-0.4
-0.8
0.1
0.2
0.2
0.1
0.8
0.6
Laboratory
2 16 25 12 10 8 14 21 23 9

Figure 18

Table 30

Sample Details

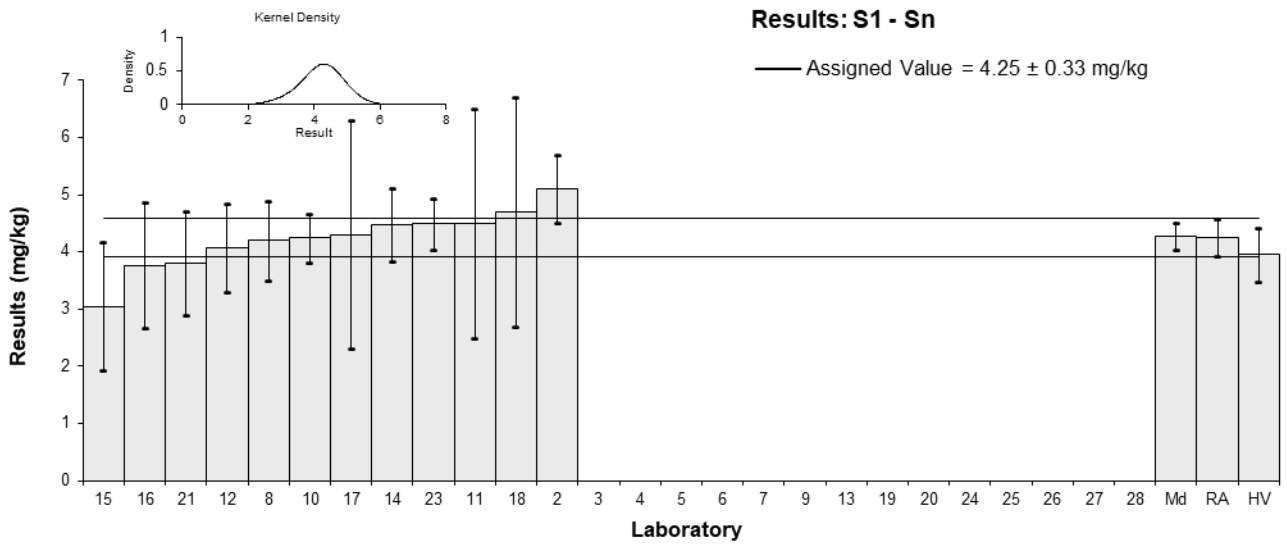
Sample No.	S1
Matrix	Soil
Analyte	Sn
Unit	mg/kg

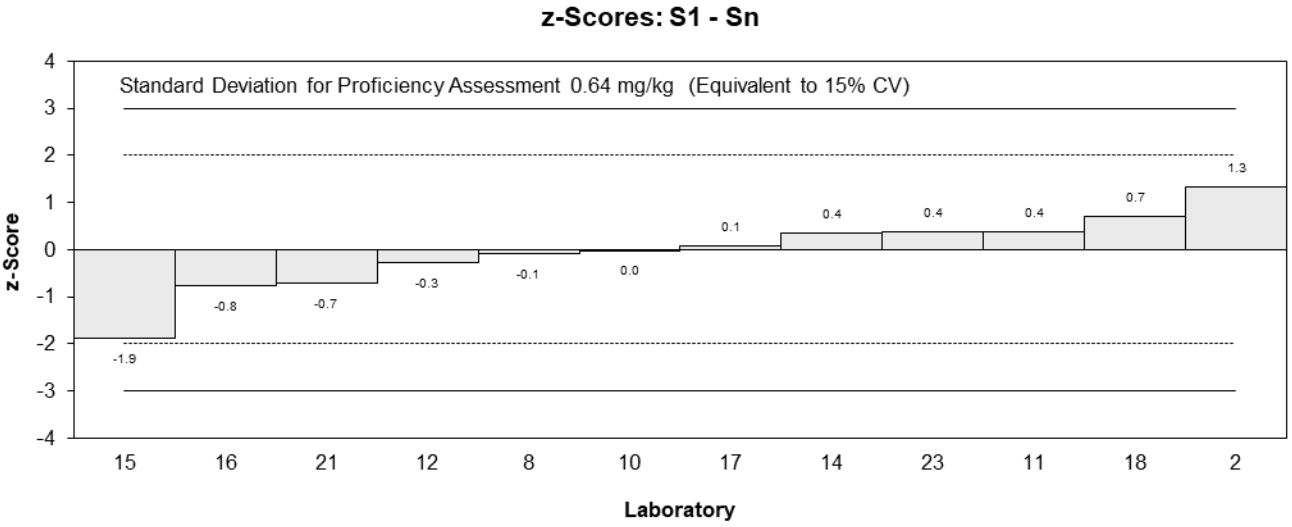
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	5.10	0.6	1.33	1.24
3	< 10	NR		
4	NT	NT		
5	NT	NT		
6	<10	NR		
7	NT	NT		
8	4.2	0.7	-0.08	-0.06
9	NT	NT		
10	4.24	0.424	-0.02	-0.02
11	4.5	2	0.39	0.12
12	4.067	0.777	-0.29	-0.22
13	NT	NT		
14	4.48	0.64	0.36	0.32
15	3.05	1.129	-1.88	-1.02
16	3.76	1.1	-0.77	-0.43
17	4.3	2	0.08	0.02
18	4.7	2	0.71	0.22
19	< 10	NR		
20	NT	NT		
21	3.8	0.91	-0.71	-0.46
23	4.495	0.450	0.38	0.44
24	NT	NT		
25	NT	NT		
26	< 10	3.33		
27	NR	NR		
28	NT	NT		

Statistics

Assigned Value	4.25	0.33
Spike Value	Not Spiked	
Homogeneity Value	3.95	0.47
Robust Average	4.25	0.33
Median	4.27	0.24
Mean	4.22	
N	12	
Max	5.10	
Min	3.05	
Robust SD	0.46	
Robust CV	11%	


Results: S1 - Sn
Assigned Value = 4.25 ± 0.33 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
15 16 21 12 8 10 17 14 23 11 18 2 3 4 5 6 7 9 13 19 20 24 25 26 27 28 Md RA HV


z-Scores: S1 - Sn
Standard Deviation for Proficiency Assessment 0.64 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
15 16 21 12 8 10 17 14 23 11 18 2
-1.9 -0.8 -0.7 -0.3 -0.1 0.0 0.1 0.4 0.4 0.4 0.7 1.3

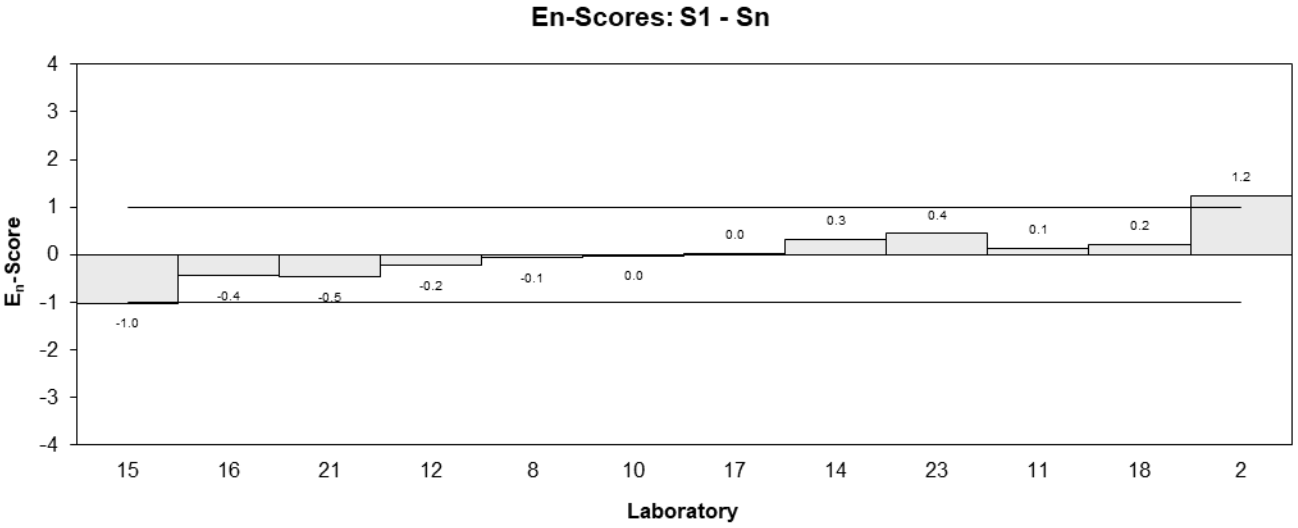

En-Scores: S1 - Sn
En-Score
Laboratory
15 16 21 12 8 10 17 14 23 11 18 2
-1.0 -0.4 -0.5 -0.2 -0.1 0.0 0.0 0.3 0.4 0.1 0.2 1.2

Figure 19

Table 31

Sample Details

Sample No.	S1
Matrix	Soil
Analyte	Th
Unit	mg/kg

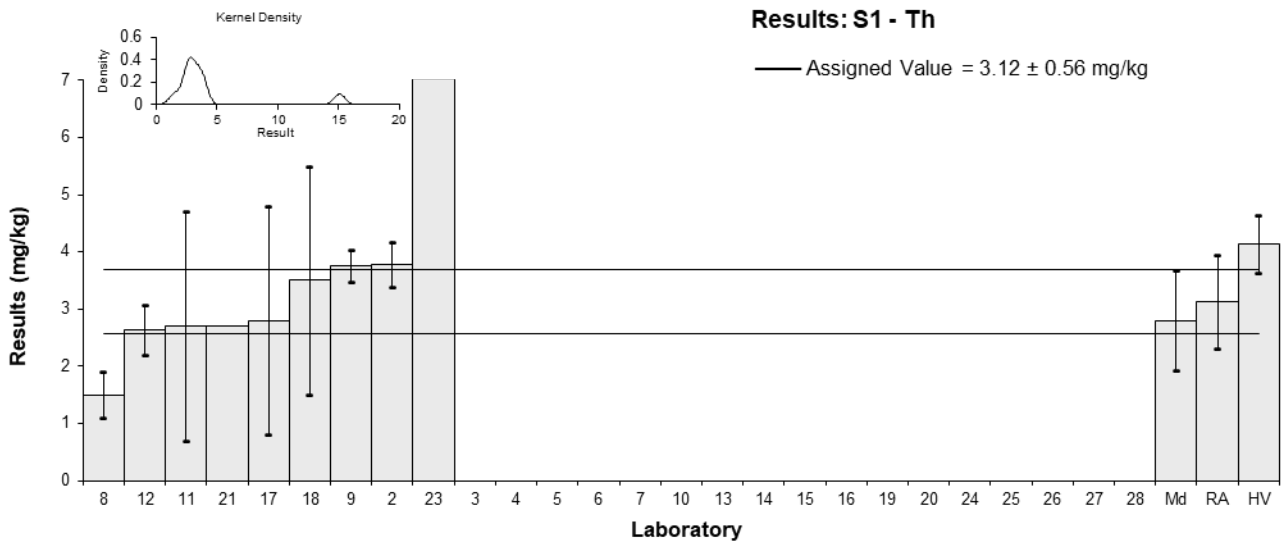
Participant Results

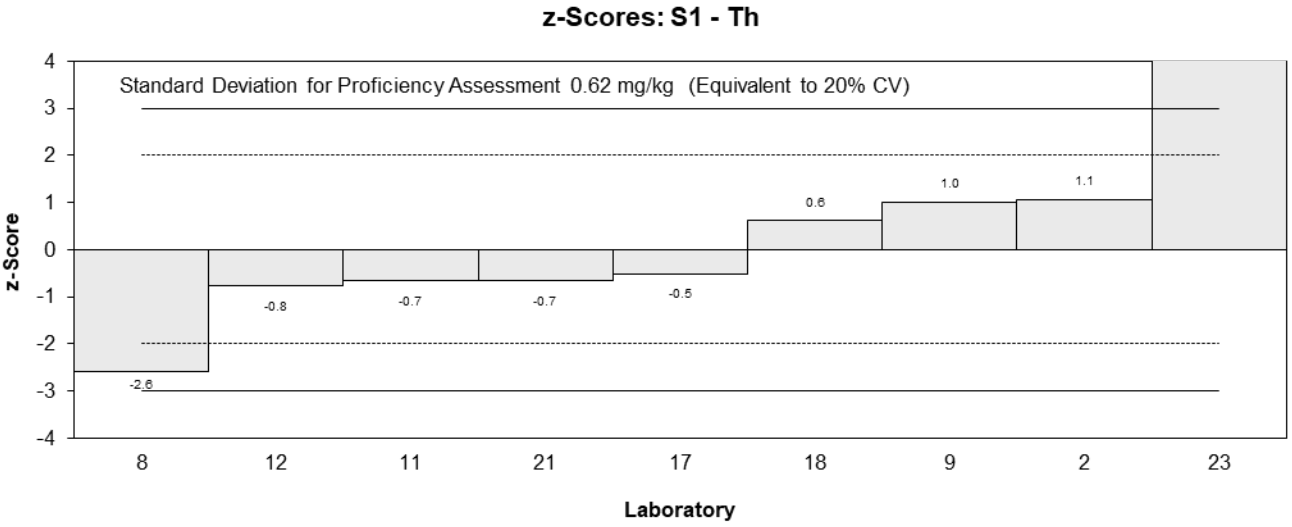
Lab. Code	Result	Uncertainty	z	E_n
2	3.78	0.4	1.06	0.96
3	NR	NR		
4	NT	NT		
5	NT	NT		
6	NT	NT		
7	NT	NT		
8*	1.5	0.4	-2.60	-2.35
9	3.75	0.28	1.01	1.01
10	NT	NT		
11	2.7	2	-0.67	-0.20
12	2.635	0.435	-0.78	-0.68
13	NT	NT		
14	NT	NT		
15	NT	NT		
16	NT	NT		
17	2.8	2	-0.51	-0.15
18	3.5	2	0.61	0.18
19	NT	NT		
20	NT	NT		
21	2.7	NR	-0.67	-0.75
23*	15.088	1.509	19.18	7.44
24	NT	NT		
25	NT	NT		
26	NT	NT		
27	NT	NT		
28	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	3.12	0.56
Spike Value	Not Spiked	
Homogeneity Value	4.14	0.50
Robust Average	3.12	0.82
Median	2.80	0.87
Mean	4.3	
N	9	
Max	15.088	
Min	1.5	
Robust SD	0.98	
Robust CV	31%	


Results: S1 - Th
Assigned Value = 3.12 ± 0.56 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
8 12 11 21 17 18 9 2 23 3 4 5 6 7 10 13 14 15 16 19 20 24 25 26 27 28 Md RA HV


z-Scores: S1 - Th
Standard Deviation for Proficiency Assessment 0.62 mg/kg (Equivalent to 20% CV)
z-Score
-2.6
-0.8
-0.7
-0.7
-0.5
0.6
1.0
1.1
Laboratory
8 12 11 21 17 18 9 2 23

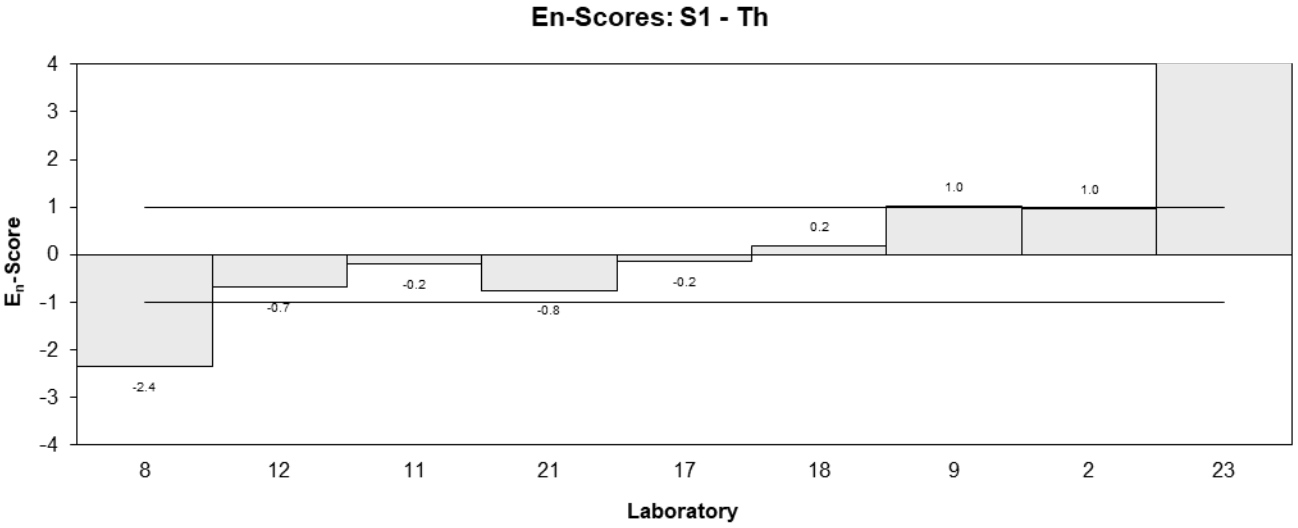

En-Scores: S1 - Th
En-Score
-2.4
-0.7
-0.2
-0.8
-0.2
0.2
1.0
1.0
Laboratory
8 12 11 21 17 18 9 2 23

Figure 20

Table 32

Sample Details

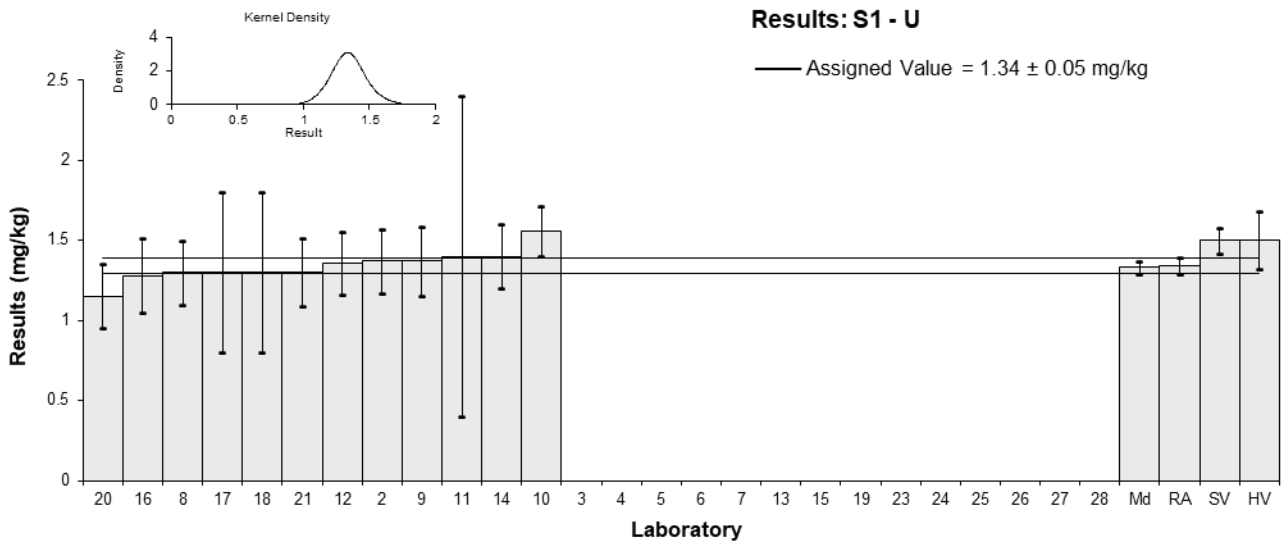
Sample No.	S1
Matrix	Soil
Analyte	U
Unit	mg/kg

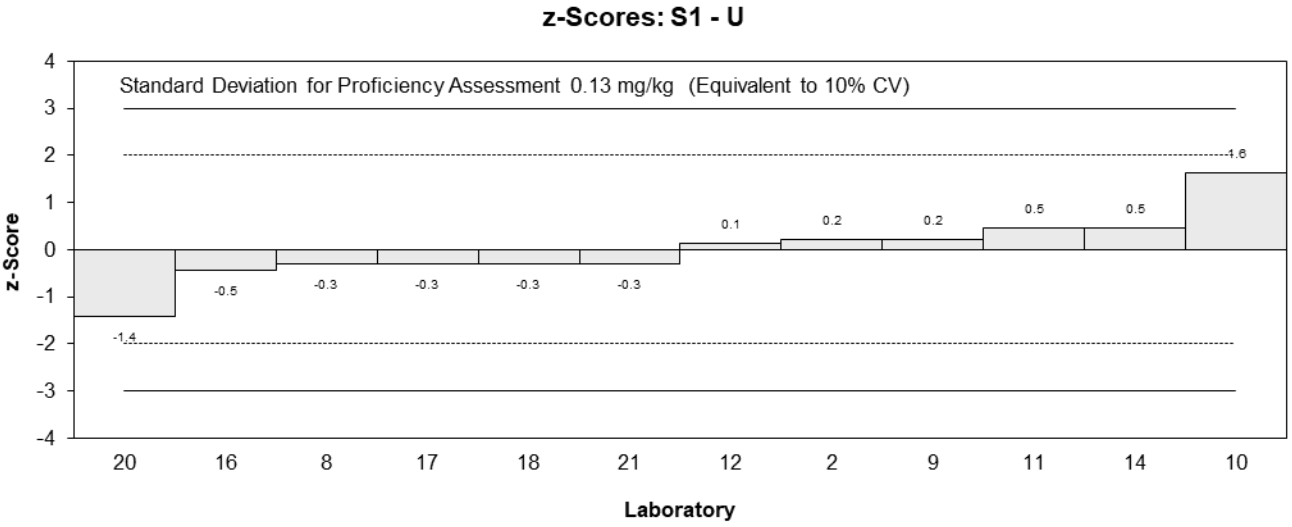
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	1.37	0.2	0.22	0.15
3	NR	NR		
4	NT	NT		
5	NT	NT		
6	<10	NR		
7	NT	NT		
8	1.3	0.2	-0.30	-0.19
9	1.37	0.22	0.22	0.13
10	1.56	0.156	1.64	1.34
11	1.4	1	0.45	0.06
12	1.358	0.199	0.13	0.09
13	NT	NT		
14	1.40	0.20	0.45	0.29
15	NT	NT		
16	1.28	0.23	-0.45	-0.25
17	1.3	0.5	-0.30	-0.08
18	1.3	0.5	-0.30	-0.08
19	< 10	NR		
20	1.15	0.2	-1.42	-0.92
21	1.3	0.21	-0.30	-0.19
23	NT	NT		
24	NT	NT		
25	NT	NT		
26	< 10	3.33		
27	NT	NT		
28	NT	NT		

Statistics

Assigned Value	1.34	0.05
Spike Value	1.50	0.08
Homogeneity Value	1.50	0.18
Robust Average	1.34	0.05
Median	1.33	0.04
Mean	1.34	
N	12	
Max	1.56	
Min	1.15	
Robust SD	0.069	
Robust CV	5.2%	


Kernel Density
Density
Result
Results: S1 - U
Assigned Value = 1.34 ± 0.05 mg/kg
Results (mg/kg)
Laboratory
20 16 8 17 18 21 12 2 9 11 14 10 3 4 5 6 7 13 15 19 23 24 25 26 27 28 Md RA SV HV


z-Scores: S1 - U
Standard Deviation for Proficiency Assessment 0.13 mg/kg (Equivalent to 10% CV)
z-Score
Laboratory
20 16 8 17 18 21 12 2 9 11 14 10
-1.4
-0.5
-0.3
-0.3
-0.3
-0.3
0.1
0.2
0.2
0.5
0.5
1.6

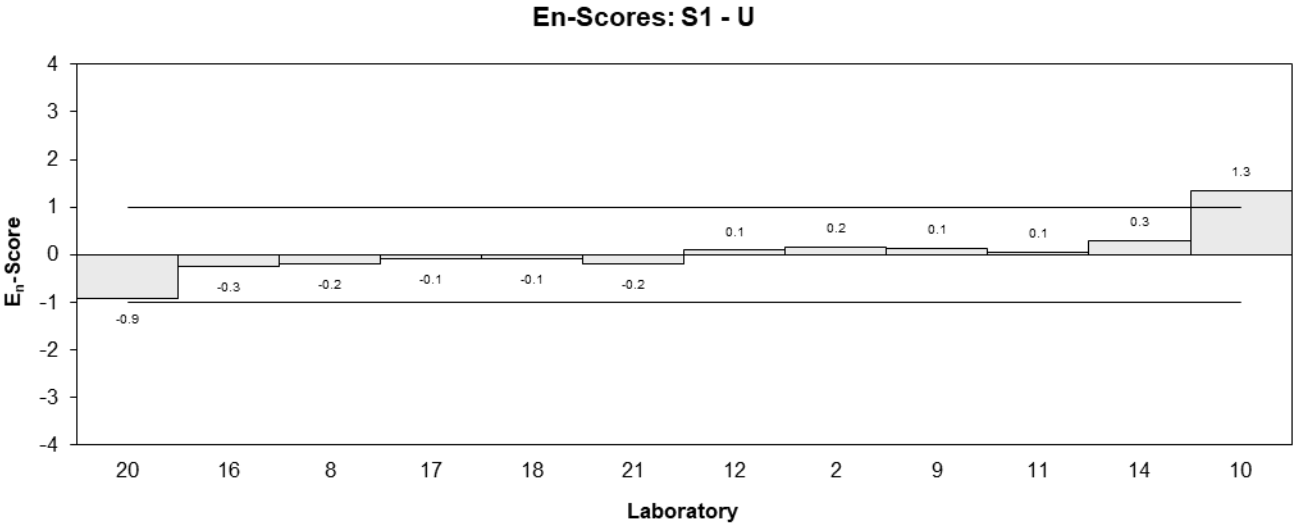

En-Scores: S1 - U
En-Score
Laboratory
20 16 8 17 18 21 12 2 9 11 14 10
-0.9
-0.3
-0.2
-0.1
-0.1
-0.2
0.1
0.2
0.1
0.1
0.3
1.3

Figure 21

Table 33

Sample Details

Sample No.	S1
Matrix	Soil
Analyte	V
Unit	mg/kg

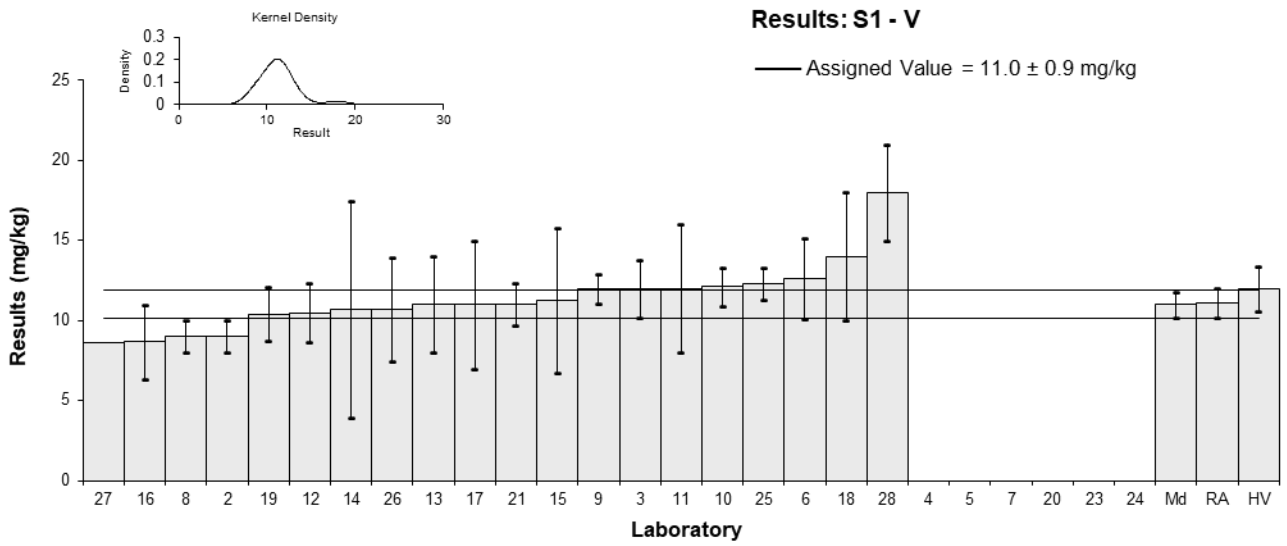
Participant Results

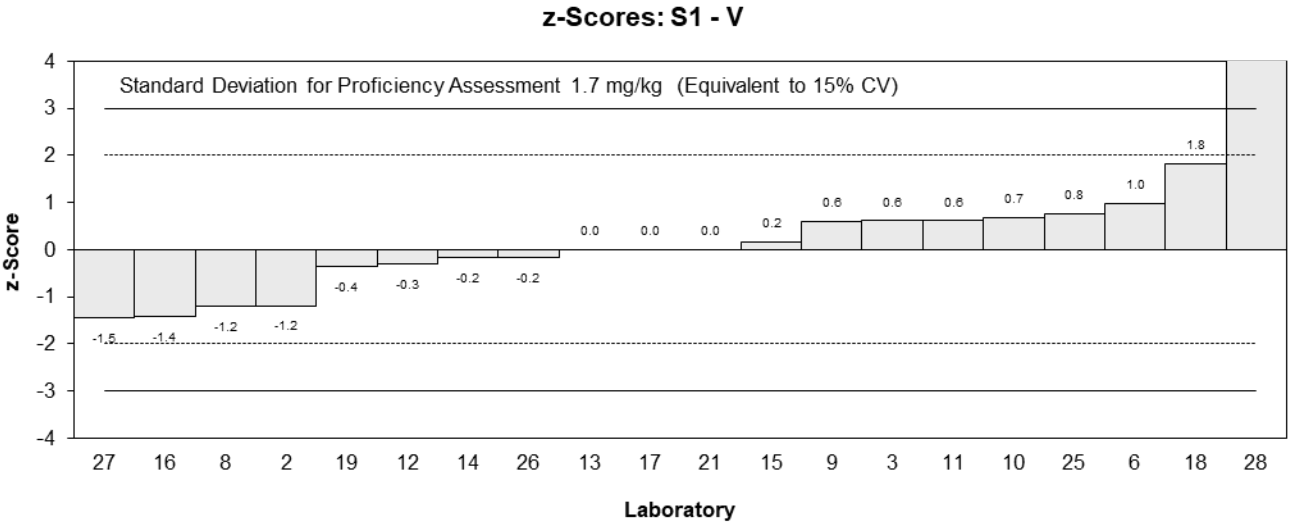
Lab. Code	Result	Uncertainty	z	E_n
2	9.03	1.0	-1.19	-1.46
3	12	1.8	0.61	0.50
4	NT	NT		
5	NT	NT		
6	12.6	2.53	0.97	0.60
7	NT	NT		
8	9	1	-1.21	-1.49
9	11.99	0.9	0.60	0.78
10	12.1	1.21	0.67	0.73
11	12	4	0.61	0.24
12	10.482	1.830	-0.31	-0.25
13	11	3	0.00	0.00
14	10.7	6.8	-0.18	-0.04
15	11.25	4.500	0.15	0.05
16	8.66	2.3	-1.42	-0.95
17	11	4	0.00	0.00
18	14	4	1.82	0.73
19	10.4	1.7	-0.36	-0.31
20	NT	NT		
21	11	1.33	0.00	0.00
23	NT	NT		
24	NT	NT		
25	12.26	1	0.76	0.94
26	10.7	3.21	-0.18	-0.09
27	8.59	NR	-1.46	-2.68
28*	18	3	4.24	2.23

* Outlier, see Section 4.2

Statistics

Assigned Value	11.0	0.9
Spike Value	Not Spiked	
Homogeneity Value	12.0	1.4
Robust Average	11.1	0.9
Median	11.0	0.8
Mean	11.3	
N	20	
Max	18	
Min	8.59	
Robust SD	1.7	
Robust CV	15%	


Kernel Density
Density
Result
Results: S1 - V
Assigned Value = 11.0 ± 0.9 mg/kg
Results (mg/kg)
Laboratory
27 16 8 2 19 12 14 26 13 17 21 15 9 3 11 10 25 6 18 28 4 5 7 20 23 24 Md RA HV


z-Scores: S1 - V
Standard Deviation for Proficiency Assessment 1.7 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
27 16 8 2 19 12 14 26 13 17 21 15 9 3 11 10 25 6 18 28
-1.5 -1.4 -1.2 -1.2 -0.4 -0.3 -0.2 -0.2 0.0 0.0 0.0 0.2 0.6 0.6 0.6 0.7 0.8 1.0 1.8

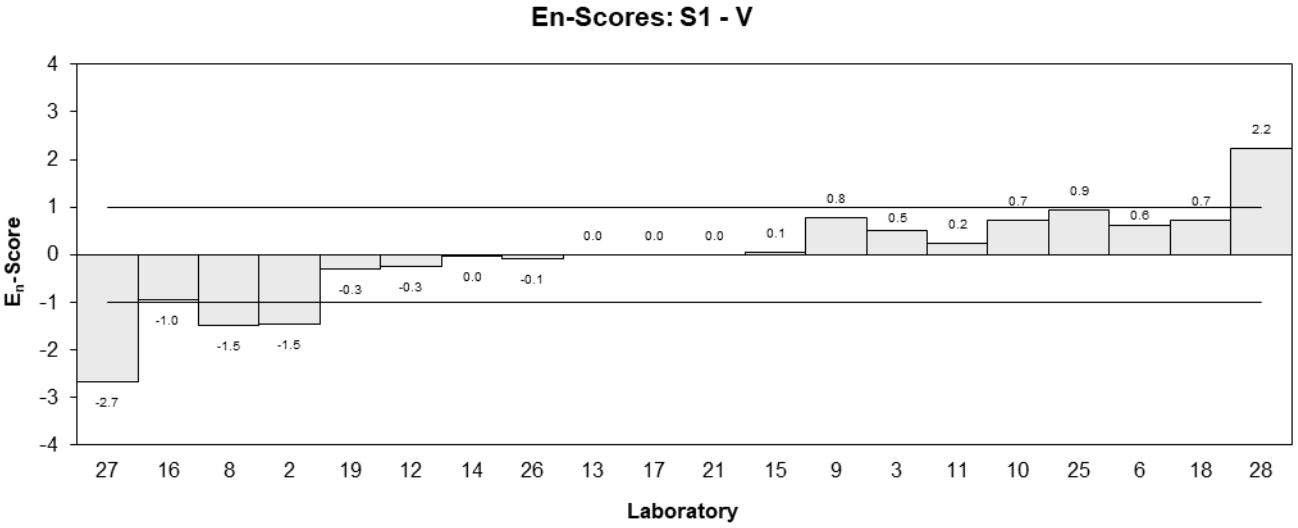

En-Scores: S1 - V
En-Score
Laboratory
27 16 8 2 19 12 14 26 13 17 21 15 9 3 11 10 25 6 18 28
-2.7 -1.0 -1.5 -1.5 -0.3 -0.3 0.0 -0.1 0.0 0.0 0.0 0.1 0.8 0.5 0.2 0.7 0.9 0.6 0.7 2.2

Figure 22

Table 34

Sample Details

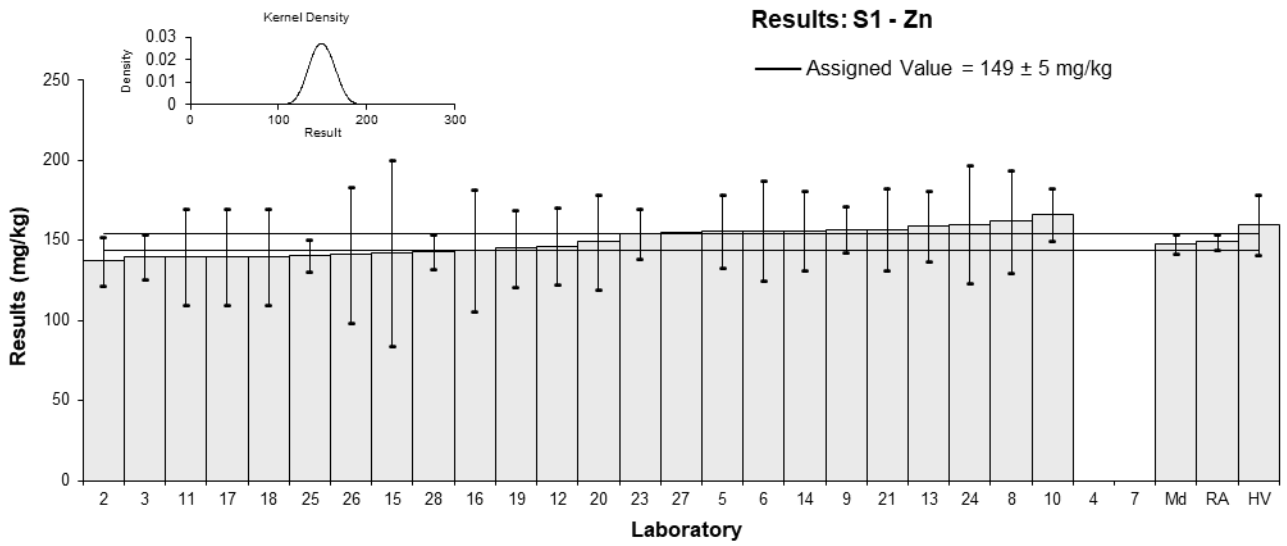
Sample No.	S1
Matrix	Soil
Analyte	Zn
Unit	mg/kg

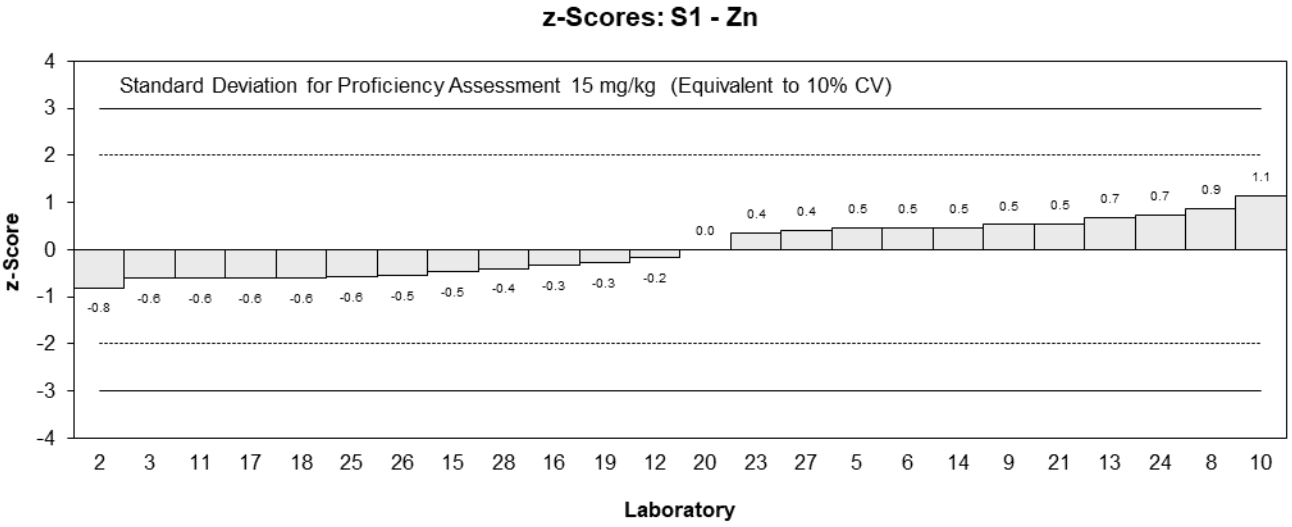
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	137	15	-0.81	-0.76
3	140	14	-0.60	-0.61
4	NT	NT		
5	156	23	0.47	0.30
6	156	31.3	0.47	0.22
7	NT	NT		
8	162	32	0.87	0.40
9	156.93	14.5	0.53	0.52
10	166	16.6	1.14	0.98
11	140	30	-0.60	-0.30
12	146.560	24.171	-0.16	-0.10
13	159	22	0.67	0.44
14	156	25	0.47	0.27
15	142.17	58.290	-0.46	-0.12
16	144	38	-0.34	-0.13
17	140	30	-0.60	-0.30
18	140	30	-0.60	-0.30
19	145	24	-0.27	-0.16
20	149	30	0.00	0.00
21	157	26.0	0.54	0.30
23	154.382	15.438	0.36	0.33
24	160	37	0.74	0.29
25	140.47	10	-0.57	-0.76
26	141	42.3	-0.54	-0.19
27	155	NR	0.40	1.20
28	143	11	-0.40	-0.50

Statistics

Assigned Value	149	5
Spike Value	Not Spiked	
Homogeneity Value	160	19
Robust Average	149	5
Median	148	6
Mean	149	
N	24	
Max	166	
Min	137	
Robust SD	9.7	
Robust CV	6.5%	


Kernel Density
Density
0.03
0.02
0.01
0
0
100
200
300
Result
Results: S1 - Zn
Assigned Value = 149 ± 5 mg/kg
Results (mg/kg)
250
200
150
100
50
0
2 3 11 17 18 25 26 15 28 16 19 12 20 23 27 5 6 14 9 21 13 24 8 10 4 7 Md RA HV
Laboratory


z-Scores: S1 - Zn
Standard Deviation for Proficiency Assessment 15 mg/kg (Equivalent to 10% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-0.8 -0.6 -0.6 -0.6 -0.6 -0.6 -0.5 -0.5 -0.4 -0.3 -0.3 -0.2 0.0 0.4 0.4 0.5 0.5 0.5 0.5 0.5 0.7 0.7 0.9 1.1
2 3 11 17 18 25 26 15 28 16 19 12 20 23 27 5 6 14 9 21 13 24 8 10
Laboratory

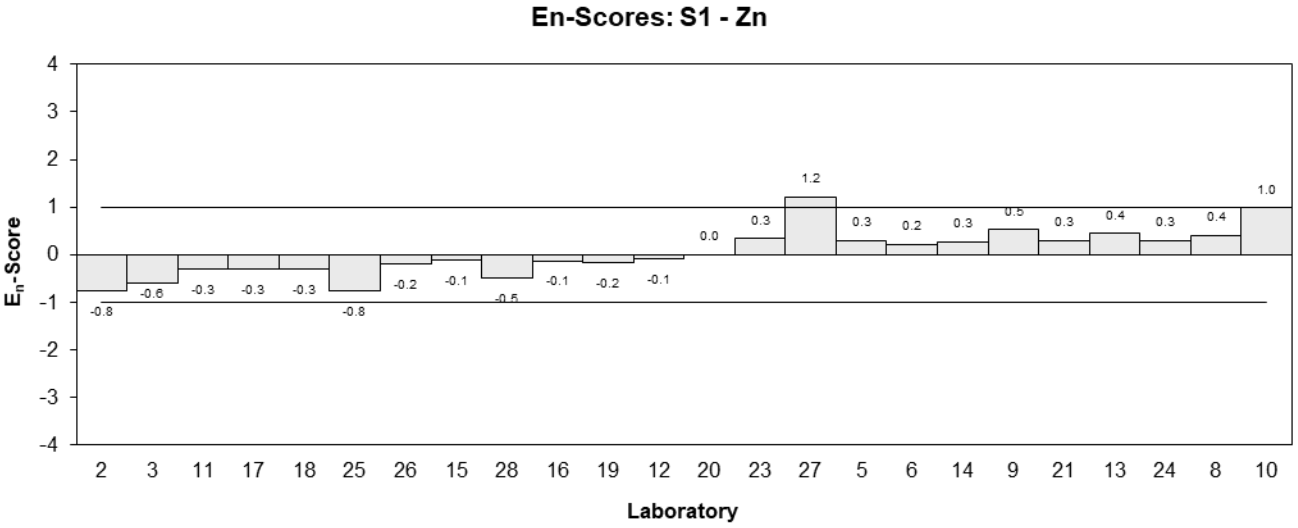

En-Scores: S1 - Zn
En-Score
4
3
2
1
0
-1
-2
-3
-4
-0.8 -0.6 -0.3 -0.3 -0.3 -0.8 -0.2 -0.1 -0.5 -0.1 -0.2 -0.1 0.0 0.3 1.2 0.3 0.2 0.3 0.5 0.3 0.4 0.3 0.4 1.0
2 3 11 17 18 25 26 15 28 16 19 12 20 23 27 5 6 14 9 21 13 24 8 10
Laboratory

Figure 23

Table 35

Sample Details

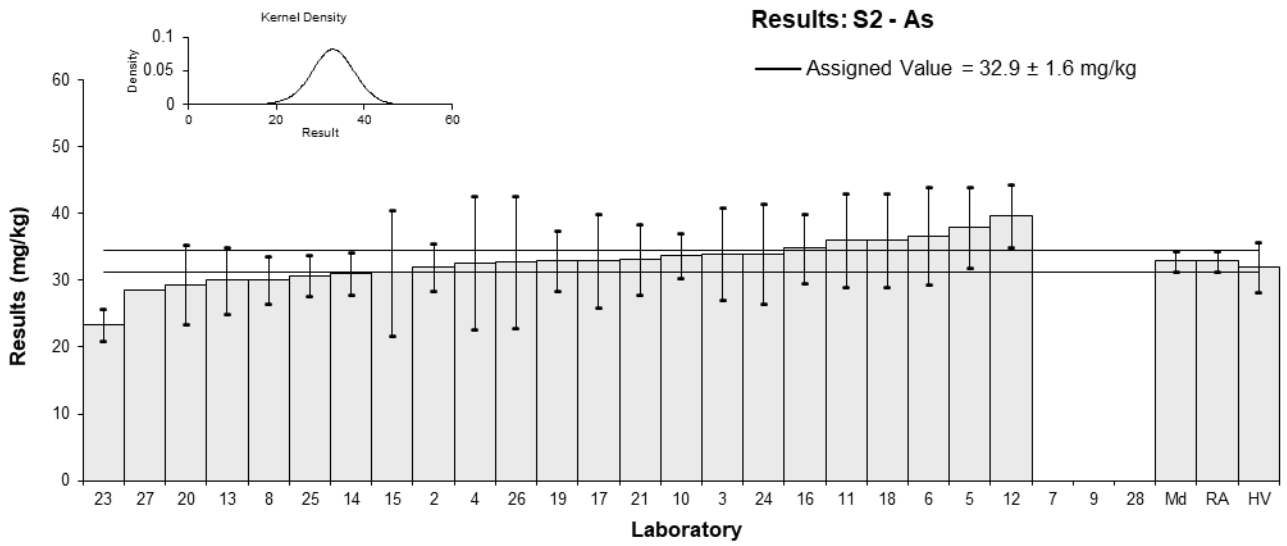
Sample No.	S2
Matrix	Moist Sediment
Analyte	As
Unit	mg/kg

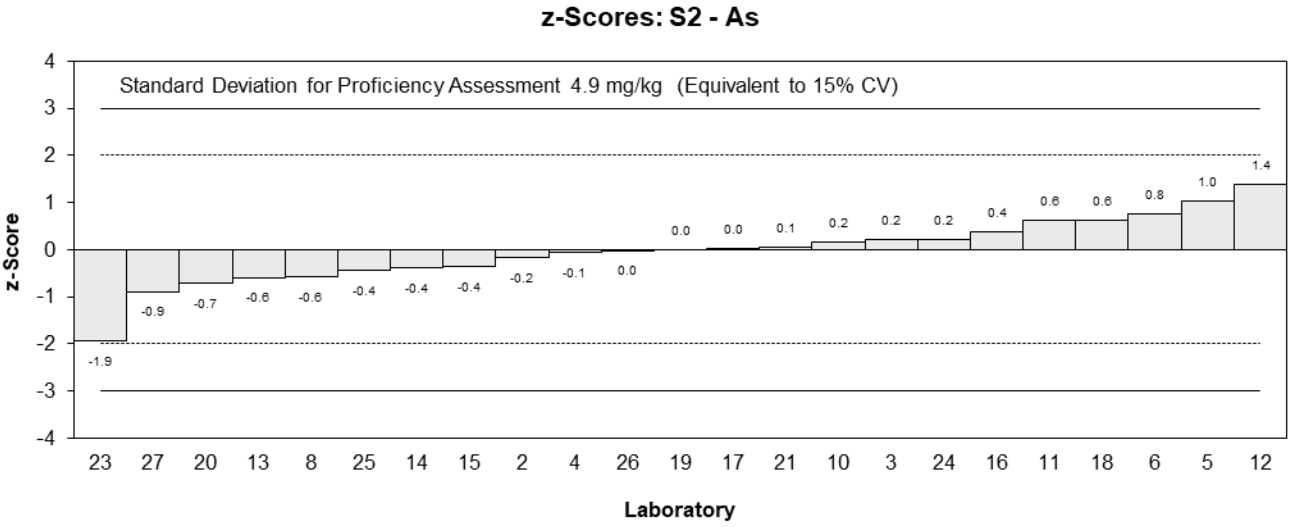
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	32.0	3.5	-0.18	-0.23
3	34	6.9	0.22	0.16
4	32.6	10	-0.06	-0.03
5	38	6	1.03	0.82
6	36.7	7.34	0.77	0.51
7	NT	NT		
8	30.1	3.6	-0.57	-0.71
9	NT	NT		
10	33.7	3.37	0.16	0.21
11	36	7	0.63	0.43
12	39.758	4.747	1.39	1.37
13	30	5	-0.59	-0.55
14	31.0	3.2	-0.39	-0.53
15	31.16	9.348	-0.35	-0.18
16	34.8	5.2	0.39	0.35
17	33	7	0.02	0.01
18	36	7	0.63	0.43
19	32.9	4.5	0.00	0.00
20	29.4	6	-0.71	-0.56
21	33.2	5.26	0.06	0.05
23	23.362	2.336	-1.93	-3.37
24	34	7.5	0.22	0.14
25	30.76	3	-0.43	-0.63
26	32.8	9.84	-0.02	-0.01
27	28.5	NR	-0.89	-2.75
28	NT	NT		

Statistics

Assigned Value	32.9	1.6
Spike Value	Not Spiked	
Homogeneity Value	32.0	3.8
Robust Average	32.9	1.6
Median	32.9	1.5
Mean	32.8	
N	23	
Max	39.758	
Min	23.362	
Robust SD	3.1	
Robust CV	9.4%	


Kernel Density
Density
Result
Results: S2 - As
Assigned Value = 32.9 ± 1.6 mg/kg
Results (mg/kg)
Laboratory
23 27 20 13 8 25 14 15 2 4 26 19 17 21 10 3 24 16 11 18 6 5 12 7 9 28 Md RA HV


z-Scores: S2 - As
Standard Deviation for Proficiency Assessment 4.9 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
23 27 20 13 8 25 14 15 2 4 26 19 17 21 10 3 24 16 11 18 6 5 12

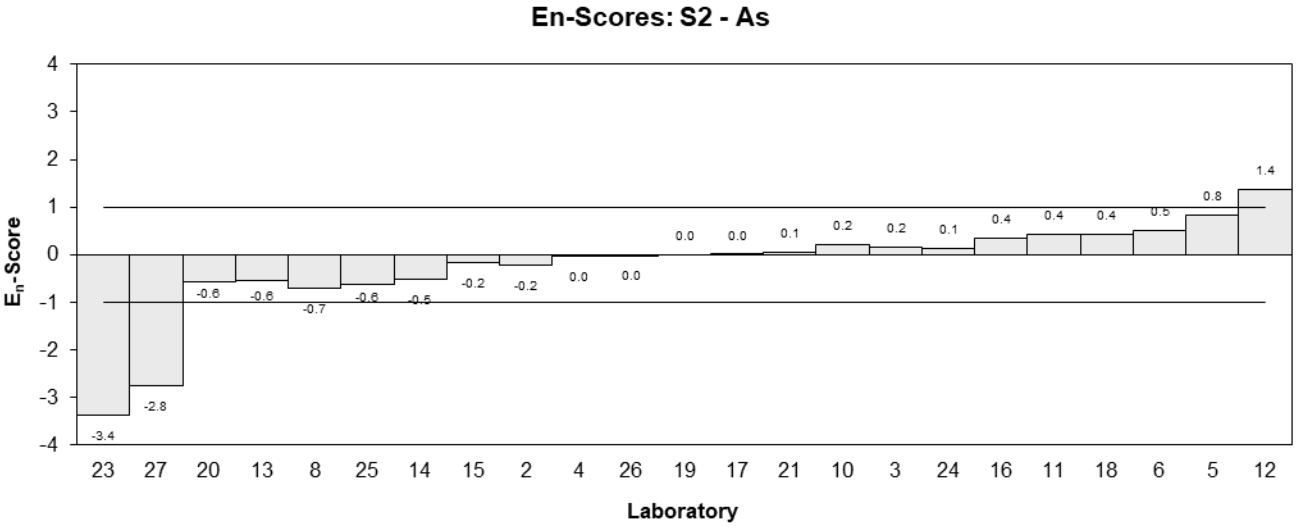

En-Scores: S2 - As
En-Score
Laboratory
23 27 20 13 8 25 14 15 2 4 26 19 17 21 10 3 24 16 11 18 6 5 12

Figure 24

Table 36

Sample Details

Sample No.	S2
Matrix	Moist Sediment
Analyte	B
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
2	5.44	0.6
3	< 5	NR
4	< 10	NR
5	NT	NT
6	<10	NR
7	NT	NT
8	<50	NR
9	NT	NT
10	2.90	0.29
11	<10	NR
12	<50	NR
13	NT	NT
14	3.7	1.5
15	<5	<5
16	<2.53	NR
17	<10	NR
18	<10	NR
19	< 10	NR
20	NT	NT
21	<50	NR
23	5.530	0.553
24	7.8	1.6
25	NT	NT
26	< 10	3.33
27	6.95	NR
28	NT	NT

Statistics

Assigned Value	Not Set	
Spike Value	Not Spiked	
Homogeneity Value	2.43	0.29
Robust Average	5.4	2.2
Median	5.5	2.5
Mean	5.4	
N	6	
Max	7.8	
Min	2.90	
Robust SD	2.1	
Robust CV	39%	

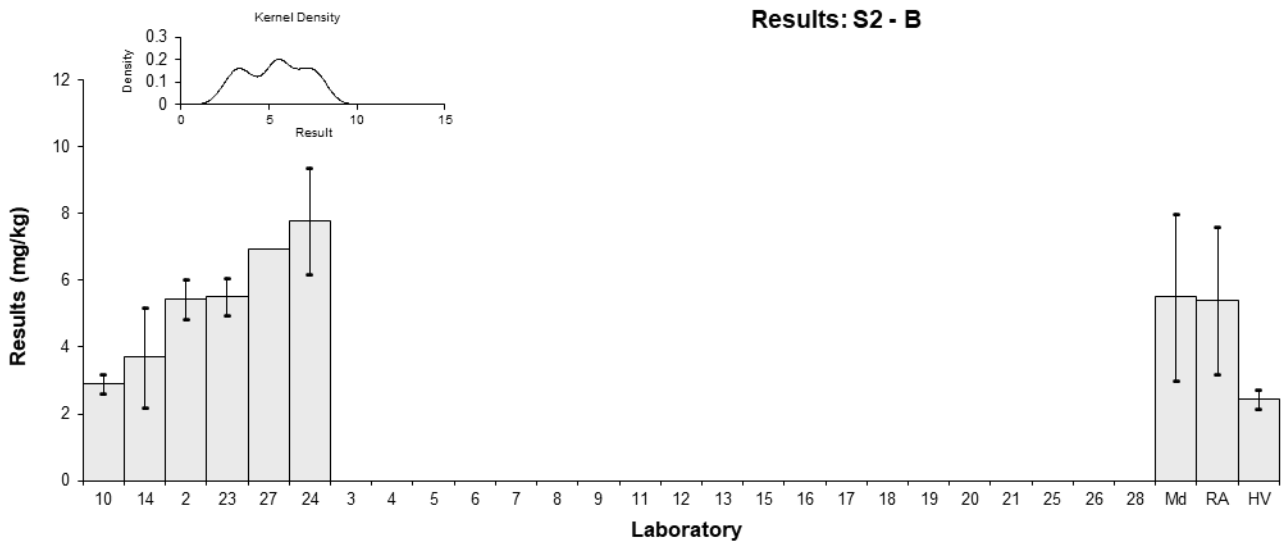

Results: S2 - B
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
10 14 2 23 27 24 3 4 5 6 7 8 9 11 12 13 15 16 17 18 19 20 21 25 26 28 Md RA HV

Figure 25

Table 37

Sample Details

Sample No.	S2
Matrix	Moist Sediment
Analyte	Ba
Unit	mg/kg

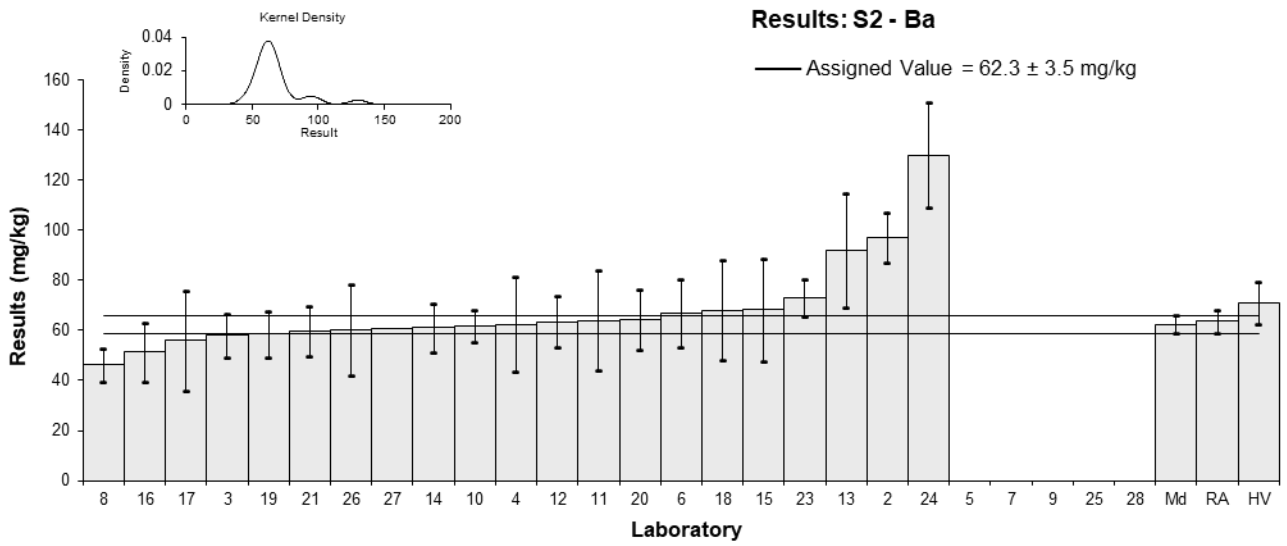
Participant Results

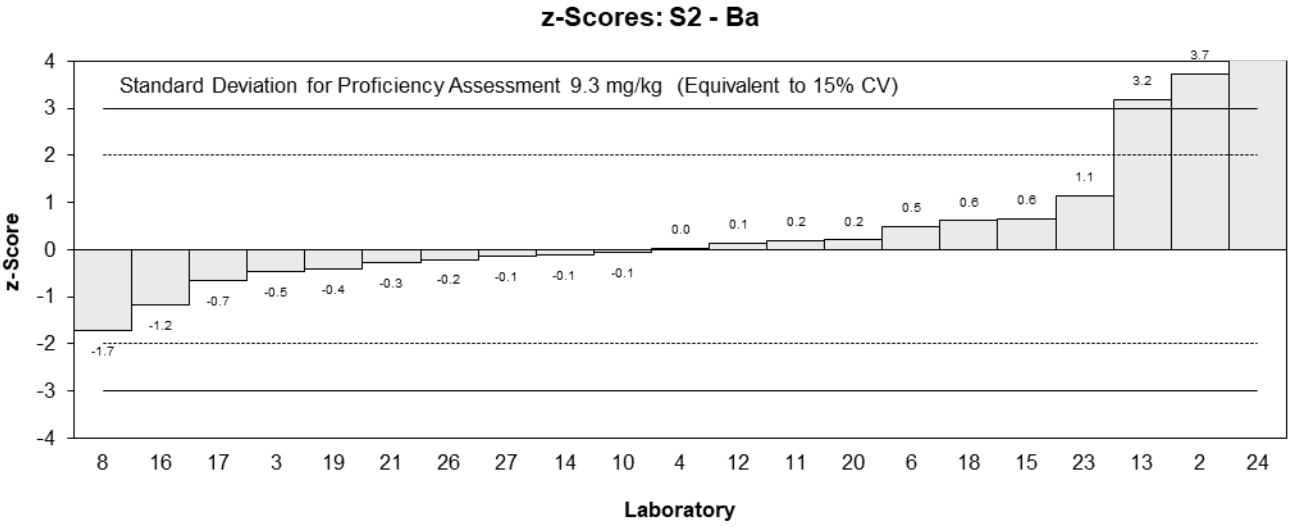
Lab. Code	Result	Uncertainty	z	E_n
2*	97.2	10	3.73	3.29
3	58	8.7	-0.46	-0.46
4	62.5	19	0.02	0.01
5	NT	NT		
6	66.9	13.4	0.49	0.33
7	NT	NT		
8	46.2	6.6	-1.72	-2.16
9	NT	NT		
10	61.8	6.18	-0.05	-0.07
11	64	20	0.18	0.08
12	63.556	10.033	0.13	0.12
13	92	23	3.18	1.28
14	61.2	9.8	-0.12	-0.11
15	68.3	20.49	0.64	0.29
16	51.3	12	-1.18	-0.88
17	56	20	-0.67	-0.31
18	68	20	0.61	0.28
19	58.5	9.3	-0.41	-0.38
20	64.2	12	0.20	0.15
21	59.7	9.77	-0.28	-0.25
23	72.995	7.300	1.14	1.32
24*	130	21	7.24	3.18
25	NT	NT		
26	60.3	18.1	-0.21	-0.11
27	61.0	NR	-0.14	-0.37
28	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	62.3	3.5
Spike Value	Not Spiked	
Homogeneity Value	71.0	8.5
Robust Average	63.7	4.6
Median	62.5	3.6
Mean	67.8	
N	21	
Max	130	
Min	46.2	
Robust SD	8.3	
Robust CV	13%	


Results: S2 - Ba
Assigned Value = 62.3 ± 3.5 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
8 16 17 3 19 21 26 27 14 10 4 12 11 20 6 18 15 23 13 2 24 5 7 9 25 28 Md RA HV


z-Scores: S2 - Ba
Standard Deviation for Proficiency Assessment 9.3 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
8 16 17 3 19 21 26 27 14 10 4 12 11 20 6 18 15 23 13 2 24
-1.7 -1.2 -0.7 -0.5 -0.4 -0.3 -0.2 -0.1 -0.1 -0.1 0.0 0.1 0.2 0.2 0.5 0.6 0.6 1.1 3.2 3.7

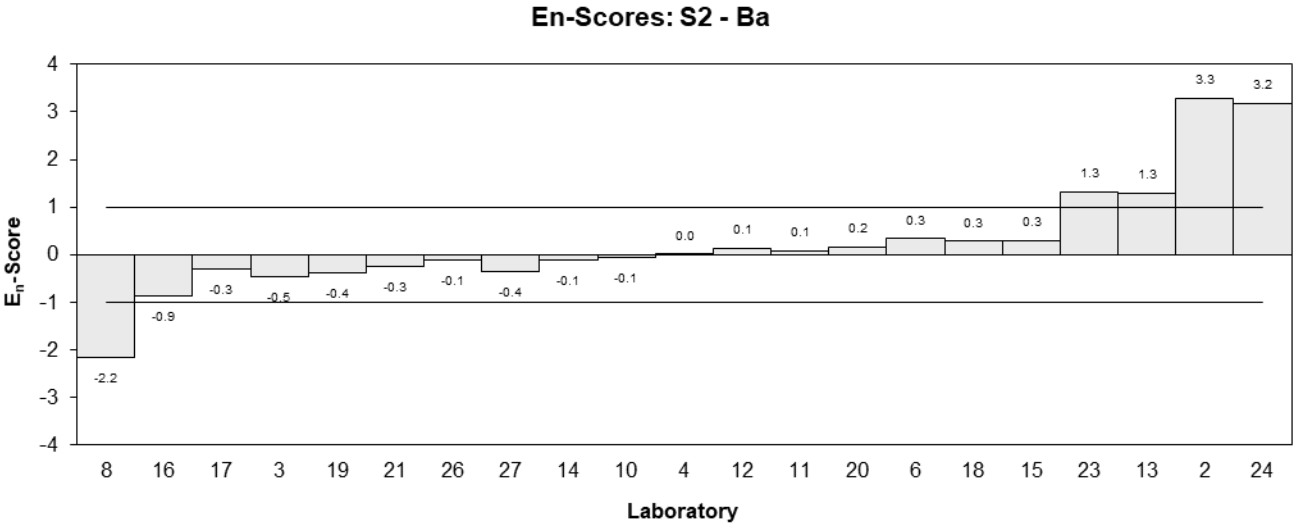

En-Scores: S2 - Ba
En-Score
Laboratory
8 16 17 3 19 21 26 27 14 10 4 12 11 20 6 18 15 23 13 2 24
-2.2 -0.9 -0.3 -0.5 -0.4 -0.3 -0.1 -0.4 -0.1 -0.1 0.0 0.1 0.1 0.2 0.3 0.3 0.3 1.3 1.3 3.3 3.2

Figure 26

Table 38

Sample Details

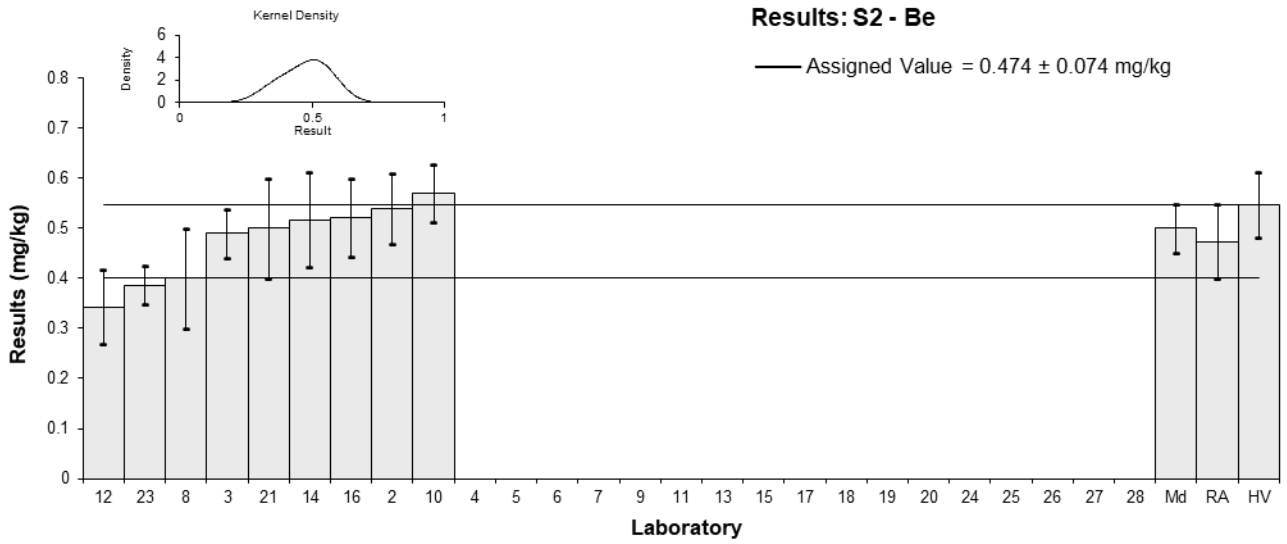
Sample No.	S2
Matrix	Moist Sediment
Analyte	Be
Unit	mg/kg

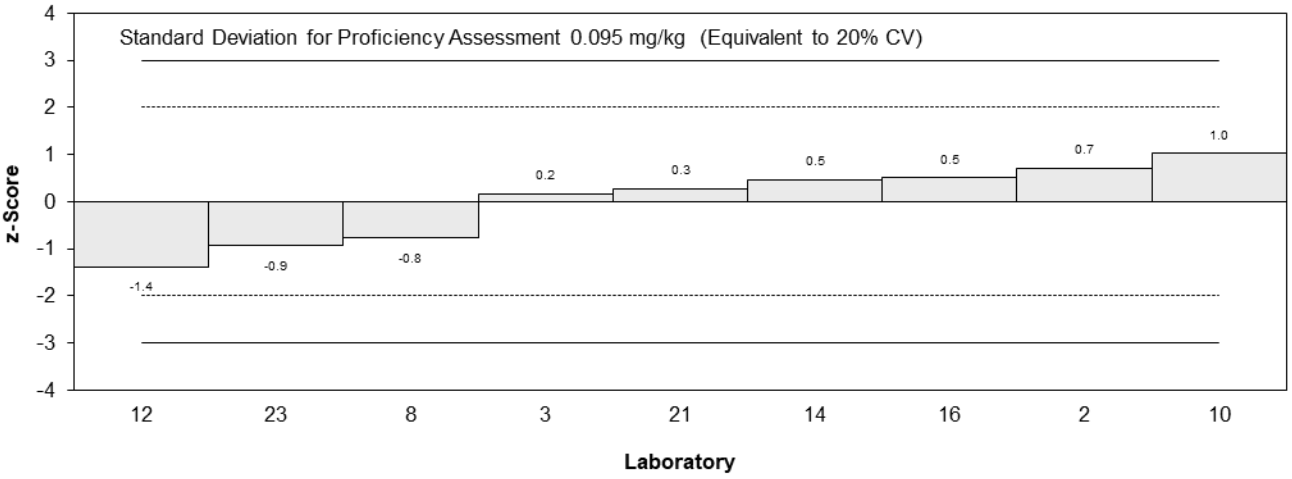
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	0.54	0.07	0.70	0.65
3	0.49	0.049	0.17	0.18
4	< 2	NR		
5	NT	NT		
6	<2	NR		
7	NT	NT		
8	0.4	0.1	-0.78	-0.59
9	NT	NT		
10	0.571	0.0571	1.02	1.04
11	<1	NR		
12	0.3431	0.0735	-1.38	-1.26
13	<1	NR		
14	0.517	0.095	0.45	0.36
15	<0.5	<0.5		
16	0.521	0.078	0.50	0.44
17	<1	NR		
18	<1	NR		
19	< 2	NR		
20	NT	NT		
21	0.5	0.10	0.27	0.21
23	0.387	0.039	-0.92	-1.04
24	NT	NT		
25	NT	NT		
26	< 2	0.6		
27	<1	NR		
28	NT	NT		

Statistics

Assigned Value	0.474	0.074
Spike Value	Not Spiked	
Homogeneity Value	0.547	0.066
Robust Average	0.474	0.074
Median	0.500	0.049
Mean	0.474	
N	9	
Max	0.571	
Min	0.3431	
Robust SD	0.089	
Robust CV	19%	


Kernel Density
Density
Result
Results: S2 - Be
Assigned Value = 0.474 ± 0.074 mg/kg
Results (mg/kg)
Laboratory
12 23 8 3 21 14 16 2 10 4 5 6 7 9 11 13 15 17 18 19 20 24 25 26 27 28 Md RA HV


z-Scores: S2 - Be
Standard Deviation for Proficiency Assessment 0.095 mg/kg (Equivalent to 20% CV)
z-Score
-1.4
-0.9
-0.8
0.2
0.3
0.5
0.5
0.7
1.0
Laboratory
12 23 8 3 21 14 16 2 10

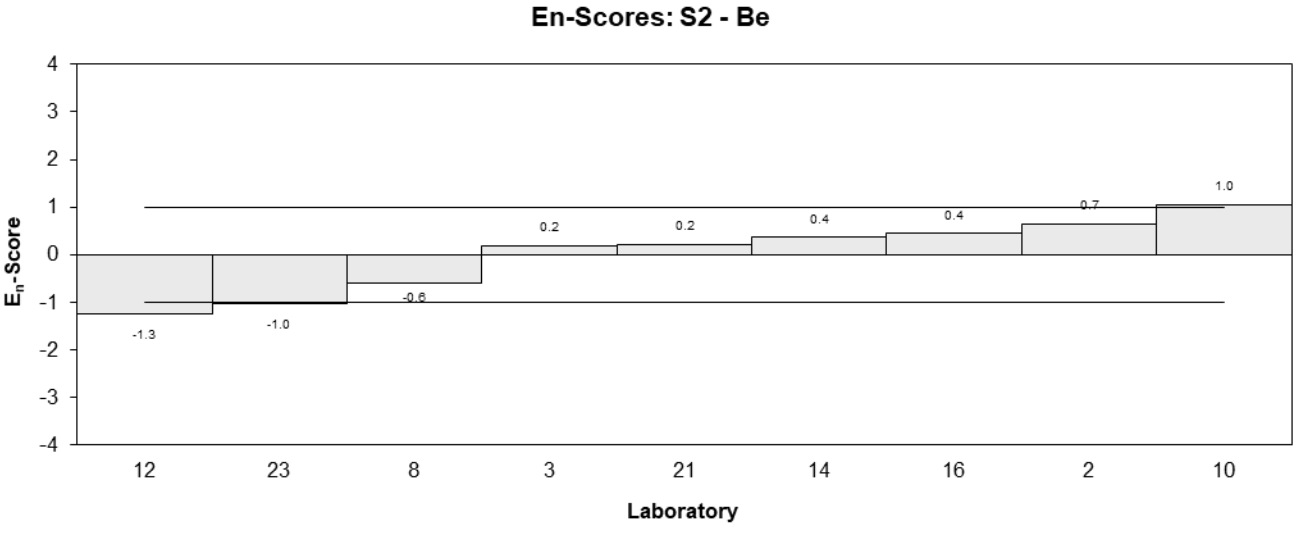

En-Scores: S2 - Be
En-Score
-1.3
-1.0
-0.6
0.2
0.2
0.4
0.4
0.7
1.0
Laboratory
12 23 8 3 21 14 16 2 10

Figure 27

Table 39

Sample Details

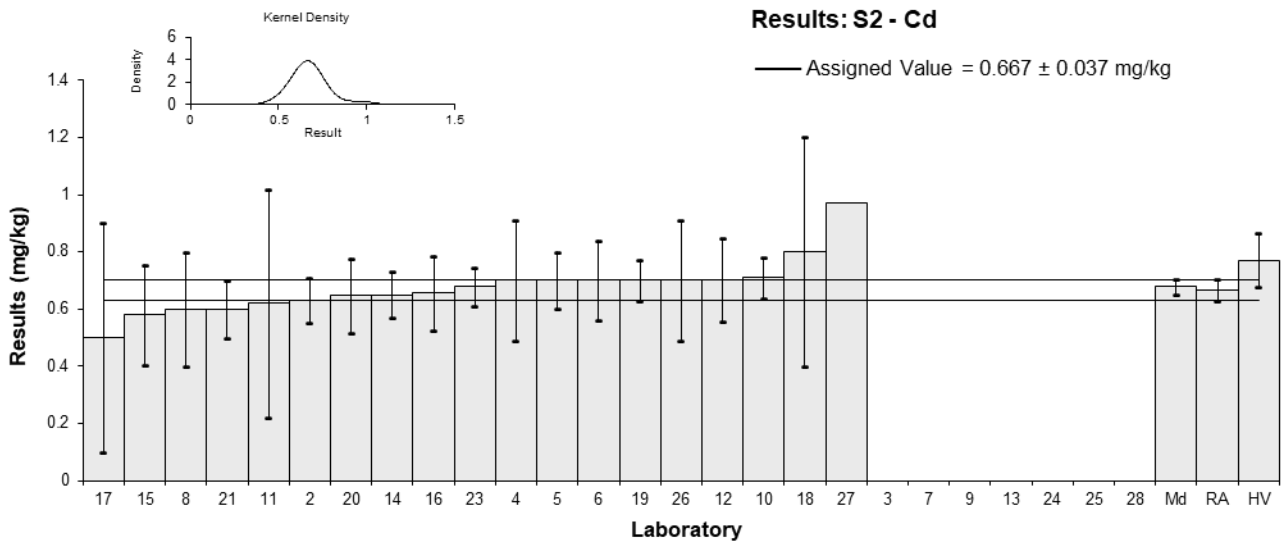
Sample No.	S2
Matrix	Moist Sediment
Analyte	Cd
Unit	mg/kg

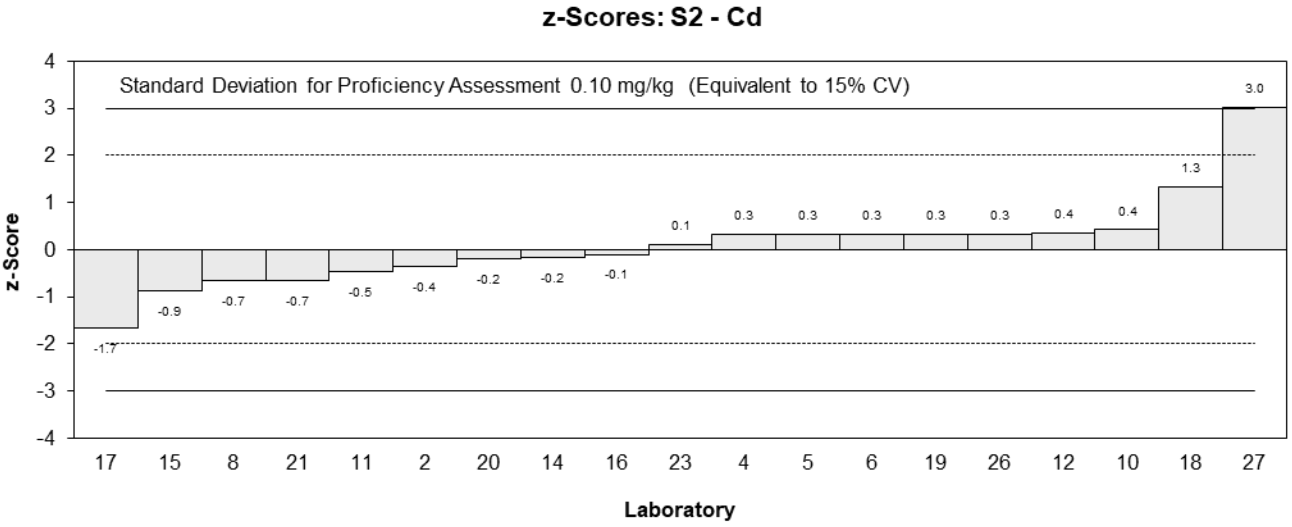
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	0.63	0.08	-0.37	-0.42
3	< 1	NR		
4	0.7	0.21	0.33	0.15
5	0.7	0.1	0.33	0.31
6	0.700	0.140	0.33	0.23
7	NT	NT		
8	0.6	0.2	-0.67	-0.33
9	NT	NT		
10	0.709	0.0709	0.42	0.53
11	0.62	0.4	-0.47	-0.12
12	0.7022	0.1456	0.35	0.23
13	<1	NR		
14	0.650	0.079	-0.17	-0.19
15	0.58	0.174	-0.87	-0.49
16	0.657	0.13	-0.10	-0.07
17	0.5	0.4	-1.67	-0.42
18	0.8	0.4	1.33	0.33
19	0.700	0.072	0.33	0.41
20	0.648	0.13	-0.19	-0.14
21	0.6	0.10	-0.67	-0.63
23	0.678	0.068	0.11	0.14
24	NR	NR		
25	NT	NT		
26	0.7	0.21	0.33	0.15
27	0.97	NR	3.03	8.19
28	NT	NT		

Statistics

Assigned Value	0.667	0.037
Spike Value	Not Spiked	
Homogeneity Value	0.771	0.093
Robust Average	0.667	0.037
Median	0.678	0.026
Mean	0.676	
N	19	
Max	0.97	
Min	0.5	
Robust SD	0.064	
Robust CV	9.5%	


Results: S2 - Cd
Assigned Value = 0.667 ± 0.037 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
17 15 8 21 11 2 20 14 16 23 4 5 6 19 26 12 10 18 27 3 7 9 13 24 25 28 Md RA HV


z-Scores: S2 - Cd
Standard Deviation for Proficiency Assessment 0.10 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
17 15 8 21 11 2 20 14 16 23 4 5 6 19 26 12 10 18 27

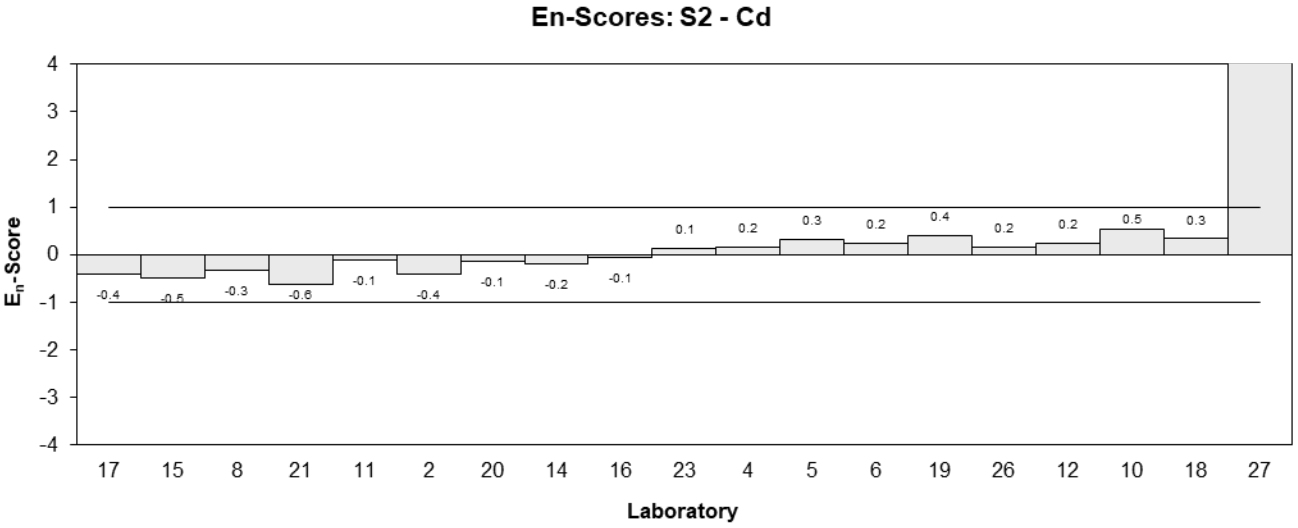

En-Scores: S2 - Cd
En-Score
Laboratory
17 15 8 21 11 2 20 14 16 23 4 5 6 19 26 12 10 18 27

Figure 28

Table 40

Sample Details

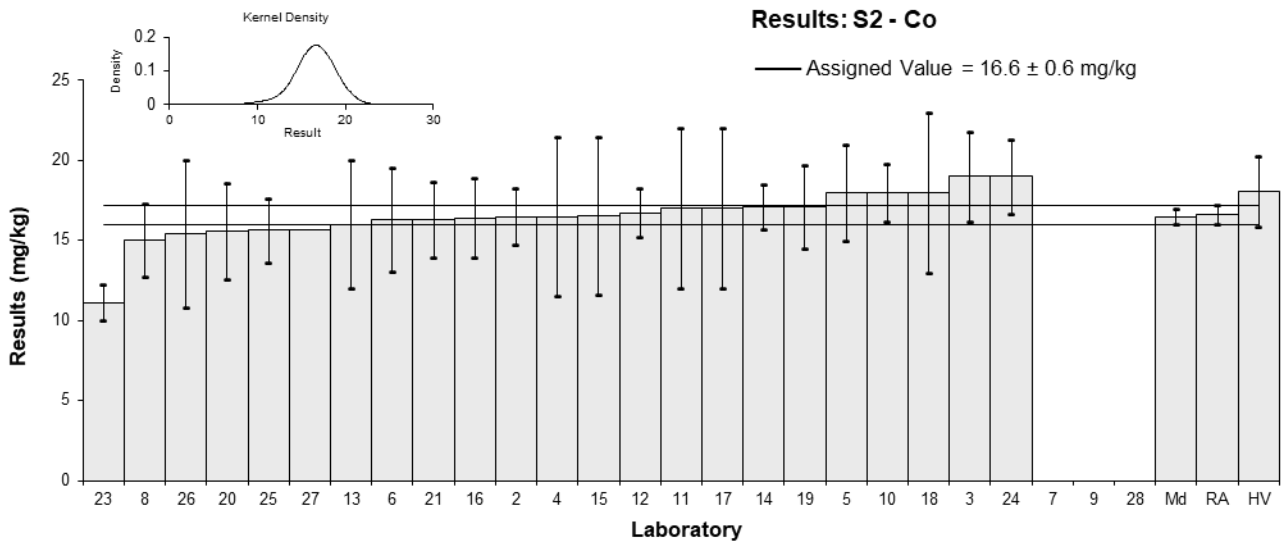
Sample No.	S2
Matrix	Moist Sediment
Analyte	Co
Unit	mg/kg

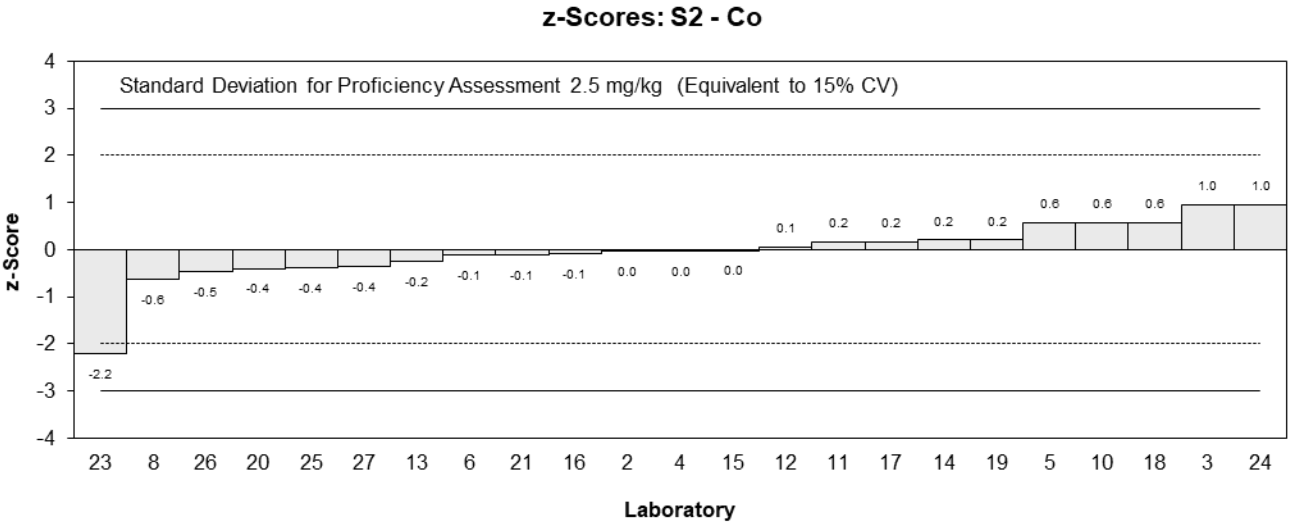
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	16.5	1.8	-0.04	-0.05
3	19	2.8	0.96	0.84
4	16.5	5	-0.04	-0.02
5	18	3	0.56	0.46
6	16.3	3.26	-0.12	-0.09
7	NT	NT		
8	15.0	2.3	-0.64	-0.67
9	NT	NT		
10	18.0	1.8	0.56	0.74
11	17	5	0.16	0.08
12	16.730	1.496	0.05	0.08
13	16	4	-0.24	-0.15
14	17.1	1.4	0.20	0.33
15	16.54	4.962	-0.02	-0.01
16	16.4	2.5	-0.08	-0.08
17	17	5	0.16	0.08
18	18	5	0.56	0.28
19	17.1	2.6	0.20	0.19
20	15.6	3	-0.40	-0.33
21	16.3	2.37	-0.12	-0.12
23	11.106	1.111	-2.21	-4.35
24	19	2.3	0.96	1.01
25	15.65	2	-0.38	-0.45
26	15.4	4.62	-0.48	-0.26
27	15.7	NR	-0.36	-1.50
28	NT	NT		

Statistics

Assigned Value	16.6	0.6
Spike Value	Not Spiked	
Homogeneity Value	18.1	2.2
Robust Average	16.6	0.6
Median	16.5	0.5
Mean	16.5	
N	23	
Max	19	
Min	11.106	
Robust SD	1.2	
Robust CV	7%	


Results: S2 - Co
Assigned Value = 16.6 ± 0.6 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
23 8 26 20 25 27 13 6 21 16 2 4 15 12 11 17 14 19 5 10 18 3 24 7 9 28 Md RA HV


z-Scores: S2 - Co
Standard Deviation for Proficiency Assessment 2.5 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
23 8 26 20 25 27 13 6 21 16 2 4 15 12 11 17 14 19 5 10 18 3 24

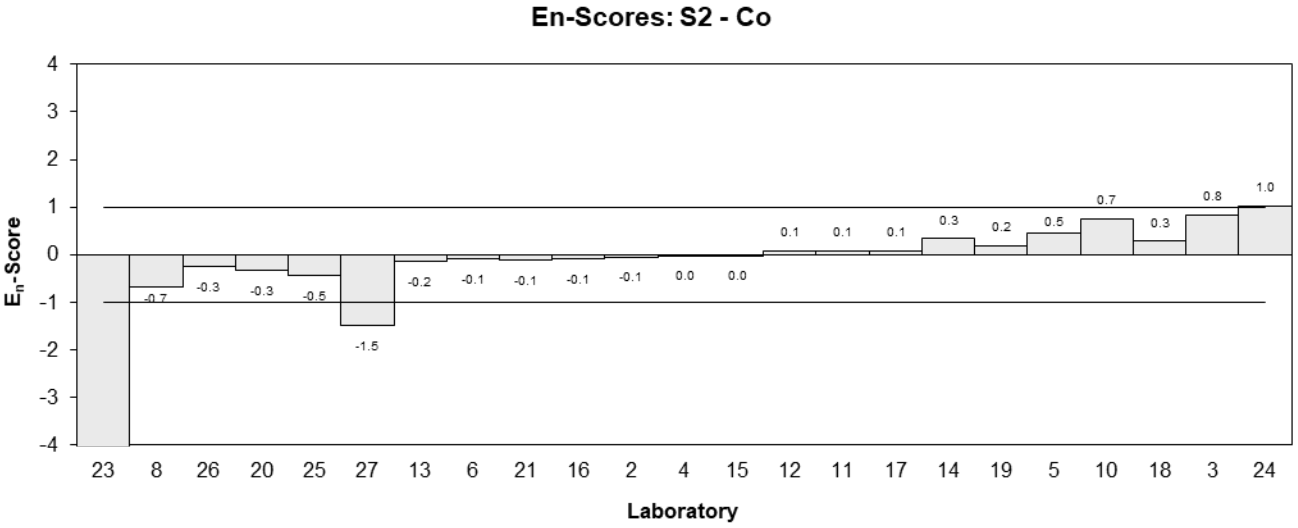

En-Scores: S2 - Co
En-Score
Laboratory
23 8 26 20 25 27 13 6 21 16 2 4 15 12 11 17 14 19 5 10 18 3 24

Figure 29

Table 41

Sample Details

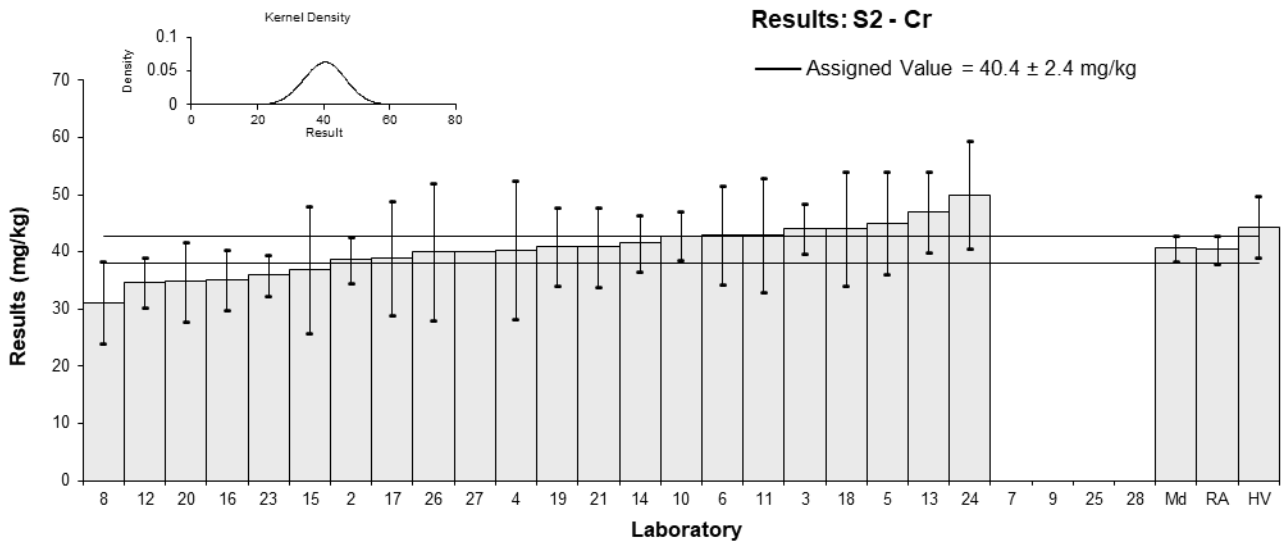
Sample No.	S2
Matrix	Moist Sediment
Analyte	Cr
Unit	mg/kg

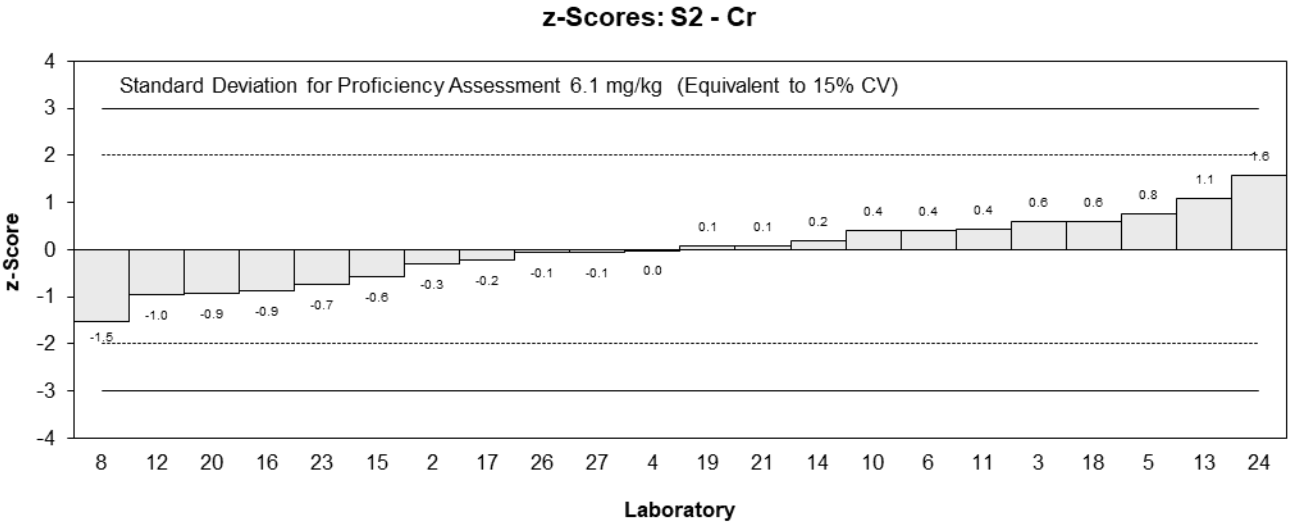
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	38.6	4.0	-0.30	-0.39
3	44	4.4	0.59	0.72
4	40.3	12.1	-0.02	-0.01
5	45	9	0.76	0.49
6	42.9	8.59	0.41	0.28
7	NT	NT		
8	31.1	7.2	-1.53	-1.23
9	NT	NT		
10	42.8	4.28	0.40	0.49
11	43	10	0.43	0.25
12	34.669	4.291	-0.95	-1.17
13	47	7	1.09	0.89
14	41.5	5.0	0.18	0.20
15	36.93	11.079	-0.57	-0.31
16	35.1	5.3	-0.87	-0.91
17	39	10	-0.23	-0.14
18	44	10	0.59	0.35
19	40.9	6.8	0.08	0.07
20	34.8	7	-0.92	-0.76
21	40.9	6.93	0.08	0.07
23	35.978	3.598	-0.73	-1.02
24	50	9.5	1.58	0.98
25	NT	NT		
26	40	12	-0.07	-0.03
27	40	NR	-0.07	-0.17
28	NT	NT		

Statistics

Assigned Value	40.4	2.4
Spike Value	Not Spiked	
Homogeneity Value	44.4	5.3
Robust Average	40.4	2.4
Median	40.6	2.3
Mean	40.4	
N	22	
Max	50	
Min	31.1	
Robust SD	4.5	
Robust CV	11%	


Kernel Density
Density
Result
Results: S2 - Cr
Assigned Value = 40.4 ± 2.4 mg/kg
Results (mg/kg)
Laboratory
8 12 20 16 23 15 2 17 26 27 4 19 21 14 10 6 11 3 18 5 13 24 7 9 25 28 Md RA HV


z-Scores: S2 - Cr
Standard Deviation for Proficiency Assessment 6.1 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
8 12 20 16 23 15 2 17 26 27 4 19 21 14 10 6 11 3 18 5 13 24
-1.5 -1.0 -0.9 -0.9 -0.7 -0.6 -0.3 -0.2 -0.1 -0.1 0.0 0.1 0.1 0.2 0.4 0.4 0.4 0.6 0.6 0.8 1.1 1.6

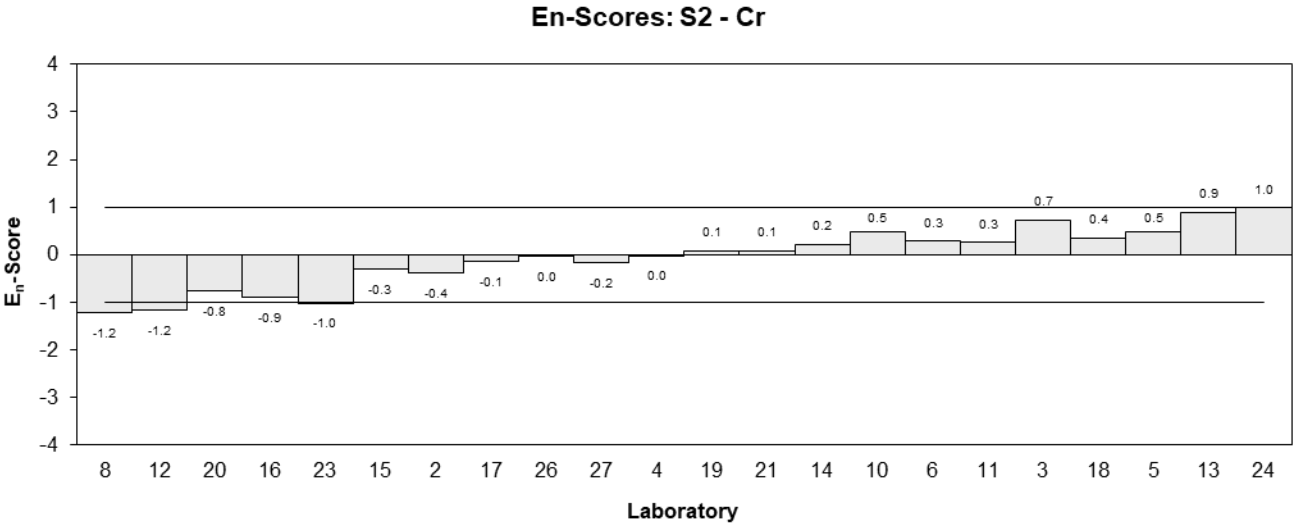

En-Scores: S2 - Cr
En-Score
Laboratory
8 12 20 16 23 15 2 17 26 27 4 19 21 14 10 6 11 3 18 5 13 24
-1.2 -1.2 -0.8 -0.9 -1.0 -0.3 -0.4 -0.1 0.0 -0.2 0.0 0.1 0.1 0.2 0.5 0.3 0.3 0.7 0.4 0.5 0.9 1.0

Figure 30

Table 42

Sample Details

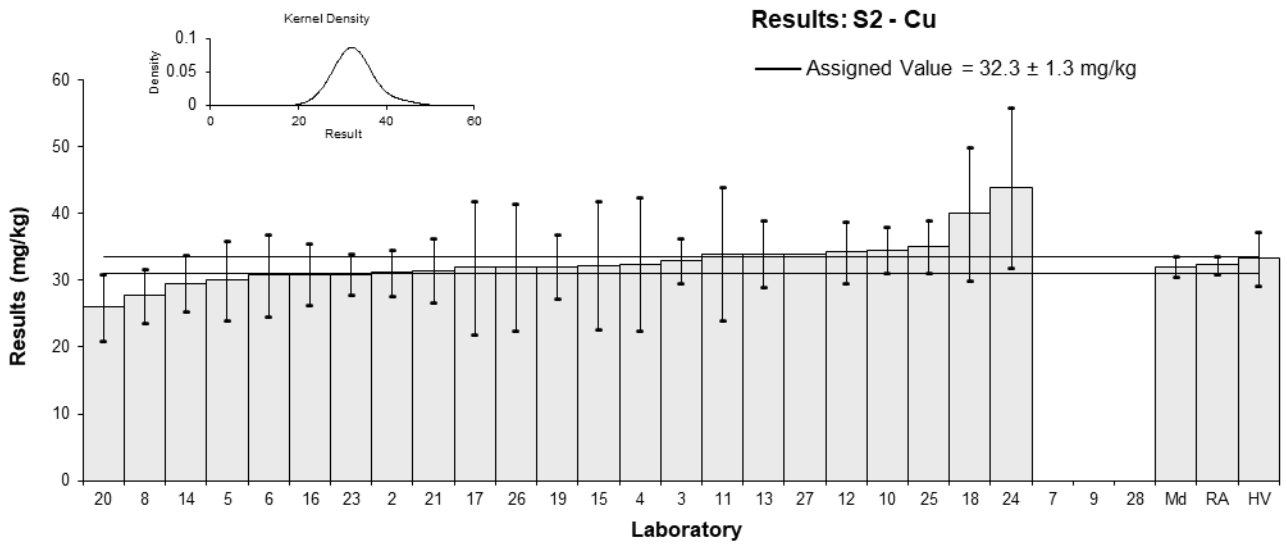
Sample No.	S2
Matrix	Moist Sediment
Analyte	Cu
Unit	mg/kg

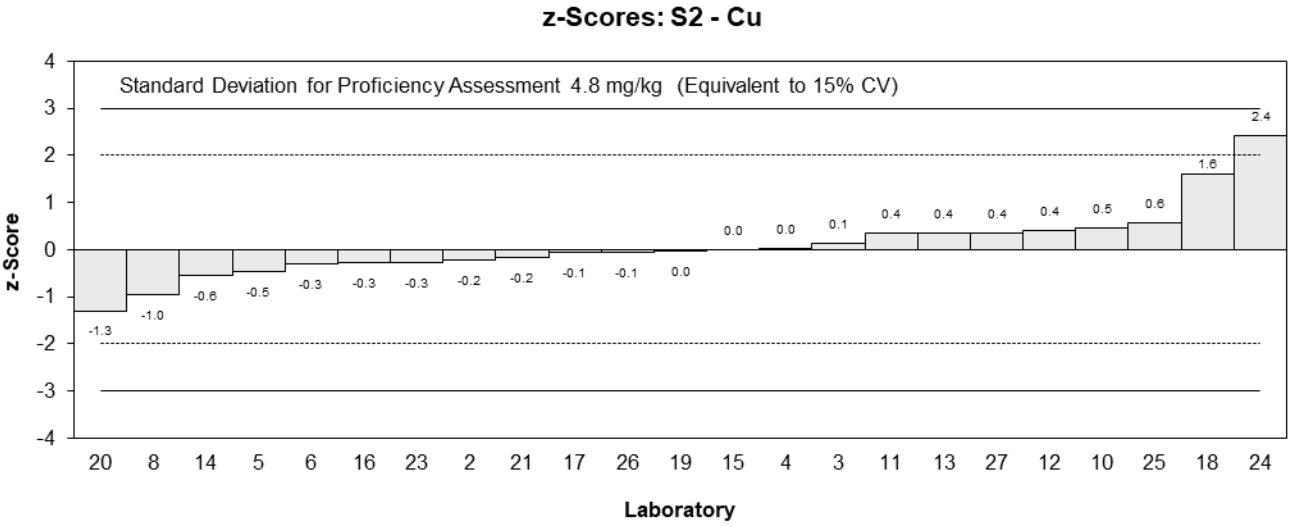
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	31.2	3.5	-0.23	-0.29
3	33	3.3	0.14	0.20
4	32.4	10	0.02	0.01
5	30	6	-0.47	-0.37
6	30.8	6.16	-0.31	-0.24
7	NT	NT		
8	27.7	4.1	-0.95	-1.07
9	NT	NT		
10	34.6	3.46	0.47	0.62
11	34	10	0.35	0.17
12	34.270	4.638	0.41	0.41
13	34	5	0.35	0.33
14	29.6	4.2	-0.56	-0.61
15	32.29	9.687	0.00	0.00
16	30.9	4.6	-0.29	-0.29
17	32	10	-0.06	-0.03
18	40	10	1.59	0.76
19	32.1	4.8	-0.04	-0.04
20	26	5	-1.30	-1.22
21	31.5	4.82	-0.17	-0.16
23	30.910	3.091	-0.29	-0.41
24	44	12	2.41	0.97
25	35.06	4	0.57	0.66
26	32	9.6	-0.06	-0.03
27	34	NR	0.35	1.31
28	NT	NT		

Statistics

Assigned Value	32.3	1.3
Spike Value	Not Spiked	
Homogeneity Value	33.3	4.0
Robust Average	32.3	1.3
Median	32.1	1.5
Mean	32.7	
N	23	
Max	44	
Min	26	
Robust SD	2.4	
Robust CV	7.4%	


Results: S2 - Cu
Kernel Density
Density
Result
Assigned Value = 32.3 ± 1.3 mg/kg
Results (mg/kg)
Laboratory
20 8 14 5 6 16 23 2 21 17 26 19 15 4 3 11 13 27 12 10 25 18 24 7 9 28 Md RA HV


z-Scores: S2 - Cu
Standard Deviation for Proficiency Assessment 4.8 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
20 8 14 5 6 16 23 2 21 17 26 19 15 4 3 11 13 27 12 10 25 18 24
-1.3 -1.0 -0.6 -0.5 -0.3 -0.3 -0.3 -0.2 -0.2 -0.1 -0.1 0.0 0.0 0.0 0.1 0.4 0.4 0.4 0.4 0.5 0.6 1.6 2.4

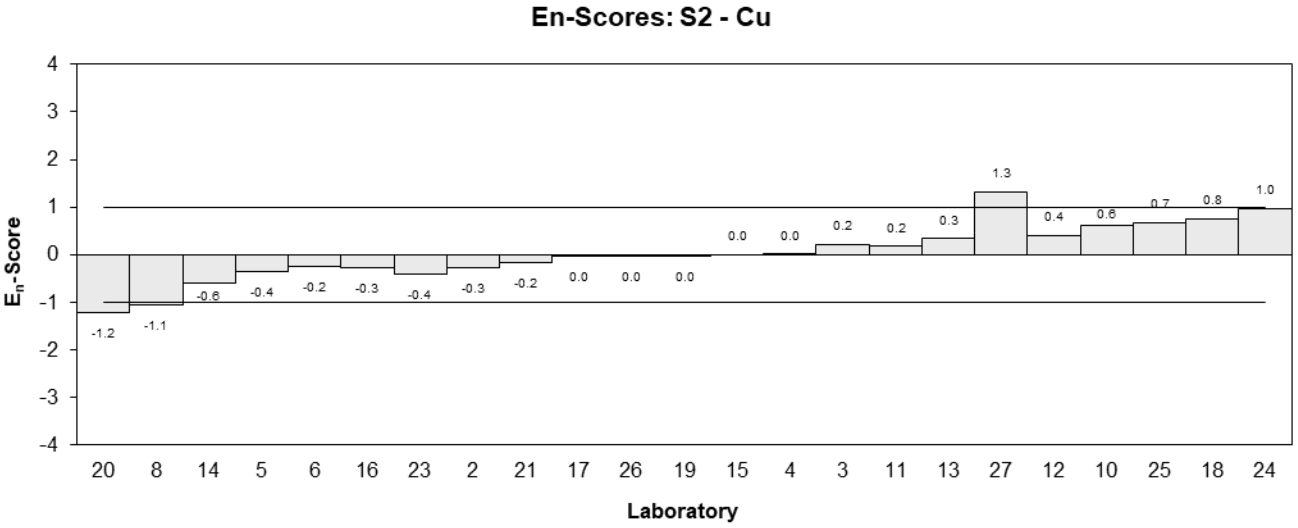

En-Scores: S2 - Cu
En-Score
Laboratory
20 8 14 5 6 16 23 2 21 17 26 19 15 4 3 11 13 27 12 10 25 18 24
-1.2 -1.1 -0.6 -0.4 -0.2 -0.3 -0.4 -0.3 -0.2 0.0 0.0 0.0 0.0 0.0 0.2 0.2 0.3 1.3 0.4 0.6 0.7 0.8 1.0

Figure 31

Table 43

Sample Details

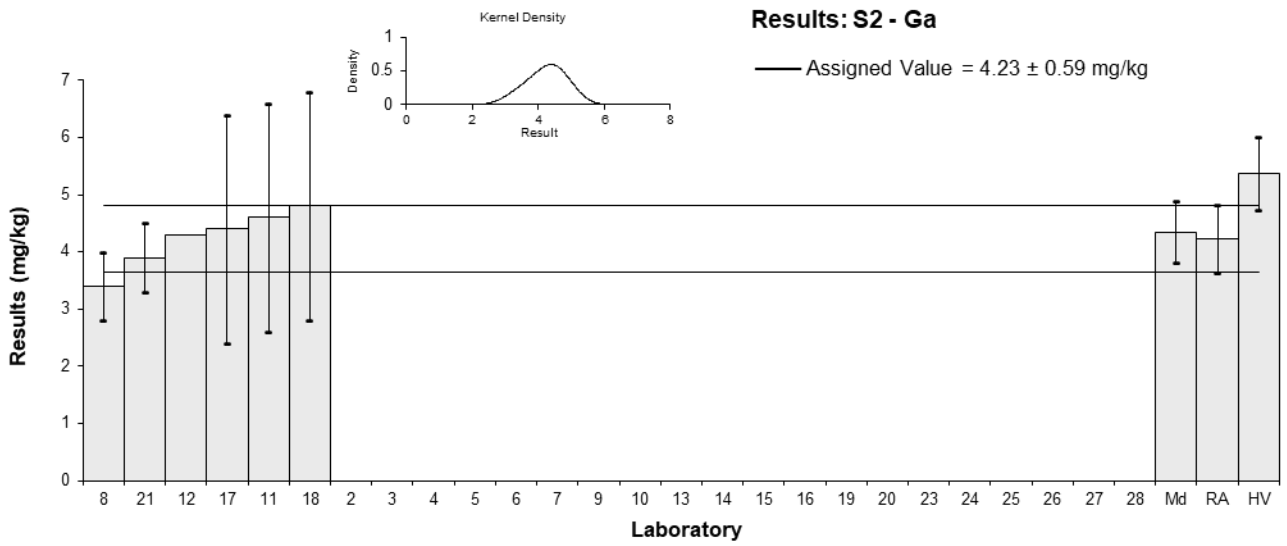
Sample No.	S2
Matrix	Moist Sediment
Analyte	Ga
Unit	mg/kg

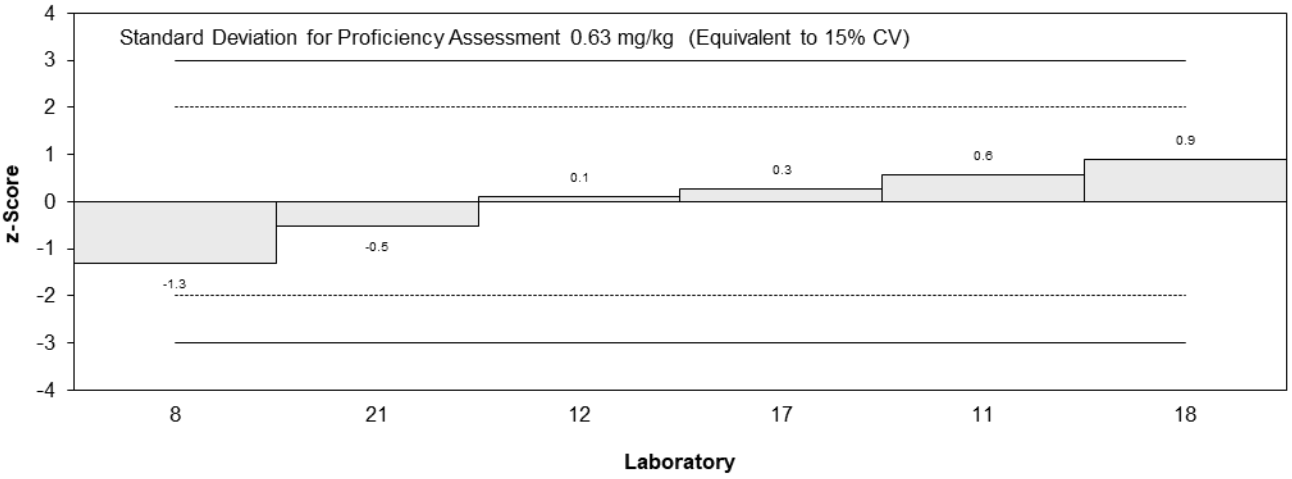
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	NT	NT		
3	NR	NR		
4	NT	NT		
5	NT	NT		
6	NT	NT		
7	NT	NT		
8	3.4	0.6	-1.31	-0.99
9	NT	NT		
10	NT	NT		
11	4.6	2	0.58	0.18
12	4.299	NR	0.11	0.12
13	NT	NT		
14	NT	NT		
15	NT	NT		
16	NT	NT		
17	4.4	2	0.27	0.08
18	4.8	2	0.90	0.27
19	NT	NT		
20	NT	NT		
21	3.9	0.6	-0.52	-0.39
23	NT	NT		
24	NT	NT		
25	NT	NT		
26	NT	NT		
27	NT	NT		
28	NT	NT		

Statistics

Assigned Value	4.23	0.59
Spike Value	Not Spiked	
Homogeneity Value	5.37	0.64
Robust Average	4.23	0.59
Median	4.35	0.53
Mean	4.23	
N	6	
Max	4.8	
Min	3.4	
Robust SD	0.58	
Robust CV	14%	


Kernel Density
Density
Result
Results: S2 - Ga
Assigned Value = 4.23 ± 0.59 mg/kg
Results (mg/kg)
Laboratory
8 21 12 17 11 18 2 3 4 5 6 7 9 10 13 14 15 16 19 20 23 24 25 26 27 28 Md RA HV


z-Scores: S2 - Ga
Standard Deviation for Proficiency Assessment 0.63 mg/kg (Equivalent to 15% CV)
z-Score
-1.3
-0.5
0.1
0.3
0.6
0.9
Laboratory
8 21 12 17 11 18

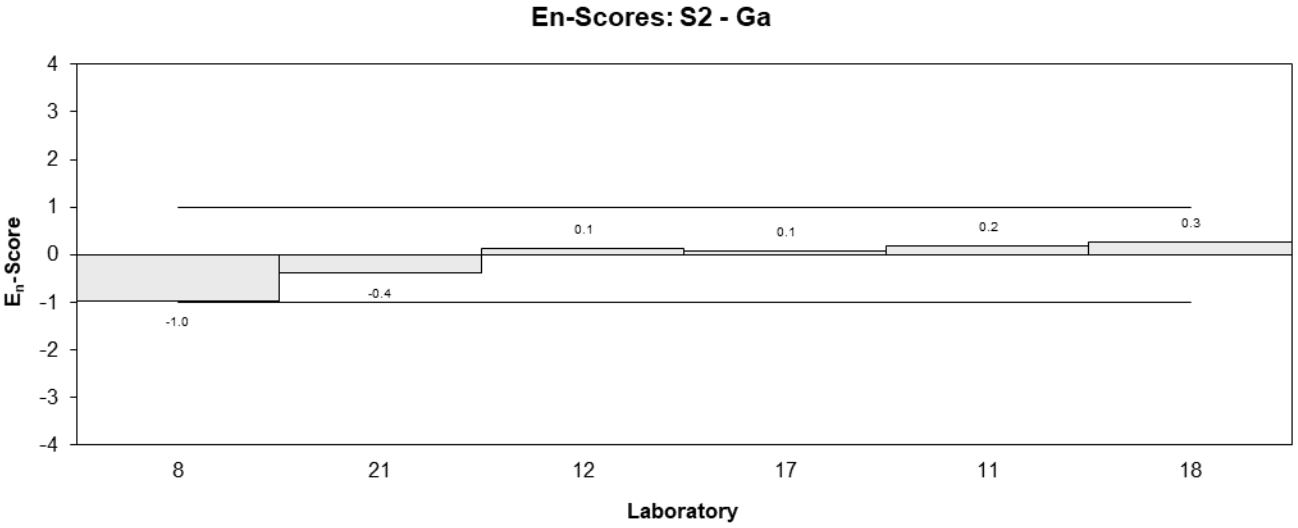

En-Scores: S2 - Ga
En-Score
-1.0
-0.4
0.1
0.1
0.2
0.3
Laboratory
8 21 12 17 11 18

Figure 32

Table 44

Sample Details

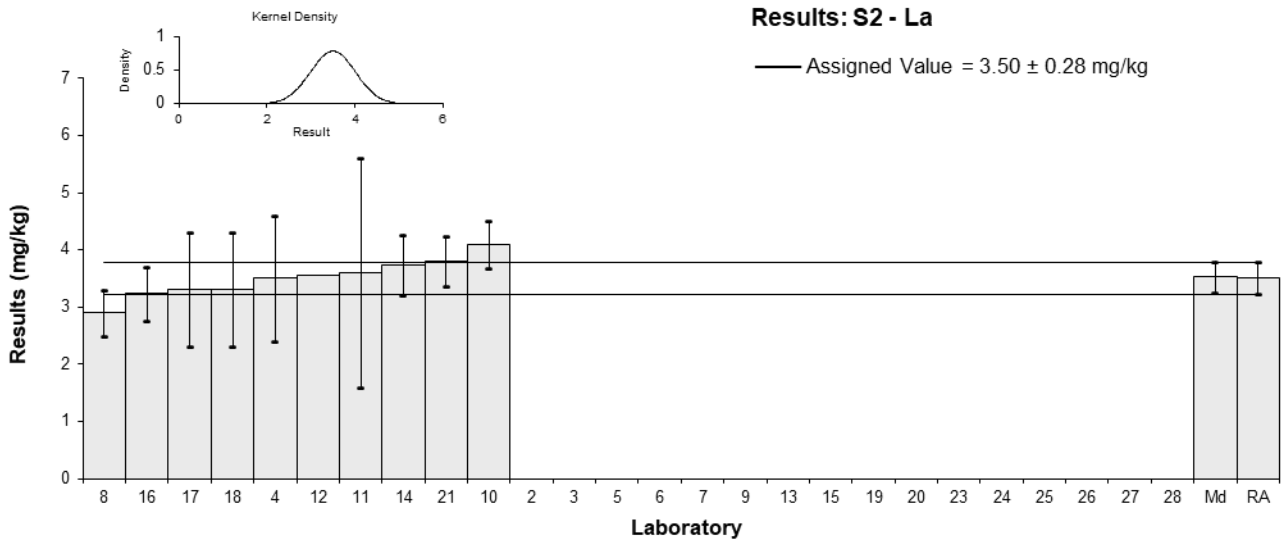
Sample No.	S2
Matrix	Moist Sediment
Analyte	La
Unit	mg/kg

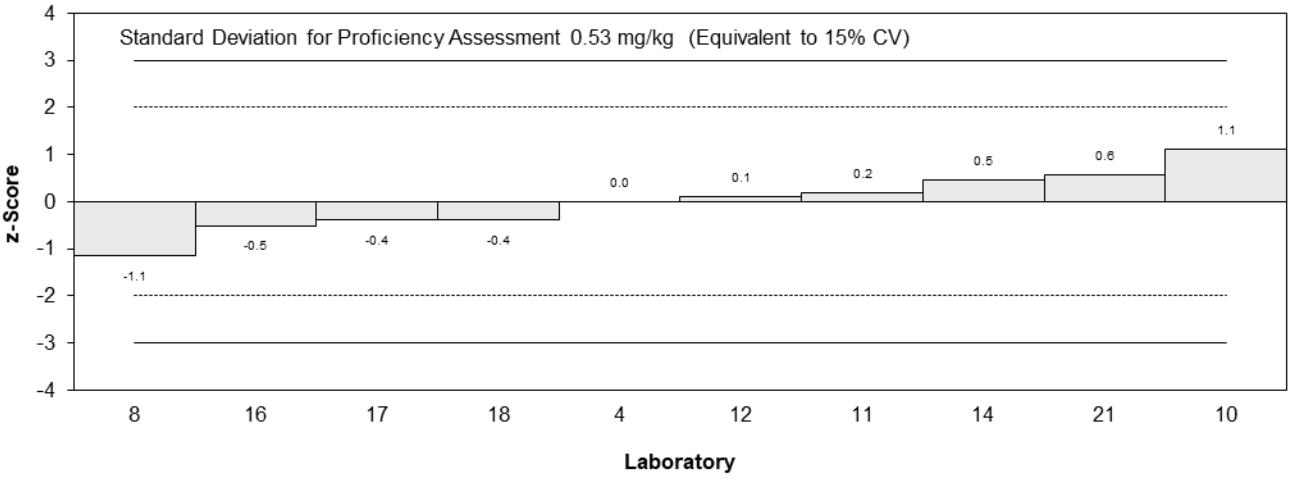
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	NT	NT		
3	NR	NR		
4	3.5	1.1	0.00	0.00
5	NT	NT		
6	NT	NT		
7	NT	NT		
8	2.9	0.4	-1.14	-1.23
9	NT	NT		
10	4.09	0.409	1.12	1.19
11	3.6	2	0.19	0.05
12	3.559	NR	0.11	0.21
13	NT	NT		
14	3.74	0.53	0.46	0.40
15	NT	NT		
16	3.23	0.48	-0.51	-0.49
17	3.3	1	-0.38	-0.19
18	3.3	1	-0.38	-0.19
19	NT	NT		
20	NT	NT		
21	3.8	0.43	0.57	0.58
23	NT	NT		
24	NT	NT		
25	NT	NT		
26	NT	NT		
27	NT	NT		
28	NT	NT		

Statistics

Assigned Value	3.50	0.28
Spike Value	Not Spiked	
Robust Average	3.50	0.28
Median	3.53	0.27
Mean	3.50	
N	10	
Max	4.09	
Min	2.9	
Robust SD	0.35	
Robust CV	10%	


Results: S2 - La
Assigned Value = 3.50 ± 0.28 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
8 16 17 18 4 12 11 14 21 10 2 3 5 6 7 9 13 15 19 20 23 24 25 26 27 28 Md RA


z-Scores: S2 - La
Standard Deviation for Proficiency Assessment 0.53 mg/kg (Equivalent to 15% CV)
z-Score
-1.1 -0.5 -0.4 -0.4 0.0 0.1 0.2 0.5 0.6 1.1
Laboratory
8 16 17 18 4 12 11 14 21 10

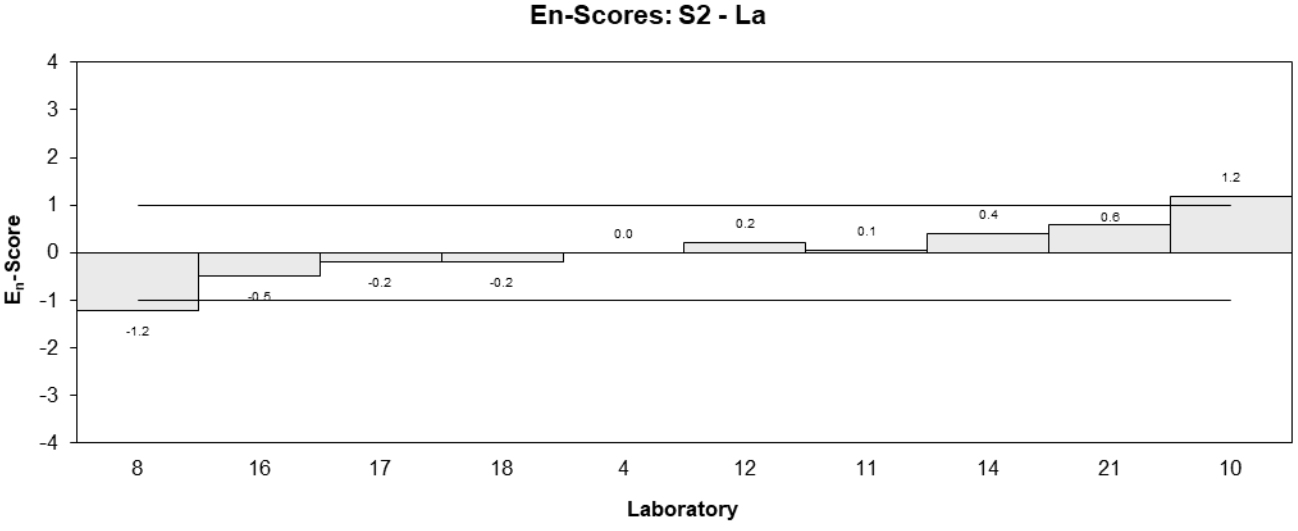

En-Scores: S2 - La
En-Score
-1.2 -0.5 -0.2 -0.2 0.0 0.2 0.1 0.4 0.6 1.2
Laboratory
8 16 17 18 4 12 11 14 21 10

Figure 33

Table 45

Sample Details

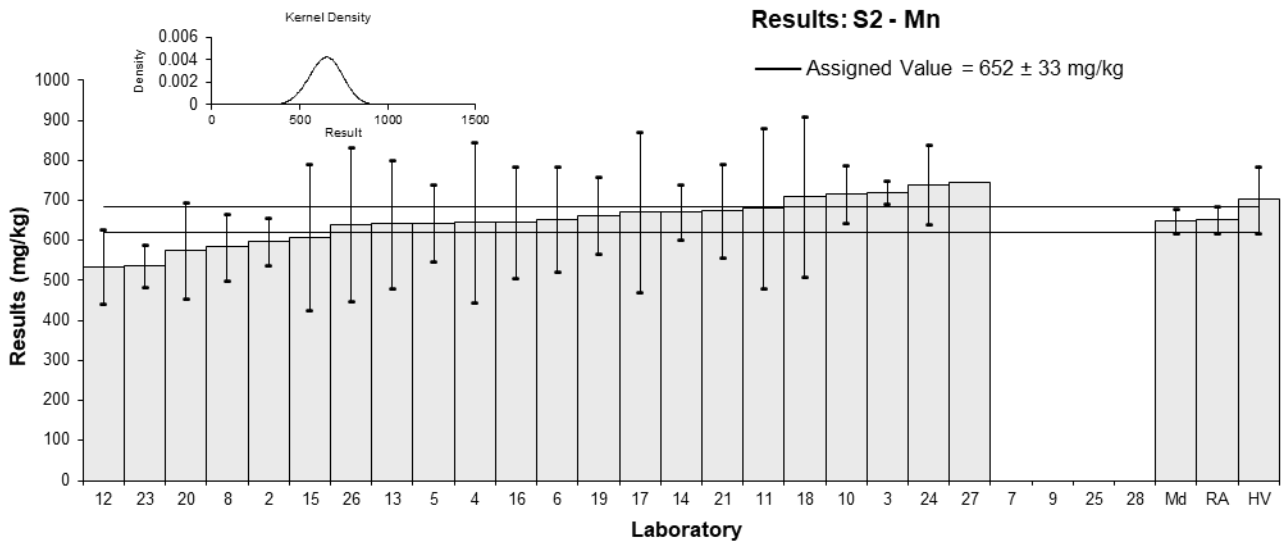
Sample No.	S2
Matrix	Moist Sediment
Analyte	Mn
Unit	mg/kg

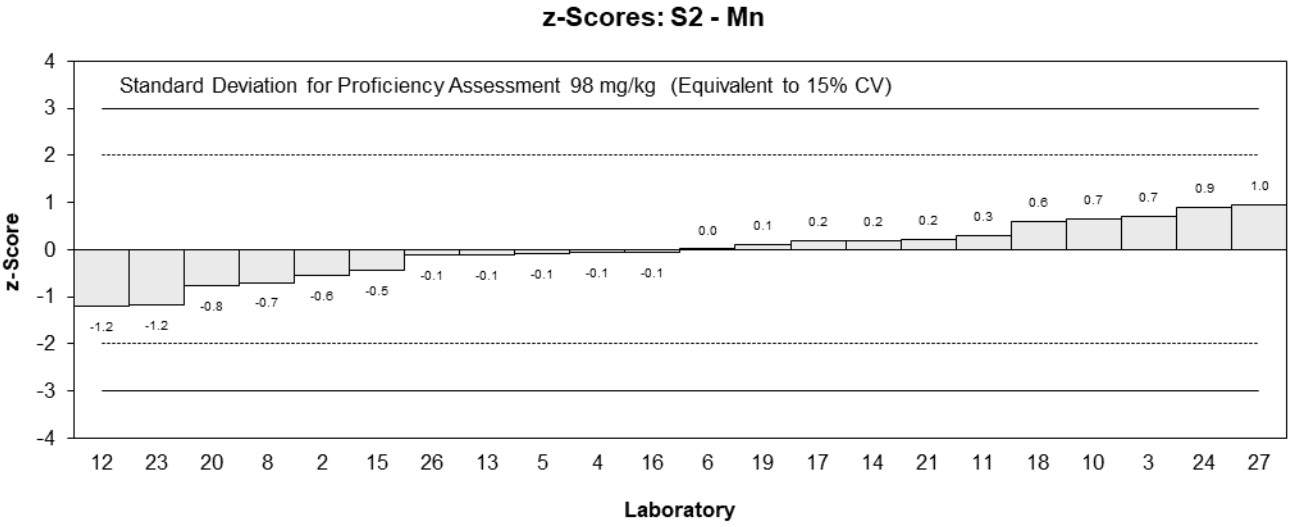
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	597	60	-0.56	-0.80
3	720	29	0.70	1.55
4	645	200	-0.07	-0.03
5	643	96	-0.09	-0.09
6	653	131	0.01	0.01
7	NT	NT		
8	584	84	-0.70	-0.75
9	NT	NT		
10	716	71.6	0.65	0.81
11	680	200	0.29	0.14
12	534.261	93.104	-1.20	-1.19
13	641	160	-0.11	-0.07
14	671	68	0.19	0.25
15	607.67	182.301	-0.45	-0.24
16	645	140	-0.07	-0.05
17	670	200	0.18	0.09
18	710	200	0.59	0.29
19	662	96	0.10	0.10
20	576	120	-0.78	-0.61
21	674	117	0.22	0.18
23	537.029	53.703	-1.18	-1.82
24	740	100	0.90	0.84
25	NT	NT		
26	640	192	-0.12	-0.06
27	745	NR	0.95	2.82
28	NT	NT		

Statistics

Assigned Value	652	33
Spike Value	Not Spiked	
Homogeneity Value	702	84
Robust Average	652	33
Median	649	29
Mean	650	
N	22	
Max	745	
Min	534.261	
Robust SD	63	
Robust CV	9.6%	


Results: S2 - Mn
Kernel Density
Density
Result
Assigned Value = 652 ± 33 mg/kg
Results (mg/kg)
Laboratory
12 23 20 8 2 15 26 13 5 4 16 6 19 17 14 21 11 18 10 3 24 27 7 9 25 28 Md RA HV


z-Scores: S2 - Mn
Standard Deviation for Proficiency Assessment 98 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
12 23 20 8 2 15 26 13 5 4 16 6 19 17 14 21 11 18 10 3 24 27

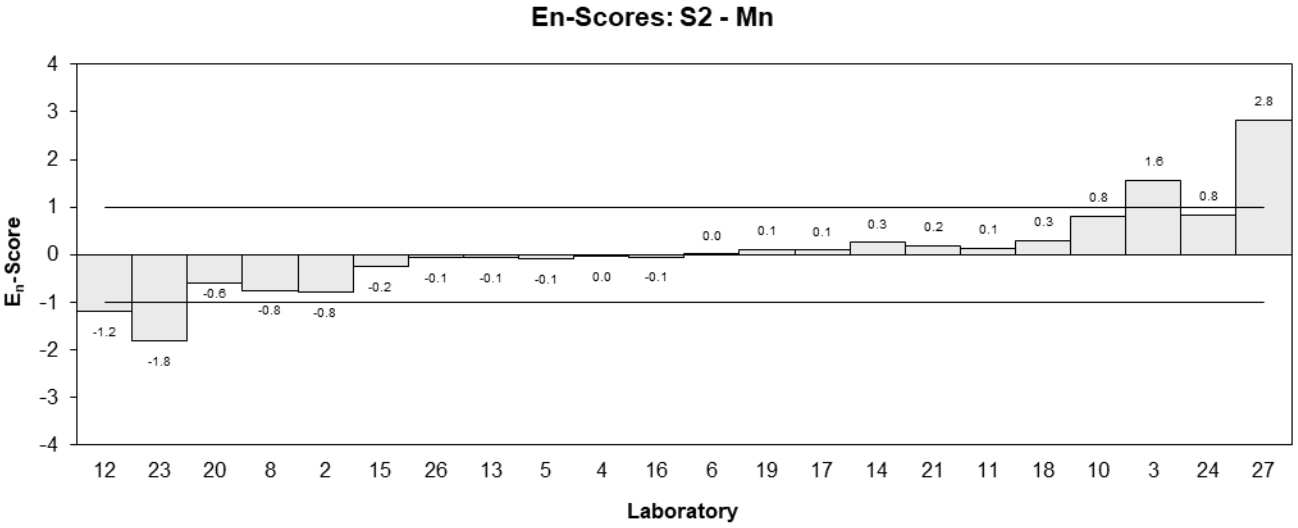

En-Scores: S2 - Mn
En-Score
Laboratory
12 23 20 8 2 15 26 13 5 4 16 6 19 17 14 21 11 18 10 3 24 27

Figure 34

Table 46

Sample Details

Sample No.	S2
Matrix	Moist Sediment
Analyte	Na
Unit	mg/kg

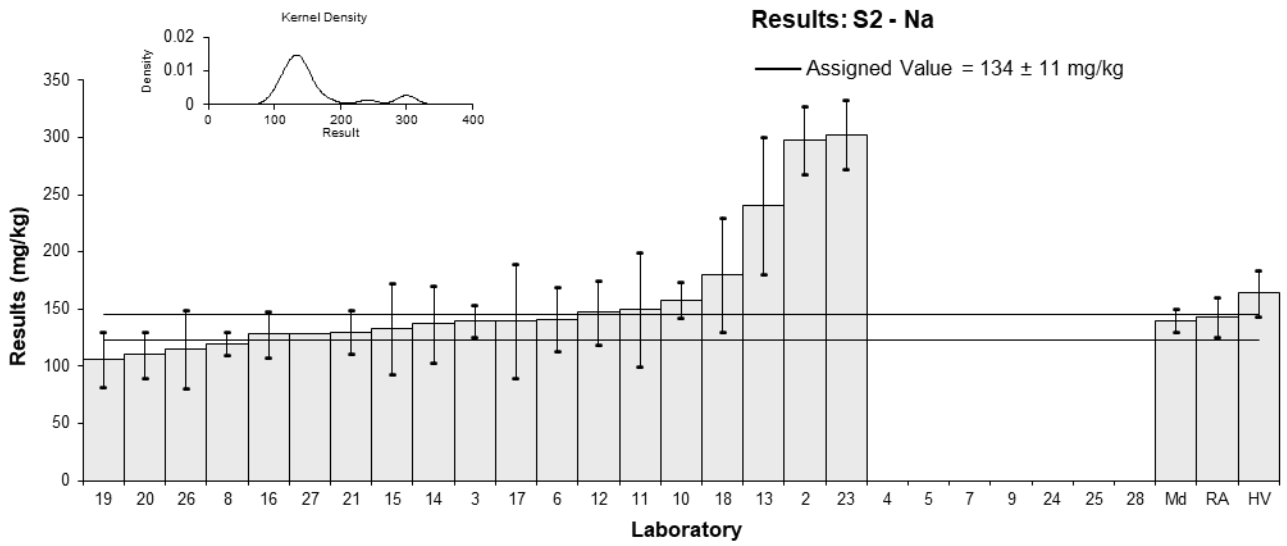
Participant Results

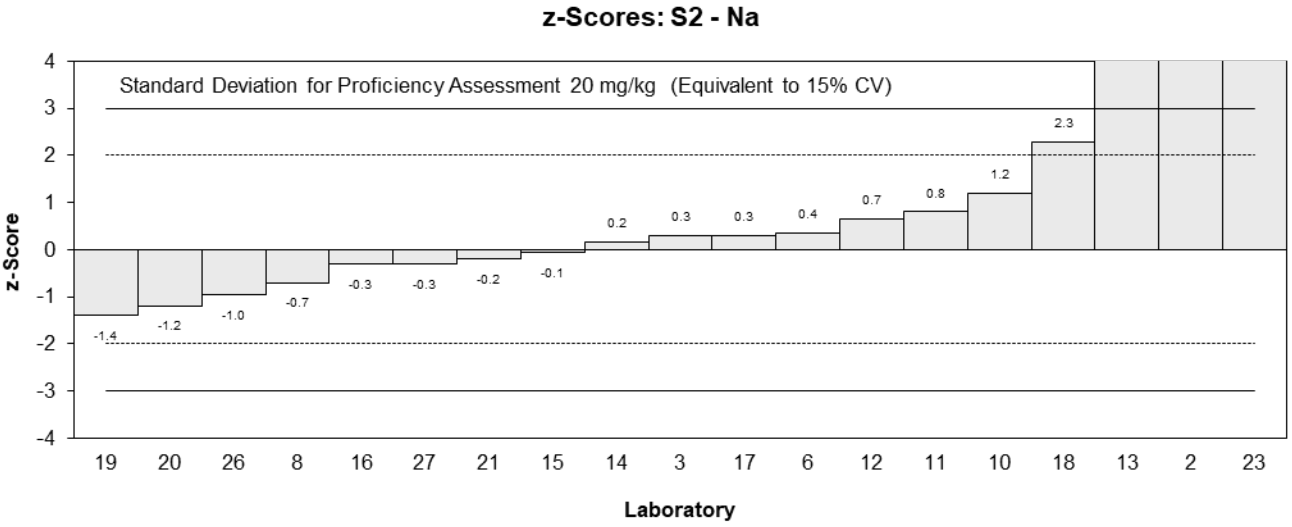
Lab. Code	Result	Uncertainty	z	E_n
2*	298	30	8.16	5.13
3	140	14	0.30	0.34
4	NT	NT		
5	NT	NT		
6	141	28.1	0.35	0.23
7	NT	NT		
8	120	10	-0.70	-0.94
9	NT	NT		
10	158	15.8	1.19	1.25
11	150	50	0.80	0.31
12	146.977	27.860	0.65	0.43
13*	241	60	5.32	1.75
14	137	34	0.15	0.08
15	132.7	39.81	-0.06	-0.03
16	128	20	-0.30	-0.26
17	140	50	0.30	0.12
18	180	50	2.29	0.90
19	106	24	-1.39	-1.06
20	110	20	-1.19	-1.05
21	130	19.5	-0.20	-0.18
23*	302.610	30.261	8.39	5.24
24	NT	NT		
25	NT	NT		
26	115	34.5	-0.95	-0.52
27	128	NR	-0.30	-0.55
28	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	134	11
Spike Value	Not Spiked	
Homogeneity Value	164	20
Robust Average	143	17
Median	140	10
Mean	158	
N	19	
Max	302.610	
Min	106	
Robust SD	30	
Robust CV	21%	


Kernel Density
Density
Result
Results: S2 - Na
Assigned Value = 134 ± 11 mg/kg
Results (mg/kg)
Laboratory
19 20 26 8 16 27 21 15 14 3 17 6 12 11 10 18 13 2 23 4 5 7 9 24 25 28 Md RA HV


z-Scores: S2 - Na
Standard Deviation for Proficiency Assessment 20 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
19 20 26 8 16 27 21 15 14 3 17 6 12 11 10 18 13 2 23

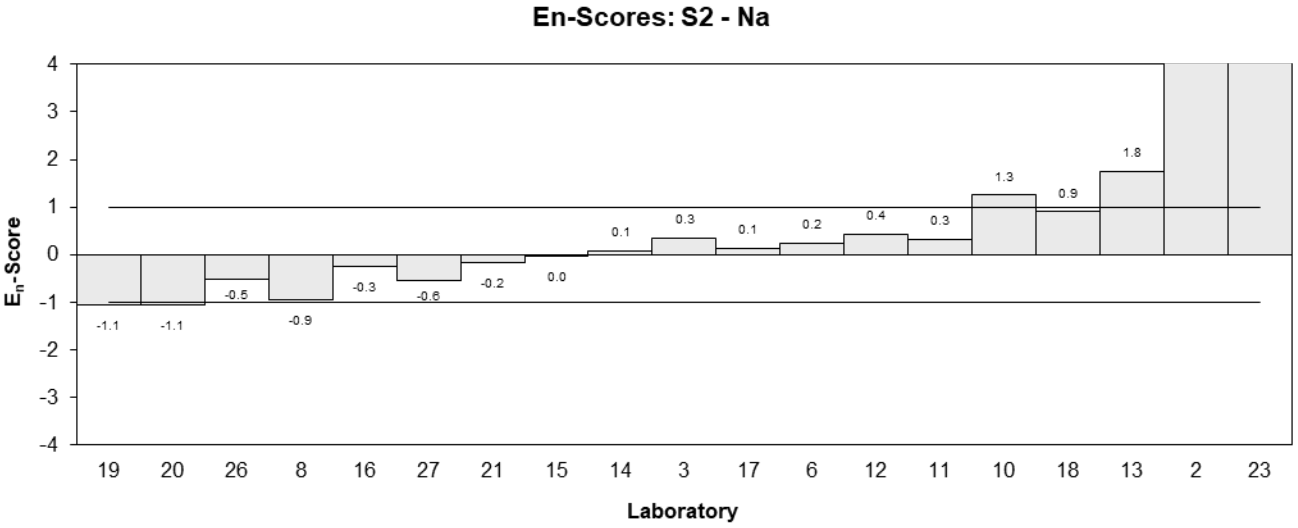

En-Scores: S2 - Na
En-Score
Laboratory
19 20 26 8 16 27 21 15 14 3 17 6 12 11 10 18 13 2 23

Figure 35

Table 47

Sample Details

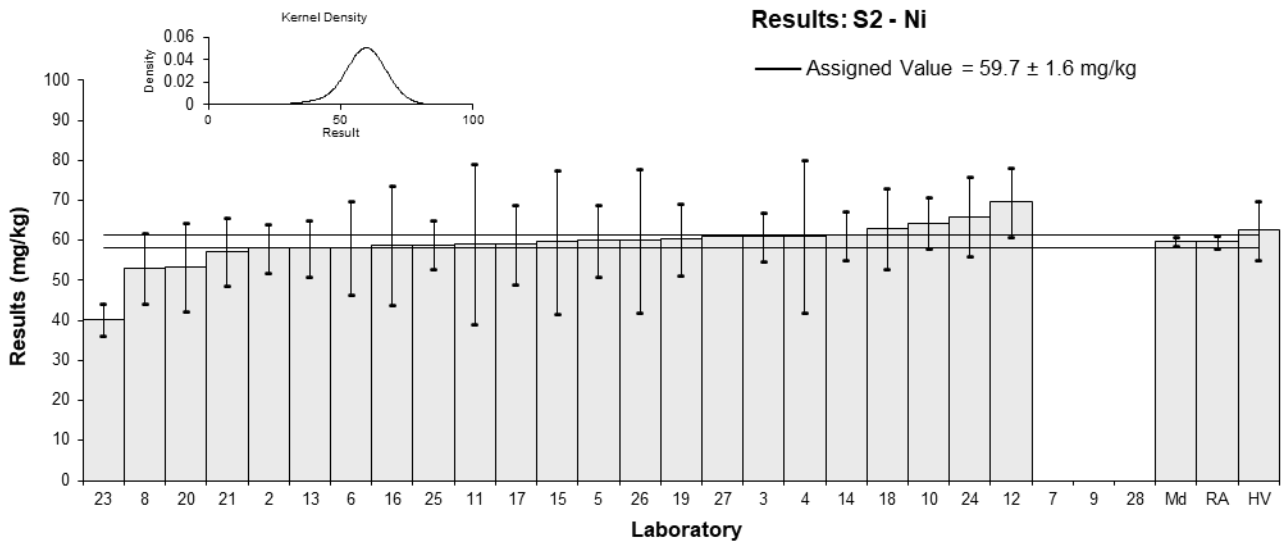
Sample No.	S2
Matrix	Moist Sediment
Analyte	Ni
Unit	mg/kg

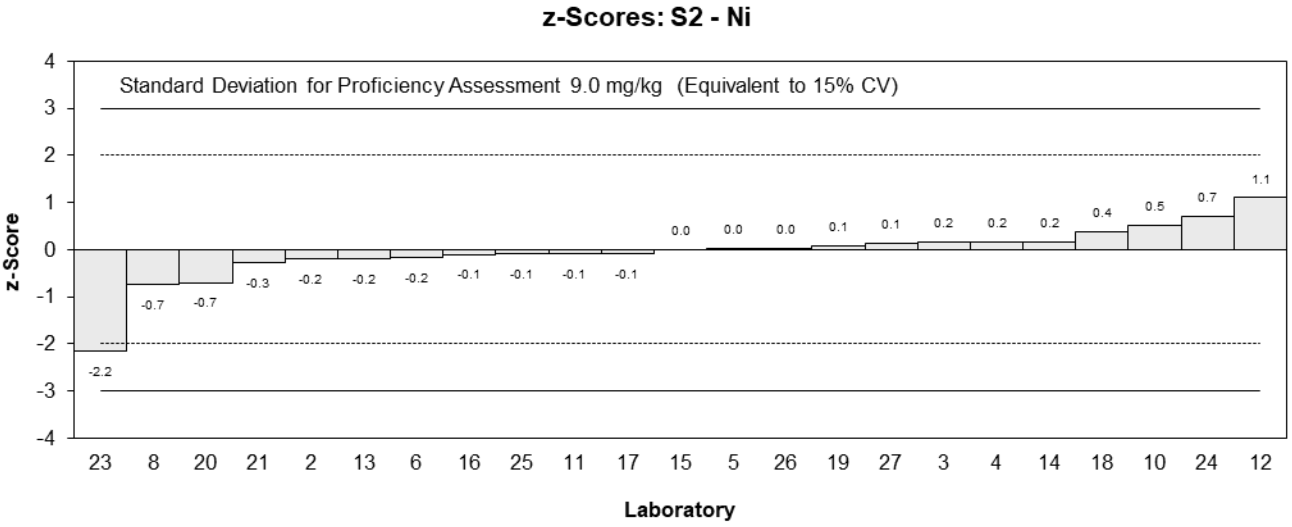
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	58.0	6.0	-0.19	-0.27
3	61	6.1	0.15	0.21
4	61.1	19	0.16	0.07
5	60	9	0.03	0.03
6	58.1	11.6	-0.18	-0.14
7	NT	NT		
8	53.1	8.8	-0.74	-0.74
9	NT	NT		
10	64.4	6.44	0.52	0.71
11	59	20	-0.08	-0.03
12	69.578	8.557	1.10	1.13
13	58	7	-0.19	-0.24
14	61.2	6.2	0.17	0.23
15	59.67	17.901	0.00	0.00
16	58.8	15	-0.10	-0.06
17	59	10	-0.08	-0.07
18	63	10	0.37	0.33
19	60.3	8.9	0.07	0.07
20	53.4	11	-0.70	-0.57
21	57.3	8.45	-0.27	-0.28
23	40.338	4.034	-2.16	-4.46
24	66	9.9	0.70	0.63
25	58.92	6	-0.09	-0.13
26	60	18	0.03	0.02
27	60.9	NR	0.13	0.75
28	NT	NT		

Statistics

Assigned Value	59.7	1.6
Spike Value	Not Spiked	
Homogeneity Value	62.5	7.5
Robust Average	59.7	1.6
Median	59.7	1.2
Mean	59.2	
N	23	
Max	69.578	
Min	40.338	
Robust SD	3.1	
Robust CV	5.2%	


Results: S2 - Ni
Assigned Value = 59.7 ± 1.6 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
23 8 20 21 2 13 6 16 25 11 17 15 5 26 19 27 3 4 14 18 10 24 12 7 9 28 Md RA HV


z-Scores: S2 - Ni
Standard Deviation for Proficiency Assessment 9.0 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
23 8 20 21 2 13 6 16 25 11 17 15 5 26 19 27 3 4 14 18 10 24 12

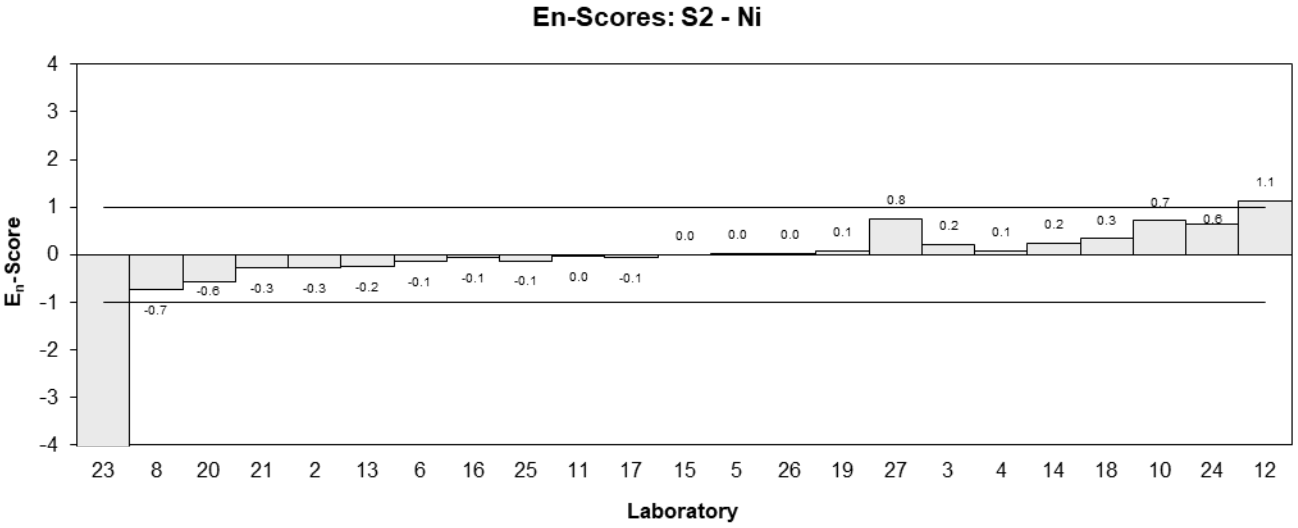

En-Scores: S2 - Ni
En-Score
Laboratory
23 8 20 21 2 13 6 16 25 11 17 15 5 26 19 27 3 4 14 18 10 24 12

Figure 36

Table 48

Sample Details

Sample No.	S2
Matrix	Moist Sediment
Analyte	P
Unit	mg/kg

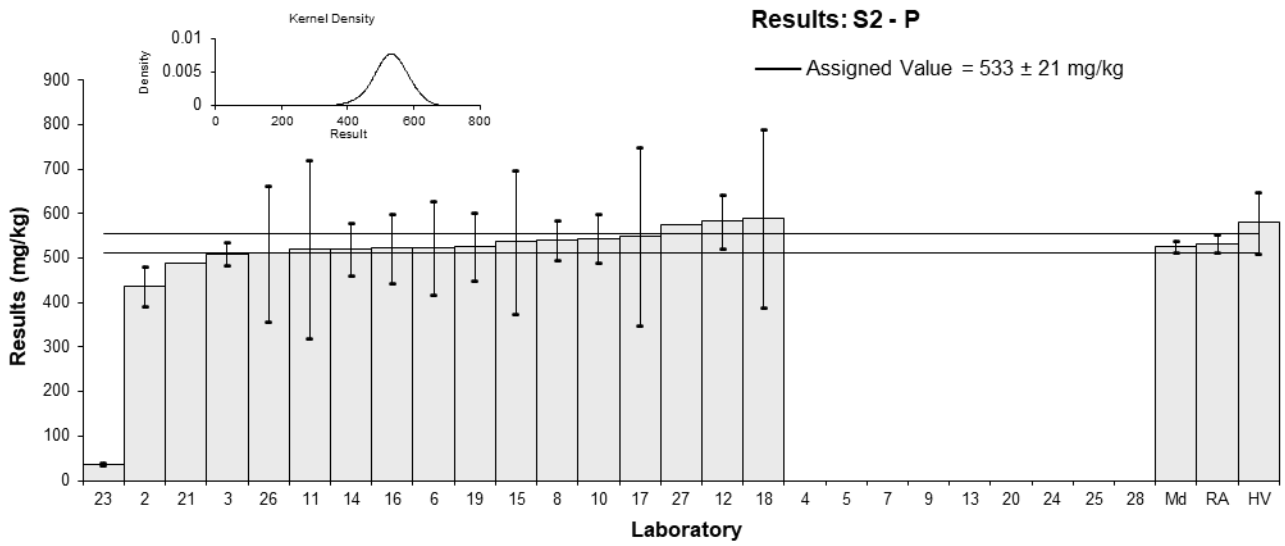
Participant Results

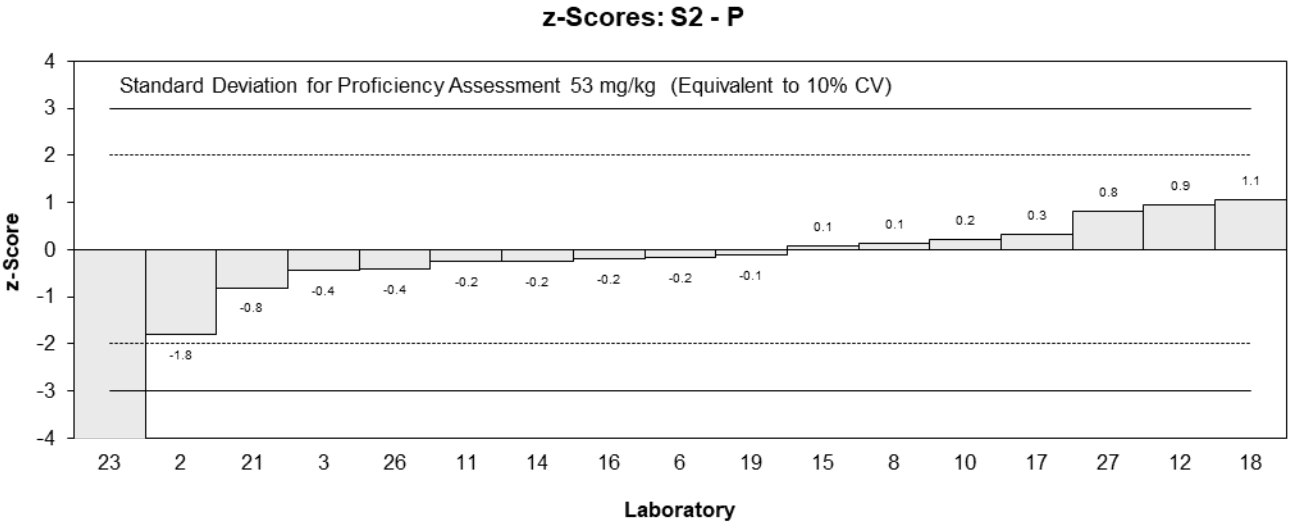
Lab. Code	Result	Uncertainty	z	E_n
2	437	45	-1.80	-1.93
3	510	26	-0.43	-0.69
4	NT	NT		
5	NT	NT		
6	524	105	-0.17	-0.08
7	NT	NT		
8	540	45	0.13	0.14
9	NT	NT		
10	544	54.4	0.21	0.19
11	520	200	-0.24	-0.06
12	583.263	60.002	0.94	0.79
13	NT	NT		
14	520	59	-0.24	-0.21
15	537.078	161.1234	0.08	0.03
16	523	78	-0.19	-0.12
17	550	200	0.32	0.08
18	590	200	1.07	0.28
19	527	77	-0.11	-0.08
20	NT	NT		
21	490	NR	-0.81	-2.05
23**	37.127	3.713	-9.30	-23.25
24	NT	NT		
25	NT	NT		
26	511	153	-0.41	-0.14
27	576	NR	0.81	2.05
28	NT	NT		

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	533	21
Spike Value	Not Spiked	
Homogeneity Value	580	70
Robust Average	533	21
Median	526	14
Mean	530	
N	16	
Max	590	
Min	437	
Robust SD	34	
Robust CV	6.4%	


Kernel Density
Density
0.01
0.005
0
0
200
400
600
800
Result
Results: S2 - P
Assigned Value = 533 ± 21 mg/kg
Results (mg/kg)
900
800
700
600
500
400
300
200
100
0
23 2 21 3 26 11 14 16 6 19 15 8 10 17 27 12 18 4 5 7 9 13 20 24 25 28 Md RA HV
Laboratory


z-Scores: S2 - P
Standard Deviation for Proficiency Assessment 53 mg/kg (Equivalent to 10% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-1.8
-0.8
-0.4
-0.4
-0.2
-0.2
-0.2
-0.2
-0.1
0.1
0.1
0.2
0.3
0.8
0.9
1.1
23 2 21 3 26 11 14 16 6 19 15 8 10 17 27 12 18
Laboratory

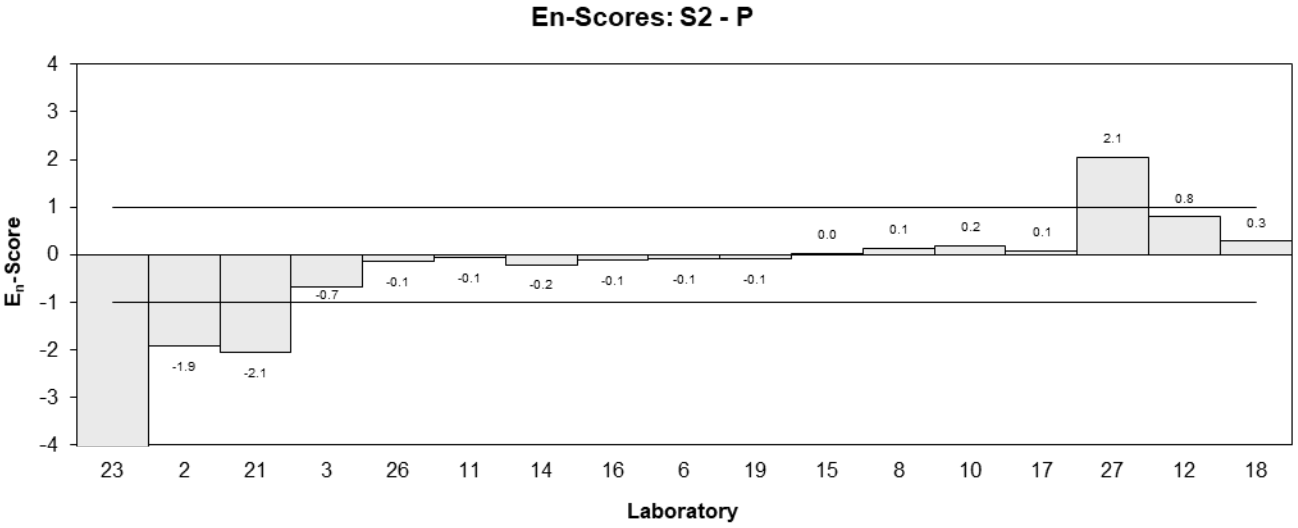

En-Scores: S2 - P
En-Score
4
3
2
1
0
-1
-2
-3
-4
-1.9
-2.1
-0.7
-0.1
-0.1
-0.2
-0.1
-0.1
-0.1
0.0
0.1
0.2
0.1
2.1
0.8
0.3
23 2 21 3 26 11 14 16 6 19 15 8 10 17 27 12 18
Laboratory

Figure 37

Table 49

Sample Details

Sample No.	S2
Matrix	Moist Sediment
Analyte	Pb
Unit	mg/kg

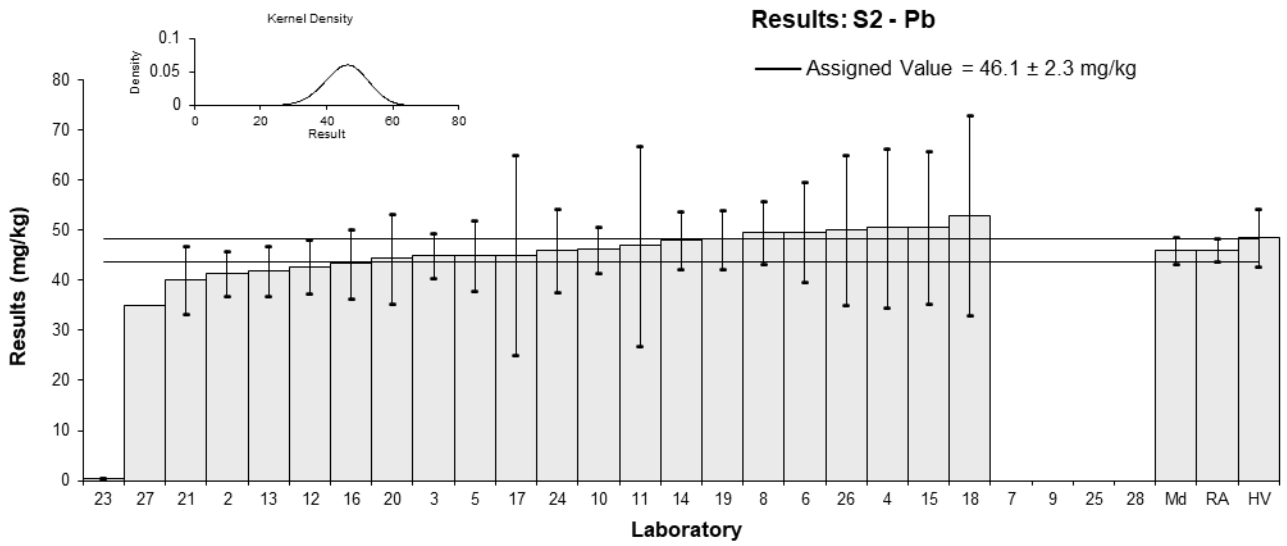
Participant Results

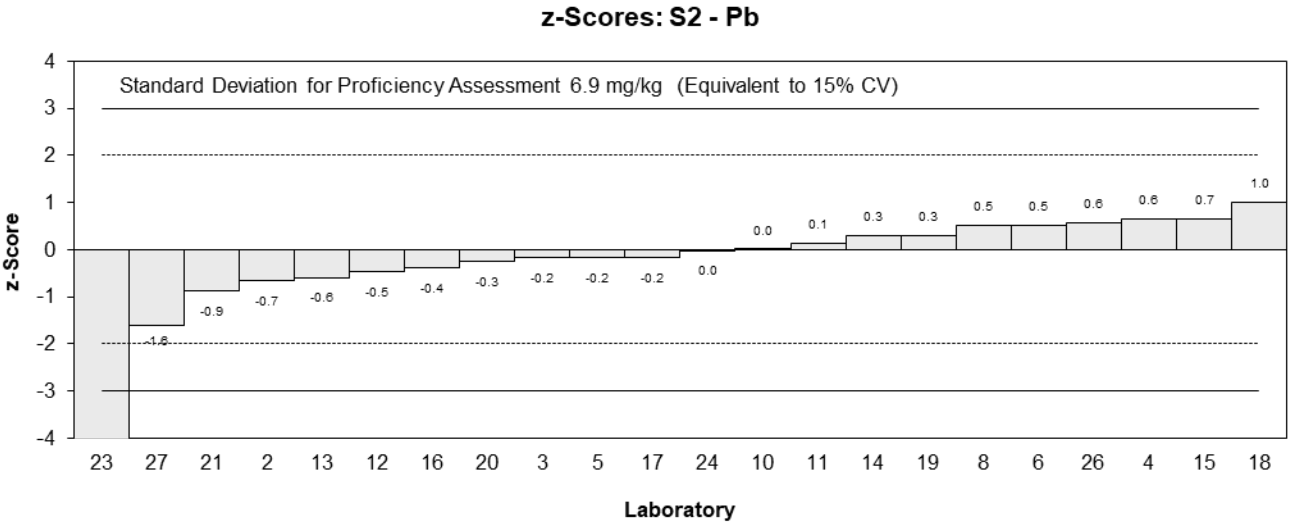
Lab. Code	Result	Uncertainty	z	E_n
2	41.5	4.5	-0.67	-0.91
3	45	4.5	-0.16	-0.22
4	50.5	16	0.64	0.27
5	45	7	-0.16	-0.15
6	49.7	9.94	0.52	0.35
7	NT	NT		
8	49.6	6.3	0.51	0.52
9	NT	NT		
10	46.2	4.62	0.01	0.02
11	47	20	0.13	0.04
12	42.769	5.465	-0.48	-0.56
13	42	5	-0.59	-0.74
14	48.1	5.8	0.29	0.32
15	50.6	15.18	0.65	0.29
16	43.4	6.9	-0.39	-0.37
17	45	20	-0.16	-0.05
18	53	20	1.00	0.34
19	48.2	5.8	0.30	0.34
20	44.4	9	-0.25	-0.18
21	40.1	6.79	-0.87	-0.84
23**	0.440	0.044	-6.60	-19.85
24	46	8.3	-0.01	-0.01
25	NT	NT		
26	50	15	0.56	0.26
27	35	NR	-1.61	-4.83
28	NT	NT		

** Extreme Outlier, see Section 4.2

Statistics

Assigned Value	46.1	2.3
Spike Value	Not Spiked	
Homogeneity Value	48.5	5.8
Robust Average	46.1	2.3
Median	46.0	2.6
Mean	45.9	
N	21	
Max	53	
Min	35	
Robust SD	4.1	
Robust CV	9%	


Results: S2 - Pb
Kernel Density
Density
Result
Assigned Value = 46.1 ± 2.3 mg/kg
Results (mg/kg)
Laboratory
23 27 21 2 13 12 16 20 3 5 17 24 10 11 14 19 8 6 26 4 15 18 7 9 25 28 Md RA HV


z-Scores: S2 - Pb
Standard Deviation for Proficiency Assessment 6.9 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
23 27 21 2 13 12 16 20 3 5 17 24 10 11 14 19 8 6 26 4 15 18

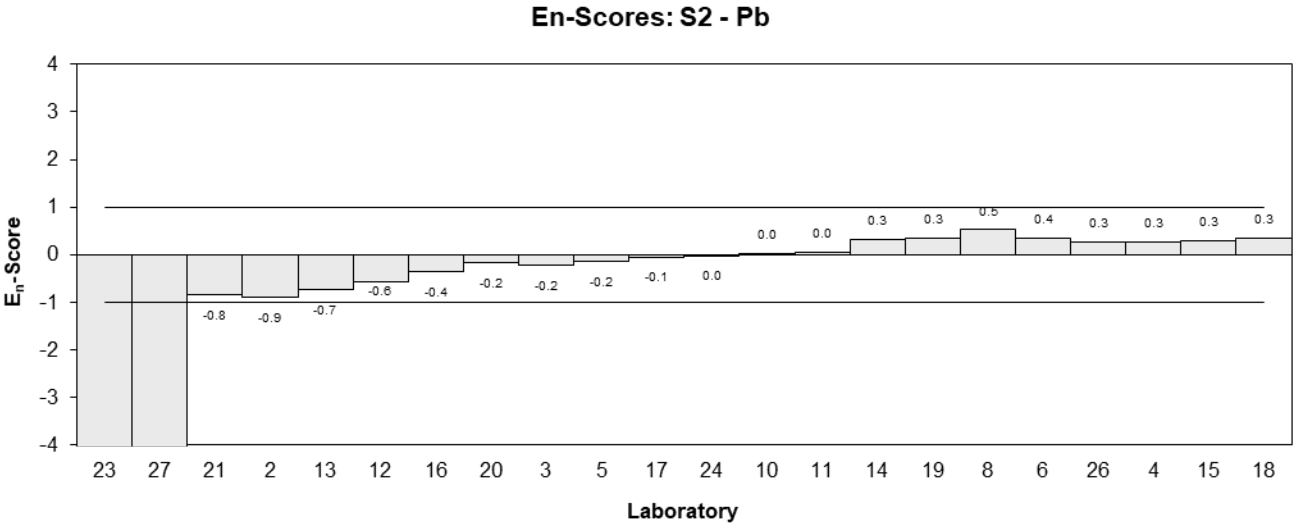

En-Scores: S2 - Pb
En-Score
Laboratory
23 27 21 2 13 12 16 20 3 5 17 24 10 11 14 19 8 6 26 4 15 18

Figure 38

Table 50

Sample Details

Sample No.	S2
Matrix	Moist Sediment
Analyte	Rb
Unit	mg/kg

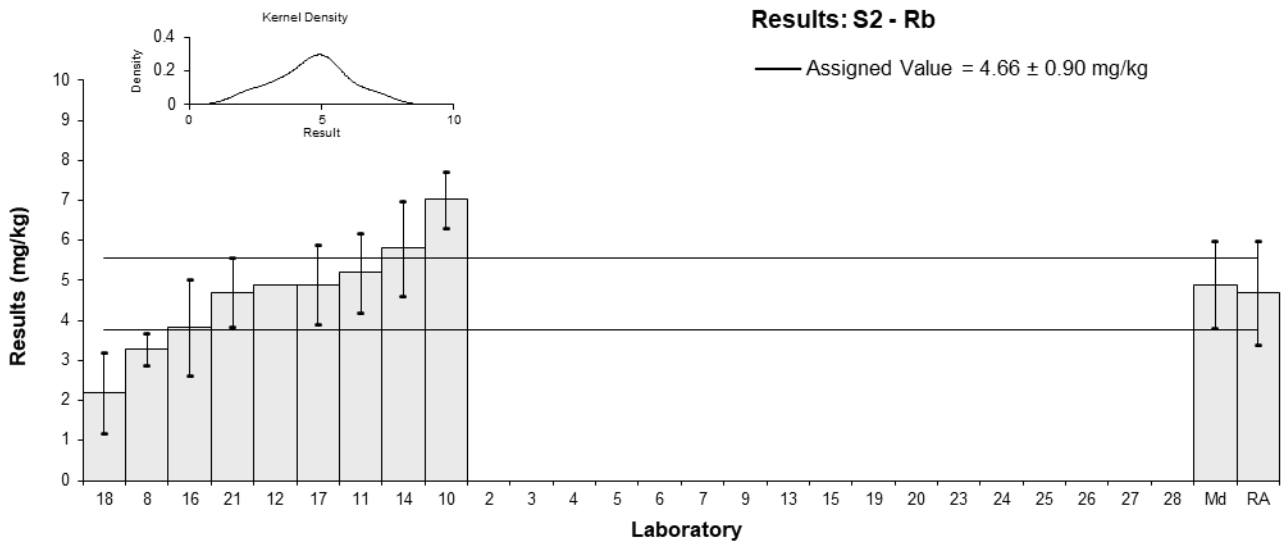
Participant Results

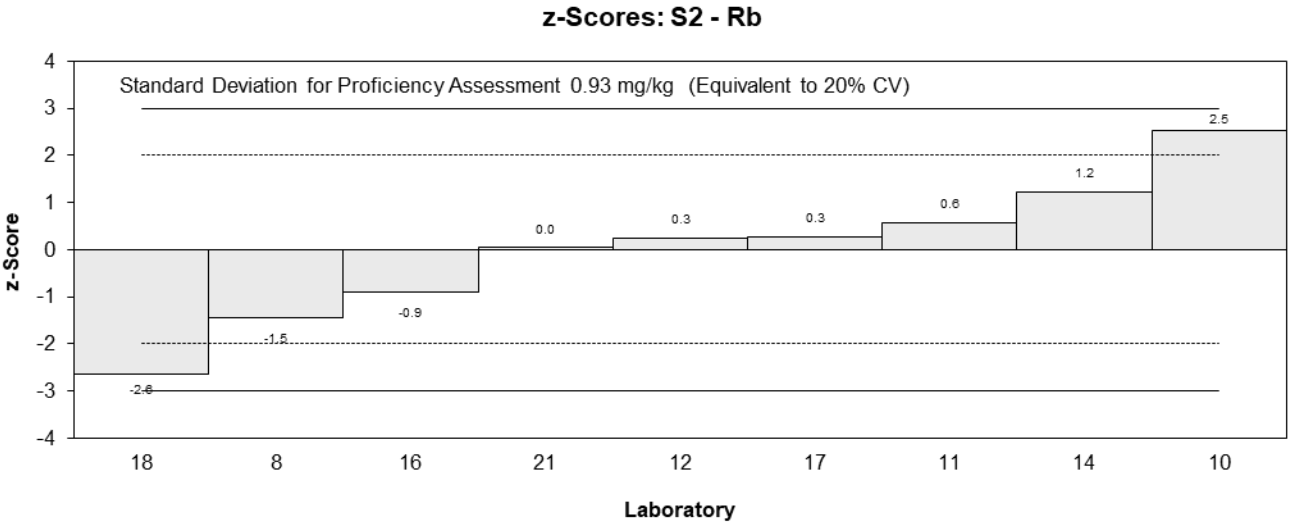
Lab. Code	Result	Uncertainty	z	E_n
2	NT	NT		
3	NR	NR		
4	NT	NT		
5	NT	NT		
6	NT	NT		
7	NT	NT		
8	3.3	0.4	-1.46	-1.38
9	NT	NT		
10*	7.02	0.702	2.53	2.07
11	5.2	1	0.58	0.40
12	4.896	NR	0.25	0.26
13	NT	NT		
14	5.8	1.2	1.22	0.76
15	NT	NT		
16	3.82	1.2	-0.90	-0.56
17	4.9	1	0.26	0.18
18*	2.2	1	-2.64	-1.83
19	NT	NT		
20	NT	NT		
21	4.7	0.87	0.04	0.03
23	NT	NT		
24	NT	NT		
25	NT	NT		
26	NT	NT		
27	NT	NT		
28	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	4.66	0.90
Spike Value	Not Spiked	
Robust Average	4.7	1.3
Median	4.9	1.1
Mean	4.65	
N	9	
Max	7.02	
Min	2.2	
Robust SD	1.6	
Robust CV	34%	


Kernel Density
Density
Result
Results: S2 - Rb
Assigned Value = 4.66 ± 0.90 mg/kg
Results (mg/kg)
Laboratory
18 8 16 21 12 17 11 14 10 2 3 4 5 6 7 9 13 15 19 20 23 24 25 26 27 28 Md RA


z-Scores: S2 - Rb
Standard Deviation for Proficiency Assessment 0.93 mg/kg (Equivalent to 20% CV)
z-Score
Laboratory
18 8 16 21 12 17 11 14 10
-2.6
-1.5
-0.9
0.0
0.3
0.3
0.6
1.2
2.5

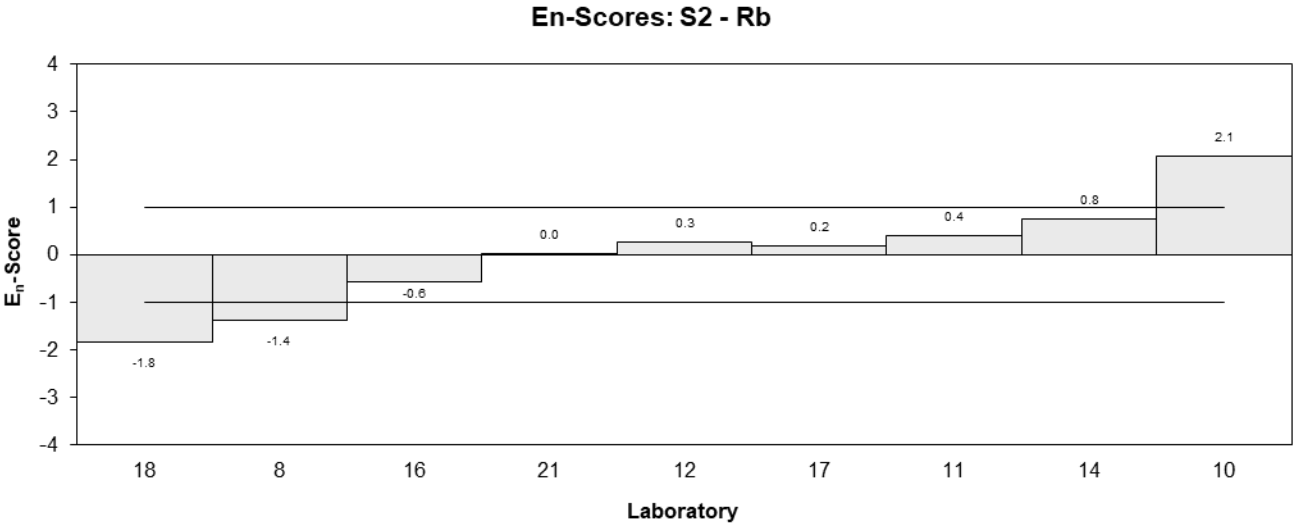

En-Scores: S2 - Rb
En-Score
Laboratory
18 8 16 21 12 17 11 14 10
-1.8
-1.4
-0.6
0.0
0.3
0.2
0.4
0.8
2.1

Figure 39

Table 51

Sample Details

Sample No.	S2
Matrix	Moist Sediment
Analyte	Se
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
2	0.62	0.1
3	< 10	NR
4	< 1	NR
5	NT	NT
6	<2	NR
7	NT	NT
8	<1	NR
9	NT	NT
10	0.99	0.099
11	<2	NR
12	<1	NR
13	<5	NR
14	0.6	1.3
15	<2	<2
16	0.573	0.086
17	<2	NR
18	<2	NR
19	< 2	NR
20	<8	NR
21	<1	NR
23	0.532	0.053
24	NR	NR
25	0.56	0.06
26	< 2	0.6
27	<100	NR
28	NT	NT

Statistics

Assigned Value	Not Set	
Spike Value	Not Spiked	
Homogeneity Value	0.703	0.084
Robust Average	0.596	0.064
Median	0.587	0.045
Mean	0.65	
N	6	
Max	0.99	
Min	0.532	
Robust SD	0.063	
Robust CV	11%	

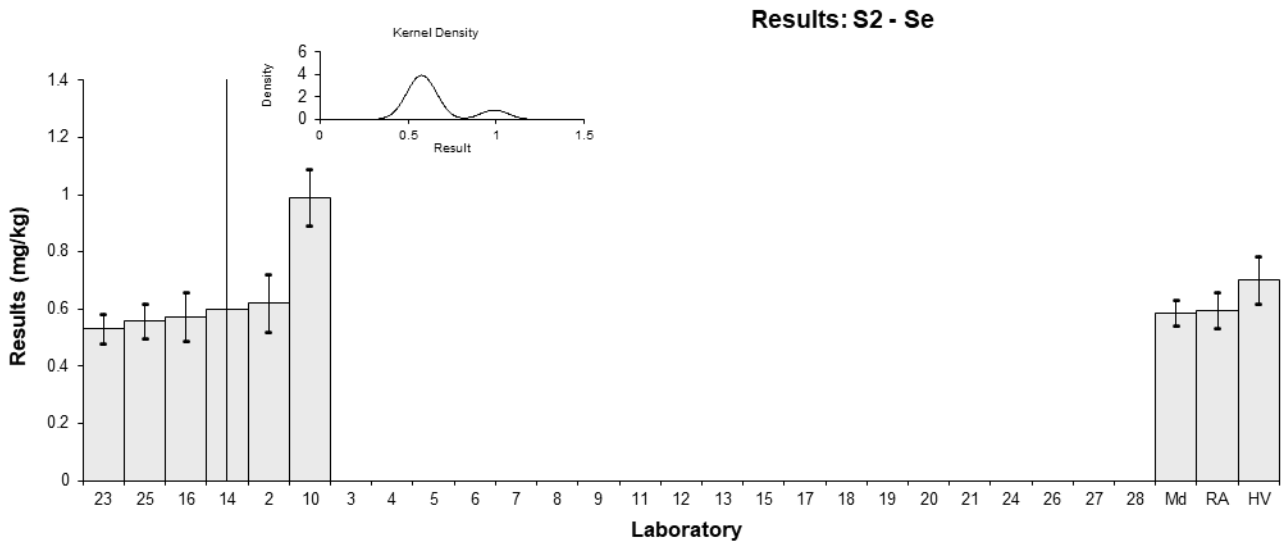

Results: S2 - Se
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
23 25 16 14 2 10 3 4 5 6 7 8 9 11 12 13 15 17 18 19 20 21 24 26 27 28 Md RA HV

Figure 40

Table 52

Sample Details

Sample No.	S2
Matrix	Moist Sediment
Analyte	Sn
Unit	mg/kg

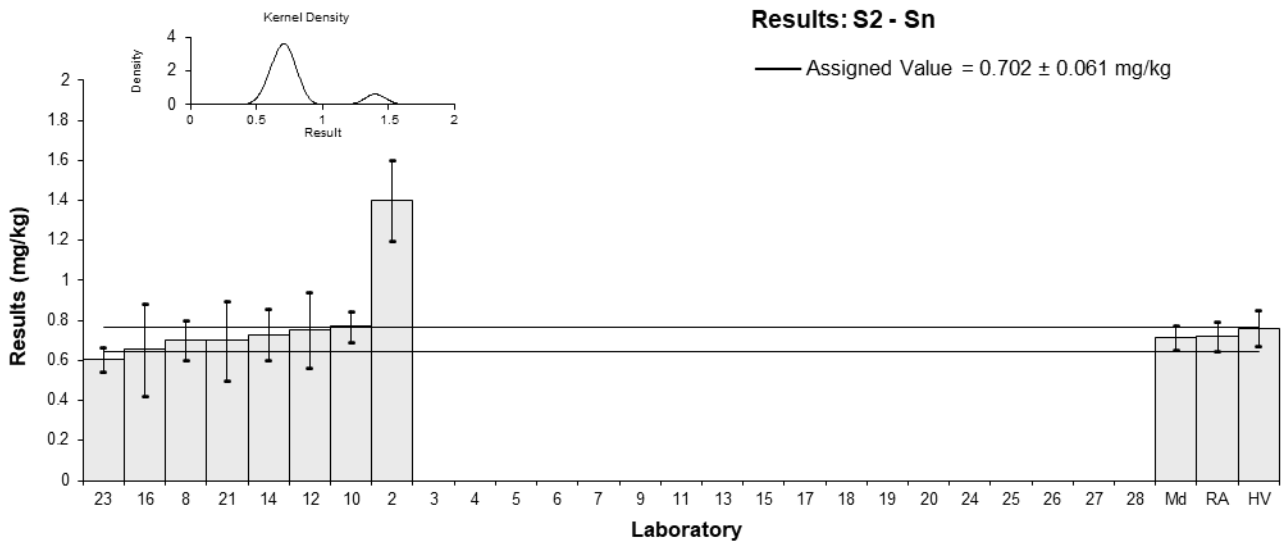
Participant Results

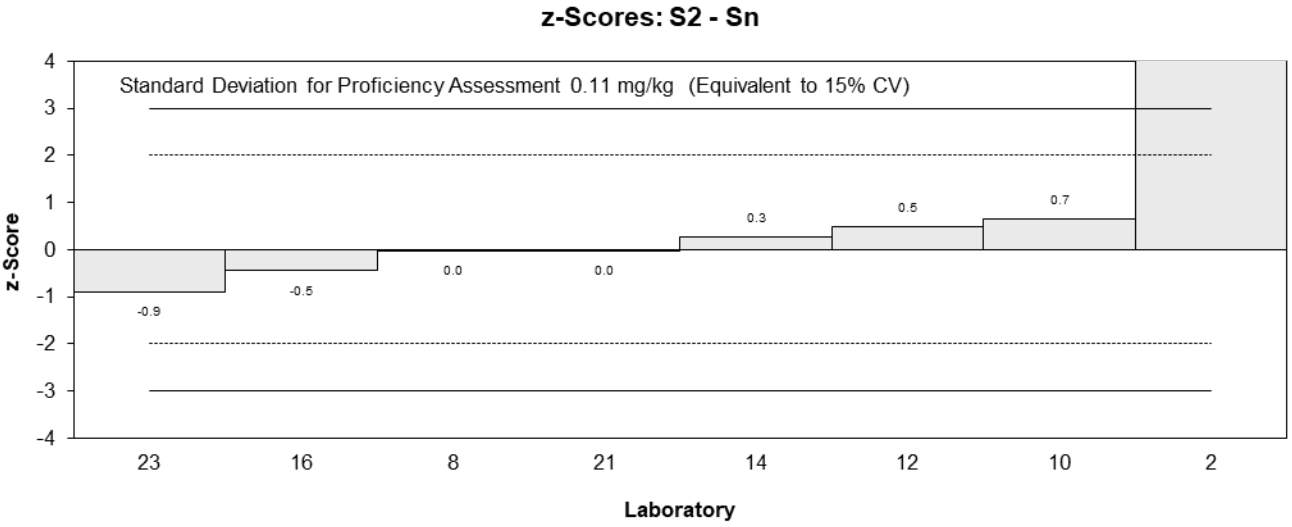
Lab. Code	Result	Uncertainty	z	E_n
2*	1.4	0.2	6.63	3.34
3	< 10	NR		
4	< 10	NR		
5	NT	NT		
6	<10	NR		
7	NT	NT		
8	0.7	0.1	-0.02	-0.02
9	NT	NT		
10	0.77	0.077	0.65	0.69
11	<2	NR		
12	0.754	0.189	0.49	0.26
13	NT	NT		
14	0.73	0.13	0.27	0.19
15	<3	<3		
16	0.655	0.23	-0.45	-0.20
17	<2	NR		
18	<2	NR		
19	< 10	NR		
20	NT	NT		
21	0.7	0.2	-0.02	-0.01
23	0.608	0.061	-0.89	-1.09
24	NT	NT		
25	NT	NT		
26	< 10	3.33		
27	<50	NR		
28	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	0.702	0.061
Spike Value	Not Spiked	
Homogeneity Value	0.761	0.091
Robust Average	0.720	0.072
Median	0.715	0.062
Mean	0.79	
N	8	
Max	1.4	
Min	0.608	
Robust SD	0.082	
Robust CV	11%	


Kernel Density
Density
Result
Results: S2 - Sn
Assigned Value = 0.702 ± 0.061 mg/kg
Results (mg/kg)
Laboratory
23 16 8 21 14 12 10 2 3 4 5 6 7 9 11 13 15 17 18 19 20 24 25 26 27 28 Md RA HV


z-Scores: S2 - Sn
Standard Deviation for Proficiency Assessment 0.11 mg/kg (Equivalent to 15% CV)
z-Score
-0.9
-0.5
0.0
0.0
0.3
0.5
0.7
Laboratory
23 16 8 21 14 12 10 2

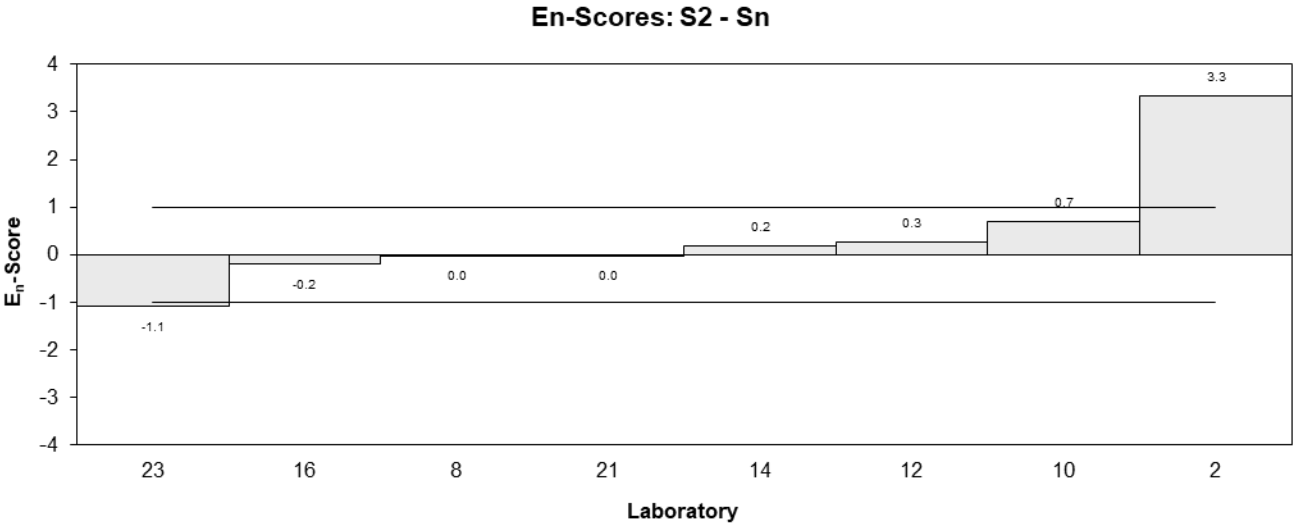

En-Scores: S2 - Sn
En-Score
-1.1
-0.2
0.0
0.0
0.2
0.3
0.7
3.3
Laboratory
23 16 8 21 14 12 10 2

Figure 41

Table 53

Sample Details

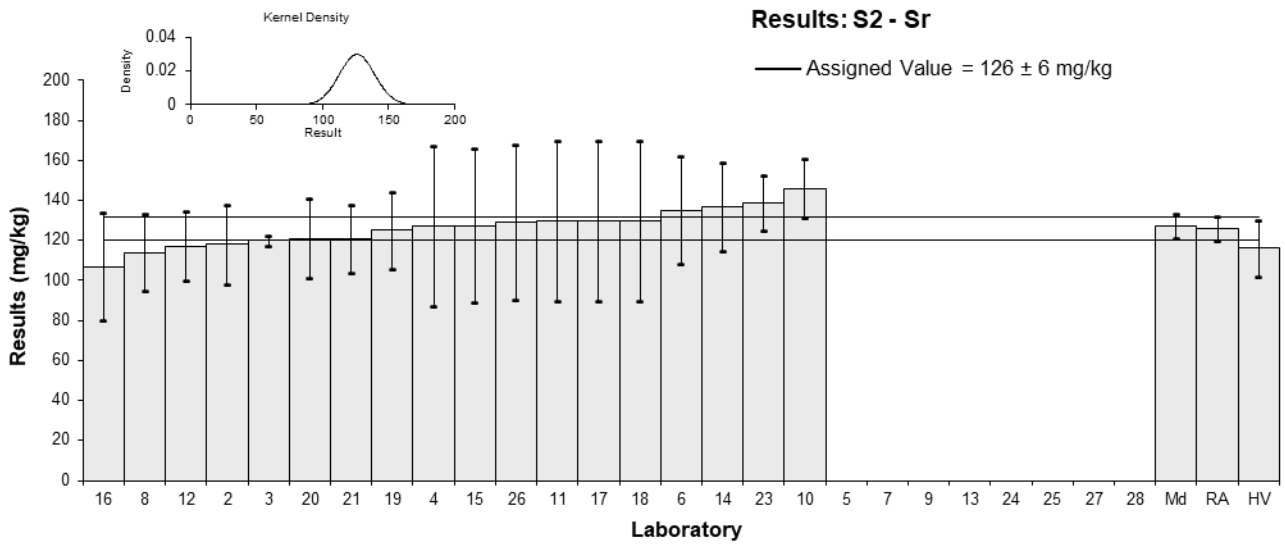
Sample No.	S2
Matrix	Moist Sediment
Analyte	Sr
Unit	mg/kg

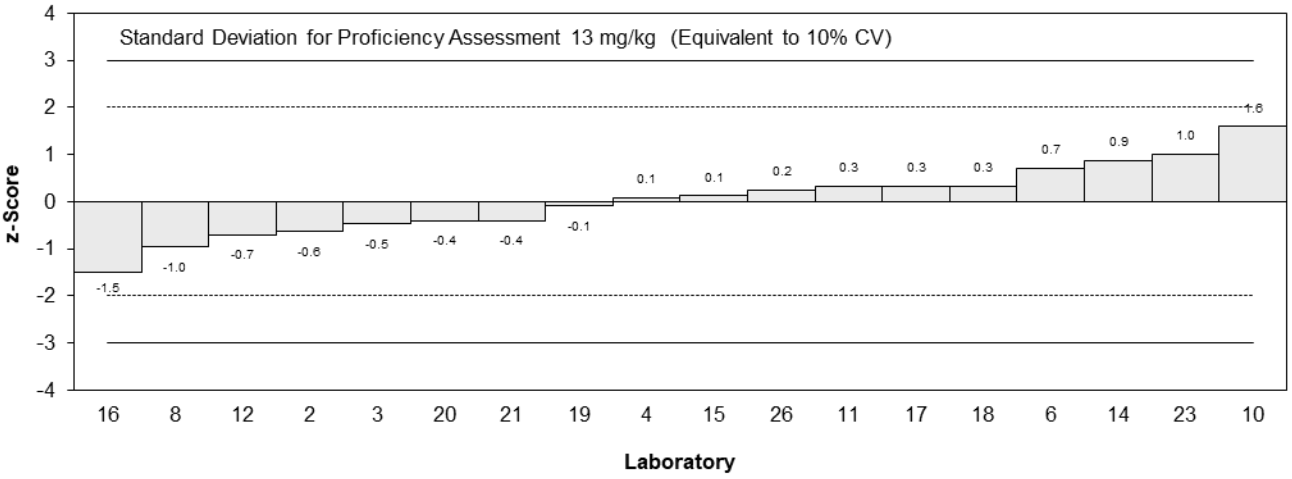
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	118	20	-0.63	-0.38
3	120	2.5	-0.48	-0.92
4	127	40	0.08	0.02
5	NT	NT		
6	135	27.0	0.71	0.33
7	NT	NT		
8	114	19	-0.95	-0.60
9	NT	NT		
10	146	14.6	1.59	1.27
11	130	40	0.32	0.10
12	117.144	17.372	-0.70	-0.48
13	NT	NT		
14	137	22	0.87	0.48
15	127.49	38.247	0.12	0.04
16	107	27	-1.51	-0.69
17	130	40	0.32	0.10
18	130	40	0.32	0.10
19	125	19	-0.08	-0.05
20	121	20	-0.40	-0.24
21	121	16.9	-0.40	-0.28
23	138.780	13.878	1.01	0.85
24	NT	NT		
25	NT	NT		
26	129	38.7	0.24	0.08
27	NR	NR		
28	NT	NT		

Statistics

Assigned Value	126	6
Spike Value	Not Spiked	
Homogeneity Value	116	14
Robust Average	126	6
Median	127	6
Mean	126	
N	18	
Max	146	
Min	107	
Robust SD	9.6	
Robust CV	7.6%	


Results: S2 - Sr
Assigned Value = 126 ± 6 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
16 8 12 2 3 20 21 19 4 15 26 11 17 18 6 14 23 10 5 7 9 13 24 25 27 28 Md RA HV


z-Scores: S2 - Sr
Standard Deviation for Proficiency Assessment 13 mg/kg (Equivalent to 10% CV)
z-Score
Laboratory
16 8 12 2 3 20 21 19 4 15 26 11 17 18 6 14 23 10
-1.5 -1.0 -0.7 -0.6 -0.5 -0.4 -0.4 -0.1 0.1 0.1 0.2 0.3 0.3 0.3 0.7 0.9 1.0 1.6

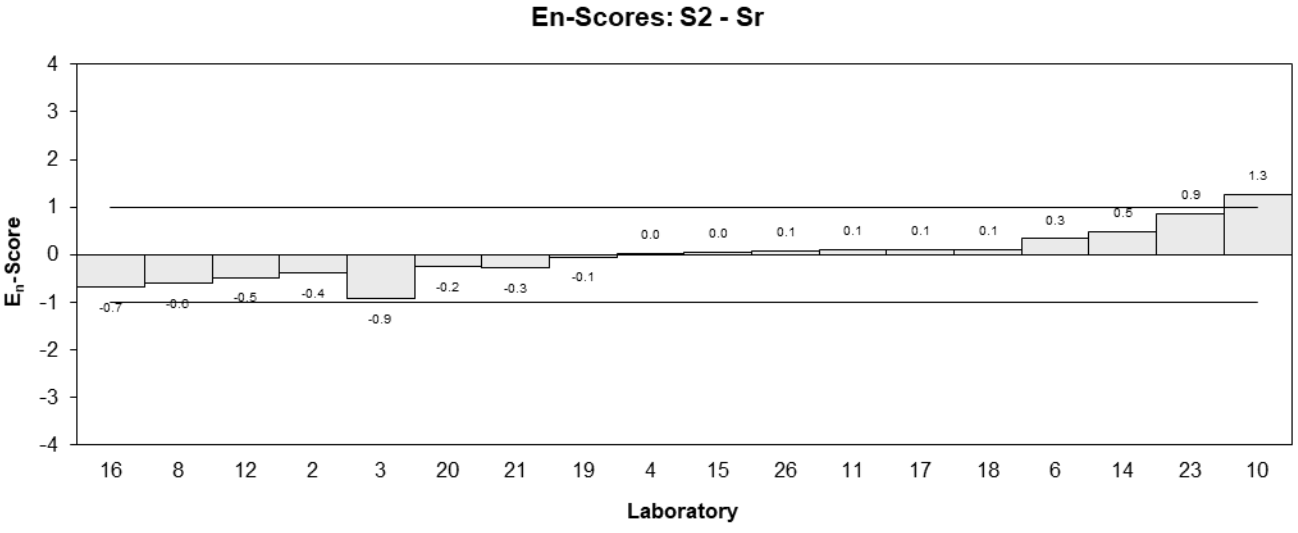

En-Scores: S2 - Sr
En-Score
Laboratory
16 8 12 2 3 20 21 19 4 15 26 11 17 18 6 14 23 10
-0.7 -0.6 -0.5 -0.4 -0.9 -0.2 -0.3 -0.1 0.0 0.0 0.1 0.1 0.1 0.1 0.3 0.5 0.9 1.3

Figure 42

Table 54

Sample Details

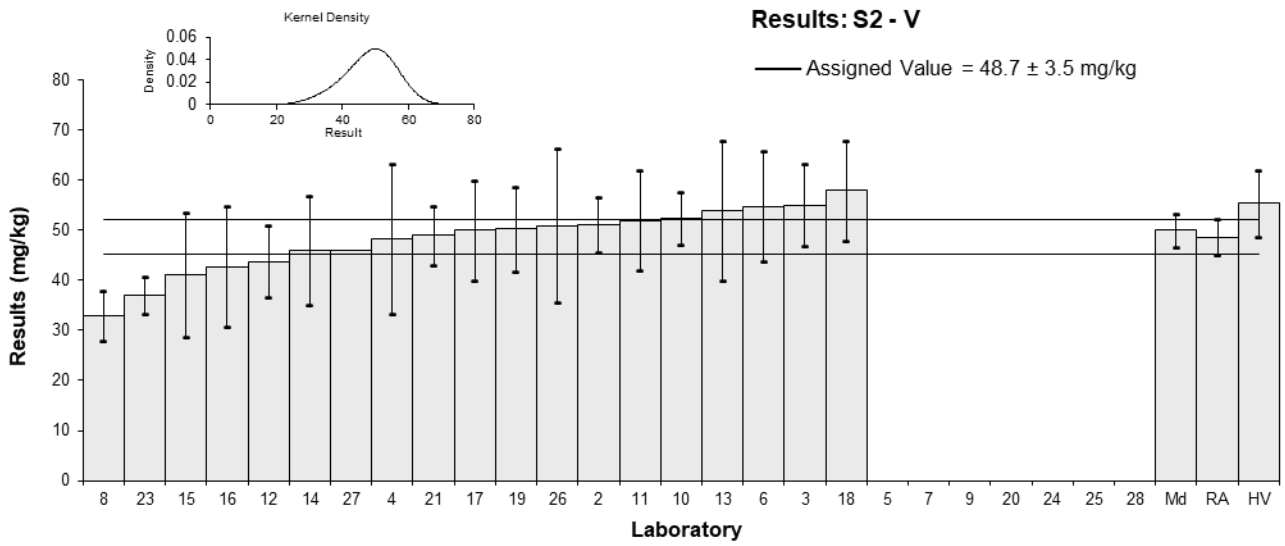
Sample No.	S2
Matrix	Moist Sediment
Analyte	V
Unit	mg/kg

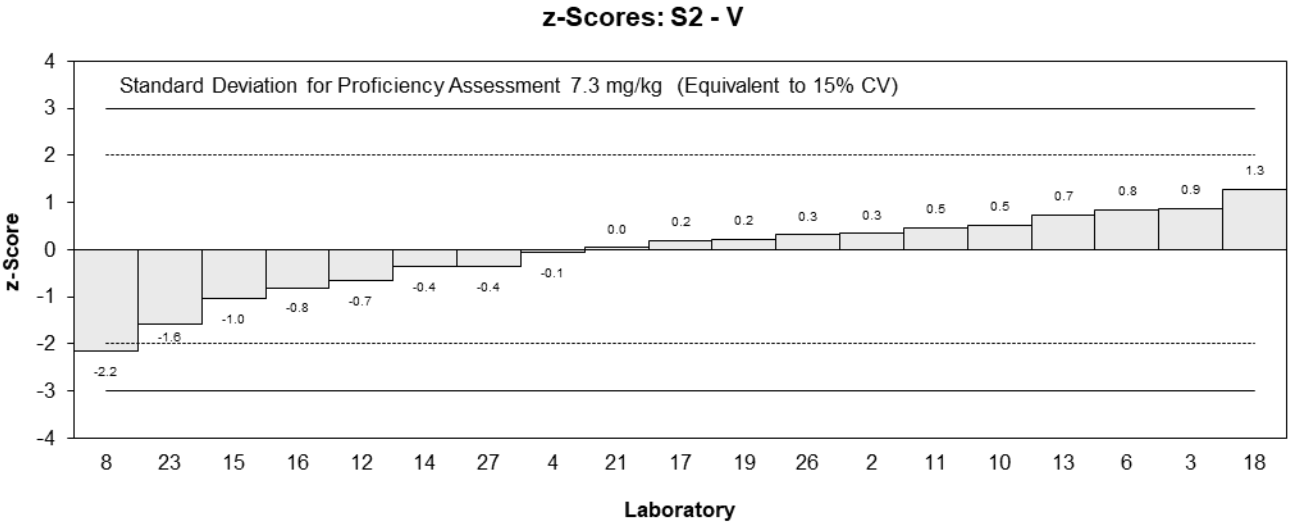
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	51.2	5.5	0.34	0.38
3	55	8.2	0.86	0.71
4	48.3	15	-0.05	-0.03
5	NT	NT		
6	54.8	11.0	0.84	0.53
7	NT	NT		
8	33	5	-2.15	-2.57
9	NT	NT		
10	52.4	5.24	0.51	0.59
11	52	10	0.45	0.31
12	43.807	7.262	-0.67	-0.61
13	54	14	0.73	0.37
14	46	11	-0.37	-0.23
15	41.19	12.357	-1.03	-0.58
16	42.8	12	-0.81	-0.47
17	50	10	0.18	0.12
18	58	10	1.27	0.88
19	50.3	8.5	0.22	0.17
20	NT	NT		
21	49	5.88	0.04	0.04
23	37.144	3.714	-1.58	-2.26
24	NT	NT		
25	NT	NT		
26	51	15.3	0.31	0.15
27	46	NR	-0.37	-0.77
28	NT	NT		

Statistics

Assigned Value	48.7	3.5
Spike Value	Not Spiked	
Homogeneity Value	55.4	6.6
Robust Average	48.7	3.5
Median	50.0	3.4
Mean	48.2	
N	19	
Max	58	
Min	33	
Robust SD	6.2	
Robust CV	13%	


Results: S2 - V
Assigned Value = 48.7 ± 3.5 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
8 23 15 16 12 14 27 4 21 17 19 26 2 11 10 13 6 3 18 5 7 9 20 24 25 28 Md RA HV


z-Scores: S2 - V
Standard Deviation for Proficiency Assessment 7.3 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
8 23 15 16 12 14 27 4 21 17 19 26 2 11 10 13 6 3 18
-2.2 -1.6 -1.0 -0.8 -0.7 -0.4 -0.4 -0.1 0.0 0.2 0.2 0.3 0.3 0.5 0.5 0.7 0.8 0.9 1.3

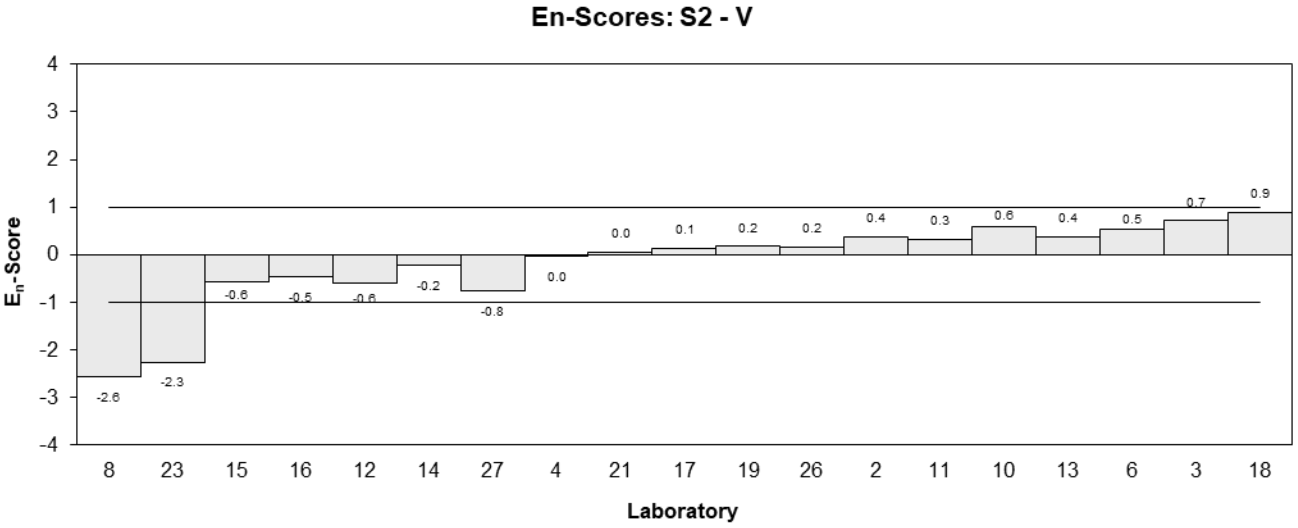

En-Scores: S2 - V
En-Score
Laboratory
8 23 15 16 12 14 27 4 21 17 19 26 2 11 10 13 6 3 18
-2.6 -2.3 -0.6 -0.5 -0.6 -0.2 -0.8 0.0 0.0 0.1 0.2 0.2 0.4 0.3 0.6 0.4 0.5 0.7 0.9

Figure 43

Table 55

Sample Details

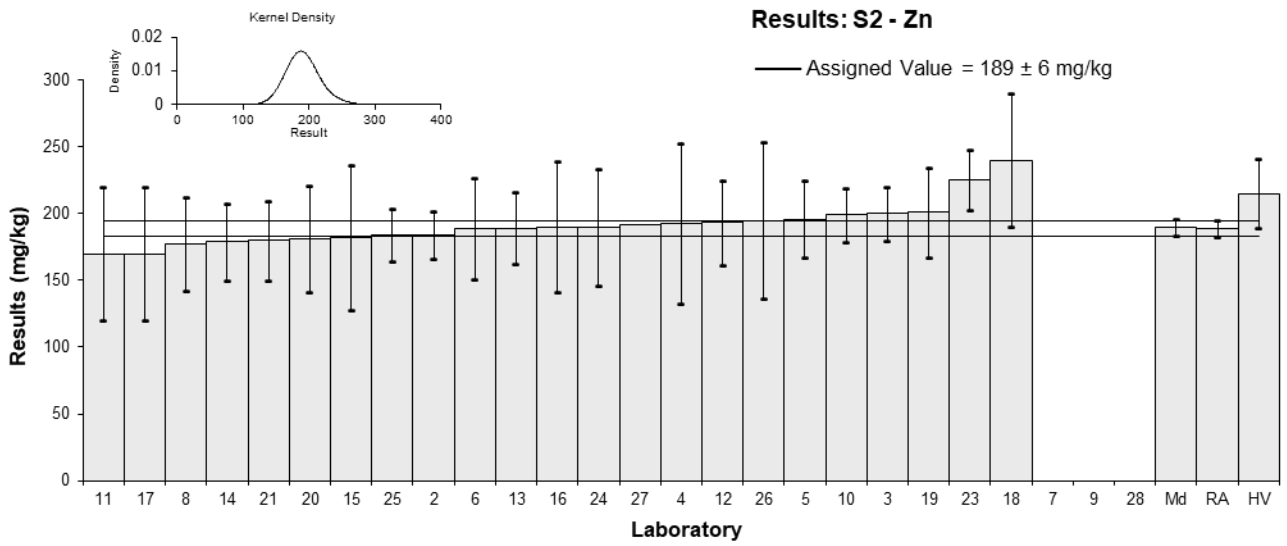
Sample No.	S2
Matrix	Moist Sediment
Analyte	Zn
Unit	mg/kg

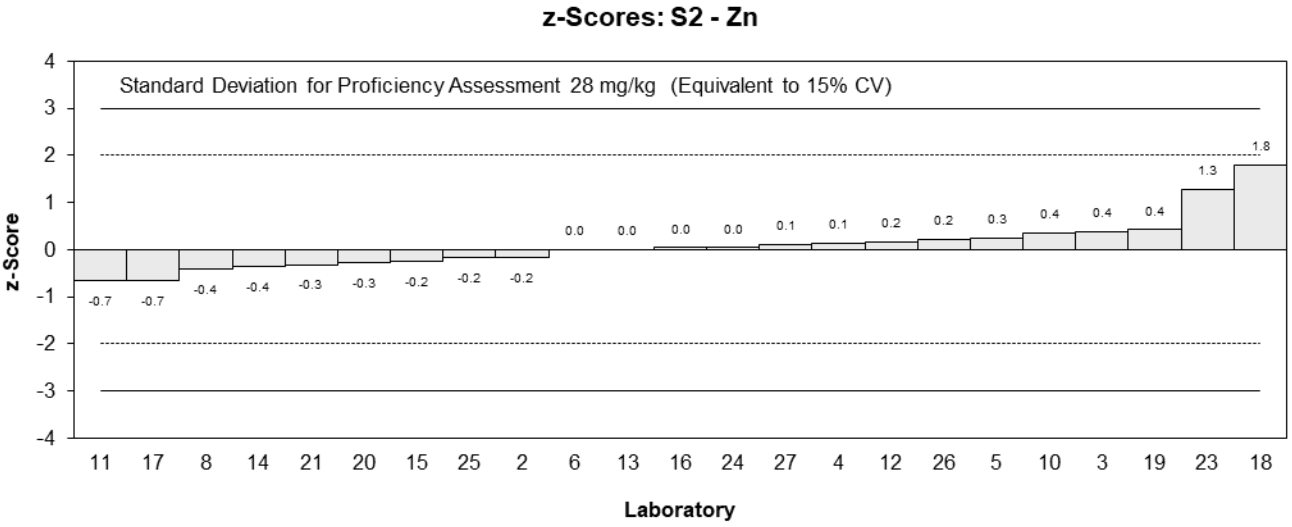
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	184	18	-0.18	-0.26
3	200	20	0.39	0.53
4	193	60	0.14	0.07
5	196	29	0.25	0.24
6	189	37.8	0.00	0.00
7	NT	NT		
8	177	35	-0.42	-0.34
9	NT	NT		
10	199	19.9	0.35	0.48
11	170	50	-0.67	-0.38
12	193.444	31.859	0.16	0.14
13	189	27	0.00	0.00
14	179	29	-0.35	-0.34
15	182.22	54.666	-0.24	-0.12
16	190	49	0.04	0.02
17	170	50	-0.67	-0.38
18	240	50	1.80	1.01
19	201	34	0.42	0.35
20	181	40	-0.28	-0.20
21	180	29.8	-0.32	-0.30
23	225.115	22.512	1.27	1.55
24	190	44	0.04	0.02
25	183.90	20	-0.18	-0.24
26	195	58.5	0.21	0.10
27	192	NR	0.11	0.50
28	NT	NT		

Statistics

Assigned Value	189	6
Spike Value	Not Spiked	
Homogeneity Value	215	26
Robust Average	189	6
Median	190	6
Mean	191	
N	23	
Max	240	
Min	170	
Robust SD	11	
Robust CV	5.8%	


Results: S2 - Zn
Assigned Value = 189 ± 6 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
11 17 8 14 21 20 15 25 2 6 13 16 24 27 4 12 26 5 10 3 19 23 18 7 9 28 Md RA HV


z-Scores: S2 - Zn
Standard Deviation for Proficiency Assessment 28 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
11 17 8 14 21 20 15 25 2 6 13 16 24 27 4 12 26 5 10 3 19 23 18

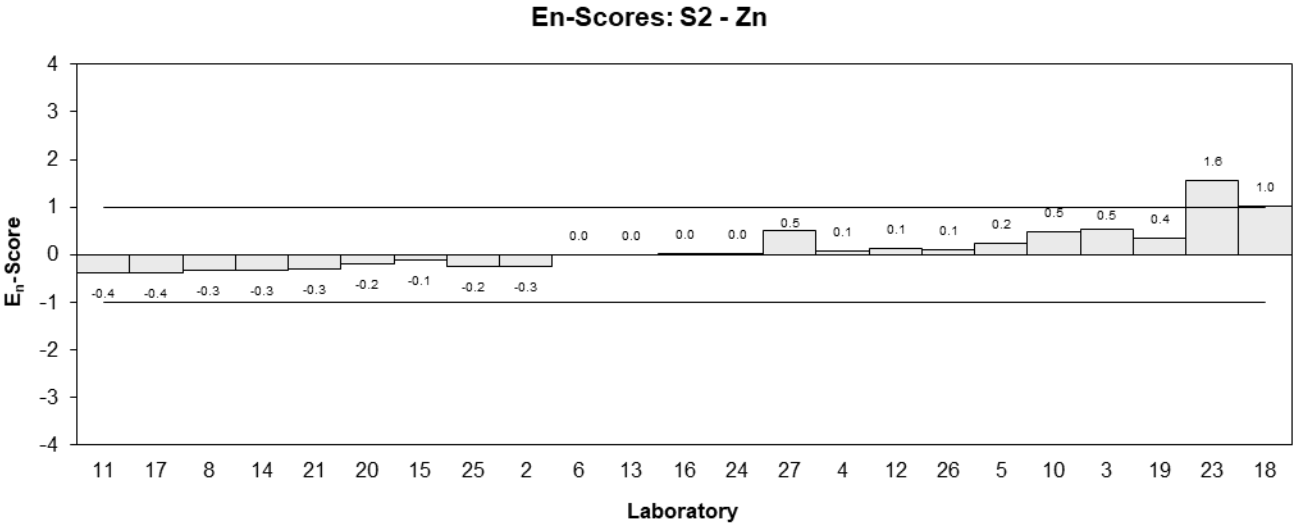

En-Scores: S2 - Zn
En-Score
Laboratory
11 17 8 14 21 20 15 25 2 6 13 16 24 27 4 12 26 5 10 3 19 23 18

Figure 44

Table 56

Sample Details

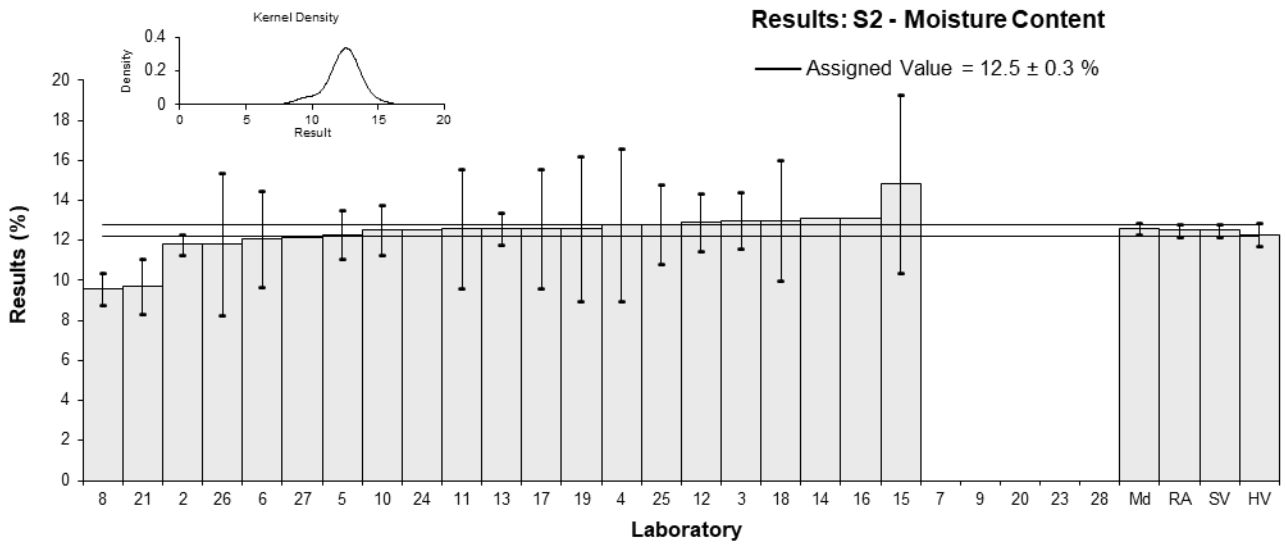
Sample No.	S2
Matrix	Moist Sediment
Analyte	Moisture Content
Unit	%

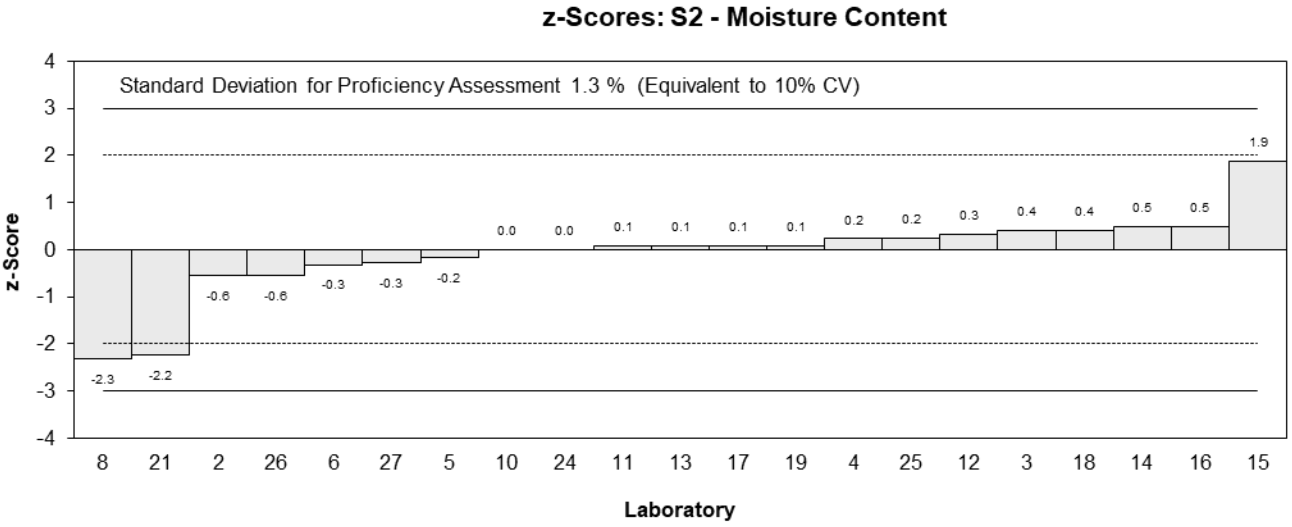
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	11.8	0.5	-0.56	-1.20
3	13	1.4	0.40	0.35
4	12.79	3.837	0.23	0.08
5	12.3	1.2	-0.16	-0.16
6	12.1	2.4	-0.32	-0.17
7	NT	NT		
8	9.6	0.8	-2.32	-3.39
9	NT	NT		
10	12.5	1.25	0.00	0.00
11	12.6	3	0.08	0.03
12	12.91	1.44	0.33	0.28
13	12.6	0.8	0.08	0.12
14	13.1	NR	0.48	2.00
15	14.84	4.45	1.87	0.52
16	13.1	NR	0.48	2.00
17	12.6	3	0.08	0.03
18	13	3	0.40	0.17
19	12.6	3.6	0.08	0.03
20	NT	NT		
21	9.7	1.40	-2.24	-1.96
23	NT	NT		
24	12.5	NR	0.00	0.00
25	12.8	2	0.24	0.15
26	11.8	3.55	-0.56	-0.20
27	12.15	NR	-0.28	-1.17
28	NT	NT		

Statistics

Assigned Value	12.5	0.3
Spike Value	12.5	0.3
Homogeneity Value	12.3	0.6
Robust Average	12.5	0.3
Median	12.6	0.3
Mean	12.4	
N	21	
Max	14.84	
Min	9.6	
Robust SD	0.57	
Robust CV	4.6%	


Results: S2 - Moisture Content
Assigned Value = 12.5 ± 0.3 %
Kernel Density
Density
Result
Results (%)
Laboratory
8 21 2 26 6 27 5 10 24 11 13 17 19 4 25 12 3 18 14 16 15 7 9 20 23 28 Md RA SV HV


z-Scores: S2 - Moisture Content
Standard Deviation for Proficiency Assessment 1.3 % (Equivalent to 10% CV)
z-Score
Laboratory
8 21 2 26 6 27 5 10 24 11 13 17 19 4 25 12 3 18 14 16 15
-2.3 -2.2 -0.6 -0.6 -0.3 -0.3 -0.2 0.0 0.0 0.1 0.1 0.1 0.1 0.2 0.2 0.3 0.4 0.4 0.5 0.5 1.9

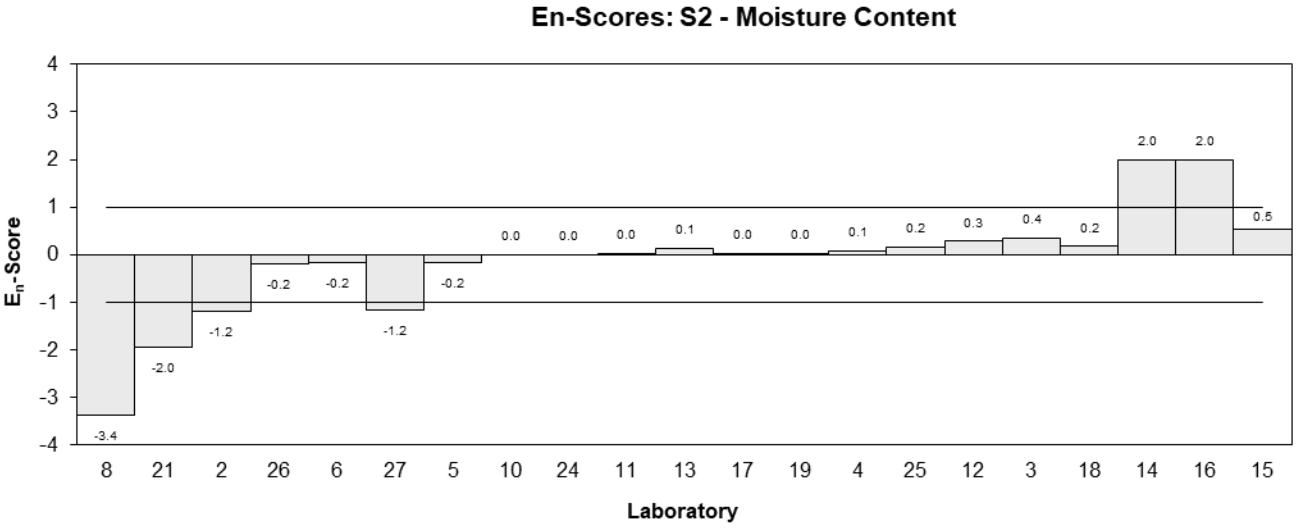

En-Scores: S2 - Moisture Content
En-Score
Laboratory
8 21 2 26 6 27 5 10 24 11 13 17 19 4 25 12 3 18 14 16 15
-3.4 -2.0 -1.2 -0.2 -0.2 -1.2 -0.2 0.0 0.0 0.0 0.1 0.0 0.0 0.1 0.2 0.3 0.4 0.2 2.0 2.0 0.5

Figure 45

Table 57

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	Ba
Unit	mg/kg

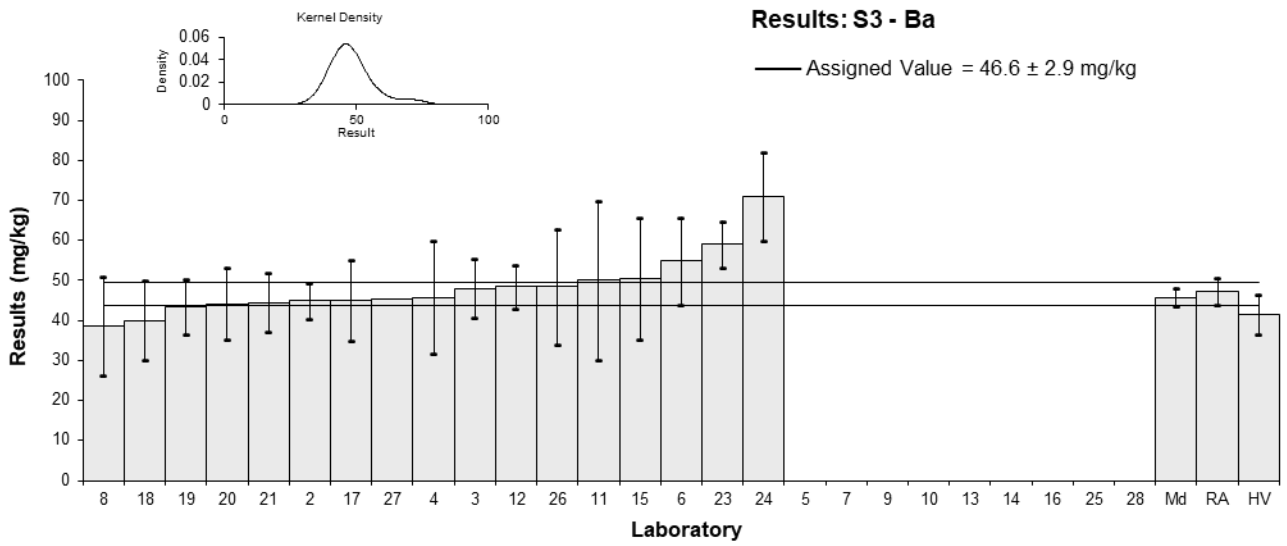
Participant Results

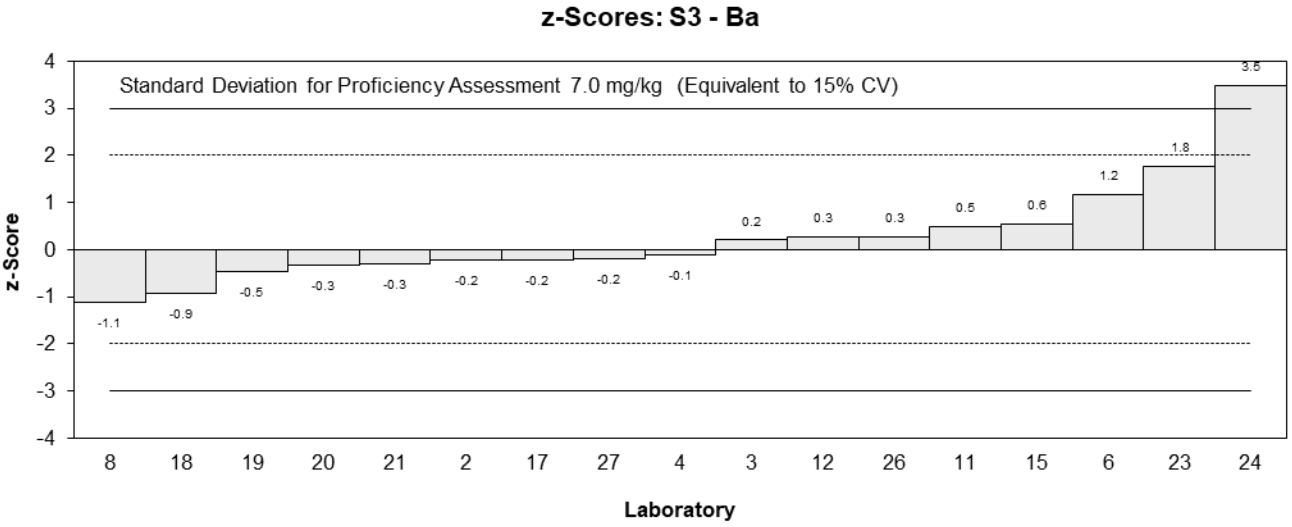
Lab. Code	Result	Uncertainty	z	E_n
2	45.0	4.5	-0.23	-0.30
3	48	7.3	0.20	0.18
4	45.8	14	-0.11	-0.06
5	NT	NT		
6	54.8	11.0	1.17	0.72
7	NR	NR		
8	38.7	12.3	-1.13	-0.63
9	NT	NT		
10	NT	NT		
11	50	20	0.49	0.17
12	48.391	5.512	0.26	0.29
13	NT	NT		
14	NT	NT		
15	50.42	15.126	0.55	0.25
16	NT	NT		
17	45	10	-0.23	-0.15
18	40	10	-0.94	-0.63
19	43.3	6.9	-0.47	-0.44
20	44.2	9	-0.34	-0.25
21	44.5	7.28	-0.30	-0.27
23	58.961	5.896	1.77	1.88
24*	71	11	3.49	2.14
25	NT	NT		
26	48.4	14.5	0.26	0.12
27	45.3	NR	-0.19	-0.45
28	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	46.6	2.9
Homogeneity Value	41.6	5.0
Robust Average	47.3	3.4
Median	45.8	2.3
Mean	48.3	
N	17	
Max	71	
Min	38.7	
Robust SD	5.6	
Robust CV	12%	


Results: S3 - Ba
Assigned Value = 46.6 ± 2.9 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
8 18 19 20 21 2 17 27 4 3 12 26 11 15 6 23 24 5 7 9 10 13 14 16 25 28 Md RA HV


z-Scores: S3 - Ba
Standard Deviation for Proficiency Assessment 7.0 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
8 18 19 20 21 2 17 27 4 3 12 26 11 15 6 23 24
-1.1 -0.9 -0.5 -0.3 -0.3 -0.2 -0.2 -0.2 -0.1 0.2 0.3 0.3 0.5 0.6 1.2 1.8 3.5

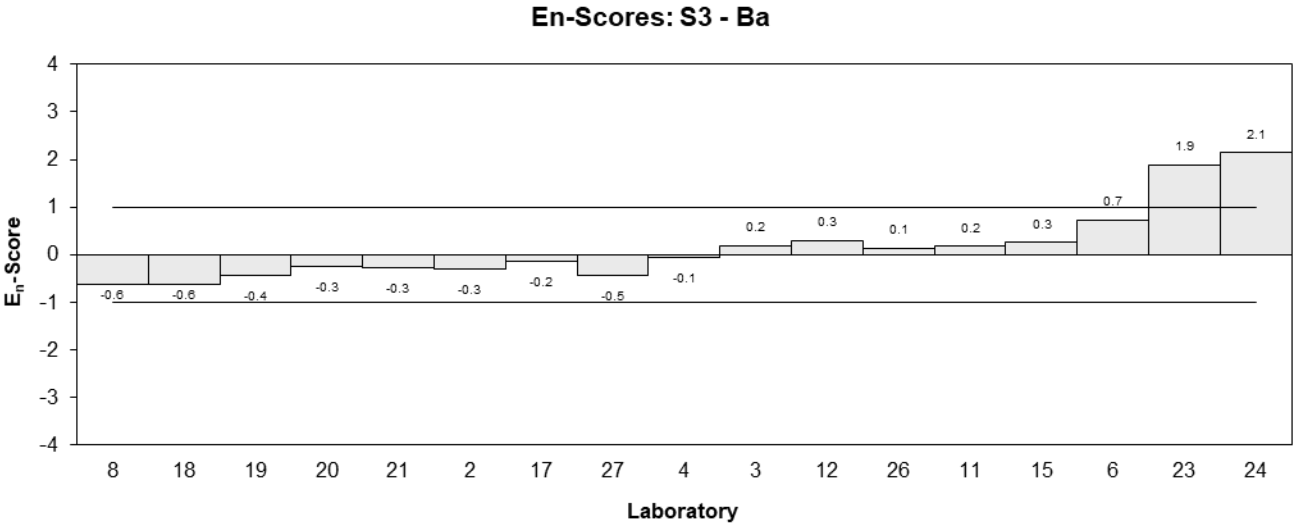

En-Scores: S3 - Ba
En-Score
Laboratory
8 18 19 20 21 2 17 27 4 3 12 26 11 15 6 23 24
-0.6 -0.6 -0.4 -0.3 -0.3 -0.3 -0.2 -0.5 -0.1 0.2 0.3 0.1 0.2 0.3 0.7 1.9 2.1

Figure 46

Table 58

Sample Details

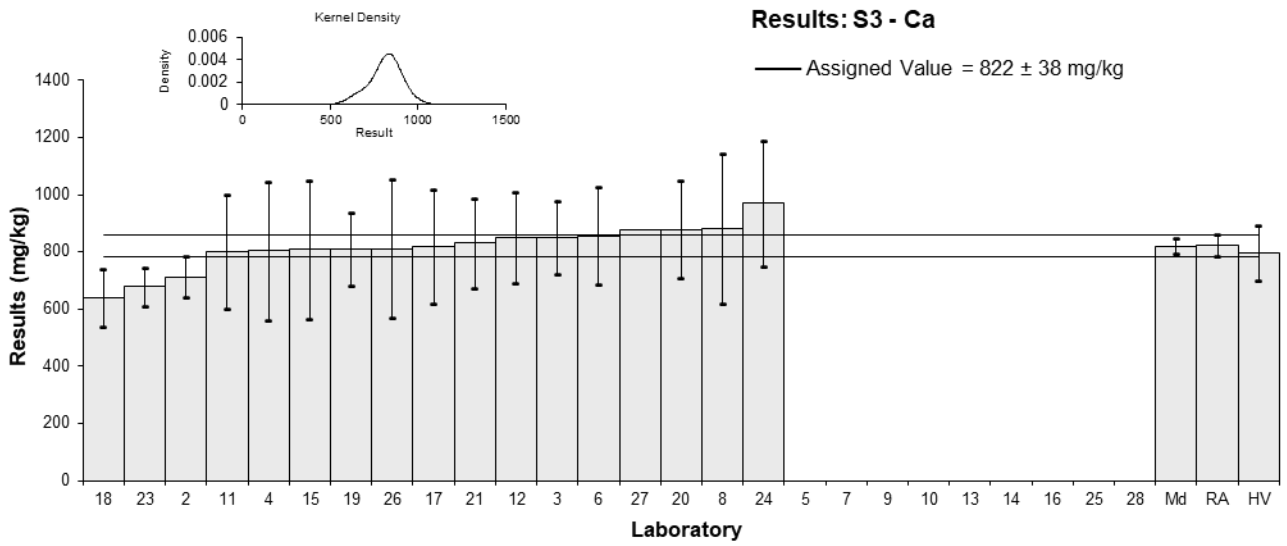
Sample No.	S3
Matrix	Soil
Analyte	Ca
Unit	mg/kg

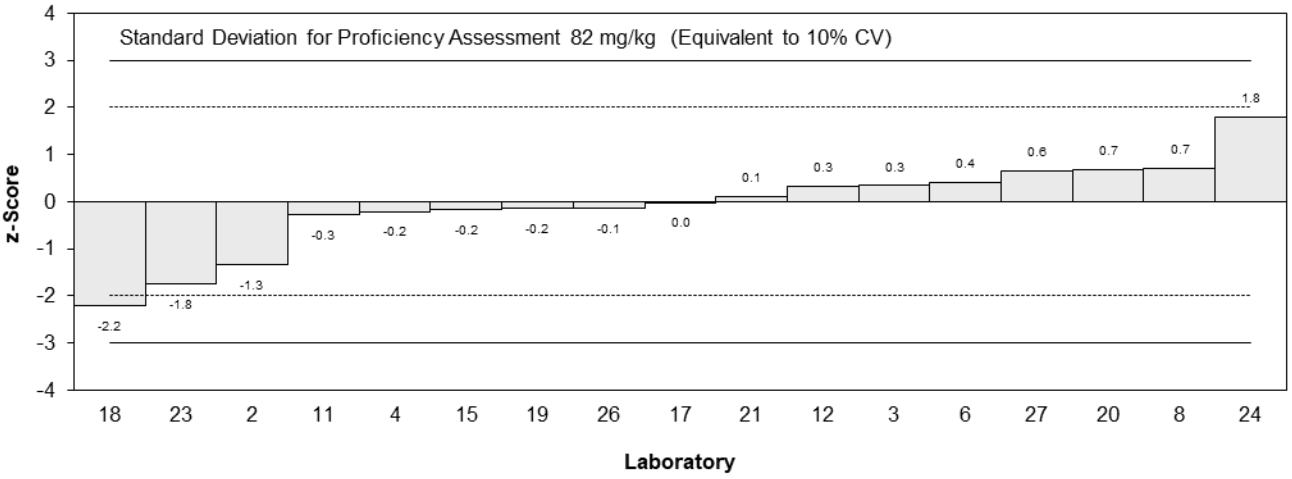
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	712	72	-1.34	-1.35
3	850	130	0.34	0.21
4	805	242	-0.21	-0.07
5	NT	NT		
6	856	171	0.41	0.19
7	NR	NR		
8	880	262	0.71	0.22
9	NT	NT		
10	NT	NT		
11	800	200	-0.27	-0.11
12	849.167	159.923	0.33	0.17
13	NT	NT		
14	NT	NT		
15	808.3	242.49	-0.17	-0.06
16	NT	NT		
17	820	200	-0.02	-0.01
18	640	100	-2.21	-1.70
19	810	127	-0.15	-0.09
20	878	170	0.68	0.32
21	830	158	0.10	0.05
23	678.210	67.821	-1.75	-1.85
24	970	220	1.80	0.66
25	NT	NT		
26	811	243	-0.13	-0.04
27	875	NR	0.64	1.39
28	NT	NT		

Statistics

Assigned Value	822	38
Homogeneity Value	796	95
Robust Average	822	38
Median	820	27
Mean	816	
N	17	
Max	970	
Min	640	
Robust SD	62	
Robust CV	7.5%	


Results: S3 - Ca
Assigned Value = 822 ± 38 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
18 23 2 11 4 15 19 26 17 21 12 3 6 27 20 8 24 5 7 9 10 13 14 16 25 28 Md RA HV


z-Scores: S3 - Ca
Standard Deviation for Proficiency Assessment 82 mg/kg (Equivalent to 10% CV)
z-Score
Laboratory
18 23 2 11 4 15 19 26 17 21 12 3 6 27 20 8 24
-2.2 -1.8 -1.3 -0.3 -0.2 -0.2 -0.2 -0.1 0.0 0.1 0.3 0.3 0.4 0.6 0.7 0.7 1.8

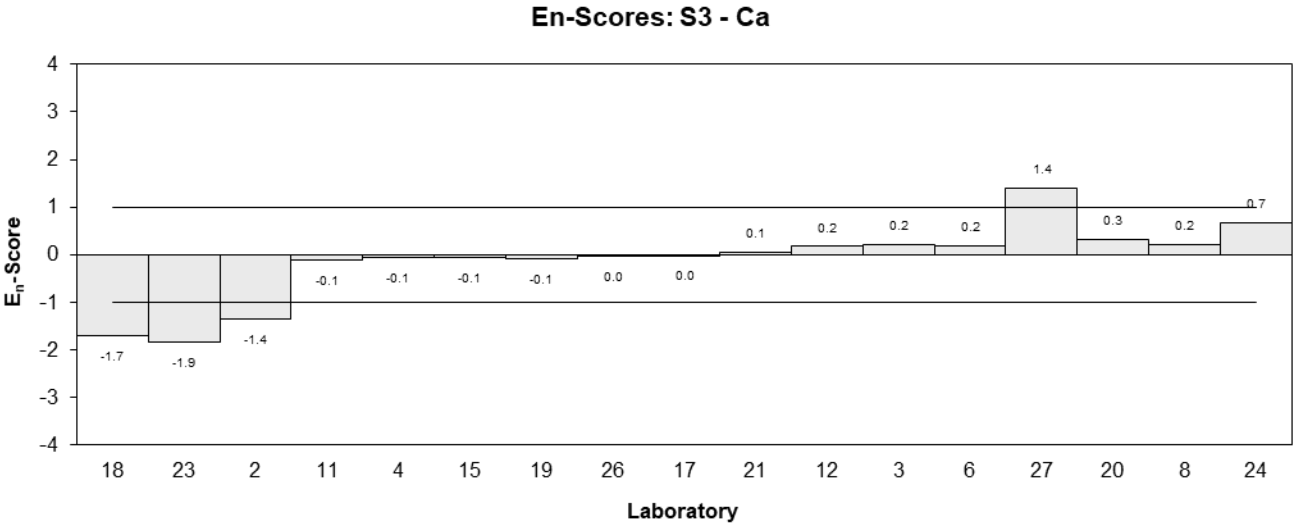

En-Scores: S3 - Ca
En-Score
Laboratory
18 23 2 11 4 15 19 26 17 21 12 3 6 27 20 8 24
-1.7 -1.9 -1.4 -0.1 -0.1 -0.1 -0.1 0.0 0.0 0.1 0.2 0.2 0.2 1.4 0.3 0.2 0.7

Figure 47

Table 59

Sample Details

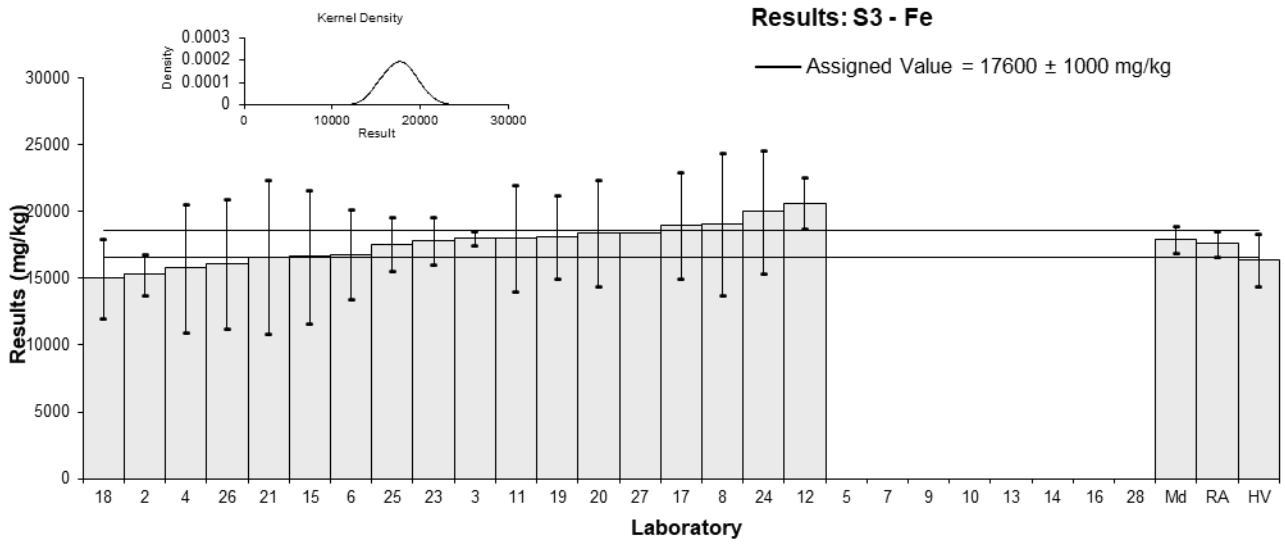
Sample No.	S3
Matrix	Soil
Analyte	Fe
Unit	mg/kg

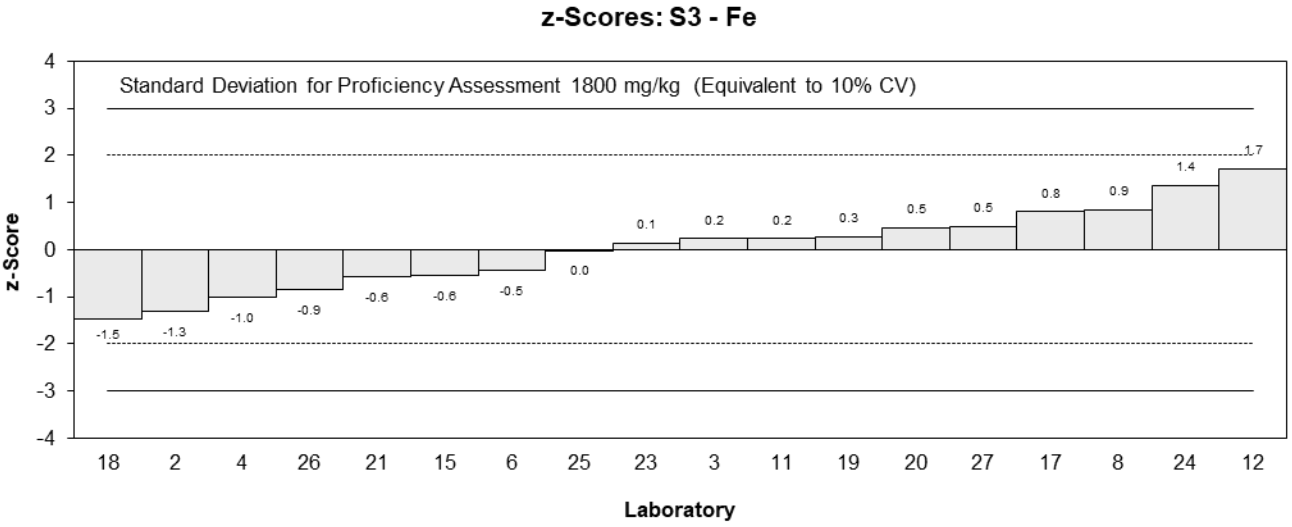
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	15290	1529	-1.31	-1.26
3	18000	530	0.23	0.35
4	15800	4800	-1.02	-0.37
5	NT	NT		
6	16800	3360	-0.45	-0.23
7	NR	NR		
8	19100	5350	0.85	0.28
9	NT	NT		
10	NT	NT		
11	18000	4000	0.23	0.10
12	20632	1917	1.72	1.40
13	NT	NT		
14	NT	NT		
15	16632	4990	-0.55	-0.19
16	NT	NT		
17	19000	4000	0.80	0.34
18	15000	3000	-1.48	-0.82
19	18100	3106	0.28	0.15
20	18400	4000	0.45	0.19
21	16600	5777	-0.57	-0.17
23	17852.300	1785.230	0.14	0.12
24	20000	4600	1.36	0.51
25	17564.77	2000	-0.02	-0.02
26	16100	4840	-0.85	-0.30
27	18450	NR	0.48	0.85
28	NT	NT		

Statistics

Assigned Value	17600	1000
Homogeneity Value	16400	2000
Robust Average	17600	1000
Median	17900	1000
Mean	17600	
N	18	
Max	20632	
Min	15000	
Robust SD	1700	
Robust CV	9.7%	


Results: S3 - Fe
Assigned Value = 17600 ± 1000 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
18 2 4 26 21 15 6 25 23 3 11 19 20 27 17 8 24 12 5 7 9 10 13 14 16 28 Md RA HV


z-Scores: S3 - Fe
Standard Deviation for Proficiency Assessment 1800 mg/kg (Equivalent to 10% CV)
z-Score
Laboratory
18 2 4 26 21 15 6 25 23 3 11 19 20 27 17 8 24 12
-1.5 -1.3 -1.0 -0.9 -0.6 -0.6 -0.5 0.0 0.1 0.2 0.2 0.3 0.5 0.5 0.8 0.9 1.4 1.7

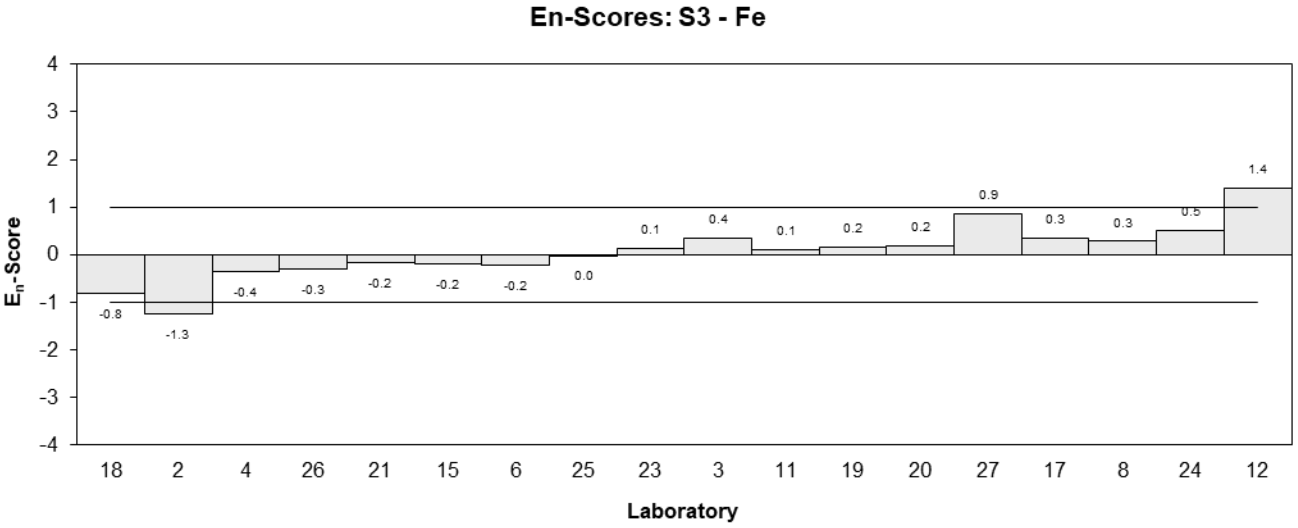

En-Scores: S3 - Fe
En-Score
Laboratory
18 2 4 26 21 15 6 25 23 3 11 19 20 27 17 8 24 12
-0.8 -1.3 -0.4 -0.3 -0.2 -0.2 -0.2 0.0 0.1 0.4 0.1 0.2 0.2 0.9 0.3 0.3 0.5 1.4

Figure 48

Table 60

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	K
Unit	mg/kg

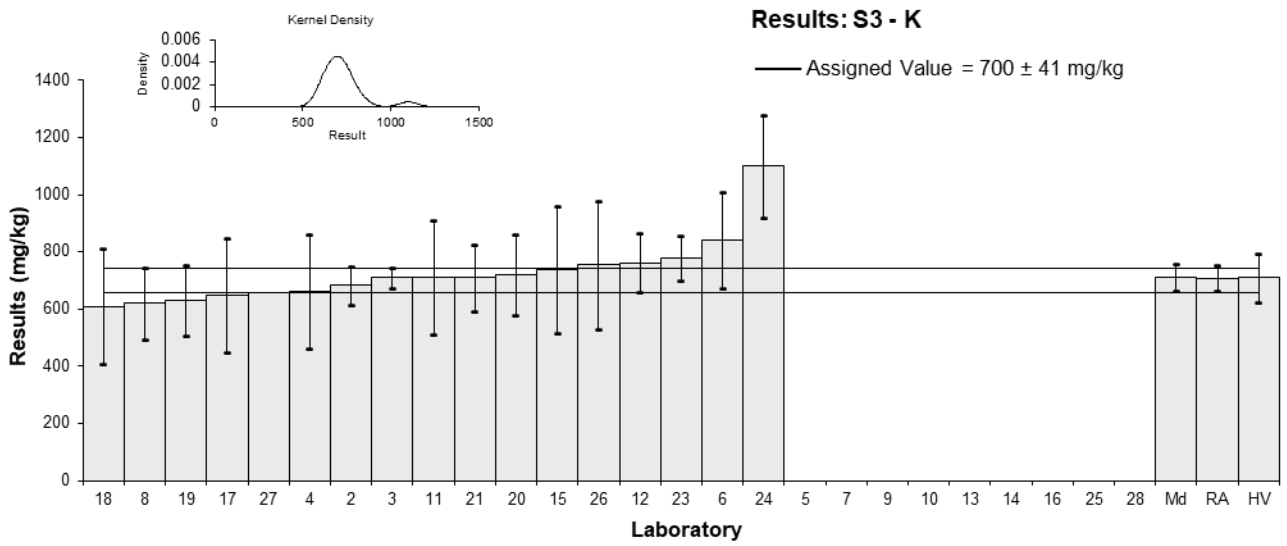
Participant Results

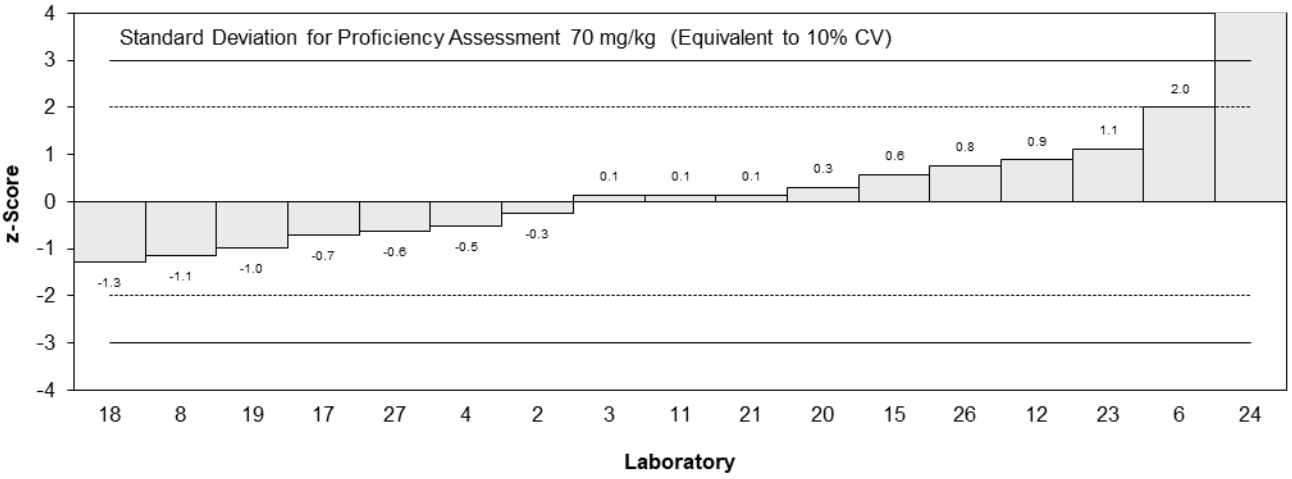
Lab. Code	Result	Uncertainty	z	E_n
2	682	68	-0.26	-0.23
3	710	36	0.14	0.18
4	663	200	-0.53	-0.18
5	NT	NT		
6	840	168	2.00	0.81
7	NR	NR		
8	620	126	-1.14	-0.60
9	NT	NT		
10	NT	NT		
11	710	200	0.14	0.05
12	761.6	104.1	0.88	0.55
13	NT	NT		
14	NT	NT		
15	739.3	221.79	0.56	0.17
16	NT	NT		
17	650	200	-0.71	-0.24
18	610	200	-1.29	-0.44
19	631	123	-0.99	-0.53
20	720	140	0.29	0.14
21	710	116	0.14	0.08
23	777.580	77.758	1.11	0.88
24*	1100	180	5.71	2.17
25	NT	NT		
26	754	226	0.77	0.24
27	656	NR	-0.63	-1.07
28	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	700	41
Homogeneity Value	709	85
Robust Average	708	45
Median	710	46
Mean	726	
N	17	
Max	1100	
Min	610	
Robust SD	74	
Robust CV	10%	


Results: S3 - K
Assigned Value = 700 ± 41 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
18 8 19 17 27 4 2 3 11 21 20 15 26 12 23 6 24 5 7 9 10 13 14 16 25 28 Md RA HV


z-Scores: S3 - K
Standard Deviation for Proficiency Assessment 70 mg/kg (Equivalent to 10% CV)
z-Score
Laboratory
18 8 19 17 27 4 2 3 11 21 20 15 26 12 23 6 24
-1.3 -1.1 -1.0 -0.7 -0.6 -0.5 -0.3 0.1 0.1 0.1 0.3 0.6 0.8 0.9 1.1 2.0

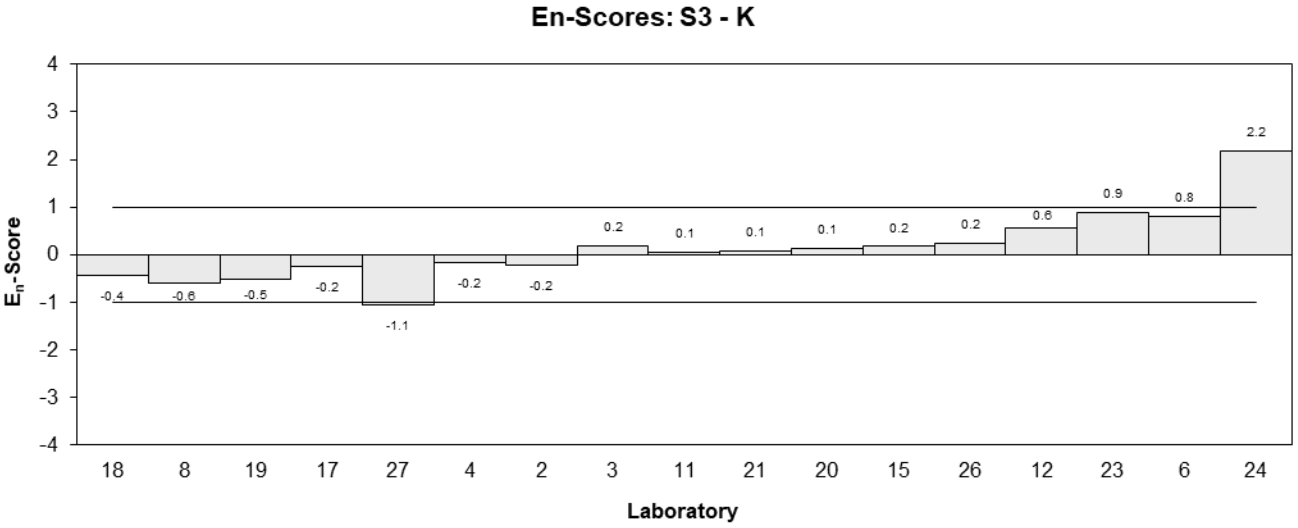

En-Scores: S3 - K
En-Score
Laboratory
18 8 19 17 27 4 2 3 11 21 20 15 26 12 23 6 24
-0.4 -0.6 -0.5 -0.2 -1.1 -0.2 -0.2 0.2 0.1 0.1 0.1 0.2 0.2 0.6 0.9 0.8 2.2

Figure 49

Table 61

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	Mg
Unit	mg/kg

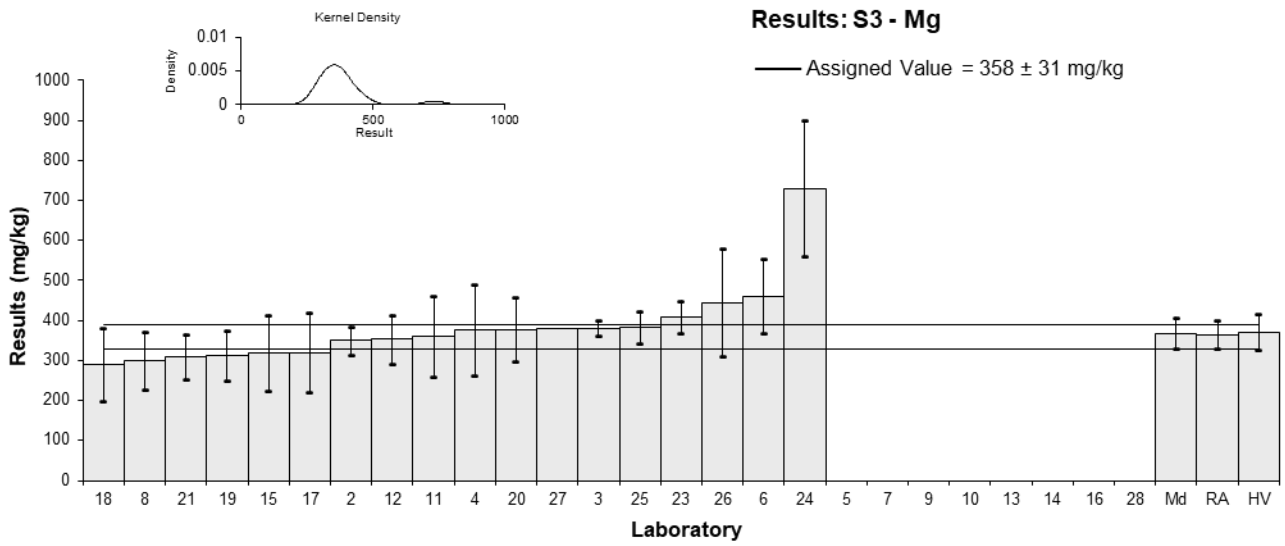
Participant Results

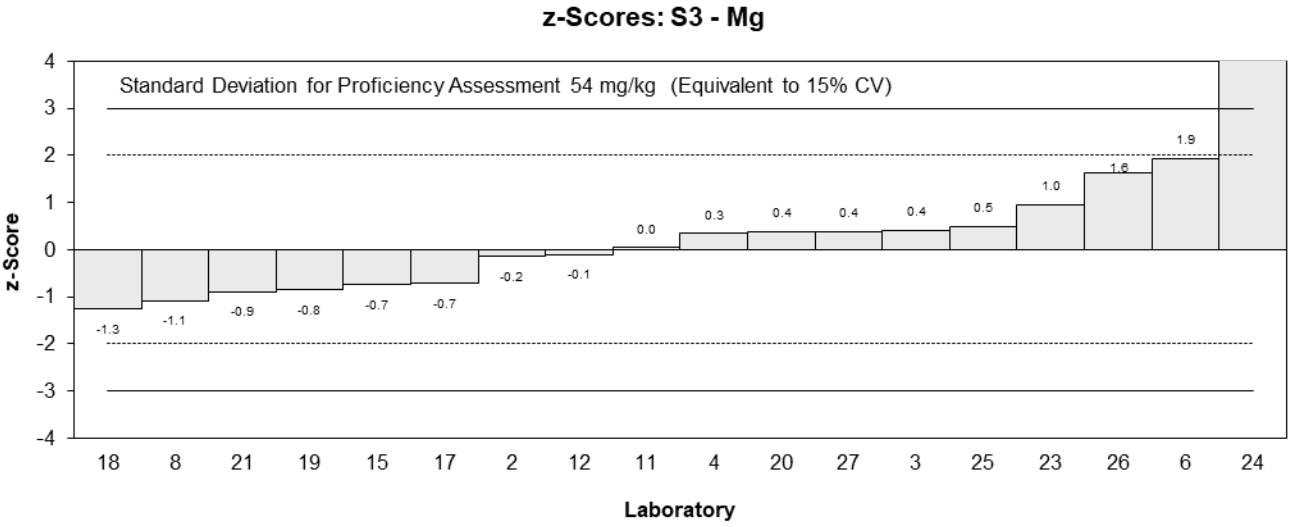
Lab. Code	Result	Uncertainty	z	E_n
2	350	35	-0.15	-0.17
3	380	19	0.41	0.61
4	376	112.8	0.34	0.15
5	NT	NT		
6	461	92.1	1.92	1.06
7	NR	NR		
8	300	72	-1.08	-0.74
9	NT	NT		
10	NT	NT		
11	360	100	0.04	0.02
12	352.8	61.1	-0.10	-0.08
13	NT	NT		
14	NT	NT		
15	318.6	95.58	-0.73	-0.39
16	NT	NT		
17	320	100	-0.71	-0.36
18	290	90	-1.27	-0.71
19	313	62	-0.84	-0.65
20	378	80	0.37	0.23
21	310	56.9	-0.89	-0.74
23	408.930	40.893	0.95	0.99
24*	730	170	6.93	2.15
25	384.4	40	0.49	0.52
26	445	134	1.62	0.63
27	379	NR	0.39	0.68
28	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	358	31
Homogeneity Value	371	44
Robust Average	365	34
Median	368	39
Mean	381	
N	18	
Max	730	
Min	290	
Robust SD	58	
Robust CV	16%	


Kernel Density
Density
0.01
0.005
0
0
500
1000
Result
Results: S3 - Mg
Assigned Value = 358 ± 31 mg/kg
Results (mg/kg)
1000
900
800
700
600
500
400
300
200
100
0
18 8 21 19 15 17 2 12 11 4 20 27 3 25 23 26 6 24 5 7 9 10 13 14 16 28 Md RA HV
Laboratory


z-Scores: S3 - Mg
Standard Deviation for Proficiency Assessment 54 mg/kg (Equivalent to 15% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-1.3
-1.1
-0.9
-0.8
-0.7
-0.7
-0.2
-0.1
0.0
0.3
0.4
0.4
0.4
0.5
1.0
1.6
1.9
18 8 21 19 15 17 2 12 11 4 20 27 3 25 23 26 6 24
Laboratory

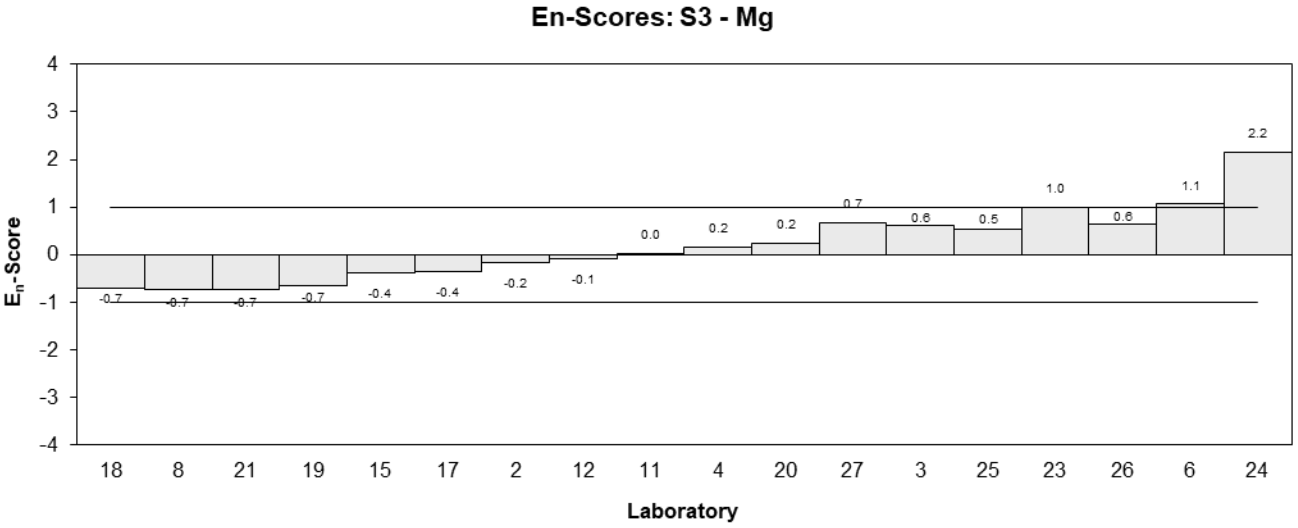

En-Scores: S3 - Mg
En-Score
4
3
2
1
0
-1
-2
-3
-4
-0.7
-0.7
-0.7
-0.7
-0.4
-0.4
-0.2
-0.1
0.0
0.2
0.2
0.7
0.6
0.5
1.0
0.6
1.1
2.2
18 8 21 19 15 17 2 12 11 4 20 27 3 25 23 26 6 24
Laboratory

Figure 50

Table 62

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	Na
Unit	mg/kg

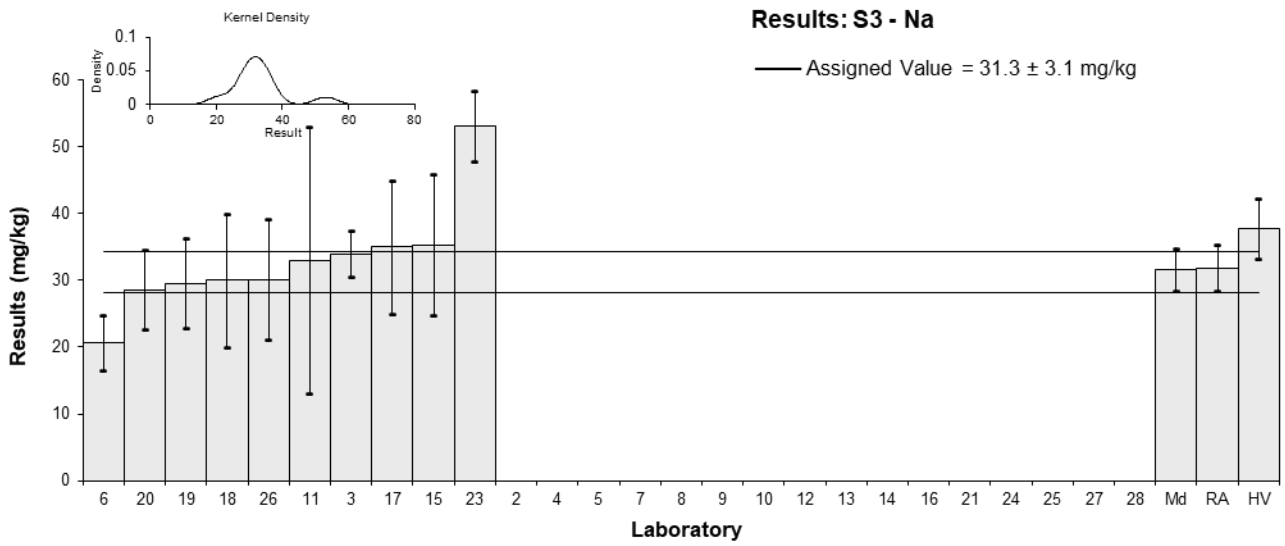
Participant Results

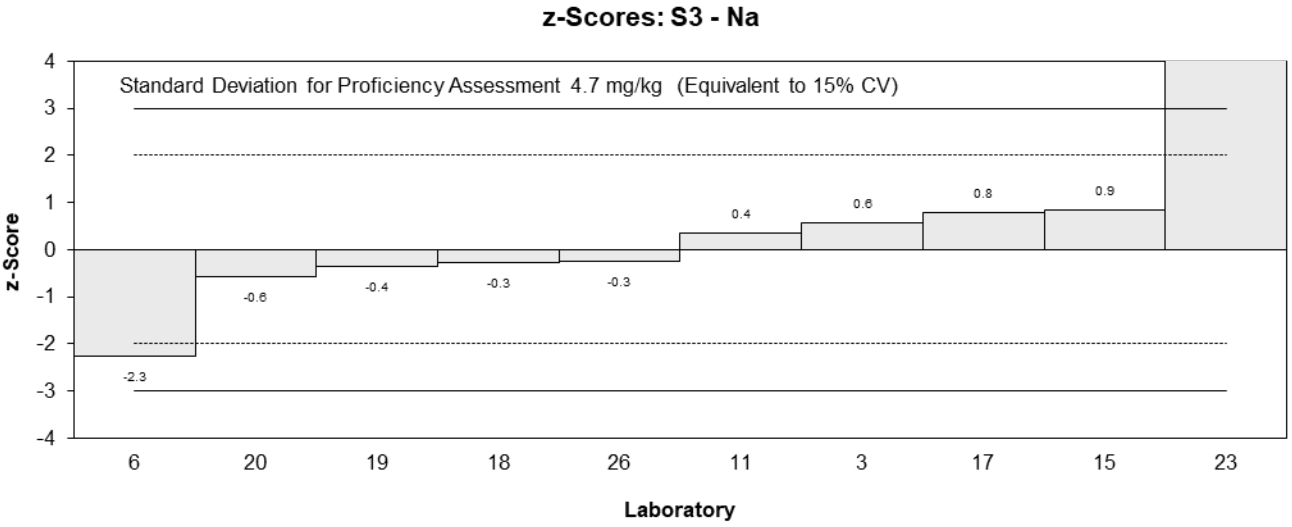
Lab. Code	Result	Uncertainty	z	E_n
2	<50	NR		
3	34	3.4	0.58	0.59
4	< 50	NR		
5	NT	NT		
6	20.7	4.13	-2.26	-2.05
7	NR	NR		
8	<50	NR		
9	NT	NT		
10	NT	NT		
11	33	20	0.36	0.08
12	<50	NR		
13	NT	NT		
14	NT	NT		
15	35.3	10.59	0.85	0.36
16	NT	NT		
17	35	10	0.79	0.35
18	30	10	-0.28	-0.12
19	29.6	6.8	-0.36	-0.23
20	28.6	6	-0.58	-0.40
21	<50	NR		
23*	53.190	5.319	4.66	3.56
24	NT	NT		
25	NT	NT		
26	30.1	9.03	-0.26	-0.13
27	<50	NR		
28	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	31.3	3.1
Homogeneity Value	37.7	4.5
Robust Average	31.9	3.5
Median	31.6	3.2
Mean	32.9	
N	10	
Max	53.190	
Min	20.7	
Robust SD	4.5	
Robust CV	14%	


Kernel Density
Density
Result
Results: S3 - Na
Assigned Value = 31.3 ± 3.1 mg/kg
Results (mg/kg)
Laboratory
6 20 19 18 26 11 3 17 15 23 2 4 5 7 8 9 10 12 13 14 16 21 24 25 27 28 Md RA HV


z-Scores: S3 - Na
Standard Deviation for Proficiency Assessment 4.7 mg/kg (Equivalent to 15% CV)
z-Score
-2.3 -0.6 -0.4 -0.3 -0.3 0.4 0.6 0.8 0.9
Laboratory
6 20 19 18 26 11 3 17 15 23

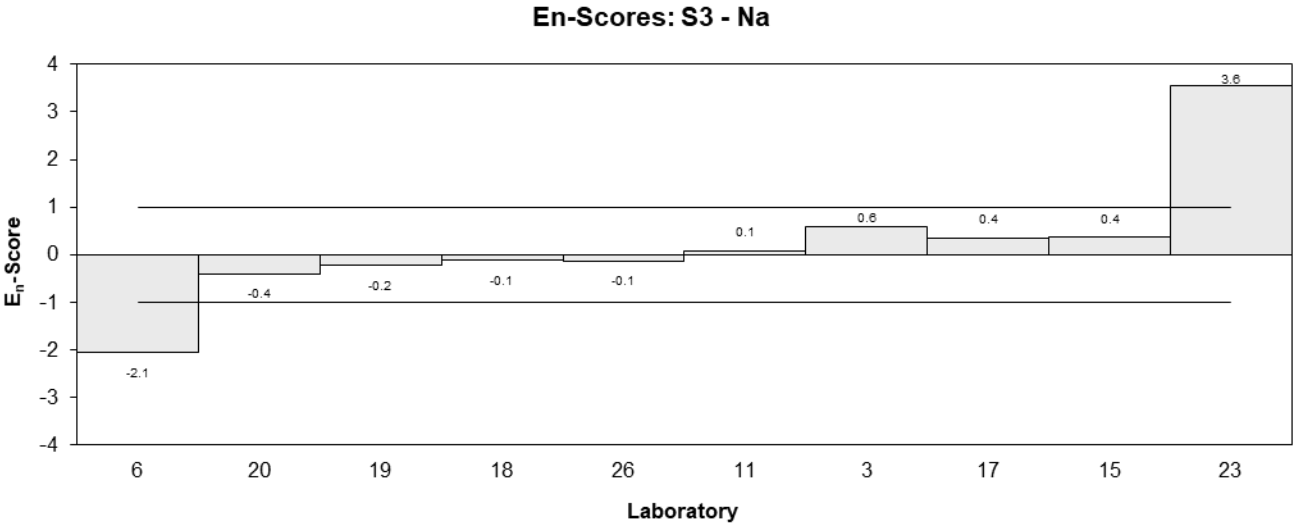

En-Scores: S3 - Na
En-Score
-2.1 -0.4 -0.2 -0.1 -0.1 0.1 0.6 0.4 0.4 3.6
Laboratory
6 20 19 18 26 11 3 17 15 23

Figure 51

Table 63

Sample Details

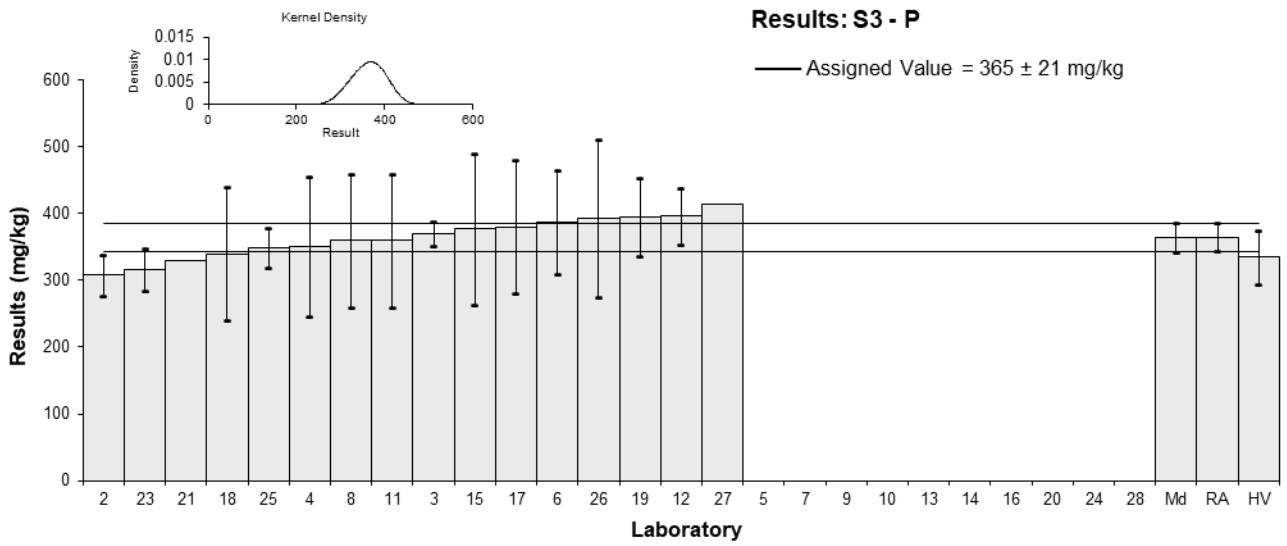
Sample No.	S3
Matrix	Soil
Analyte	P
Unit	mg/kg

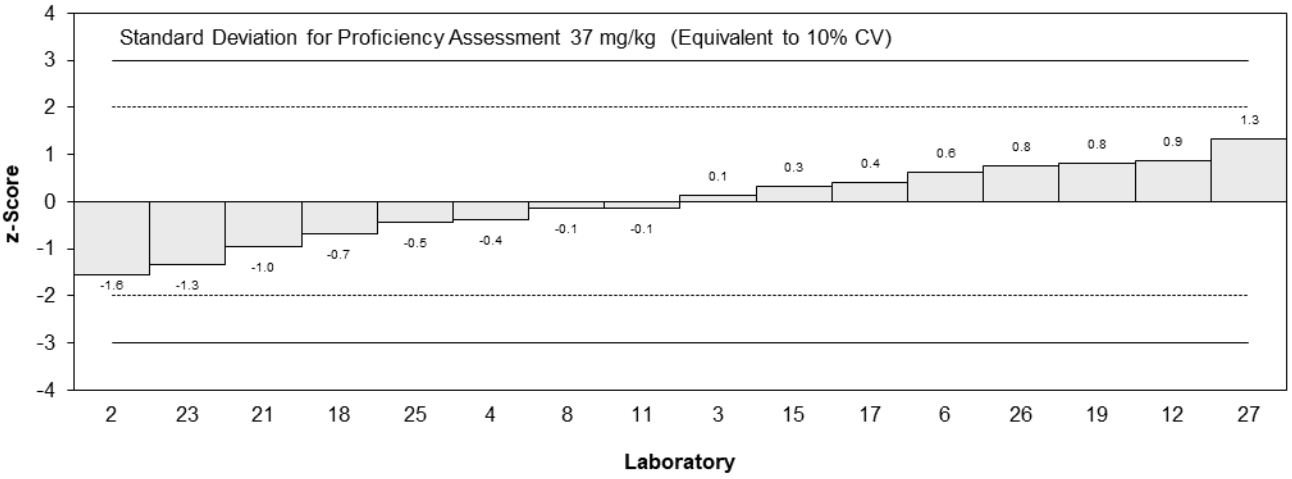
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	308	31	-1.56	-1.52
3	370	18	0.14	0.18
4	351	105.3	-0.38	-0.13
5	NT	NT		
6	388	77.6	0.63	0.29
7	NR	NR		
8	360	100	-0.14	-0.05
9	NT	NT		
10	NT	NT		
11	360	100	-0.14	-0.05
12	396.4	42.2	0.86	0.67
13	NT	NT		
14	NT	NT		
15	377.05	113.114	0.33	0.10
16	NT	NT		
17	380	100	0.41	0.15
18	340	100	-0.68	-0.24
19	395	58	0.82	0.49
20	NT	NT		
21	330	NR	-0.96	-1.67
23	316.630	31.663	-1.33	-1.27
24	NT	NT		
25	348.53	30	-0.45	-0.45
26	393	118	0.77	0.23
27	414	NR	1.34	2.33
28	NT	NT		

Statistics

Assigned Value	365	21
Homogeneity Value	335	40
Robust Average	365	21
Median	365	22
Mean	364	
N	16	
Max	414	
Min	308	
Robust SD	34	
Robust CV	9.3%	


Results: S3 - P
Assigned Value = 365 ± 21 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
2 23 21 18 25 4 8 11 3 15 17 6 26 19 12 27 5 7 9 10 13 14 16 20 24 28 Md RA HV


z-Scores: S3 - P
Standard Deviation for Proficiency Assessment 37 mg/kg (Equivalent to 10% CV)
z-Score
Laboratory
2 23 21 18 25 4 8 11 3 15 17 6 26 19 12 27
-1.6 -1.3 -1.0 -0.7 -0.5 -0.4 -0.1 -0.1 0.1 0.3 0.4 0.6 0.8 0.8 0.9 1.3

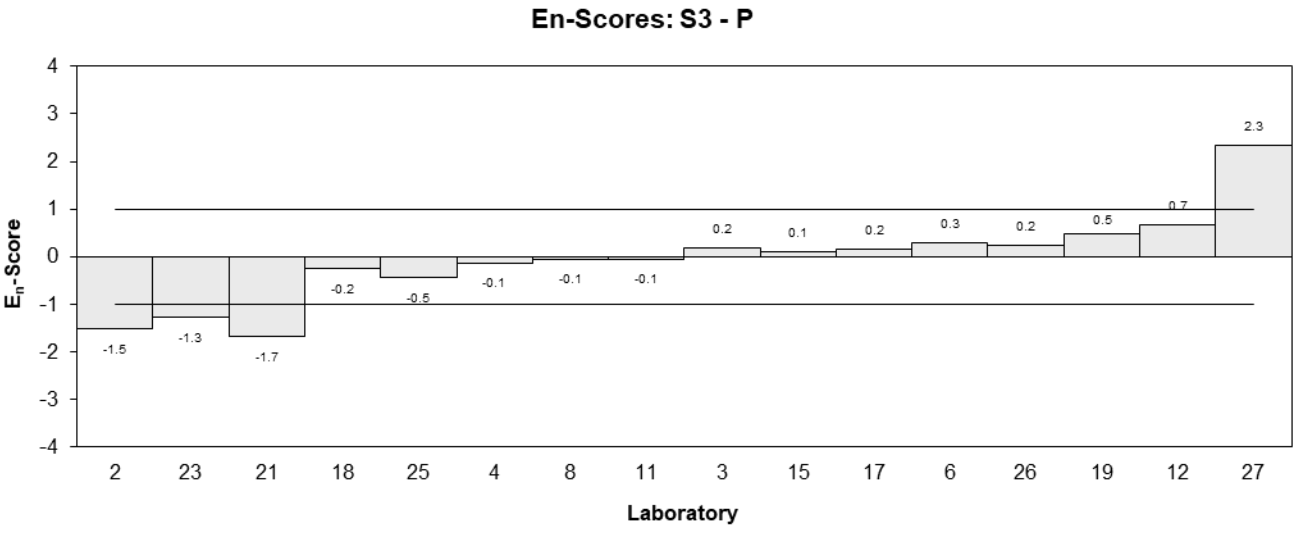

En-Scores: S3 - P
En-Score
Laboratory
2 23 21 18 25 4 8 11 3 15 17 6 26 19 12 27
-1.5 -1.3 -1.7 -0.2 -0.5 -0.1 -0.1 -0.1 0.2 0.1 0.2 0.3 0.2 0.5 0.7 2.3

Figure 52

Table 64

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	S
Unit	mg/kg

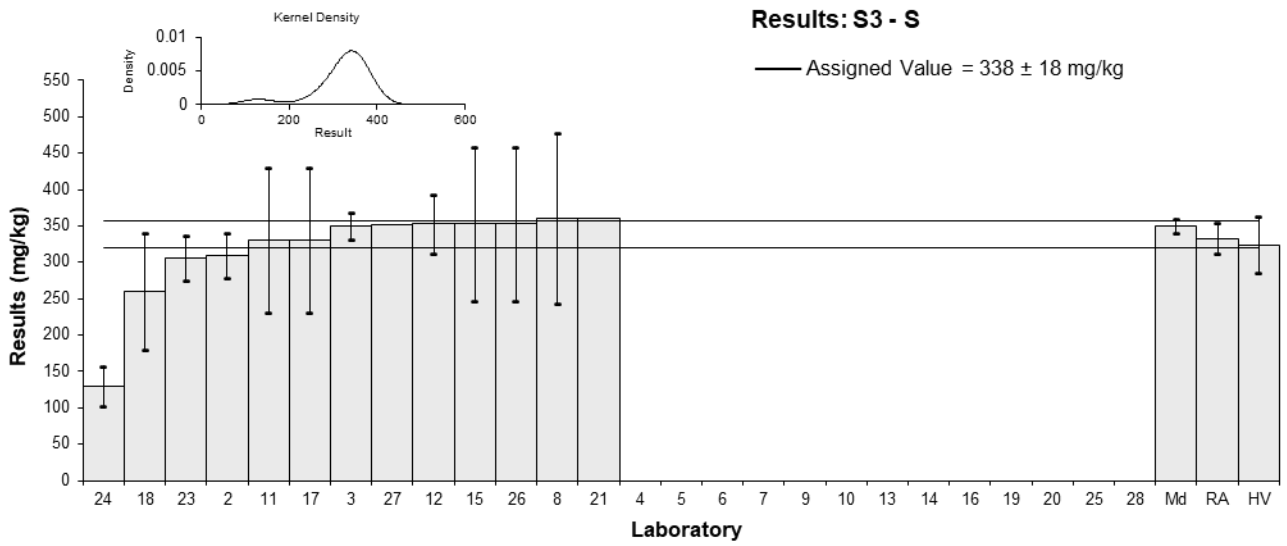
Participant Results

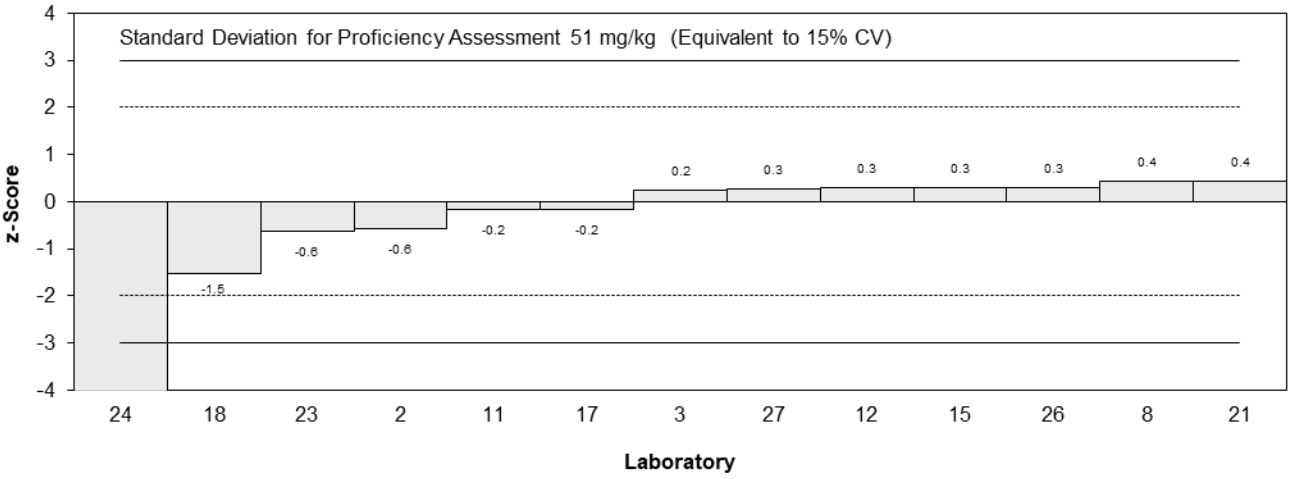
Lab. Code	Result	Uncertainty	z	E_n
2	309	31	-0.57	-0.81
3	350	18	0.24	0.47
4	< 1000	NR		
5	NT	NT		
6	NT	NT		
7	NR	NR		
8	360	117	0.43	0.19
9	NT	NT		
10	NT	NT		
11	330	100	-0.16	-0.08
12	352.5	40.0	0.29	0.33
13	NT	NT		
14	NT	NT		
15	353.0	105.90	0.30	0.14
16	NT	NT		
17	330	100	-0.16	-0.08
18	260	80	-1.54	-0.95
19	NT	NT		
20	NT	NT		
21	360	NR	0.43	1.22
23	306	30.6	-0.63	-0.90
24*	130	27	-4.10	-6.41
25	NT	NT		
26	353	106	0.30	0.14
27	352	NR	0.28	0.78
28	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	338	18
Homogeneity Value	324	39
Robust Average	333	21
Median	350	10
Mean	319	
N	13	
Max	360	
Min	130	
Robust SD	31	
Robust CV	9.3%	


Results: S3 - S
Assigned Value = 338 ± 18 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
24 18 23 2 11 17 3 27 12 15 26 8 21 4 5 6 7 9 10 13 14 16 19 20 25 28 Md RA HV


z-Scores: S3 - S
Standard Deviation for Proficiency Assessment 51 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
24 18 23 2 11 17 3 27 12 15 26 8 21
-1.5 -0.6 -0.6 -0.2 -0.2 0.2 0.3 0.3 0.3 0.3 0.4 0.4

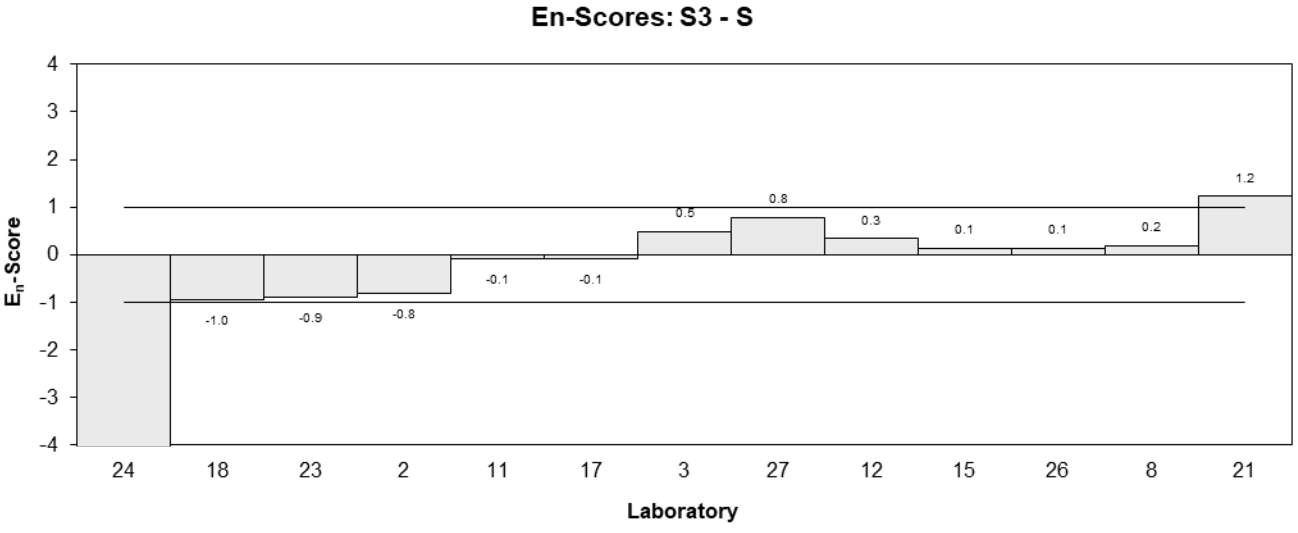

En-Scores: S3 - S
En-Score
Laboratory
24 18 23 2 11 17 3 27 12 15 26 8 21
-1.0 -0.9 -0.8 -0.1 -0.1 0.5 0.8 0.3 0.1 0.1 0.2 1.2

Figure 53

Table 65

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	Sr
Unit	mg/kg

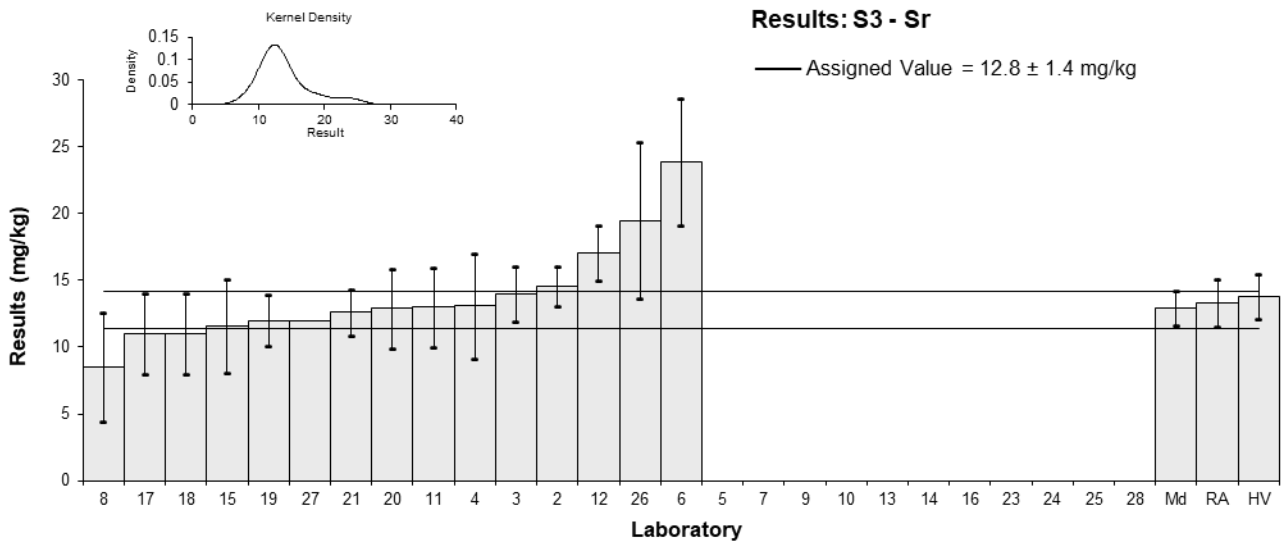
Participant Results

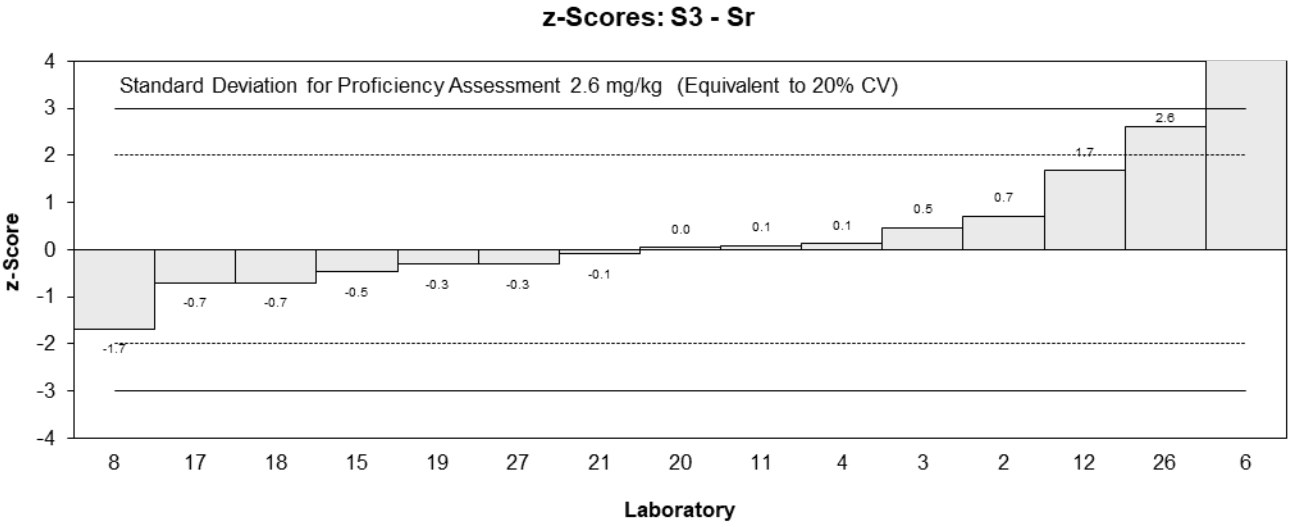
Lab. Code	Result	Uncertainty	z	E_n
2	14.6	1.5	0.70	0.88
3	14	2.1	0.47	0.48
4	13.1	3.93	0.12	0.07
5	NT	NT		
6*	23.9	4.78	4.34	2.23
7	NR	NR		
8	8.5	4.1	-1.68	-0.99
9	NT	NT		
10	NT	NT		
11	13	3	0.08	0.06
12	17.070	2.038	1.67	1.73
13	NT	NT		
14	NT	NT		
15	11.59	3.477	-0.47	-0.32
16	NT	NT		
17	11	3	-0.70	-0.54
18	11	3	-0.70	-0.54
19	12	1.9	-0.31	-0.34
20	12.9	3	0.04	0.03
21	12.6	1.77	-0.08	-0.09
23	NT	NT		
24	NT	NT		
25	NT	NT		
26	19.5	5.85	2.62	1.11
27	12	NR	-0.31	-0.57
28	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	12.8	1.4
Homogeneity Value	13.8	1.7
Robust Average	13.3	1.8
Median	12.9	1.3
Mean	13.8	
N	15	
Max	23.9	
Min	8.5	
Robust SD	2.8	
Robust CV	21%	


Results: S3 - Sr
Kernel Density
Density
Result
Assigned Value = 12.8 ± 1.4 mg/kg
Results (mg/kg)
Laboratory
8 17 18 15 19 27 21 20 11 4 3 2 12 26 6 5 7 9 10 13 14 16 23 24 25 28 Md RA HV


z-Scores: S3 - Sr
Standard Deviation for Proficiency Assessment 2.6 mg/kg (Equivalent to 20% CV)
z-Score
Laboratory
8 17 18 15 19 27 21 20 11 4 3 2 12 26 6
-1.7 -0.7 -0.7 -0.5 -0.3 -0.3 -0.1 0.0 0.1 0.1 0.5 0.7 1.7 2.6

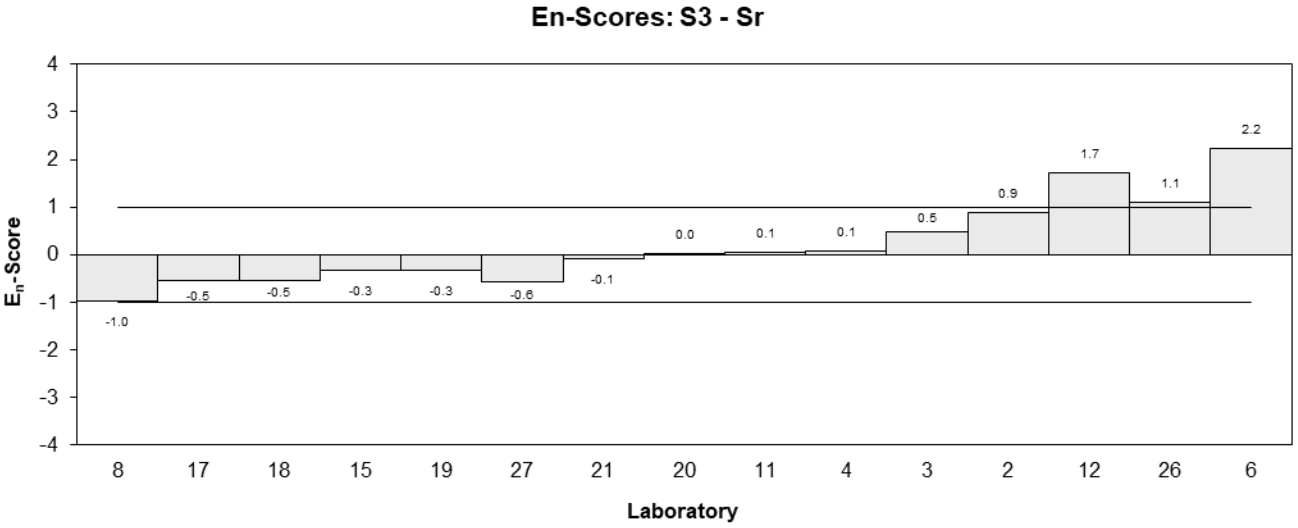

En-Scores: S3 - Sr
En-Score
Laboratory
8 17 18 15 19 27 21 20 11 4 3 2 12 26 6
-1.0 -0.5 -0.5 -0.3 -0.3 -0.6 -0.1 0.0 0.1 0.1 0.5 0.9 1.7 1.1 2.2

Figure 54

Table 66

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	Colwell K
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
2	256	26
3	NR	NR
4	NT	NT
5	NT	NT
6	NT	NT
7	NR	NR
8	468	162
9	NT	NT
10	NT	NT
11	340	100
12	NT	NT
13	NT	NT
14	NT	NT
15	NT	NT
16	NT	NT
17	NR	NR
18	NT	NT
19	NT	NT
20	NT	NT
21	NT	NT
23	NT	NT
24	NT	NT
25	NT	NT
26	NT	NT
27	NT	NT
28	NT	NT

Statistics

Assigned Value	Not Set	
Robust Average	NA (N<6)	
Median	340	180
Mean	350	
N	3	
Max	468	
Min	256	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

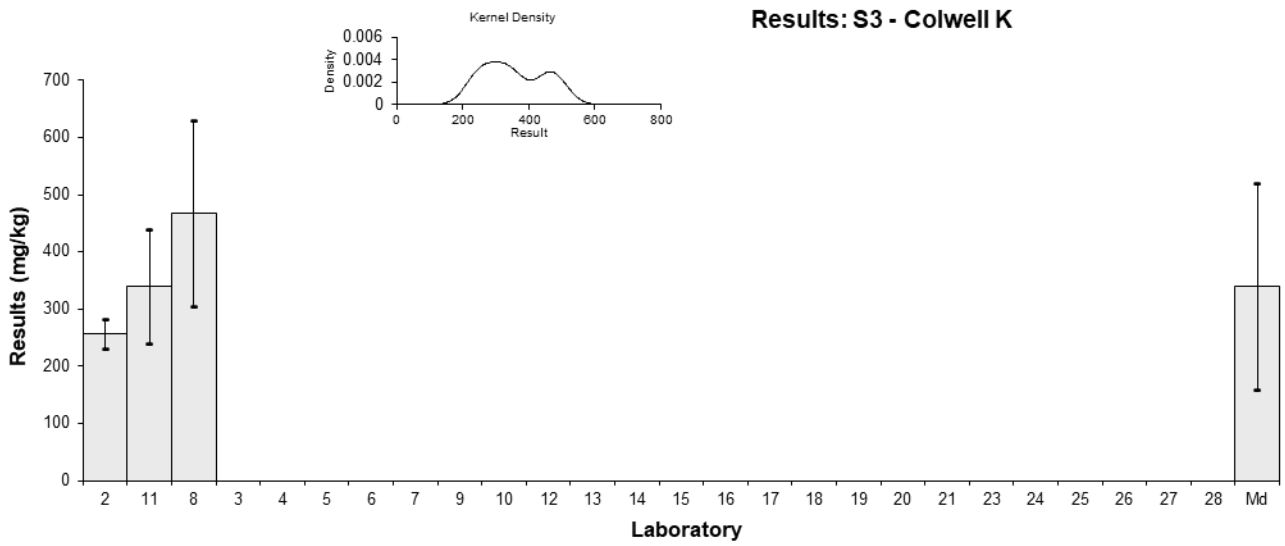

Results: S3 - Colwell K
Kernel Density
Density
0.006
0.004
0.002
0
0
200
400
600
800
Result
Results (mg/kg)
700
600
500
400
300
200
100
0
2
11
8
3
4
5
6
7
9
10
12
13
14
15
16
17
18
19
20
21
23
24
25
26
27
28
Md
Laboratory

Figure 55

Table 67

Sample Details

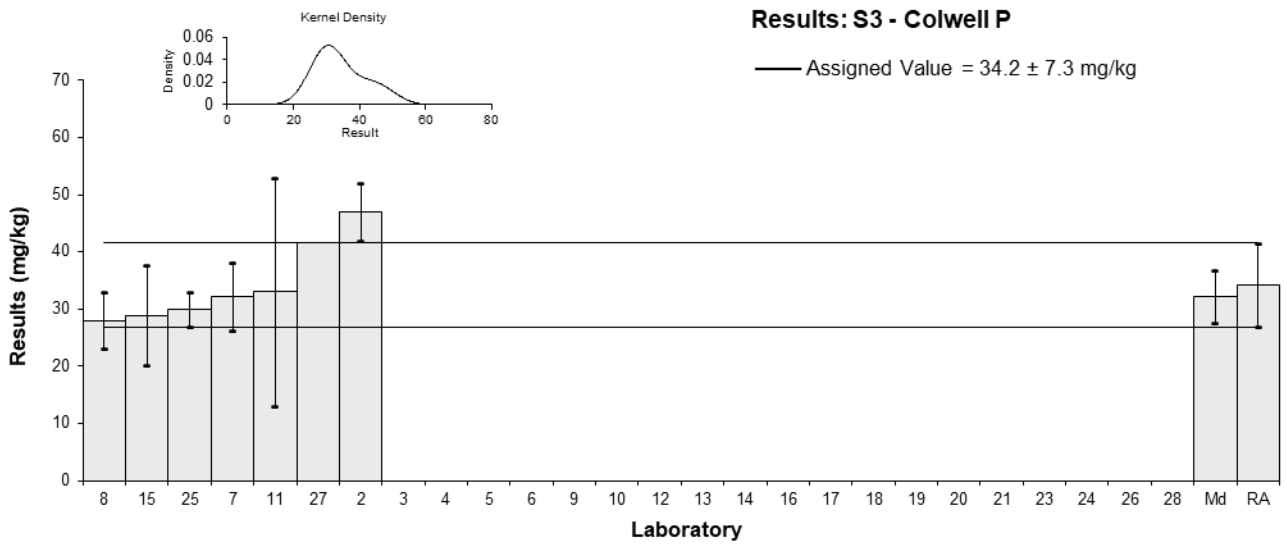
Sample No.	S3
Matrix	Soil
Analyte	Colwell P
Unit	mg/kg

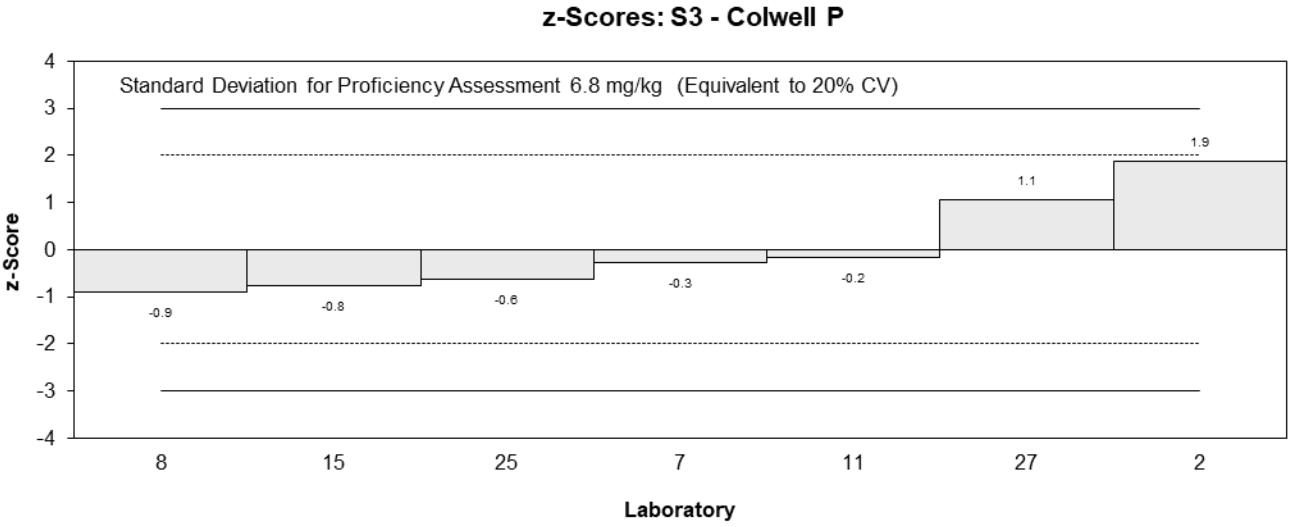
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	47	5.0	1.87	1.45
3	NR	NR		
4	NT	NT		
5	NT	NT		
6	NT	NT		
7	32.20	6.0	-0.29	-0.21
8	28	5	-0.91	-0.70
9	NT	NT		
10	NT	NT		
11	33	20	-0.18	-0.06
12	NT	NT		
13	NT	NT		
14	NT	NT		
15	28.9	8.67	-0.77	-0.47
16	NT	NT		
17	NR	NR		
18	NT	NT		
19	NT	NT		
20	NT	NT		
21	NT	NT		
23	NT	NT		
24	NT	NT		
25	29.9	3	-0.63	-0.54
26	NT	NT		
27	41.5	NR	1.07	1.00
28	NT	NT		

Statistics

Assigned Value	34.2	7.3
Robust Average	34.2	7.3
Median	32.2	4.6
Mean	34.4	
N	7	
Max	47	
Min	28	
Robust SD	7.7	
Robust CV	23%	


Kernel Density
Density
Result
Results: S3 - Colwell P
Assigned Value = 34.2 ± 7.3 mg/kg
Results (mg/kg)
Laboratory
8 15 25 7 11 27 2 3 4 5 6 9 10 12 13 14 16 17 18 19 20 21 23 24 26 28 Md RA


z-Scores: S3 - Colwell P
Standard Deviation for Proficiency Assessment 6.8 mg/kg (Equivalent to 20% CV)
z-Score
-0.9
-0.8
-0.6
-0.3
-0.2
1.1
1.9
Laboratory
8 15 25 7 11 27 2

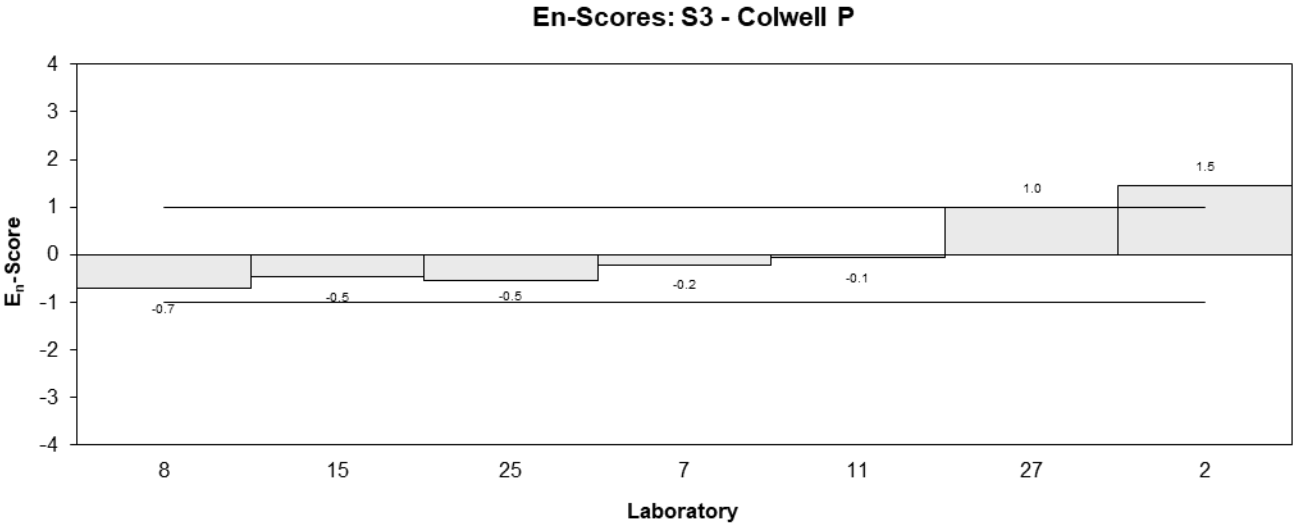

En-Scores: S3 - Colwell P
En-Score
-0.7
-0.5
-0.5
-0.2
-0.1
1.0
1.5
Laboratory
8 15 25 7 11 27 2

Figure 56

Table 68

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	EC
Unit	µS/cm

Participant Results

Lab. Code	Result	Uncertainty
2	239	25
3	NR	NR
4	NT	NT
5	NT	NT
6	NT	NT
7	244	NR
8	228	8
9	NT	NT
10	NT	NT
11	NT	NT
12	2507.5	47.9
13	NT	NT
14	NT	NT
15	261.5	78.45
16	NT	NT
17	2500	800
18	2700	1000
19	NT	NT
20	NT	NT
21	253	13.6
23	NT	NT
24	900	9
25	270.4	30
26	NT	NT
27	250	NR
28	NT	NT

Statistics

Assigned Value	Not Set	
Robust Average	940	910
Median	262	25
Mean	940	
N	11	
Max	2700	
Min	228	
Robust SD	1200	
Robust CV	130%	

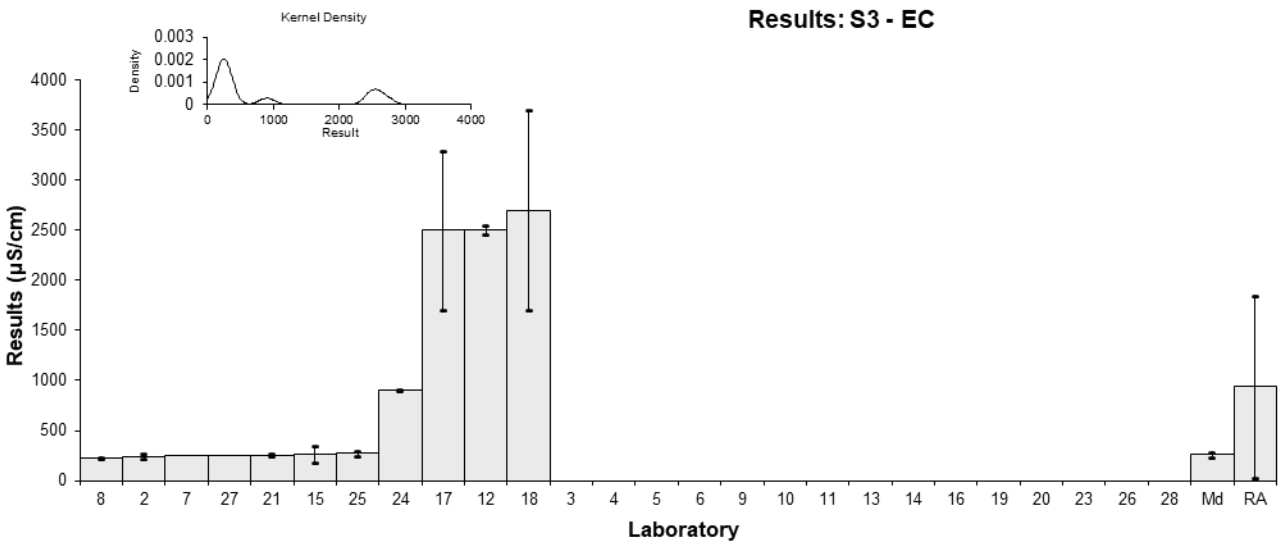

Results: S3 - EC
Kernel Density
Density
0.003
0.002
0.001
0
0
1000
2000
3000
4000
Result
Results (µS/cm)
4000
3500
3000
2500
2000
1500
1000
500
0
8
2
7
27
21
15
25
24
17
12
18
3
4
5
6
9
10
11
13
14
16
19
20
23
26
28
Md
RA
Laboratory

Figure 57

Table 69

Sample Details

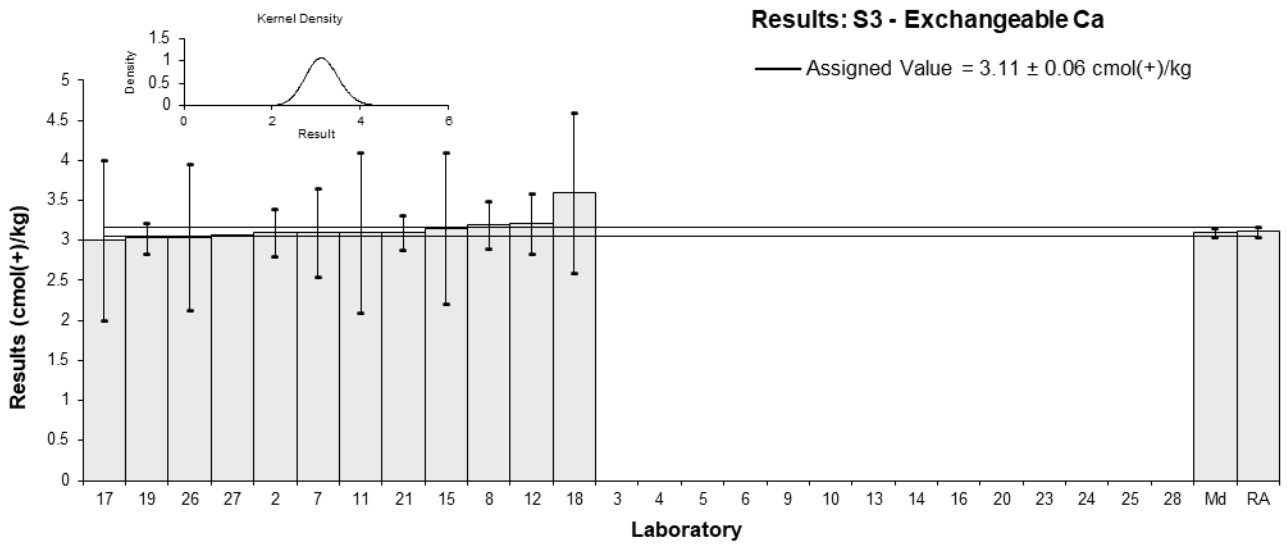
Sample No.	S3
Matrix	Soil
Analyte	Exchangeable Ca
Unit	cmol(+)/kg

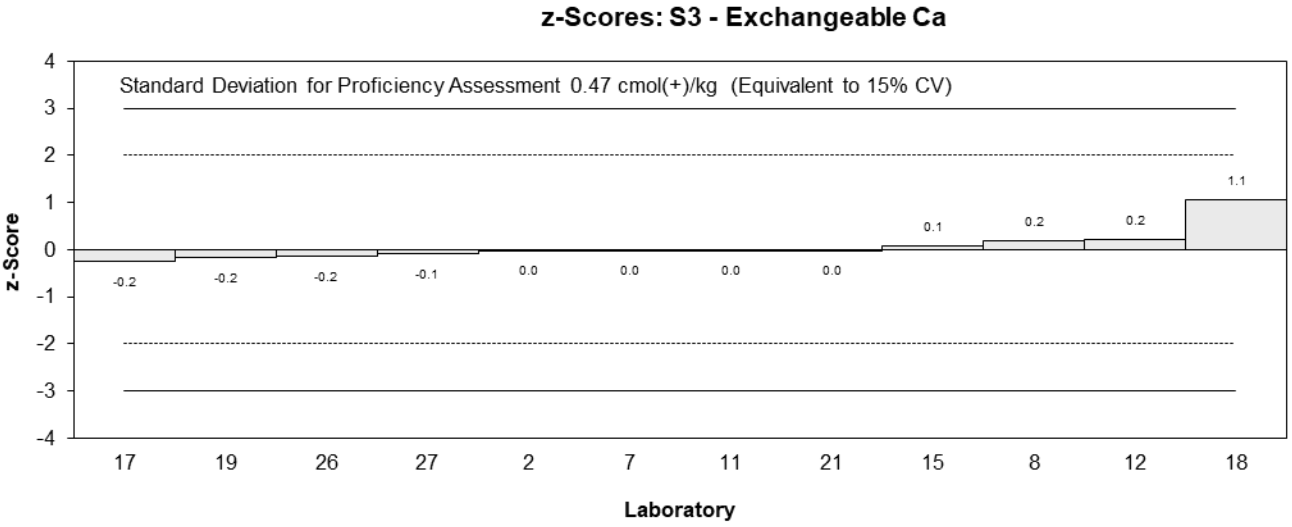
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	3.10	0.3	-0.02	-0.03
3	NR	NR		
4	NT	NT		
5	NT	NT		
6	NT	NT		
7	3.1	0.56	-0.02	-0.02
8	3.2	0.3	0.19	0.29
9	NT	NT		
10	NT	NT		
11	3.1	1	-0.02	-0.01
12	3.207	0.375	0.21	0.26
13	NT	NT		
14	NT	NT		
15	3.149	0.9447	0.08	0.04
16	NT	NT		
17	3	1	-0.24	-0.11
18	3.6	1	1.05	0.49
19	3.03	0.19	-0.17	-0.40
20	NT	NT		
21	3.1	0.22	-0.02	-0.04
23	NT	NT		
24	NT	NT		
25	NT	NT		
26	3.04	0.912	-0.15	-0.08
27	3.07	NR	-0.09	-0.67
28	NT	NT		

Statistics

Assigned Value	3.11	0.06
Robust Average	3.11	0.06
Median	3.10	0.06
Mean	3.14	
N	12	
Max	3.6	
Min	3	
Robust SD	0.084	
Robust CV	2.7%	


Results: S3 - Exchangeable Ca
Assigned Value = 3.11 ± 0.06 cmol(+)/kg
Kernel Density
Density
Result
Results (cmol(+)/kg)
Laboratory
17 19 26 27 2 7 11 21 15 8 12 18 3 4 5 6 9 10 13 14 16 20 23 24 25 28 Md RA


z-Scores: S3 - Exchangeable Ca
Standard Deviation for Proficiency Assessment 0.47 cmol(+)/kg (Equivalent to 15% CV)
z-Score
-0.2 -0.2 -0.2 -0.1 0.0 0.0 0.0 0.0 0.1 0.2 0.2 1.1
Laboratory
17 19 26 27 2 7 11 21 15 8 12 18

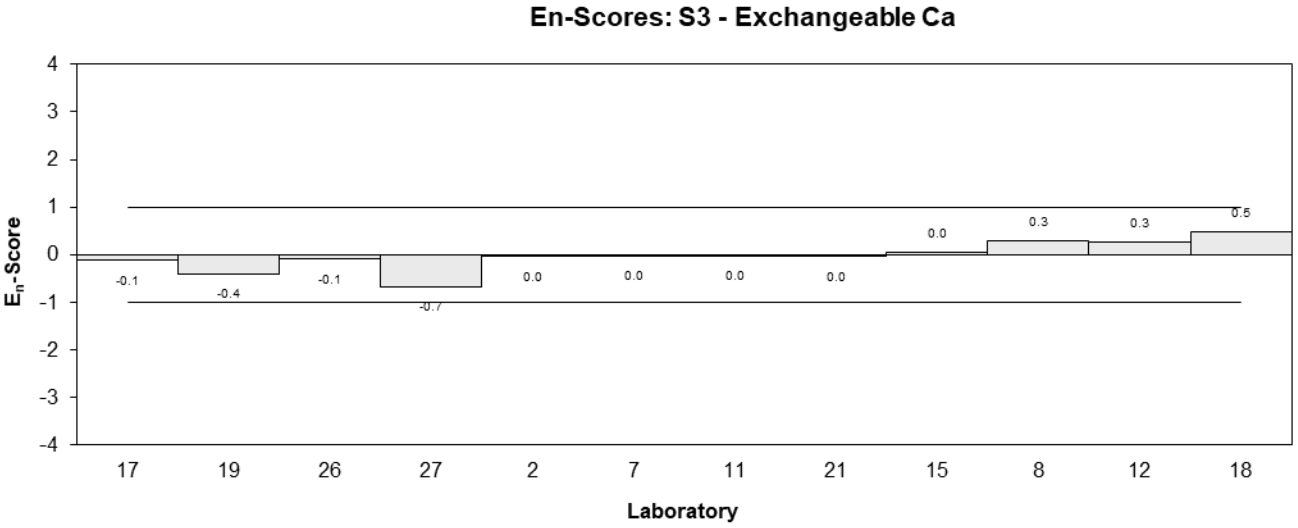

En-Scores: S3 - Exchangeable Ca
En-Score
-0.1 -0.4 -0.1 -0.7 0.0 0.0 0.0 0.0 0.0 0.3 0.3 0.5
Laboratory
17 19 26 27 2 7 11 21 15 8 12 18

Figure 58

Table 70

Sample Details

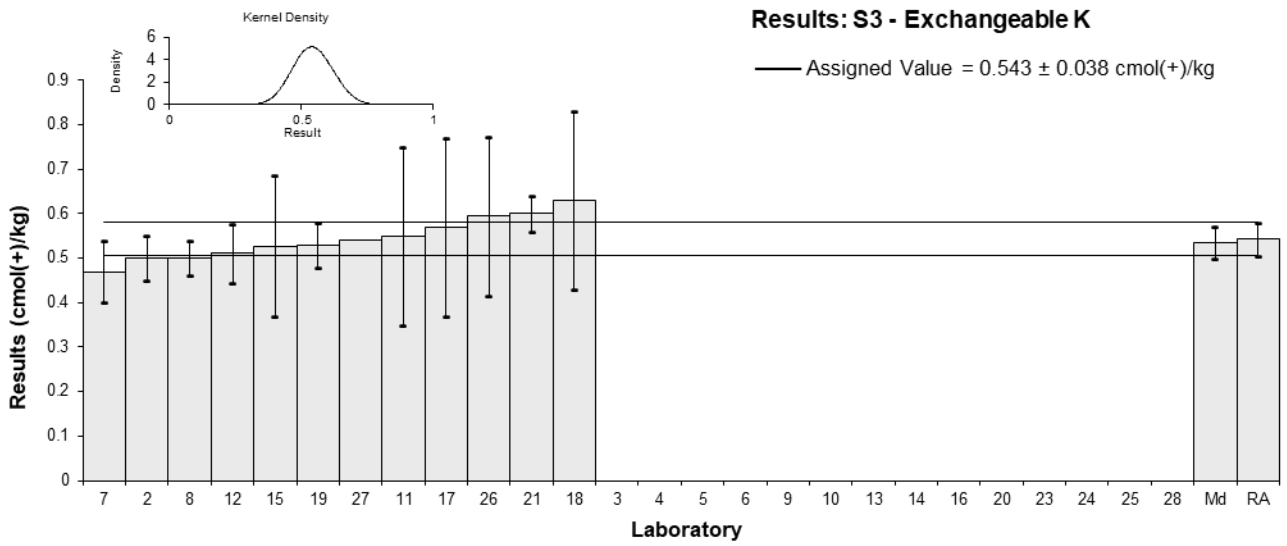
Sample No.	S3
Matrix	Soil
Analyte	Exchangeable K
Unit	cmol(+)/kg

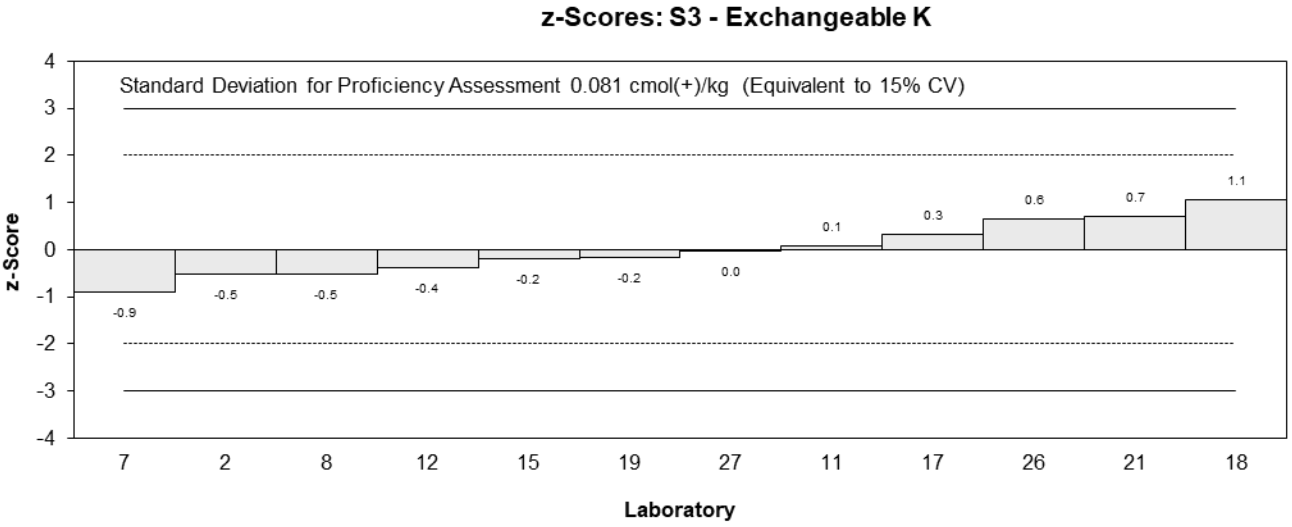
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	0.50	0.05	-0.53	-0.68
3	NR	NR		
4	NT	NT		
5	NT	NT		
6	NT	NT		
7	0.47	0.07	-0.90	-0.92
8	0.5	0.04	-0.53	-0.78
9	NT	NT		
10	NT	NT		
11	0.55	0.2	0.09	0.03
12	0.511	0.067	-0.39	-0.42
13	NT	NT		
14	NT	NT		
15	0.527	0.1581	-0.20	-0.10
16	NT	NT		
17	0.57	0.2	0.33	0.13
18	0.63	0.2	1.07	0.43
19	0.53	0.05	-0.16	-0.21
20	NT	NT		
21	0.6	0.04	0.70	1.03
23	NT	NT		
24	NT	NT		
25	NT	NT		
26	0.595	0.179	0.64	0.28
27	0.54	NR	-0.04	-0.08
28	NT	NT		

Statistics

Assigned Value	0.543	0.038
Robust Average	0.543	0.038
Median	0.535	0.037
Mean	0.544	
N	12	
Max	0.63	
Min	0.47	
Robust SD	0.052	
Robust CV	9.6%	


Kernel Density
Density
Result
Results: S3 - Exchangeable K
Assigned Value = 0.543 ± 0.038 cmol(+)/kg
Results (cmol(+)/kg)
Laboratory
7 2 8 12 15 19 27 11 17 26 21 18 3 4 5 6 9 10 13 14 16 20 23 24 25 28 Md RA


z-Scores: S3 - Exchangeable K
Standard Deviation for Proficiency Assessment 0.081 cmol(+)/kg (Equivalent to 15% CV)
z-Score
-0.9 -0.5 -0.5 -0.4 -0.2 -0.2 0.0 0.1 0.3 0.6 0.7 1.1
Laboratory
7 2 8 12 15 19 27 11 17 26 21 18

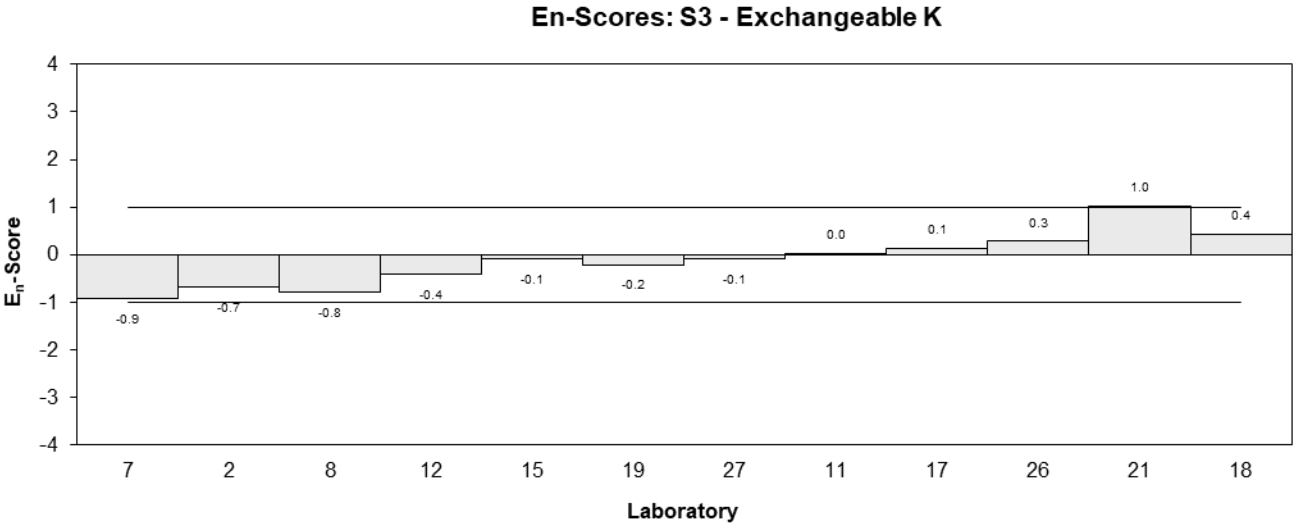

En-Scores: S3 - Exchangeable K
En-Score
-0.9 -0.7 -0.8 -0.4 -0.1 -0.2 -0.1 0.0 0.1 0.3 1.0 0.4
Laboratory
7 2 8 12 15 19 27 11 17 26 21 18

Figure 59

Table 71

Sample Details

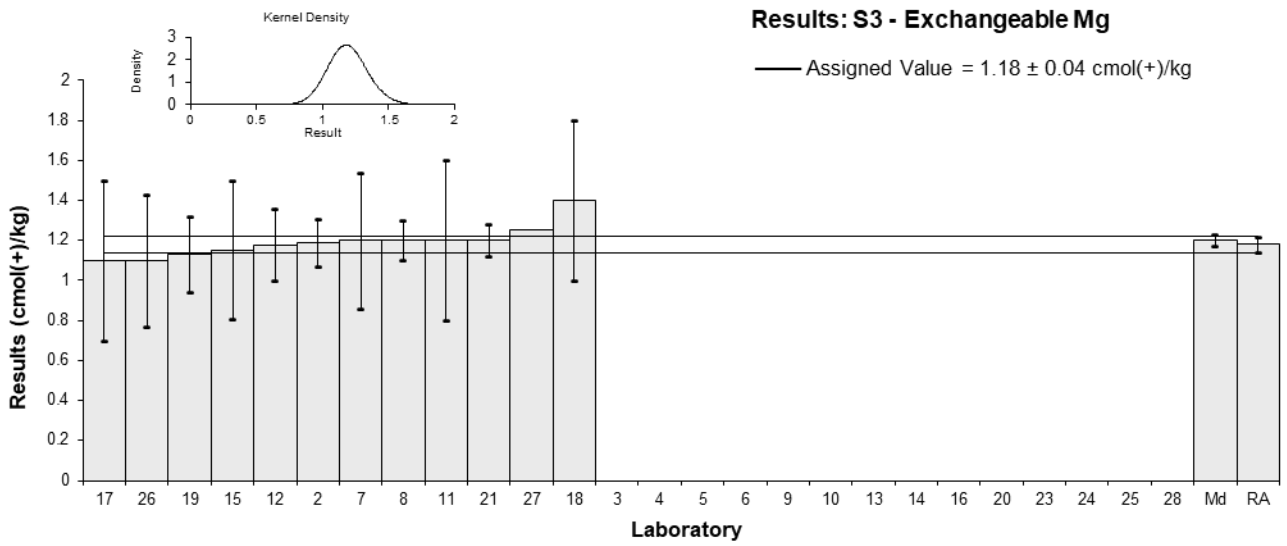
Sample No.	S3
Matrix	Soil
Analyte	Exchangeable Mg
Unit	cmol(+)/kg

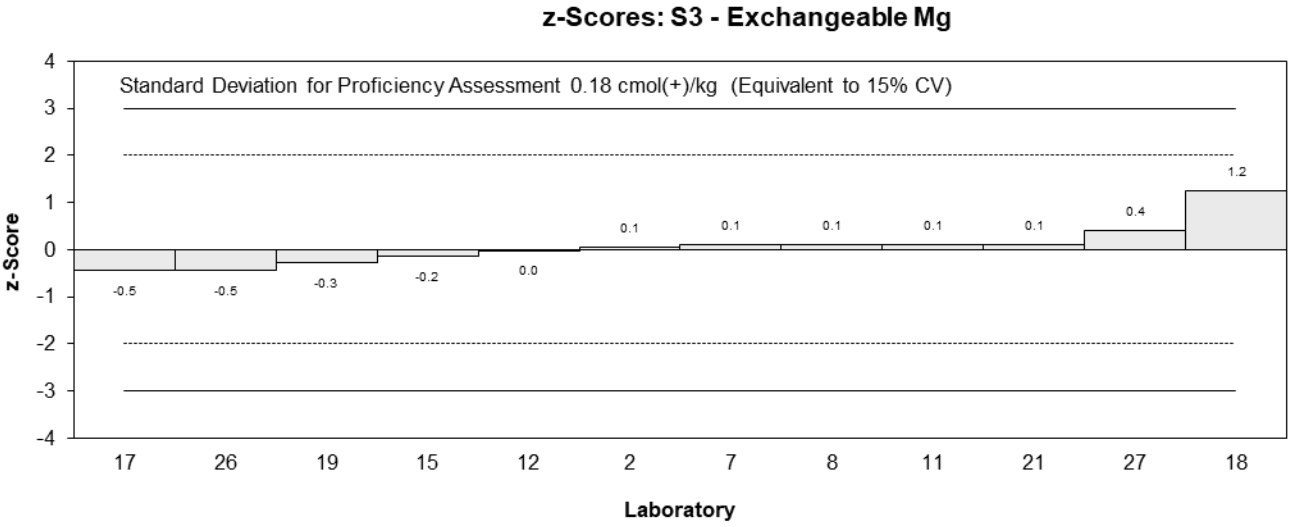
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	1.19	0.12	0.06	0.08
3	NR	NR		
4	NT	NT		
5	NT	NT		
6	NT	NT		
7	1.2	0.34	0.11	0.06
8	1.2	0.1	0.11	0.19
9	NT	NT		
10	NT	NT		
11	1.2	0.4	0.11	0.05
12	1.178	0.181	-0.01	-0.01
13	NT	NT		
14	NT	NT		
15	1.153	0.3459	-0.15	-0.08
16	NT	NT		
17	1.1	0.4	-0.45	-0.20
18	1.4	0.4	1.24	0.55
19	1.13	0.19	-0.28	-0.26
20	NT	NT		
21	1.2	0.08	0.11	0.22
23	NT	NT		
24	NT	NT		
25	NT	NT		
26	1.1	0.33	-0.45	-0.24
27	1.25	NR	0.40	1.75
28	NT	NT		

Statistics

Assigned Value	1.18	0.04
Robust Average	1.18	0.04
Median	1.20	0.03
Mean	1.19	
N	12	
Max	1.4	
Min	1.1	
Robust SD	0.060	
Robust CV	5.1%	


Results: S3 - Exchangeable Mg
Assigned Value = 1.18 ± 0.04 cmol(+)/kg
Kernel Density
Density
Result
Results (cmol(+)/kg)
Laboratory
17 26 19 15 12 2 7 8 11 21 27 18 3 4 5 6 9 10 13 14 16 20 23 24 25 28 Md RA


z-Scores: S3 - Exchangeable Mg
Standard Deviation for Proficiency Assessment 0.18 cmol(+)/kg (Equivalent to 15% CV)
z-Score
-0.5 -0.5 -0.3 -0.2 0.0 0.1 0.1 0.1 0.1 0.1 0.4 1.2
Laboratory
17 26 19 15 12 2 7 8 11 21 27 18

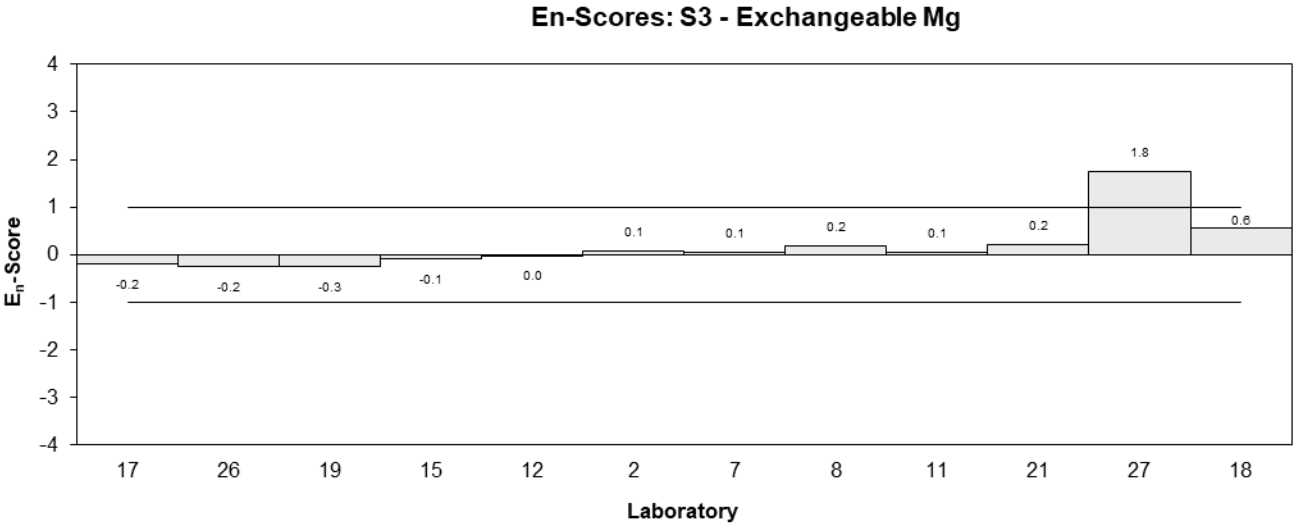

En-Scores: S3 - Exchangeable Mg
En-Score
-0.2 -0.2 -0.3 -0.1 0.0 0.1 0.1 0.2 0.1 0.2 1.8 0.6
Laboratory
17 26 19 15 12 2 7 8 11 21 27 18

Figure 60

Table 72

Sample Details

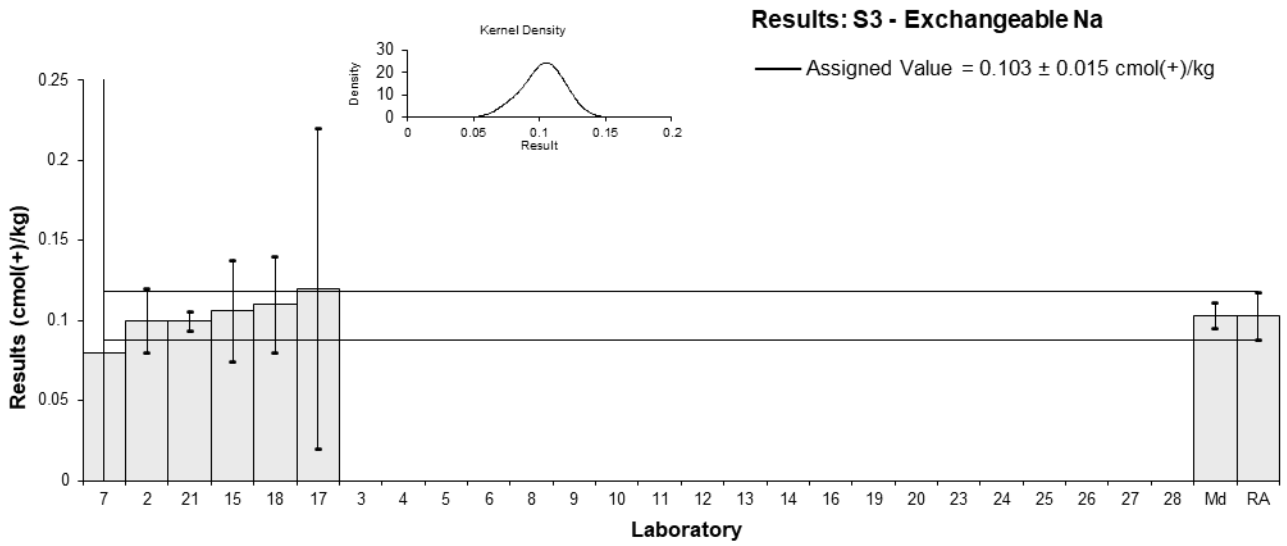
Sample No.	S3
Matrix	Soil
Analyte	Exchangeable Na
Unit	cmol(+)/kg

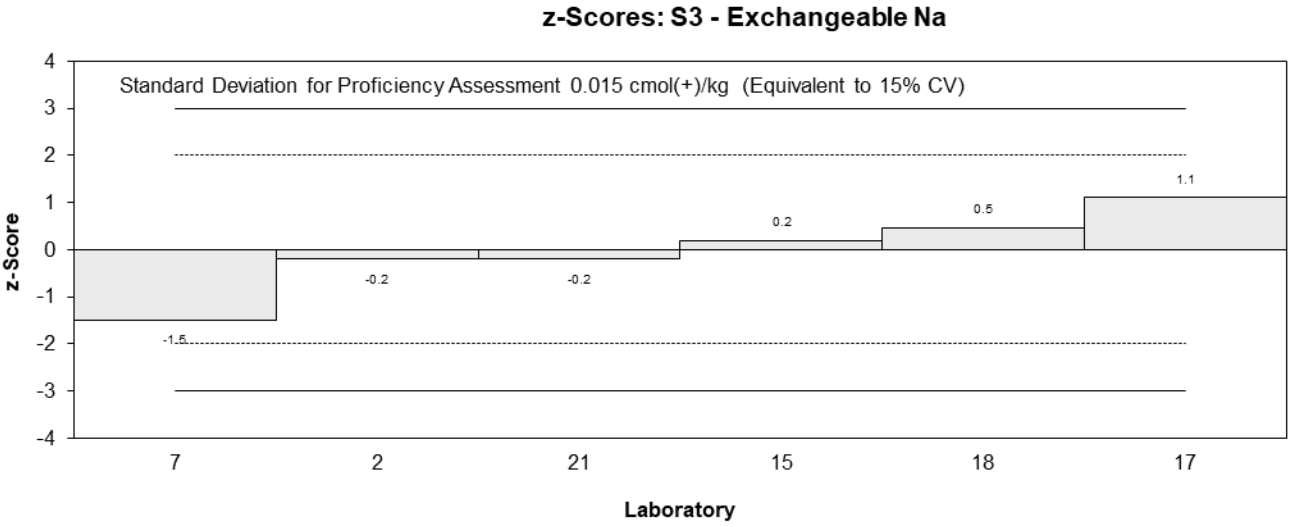
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	0.10	0.02	-0.19	-0.12
3	NR	NR		
4	NT	NT		
5	NT	NT		
6	NT	NT		
7	0.08	0.18	-1.49	-0.13
8	<0.1	NR		
9	NT	NT		
10	NT	NT		
11	<0.1	0.2		
12	<0.1	NR		
13	NT	NT		
14	NT	NT		
15	0.106	0.0318	0.19	0.09
16	NT	NT		
17	0.12	0.1	1.10	0.17
18	0.11	0.03	0.45	0.21
19	< 0.1	NR		
20	NT	NT		
21	0.1	0.006	-0.19	-0.19
23	NT	NT		
24	NT	NT		
25	NT	NT		
26	< 0.2	0.6		
27	<0.01	NR		
28	NT	NT		

Statistics

Assigned Value	0.103	0.015
Robust Average	0.103	0.015
Median	0.103	0.008
Mean	0.103	
N	6	
Max	0.12	
Min	0.08	
Robust SD	0.015	
Robust CV	15%	


Results: S3 - Exchangeable Na
Assigned Value = 0.103 ± 0.015 cmol(+)/kg
Kernel Density
Density
Result
Results (cmol(+)/kg)
Laboratory
7 2 21 15 18 17 3 4 5 6 8 9 10 11 12 13 14 16 19 20 23 24 25 26 27 28 Md RA


z-Scores: S3 - Exchangeable Na
Standard Deviation for Proficiency Assessment 0.015 cmol(+)/kg (Equivalent to 15% CV)
z-Score
-1.5
-0.2
-0.2
0.2
0.5
1.1
Laboratory
7 2 21 15 18 17

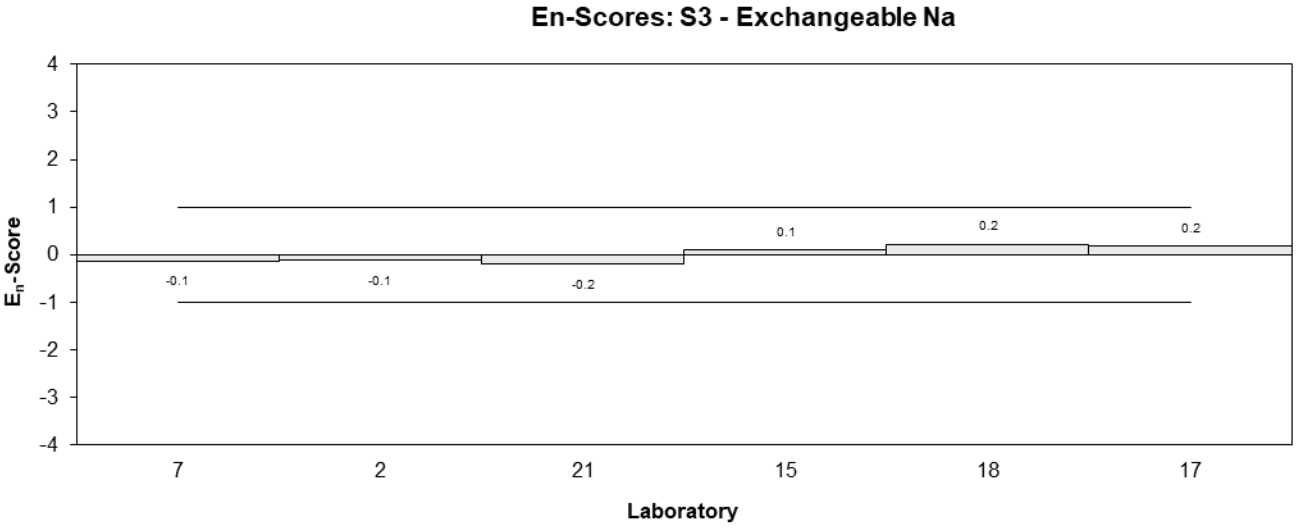

En-Scores: S3 - Exchangeable Na
En-Score
-0.1
-0.1
-0.2
0.1
0.2
0.2
Laboratory
7 2 21 15 18 17

Figure 61

Table 73

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	Extractable B
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
2	0.63	0.08
3	NR	NR
4	NT	NT
5	NT	NT
6	NT	NT
7	NR	NR
8	0.2	0.09
9	NT	NT
10	NT	NT
11	0.7	0.5
12	NT	NT
13	NT	NT
14	NT	NT
15	NT	NT
16	NT	NT
17	<0.2	NR
18	NT	NT
19	NT	NT
20	NT	NT
21	0.5	NR
23	NT	NT
24	NT	NT
25	NT	NT
26	NT	NT
27	<1	NR
28	NT	NT

Statistics

Assigned Value	Not Set	
Robust Average	NA (N<6)	
Median	0.57	0.19
Mean	0.51	
N	4	
Max	0.7	
Min	0.2	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

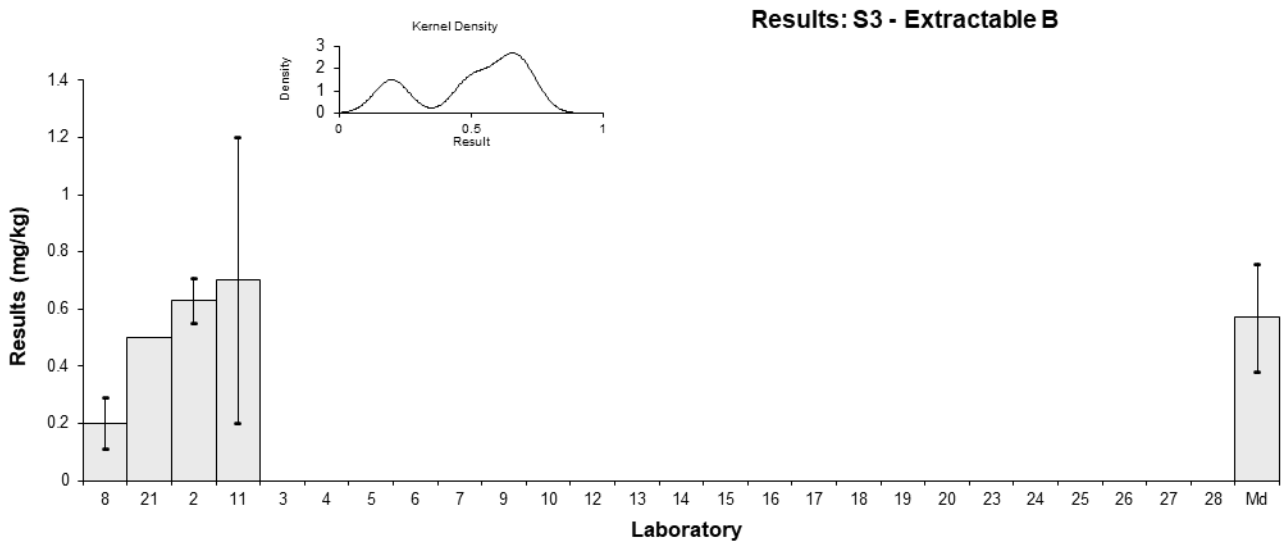

Results: S3 - Extractable B
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
8
21
2
11
3
4
5
6
7
9
10
12
13
14
15
16
17
18
19
20
23
24
25
26
27
28
Md

Figure 62

Table 74

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	PBI
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
2	177	20
3	NR	NR
4	NT	NT
5	NT	NT
6	NT	NT
7	NR	NR
8	NT	NT
9	NT	NT
10	NT	NT
11	NT	NT
12	NT	NT
13	NT	NT
14	NT	NT
15	NT	NT
16	NT	NT
17	NR	NR
18	NT	NT
19	NT	NT
20	NT	NT
21	NT	NT
23	NT	NT
24	NT	NT
25	NT	NT
26	NT	NT
27	163	NR
28	NT	NT

Statistics

Assigned Value	Not Set	
Robust Average	NA (N<6)	
Median	NA (N<3)	
Mean	170	
N	2	
Max	177	
Min	163	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

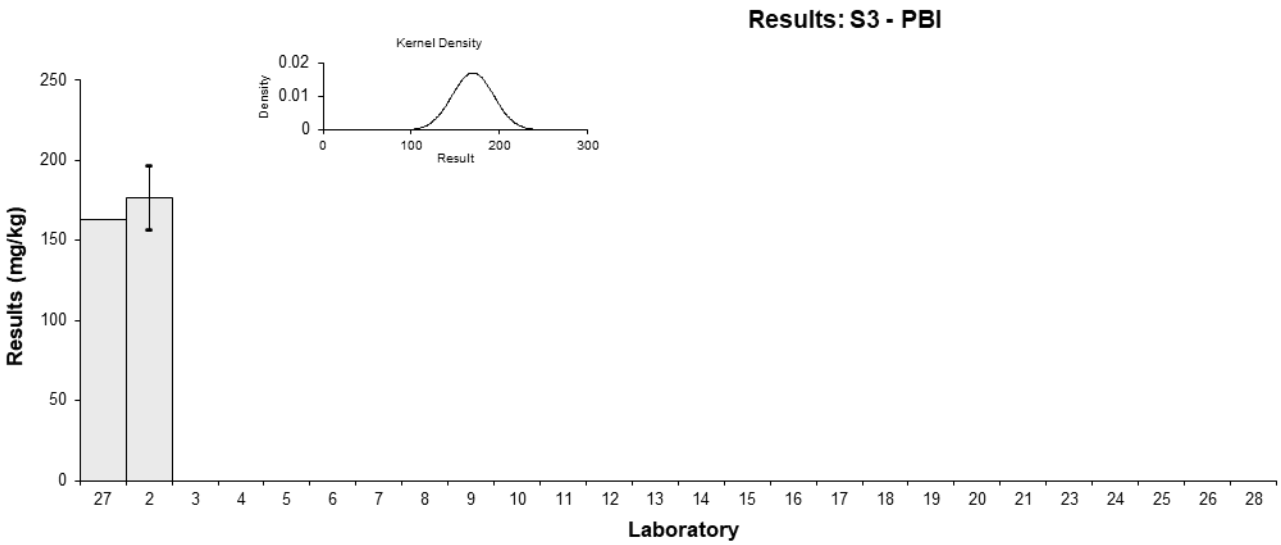

Results: S3 - PBI
Kernel Density
Density
0.02
0.01
0
0
100
200
300
Result
Results (mg/kg)
250
200
150
100
50
0
27
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
23
24
25
26
28
Laboratory

Figure 63

Table 75

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	pH

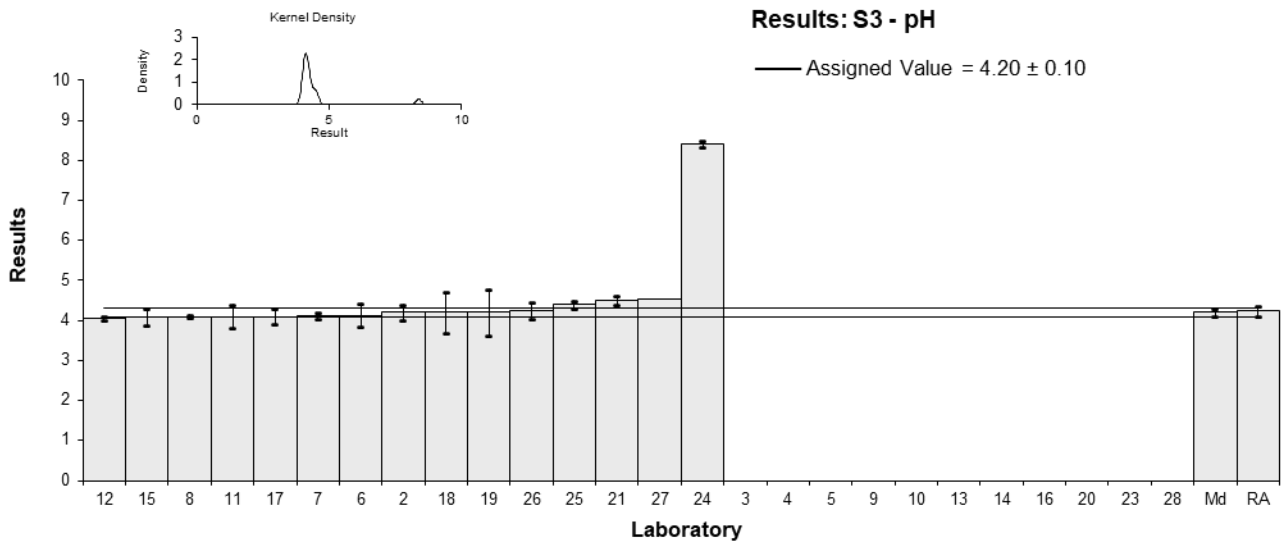
Participant Results

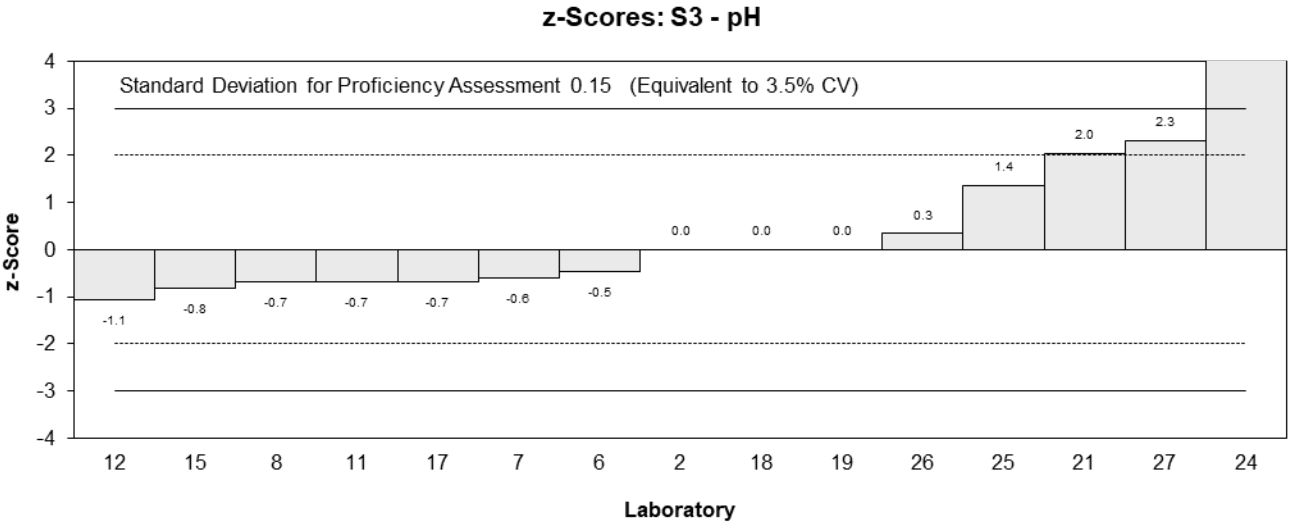
Lab. Code	Result	Uncertainty	z	E_n
2	4.20	0.2	0.00	0.00
3	NR	NR		
4	NT	NT		
5	NT	NT		
6	4.13	0.3	-0.48	-0.22
7	4.11	0.08	-0.61	-0.70
8	4.1	0.04	-0.68	-0.93
9	NT	NT		
10	NT	NT		
11	4.1	0.3	-0.68	-0.32
12	4.0435	0.053	-1.06	-1.38
13	NT	NT		
14	NT	NT		
15	4.08	0.2	-0.82	-0.54
16	NT	NT		
17	4.1	0.2	-0.68	-0.45
18	4.2	0.5	0.00	0.00
19	4.2	0.58	0.00	0.00
20	NT	NT		
21	4.5	0.12	2.04	1.92
23	NT	NT		
24*	8.4	0.084	28.57	32.16
25	4.4	0.1	1.36	1.41
26	4.25	0.2	0.34	0.22
27	4.54	NR	2.31	3.40
28	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	4.20	0.10
Robust Average	4.23	0.12
Median	4.20	0.10
Mean	4.49	
N	15	
Max	8.4	
Min	4.0435	
Robust SD	0.19	
Robust CV	4.5%	


Kernel Density
Density
Result
Results: S3 - pH
Assigned Value = 4.20 ± 0.10
Results
12 15 8 11 17 7 6 2 18 19 26 25 21 27 24 3 4 5 9 10 13 14 16 20 23 28 Md RA
Laboratory


z-Scores: S3 - pH
Standard Deviation for Proficiency Assessment 0.15 (Equivalent to 3.5% CV)
z-Score
-1.1 -0.8 -0.7 -0.7 -0.7 -0.6 -0.5 0.0 0.0 0.0 0.3 1.4 2.0 2.3
12 15 8 11 17 7 6 2 18 19 26 25 21 27 24
Laboratory

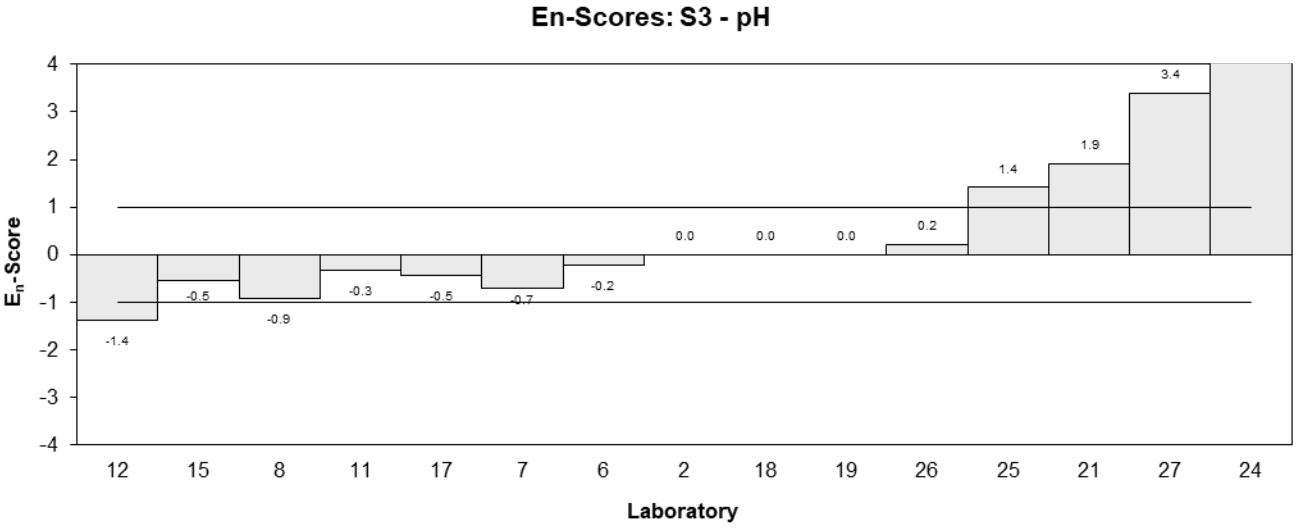

En-Scores: S3 - pH
En-Score
-1.4 -0.5 -0.9 -0.3 -0.5 -0.7 -0.2 0.0 0.0 0.0 0.2 1.4 1.9 3.4
12 15 8 11 17 7 6 2 18 19 26 25 21 27 24
Laboratory

Figure 64

Table 76

Sample Details

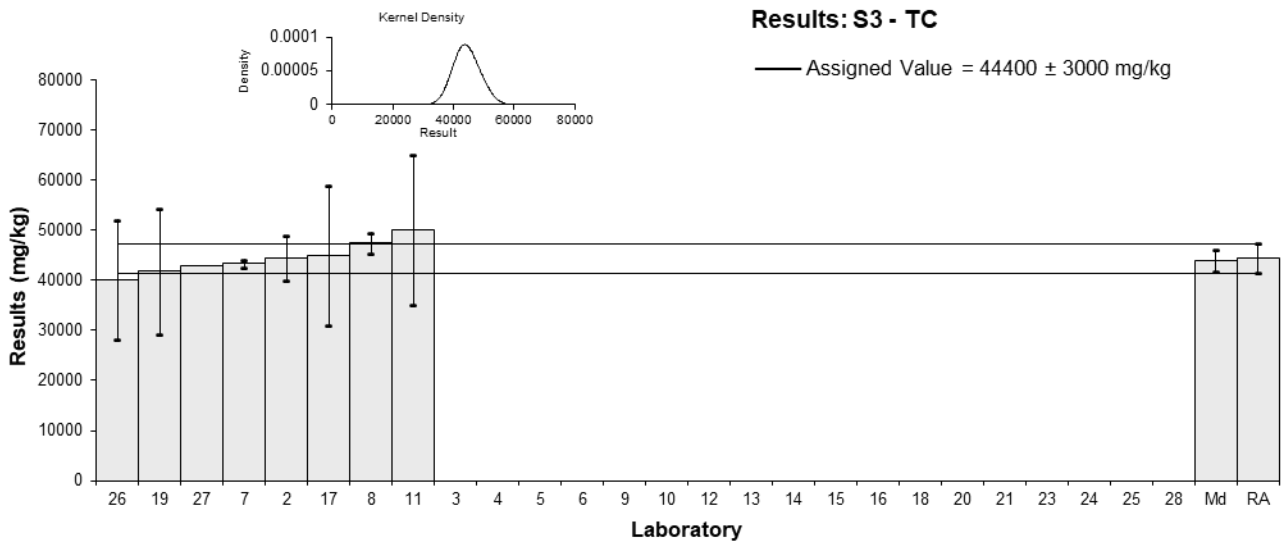
Sample No.	S3
Matrix	Soil
Analyte	TC
Unit	mg/kg

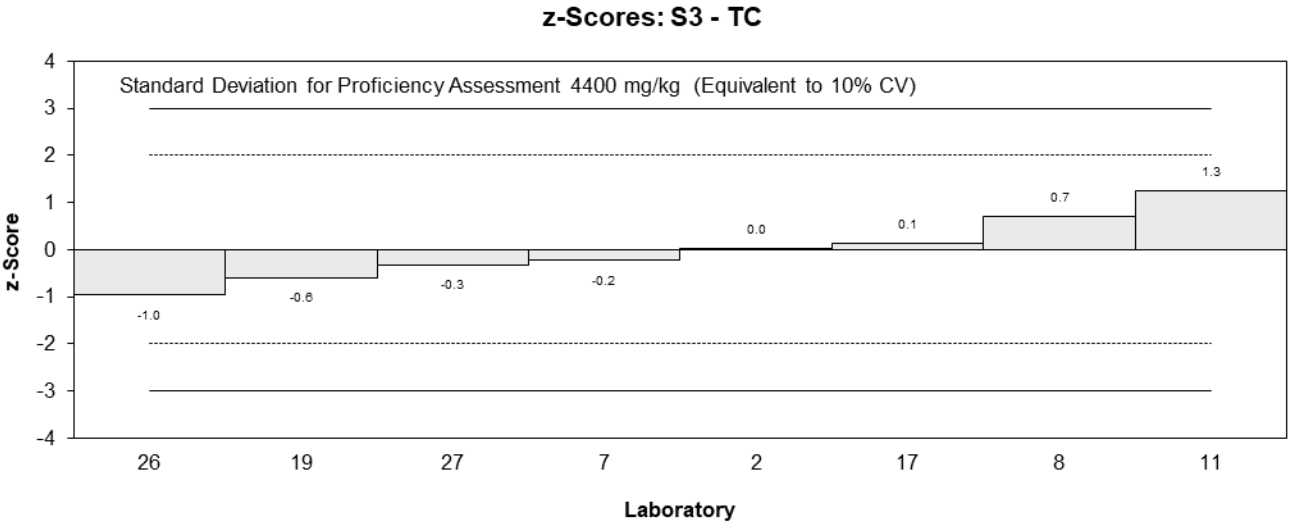
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	44500	4450	0.02	0.02
3	NR	NR		
4	NT	NT		
5	NT	NT		
6	NT	NT		
7	43400	800	-0.23	-0.32
8	47500	2080	0.70	0.85
9	NT	NT		
10	NT	NT		
11	50000	15000	1.26	0.37
12	NT	NT		
13	NT	NT		
14	NT	NT		
15	NT	NT		
16	NT	NT		
17	45000	14000	0.14	0.04
18	NT	NT		
19	41790	12537	-0.59	-0.20
20	NT	NT		
21	NT	NT		
23	NT	NT		
24	NT	NT		
25	NT	NT		
26	40147	12000	-0.96	-0.34
27	43000	NR	-0.32	-0.47
28	NT	NT		

Statistics

Assigned Value	44400	3000
Robust Average	44400	3000
Median	44000	2100
Mean	44400	
N	8	
Max	50000	
Min	40147	
Robust SD	3400	
Robust CV	7.7%	


Kernel Density
Density
Result
Results: S3 - TC
Assigned Value = 44400 ± 3000 mg/kg
Results (mg/kg)
Laboratory
26 19 27 7 2 17 8 11 3 4 5 6 9 10 12 13 14 15 16 18 20 21 23 24 25 28 Md RA


z-Scores: S3 - TC
Standard Deviation for Proficiency Assessment 4400 mg/kg (Equivalent to 10% CV)
z-Score
-1.0
-0.6
-0.3
-0.2
0.0
0.1
0.7
1.3
Laboratory
26 19 27 7 2 17 8 11

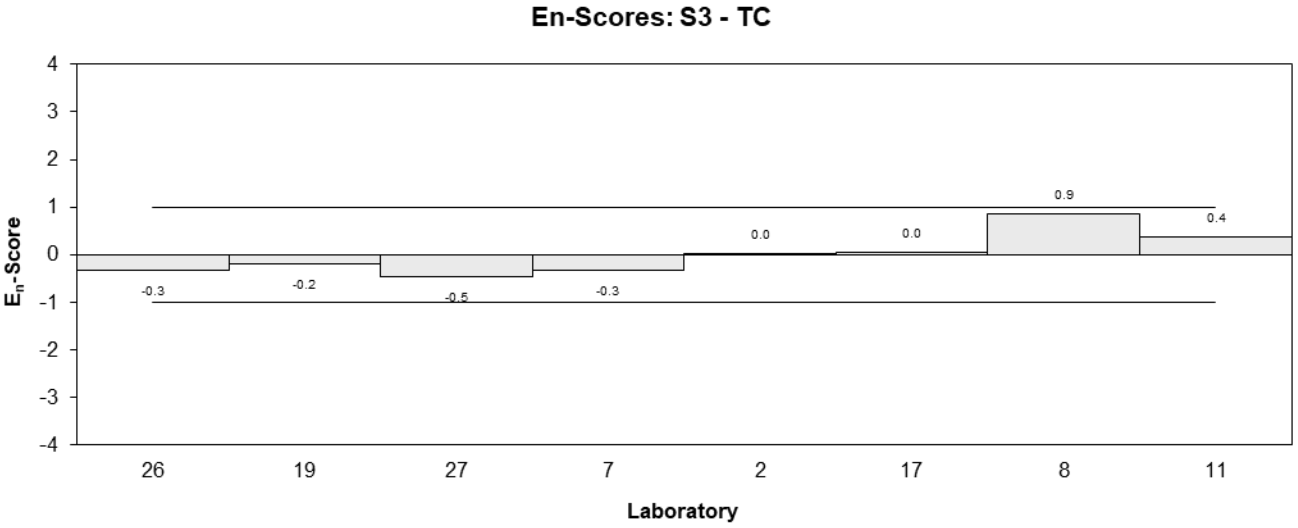

En-Scores: S3 - TC
En-Score
-0.3
-0.2
-0.5
-0.3
0.0
0.0
0.9
0.4
Laboratory
26 19 27 7 2 17 8 11

Figure 65

Table 77

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	TN
Unit	mg/kg

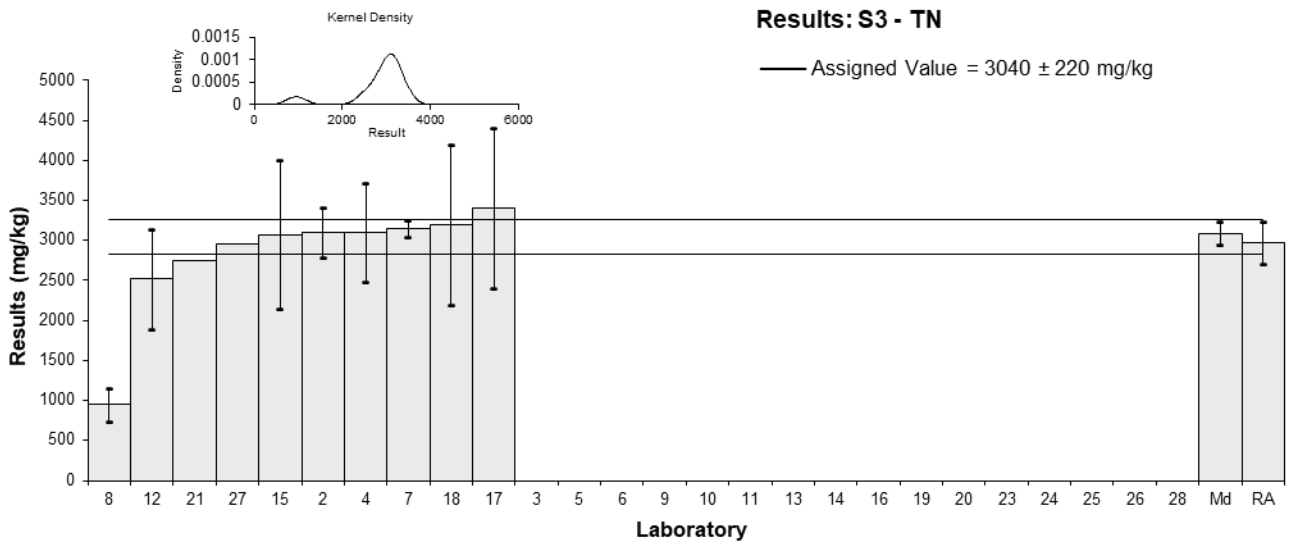
Participant Results

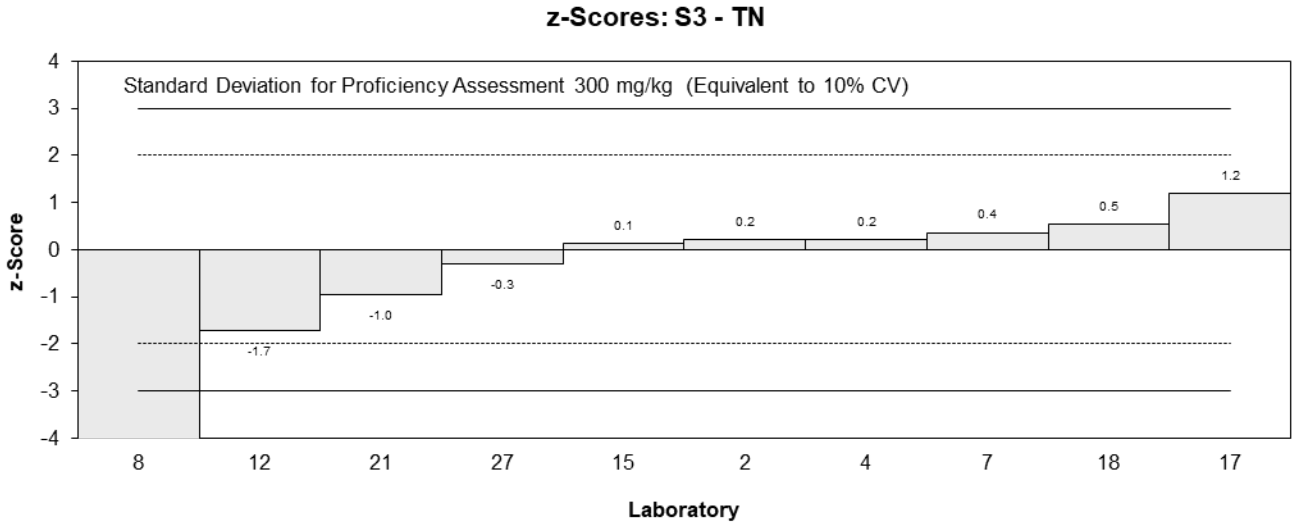
Lab. Code	Result	Uncertainty	z	E_n
2	3100	310	0.20	0.16
3	NR	NR		
4	3100	620	0.20	0.09
5	NT	NT		
6	NT	NT		
7	3150	100	0.36	0.46
8*	950	205	-6.88	-6.95
9	NT	NT		
10	NT	NT		
11	NT	NT		
12	2518.7	628.8	-1.71	-0.78
13	NT	NT		
14	NT	NT		
15	3075.9	922.77	0.12	0.04
16	NT	NT		
17	3400	1000	1.18	0.35
18	3200	1000	0.53	0.16
19	NT	NT		
20	NT	NT		
21	2750	NR	-0.95	-1.32
23	NT	NT		
24	NT	NT		
25	NT	NT		
26	NT	NT		
27	2950	NR	-0.30	-0.41
28	NT	NT		

* Outlier, see Section 4.2

Statistics

Assigned Value	3040	220
Robust Average	2970	270
Median	3090	150
Mean	2820	
N	10	
Max	3400	
Min	950	
Robust SD	350	
Robust CV	12%	


Results: S3 - TN
Assigned Value = 3040 ± 220 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
8 12 21 27 15 2 4 7 18 17 3 5 6 9 10 11 13 14 16 19 20 23 24 25 26 28 Md RA


z-Scores: S3 - TN
Standard Deviation for Proficiency Assessment 300 mg/kg (Equivalent to 10% CV)
z-Score
Laboratory
8 12 21 27 15 2 4 7 18 17
-1.7
-1.0
-0.3
0.1
0.2
0.2
0.4
0.5
1.2

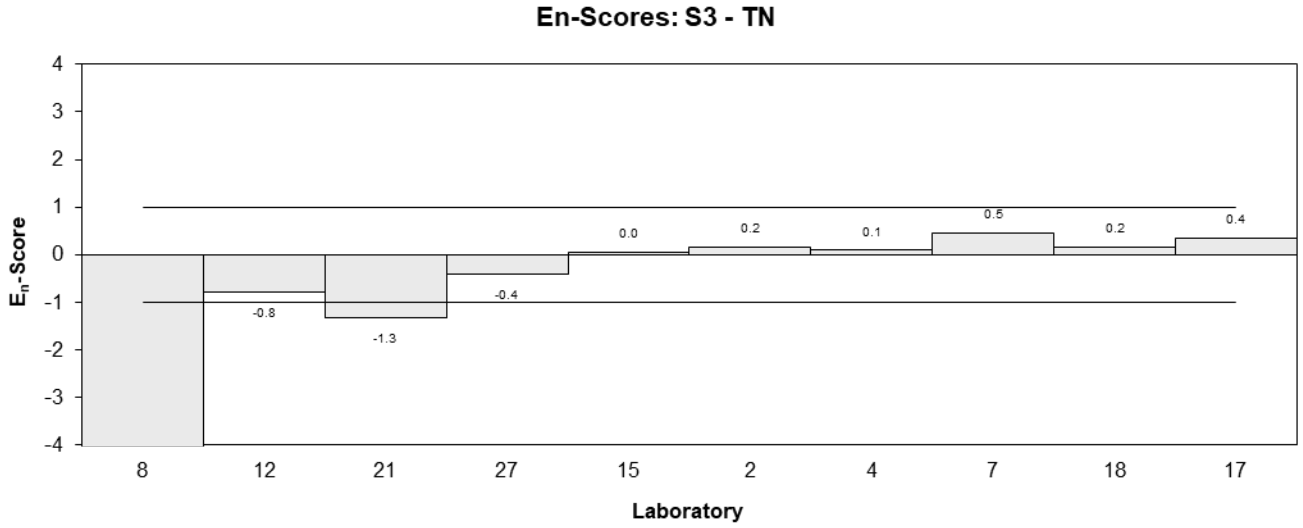

En-Scores: S3 - TN
En-Score
Laboratory
8 12 21 27 15 2 4 7 18 17
-0.8
-1.3
-0.4
0.0
0.2
0.1
0.5
0.2
0.4

Figure 66

Table 78

Sample Details

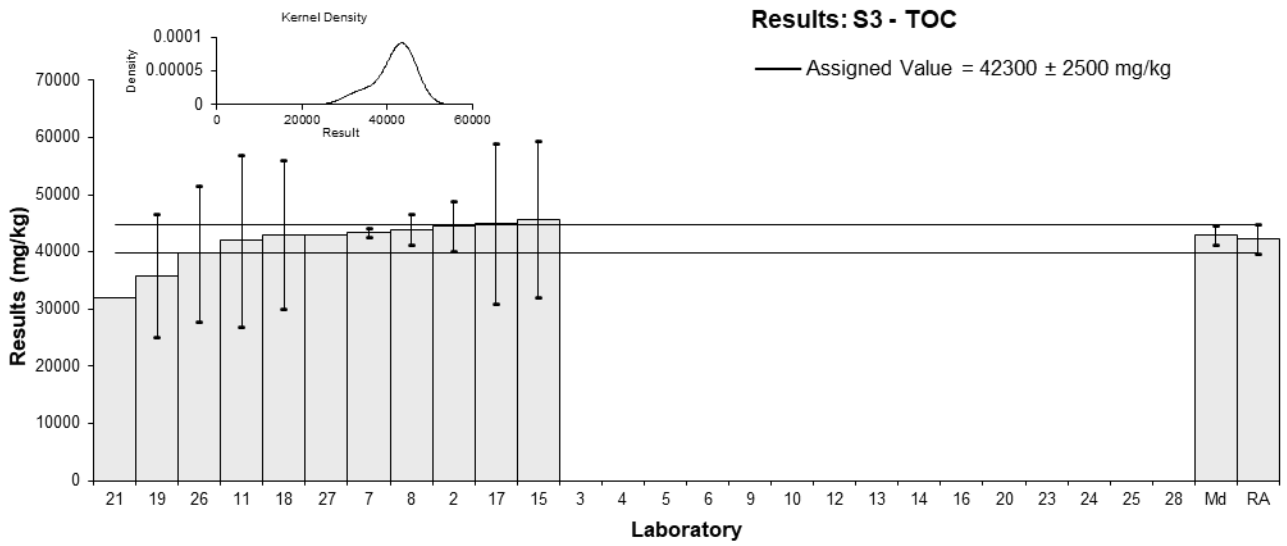
Sample No.	S3
Matrix	Soil
Analyte	TOC
Unit	mg/kg

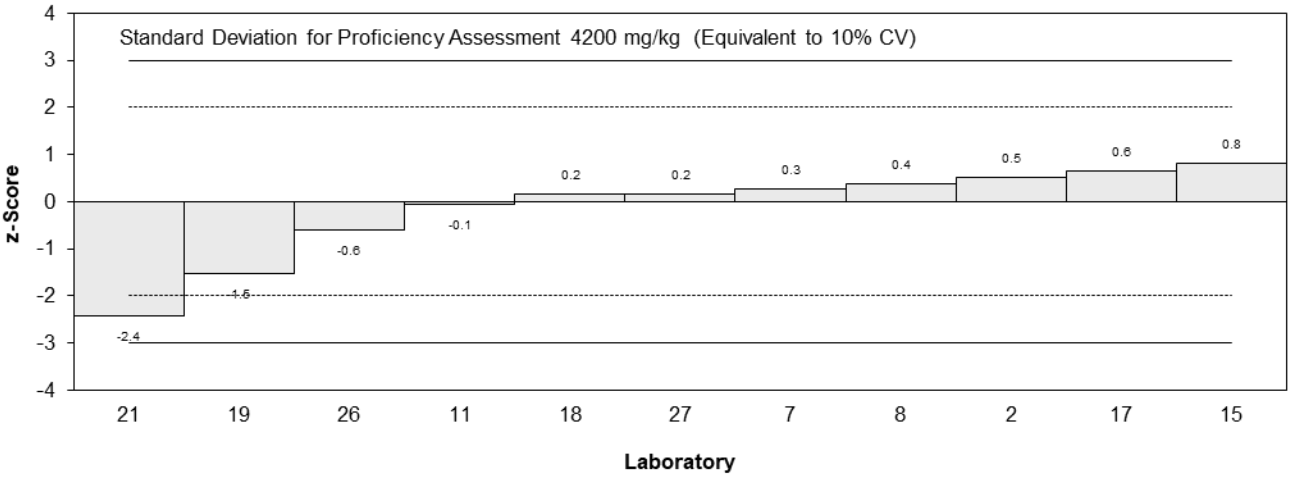
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
2	44500	4450	0.52	0.43
3	NR	NR		
4	NT	NT		
5	NT	NT		
6	NT	NT		
7	43400	853	0.26	0.42
8	43900	2670	0.38	0.44
9	NT	NT		
10	NT	NT		
11	42000	15000	-0.07	-0.02
12	NT	NT		
13	NT	NT		
14	NT	NT		
15	45730	13719	0.81	0.25
16	NT	NT		
17	45000	14000	0.64	0.19
18	43000	13000	0.17	0.05
19	35810	10743	-1.53	-0.59
20	NT	NT		
21	32000	NR	-2.43	-4.12
23	NT	NT		
24	NT	NT		
25	NT	NT		
26	39754	11900	-0.60	-0.21
27	43000	NR	0.17	0.28
28	NT	NT		

Statistics

Assigned Value	42300	2500
Robust Average	42300	2500
Median	43000	1700
Mean	41600	
N	11	
Max	45730	
Min	32000	
Robust SD	3300	
Robust CV	7.8%	


Results: S3 - TOC
Assigned Value = 42300 ± 2500 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
21 19 26 11 18 27 7 8 2 17 15 3 4 5 6 9 10 12 13 14 16 20 23 24 25 28 Md RA


z-Scores: S3 - TOC
Standard Deviation for Proficiency Assessment 4200 mg/kg (Equivalent to 10% CV)
z-Score
-2.4
-1.6
-0.6
-0.1
0.2
0.2
0.3
0.4
0.5
0.6
0.8
Laboratory
21 19 26 11 18 27 7 8 2 17 15

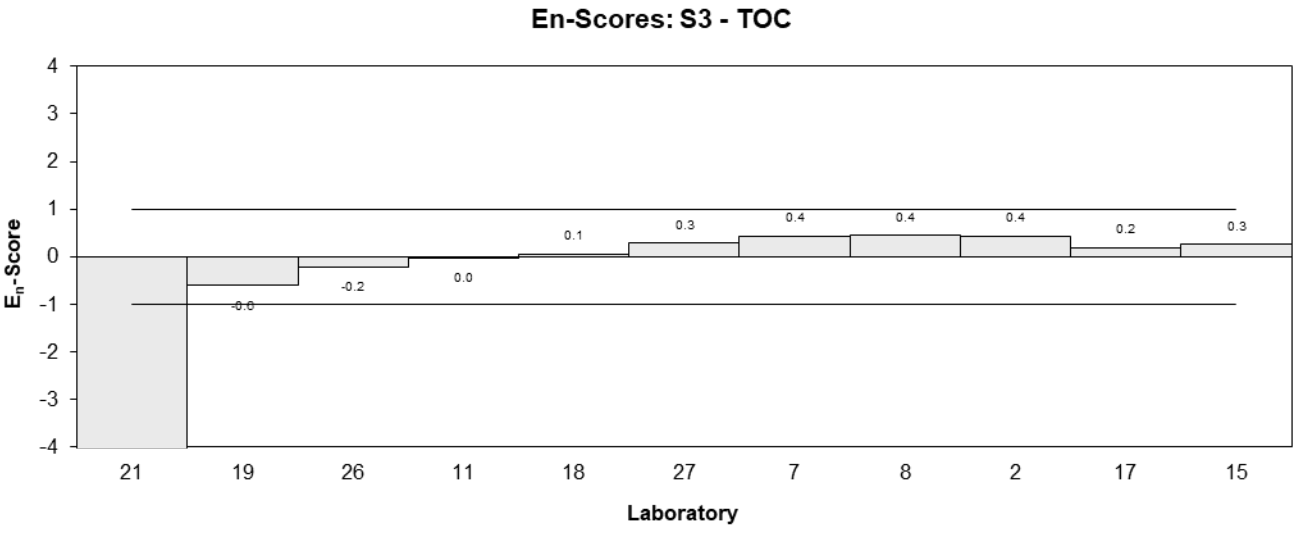

En-Scores: S3 - TOC
En-Score
-0.6
-0.2
0.0
0.1
0.3
0.4
0.4
0.4
0.2
0.3
Laboratory
21 19 26 11 18 27 7 8 2 17 15

Figure 67

Table 79

Sample Details

Sample No.	S3
Matrix	Soil
Analyte	Total P
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
2	NR	NR
3	NR	NR
4	NT	NT
5	NT	NT
6	NT	NT
7	NR	NR
8	166	52
9	NT	NT
10	NT	NT
11	NT	NT
12	361.8	84.2
13	NT	NT
14	NT	NT
15	518.424	155.5272
16	NT	NT
17	NR	NR
18	NT	NT
19	NT	NT
20	NT	NT
21	418	87
23	NT	NT
24	NT	NT
25	NT	NT
26	NT	NT
27	414	NR
28	NT	NT

Statistics

Assigned Value	Not Set	
Robust Average	NA (N<6)	
Median	414	87
Mean	380	
N	5	
Max	518.424	
Min	166	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

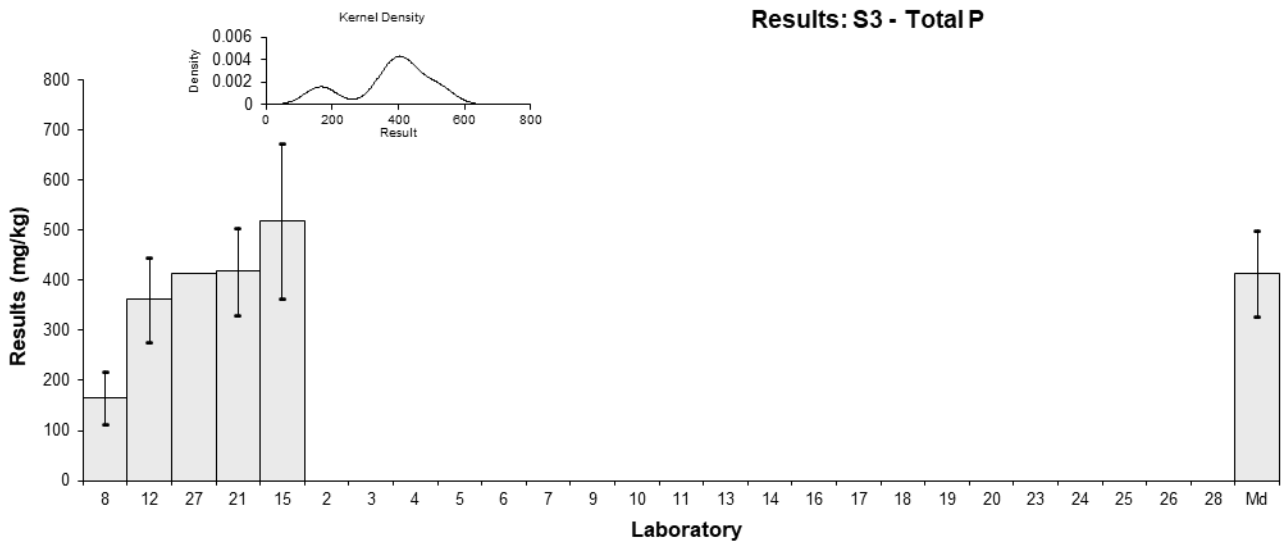

Results: S3 - Total P
Kernel Density
Density
0.006
0.004
0.002
0
0
200
400
600
800
Result
Results (mg/kg)
800
700
600
500
400
300
200
100
0
8
12
27
21
15
2
3
4
5
6
7
9
10
11
13
14
16
17
18
19
20
23
24
25
26
28
Md
Laboratory

Figure 68

6 DISCUSSION OF RESULTS

6.1 Assigned Value

Sample S1 was dried soil. Participants were asked to report results for Sample S1 on an as-received basis.

Sample S2 was a dried contaminated sediment material to which a known amount of ultrapure water was added. Participants were asked to use their normal analytical method and to report results corrected for moisture content.

Sample S3 was dried agricultural soil.

Assigned values for all scored analytes were calculated as the robust averages of participants' results. The robust averages and their associated expanded uncertainties were calculated using the procedures described in ISO 13528. [6] Extreme outliers and results less than 50% or more than 150% of the robust average were excluded prior to the calculation of each assigned value. Appendix 2 sets out the calculation of the robust average of As in Sample S1 and its associated uncertainty.

No assigned values were set for B and Se in S2 and Colwell K, EC, extractable B, PBI, and Total P in S3 because the results were too few or too variable. However, participants may still compare their reported results for some of these elements with the robust average of participants' results, median value, and/or the homogeneity value. Descriptive statistics for these elements are presented in Section 5.

Losses during the drying process may explain the discrepancies between the spike value and the assigned value for Sb in S1.

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

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

6.2 Measurement Uncertainty Reported by Participants

Participants were asked to report an evaluation of the expanded measurement uncertainty associated with their results. Of 1039 numerical results, 975 (94%) were reported with an expanded measurement uncertainty. The magnitude of these expanded uncertainties was within the range 0.033% to 225% of the reported value. The participants used a wide variety of procedures to evaluate the expanded measurement uncertainty. These are presented in Tables 11 and 12.

Approaches to evaluating measurement uncertainty include standard deviation of replicate analysis, Horwitz formula, long term reproducibility, professional judgement, bottom up approach, top down approach using precision and evaluations of method and laboratory bias, and top down approach using only the reproducibility from inter-laboratory comparison studies.[9 – 15]

Participation in proficiency testing programs allows participants to check how reasonable their evaluations of uncertainty are. Results and the expanded uncertainties are presented in the bar charts for each analyte (Figure 2 to 68).

As a simple rule of thumb, when the uncertainty evaluation is smaller than the uncertainty of the assigned value, or larger than the uncertainty of the assigned value plus twice the SDPA, then this should be reviewed as suspect.

For example, 21 laboratories reported results for Ca in S1. The uncertainty of the assigned value evaluated from the robust standard deviation of the 21 laboratories' results is 600 mg/kg

or 3.2% of the assigned value. Laboratory 9 may have under-estimated their expanded measurement uncertainty for Ca in S1, as their reported uncertainty evaluation was 0.23% of their reported concentration. An uncertainty evaluated from one measurement cannot be smaller than the uncertainty evaluated from 21 measurements. Alternatively, evaluations of uncertainties for Cd in S2 larger than 0.24 mg/kg or 36% (the uncertainty of the assigned value, 0.037 mg/kg, plus the allowable variation from the assigned value, the SDPA of 0.10 mg/kg, multiplied by 2, the coverage factor for a confidence interval of 95%), should also be viewed as suspect. For example, the expanded measurement uncertainty reported by Laboratory 17 for Cd in S2 (0.4 mg/kg) might have been over-estimated.

Laboratory 9 should review their procedure for evaluating measurement uncertainty as several of their evaluated uncertainties may be under-estimated. Laboratory 11 should also review their measurement uncertainty evaluation procedure, as several of their results may have been over-estimated. Laboratory 7 could also review their uncertainty evaluation procedure as several of their results may have been both under and over-estimated.

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

Laboratories 11 and 26 attached evaluations of the expanded measurement uncertainty to results reported as less than their limit of detection. An evaluation of uncertainty expressed as a value cannot be attached to a result expressed as a range.[9] Similarly, for some results, Laboratory 15 reported their limit of detection both as the measurement and the expanded uncertainty, rather than reporting no uncertainty evaluation for a result expressed as a range.

Laboratories 7 and 14 reported an evaluation of expanded uncertainty for some measurement results larger than the results themselves. These laboratories should also review their evaluation procedure as it might not be fit-for-purpose.

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 142.17 ± 58.290 mg/kg, it is better to report 142 ± 58 mg/kg or instead of 4.09 ± 0.409 mg/kg, it is better to report 4.09 ± 0.41 mg/kg.[9]

6.3 z-Score

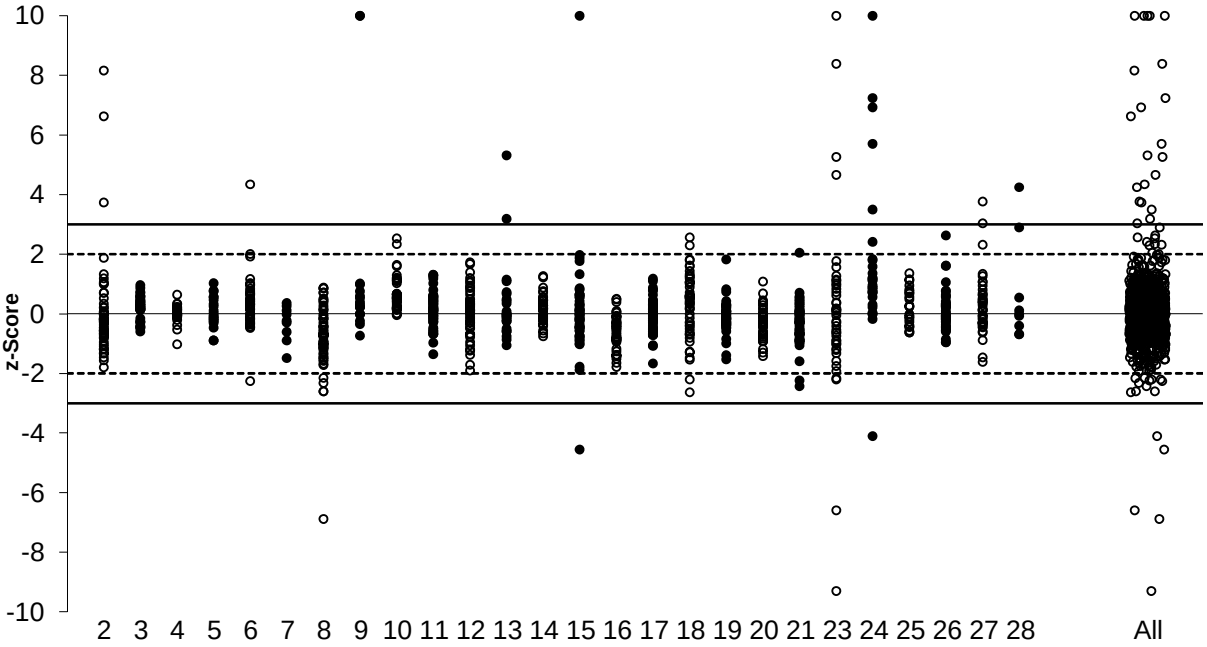
The z-score compares a participant's deviation from the assigned value with the standard deviation for proficiency assessment (SDPA). The SDPA defines acceptable performance in a proficiency test. SDPAs equivalent to 3.5%-20% PCV were used to calculate z-scores in this study. Unlike the standard deviation based on between-laboratory CV, setting the SDPA as a realistic set value enables z-scores to be used as reference value points for assessment of laboratory performance, independent of group's performance.

The between-laboratory coefficient of variation predicted by the Thompson-Horwitz equation[8] and the between-laboratory coefficient of variation from reported results in this study are presented for comparison in Table 80. The dispersal of participants' z-scores is presented in Figure 69 (by laboratory code) and in Figure 71 (by test). Of 1002 results for which z-scores were calculated, 956 (95%) returned an acceptable score of $|z| \leq 2.0$ and 20 (2%) were questionable at $2.0 < |z| < 3.0$. Participants with multiple z-scores larger than 2.0 or smaller than -2.0 should check for laboratory bias.

A summary of participants' performance is presented in Figure 72**.** No laboratory reported results for all 60 tests for which a z-score was calculated.

Laboratory 17 returned the highest number of acceptable z-scores (55 out of 55 reported).

All results reported by Laboratories 11 (54), 12 (54), 19 (45), 14 (40), 16 (40), 3 (38), 20 (34), 25 (24), 4 (22), 5 (20), and 7 (9) returned acceptable z-scores.



Scores of >10 have been plotted as 10.

Figure 69 z-Score Dispersal by Laboratory

Table 80 Between-Laboratory CV of this Study, Thompson/Horwitz CV, and SDPA

Sample	Analyte	Numeric Results Reported*	Assigned Value (mg/kg)	Between-Laboratory CV* (%)	Thompson/ Horwitz CV (%)	SDPA (as PCV) (%)
S1	Ag	16	3.21	8.4	13	15
S1	Al	21	8630	12	4.1	15
S1	As	22	9.47	6.9	11	10
S1	B	15	11.7	20	11	15
S1	Bi	8	0.923	11	16	15
S1	Ca	21	18500	6.3	3.6	10
S1	Cr	24	30.0	11	9.6	15
S1	Cu	23	27.7	8.7	9.7	10
S1	Fe	23	22300	8.7	3.5	10
S1	Hg	23	0.925	10	16	15
S1	Li	18	15.9	18	11	15
S1	Mn	23	276	8	6.9	10
S1	Mo	16	1.27	17	15	20
S1	Ni	24	11.1	8.3	11	15
S1	Pb	24	116	6.4	7.8	10
S1	Sb	18	64.5	20	8.5	20
S1	Se	9	1.91	7.1	15	10
S1	Sn	12	4.25	11	13	15
S1	Th	7	3.12	19	13	20
S1	U	12	1.34	5.2	15	10
S1	V	19	11.0	14	11	15
S1	Zn	24	149	6.5	7.5	10
S2	As	23	32.9	9.4	9.5	15
S2	B	6	5.4**	39	12	Not Set
S2	Ba	19	62.3	9.7	8.6	15
S2	Be	9	0.474	19	18	20
S2	Cd	19	0.667	9.5	17	15
S2	Co	23	16.6	7	10	15
S2	Cr	22	40.4	11	9.2	15

Sample	Analyte	Numeric Results Reported*	Assigned Value (mg/kg)	Between-Laboratory CV* (%)	Thompson/ Horwitz CV (%)	SDPA (as PCV) (%)
S2	Cu	23	32.3	7.4	9.5	15
S2	Ga	6	4.23	14	13	15
S2	La	10	3.50	10	13	15
S2	Mn	22	652	9.6	6	15
S2	Na	16	134	14	7.7	15
S2	Ni	23	59.7	5.2	8.6	15
S2	P	16	533	6.4	6.2	10
S2	Pb	21	46.1	9	9	15
S2	Rb	7	4.66	21	13	20
S2	Se	6	0.596**	11	17	Not Set
S2	Sn	7	0.702	9.1	17	15
S2	Sr	18	126	7.6	7.7	10
S2	V	19	48.7	13	8.9	15
S2	Zn	23	189	5.8	7.3	15
S2	Moisture Content	21	12.5 %	4.6	2.7	10
S3	Ba	16	46.6	10	9	15
S3	Ca	17	822	7.5	5.8	10
S3	Fe	18	17600	9.7	3.7	10
S3	K	16	700	9.4	6	10
S3	Mg	17	358	14	6.6	15
S3	Na	9	31.3	12	9.5	15
S3	P	16	365	9.3	6.6	10
S3	S	12	338	7.4	6.7	15
S3	Sr	14	12.8	16	11	20
S3	Colwell K	3	340**	37	6.7	Not Set
S3	Colwell P	7	34.2	23	9.4	20
S3	EC	11	940** µS/cm	130	5.7	Not Set
S3	Exchangeable Ca	12	3.11 cmol(+)/kg	2.7	13	15
S3	Exchangeable K	12	0.543 cmol(+)/kg	9.6	18	15
S3	Exchangeable Mg	12	1.18 cmol(+)/kg	5.1	16	15
S3	Exchangeable Na	6	0.103 cmol(+)/kg	15	22	15
S3	Extractable B	4	0.57**	26	17	Not Set
S3	pH	14	4.20	3.5	13	3.5
S3	TC	8	44400	7.7	3.2	10
S3	TN	9	3040	8.5	4.8	10
S3	TOC	11	42300	7.8	3.2	10
S3	Total P	5	414**	19	6.5	Not Set

*Values exclude outliers if applicable.
** Robust Average or Median Value as applicable (assigned value not set).

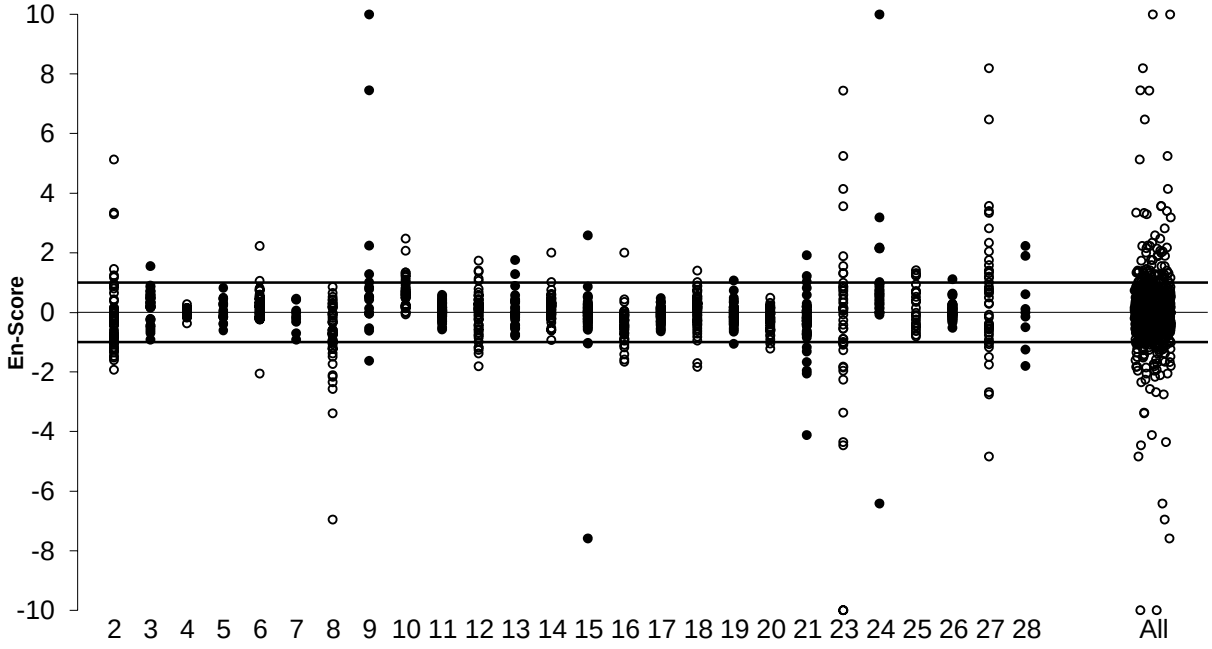
6.4 E_n-score

E_n-scores can be interpreted in conjunction with z-scores. The E_n-score indicates how closely a result agrees with the assigned value considering the respective uncertainties. A not acceptable E_n-score for an analyte can either be caused by an inappropriate measurement, an inappropriate evaluation of measurement uncertainty, or both.

The dispersal of participants' E_n-scores is graphically presented in Figure 70. 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 1002 results for which E_n-scores were calculated, 848 (85%) returned an acceptable score of $|E_n| < 1$ indicating agreement of the participants' results with the assigned values within their respective expanded measurement uncertainties.

Laboratory 17 had the highest number of acceptable E_n-scores at 55 out of 55 reported. All results reported by Laboratories 11 (54), 4 (22), 5 (20), and 7 (9) returned acceptable E_n-scores.



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

Figure 70 E_n-Score Dispersal by Laboratory

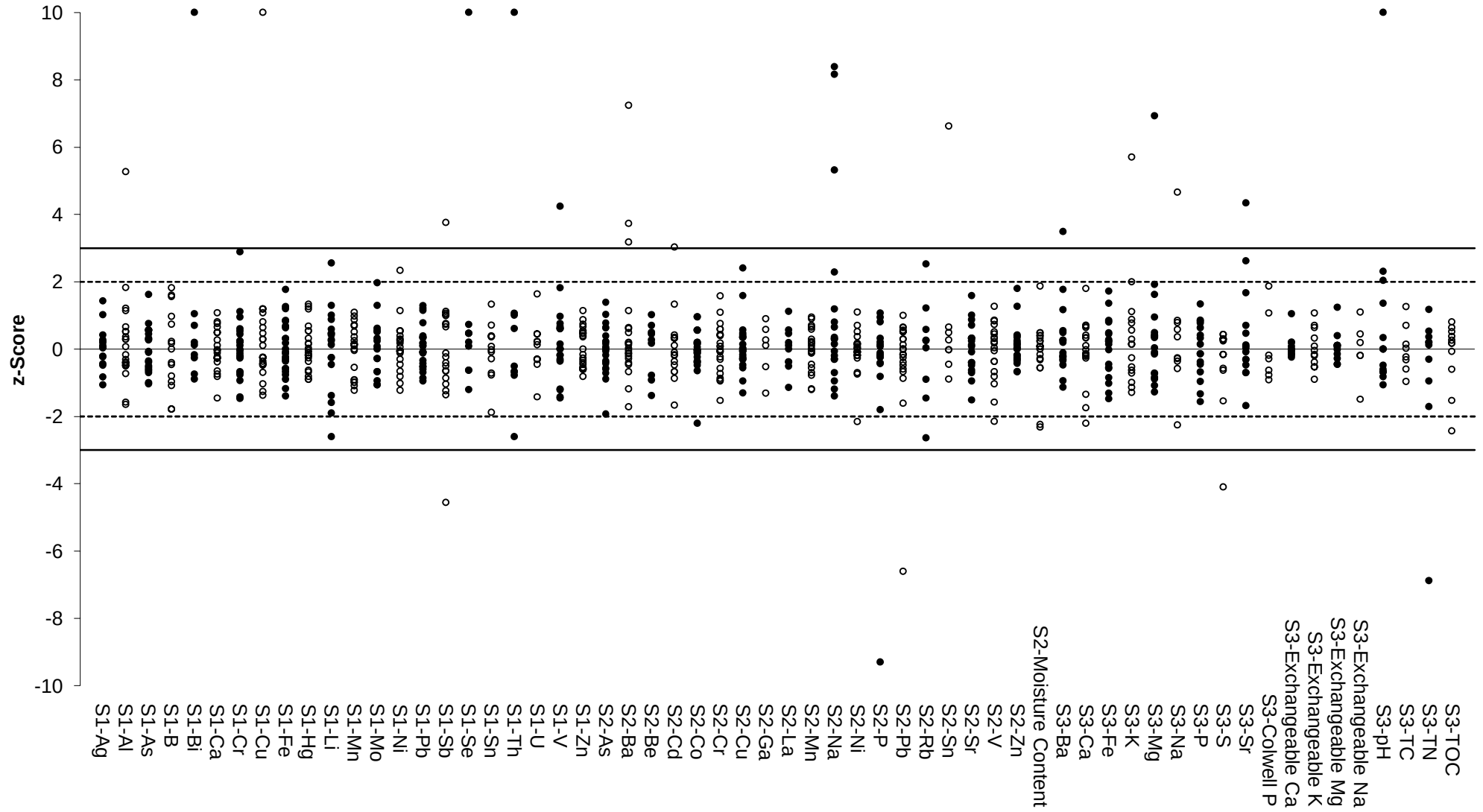
6.5 Participants' Results and Analytical Methods for Acid Extractable Elements

Sample S1 was dried soil, while Sample S2 was moist sediment. A good preparation procedure to subsample a representative test portion was required for Sample S2. An appropriate calculation/reporting procedure was also required for this sample as participants were asked to report results corrected for moisture content.

A summary of participants' results and performance is presented in Tables 81 to 83 and in Figures 69 to 72.

Measurements of B and of low-level Se in Sample S2 presented the greatest analytical difficulty to participants. Only a small number of participants submitted results for these tests (6). The results reported were not compatible with each other and no assigned value could be set.

The method descriptions provided by participants are presented in Tables 1 and 10 while the instrumental conditions are presented in Appendix 5.



Scores of >10 have been plotted as 10.

Figure 71 z-Score Dispersal by Test

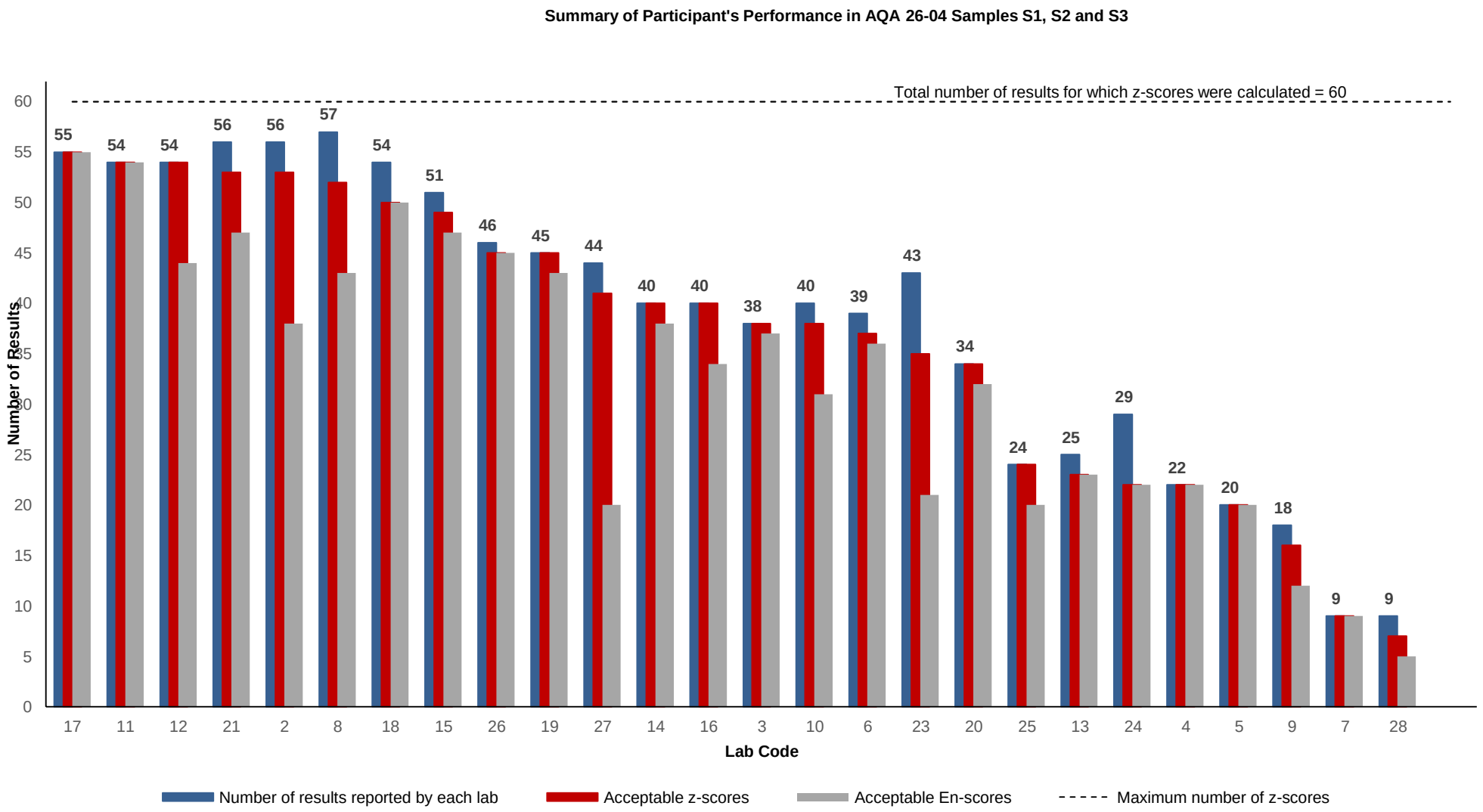


Figure 72 Summary of Participants' Performance in AQA 26-04

Table 81 Summary of Participants' Results and Performance in Sample S1

Lab Code	Ag mg/kg	Al mg/kg	As mg/kg	B mg/kg	Bi mg/kg	Ca mg/kg	Cr mg/kg	Cu mg/kg	Fe mg/kg	Hg mg/kg	Li mg/kg
AV	3.21	8630	9.47	11.7	0.923	18500	30.0	27.7	22300	0.925	15.9
HV	3.28	8100	9.1	NA	0.93	18200	30.8	27.2	22200	1.03	14.5
2	3.23	8040	8.49	10.3	0.82	15800	27.0	26.4	19700	1.09	18.3
3	NR	9000	< 10	11	NR	18000	31	27	23000	< 5	17
4	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
5	NT	8230	10	NT	NT	NT	29	27	20300	0.8	NT
6	<5	9490	9.77	13.4	<10	18400	31.1	26.5	21500	1.02	15.3
7	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
8	3.0	6580	9.1	<50	0.9	19000	23.4	23.9	24200	0.9	9.7
9	3.32	7684	9.14	NT	NT	18469	29.94	84.38	21768	0.97	NT
10	3.3	10200	10.0	12.1	0.94	19700	32.4	28.5	22700	0.948	17.3
11	3.7	9300	10	10	<1	18000	31	31	21000	1	19
12	2.981	8717	10.191	<50	1.069	19402	26.870	27.024	24978	0.928	11.370
13	NT	10100	9	NT	NT	19400	32	27	20600	0.91	NT
14	3.34	9000	10.0	11.7	0.95	19900	26.6	28.5	25100	0.92	16.2
15	3.41	8093	8.52	8.58	4.10	17129	29.01	29.47	26255	1.11	16.57
16	3.24	6490	8.81	8.56	0.887	17800	23.6	24.2	19200	0.812	12.6
17	3.1	8000	9.9	9.8	<1	18000	31	29	21000	0.9	18
18	3.9	8100	11	12	<1	17000	31	31	22000	1	22
19	3.11	8412	9.74	14.9	< 10	18072	29.4	26.4	21632	0.874	16.5
20	2.81	8120	8.86	NT	<8	18300	25.8	30.7	22300	0.946	14.8
21	2.7	7980	8.9	<50	0.8	17300	28.8	25.8	20800	0.8	12.1
23	3.229	15458.169	8.955	14.442	NT	18701.785	29.765	24.836	24149.220	0.838	15.312
24	NT	11000	10	13	NT	20000	35	31	23000	0.9	NT
25	NT	NT	9.38	NT	1.02	NT	34.28	29.95	23821	0.8886	NT
26	3.26	9090	9.73	14.5	< 10	18000	32.7	26.7	22100	0.9	16.9
27	NR	9305	<15	10.9	NT	20500	30.5	26.5	23700	1.10	17.0
28	NT	NT	9.4	NT	NT	NT	43	28	NT	0.83	NT

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

Table 81 Summary of Participants' Results and Performance in Sample S1 (continued)

Lab Code	Mn mg/kg	Mo mg/kg	Ni mg/kg	Pb mg/kg	Sb mg/kg	Se mg/kg	Sn mg/kg	Th mg/kg	U mg/kg	V mg/kg	Zn mg/kg
AV	276	1.27	11.1	116	64.5	1.91	4.25	3.12	1.34	11.0	149
HV	266	1.34	11.6	120	62.4	1.78	3.95	4.14	1.50	12.0	160
2	246	1.29	10.9	105	77.3	1.68	5.10	3.78	1.37	9.03	137
3	280	1.2	12	120	74	< 10	< 10	NR	NR	12	140
4	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
5	279	NT	11	125	NT	NT	NT	NT	NT	NT	156
6	280	<10	11.6	118	77.6	<2	<10	NT	<10	12.6	156
7	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
8	249	1.1	9.4	111	51.1	2	4.2	1.5	1.3	9	162
9	303	1.27	11.50	120.55	74.27	4.67	NT	3.75	1.37	11.99	156.93
10	306	1.40	15.0	131	73.0	1.95	4.24	NT	1.56	12.1	166
11	280	1.6	11	110	47	<2	4.5	2.7	1.4	12	140
12	242.327	1.352	11.757	117.31	48.503	1.928	4.067	2.635	1.358	10.482	146.560
13	275	1	11	106	NT	<5	NT	NT	NT	11	159
14	296	1.41	11.4	115	56	2.0	4.48	NT	1.40	10.7	156
15	250.63	1.77	10.34	114.60	5.67	<2	3.05	NT	NT	11.25	142.17
16	261	1.03	9.75	117	53.4	1.79	3.76	NT	1.28	8.66	144
17	280	1	11	110	63	<2	4.3	2.8	1.3	11	140
18	290	1.1	12	120	58	<2	4.7	3.5	1.3	14	140
19	279	< 5	11.2	112	74	< 2	< 10	NT	< 10	10.4	145
20	251	<2	11	115	56.2	<8	NT	NT	1.15	NT	149
21	286	1.2	10	120	61.5	2	3.8	2.7	1.3	11	157
23	248.734	1.428	9.070	118.121	59.225	2.049	4.495	15.088	NT	NT	154.382
24	300	NR	13	130	NT	NR	NT	NT	NT	NT	160
25	NT	1.33	11.55	129.3	78.99	1.79	NT	NT	NT	12.26	140.47
26	283	< 5	11	115	78.2	< 2	< 10	NT	< 10	10.7	141
27	295	<5	10.6	109	113	<100	NR	NT	NT	8.59	155
28	276	NT	12	108	NT	NT	NT	NT	NT	18	143

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

Table 82 Summary of Participants' Results and Performance in Sample S2

Lab Code	As mg/kg	B mg/kg	Ba mg/kg	Be mg/kg	Cd mg/kg	Co mg/kg	Cr mg/kg	Cu mg/kg	Ga mg/kg	La mg/kg	Mn mg/kg
AV	32.9	Not Set	62.3	0.474	0.667	16.6	40.4	32.3	4.23	3.50	652
HV	32.0	2.43	71.0	0.547	0.771	18.1	44.4	33.3	5.37	NA	702
2	32.0	5.44	97.2	0.54	0.63	16.5	38.6	31.2	NT	NT	597
3	34	< 5	58	0.49	< 1	19	44	33	NR	NR	720
4	32.6	< 10	62.5	< 2	0.7	16.5	40.3	32.4	NT	3.5	645
5	38	NT	NT	NT	0.7	18	45	30	NT	NT	643
6	36.7	<10	66.9	<2	0.700	16.3	42.9	30.8	NT	NT	653
7	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
8	30.1	<50	46.2	0.4	0.6	15.0	31.1	27.7	3.4	2.9	584
9	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
10	33.7	2.90	61.8	0.571	0.709	18.0	42.8	34.6	NT	4.09	716
11	36	<10	64	<1	0.62	17	43	34	4.6	3.6	680
12	39.758	<50	63.556	0.3431	0.7022	16.730	34.669	34.270	4.299	3.559	534.261
13	30	NT	92	<1	<1	16	47	34	NT	NT	641
14	31.0	3.7	61.2	0.517	0.650	17.1	41.5	29.6	NT	3.74	671
15	31.16	<5	68.3	<0.5	0.58	16.54	36.93	32.29	NT	NT	607.67
16	34.8	<2.53	51.3	0.521	0.657	16.4	35.1	30.9	NT	3.23	645
17	33	<10	56	<1	0.5	17	39	32	4.4	3.3	670
18	36	<10	68	<1	0.8	18	44	40	4.8	3.3	710
19	32.9	< 10	58.5	< 2	0.700	17.1	40.9	32.1	NT	NT	662
20	29.4	NT	64.2	NT	0.648	15.6	34.8	26	NT	NT	576
21	33.2	<50	59.7	0.5	0.6	16.3	40.9	31.5	3.9	3.8	674
23	23.362	5.530	72.995	0.387	0.678	11.106	35.978	30.910	NT	NT	537.029
24	34	7.8	130	NT	NR	19	50	44	NT	NT	740
25	30.76	NT	NT	NT	NT	15.65	NT	35.06	NT	NT	NT
26	32.8	< 10	60.3	< 2	0.7	15.4	40	32	NT	NT	640
27	28.5	6.95	61.0	<1	0.97	15.7	40	34	NT	NT	745
28	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT

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

Table 82 Summary of Participants' Results and Performance in Sample S2 (continued)

Lab Code	Na mg/kg	Ni mg/kg	P mg/kg	Pb mg/kg	Rb mg/kg	Se mg/kg	Sn mg/kg	Sr mg/kg	V mg/kg	Zn mg/kg	Moisture Content %
AV	134	59.7	533	46.1	4.66	Not Set	0.702	126	48.7	189	12.5
HV	164	62.5	580	48.5	NA	0.703	0.761	116	55.4	215	12.3
2	298	58.0	437	41.5	NT	0.62	1.4	118	51.2	184	11.8
3	140	61	510	45	NR	< 10	< 10	120	55	200	13
4	NT	61.1	NT	50.5	NT	< 1	< 10	127	48.3	193	12.79
5	NT	60	NT	45	NT	NT	NT	NT	NT	196	12.3
6	141	58.1	524	49.7	NT	<2	<10	135	54.8	189	12.1
7	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
8	120	53.1	540	49.6	3.3	<1	0.7	114	33	177	9.6
9	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
10	158	64.4	544	46.2	7.02	0.99	0.77	146	52.4	199	12.5
11	150	59	520	47	5.2	<2	<2	130	52	170	12.6
12	146.977	69.578	583.263	42.769	4.896	<1	0.754	117.144	43.807	193.444	12.91
13	241	58	NT	42	NT	<5	NT	NT	54	189	12.6
14	137	61.2	520	48.1	5.8	0.6	0.73	137	46	179	13.1
15	132.7	59.67	537.078	50.6	NT	<2	<3	127.49	41.19	182.22	14.84
16	128	58.8	523	43.4	3.82	0.573	0.655	107	42.8	190	13.1
17	140	59	550	45	4.9	<2	<2	130	50	170	12.6
18	180	63	590	53	2.2	<2	<2	130	58	240	13
19	106	60.3	527	48.2	NT	< 2	< 10	125	50.3	201	12.6
20	110	53.4	NT	44.4	NT	<8	NT	121	NT	181	NT
21	130	57.3	490	40.1	4.7	<1	0.7	121	49	180	9.7
23	302.610	40.338	37.127	0.440	NT	0.532	0.608	138.780	37.144	225.115	NT
24	NT	66	NT	46	NT	NR	NT	NT	NT	190	12.5
25	NT	58.92	NT	NT	NT	0.56	NT	NT	NT	183.90	12.8
26	115	60	511	50	NT	< 2	< 10	129	51	195	11.8
27	128	60.9	576	35	NT	<100	<50	NR	46	192	12.15
28	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT

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

Table 83 Summary of Participants' Results and Performance in Sample S3

Lab Code	Ba mg/kg	Ca mg/kg	Fe mg/kg	K mg/kg	Mg mg/kg	Na mg/kg	P mg/kg	S mg/kg	Sr mg/kg	Colwell K mg/kg	Colwell P mg/kg	EC µS/cm
AV	46.6	822	17600	700	358	31.3	365	338	12.8	Not Set	34.2	Not Set
HV	41.6	796	16400	709	371	37.7	335	324	13.8	NA	NA	NA
2	45.0	712	15290	682	350	<50	308	309	14.6	256	47	239
3	48	850	18000	710	380	34	370	350	14	NR	NR	NR
4	45.8	805	15800	663	376	< 50	351	< 1000	13.1	NT	NT	NT
5	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
6	54.8	856	16800	840	461	20.7	388	NT	23.9	NT	NT	NT
7	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	32.20	244
8	38.7	880	19100	620	300	<50	360	360	8.5	468	28	228
9	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
10	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
11	50	800	18000	710	360	33	360	330	13	340	33	NT
12	48.391	849.167	20632	761.6	352.8	<50	396.4	352.5	17.070	NT	NT	2507.5
13	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
14	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
15	50.42	808.3	16632	739.3	318.6	35.3	377.05	353.0	11.59	NT	28.9	261.5
16	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
17	45	820	19000	650	320	35	380	330	11	NR	NR	2500
18	40	640	15000	610	290	30	340	260	11	NT	NT	2700
19	43.3	810	18100	631	313	29.6	395	NT	12	NT	NT	NT
20	44.2	878	18400	720	378	28.6	NT	NT	12.9	NT	NT	NT
21	44.5	830	16600	710	310	<50	330	360	12.6	NT	NT	253
23	58.961	678.210	17852.300	777.580	408.930	53.190	316.630	306	NT	NT	NT	NT
24	71	970	20000	1100	730	NT	NT	130	NT	NT	NT	900
25	NT	NT	17564.77	NT	384.4	NT	348.53	NT	NT	NT	29.9	270.4
26	48.4	811	16100	754	445	30.1	393	353	19.5	NT	NT	NT
27	45.3	875	18450	656	379	<50	414	352	12	NT	41.5	250
28	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT

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

Table 83 Summary of Participants' Results and Performance for Sample in (continued)

Lab Code	Exchangeable Ca cmol(+)/kg	Exchangeable K cmol(+)/kg	Exchangeable Mg cmol(+)/kg	Exchangeable Na cmol(+)/kg	Extractable B mg/kg	PBI+ColP mg/kg	pH	TC mg/kg	TN mg/kg	TOC mg/kg	Total P mg/kg
AV	3.11	0.543	1.18	0.103	Not Set	Not Set	4.20	44400	3040	42300	Not Set
2	3.10	0.50	1.19	0.10	0.63	177	4.20	44500	3100	44500	NR
3	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
4	NT	NT	NT	NT	NT	NT	NT	NT	3100	NT	NT
5	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
6	NT	NT	NT	NT	NT	NT	4.13	NT	NT	NT	NT
7	3.1	0.47	1.2	0.08	NR	NR	4.11	43400	3150	43400	NR
8	3.2	0.5	1.2	<0.1	0.2	NT	4.1	47500	950	43900	166
9	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
10	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
11	3.1	0.55	1.2	<0.1	0.7	NT	4.1	50000	NT	42000	NT
12	3.207	0.511	1.178	<0.1	NT	NT	4.0435	NT	2518.7	NT	361.8
13	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
14	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
15	3.149	0.527	1.153	0.106	NT	NT	4.08	NT	3075.9	45730	518.424
16	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
17	3	0.57	1.1	0.12	<0.2	NR	4.1	45000	3400	45000	NR
18	3.6	0.63	1.4	0.11	NT	NT	4.2	NT	3200	43000	NT
19	3.03	0.53	1.13	< 0.1	NT	NT	4.2	41790	NT	35810	NT
20	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
21	3.1	0.6	1.2	0.1	0.5	NT	4.5	NT	2750	32000	418
23	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
24	NT	NT	NT	NT	NT	NT	8.4	NT	NT	NT	NT
25	NT	NT	NT	NT	NT	NT	4.4	NT	NT	NT	NT
26	3.04	0.595	1.1	< 0.2	NT	NT	4.25	40147	NT	39754	NT
27	3.07	0.54	1.25	<0.01	<1	163	4.54	43000	2950	43000	414
28	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT

Shaded cells are results which returned a questionable or not acceptable z-score. AV = Assigned Value; NT = Not Tested, NR = Not Reported.

Moisture Content and Reporting Results on a Dry Weight Basis (Corrected for Moisture Content).

The moisture content of Sample S2 was 12.5%. Participants were instructed to apply their routine analytical methods but to report results corrected for moisture content.

Participants were expected to calculate the mass fraction of each element by multiplying the analyte concentration in the final solution by the dilution factor and dividing it by the mass of the sample analysed. Where samples were analysed as received, results were required to be corrected for moisture content by dividing by the percentage of solid content and multiplying by 100. If analyses were performed on dried samples, no additional moisture correction was necessary.

Determination of moisture content did not challenge the participating laboratories, with all but two reporting acceptable results. No systematic bias was observed in the values reported for acid-extractable elements in this sample. This suggests that laboratories are generally using appropriate procedures to correct results to a dry weight basis.

Extraction Methods

The request was for acid extractable elements; NMIA PT studies of metals in soil focus on 'pseudo-total' analyses of elements in soil rather than on true total metal content because when an assessment of the anthropogenic impact of the metal content in a soil sample is made, aggressive digestion regimes (HF, high digestion temperature, high ratio acid to sample size) can lead to misleading conclusions since metals can be extracted from the fraction naturally present in the soil matrix.[5, 16-19] While an aggressive digestion regime can produce high, misleading results, weak digestion regimes (low digestion temperature, reduced digestion time, diluted acids and/or a low ratio of acid to sample size) may extract just a fraction of the contaminants from the soil.

In the present study, most participating laboratories used a sample size of between 0.5 g to 1 g, an extraction temperature of 95ºC to 105ºC, an extraction time of between 60 min to 120 min, and a ratio HCl to HNO_3 of 1:1 or 3:1.

All participants used both HNO_3 and HCl as extraction agents except for Laboratories 12 and 21 which used dilute acids for extraction.

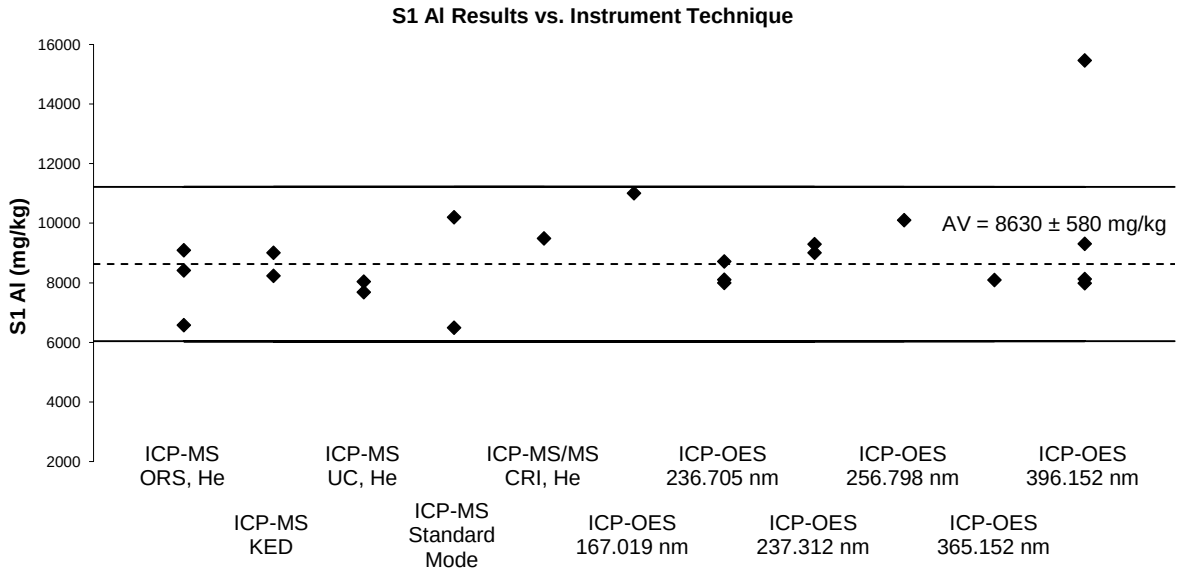
Laboratories 2 and 28 used a high ratio of acid to sample size, of 25:1.

Laboratory 6 used 2 g of sample but only 0.4 mL of HNO_3 and 1.2 mL of HCl.

Laboratories whose results are biased high or low should investigate their extraction regime.

Individual Element Commentary

Aluminium Plots of Al results versus instrumental technique used by participants are presented in Figure 73. All reported results for Al in S1 returned satisfactory z-scores, with the exception of one. Laboratory 23 reported a value of 15458.169 mg/kg, approximately double the assigned value. This laboratory may need to review its dilution and calculation procedures to identify the potential source of error.



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

Figure 73 S1 Al Results vs. Instrumental Technique

Antimony The between-laboratory CV for Sb in S1 was more than twice the value predicted by the Thompson/Horwitz model, at 20%.

Antimony is an element whose recovery strongly depends on the acids employed for digestion. It is known that when only nitric acid is used, Sb is transformed into a mixture of insoluble oxides (Sb_2O_3, Sb_2O_5, $Sb_4O_4(OH)_2(NO_3)_2$) but when hydrochloric acid is also involved it changes into chloro-complexes ($SbCl_6^-$). In an aqueous solution, sufficient hydrogen ion concentration must be maintained to prevent $SbCl_6^-$ hydrolysis.[20,21] Laboratories should consider using matrix matched control samples to assess their digestion regime and increase their evaluations of uncertainty for Sb measurements in soil.

Arsenic All results reported for As in S1 and S2 returned acceptable z-scores.

Figure 74 presents plots of participants' z-scores versus the instrumental technique used. Participants used ICP-MS in collision mode or ICP-OES with a wavelength of 188.98 nm.

Boron Measurement of B in Sample S2 challenged participants' analytical techniques. Of the 26 participants who reported results in this study, only six reported results for B in Sample S2. The reported values were highly variable, and no assigned value could be set.

A discrepancy was observed between results obtained by ICP-OES and ICP-MS, with ICP-OES results showing a positive bias. Caution is advised when using ICP-OES at the wavelength of 249.7 nm for soil samples with high Fe content unless an appropriate correction equation is applied. The Fe emission line at 249.771 nm directly overlaps with the B line at 249.7 nm, causing interference. The Fe concentration in S2 (47,000 mg/kg) was significantly higher than in S1. Plots of participants' results for B in S1 and S2 versus instrumental techniques used are presented in Figures 75 and 76.

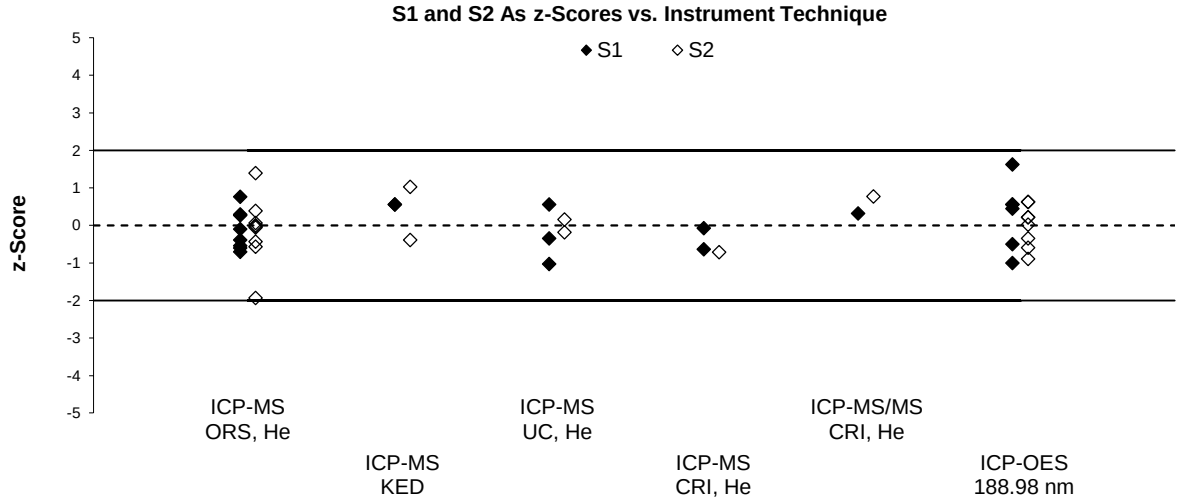
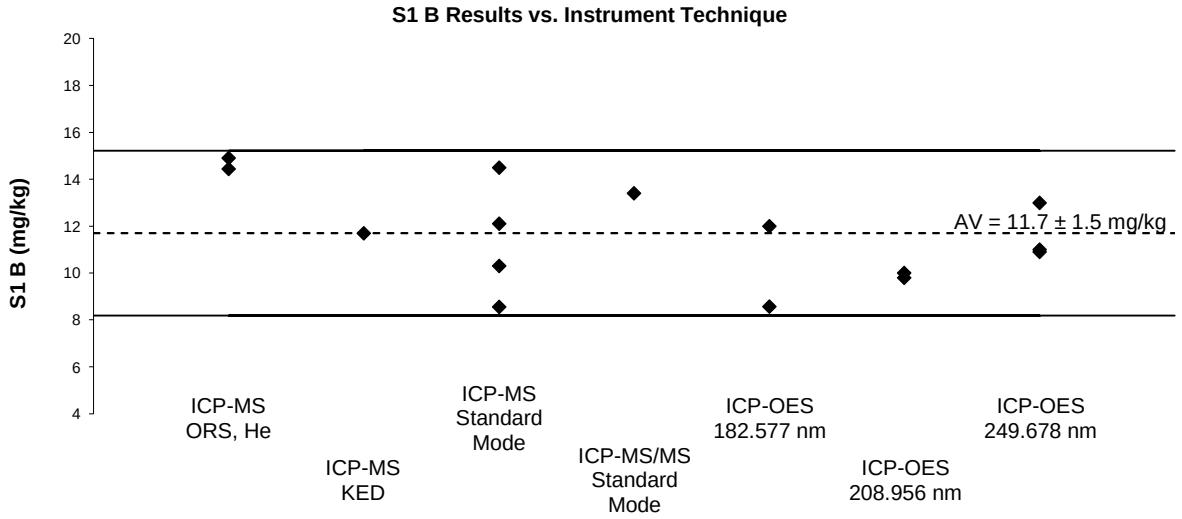


Figure 74 As z-Scores in S1 and S2 vs. Instrumental Technique



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

Figure 75 B Results in S1 vs. Instrumental Technique

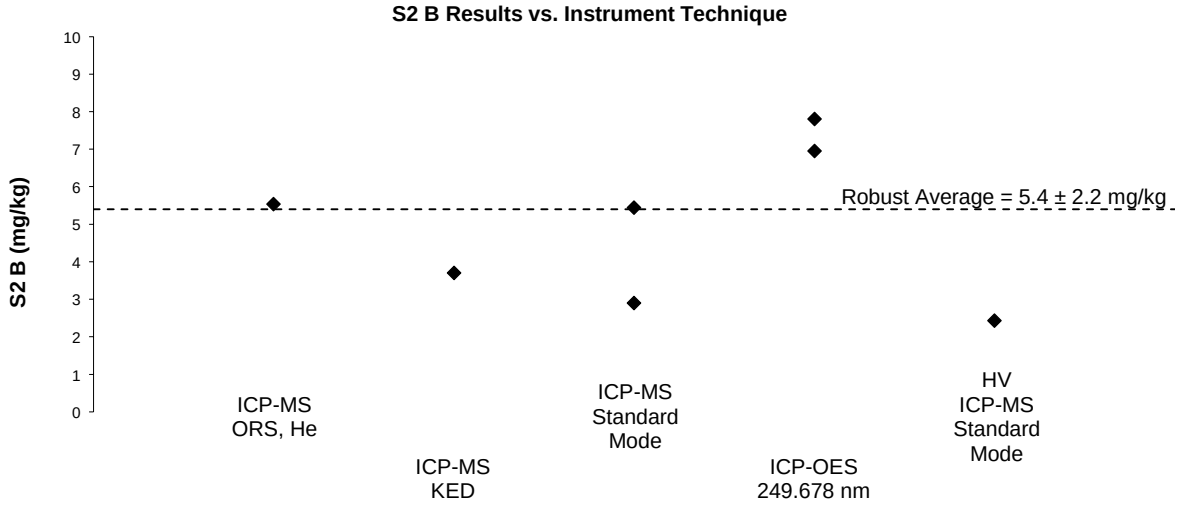
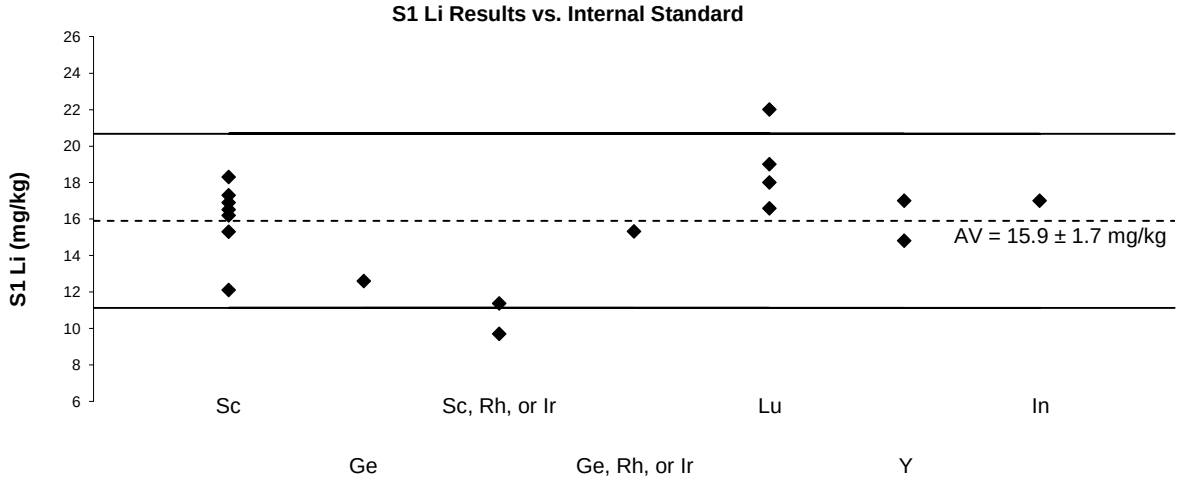


Figure 76 B Results in S2 vs. Instrumental Technique

Lead results reported by participants in samples S1 and S2 were in excellent agreement with each other and the assigned values. A calculation error may explain laboratory 23's not acceptable result in Sample S2 as it was around 100 times lower than the assigned value.

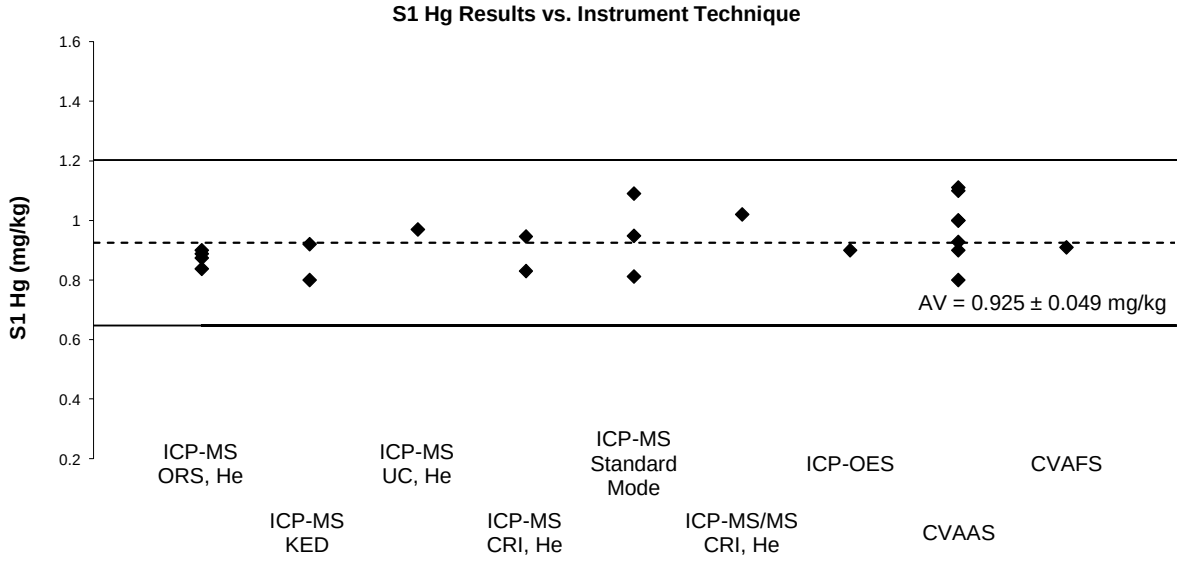
Lithium ICP-MS has low sensitivity for light elements like Li due to space-charge effects. An internal standard with similar behaviour is recommended to overcome this problem. Li results versus the internal standard used by participants for Sample S1 are presented in Figure 77.



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

Figure 77 S1 Li Results vs. Internal Standard

Mercury Participants used a wide variety of analytical techniques for Hg measurements, and all produced acceptable results (Figure 78).



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

Figure 78 S1 Hg Results vs. Instrumental Technique

Chromium, Iron, Nickel, and Vanadium are strongly dependent on the digestion regime. Participants' performance for these elements in the three study samples is presented in Figures 79 to 82. Participants whose z-scores were all on the same side of the zero line may need to review their extraction regime.

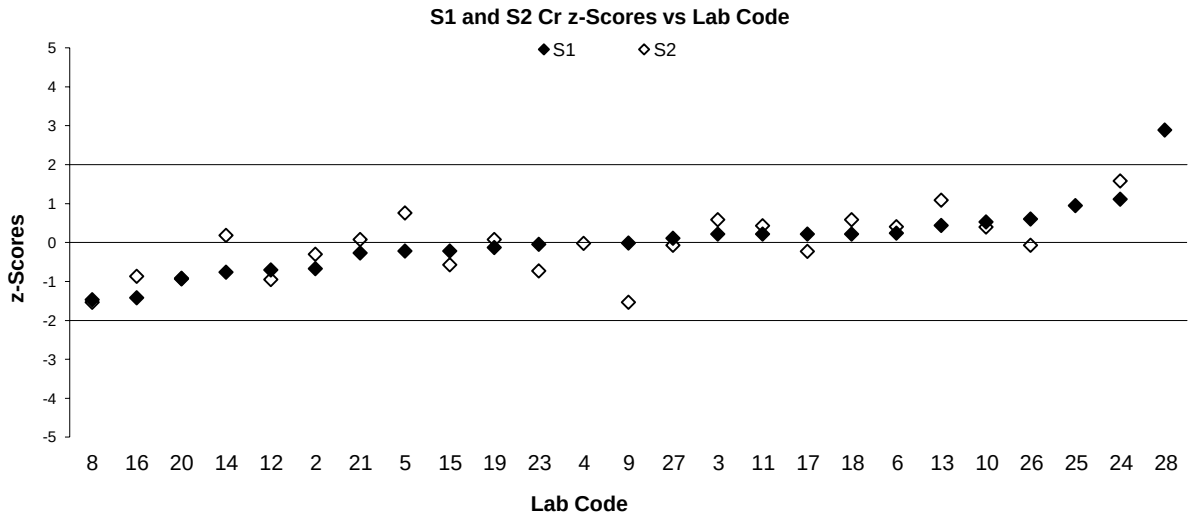


Figure 79 S1 and S2 Cr z-Scores vs. Laboratory Code Number

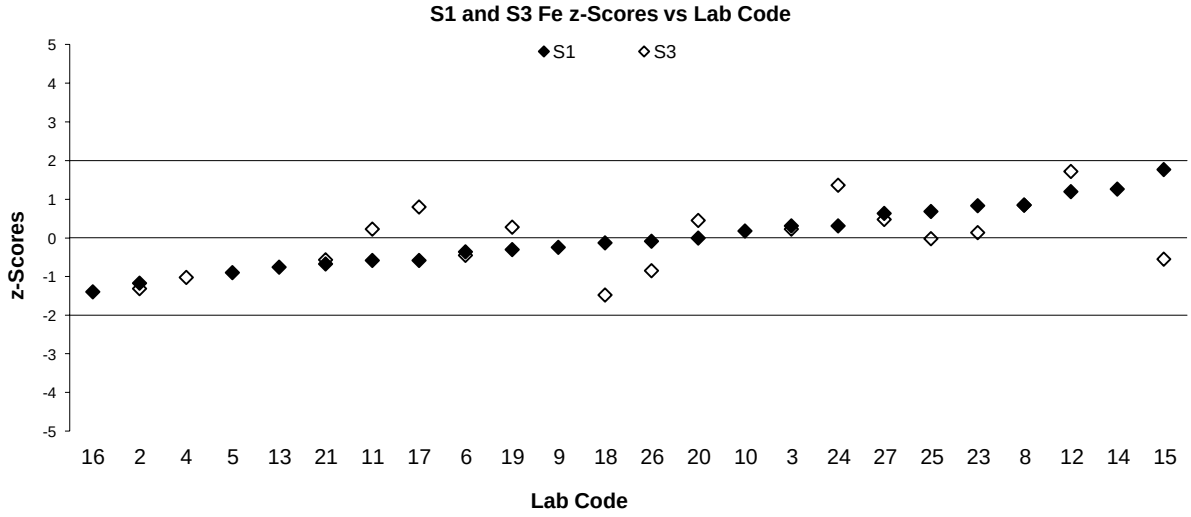


Figure 80 S1 and S3 Fe z-Scores vs. Laboratory Code Number

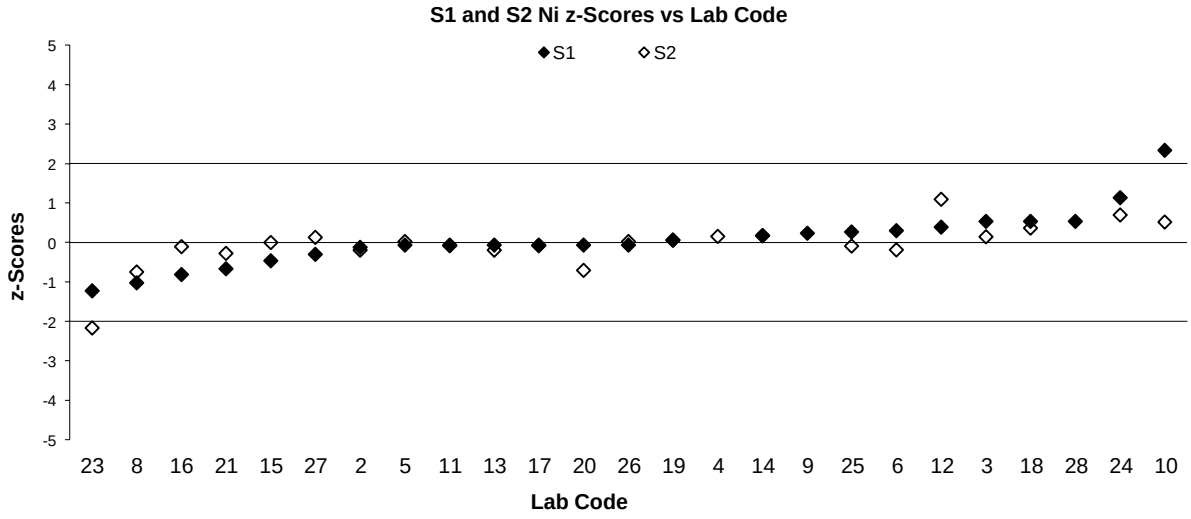


Figure 81 S1 and S2 Ni z-Scores vs. Laboratory Code Number

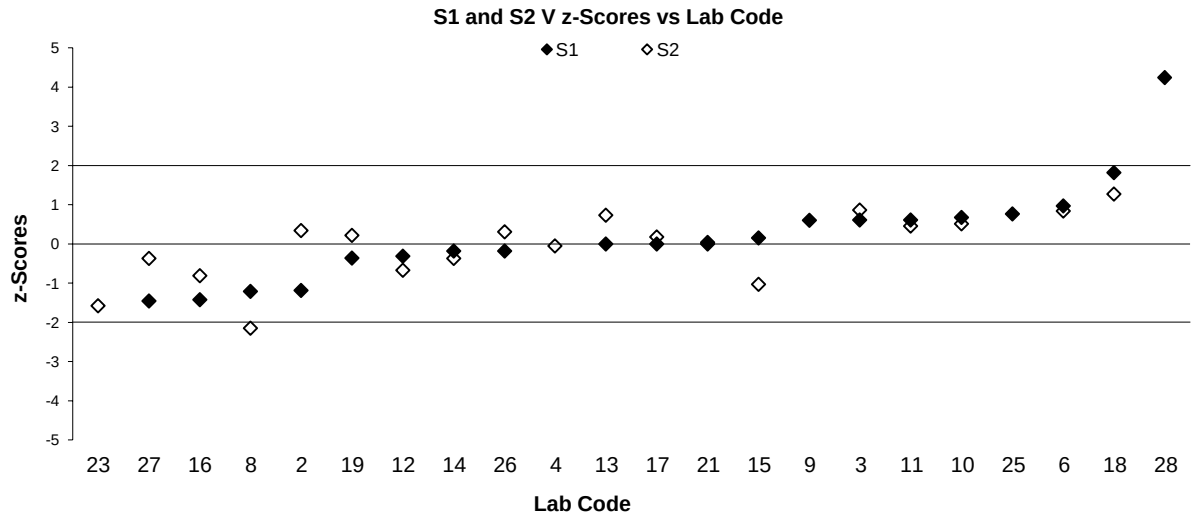


Figure 82 S1 and S2 V z-Scores vs. Laboratory Code Number

Selenium analysis at low level in Sample S2 challenged participants' analytical techniques, only 6 laboratories reported results for this test in S2.

Plots of participants' results reported for Se in S2 versus instrumental technique used are presented in Figure 83. Laboratories employed 4 different instrumental techniques: ICP-MS in collision mode, ICP-MS in collision mode with high energy He, and ICP-MS in reaction mode with H_2 and or NH_3. All reported results were in good agreement with each other and with the robust average, except for one. The laboratory who used the ICP-MS-UC technique in collision mode may have not fully resolved the interferences associated with this analyte.

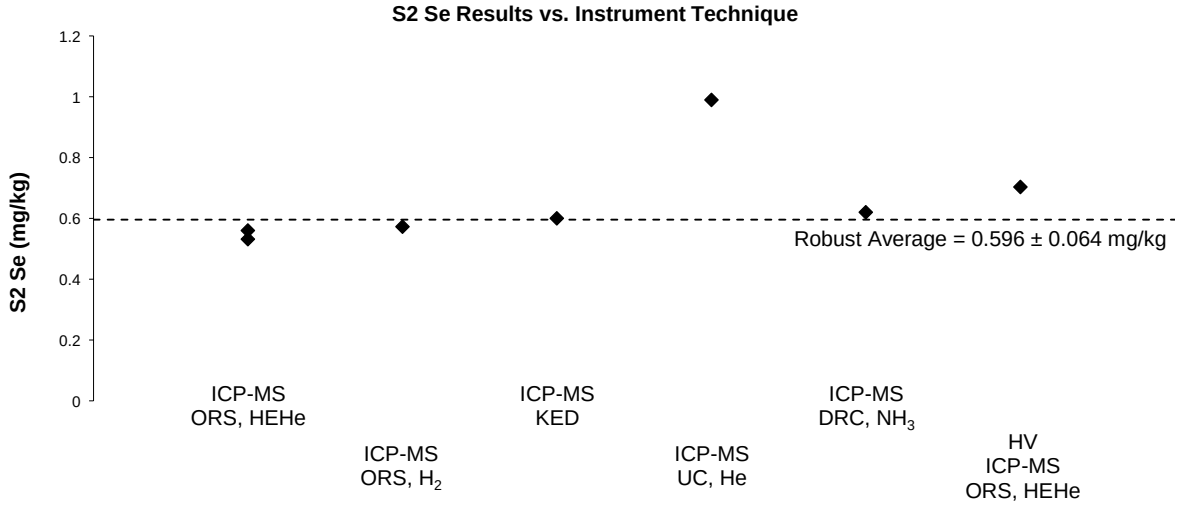
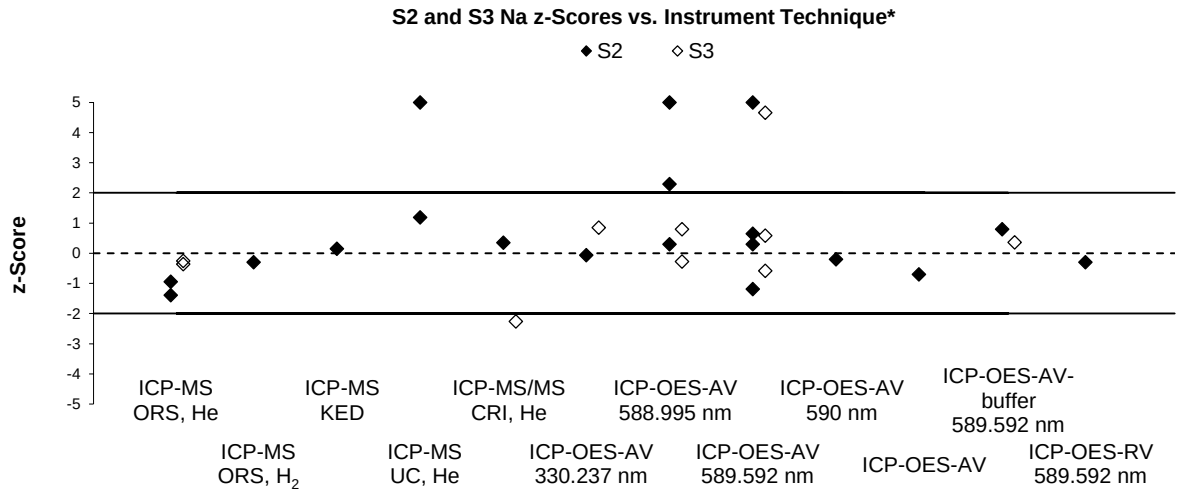


Figure 83 Se Results in S2 vs. Instrumental Technique

Sodium Participants used a wide range of instrumental techniques for Na measurements in Samples S2, and S3 with ICP-OES in axial view being the most popular one (see Figure 84).

Caution should be exercised when using ICP-OES in axial view without buffer or appropriate correction equation. The emission signal for Na can be significantly enhanced in the presence of other easily ionised elements, often resulting in concentrations much higher than the true values.



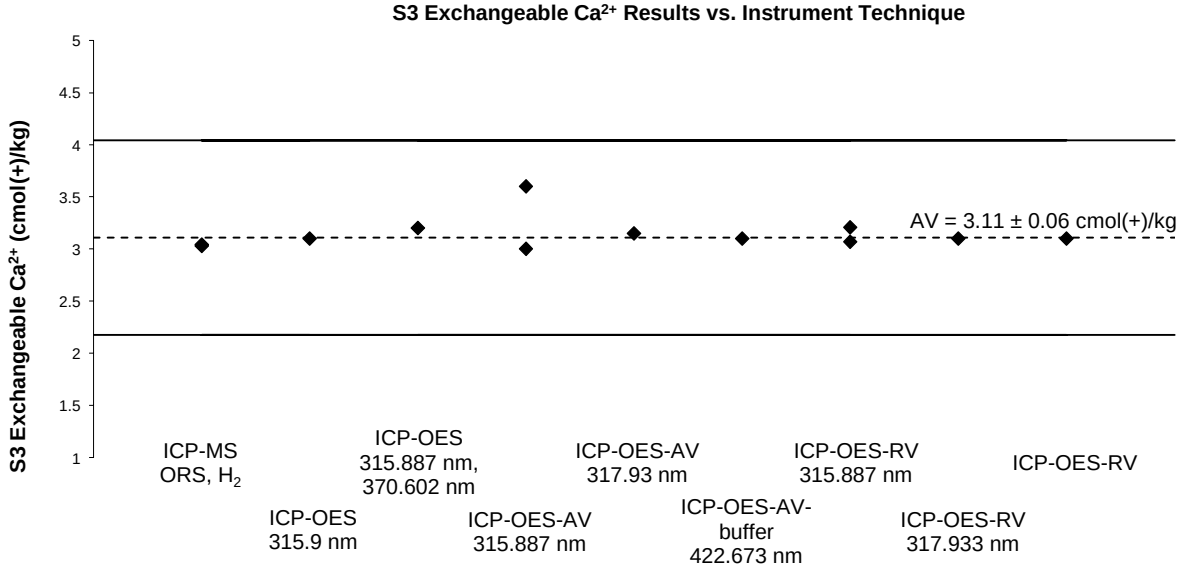
*z-Scores > 5 have been plotted as 5.

Figure 84 S2 and S3 Na Results vs. Instrumental Technique

6.6 Participants' Results and Analytical Methods for Exchangeable Bases

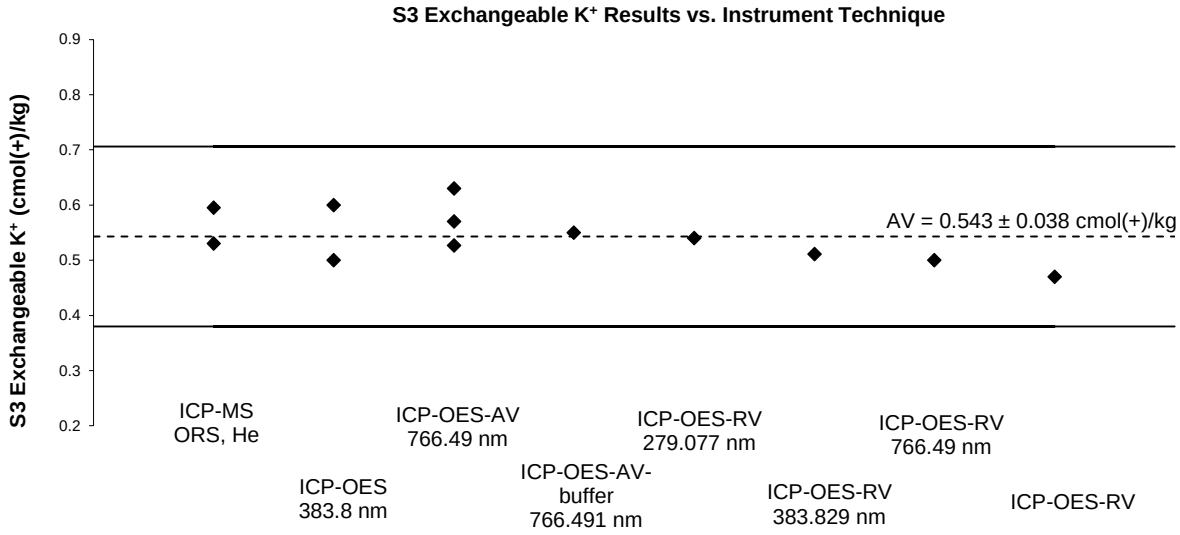
Measurement of exchangeable bases in soil is an empirical measurement – where the method of extraction defines the measurand. The participating laboratories were asked to analyse the sample using their normal measurement technique but to use the same preparation procedure Method 15A1 as defined by Rayment, G.E. and David, J. L in "Soil Chemical Methods-Australasia".[22]

The method descriptions provided by participants are presented in Table 9. With one exception, all participants used a ratio sample mass/extraction solution of 1:20 and shook their sample for 1 hour. Laboratory 27 used a ratio of 1:5 for sample mass/extraction solution, still shaking their sample for 1 hour. No significant differences were noticed between the results reported by this participant and the results reported by participants who used a ratio of 1:20. Plots of participants' results versus the analytical methods used for the exchangeable bases measurement are presented in Figures 85 to 88. All results were in good agreement with each other and the assigned values for all four analytes.



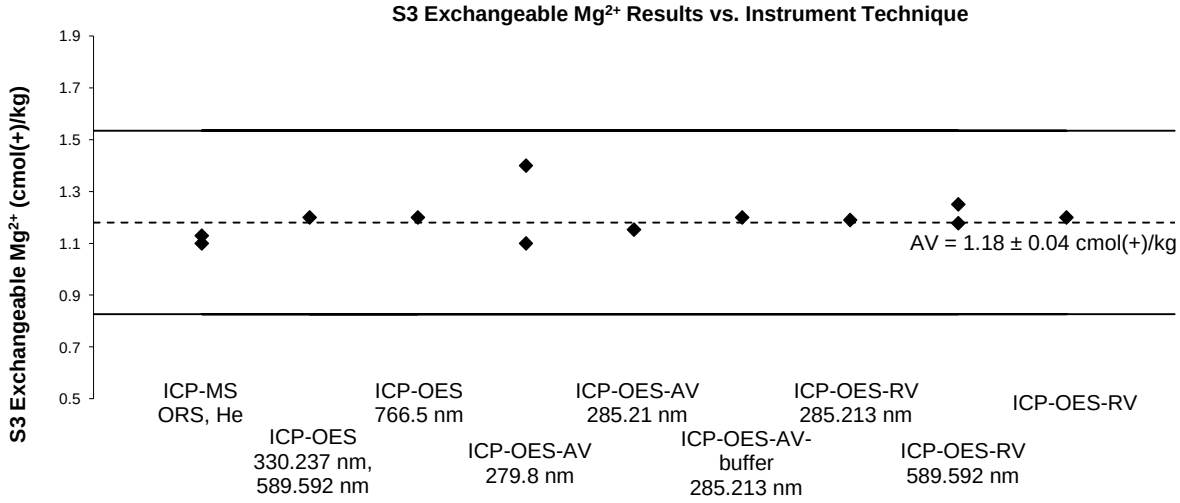
Horizontal lines are equivalent to z-scores of 2 and -2 respectively.

Figure 85 Exchangeable Ca^{2+} Results vs. Instrumental Techniques



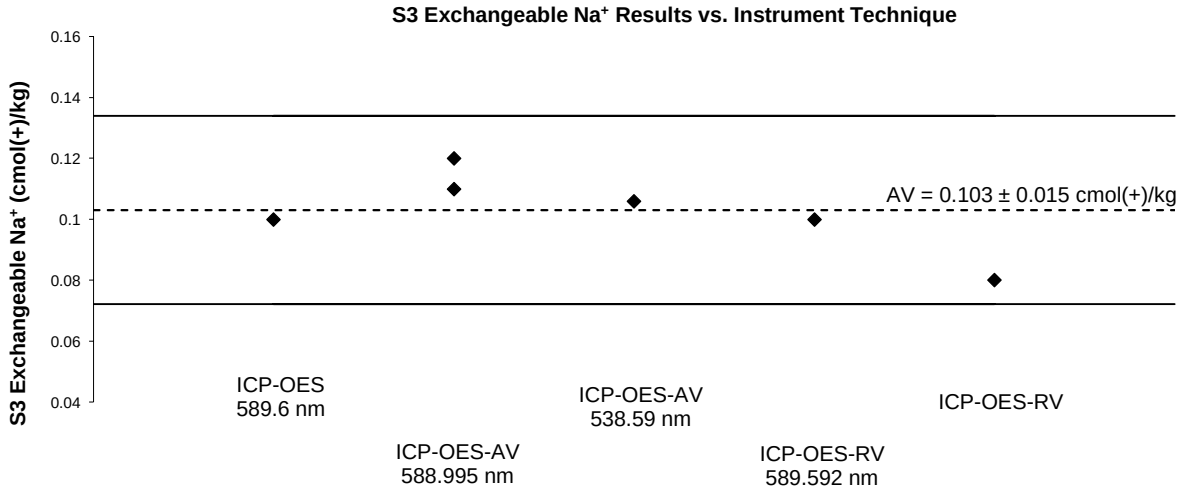
Horizontal lines are equivalent to z-scores of 2 and -2 respectively.

Figure 86 Exchangeable K^+ Results vs. Instrumental Techniques



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

Figure 87 Exchangeable Mg^{2+} Results vs. Instrumental Techniques



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

Figure 88 Exchangeable Na^+ Results vs. Instrumental Techniques

6.7 Participants' Results and Analytical Methods for Colwell P and Colwell K

The participating laboratories were asked to follow the preparation procedure described in Method 9B1 as defined by Rayment, G.E. and David, J. L in "Soil Chemical Methods-Australasia".[22] All participants shook the sample for approximately 16 hours and used a ratio of 1:100 sample mass/extraction solution (Table 4).

Colwell K Only three participants reported results for Colwell K in Sample S3. All three results were in good agreement with each other, centred around the value of 340 mg/kg (Figure 89).

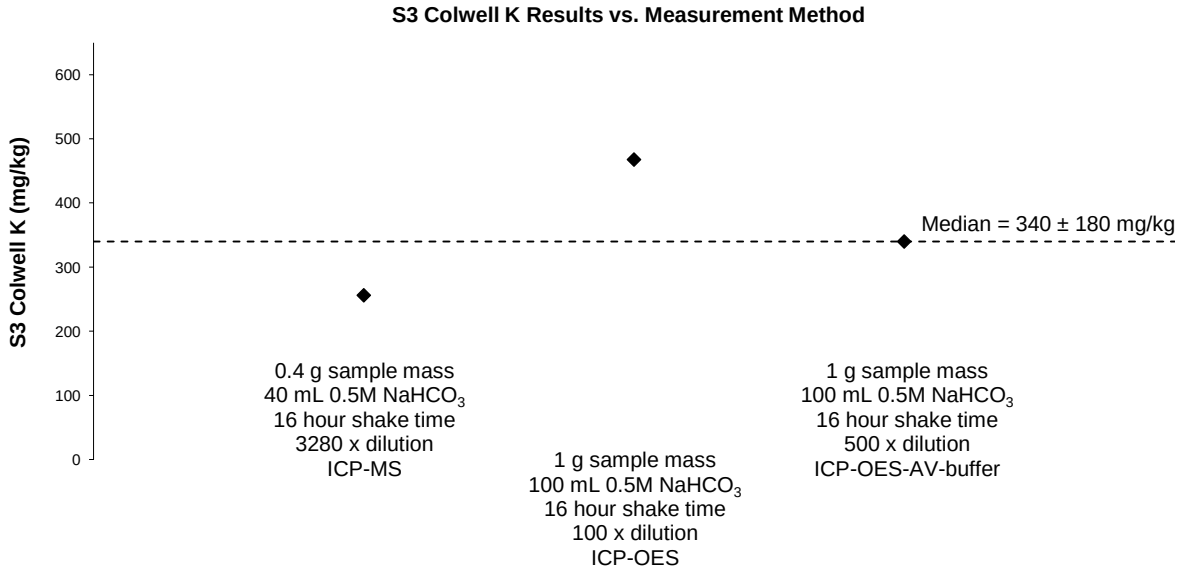


Figure 89 Colwell K Results vs. Method

Colwell P Seven participants reported results for Colwell P in Sample S3, and all agreed with each other. Discrete analyser was the preferred instrumental technique (Figure 90).

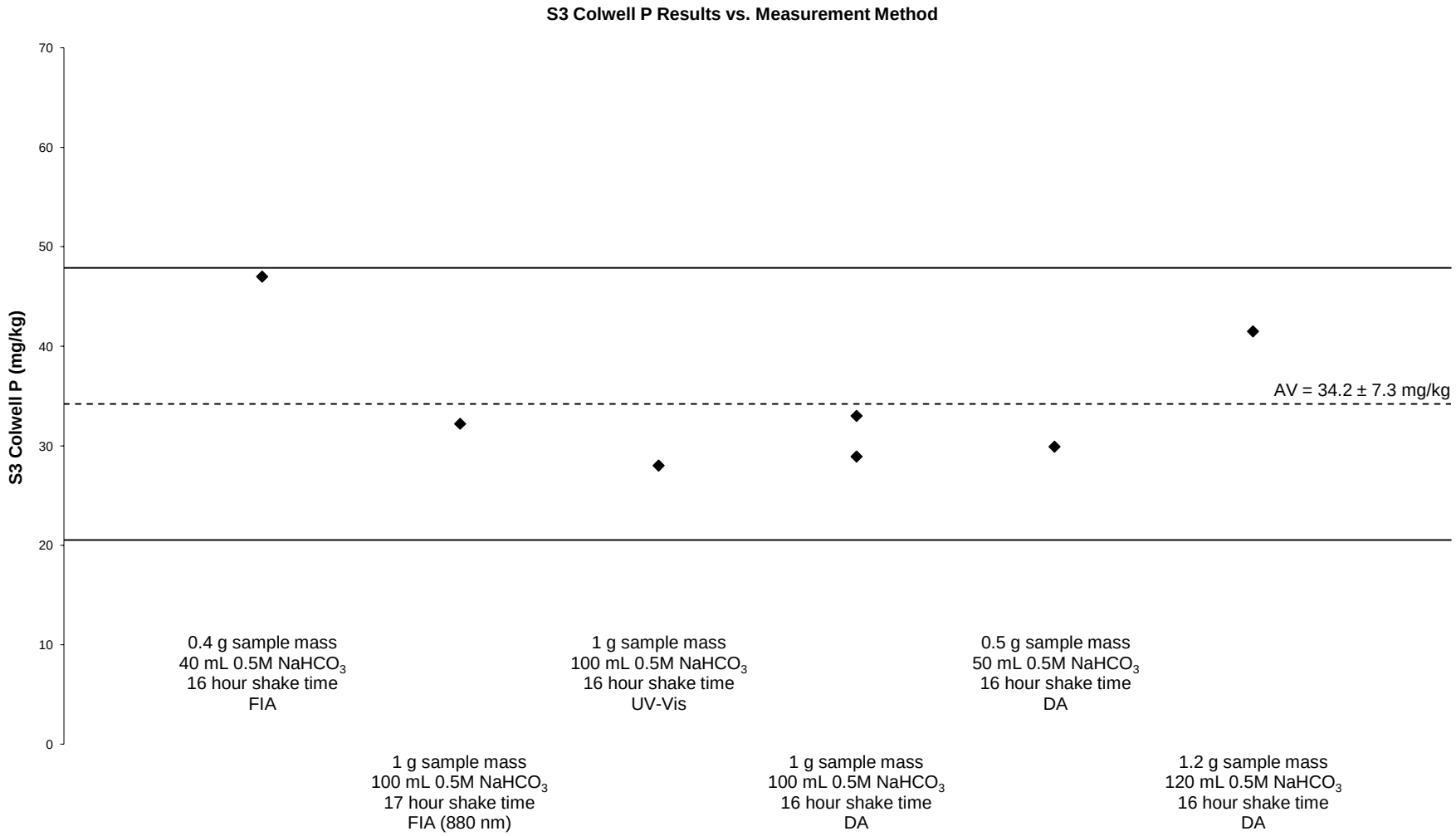
6.8 EC

No assigned value could be set for this test, as the results were too variable (between 228 µS/cm and 2700 µS/cm).

6.9 Participants' Results and Analytical Methods for Extractable B

Only four participant's reported numeric results for Calcium Chloride Extractable B in Sample S3. All participants used 20 mL 0.01 M $CaCl_2$ extraction solution, a sample mass of 5 g or 10 g, and a reflux time of 10 min or 1 hour (Figure 91).

The results reported by Laboratories 2, 11, and 21 were in good agreement with each other.



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

Figure 90 Colwell P Results vs. Method

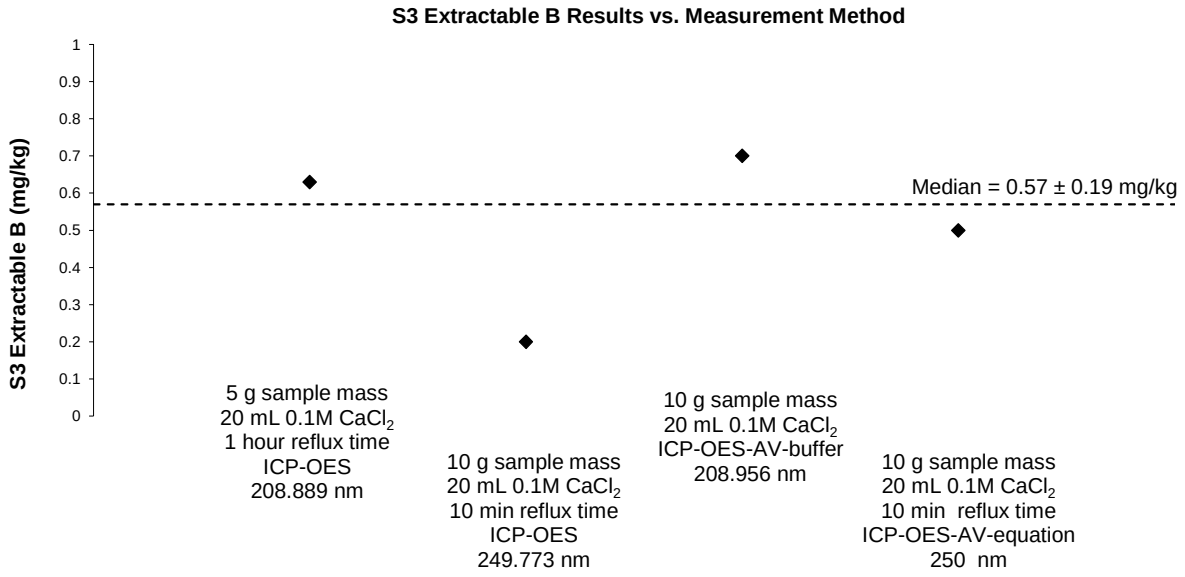


Figure 91 Calcium Chloride Extractable B Results vs. Method

6.10 Participants' Results and Analytical Methods for Phosphorus Buffer Index-PBI$_{+ColP}$

P Buffer Index-PBI$_{+ColP}$ gives an indication of the soil's ability to fix P and make it unavailable to plant uptake.

Two laboratories reported results for this test and both used a similar method: 2 g of sample, 20 mL P equilibrating solution, and 16 to 17 hours shake time and ICP-OES as instrumental technique at 213.617 nm. The results were in good agreement with each other.

6.11 Participants' Results and Analytical Methods for Total P

Only five laboratories reported results for total P in Sample S3. The results reported by Laboratories 12, 15, 21 and 27 were in good agreement, clustered around the value of 414 mg/kg. Plots of participants' results by the method employed are presented in Figure 92.

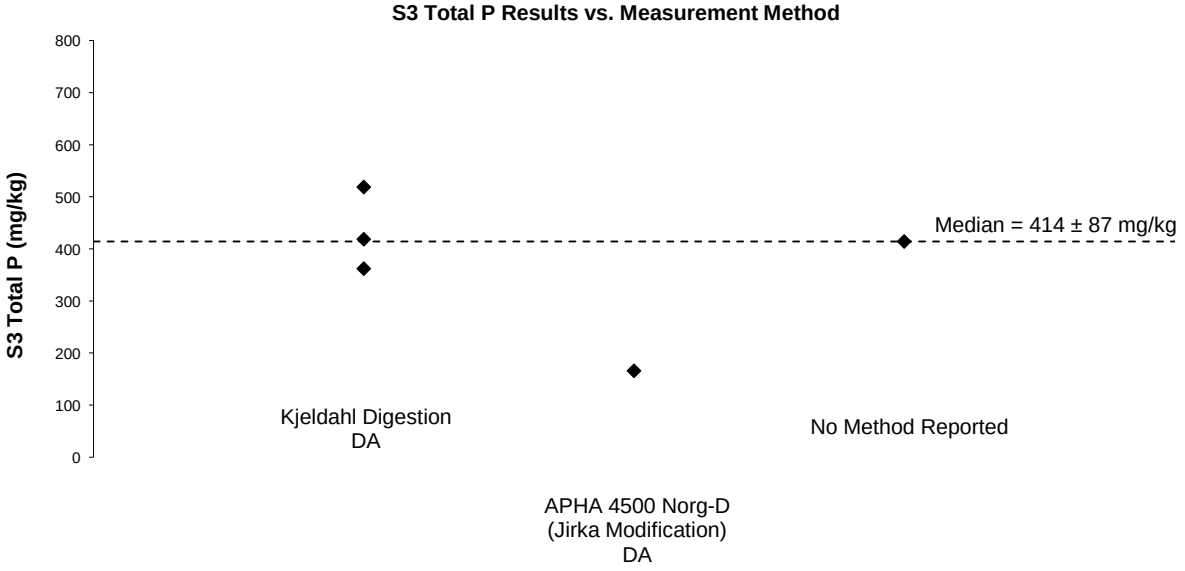
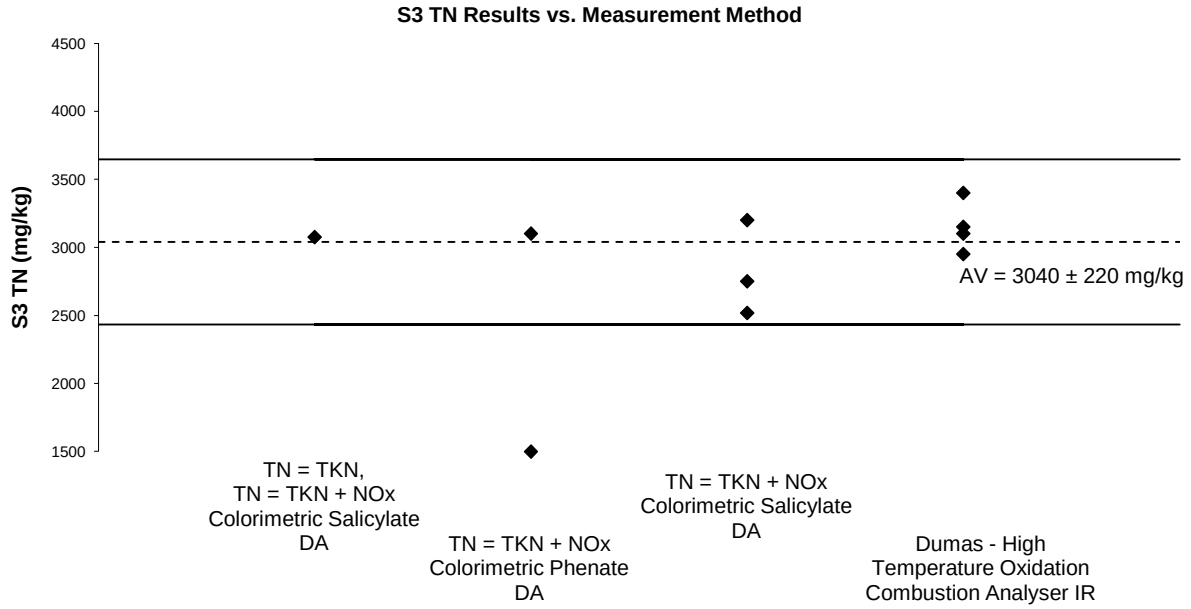


Figure 92 Total P Results vs. Method

6.12 Participants' Results and Analytical Methods for Total Nitrogen

No significant difference was found between TN results from combustion and those results calculated from TKN and NOx. Method descriptions provided by participants are presented in Table 8. A plot of participants' results versus analytical method and measurement technique used for TN analysis in S3 is presented in Figure 93.

All reported results returned acceptable z-scores with the exception of one. Laboratory 8 reported using APHA Method 4500-Norg A&D with Jirka Modification, which involves simultaneous determination of both TKN and Total P. The results reported by them for both Total P and TN were biased low (Figure 92 and Figure 93.).



Horizontal lines are equivalent to z-scores of 2 and -2 respectively. Results <1500 mg/kg have been plotted as 1500 mg/kg.

Figure 93 TN Results vs. Method

6.13 Participants' Results and Analytical Methods for Total Carbon and Total Organic Carbon

Participants were free to choose an appropriate method and were given no guidance apart from the instruction to: "Quantitatively analyse the samples using your normal test method." The method descriptions provided by participants for TC and TOC analyses are presented in Tables 2 and 3.

Total Carbon All reported results for TC in S3 returned acceptable z-scores.

All participants reported using the high temperature oxidation method for TC measurement.

Total Organic Carbon Total organic carbon (TOC) measurements should involve the measurement of both volatile organic carbon (VOC) and of non–purgeable organic carbon (NPOC). As the loss of VOC is considered negligible when compared to the content of NPOC in a soil sample, all the NPOC reported results in Sample S3 have been considered as TOC.[22. -25]

Two laboratories reported adding silver sulfate to remove chloride interference.

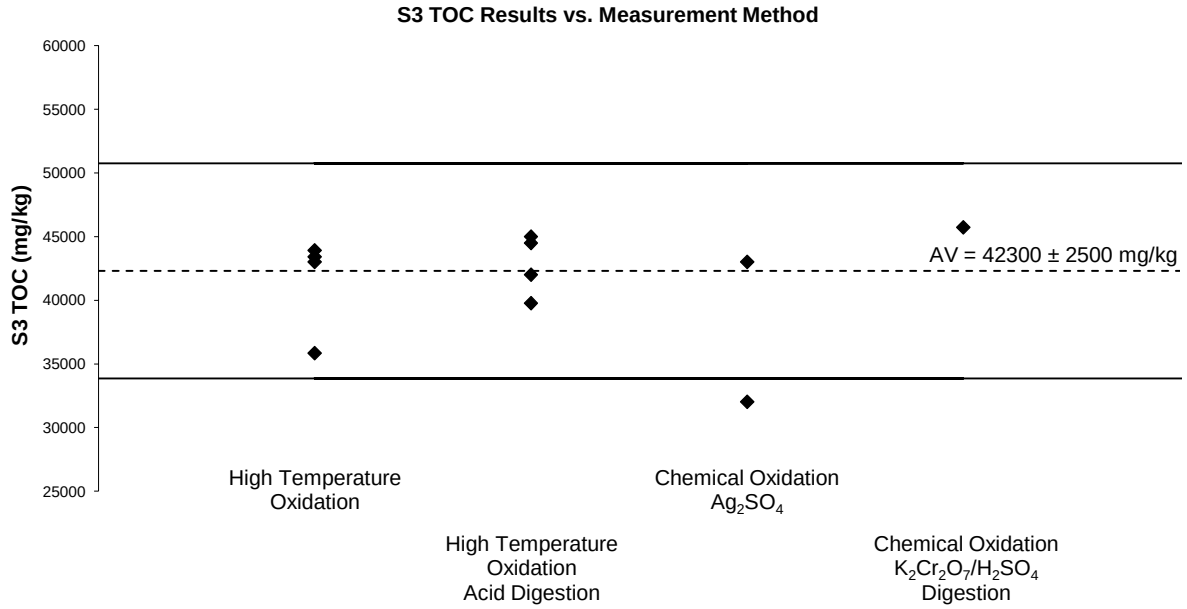
Most participants used the high temperature oxidation method (Figure 94).

The high temperature oxidation method for organic carbon determination can be rapid and reliable when inorganic carbon is removed prior to combustion. The separation of organic

carbon from inorganic carbon can be achieved by ashing or acid treatment. Four participants reported using this technique, with one participant reporting predigesting the sample with H_2SO_4 before the high temperature oxidation treatment.

When ashing is used, good knowledge of the nature of soil is required to choose the right ashing temperature. The major problem when acid treatment is used is uncertainty about the completeness of inorganic carbon removal. Introduction of a pretesting step to establish the right amount of the sample to be taken for analysis and the right type and concentration of acid to be used can help avoid these problems.[25, 26]

Comparison studies on the efficiency of TOC methods found that the most appropriate method for soil TOC analyses is the automated dry combustion technique after pre-testing and pre-treatment for inorganic carbon removal. [26, 27]



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

Figure 94 TOC Result vs. Method

6.14 Comparison with Previous NMIA Proficiency Tests of Metals in Soil

AQA 26-04 is the 38th NMIA proficiency study of inorganic analytes in soil.

A summary of participants' performance in measurement of metals in soil over the last fifteen years is presented in Figure 95. Despite different matrices, analytes, and analyte concentrations, on average participants' performance remained consistent.

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 $2.0 < |z| < 3.0$ can 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.

6.15 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 84).

Table 84 Control Samples Used by Participants

Lab. Code	Description of Control Samples
2	RM / Ex PT Sample: AGAL 12
3	RM / Ex PT Sample
4	CRM
5	CRM: Metals in Soil – LRAD9420
6	CRM
7	RM / Ex PT Sample: Aspac 13959, 13957, 15759, 7098, 9104, 9105
8	CRM: Choice Analytical
10	SS
11	SS
12	CRM, SS
13	SS, RM / Ex PT Sample
14	CRM
15	SS
17	SS
18	SS
19	CRM: NMI AGAL-12 Biosoil; AQA 20-13 S2 RM
20	CRM, SS
21	CRM
23	SS
24	CRM
25	RM / Ex PT Sample: Internal Reference material
26	CRM, SS
27	CRM: ASPAC CRM 14160-QC-PR12165EX; AGAL 12; LOAM B
28	SS

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'*[28]

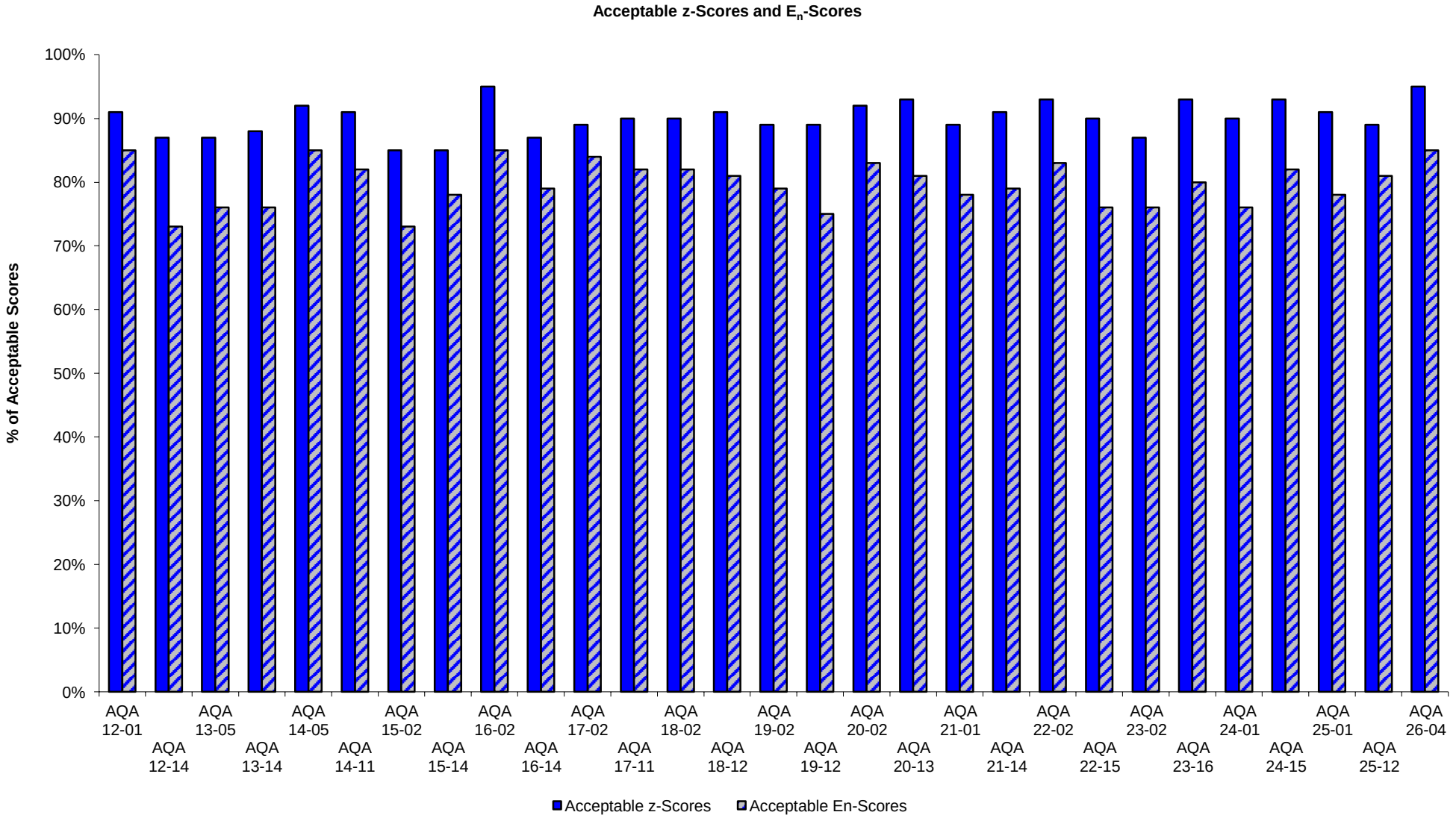


Figure 95 Participants' Performance over Time (2012-2026)

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 a soil material fortified for 9 elements, mixed, dried and sieved prior to being divided into portions of approximately 30 g each.

Sample S2 was a contaminated sediment material to which a known amount of water was added. The soil was then mixed and dispensed into 35 g portions.

Sample S3 was an agricultural soil material that was ground, sieved, mixed and divided into portions of 75 g each.

Sample Analysis and Homogeneity Testing

The same procedure was followed for the preparation of Samples S1 and S3 as in previous NMI PT studies. Therefore, only a partial homogeneity test was conducted for elements of interest in Sample S1, except for B, and all acid extractable elements of interest in Sample S3. Three bottles were analysed in duplicate, and the average of the results was reported as the homogeneity value. Measurements were made under repeatability conditions in random order.

As a new preparation procedure was utilised for Sample S2, a full homogeneity testing was conducted for Sample S2 for all analytes except for La and Rb. The results reported by participants for these analytes gave no reason to question homogeneity. Homogeneity testing for this sample was based on that described by Thompson and Fearn,[29] which is also the procedure as described in the International Harmonised Protocol for Proficiency Testing.[4] A minimum of 6 bottles from S2 were selected at random. Duplicate test-portions were taken from each bottle and the concentration of all targeted analytes measured. Measurements were made under repeatability conditions in random order. The data for the full homogeneity testing of Sample S2 can be found below in Tables 85 – 104.

Table 85 Sample S2 As Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
2	29.9	32.8
13	29.7	29.2
21	39.8	35.4
26	30.0	32.9
35	33.7	29.9
47	32.9	30.0
60	28.1	33.9
Mean	32.0	
CV	16%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.36	0.73	**Pass**
s_{an}/σ	0.54	0.50	**Fail**
s^2_{sam}	3.4	14	**Pass**

Table 86 Sample S2 B Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
13	2.56	2.45
21	2.59	2.43
26	2.79	2.30
35	2.14	2.57
47	2.27	2.42
60	2.23	2.40
Mean	2.43	
CV	17%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.47	0.78	**Pass**
s_{an}/σ	0.42	0.50	**Pass**
s^2_{sam}	0.00001	0.12	**Pass**

Table 87 Sample S2 Ba Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
2	69.3	72.0
13	74.6	70.0
21	70.1	74.6
26	69.0	70.5
35	72.1	73.4
47	66.5	69.1
60	70.0	72.1
Mean	71.0	
CV	6.6%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.33	0.73	**Pass**
s_{an}/σ	0.22	0.50	**Pass**
s^2_{sam}	0.95	29	**Pass**

Table 88 Sample S2 Be Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
13	0.547	0.542
21	0.556	0.555
26	0.566	0.547
35	0.539	0.537
47	0.550	0.545
60	0.548	0.540
Mean	0.547	
CV	2.3%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.74	0.78	**Pass**
s_{an}/σ	0.058	0.50	**Pass**
s^2_{sam}	0.00003	0.0025	**Pass**

Table 89 Sample S2 Cd Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
13	0.805	0.889
21	0.940	0.767
26	0.760	0.718
35	0.751	0.714
47	0.659	0.754
60	0.797	0.702
Mean	0.771	
CV	18%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.51	0.78	**Pass**
s_{an}/σ	0.60	0.50	**Fail**
s^2_{sam}	0.0015	0.011	**Pass**

Table 90 Sample S2 Co Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
2	17.8	17.9
13	18.0	18.0
21	18.1	18.2
26	17.9	18.6
35	18.2	18.3
47	17.9	18.5
60	17.9	17.9
Mean	18.1	
CV	2.9%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.52	0.73	**Pass**
s_{an}/σ	0.10	0.50	**Pass**
s^2_{sam}	0.00001	1.5	**Pass**

Table 91 Sample S2 Cr Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
2	43.3	43.3
13	44.9	46.2
21	48.5	44.2
26	44.1	41.7
35	42.5	43.4
47	44.9	45.8
60	45.3	43.0
Mean	44.4	
CV	6.9%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.57	0.73	**Pass**
s_{an}/σ	0.23	0.50	**Pass**
s^2_{sam}	0.72	12	**Pass**

Table 92 Sample S2 Cu Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
2	30.9	33.3
13	34.4	34.5
21	31.7	35.6
26	32.7	30.8
35	31.6	31.6
47	36.0	37.6
60	31.6	33.7
Mean	33.3	
CV	9%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.48	0.73	**Pass**
s_{an}/σ	0.30	0.50	**Pass**
s^2_{sam}	2.4	7.9	**Pass**

Table 93 Sample S2 Ga Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
2	5.25	5.31
13	5.40	5.46
21	5.36	5.36
26	5.35	5.56
35	5.20	5.53
47	5.29	5.40
60	5.32	5.38
Mean	5.37	
CV	4.2%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.61	0.73	**Pass**
s_{an}/σ	0.14	0.50	**Pass**
s^2_{sam}	0.00001	0.14	**Pass**

Table 94 Sample S2 Mn Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
2	689	708
13	716	699
21	704	687
26	689	709
35	695	721
47	697	715
60	690	706
Mean	702	
CV	3.9%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.25	0.73	**Pass**
s_{an}/σ	0.13	0.50	**Pass**
s^2_{sam}	0.00001	2400	**Pass**

Table 95 Sample S2 Na Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
2	159	169
13	172	163
21	167	162
26	151	163
35	164	165
47	164	168
60	170	167
Mean	164	
CV	6%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.36	0.73	**Pass**
s_{an}/σ	0.20	0.50	**Pass**
s^2_{sam}	0.00001	150	**Pass**

Table 96 Sample S2 Ni Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
2	62.3	61.0
13	62.5	63.7
21	62.4	62.7
26	60.8	64.7
35	63.0	60.1
47	61.4	64.2
60	63.9	62.6
Mean	62.5	
CV	5.2%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.42	0.73	**Pass**
s_{an}/σ	0.17	0.50	**Pass**
s^2_{sam}	0.00001	20	**Pass**

Table 97 Sample S2 P Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
2	590	565
13	581	574
21	564	563
26	563	604
35	582	554
47	569	624
60	608	582
Mean	580	
CV	7.6%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.44	0.73	**Pass**
s_{an}/σ	0.38	0.50	**Pass**
s^2_{sam}	0.00001	1300	**Pass**

Table 98 Sample S2 Pb Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
2	52.9	48.1
13	51.6	42.5
21	44.9	44.7
26	54.3	52.2
35	45.7	47.4
47	53.9	46.3
60	46.2	48.7
Mean	48.5	
CV	15%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.47	0.73	**Pass**
s_{an}/σ	0.49	0.50	**Pass**
s^2_{sam}	2.0	28	**Pass**

Table 99 Sample S2 Se Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
2	0.665	0.705
13	0.681	0.683
21	0.694	0.683
26	0.685	0.737
35	0.724	0.707
47	0.713	0.729
60	0.717	0.722
Mean	0.703	
CV	5.4%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.54	0.73	**Pass**
s_{an}/σ	0.13	0.50	**Pass**
s^2_{sam}	0.00012	0.0043	**Pass**

Table 100 Sample S2 Sn Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
2	0.703	0.698
13	0.738	0.755
21	0.848	0.753
26	0.789	0.772
35	0.729	0.746
47	0.856	0.786
60	0.692	0.785
Mean	0.761	
CV	11%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.38	0.73	**Pass**
s_{an}/σ	0.36	0.50	**Pass**
s^2_{sam}	0.00091	0.0049	**Pass**

Table 101 Sample S2 Sr Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
2	116	117
13	120	115
21	117	115
26	116	116
35	115	113
47	115	117
60	117	118
Mean	116	
CV	2.6%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.70	0.73	**Pass**
s_{an}/σ	0.13	0.50	**Pass**
s^2_{sam}	0.35	29	**Pass**

Table 102 Sample S2 V Homogeneity Testing

Container Number	Result (mg/kg)	
	Replicate 1	Replicate 2
2	55.1	55.5
13	55.4	56.0
21	55.6	54.8
26	55.7	56.4
35	55.3	55.1
47	55.0	56.3
60	54.3	54.9
Mean	55.4	
CV	1.9%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.47	0.73	**Pass**
s_{an}/σ	0.063	0.50	**Pass**
s^2_{sam}	0.079	13	**Pass**

Table 103 Sample S2 Zn Homogeneity Testing

Container Number	Result (%)	
	Replicate 1	Replicate 2
2	197	235
13	230	228
21	240	211
26	211	205
35	208	211
47	195	206
60	217	211
Mean	215	
CV	13%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.59	0.73	**Pass**
s_{an}/σ	0.42	0.50	**Pass**
s^2_{sam}	8.5	450	**Pass**

Table 104 Sample S2 Moisture Content Homogeneity Testing

Container Number	Result (%)	
	Replicate 1	Replicate 2
2	12.5	12.5
13	12.4	12.3
21	12.4	12.4
26	12.3	12.3
35	12.3	12.3
47	12.3	12.3
60	12.3	12.3
Mean	12.3	
CV	0.6%	

Thompson and Fearn Homogeneity Tests

Test	Value	Critical	Result
Cochran	0.27	0.73	**Pass**
s_{an}/σ	0.026	0.50	**Pass**
s^2_{sam}	0.00001	0.00004	**Pass**

Sample Analysis for Acid Extractable Elements

Measurements for acid extractable elements involved solubilisation of metals and metal complexes using a mixture of nitric acid and hydrochloric acid. Metals were then measured using ICP-MS or ICP-OES.

The analyses for homogeneity were conducted by CRV section of NMI as per method NT2.49. [30] A test portion of approximately 0.5 g of soil for S1 and S3, and 0.7 g for S2 was weighed into a 50 mL graduated polypropylene centrifuge tube. The sample was digested using 3 mL of concentrated nitric acid and 3 mL of concentrated hydrochloric acid on a hot block at 95°C ± 5°C. After digestion, each sample was diluted to 40 mL with Type I water and then further diluted as necessary.

The measurement instrument was calibrated using external standards for targeted analytes. A set of quality control samples consisting of blanks, blank matrix spikes, matrix matched reference materials, duplicates and sample matrix spikes, was carried through the same set of procedures and analysed at the same time as the samples. A summary of the instrument conditions used, and the ion/wavelength monitored for each analyte is given in Table 105.

Table 105 Instrumental Technique used for Acid Extractable Elements

Analyte	Instrument	Internal Standard	Reaction/ Collision Cell (if applicable)	Cell Mode/Gas (if applicable)	Final Dilution Factor (S1/S3)	Final Dilution Factor (S2)	Ion (m/z) / Wavelength (nm)
Ag	ICP-MS	Rh	ORS	He	800	NA	107 m/z
Al	ICP-MS	Rh	NA	NA	800	NA	27 m/z
As	ICP-MS	Rh	ORS	He	800	800	75 m/z
B	ICP-MS	Rh	NA	NA	NA	800	11 m/z
Ba (S2)	ICP-MS	Rh	ORS	He	NA	800	137 m/z
Ba (S3)	ICP-OES	Y	NA	NA	800	NA	233.527 nm
Be	ICP-MS	Rh	NA	NA	NA	800	9 m/z
Bi	ICP-MS	Ir	ORS	He	800	NA	209 m/z
Ca (S1)	ICP-MS	Rh	ORS	He	800	NA	43 m/z
Ca (S3)	ICP-OES	Y	NA	NA	800	NA	317.993 nm
Cd	ICP-MS	Rh	ORS	He	NA	800	111 m/z
Co	ICP-MS	Rh	ORS	He	NA	800	59 m/z
Cr	ICP-MS	Rh	ORS	He	800	800	52 m/z

Analyte	Instrument	Internal Standard	Reaction/ Collision Cell (if applicable)	Cell Mode/Gas (if applicable)	Final Dilution Factor (S1/S3)	Final Dilution Factor (S2)	Ion (m/z) / Wavelength (nm)
Cu	ICP-MS	Rh	ORS	He	800	800	63 m/z
Fe (S1)	ICP-MS	Rh	ORS	He	800	NA	56 m/z
Fe (S3)	ICP-OES	Y	NA	NA	800	NA	238.204 nm
Ga	ICP-MS	Rh	ORS	He	NA	800	71 m/z
Hg	ICP-MS	Rh	ORS	He	800	NA	201 m/z
K	ICP-OES	Y	NA	NA	800	NA	766.491 nm
Li	ICP-MS	Rh	ORS	He	800	NA	7 m/z
Mg	ICP-OES	Y	NA	NA	800	NA	285.213 nm
Mn	ICP-MS	Rh	ORS	He	800	800	55 m/z
Mo	ICP-MS	Rh	ORS	He	800	NA	95 m/z
Na (S1)	ICP-MS	Rh	ORS	He	800	NA	23 m/z
Na (S3)	ICP-OES	Y	NA	NA	800	NA	588.995 nm
Ni	ICP-MS	Rh	ORS	He	800	800	60 m/z
P (S2)	ICP-MS	Rh	ORS	He	NA	800	31 m/z
P (S3)	ICP-OES	Y	NA	NA	800	NA	177.434 nm
Pb	ICP-MS	Ir	ORS	He	800	800	206 m/z
S	ICP-OES	Y	NA	NA	800	NA	181.972 nm
Sb	ICP-MS	Rh	ORS	He	800	NA	121 m/z
Se	ICP-MS	Rh	ORS	HEHe	800	800	78 m/z
Sn	ICP-MS	Rh	ORS	He	800	800	118 m/z
Sr (S2)	ICP-MS	Rh	ORS	He	NA	800	88 m/z
Sr (S3)	ICP-OES	Y	NA	NA	800	NA	421.552 nm
Th	ICP-MS	Rh	ORS	He	800	NA	232 m/z
U	ICP-MS	Ir	ORS	He	800	NA	238 m/z
V	ICP-MS	Rh	ORS	He	800	800	51 m/z
Zn	ICP-MS	Rh	ORS	He	800	800	64 m/z

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

The assigned value was calculated as the robust average using the procedure described in 'ISO 13258'[6]; the uncertainty was evaluated as:

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

where:

$u_{rob\ av}$ robust average standard uncertainty
$S_{rob\ mean}$ 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 106.

Table 106 Uncertainty of Assigned Value for As in Sample S1

No. results (p)	22
Robust Average	9.47 mg/kg
$S_{rob\ av}$	0.66
$u_{rob\ av}$	0.18 mg/kg
k	2
$U_{rob\ av}$	0.35 mg/kg

The assigned value for **As** in Sample S1 is **9.47 ± 0.35 mg/kg**

z-Score and E_n-score

For each participant's result z-score and E_n-score are calculated according to Equation 2 and Equation 3 respectively (see Section 4).

A worked example is set out below in Table 107.

Table 107 z-Score and E_n-score for As result reported by Laboratory 28 in S1

As Result mg/kg	Assigned Value mg/kg	Standard Deviation for Proficiency Assessment	z-Score	E_n-Score
9.4 ± 0.3	9.47 ± 0.35	10% as PCV or 0.10 x 9.47 = = 0.947 mg/kg	$z = \frac{(9.4 - 9.47)}{0.947}$ z = -0.07	$En = \frac{(9.4 - 9.47)}{\sqrt{0.3^2 + 0.35^2}}$ E_n= -0.15

APPENDIX 3 - USING PT DATA FOR UNCERTAINTY EVALUATION

When a laboratory has successfully participated in at least 6 proficiency testing studies (e.g. is demonstrating control of bias and verification of repeatability), the standard deviation from proficiency testing studies (the reproducibility between-laboratory variation) can also be used to evaluate the uncertainty of their measurement results.[11, 13] An example is given.

Between 2009 and 2026 NMI carried out 33 proficiency tests of metals in soil. These studies involved analyses of acid-extractable elements at low and high levels in dried soil, moist soil, biosolid, clay, compost, sediment and sludge.

Laboratory X submitted results for As in all of these PTs. Most reported results returned acceptable z-scores. This data can be separated into two ranges of results: 10 to 50 mg/kg and 1 to 10 mg/kg (Tables 108 and 109). The pooled standard deviation of the robust CV over these PT samples for each concentration range gives evaluations of the relative standard uncertainty of 9.7% and 13% respectively. Using a coverage factor of two gives relative expanded uncertainties of 20% and 26% respectively, at a level of confidence of approximately 95%.

Table 108 Laboratory X Reported Results for As at 10 to 50 mg/kg Level.

Study No.	Sample	Laboratory result mg/kg	Assigned value mg/kg	Number of Laboratories	Robust CV of all results (%)
AQA 10-12	S1 – Soil	16.6	14.4	19	8.5
AQA 11-12	S1 – Moist Sludge	25	21.6	13	15
AQA 12-01	S1 – Sediment	18.4	17.3	21	8.1
AQA 12-14	S2 – Soil	16.6	14.8	20	11
AQA 13-14	S1 – Sandy Soil	16.6	15.1	21	10
AQA 14-05	S1 – Soil	13.2	12.3	25	7.8
AQA 17-11	S1 – Sediment	18.1	17.4	22	11
AQA 18-12	S2 – Soil	10.4	9.6	20	8
AQA 19-12	S2 – Sediment	21	19.9	19	9
AQA 20-02	S1 – Soil	18.8	21.6	23	8.8
	S2 – Moist Soil	16.5	17.8	24	6.7
AQA 21-14	S1 – Sediment	19.5	20.9	21	8.9
AQA 22-15	S2 – Sediment	58.6	56.8	22	7.8
AQA 23-16	S1 – Soil	10.9	12.3	18	9.7
	S2 – Soil	12.4	12.3	17	9.4
AQA 24-01	S1 – Soil	35.9	35.2	20	10
	S2 – Moist Soil	11.8	12.5	16	13
AQA 25-12	S2 – Sediment	36.6	33.9	20	12
AQA 26-04	S2 – Moist Sediment	32.0	32.9	23	9.4
				Average	9.7%*
$\boldsymbol{pooled\ s\%} = \sqrt{\frac{((\mathbf{19}-\mathbf{1})\times\mathbf{8.5^2}+(\mathbf{13}-\mathbf{1})\times\mathbf{15^2}+\cdots\cdots+(\mathbf{23}-\mathbf{1})\times\mathbf{9.4^2})}{\mathbf{384}-\mathbf{19}}}$					**9.7%**

* The pooled standard deviation was used

Table 109 Laboratory X Reported Results for As at 1 to 10 mg/kg Level.

Study No.	Sample	Laboratory result mg/kg	Assigned value mg/kg	Number of laboratories	Robust CV of all results (%)
AQA 09-13	S1 – Biosolid	4.091	3.64	11	16
	S2 – Soil	4.29	4.57	12	15
AQA 11-01	S1 – Biosolid	3.54	3.57	18	20
AQA 13-05	S1 – Soil	9.22	9.21	22	14
AQA 14-11	S1 – Sediment	7.91	7.37	21	12
AQA 15-02	S1 – Moist Sludge	8.29	7.02	22	13
	S2 – Moist Sludge	7.42	7.02	17	11
AQA 15-14	S1 – Sediment	10	9.95	17	6.7
	S2 – Soil	4.53	4.47	14	6.4
AQA 16-02	S2 – Clay	2.67	2.11	20	14
AQA 16-14	S1 – Soil	6.03	5.61	17	20
AQA 17-02	S1 – Soil	3.71	3.76	13	10
	S2 – Soil	2.92	3.01	13	4
AQA 18-02	S1 – Compost	2.22	2.73	17	11
AQA 19-02	S1 – Soil	2.83	2.65	24	11
AQA 19-12	S1 – Soil	2.32	2.12	16	16
AQA 20-13	S1 – Biosolid	2.85	3.29	17	11
AQA 21-01	S1 – Sediment	7.02	6.26	18	6.9
	S2 – Moist Sludge	3.99	3.58	13	13
AQA 22-02	S1 – Sediment	4.32	4.02	15	9.5
	S2 – Moist Soil	3.57	3.56	13	6.2
AQA 22-15	S2 – Clay	4.29	3.63	19	17
AQA 23-02	S1 – Soil	4.41	4.12	16	5.9
	S2 – Sludge	4.43	4.8	8	24
AQA 24-15	S2 - Biosolid	3.70	3.83	20	10
AQA 25-01	S2 - Sludge	4.92	3.76	14	17
AQA 25-12	S1 – Biosolid	3.29	3.34	16	16
AQA 26-04	S1 - Soil	8.49	9.47	22	6.9
				Average	12%*
$\boldsymbol{pooled\ s\%} = \sqrt{\frac{((\mathbf{11}-\mathbf{1})\times\mathbf{16^2}+(\mathbf{12}-\mathbf{1})\times\mathbf{15^2}+\cdots\cdots+(\mathbf{22}-\mathbf{1})\times\mathbf{6.9^2})}{\mathbf{465}-\mathbf{28}}}$					**13%**

* The pooled standard deviation was used.

Table 110 sets out the expanded uncertainty for results of the measurement of As in soil, biosolid, clay, sediment, sludge, sandy soil, moist soil, compost and agricultural soil over the ranges 10 to 50 mg/kg and 1 to 10 mg/kg.

Table 110 Uncertainty of As Results Evaluated Using PT Data.

Results mg/kg	Uncertainty mg/kg
1.00	0.26
5.0	1.3
10.0	2.6
20.0	4.0
50	10

The evaluations of 20% and 26% relative pass the test of being reasonable, and the analysis of the 47 different PT samples over eighteen years can be assumed to include all the relevant uncertainty components (different matrices, operators, reagents, calibrators etc.), and so complies with ISO/IEC 17025 requirements.[9]

APPENDIX 4 - ACRONYMS AND ABBREVIATIONS

AAS	Atomic Absorption Spectroscopy
APHA	American Public Health Association
ASPAC	Australian Soil and Plant Analysis Council
ASTM	Australian Society for Testing and Materials
AV	Assigned Value
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 Spectroscopy
CVAFS	Cold Vapour Atomic Fluorescence Spectroscopy
DA	Discreet Analyser
DRC	Dynamic Reaction Cell
EC	Electrical conductivity
FIA	Flow Injection Analyser
GUM	Guide to the Expression of Uncertainty in Measurement
HEHe	High energy He mode
HV	Homogeneity Value
ICP-MS	Quadrupole - Inductively Coupled Plasma - Mass Spectrometry
ICP-MS/MS	Inductively Coupled Plasma – Tandem Mass Spectrometry
ICP-OES	Inductively Coupled Plasma - Optical Emission 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
ICP-OES-RV	Inductively Coupled Plasma - Optical Emission Spectrometry- radial view
ISO/IEC	International Organisation for Standardisation / International Electrotechnical Commission
k	Coverage Factor
KED	Kinetic Energy Discrimination
LOR	Limit of Reporting
Max	Maximum value in a set of results
Md	Median
Min	Minimum value in a set of results
MU	Measurement Uncertainty
N	Number of Participants
NA	Not Applicable
NATA	National Association of Testing Authorities
NEPC	National Environmental Protection Council
NMIA	National Measurement Institute Australia
NR	Not Reported
NT	Not Tested
ORS	Octopole Reaction System
PBI	Phosphorus Buffer Index
PCV	Performance Coefficient of Variation
PT	Proficiency Test
RA	Robust Average

RM	Reference Material
SD	Standard Deviation
SDPA	Standard Deviation for Proficiency Assessment (symbol: σ)
SV	Spiked value or formulated concentration of a PT sample
SS	Spiked sample
SI	The International System of Units
s^2_{sam}	Sampling variance
s_{an}/σ	Analytical standard deviation divided by the standard deviation for proficiency assessment
TC	Total Carbon
TN	Total Nitrogen
TOC	Total Organic Carbon
UC	Universal Cell
USEPA	United States Environmental Protection Agency
UV-Vis	Ultraviolet and Visible Spectroscopy

APPENDIX 5 - INSTRUMENT DETAILS

Table 111 Instrument Conditions Ag

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Rh	NA	NA	625	NA	109
6	ICP-MS/MS	Rh	CRI	He	500	NA	107
8	ICP-MS	Ir, Rh & Sc	NA	NA	50	NA	107 m/z
9	ICP-MS					NA	
10	ICP-MS	Rh			250	NA	
11	ICP-OES-AV-buffer	Lu	NA	NA	50	NA	328.068
12	ICP-OES-AV	Eu				NA	328.068
14	ICP-MS	Rh	KED	He	400	NA	109
15	ICP-OES-AV	Lu			83	NA	328.068
16	ICP-MS	103	ORS	He	500	NA	107
17	ICP-OES-AV	Lutetium	NA	NA	50	NA	328.068nm
18	ICP-OES-AV	Lu	NA	NA	50	NA	328.289
19	ICP-MS	Rh	ORS	He	500	NA	107 (m/z)
20	ICP-MS	Y	Collision cell	He	800	NA	107
21	ICP-MS	103	ORS	He	50	NA	107
24	ICP-OES-RV					NA	328.068
26	ICP-MS	103 Rh	ORS	He	20	NA	107 m/z

Table 112 Instrument Conditions Al

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Sc	UC	He	625	NA	27
3	ICP-OES-AV	Bi 223.061			80	80	237.312
5	ICP-MS	Rhodium	KED	He	1000	NA	26.982 m/z
6	ICP-MS/MS	Sc	CRI	He	500	NA	27
8	ICP-MS	Ir, Rh & Sc	NA	NA	50	NA	27 m/z
9	ICP-MS					NA	
10	ICP-MS	Sc			250	NA	
11	ICP-OES-AV-buffer	Lu	NA	NA	50	NA	237.312
12	ICP-OES-AV	Eu				NA	236.705
13	ICP-OES-AV	Y 371.029	NA	NA	50	NA	256.798 (nm)
14	ICP-MS	Sc	KED	He	1000	NA	27
15	ICP-OES-AV	Lu			83	NA	365.152
16	ICP-MS	72	ORS	Standard Mode	500	NA	27
17	ICP-OES-AV	Lutetium	NA	NA	50	NA	236.705nm
18	ICP-OES-AV	Lu	NA	NA	50	NA	236.705
19	ICP-MS	Sc	ORS	He	5000	NA	27 (m/z)
20	ICP OES	Y	N/A	N/A	4000	NA	396.153
21	ICP-OES-AV	Eu			50	NA	396
24	ICP-OES-RV					NA	167.019
26	ICP-MS	45 Sc	ORS	He	20	NA	27 m/z
27	ICP-OES-RV	Yttrium				NA	

Table 113 Instrument Conditions As

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Rh	UC	He	625	625	75
3	ICP-OES-AV	Bi 223.061			80	80	188.98
4	ICP-MS	Rh	NA	He	NA	500	
5	ICP-MS	Rhodium	KED	He	1000	1000	74.922 m/z
6	ICP-MS/MS	Rh	CRI	He	500	500	27
8	ICP-MS	Ir, Rh & Sc	NA	NA	50	50	75 m/z
9	ICP-MS					NA	
10	ICP-MS	Rh	UC	He	250	250	
11	ICP-OES-AV-buffer	Lu	NA	NA	50	NA	188.98
12	ICP-MS	Sc,Ir,Rh	ORS	He			75
13	ICP-OES-AV	Y 371.029	NA	NA	50	50	188.98 (nm)
14	ICP-MS	Te	KED	He	400	400	75
15	ICP-OES-AV	Lu			83	83	188.98
16	ICP-MS	72	ORS	He	500	500	75
17	ICP-OES-AV	Lutetium	NA	NA	50	50	188.980nm
18	ICP-OES-AV	Lu	NA	NA	50	50	188.98
19	ICP-MS	Rh	ORS	He	500	500	75 (m/z)
20	ICP-MS	Y	Collision cell	He	4000	4000	75
21	ICP-MS	45	ORS	He	50	50	75
24	ICP-OES-RV					NA	188.98
25	ICP-MS	Rh-103	ORS	He	400	400	75
26	ICP-MS	72 Ge	ORS	He	20	20	75 m/z
27	ICP-OES-AV	Yttrium					
28	ICP-MS	Rh	CRI	He	250	NA	77

Table 114 Instrument Conditions B

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Sc	NA	NA	625	625	10
3	ICP-OES-AV	Bi 223.061			80	80	249.678
4	ICP-MS	Sc	NA	He	NA	500	
6	ICP-MS/MS	Sc	CRI	No Gas	500	500	11
8	ICP-OES-AV	Eu & Cs	NA	NA	50	50	249.773 nm
10	ICP-MS	Sc			250	250	
11	ICP-OES-AV-buffer	Lu	NA	NA	50	NA	208.956
12	ICP-OES-AV	Eu					249.772
14	ICP-MS	Sc	KED	He	400	400	10
15	ICP-OES-AV	Lu			83	83	182.577
16	ICP-MS	89	ORS	Standard Mode	500	500	11
17	ICP-OES-AV	Lutetium	NA	NA	50	50	208.956nm
18	ICP-OES-AV	Lu	NA	NA	50	50	182.577
19	ICP-MS	Sc	ORS	He	500	500	11 (mz)
21	ICP-OES-AV	Eu			50	50	250
24	ICP-OES-RV					NA	249.678
26	ICP-MS	45 Sc	ORS	NA	20	20	11 m/z
27	ICP-OES-AV	Yttrium					

Table 115 Instrument Conditions Ba

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Rh	NA	NA	625	625	138
3	ICP-OES-AV	Eu 397.197			80	80	455.403
4	ICP-MS	Rh	NA	He	500	500	
6	ICP-MS/MS	Rh	CRI	He	500	500	135
8	ICP-MS	Ir, Rh & Sc	NA	NA	50	50	138 m/z
10	ICP-MS	In			NA	250	
11	ICP-OES-AV-buffer	Lu	NA	NA	50	NA	455.403
12	ICP-OES-AV	Eu					585.367
13	ICP-OES-AV	Y 371.029	NA	NA	NA	50	585.367 (nm)
14	ICP-MS	Tb	KED	He	NA	400	137
15	ICP-OES-AV	Lu			83	83	493.408
16	ICP-MS	159	ORS	He	NA	500	137
17	ICP-OES-AV	Lutetium	NA	NA	50	50	230.424nm
18	ICP-OES-AV	Lu	NA	NA	50	50	230.424
19	ICP-MS	Rh	ORS	He	500	500	135 (m/z)
20	ICP-MS	Y	Collision cell	He	400	400	137
21	ICP-MS	193	ORS	He	50	50	137
24	ICP-OES-RV					NA	455.403
26	ICP-MS	103 Rh	ORS	He	20	20	137 m/z
27	ICP-OES-AV	Yttrium					

Table 116 Instrument Conditions Be

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Sc	NA	NA	625	625	9
3	ICP-OES-AV	Lu 307.760			80	80	313.107
4	ICP-MS	Sc	NA	Standard Mode	NA	500	
6	ICP-MS/MS	Sc	CRI	No Gas	NA	500	9
8	ICP-MS	Ir, Rh & Sc	NA	NA	NA	50	9 m/z
10	ICP-MS	Sc			NA	250	
11	ICP-OES-AV-buffer	Lu	NA	NA	NA	50	313.107
12	ICP-MS	Sc,Ir,Rh	ORS	He	NA		9
13	ICP-OES-AV	Y 371.029	NA	NA	NA	50	234.861 (nm)
14	ICP-MS	Sc	KED	He	NA	400	9
15	ICP-OES-AV	Lu			NA	83	313.042
16	ICP-MS	72	ORS	Standard Mode	NA	500	9
17	ICP-OES-AV	Lutetium	NA	NA	NA	50	313.042nm
18	ICP-OES-AV	Lu	NA	NA	NA	50	313.107
19	ICP-MS	Sc	ORS	Standard Mode	NA	500	9 (m/z)
21	ICP-MS	45			NA	50	9
24	ICP-OES-RV					NA	
26	ICP-MS	45 Sc	ORS	NA	NA	20	9 m/z
27	ICP-OES-AV	Yttrium			NA		

Table 117 Instrument Conditions Bi

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Ir	NA	NA	625	NA	209
6	ICP-MS/MS	Lu	CRI	He	500	NA	209
8	ICP-MS	Ir, Rh & Sc	NA	NA	50	NA	209 m/z
10	ICP-MS	Ir			250	NA	
11	ICP-MS	Lu	ORS	Standard Mode	1000	NA	209
12	ICP-MS	Sc,Ir,Rh	ORS	He		NA	209
14	ICP-MS	Tb	KED	He	400	NA	209
15	ICP-OES-AV	Lu			83	NA	223.061
16	ICP-MS	159	ORS	Standard Mode	500	NA	209
17	ICP-MS	Lutetium	ORS	No Gas	1000	NA	m/z 209
18	ICP-MS	Lu	ORS	standard mode	50	NA	209
19	ICP-MS	Lu	ORS	He	500	NA	209 (m/z)
20	ICP OES	Y	N/A	N/A	80	NA	223.061
21	ICP-MS	193	ORS	He	50	NA	209
25	ICP-MS	Ir-193	ORS	Standard Mode	400	NA	209
26	ICP-MS	175 Lu	ORS	He	20	NA	209 m/z

Table 118 Instrument Conditions Ca

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Sc	UC	He	NA	NA	44
3	ICP-OES-RV	Eu 290.667			80	80	317.933
4	ICP-MS	Sc	NA		500	NA	
6	ICP-MS/MS	Sc	CRI	H2	500	NA	40
8	ICP-OES-AV	Eu & Cs	NA	NA	50	NA	315.887, 370.602 nm
9	ICP-MS					NA	
10	ICP-MS	Sc	UC	He	250	NA	
11	ICP-OES-AV-buffer	Lu	NA	NA	NA	50	315.887
12	ICP-OES-AV	Eu				NA	315.885
13	ICP-OES-AV	Y 371.029	NA	NA	50	NA	210.234 (nm)
14	ICP-MS	Sc	KED	He	1000	NA	43
15	ICP-OES-AV	Lu			83	NA	317.933
16	ICP-MS	89	ORS	H2	500	NA	40
17	ICP-OES-AV	Lutetium	NA	NA	50	NA	315.887nm
18	ICP-OES-AV	Lu	NA	NA	50	NA	315.887
19	ICP-MS	Sc	ORS	H2	500/100	NA	40 (m/z)
20	ICP OES	Y	N/A	N/A	4000 / 80	NA	317.933
21	ICP-OES-AV	Eu			50	NA	316
24	ICP-OES-RV				NA		315.887
26	ICP-MS	72 Ge	ORS	H2	100	100	40 m/z
27	ICP-OES-RV	Yttrium				NA	

Table 119 Instrument Conditions Cd

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Rh	NA	NA	625	625	111
3	ICP-OES-AV	Lu 307.760			80	80	214.439
4	ICP-MS	Rh	NA	He	NA	500	
5	ICP-MS	Rhodium	KED	He	NA	1000	110.904 m/z
6	ICP-MS/MS	Rh	CRI	He	NA	500	111
8	ICP-MS	Ir, Rh & Sc	NA	NA	NA	50	114 m/z
10	ICP-MS	Rh			NA	250	
11	ICP-OES-AV-buffer	Lu	NA	NA	50	NA	228.802
12	ICP-MS	Sc,Ir,Rh	ORS	He	NA		111
13	ICP-OES-AV	Y 371.029	NA	NA	NA	50	228.802 (nm)
14	ICP-MS	Rh	KED	He	400	400	111
15	ICP-OES-AV	Lu			NA	83	214.439
16	ICP-MS	103	ORS	He	NA	500	111
17	ICP-OES-AV	Lutetium	NA	NA	NA	50	214.439nm
18	ICP-OES-AV	Lu	NA	NA	NA	50	228.802
19	ICP-MS	Rh	ORS	He	NA	500	111 (m/z)
20	ICP-MS	Y	Collision cell	He	NA	400	112
21	ICP-MS	103	ORS	He	NA	50	111
24	ICP-OES-RV					NA	214.439
26	ICP-MS	103 Rh	ORS	He	NA	20	114 m/z
27	ICP-OES-AV	Yttrium			NA		

Table 120 Instrument Conditions Co

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Ge	UC	He	625	625	59
3	ICP-OES-AV	Lu 219.556			80	80	228.615
4	ICP-MS	Sc	NA	He	NA	500	
5	ICP-MS	Rhodium	KED	He	NA	1000	58.933 m/z
6	ICP-MS/MS	Sc	CRI	He	NA	500	59
8	ICP-MS	Ir, Rh & Sc	NA	NA	NA	50	59 m/z
10	ICP-MS	Rh	UC	He	NA	250	
11	ICP-OES-AV-buffer	Lu	NA	NA	50	NA	230.786
12	ICP-MS	Sc,Ir,Rh	ORS	He	NA		59
13	ICP-OES-AV	Y 371.029	NA	NA	NA	50	230.786 (nm)
14	ICP-MS	Ga	KED	He	NA	400	59
15	ICP-OES-AV	Lu			NA	83	230.786
16	ICP-MS	103	ORS	He	NA	500	59
17	ICP-OES-AV	Lutetium	NA	NA	NA	50	231.160nm
18	ICP-OES-AV	Lu	NA	NA	NA	50	228.615
19	ICP-MS	Sc	ORS	He	NA	500	59 (m/z)
20	ICP OES	Y	N/A	N/A	NA	80	228.616
21	ICP-MS	45	ORS	He	NA	50	59
24	ICP-OES-RV					NA	228.615
26	ICP-MS	45 Sc	ORS	He	NA	20	59 m/z
27	ICP-OES-AV	Yttrium			NA		

Table 121 Instrument Conditions Cr

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Sc	UC	He	625	625	52
3	ICP-OES-AV	Lu 219.556			80	80	205.56
4	ICP-MS	Sc	NA	He	NA	500	
5	ICP-MS	Rhodium	KED	He	1000	1000	51.941 m/z
6	ICP-MS/MS	Sc	CRI	He	500	500	52
8	ICP-MS	Ir, Rh & Sc	NA	NA	50	50	52 m/z
9	ICP-MS					NA	
10	ICP-MS	Sc	UC	He	250	250	
11	ICP-OES-AV-buffer	Lu	NA	NA	50	NA	267.716
12	ICP-MS	Sc,Ir,Rh	ORS	He			52
13	ICP-OES-AV	Y 371.029	NA	NA	50	50	267.716 (nm)
14	ICP-MS	Sc	KED	He	400	400	52
15	ICP-OES-AV	Lu			83	83	267.716
16	ICP-MS	72	ORS	He	500	500	52
17	ICP-OES-AV	Lutetium	NA	NA	50	50	205.560nm
18	ICP-OES-AV	Lu	NA	NA	50	50	205.56
19	ICP-MS	Sc	ORS	He	500	500	52 (m/z)
20	ICP-MS	Y	Collision cell	He	4000	4000	52
21	ICP-MS	45	ORS	He	50	50	52
24	ICP-OES-RV					NA	267.716
25	ICP-MS	Rh-103	ORS	He	400	400	52
26	ICP-MS	45 Sc	ORS	He	20	20	52 m/z
27	ICP-OES-AV	Yttrium					
28	ICP-MS	Rh	CRI	He	250	NA	53

Table 122 Instrument Conditions Cu

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Ge	UC	He	625	625	63
3	ICP-OES-AV	In 303.936			80	80	327.395
4	ICP-MS	Sc	NA	He	NA	500	
5	ICP-MS	Rhodium	KED	He	1000	1000	62.93 m/z
6	ICP-MS/MS	Sc	CRI	He	500	500	63
8	ICP-MS	Ir, Rh & Sc	NA	NA	50	50	63 m/z
9	ICP-MS					NA	
10	ICP-MS	Rh	UC	He	250	250	
11	ICP-OES-AV-buffer	Lu	NA	NA	50	50	324.754
12	ICP-MS	Sc,Ir,Rh	ORS	He			63
13	ICP-OES-AV	Y 371.029	NA	NA	50	50	327.395 (nm)
14	ICP-MS	Ga	KED	He	400	400	63
15	ICP-OES-AV	Lu			83	83	327.395
16	ICP-MS	103	ORS	He	500	500	63
17	ICP-OES-AV	Lutetium	NA	NA	50	50	324.754nm
18	ICP-OES-AV	Lu	NA	NA	50	50	324.754
19	ICP-MS	Sc	ORS	He	500	500	63 (m/z)
20	ICP-MS	Y	Collision cell	He	4000	4000	65
21	ICP-MS	45	ORS	He	50	50	63
24	ICP-OES-RV					NA	324.754
25	ICP-MS	Rh-103	ORS	He	400	400	63
26	ICP-MS	45 Sc	ORS	He	20	20	63 m/z
27	ICP-OES-AV	Yttrium					
28	ICP-MS	Rh	CRI	He	250	NA	63

Table 123 Instrument Conditions Fe

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Sc	UC	He	NA	NA	56
3	ICP-OES-RV	Eu 271.700			80	80	238.204
4	ICP-MS	Sc	NA	He	500	NA	
5	ICP-MS	Rhodium	KED	He	1000	NA	55.935 m/z
6	ICP-MS/MS	Sc	CRI	He	500	NA	56
8	ICP-OES-AV	Eu & Cs	NA	NA	50	NA	238.204, 258.588, 259.940 nm
9	ICP-MS					NA	
10	ICP-MS	Sc	UC	He	250	NA	
11	ICP-OES-AV-buffer	Lu	NA	NA	50	NA	261.187
12	ICP-OES-AV	Eu				NA	258.588
13	ICP-OES-AV	Y 371.029	NA	NA	50	NA	370.792 (nm)
14	ICP-MS	Sc	KED	He	1000	NA	56
15	ICP-OES-AV	Lu			83	NA	238.204
16	ICP-MS	103	ORS	H2	2500	NA	56
17	ICP-OES-AV	Lutetium	NA	NA	50	NA	234.350nm
18	ICP-OES-AV	Lu	NA	NA	50	NA	261.382
19	ICP-MS	Sc	ORS	He	5000	NA	56 (m/z)
20	ICP OES	Y	N/A	N/A	4000	NA	238.204
21	ICP-OES-AV	Eu			50	NA	260
24	ICP-OES-RV				NA		234.35
25	ICP-MS	Rh-103	ORS	HeHe	40000	NA	56
26	ICP-MS	45 Sc	ORS	He	20	NA	56 m/z
27	ICP-OES-RV	Yttrium				NA	

Table 124 Instrument Conditions Ga

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
4	ICP-MS	Rh	NA	He	NA	500	
8	ICP-MS	Ir, Rh & Sc	NA	NA	NA	50	69 m/z
11	ICP-MS	Ge	ORS	standard mode	NA	1000	71
12	ICP-MS	Sc,Ir,Rh	ORS	He	NA		71
17	ICP-MS	Indium	ORS	He	NA	1000	m/z 71
18	ICP-MS/MS	Ge	ORS	standard mode	NA	50	71
21	ICP-MS	45	ORS	He	NA	50	71

Table 125 Instrument Conditions Hg

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Ir	NA	NA	625	NA	201
3	ICP-OES-AV	Lu 307.760			80	80	194.164
5	ICP-MS	Iridium	KED	He	1000	NA	201.971 m/z
6	ICP-MS/MS	Lu	CRI	He	500	NA	202
8	ICP-MS	Ir, Rh & Sc	NA	NA	50	NA	202 m/z
9	ICP-MS					NA	
10	ICP-MS	Ir			250	NA	
11	CVAAS	NA	NA	NA	50	NA	253.7
12	AAS	NA				NA	253.7
13	CVAFS	NA	NA	NA	500	NA	254 (nm)
14	ICP-MS	Tb	KED	He	400	400	201
15	CVAAS				83	NA	253.7
16	ICP-MS	193	ORS	Standard Mode	500	NA	201
17	CVAAS	NA	NA	NA	500	NA	253.7nm
18	CVAAS	NA	NA	NA	50	NA	253.7
19	ICP-MS	Lu	ORS	He	500	NA	202 (m/z)
20	ICP-MS	Y	Collision cell	He	160	NA	202
21	CVAAS				50	NA	253
24	ICP-OES-RV					NA	
25	ICP-MS	Ir-193	ORS	He	400	NA	201
26	ICP-MS	175 Lu	ORS	He	20	NA	202 m/z
27	CVAAS					NA	
28	ICP-MS	Tb	CRI	He	250	NA	200

Table 126 Instrument Conditions K

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Sc	UC	He	NA	NA	39
3	ICP-OES-RV	In 410.176			80	80	766.491
4	ICP-MS	Sc	NA	He	100	NA	
6	ICP-MS/MS	Sc	CRI	He	500	NA	39
8	ICP-OES-AV	Eu & Cs	NA	NA	50	NA	404.721, 766.491 nm
11	ICP-OES-AV-buffer	Lu	NA	NA	50	NA	766.491
12	ICP-OES-AV	Eu				NA	766.491
15	ICP-OES-AV	Lu			83	NA	769.897
17	ICP-OES-AV	Lutetium	NA	NA	50	NA	766.491nm
18	ICP-OES-AV	Lu	NA	NA	50	NA	766.491
19	ICP-MS	Sc	ORS	He	100	NA	39 (m/z)
20	ICP OES	Y	N/A	N/A	80	NA	766.49
21	ICP-OES-AV	Eu			50	NA	766
24	ICP-OES-RV				NA		766.491
26	ICP-MS	72 Ge	ORS	He	100	NA	39 m/z
27	ICP-OES-RV	Yttrium				NA	

Table 127 Instrument Conditions La

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
4	ICP-MS	Lu	NA	He	NA	500	
8	ICP-MS	Ir, Rh & Sc	NA	NA	NA	50	139 m/z
10	ICP-MS	In			NA	250	
11	ICP-OES-AV-buffer	Lu	NA	NA	50	50	333.749
12	ICP-MS	Sc,Ir,Rh	ORS	He	NA		139
14	ICP-MS	Tb	KED	He	NA	400	139
16	ICP-MS	159	ORS	He	NA	500	139
17	ICP-MS	Lutetium	ORS	No Gas	NA	1000	m/z 139
18	ICP-MS	Lu	NA	He	NA	50	139
21	ICP-MS	193	ORS	He	NA	50	139
24	ICP-OES-RV					NA	670.783

Table 128 Instrument Conditions Li

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Sc	NA	NA	625	NA	7
3	ICP-OES-AV	In 410.176			80	80	670.783
6	ICP-MS/MS	Sc	CRI	No Gas	500	NA	7
8	ICP-MS	Ir, Rh & Sc	NA	NA	50	NA	7 m/z
10	ICP-MS	Sc			250	NA	
11	ICP-OES-AV-buffer	Lu	NA	NA	50	NA	670.783
12	ICP-MS	Sc,Ir,Rh	ORS	He		NA	7
14	ICP-MS	Sc	KED	He	1000	NA	7
15	ICP-OES-AV	Lu			83	NA	670.783
16	ICP-MS	72	ORS	H2	500	NA	7
17	ICP-OES-AV	Lutetium	NA	NA	50	NA	670.783nm
18	ICP-OES-AV	Lu	NA	NA	50	NA	670.783
19	ICP-MS	Sc	ORS	Standard Mode	500	NA	7 (m/z)
20	ICP OES	Y	N/A	N/A	80	NA	670.784
21	ICP-MS	45			50	NA	7
24	ICP-OES-RV				NA		383.23
26	ICP-MS	45 Sc	ORS	NA	20	NA	7 m/z
27	ICP-OES-AV	Yttrium				NA	

Table 129 Instrument Conditions Mg

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Sc	UC	He	625	NA	25
3	ICP-OES-RV	In 303.936			80	80	285.213
4	ICP-MS	Sc	NA	He	100	NA	
6	ICP-MS/MS	Sc	CRI	He	500	NA	24
8	ICP-OES-AV	Eu & Cs	NA	NA	50	NA	383.829 nm
11	ICP-OES-AV-buffer	Lu	NA	NA	50	NA	278.142
12	ICP-OES-AV	Eu				NA	383.33
15	ICP-OES-AV	Lu			83	NA	383.829
17	ICP-OES-AV	Lutetium	NA	NA	50	NA	279.800nm
18	ICP-OES-AV	Lu	NA	NA	50	NA	279.8
19	ICP-MS	Sc	ORS	He	100	NA	24 (m/z)
20	ICP OES	Y	N/A	N/A	80	NA	285.213
21	ICP-OES-AV	Eu			50	NA	384
24	ICP-OES-RV					NA	257.61
26	ICP-MS	72 Ge	ORS	He	20	NA	24 m/z
27	ICP-OES-RV	Yttrium				NA	

Table 130 Instrument Conditions Mn

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Sc	UC	He	625	625	55
3	ICP-OES-AV	Eu 271.700			80	80	257.61
4	ICP-MS	Sc	NA	He	NA	500	
5	ICP-MS	Rhodium	KED	He	1000	1000	54.938 m/z
6	ICP-MS/MS	Sc	CRI	He	500	500	55
8	ICP-MS	Ir, Rh & Sc	NA	NA	50	50	55 m/z
9	ICP-MS					NA	
10	ICP-MS	Sc	UC	He	250	250	
11	ICP-OES-AV-buffer	Lu	NA	NA	50	50	257.61
12	ICP-MS	Sc,Ir,Rh	ORS	He			55
13	ICP-OES-AV	Y 371.029	NA	NA	50	50	293.931 (nm)
14	ICP-MS	Sc	KED	He	1000	1000	55
15	ICP-OES-AV	Lu			83	83	260.568
16	ICP-MS	103	ORS	Standard Mode	500	500	55
17	ICP-OES-AV	Lutetium	NA	NA	50	50	257.610nm
18	ICP-OES-AV	Lu	NA	NA	50	50	257.61
19	ICP-MS	Sc	ORS	He	500	500	55 (m/z)
20	ICP-MS	Y	Collision cell	He	4000	4000	55
21	ICP-MS	45	ORS	He	50	50	55
24	ICP-OES-RV					NA	202.032
26	ICP-MS	45 Sc	ORS	He	20	20	55 m/z
27	ICP-OES-AV	Yttrium					
28	ICP-MS	Rh	CRI	He	250	NA	55

Table 131 Instrument Conditions Mo

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Rh	NA	NA	625	NA	95
3	ICP-OES-AV	Lu 219.556			80	80	202.032
6	ICP-MS/MS	Sc	CRI	He	500	NA	95
8	ICP-MS	Ir, Rh & Sc	NA	NA	50	NA	95 m/z
9	ICP-MS					NA	
10	ICP-MS	Rh	UC	He	250	NA	
11	ICP-OES-AV-buffer	Lu	NA	NA	50	NA	202.032
12	ICP-MS	Sc,Ir,Rh	ORS	He		NA	95
13	ICP-OES-AV	Y 371.029	NA	NA	50	NA	202.032 (nm)
14	ICP-MS	Rh	KED	He	400	NA	98
15	ICP-OES-AV	Lu			83	NA	208.568
16	ICP-MS	89	ORS	He	500	NA	95
17	ICP-OES-AV	Lutetium	NA	NA	50	NA	202.032nm
18	ICP-OES-AV	Lu	NA	NA	50	NA	202.032
19	ICP-MS	Rh	ORS	He	500	NA	95 (m/z)
20	ICP-MS	Y	Collision cell	He	4000	NA	98
21	ICP-MS	103	ORS	He	50	NA	95
24	ICP-OES-RV						589.592
25	ICP-MS	Rh-103	ORS	Standard Mode	400	NA	95
26	ICP-MS	72 Ge	ORS	He	20	NA	95 m/z
27	ICP-OES-AV	Yttrium				NA	

Table 132 Instrument Conditions Na

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Sc	UC	He	625	625	23
3	ICP-OES-AV	In 410.176			80	80	589.592
4	ICP-MS	Sc	NA	He	500	100	
6	ICP-MS/MS	Sc	CRI	He	500	500	23
8	ICP-OES-AV	Eu & Cs	NA	NA	50	50	330.237, 589.592 nm
10	ICP-MS	Sc	UC	He	NA	250	
11	ICP-OES-AV-buffer	Lu	NA	NA	50	50	589.592
12	ICP-OES-AV	Eu					589.592
13	ICP-OES-AV	Y 371.029	NA	NA	NA	50	588.995 (nm)
14	ICP-MS	Sc	KED	He	NA	1000	23
15	ICP-OES-AV	Lu			83	83	330.237
16	ICP-MS	89	ORS	H2	NA	500	23
17	ICP-OES-AV	Lutetium	NA	NA	50	50	588.995nm
18	ICP-OES-AV	Lu	NA	NA	50	50	588.995
19	ICP-MS	Sc	ORS	He	100	100	23 (m/z)
20	ICP OES	Y	N/A	N/A	80	80	589.592
21	ICP-OES-AV	Eu			50	50	590
24	ICP-OES-RV					NA	216.555
26	ICP-MS	72 Ge	ORS	He	100	100	23 m/z
27	ICP-OES-RV	Yttrium					

Table 133 Instrument Conditions Ni

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Ge	UC	He	625	625	60
3	ICP-OES-AV	Lu 219.556			80	80	231.604
4	ICP-MS	Sc	NA	He	NA	500	
5	ICP-MS	Rhodium	KED	He	1000	1000	59.933 m/z
6	ICP-MS/MS	Sc	CRI	He	500	500	60
8	ICP-MS	Ir, Rh & Sc	NA	NA	50	50	60 m/z
9	ICP-MS					NA	
10	ICP-MS	Rh	UC	He	250	250	
11	ICP-OES-AV-buffer	Lu	NA	NA	50	NA	231.604
12	ICP-MS	Sc,Ir,Rh	ORS	He			60
13	ICP-OES-AV	Y 371.029	NA	NA	50	50	231.604 (nm)
14	ICP-MS	Ga	KED	He	400	400	60
15	ICP-OES-AV	Lu			83	83	231.604
16	ICP-MS	103	ORS	He	500	500	60
17	ICP-OES-AV	Lutetium	NA	NA	50	50	231.604nm
18	ICP-OES-AV	Lu	NA	NA	50	50	231.604
19	ICP-MS	Sc	ORS	He	500	500	60 (m/z)
20	ICP-MS	Y	Collision cell	He	4000	4000	60
21	ICP-MS	45	ORS	He	50	50	60
25	ICP-MS	Rh-103	ORS	He	400		60
26	ICP-MS	45 Sc	ORS	He	20	20	60 m/z
27	ICP-OES-AV	Yttrium					
28	ICP-MS	Rh	CRI	He	250	NA	60

Table 134 Instrument Conditions P

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Sc	UC	He	625	625	31
3	ICP-OES-AV	Bi 223.061			80	80	185.878
4	ICP-MS	Sc	NA	He	100	100	
6	ICP-MS/MS	Sc	CRI	HEHe	500	500	31
8	ICP-OES-AV	Eu & Cs	NA	NA	50	50	213.617 nm
10	ICP-MS	Sc	UC	He	NA	250	
11	ICP-OES-AV-buffer	Lu	NA	NA	NA	1000	213.618
12	ICP-OES-AV	Eu					185.827
14	ICP-MS	Sc	KED	He	NA	1000	31
15	ICP-OES-AV	Lu			83	83	213.618
16	ICP-MS	72	ORS	He	NA	500	31
17	ICP-OES-AV	Lutetium	NA	NA	50	50	213.618nm
18	ICP-OES-AV	Lu	NA	NA	50	50	182.143
19	ICP-MS	Sc	ORS	He	500	500	31 (m/z)
21	ICP-OES-AV	Eu			50	50	186
24	ICP-OES-RV					NA	22.353
26	ICP-MS	72 Ge	ORS	He	NA	100	31 m/z
27	ICP-OES-AV	Yttrium					

Table 135 Instrument Conditions Pb

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Ir	NA	NA	625	625	206+207+208
3	ICP-OES-AV	Lu 219.556			80	80	220.353
4	ICP-MS	Lu	NA	He	NA	500	
5	ICP-MS	Iridium	KED	He	1000	1000	207.977 m/z
6	ICP-MS/MS	Lu	CRI	He	500	500	208
8	ICP-MS	Ir, Rh & Sc	NA	NA	50	50	208 m/z
9	ICP-MS					NA	
10	ICP-MS	Ir			250	250	
11	ICP-OES-AV-buffer	Lu	NA	NA	50	NA	220.353
12	ICP-MS	Sc,Ir,Rh	ORS	He			208
13	ICP-OES-AV	Y 371.029	NA	NA	50	50	220.353 (nm)
14	ICP-MS	Tb	KED	He	400	400	206+207+208
15	ICP-OES-AV	Lu			83	83	220.353
16	ICP-MS	159	ORS	Standard Mode	500	500	206+207+208
17	ICP-OES-AV	Lutetium	NA	NA	50	50	220.353nm
18	ICP-OES-AV	Lu	NA	NA	50	50	220.353
19	ICP-MS	Lu	ORS	He	500	500	208 (m/z)
20	ICP OES	Y	N/A	N/A	80	80	220.353
21	ICP-MS	193	ORS	He	50	50	208
25	ICP-MS	Ir-193	ORS	Standard Mode	400		208+207+206
26	ICP-MS	175 Lu	ORS	He	20	20	208 m/z
27	ICP-OES-AV	Yttrium					
28	ICP-MS	Bi	CRI	He	250	NA	206+207+208

Table 136 Instrument Conditions Rb

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
8	ICP-MS	Ir, Rh & Sc	NA	NA	NA	50	85 m/z
10	ICP-MS	Rh			NA	250	
11	ICP-MS	Ge	ORS	standard mode	1000	NA	85
12	ICP-MS	Sc,Ir,Rh	ORS	He	NA		85
14	ICP-MS	Rh	KED	He	NA	400	85
16	ICP-MS	89	ORS	He	NA	500	85
17	ICP-MS	Rhodium	ORS	He	NA	1000	m/z 85
18	ICP-MS	Ge	ORS	standard mode	NA	50	85
21	ICP-MS	45	ORS	He	NA	50	85

Table 137 Instrument Conditions S

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-OES-AV	Lu	NA	NA	62.5	NA	181.975
3	ICP-OES-AV	Bi 223.061			80	80	181.972
4	ICP-MS	Sc	NA	H2	500	NA	
8	ICP-OES-AV	Eu & Cs	NA	NA	50	NA	180.731 nm
11	ICP-OES-AV-buffer	Lu	NA	NA	NA	1000	181.972
12	ICP-OES-AV	Eu				NA	181.972
15	ICP-OES-AV	Lu			83	NA	181.972
17	ICP-OES-AV	Lutetium	NA	NA	50	NA	181.972nm
18	ICP-OES-AV	Lu	NA	NA	50	NA	181.972
21	ICP-OES-AV	Eu			50	NA	182
24	ICP-OES-RV					NA	217.582
26	ICP-MS/MS	45 Sc - > 61 Sc	ORS	O2	2000	NA	32 S - > 48 S (m/z)
27	ICP-OES-AV	Yttrium				NA	

Table 138 Instrument Conditions Sb

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Rh	NA	NA	625	NA	121
3	ICP-OES-AV	Bi 223.061			80	80	206.834
6	ICP-MS/MS	Rh	CRI	He	500	NA	123
8	ICP-MS	Ir, Rh & Sc	NA	NA	50	NA	121 m/z
9	ICP-MS					NA	
10	ICP-MS	Rh			250	NA	
11	ICP-OES-AV-buffer	Lu	NA	NA	50	NA	206.834
12	ICP-MS	Sc,Ir,Rh	ORS	He		NA	121
14	ICP-MS	Rh	KED	He	400	NA	121
15	ICP-OES-AV	Lu			83	NA	206.834
16	ICP-MS	193	ORS	Standard Mode	500	NA	121
17	ICP-OES-AV	Lutetium	NA	NA	50	NA	206.834nm
18	ICP-OES-AV	Lu	NA	NA	50	NA	206.834
19	ICP-MS	Rh	ORS	He	500	NA	123 (m/z)
20	ICP-MS	Y	Collision cell	He	400	NA	121
21	ICP-MS	45	ORS	He	50	NA	121
24	ICP-OES-RV					NA	196.026
25	ICP-MS	Ir-193	ORS	Standard Mode	400	NA	121
26	ICP-MS	175 Lu	ORS	He	20	NA	121 m/z
27	ICP-OES-AV	Yttrium				NA	

Table 139 Instrument Conditions Se

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Rh	DRC	NH3	625	625	82
3	ICP-OES-AV	Bi 223.061			80	80	196.026
4	ICP-MS	Sc	NA	H2	NA	500	
6	ICP-MS/MS	Sc	CRI	H2	500	500	78
8	ICP-MS	Ir, Rh & Sc	NA	NA	50	50	78 m/z
9	ICP-MS					NA	
10	ICP-MS	Rh	UC	He	250	250	
11	ICP-OES-AV-buffer	Lu	NA	NA	50	50	196.026
12	ICP-MS	Sc,Ir,Rh	ORS	He			78
13	ICP-OES-AV	Y 371.029	NA	NA	50	50	196.026 (nm)
14	ICP-MS	Te	KED	He	400	400	82
15	ICP-OES-AV	Lu			83	83	196.026
16	ICP-MS	72	ORS	H2	500	500	78
17	ICP-OES-AV	Lutetium	NA	NA	50	50	196.026nm
18	ICP-OES-AV	Lu	NA	NA	50	50	196.026
19	ICP-MS	Sc	ORS	H2	500	500	78 (m/z)
20	ICP-MS	Y	Collision cell	He	4000	4000	78
21	ICP-MS	45	ORS	HEHe	50	50	78
25	ICP-MS	Rh-103	ORS	HeHe	400		78
26	ICP-MS	72 Ge	ORS	He	20	20	78 m/z

Table 140 Instrument Conditions Sn

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Rh	NA	NA	625	625	118
3	ICP-OES-RV	Lu 219.556			80	80	189.925
4	ICP-MS	Rh	NA	He	NA	500	
6	ICP-MS/MS	Rh	CRI	He	500	500	118
8	ICP-MS	Ir, Rh & Sc	NA	NA	50	50	116 m/z
10	ICP-MS	Rh			250	250	
11	ICP-OES-AV-buffer	Lu	NA	NA	50	50	189.925
12	ICP-MS	Sc,Ir,Rh	ORS	He			118
14	ICP-MS	Rh	KED	He	400	400	120
15	ICP-OES-AV	Lu			83	83	189.925
16	ICP-MS	103	ORS	He	500	500	118
17	ICP-OES-AV	Lutetium	NA	NA	50	50	189.925nm
18	ICP-OES-AV	Lu	NA	NA	50	50	189.925
19	ICP-MS	Rh	ORS	He	500	500	118 (m/z)
21	ICP-MS	45	ORS	He	50	50	118
26	ICP-MS	175 Lu	ORS	He	20	20	118 m/z

Table 141 Instrument Conditions Sr

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Rh	NA	NA	625	625	88
3	ICP-OES-RV	Eu 390.711			80	80	407.771
4	ICP-MS	Rh	NA	He	500	500	
6	ICP-MS/MS	Sc	CRI	He	500	500	88
8	ICP-MS	Ir, Rh & Sc	NA	NA	50	50	88 m/z
10	ICP-MS	Rh			NA	250	
11	ICP-OES-AV-buffer	Lu	NA	NA	50	50	407.771
12	ICP-MS	Sc,Ir,Rh	ORS	He			88
14	ICP-MS	Rh	KED	He	NA	400	88
15	ICP-OES-AV	Lu			83	83	407.771
16	ICP-MS	89	ORS	He	NA	2500	88
17	ICP-OES-AV	Lutetium	NA	NA	50	50	407.771nm
18	ICP-OES-AV	Lu	NA	NA	50	50	421.552
19	ICP-MS	Rh	ORS	He	500	500	88 (m/z)
20	ICP OES	Y	N/A	N/A	80	80	421.552
21	ICP-MS	45	ORS	He	50	50	88
26	ICP-MS	72 Ge	ORS	He	20	20	88 m/z
27	ICP-OES-AV	Yttrium					

Table 142 Instrument Conditions Th

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Ir	NA	NA	625	NA	232
8	ICP-MS	Ir, Rh & Sc	NA	NA	50	NA	232 m/z
9	ICP-MS					NA	
11	ICP-MS	Ge	ORS	Standard Mode	1000	NA	232
12	ICP-MS	Sc,Ir,Rh	ORS	He		NA	232
17	ICP-MS	Lutetium	ORS	No Gas	1000	NA	m/z 232
18	ICP-MS/MS	Ge	ORS	Standard Mode	50	NA	232
21	ICP-MS	193	ORS	He	50	NA	232

Table 143 Instrument Conditions U

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Ir	NA	NA	625	NA	238
6	ICP-MS/MS	Lu	CRI	NA	500	NA	238
8	ICP-MS	Ir, Rh & Sc	NA	NA	50	NA	238 m/z
9	ICP-MS					NA	
10	ICP-MS	Ir			250	NA	
11	ICP-MS	Lu	ORS	standard mode	1000	NA	238
12	ICP-MS	Sc,Ir,Rh	ORS	He		NA	238
14	ICP-MS	Tb	KED	He	400	NA	238
16	ICP-MS	159	ORS	Standard Mode	500	NA	238
17	ICP-MS	Lutetium	ORS	No Gas	1000	NA	m/z 238
18	ICP-MS	Lu	ORS	standard mode	50	NA	238
19	ICP-MS	Lu	ORS	He	500	NA	238 (m/z)
20	ICP-MS	Y	Collision cell	He	400	NA	238
21	ICP-MS	193	ORS	He	50	NA	238
26	ICP-MS	175 Lu	ORS	He	20	NA	238 m/z

Table 144 Instrument Conditions V

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Sc	UC	He	625	625	51
3	ICP-OES-AV	Eu 271.700			80	80	292.401
4	ICP-MS	Sc	NA	He	NA	500	
6	ICP-MS/MS	Sc	CRI	NA	500	500	51
8	ICP-MS	Ir, Rh & Sc	NA	NA	50	50	51 m/z
9	ICP-MS					NA	
10	ICP-MS	Sc	UC	He	250	250	
11	ICP-OES-AV-buffer	Lu	NA	NA	50	50	292.401
12	ICP-MS	Sc,Ir,Rh	ORS	He			51
13	ICP-OES-AV	Y 371.029	NA	NA	50	50	311.837 (nm)
14	ICP-MS	Sc	KED	He	400	400	51
15	ICP-OES-AV	Lu			83	83	292.401
16	ICP-MS	72	ORS	He	500	500	51
17	ICP-OES-AV	Lutetium	NA	NA	50	50	292.401nm
18	ICP-OES-AV	Lu	NA	NA	50	50	292.401
19	ICP-MS	Sc	ORS	He	500	500	51 (m/z)
21	ICP-MS	45	ORS	He	50	50	51
24	ICP-OES-RV					NA	292.401
25	ICP-MS	Rh-103	ORS	He	400		51
26	ICP-MS	45 Sc	ORS	He	20	20	51 m/z
27	ICP-OES-AV	Yttrium					
28	ICP-MS	Rh	CRI	He	250	NA	51

Table 145 Instrument Conditions Zn

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S1/S3 Final Dilution Factor	S2 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-MS	Ge	UC	He	625	625	66
3	ICP-OES-AV	Bi 223.061			80	80	206.2
4	ICP-MS	Sc	NA	He	NA	500	
5	ICP-MS	Rhodium	KED	He	1000	1000	65.926 m/z
6	ICP-MS/MS	Sc	CRI	NA	500	500	66
8	ICP-MS	Ir, Rh & Sc	NA	NA	50	50	64 m/z
9	ICP-MS					NA	
10	ICP-MS	Rh	UC	He	250	250	
11	ICP-OES-AV-buffer	Lu	NA	NA	50	50	206.2
12	ICP-MS	Sc,Ir,Rh	ORS	He			66
13	ICP-OES-AV	Y 371.029	NA	NA	50	50	213.857 (nm)
14	ICP-MS	Ga	KED	He	400	400	66
15	ICP-OES-AV	Lu			83	83	213.857
16	ICP-MS	103	ORS	He	500	500	66
17	ICP-OES-AV	Lutetium	NA	NA	50	50	206.200nm
18	ICP-OES-AV	Lu	NA	NA	50	50	206.2
19	ICP-MS	Sc	ORS	He	500	500	66 (m/z)
20	ICP OES	Y	N/A	N/A	80	80	213.857
21	ICP-MS	45	ORS	He	50	50	66
24	ICP-OES-RV					NA	206.2
25	ICP-MS	Rh-103	ORS	He	400		68
26	ICP-MS	45 Sc	ORS	He	20	20	66 m/z
27	ICP-OES-AV	Yttrium					
28	ICP-MS	Rh	CRI	He	250	NA	64

Table 146 Instrument Conditions Exchangeable Ca^{2+}

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-OES-RV	Y	NA		20	317.933
7	ICP-OES-RV					
8	ICP-OES	Eu & Cs	NA	NA	500	315.887, 370.602nm
11	ICP-OES-AV-buffer	Lu	NA	NA	25	422.673
12	ICP-OES-RV					315.887
15	ICP-OES-AV	Lu			20	317.93
17	ICP-OES-AV	Lu	NA	NA	25	315.887
19	ICP-MS	Sc	ORS	H2	20	40 (m/z)
26	ICP-MS	72 Ge	ORS	H2	200	40 m/z
27	ICP-OES-RV	Yttrium			50	315.887

Table 147 Instrument Conditions Exchangeable K^{+}

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-OES-RV	Y	NA		20	766.49
7	ICP-OES-RV					
8	ICP-OES	Eu & Cs	NA	NA	500	383.829nm
11	ICP-OES-AV-buffer	Lu	NA	NA	25	766.491
12	ICP-OES-RV					383.829
15	ICP-OES-AV	Lu			20	766.49
17	ICP-OES-AV	Lu	NA	NA	25	766.491
19	ICP-MS	Sc	ORS	He	20	39 (m/z)
26	ICP-MS	72 Ge	ORS	He	200	39 m/z
27	ICP-OES-RV	Yttrium			50	279.077

Table 148 Instrument Conditions Exchangeable Mg^{2+}

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-OES-RV	Y	NA		20	285.213
7	ICP-OES-RV					
8	ICP-OES	Eu & Cs	NA	NA	500	330.237, 589.592nm
11	ICP-OES-AV-buffer	Lu	NA	NA	25	285.213
12	ICP-OES-RV					589.592
15	ICP-OES-AV	Lu			20	285.21
17	ICP-OES-AV	Lu	NA	NA	25	279.8
19	ICP-MS	Sc	ORS	He	20	24 (m/z)
26	ICP-MS	72 Ge	ORS	He	200	24 m/z
27	ICP-OES-RV	Yttrium			50	589.592

Table 149 Instrument Conditions Exchangeable Na^{+}

Laboratory Code	Instrument	Internal standard	Reaction Cell	Reaction Gas	S3 Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance(nm)
2	ICP-OES-RV	Y	NA		20	589.592
7	ICP-OES-RV					
8	ICP-OES	Eu & Cs	NA	NA	500	404.721nm, 766.491nm
11	ICP-OES-AV-buffer	Lu	NA	NA	25	589.592
12	ICP-OES-RV					253.7
15	ICP-OES-AV	Lu			20	538.59
17	ICP-OES-AV	Lu	NA	NA	25	588.995
19	ICP-MS	Sc	ORS	He	20	23 (m/z)
26	ICP-MS	72 Ge	ORS	He	200	23 m/z
27	ICP-OES-RV	Yttrium			50	766.49

END OF REPORT