Australian Government
Department of Industry, Science and Resources

National Measurement Institute

Proficiency Test Final Report AQA 26-11 Organic Compounds in Potable Water

August 2026

Our purpose is to help the government build a better future for all Australians through enabling a productive, resilient and sustainable economy, enriched by science and technology.

measurement.gov.au

© Commonwealth of Australia 2026.

Unless otherwise noted, the Commonwealth owns the copyright (and any other intellectual property rights, if any) in this publication.

All material in this publication is provided under a Creative Commons Attribution 4.0 International Licence (CC BY 4.0), with the exception of:

- the Commonwealth Coat of Arms;
- the logo of the Department of Industry, Science and Resources;
- photographs of our staff and premises; and
- content supplied by third parties.

Creative Commons Attribution 4.0 International Licence is a standard form licence agreement that allows you to copy, distribute, transmit and adapt this publication provided you attribute the work. A summary of the licence terms is available at: creativecommons.org/licenses/by/4.0/. Further details are available on the Creative Commons website, at: creativecommons.org/licenses/by/4.0/legalcode.

You may not copy, distribute, transmit or adapt any material in this publication in any way that suggests that this department or the Commonwealth endorses you or any of your services or products.

Attribution

Material contained in this publication is to be attributed to this department as:

© Commonwealth of Australia, Department of Industry, Science and Resources, Proficiency Test Final Report AQA 26-11 Organic Compounds in Potable Water, 2026.

Third party copyright

Wherever a third party holds copyright in material contained in this publication, the copyright remains with that party. Their permission may be required to use the material.

This department has made all reasonable efforts to:

- clearly label material where the copyright is owned by a third party;
- ensure that the copyright owner has consented to this material being contained in this publication.

Using the Commonwealth Coat of Arms

The terms of use for the Coat of Arms are available on the Department of Prime Minister and Cabinet's website, at www.pmc.gov.au/resource-centre/government/commonwealth-coat-arms-information-and-guidelines

ACKNOWLEDGMENTS

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

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

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

Jenny Xu

Geoff Morschel

Jasmine Duong

Luminita Antin

Aaron Mamo

Zoë Baker-Moss

Lesley Johnston

Raluca Iavetz

Manager, Chemical Reference Values

105 Delhi Rd, North Ryde, NSW 2113, Australia

Phone: +61 2 9449 0234

Email: proficiency@measurement.gov.au

Accredited for compliance with ISO/IEC 17043

Accreditation No. 198; Site No. 14485

SUMMARY

This report presents the results of the proficiency testing study AQA 26-11 Organic Compounds in Potable Water.

The sample set consisted of 3 potable water samples. Sample S1 was spiked with volatile organic compounds (VOCs), Sample S2 was spiked with polycyclic aromatic hydrocarbons (PAHs), and Sample S3 was spiked with phenols.

Of a possible 496 results, 408 numeric results (82%) were submitted. Thirty-three results were a 'less than' value (< *x*) or Not Reported (NR), and 55 results were Not Tested (NT).

The assigned values for all scored analytes were the robust averages of participants' results. The associated uncertainties were evaluated from the robust standard deviations of the participants' results. The consensus of participants' results is not traceable to any external reference, so although expressed in SI units, metrological traceability has not been established.

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

i. Assess participants' ability to correctly identify organic compounds in potable water.

Laboratories 3 and 8 reported numeric results for all 23 scored analytes.

Laboratories 6, 9, 13, 14, 15, 16, 19, and 20 did not report numeric results for analytes that they tested for and were present in the test samples (total of 17 results).

Five participants reported additional analytes that were not spiked into the test samples (total of 5 results).

ii. Compare participants' performance and assess their capabilities to measure organic compounds in potable water.

Of 367 z-scores, 301 (82%) returned a score of $|z| \leq 2.0$, indicating an acceptable performance.

Of 367 E_n-scores, 285 (78%) returned a score of $|E_n| < 1.0$, indicating agreement of the participant's result with the assigned value within their respective expanded uncertainties.

Laboratory 8 returned the highest number of acceptable z-scores (22).

iii. Assess the consequence of participants' results for organic compounds in potable water against regulatory guidelines.

Of the 164 results assessed against the Australian Drinking Water Guidelines, 154 (94%) correctly reflected whether the sample exceeded the guideline(s) or not.

In some cases, reported results had measurement uncertainties spanning the guideline level. This may lead to an inconclusive assessment even when the assigned value indicates compliance or non-compliance. These participants may need to review if their measurement uncertainties are too large to be fit-for-purpose.

iv. Evaluate participants' methods for the measurement of organic compounds in potable water.

The most common methodology for Sample S1 VOCs was purge-and-trap GC-MS with an undiluted sample and no blank correction.

The most common methodology for Samples S2 PAHs and S3 phenols was liquid-liquid extraction using dichloromethane, followed by analysis using GC-MS(/MS). pH adjustment may be required to ensure complete extraction of phenols from the water matrix.

v. *Develop the practical application of measurement uncertainty, and provide participants with information that will be useful in assessing their uncertainty evaluations.*

Of 408 numeric results, 391 (96%) were reported with an expanded measurement uncertainty. The magnitude of reported uncertainties was within the range of 4.2% to 270%. Participants used a wide variety of procedures to evaluate their uncertainty.

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

The test samples produced for this study are homogeneous and well characterised. Surplus samples are available for purchase and can be used for quality control and method validation purposes.

TABLE OF CONTENTS

1 INTRODUCTION 1
1.1 NMIA Proficiency Testing Program 1
1.2 Study Aims 1
1.3 Study Conduct 1
2 STUDY INFORMATION 2
2.1 Study Timetable 2
2.2 Participation and Laboratory Code 2
2.3 Selection of Analytes and Test Material Preparation 2
2.4 Homogeneity and Stability of Test Materials 3
2.5 Test Material Storage, Dispatch, and Receipt 3
2.6 Instructions to Participants 4
2.7 Interim Report and Preliminary Report 5
3 PARTICIPANT LABORATORY INFORMATION 6
3.1 Participants' Test Methods 6
3.2 Basis of Participants' Measurement Uncertainty Evaluations 6
3.3 Participants' Comments 8
4 PRESENTATION OF RESULTS AND STATISTICAL ANALYSIS 9
4.1 Results Summary 9
4.2 Outliers and Extreme Outliers 9
4.3 Assigned Value 9
4.4 Robust Average and Robust Between-Laboratory Coefficient of Variation 9
4.5 Performance Coefficient of Variation 9
4.6 Standard Deviation for Proficiency Assessment 10
4.7 z-Score 10
4.8 E_n-Score 10
4.9 Traceability and Measurement Uncertainty 10
5 TABLES AND FIGURES 11
6 DISCUSSION OF RESULTS 63
6.1 Assigned Value 63
6.2 Measurement Uncertainty Reported by Participants 64
6.3 z-Score 65
6.4 E_n-Score 68
6.5 False Negatives 68
6.6 Reporting of Additional Analytes 69
6.7 Fitness for Purpose of Results – Australian Drinking Water Guidelines 69
6.8 Participants' Analytical Methods 75
6.9 Certified Reference Materials 83
6.10 Summary of Participants' Results and Performances 83
6.11 Comparison with Previous Organic Compounds in Potable Water PT Studies 87
7 REFERENCES 89
APPENDIX 1 SAMPLE PREPARATION 90
APPENDIX 2 ASSESSMENT OF HOMOGENEITY AND STABILITY 91
A2.1 Homogeneity 91

A2.2 Stability 91
APPENDIX 3 ROBUST AVERAGE AND ASSOCIATED UNCERTAINTY, z-SCORE AND E_n-SCORE CALCULATIONS 92
A3.1 Robust Average and Associated Uncertainty 92
A3.2 z-Score and E_n-Score Calculation 92
APPENDIX 4 PARTICIPANTS' TEST METHODS 93
APPENDIX 5 ACRONYMS AND ABBREVIATIONS 101

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, compost, water, biota, food, and consumer goods;
- hydrocarbons, phenols, and other organic compounds in soil and water;
- pesticide residues in soil, compost, 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.

1.2 Study Aims

The aims of the study were to:

- assess participants' ability to correctly identify organic compounds in potable water;
- compare participants' performance and assess their capabilities to measure organic compounds in potable water;
- assess the consequence of participants' results for organic compounds in potable water against regulatory guidelines;
- evaluate participants' methods for the measurement of organic compounds in potable water;
- develop the practical application of measurement uncertainty, and provide participants with information that will be useful in assessing their uncertainty evaluations; and
- produce materials that can be used in method validation and as control samples.

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

1.3 Study Conduct

The conduct of NMIA PT studies 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 the 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.[1] This study falls within the scope of NMIA's accreditation (Accreditation No. 198; Site No. 14485).

2 STUDY INFORMATION

2.1 Study Timetable

The timetable of the study was:

Invitations sent	13/04/2026
Samples sent	11/05/2026
Results due	12/06/2026
Interim Report	18/06/2026
Preliminary Report	23/06/2026

2.2 Participation and Laboratory Code

Nineteen laboratories registered to participate in this study. Two laboratories each requested 2 sets of samples to be analysed independently, for a total of 21 participants. All participants were assigned a confidential laboratory code number for this study, and all submitted results.

2.3 Selection of Analytes and Test Material Preparation

When selecting analytes and spiked values for this study, consideration was given to:

- the Australian Drinking Water Guidelines (ADWG);[5]
- a variety of analytes amenable to gas and/or liquid chromatography; and
- feedback from participants and other stakeholders.

Three test samples were provided for analysis:

- Sample S1 consisted of 2 x 42 mL potable water spiked with various volatile organic compounds (VOCs).
- Sample S2 consisted of either 3 x 100 mL or 1 x 500 mL potable water (depending on participant preference) spiked with various polycyclic aromatic hydrocarbons (PAHs).
- Sample S3 consisted of 2 x 100 mL potable water spiked with various phenols.

Details of the spiked analytes and levels, as well as the corresponding ADWG values, are presented in Table 1.[5]

Table 1 Spiked Values and ADWG Values of Test Samples

Sample	Analyte	Spiked Value (mg/L)	ADWG Health Guideline Value (mg/L)	ADWG Aesthetic Guideline Value (mg/L)
S1	Carbon tetrachloride	0.0589	0.003	-
S1	1,3-dichlorobenzene	0.0293	-	0.02
S1	1,4-dichlorobenzene	0.0296	0.04	0.0003
S1	1,2-dichloroethane	0.0985	0.003	-
S1	1,2-dichloroethene	0.0780	0.06	-
S1	Dichloromethane	0.00977	0.004	-
S1	Toluene	0.0196	0.8	0.025
S1	Chloroform*	0.0977	0.25	-
S2	Acenaphthene	0.0100	-	-

Sample	Analyte	Spiked Value (mg/L)	ADWG Health Guideline Value (mg/L)	ADWG Aesthetic Guideline Value (mg/L)
S2	Fluorene	0.0121	-	-
S2	Phenanthrene	0.00361	-	-
S2	Anthracene	0.00352	-	-
S2	Fluoranthene	0.00661	-	-
S2	Benz[a]anthracene	0.00200	-	-
S2	Chrysene	0.00401	-	-
S2	Benzo[b]fluoranthene	0.0110	-	-
S2	Benzo[a]pyrene	0.00100	0.00001	-
S2	Benzo[g,h,i]perylene	0.0200	-	-
S3	Phenol	0.0203	-	-
S3	2-Methylphenol	0.00802	-	-
S3	3-Methylphenol**	0.00604	-	-
S3	4-Methylphenol**	0.00605	-	-
S3	2-Nitrophenol	0.0506	-	-
S3	4-Nitrophenol	0.0504	-	-
S3	2,4-Dichlorophenol	0.00710	0.2	0.0003
S3	2,6-Dichlorophenol	0.00703	-	-
S3	Pentachlorophenol	0.0301	0.01	-

*Participants were requested to report for Trihalomethanes (Total). **Participants were requested to report for 3 & 4-Methylphenols (Total).

Additional sample preparation details are provided in Appendix 1.

2.4 Homogeneity and Stability of Test Materials

No homogeneity or stability testing was conducted on these test materials before the samples were sent. The samples were prepared, packaged, and stored using a process that has been demonstrated to produce sufficiently homogeneous and stable samples in previous NMIA PT studies.

To further assess possible instability, the results returned by participants were compared to the spiked concentrations. For scored analytes, assigned values were within the range of 65% to 100% of the spiked values. This is similar to ratios observed in previous NMIA PT studies. Analytes were only scored when there was a reasonable consensus between participants' results.

The results of this study also gave no reason to question the homogeneity or stability of the samples (Appendix 2).

2.5 Test Material Storage, Dispatch, and Receipt

After preparation, the samples were stored at 4 °C. Samples were packaged into insulated polystyrene foam boxes with cooler bricks and dispatched by courier on 11 May 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 for participants to confirm the receipt and condition of the test samples.

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

2.6 Instructions to Participants

Participants were provided with lists of possible analytes spiked into each of the samples (Tables 2 to 4).

Table 2 List of Possible Analytes for Sample S1

Benzene	1,2-dichloroethane	Toluene
Carbon tetrachloride	1,1-dichloroethene	Trichlorobenzenes (Total)
Chlorobenzene	1,2-dichloroethene	1,1,1-Trichloroethane
1,2-dichlorobenzene	Dichloromethane	Trichloroethylene
1,3-dichlorobenzene	Ethylbenzene	Trihalomethanes (Total)
1,4-dichlorobenzene	Styrene	Vinyl Chloride
1,1-dichloroethane	Tetrachloroethene	Xylenes

Table 3 List of Possible Analytes for Sample S2

Naphthalene	Phenanthrene	Benz[a]anthracene	Benzo[a]pyrene
Acenaphthylene	Anthracene	Chrysene	Indeno[1,2,3-cd]pyrene
Acenaphthene	Fluoranthene	Benzo[b]fluoranthene	Dibenz[a,h]anthracene
Fluorene	Pyrene	Benzo[k]fluoranthene	Benzo[g,h,i]perylene

Table 4 List of Possible Analytes for Sample S3

Phenol	2,4-Dimethylphenol	2,4-Dichlorophenol	2,4,6-Trichlorophenol
2-Chlorophenol	2-Nitrophenol	2,6-Dichlorophenol	2,3,4,6-Tetrachlorophenol
2-Methylphenol	4-Nitrophenol	4-Chloro-3-methylphenol	Pentachlorophenol
3 & 4-Methylphenols (Total)	2,4-Dinitrophenol	2,4,5-Trichlorophenol	

Participants were instructed as follows:

- Quantitatively analyse the samples using your routine test method.
- Participants need not test for all listed analytes.
- If samples cannot be analysed on the day of receipt, please store them refrigerated.
- For each analyte in each sample, report a single result in units of mg/L. This figure will be used in all statistical analysis in the study report.
- Report results as you would report to a client, i.e. corrected for recovery or not according to your standard procedure and applying the limit of reporting of the method used for analysis (no limit of reporting has been set for this study).
- For each analyte in each sample, report the associated expanded uncertainty in units of mg/L (e.g. 0.50 ± 0.02 mg/L).
- Report any analytes not tested with NT as the result.

- Report the basis of your uncertainty evaluations as requested in the results sheet (e.g. uncertainty budget, repeatability precision, long term result variability).
- Please complete the method details as requested in the Methodology sheet.
- Return the completed results sheet by email (proficiency@measurement.gov.au).
- Please return results by 5 June 2026. Late results may not be included in the study report.

The results due date was later extended to 12 June 2026 due to a circumstance affecting a participant.

2.7 Interim Report and Preliminary Report

An Interim Report was emailed to all participants on 18 June 2026.

A Preliminary Report was emailed to all participants on 23 June 2026. This report included a summary of the results reported by participants, assigned values, performance coefficient of variations, z-scores and E_n-scores for each analyte in this study. No data from the Preliminary Report has been changed in the present Final Report.

3 PARTICIPANT LABORATORY INFORMATION

3.1 Participants' Test Methods

Participants were requested to provide information about their test methods. Responses are presented in Appendix 4. Some responses may be modified so that the participant cannot be identified.

3.2 Basis of Participants' Measurement Uncertainty Evaluations

Participants were requested to provide information about the basis of their measurement uncertainty (MU) evaluations. Responses are presented in Tables 5 and 6. Some responses may be modified so that the participant cannot be identified.

Table 5 Basis of Measurement Uncertainty Evaluation

Lab. Code	Approach to Evaluating MU	Information Sources for MU Evaluation*		Guide Document for Evaluating MU
		Precision	Method Bias	
1	Repeatability precision - based upon internal historical data Coverage factor not reported	PAHs/Phenols: Control samples - CRM	VOCs: Recoveries of SS	
2	Top Down - precision and evaluation of the method and laboratory bias Coverage factor not reported	Duplicate analysis	Instrument calibration	ISO/GUM
3	Top Down - precision and evaluation of the method and laboratory bias Coverage factor not reported	Control samples - SS Duplicate analysis Instrument calibration	CRM Instrument calibration Recoveries of SS Standard purity	ISO/GUM
4	Top Down - reproducibility (standard deviation) from PT studies used directly Coverage factor not reported	Duplicate analysis	Instrument calibration	
5	Standard deviation of replicate analyses multiplied by 2 or 3 Coverage factor not reported	Control samples	CRM	
6	Top Down - precision and evaluation of the method and laboratory bias k = 2	Control samples - CRM Duplicate analysis Instrument calibration	CRM Instrument calibration Recoveries of SS	NMIA Uncertainty Course
7**	Top Down - precision and evaluation of the method and laboratory bias k = 2	Duplicate analysis		
8	Top Down - precision and evaluation of the method and laboratory bias k = 2	Control samples - SS Instrument calibration	CRM Instrument calibration Recoveries of SS Standard purity	
9	Top Down - precision and evaluation of the method and laboratory bias k = 2	Duplicate analysis Instrument calibration	Standard purity	Eurachem/CITAC Guide

Lab. Code	Approach to Evaluating MU	Information Sources for MU Evaluation*		Guide Document for Evaluating MU
		Precision	Method Bias	
10	Top Down - precision and evaluation of the method and laboratory bias k = 2	Control samples - SS	Recoveries of SS	Eurachem/CITAC Guide
11	Top Down - precision and evaluation of the method and laboratory bias Coverage factor not reported	Control samples - SS	Recoveries of SS	ISO/GUM
12	Professional judgment k = 2	Control samples - SS Duplicate analysis Instrument calibration	Instrument calibration Recoveries of SS Standard purity	Eurachem/CITAC Guide
13	Standard deviation of replicate analyses multiplied by 2 or 3 Coverage factor not reported	Duplicate analysis	Recoveries of SS	
14	Bottom Up (ISO/GUM, fish bone/cause and effect diagram) Coverage factor not reported	Control samples Duplicate analysis	Instrument calibration Recoveries of SS	
15**	Top Down - precision and evaluation of the method and laboratory bias VOCs/PAHs: k = 2.31 Phenols: k = 2.26	Control samples - SS	Recoveries of SS	Eurachem/CITAC Guide
16	Top Down - precision and evaluation of the method and laboratory bias Coverage factor not reported	Control samples - SS Duplicate analysis Instrument calibration	Instrument calibration Recoveries of SS	Eurachem/CITAC Guide
17	Top Down - precision and evaluation of the method and laboratory bias k = 2	Control samples - SS Duplicate analysis	CRM Recoveries of SS	NMIA Uncertainty Course
18	Based on historical data k = 2	Duplicate analysis Instrument calibration	Instrument calibration	Eurachem/CITAC Guide
19	Top Down - precision and evaluation of the method and laboratory bias Coverage factor not reported	Control samples Duplicate analysis Instrument calibration	CRM Instrument calibration	Eurachem/CITAC Guide
20	Top Down - precision and evaluation of the method and laboratory bias Coverage factor not reported	Control samples - SS Duplicate analysis Instrument calibration	Instrument calibration Recoveries of SS	Eurachem/CITAC Guide
22**	Top Down - precision and evaluation of the method and laboratory bias k = 2	Duplicate analysis		

*SS = Spiked Samples; CRM = Certified Reference Material
**Additional information presented in Table 6.

Table 6 Basis of Measurement Uncertainty Evaluation – Additional Information

Lab. Code	Measurement Uncertainty Evaluation Additional Information
7	Replicate analysis of sample of known concentrations
15	Uncertainty was set to 50 % based off previous proficiency trials, validation data and ongoing spike monitoring.
22	Replicate analysis of sample of known concentrations

3.3 Participants' Comments

Participants were invited to make comments or suggestions on the samples, this study, or possible future studies. Such feedback may be useful in improving future studies. Participants' comments received for this study are presented in Table 7. Some responses may be modified so that the participant cannot be identified.

Table 7 Participants' Comments

Lab. Code	Participants Comments	Study Coordinator's Response
3	More samples will be required to prevent any incident as vials may broke	The sample receipt notification form we received from your laboratory indicated that the samples arrived in a condition fit for analysis. In general, we will replace samples if they have arrived in an unsuitable condition, so please let us know as soon as possible if this occurs. If any samples break while at your laboratory, please still contact us as we may be able to organise replacement samples.
10	Can we report the results as ug/L in future studies?	Thank you for your feedback. We have requested participants to report results in units of mg/L to align with the ADWG values.[5]

4 PRESENTATION OF RESULTS AND STATISTICAL ANALYSIS

4.1 Results Summary

Participant results are listed in Tables 8 to 33 with summary statistics and other estimates of analyte concentration. Bar charts of results and performance scores are presented in Figures 2 to 27. An example chart with interpretation guide is shown in Figure 1.

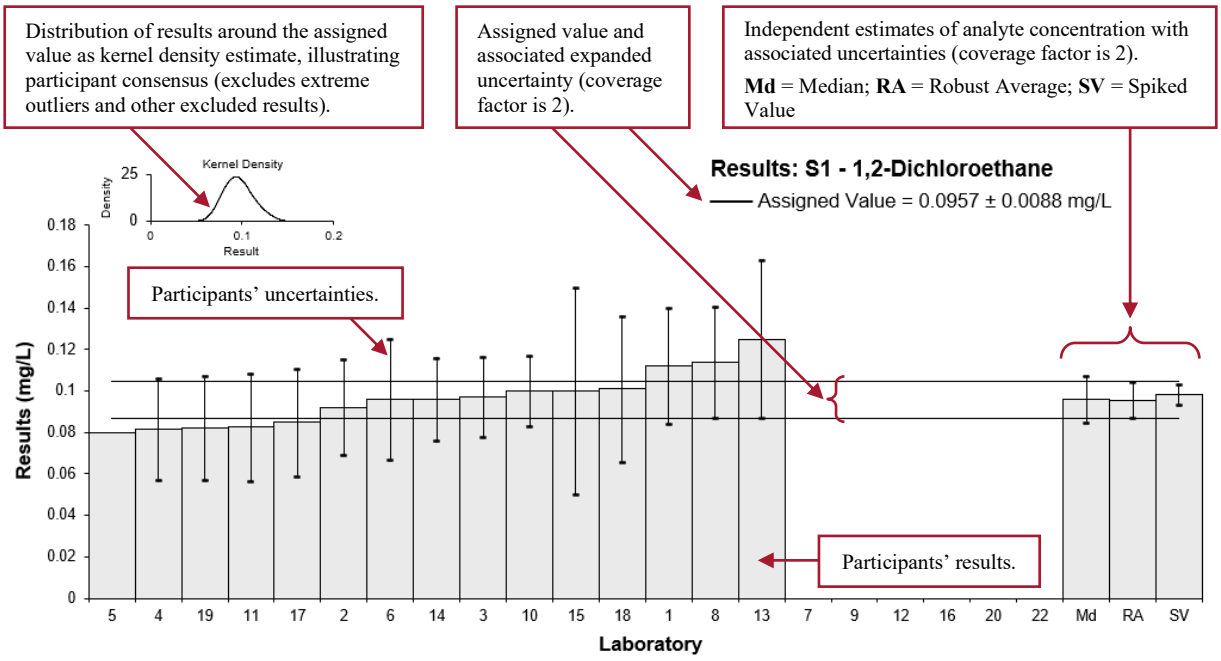


Figure 1 Guide to Presentation of Results

4.2 Outliers and Extreme Outliers

Outliers were results less than 50% and greater than 150% of the robust average, and these were removed before the calculation of the assigned value.[3,4] Extreme outliers, if applicable, were obvious blunders, e.g. results reported with incorrect units or for a different analyte or sample, and such results were removed for the calculation of all summary statistics.[3,4]

4.3 Assigned Value

The assigned value is defined as the 'value attributed to a particular property or characteristic of a proficiency testing item'.[1] In this PT study, this property is the concentration of the analytes in the samples. Assigned values were the robust averages of participants' results with all outliers removed, and the expanded uncertainties were evaluated from the associated robust standard deviations (robust SDs) (Appendix 3).[3,6]

4.4 Robust Average and Robust Between-Laboratory Coefficient of Variation

The robust averages and associated expanded MUs, and robust coefficients of variation (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 CVs 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 Performance Coefficient of Variation

The performance coefficient of variation (PCV) is a set measure of the between-laboratory variation that in the judgement of the study coordinator would be expected from participants given the analyte concentrations. The PCV is not the CV of participants' results. It is set by

the study coordinator and is based on the analyte concentrations and experience from previous studies. It is supported by mathematical models such as the Thompson-Horwitz equation.[7] By setting a realistic value for the PCV, a participant's performance does not depend on other participants' performances and can be compared from study to study when the PCV remains the same.

4.6 Standard Deviation for Proficiency Assessment

The standard deviation for proficiency assessment (SDPA, σ) is the product of the assigned value (X) and the PCV, as presented in Equation 1.

$$\sigma = X \times PCV \qquad \textit{Equation 1}$$

4.7 z-Score

For each participant's result, a z-score is calculated according to Equation 2.

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

where:

z is z-score

χ is a participant's result

X is the assigned value

σ is the SDPA from Equation 1

For the absolute value of a z-score: $|z| \leq 2.0$ is acceptable, $2.0 < |z| < 3.0$ is questionable, and $|z| \geq 3.0$ is not acceptable.

4.8 E_n-Score

The E_n-score is complementary to the z-score in the assessment of laboratory performance. The E_n-score includes expanded uncertainty and is calculated according to Equation 3.

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

where:

E_n is E_n-score

χ is a participant's result

X is the assigned value

U_χ is the expanded uncertainty of the participant's result

U_X is the expanded uncertainty of the assigned value

For the absolute value of an E_n-score: $|E_n| < 1.0$ is acceptable and $|E_n| \geq 1.0$ is not acceptable.

4.9 Traceability and Measurement Uncertainty

Laboratories accredited to ISO/IEC 17025 must establish and demonstrate the traceability and MU 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 8

Sample Details

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

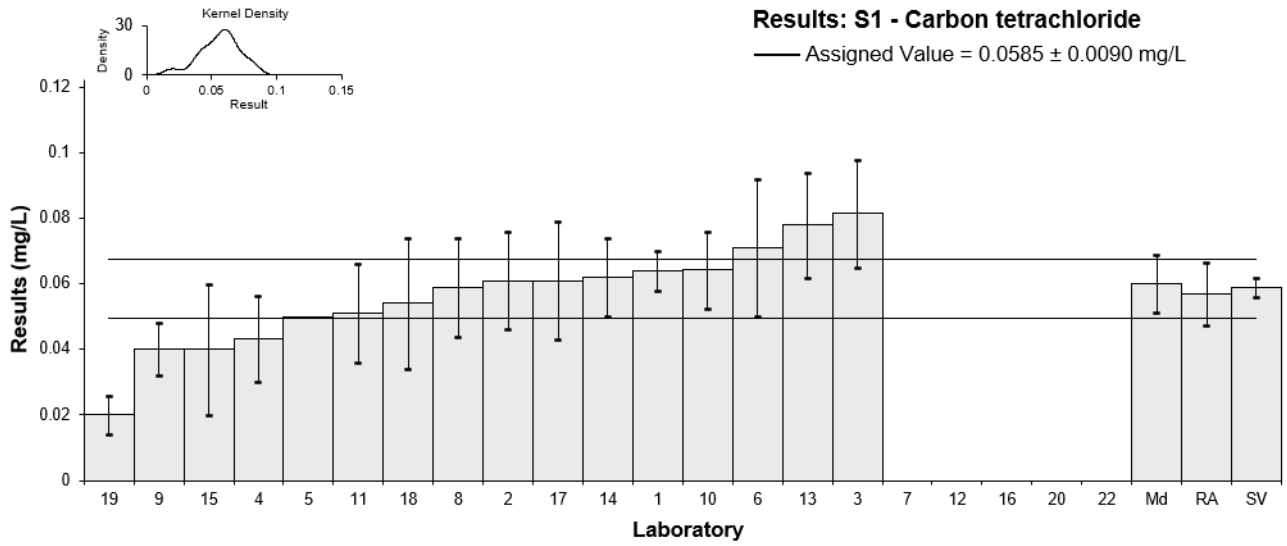
Participant Results

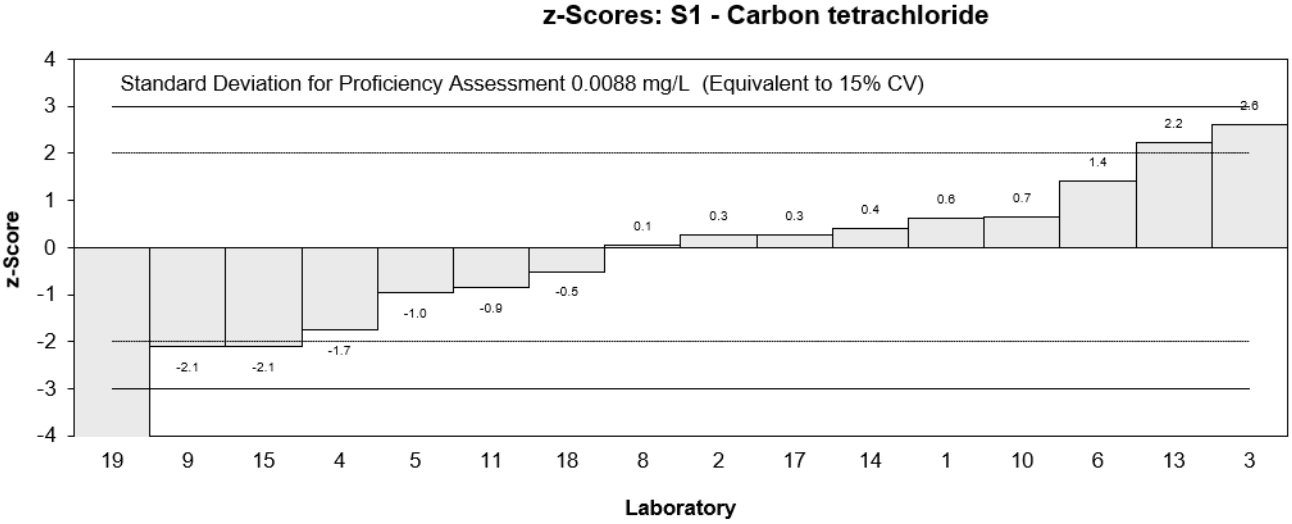
Lab. Code	Result	Uncertainty	z	E_n
1	0.064	0.006	0.63	0.51
2	0.061	0.015	0.28	0.14
3	0.0814	0.01628	2.61	1.23
4	0.0432	0.01296	-1.74	-0.97
5	0.05	NR	-0.97	-0.94
6	0.071	0.021	1.42	0.55
7	NS	NS		
8	0.059	0.015	0.06	0.03
9	0.040	0.0081	-2.11	-1.53
10	0.0642	0.0116	0.65	0.39
11	0.051	0.015	-0.85	-0.43
12	NT	NT		
13	0.078	0.016	2.22	1.06
14	0.062	0.012	0.40	0.23
15	0.040	0.020	-2.11	-0.84
16	NT	NT		
17	0.061	0.018	0.28	0.12
18	0.054	0.02	-0.51	-0.21
19*	0.02	0.006	-4.39	-3.56
20	NT	NT		
22	NS	NS		

* Outlier, see Section 4.2

Statistics

Assigned Value	0.0585	0.0090
Spike Value	0.0589	0.0029
Robust Average	0.0570	0.0095
Median	0.0600	0.0088
Mean	0.0562	
N	16	
Max	0.0814	
Min	0.02	
Robust SD	0.015	
Robust CV	27%	


Kernel Density
Density
Result
Results: S1 - Carbon tetrachloride
Assigned Value = 0.0585 ± 0.0090 mg/L
Results (mg/L)
Laboratory
19 9 15 4 5 11 18 8 2 17 14 1 10 6 13 3 7 12 16 20 22 Md RA SV


z-Scores: S1 - Carbon tetrachloride
Standard Deviation for Proficiency Assessment 0.0088 mg/L (Equivalent to 15% CV)
z-Score
Laboratory
19 9 15 4 5 11 18 8 2 17 14 1 10 6 13 3

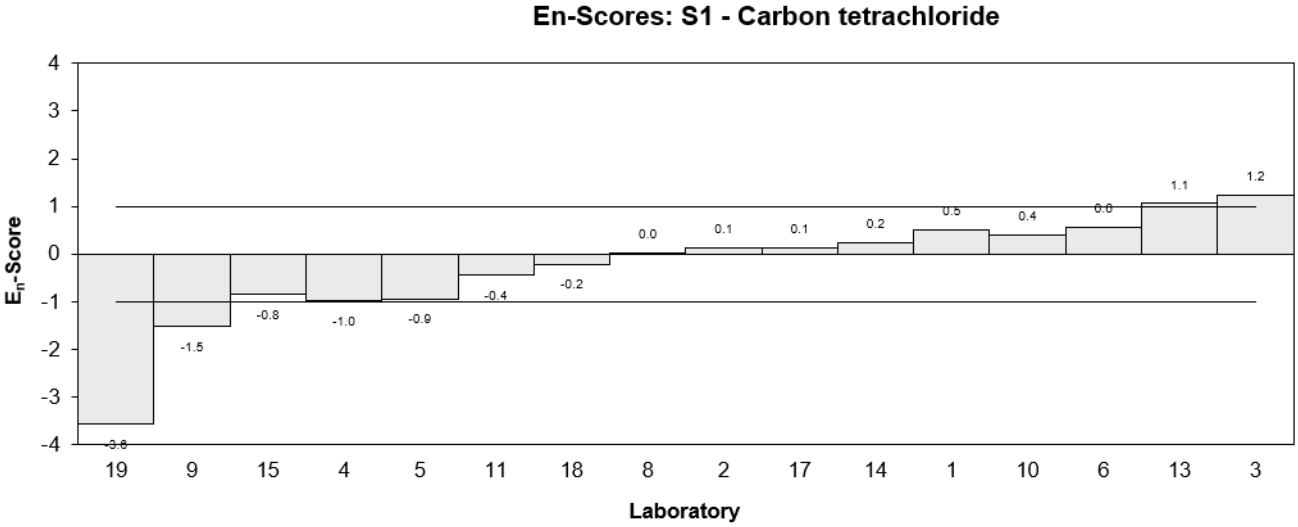

En-Scores: S1 - Carbon tetrachloride
En-Score
Laboratory
19 9 15 4 5 11 18 8 2 17 14 1 10 6 13 3

Figure 2

Table 9

Sample Details

Sample No.	S1
Matrix	Potable Water
Analyte	1,3-Dichlorobenzene
Unit	mg/L

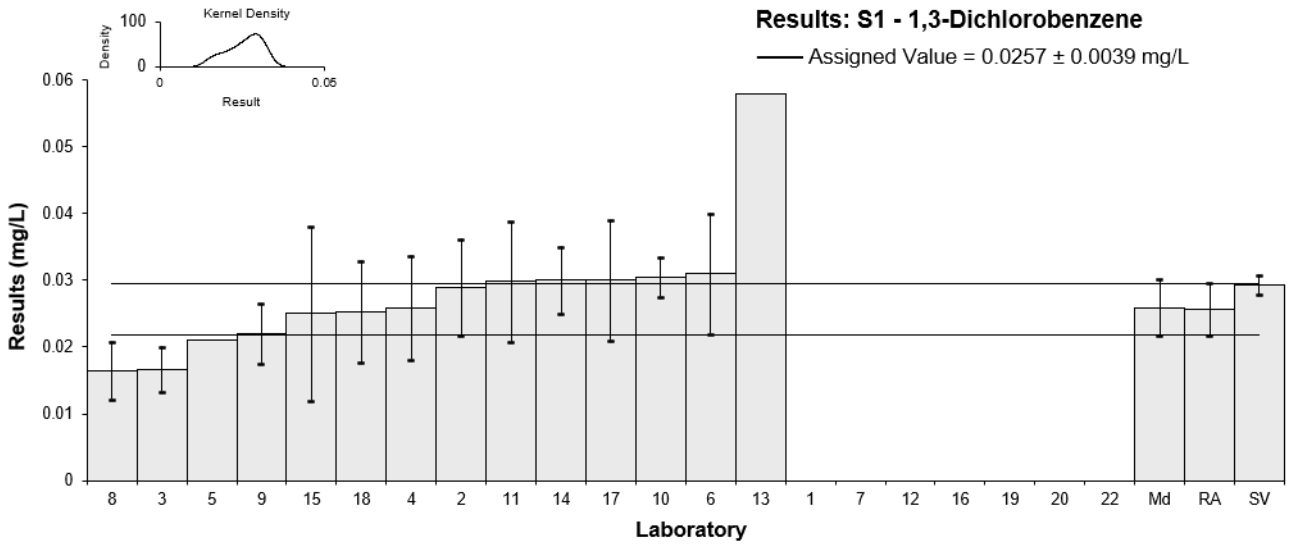
Participant Results

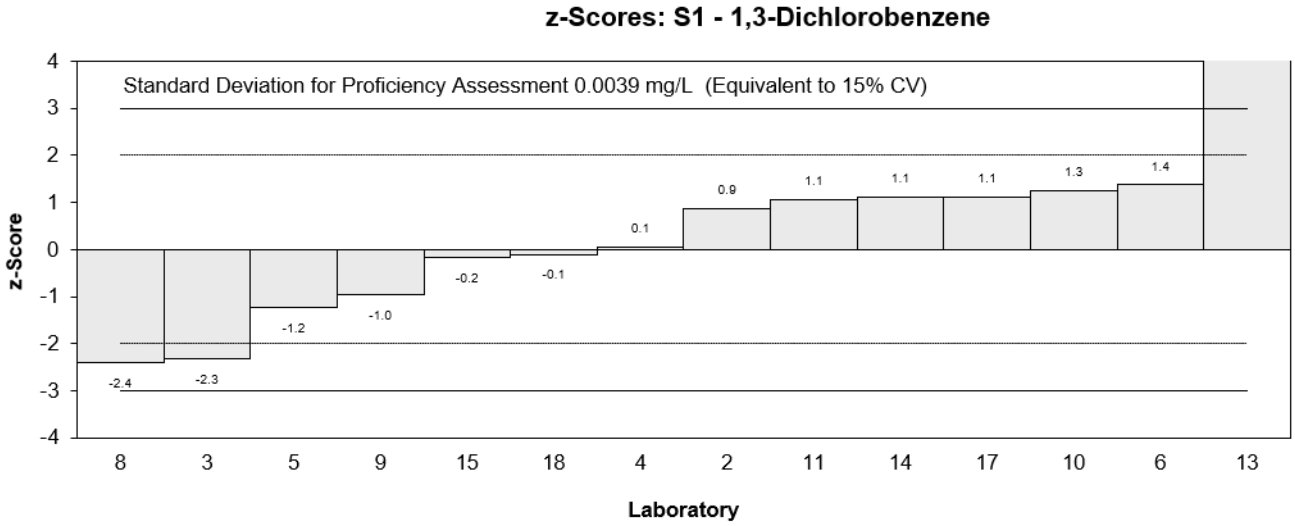
Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	0.029	0.0072	0.86	0.40
3	0.0167	0.00334	-2.33	-1.75
4	0.0259	0.00777	0.05	0.02
5	0.021	NR	-1.22	-1.21
6	0.031	0.009	1.37	0.54
7	NS	NS		
8	0.0165	0.0043	-2.39	-1.58
9	0.022	0.0045	-0.96	-0.62
10	0.0305	0.0030	1.25	0.98
11	0.0298	0.009	1.06	0.42
12	NT	NT		
13**	0.058	NR	8.38	8.28
14	0.03	0.005	1.12	0.68
15	0.025	0.013	-0.18	-0.05
16	NT	NT		
17	0.030	0.0090	1.12	0.44
18	0.0253	0.0076	-0.10	-0.05
19	<0.001	NR		
20	NT	NT		
22	NS	NS		

** Excluded Result, see Section 6.1. The z-score and E_n-score were calculated using the reported result, which was biased high because the participant reported the total of multiple spiked analytes rather than for the named analyte only.

Statistics

Assigned Value	0.0257	0.0039
Spike Value	0.0293	0.0015
Robust Average	0.0257	0.0039
Median	0.0259	0.0042
Mean	0.0256	
N	13	
Max	0.031	
Min	0.0165	
Robust SD	0.0056	
Robust CV	22%	


Kernel Density
Density
100
0
0
0.05
Result
Results: S1 - 1,3-Dichlorobenzene
Assigned Value = 0.0257 ± 0.0039 mg/L
Results (mg/L)
0.06
0.05
0.04
0.03
0.02
0.01
0
8 3 5 9 15 18 4 2 11 14 17 10 6 13 1 7 12 16 19 20 22 Md RA SV
Laboratory


z-Scores: S1 - 1,3-Dichlorobenzene
Standard Deviation for Proficiency Assessment 0.0039 mg/L (Equivalent to 15% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-2.4
-2.3
-1.2
-1.0
-0.2
-0.1
0.1
0.9
1.1
1.1
1.1
1.3
1.4
8 3 5 9 15 18 4 2 11 14 17 10 6 13
Laboratory

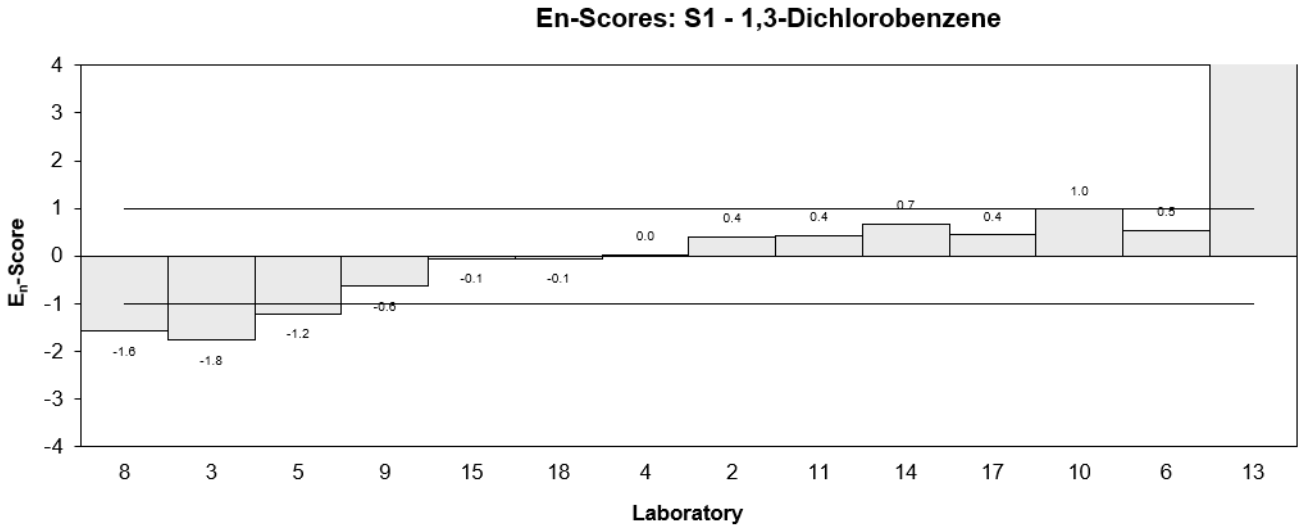

En-Scores: S1 - 1,3-Dichlorobenzene
En-Score
4
3
2
1
0
-1
-2
-3
-4
-1.6
-1.8
-1.2
-0.6
-0.1
-0.1
0.0
0.4
0.4
0.7
0.4
1.0
0.5
8 3 5 9 15 18 4 2 11 14 17 10 6 13
Laboratory

Figure 3

Table 10

Sample Details

Sample No.	S1
Matrix	Potable Water
Analyte	1,4-Dichlorobenzene
Unit	mg/L

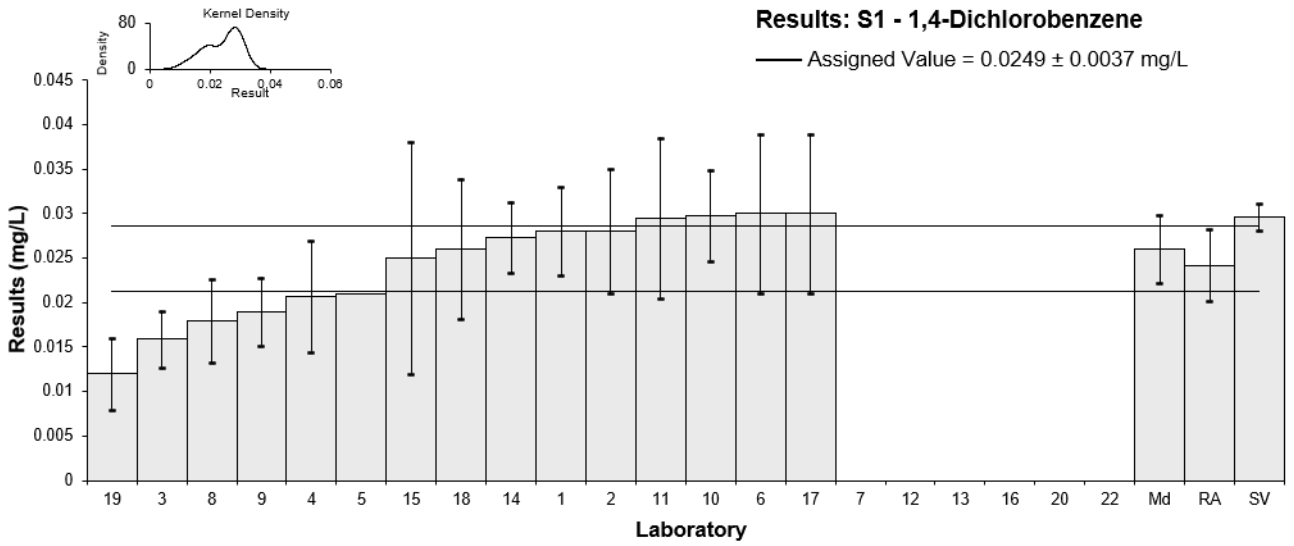
Participant Results

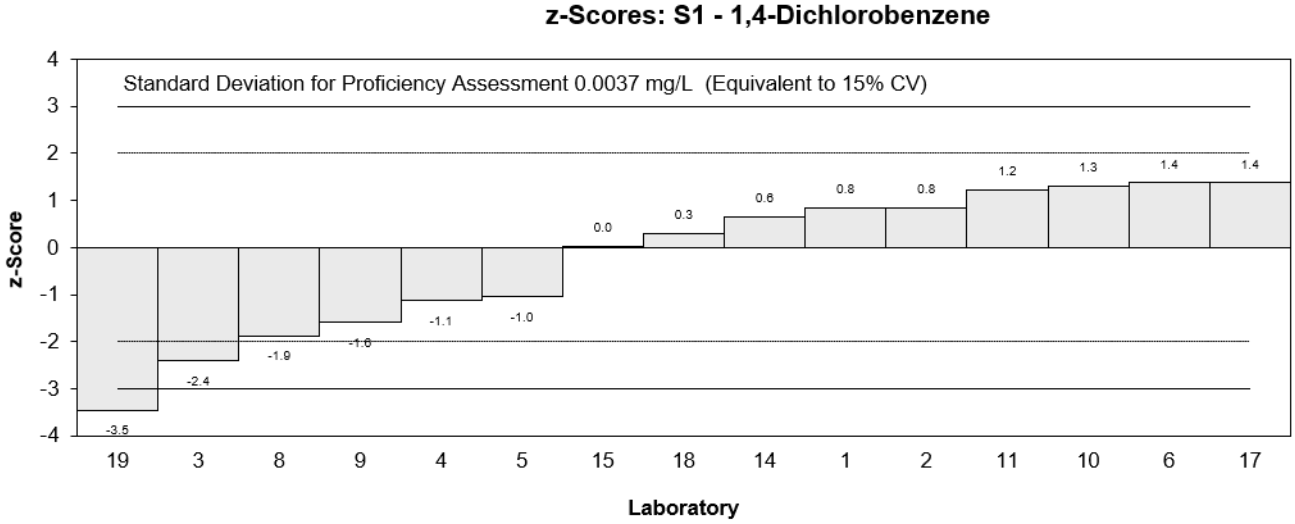
Lab. Code	Result	Uncertainty	z	E_n
1	0.028	0.005	0.83	0.50
2	0.028	0.007	0.83	0.39
3	0.0159	0.00318	-2.41	-1.84
4	0.0207	0.00621	-1.12	-0.58
5	0.021	NR	-1.04	-1.05
6	0.030	0.009	1.37	0.52
7	NS	NS		
8	0.0179	0.0047	-1.87	-1.17
9	0.019	0.0038	-1.58	-1.11
10	0.0298	0.0051	1.31	0.78
11	0.0295	0.009	1.23	0.47
12	NT	NT		
13	NT	NT		
14	0.0273	0.004	0.64	0.44
15	0.025	0.013	0.03	0.01
16	NT	NT		
17	0.030	0.0090	1.37	0.52
18	0.026	0.0079	0.29	0.13
19*	0.012	0.004	-3.45	-2.37
20	NT	NT		
22	NS	NS		

* Outlier, see Section 4.2

Statistics

Assigned Value	0.0249	0.0037
Spike Value	0.0296	0.0015
Robust Average	0.0242	0.0040
Median	0.0260	0.0038
Mean	0.0240	
N	15	
Max	0.030	
Min	0.012	
Robust SD	0.0062	
Robust CV	25%	


Kernel Density
Density
Result
Results: S1 - 1,4-Dichlorobenzene
Assigned Value = 0.0249 ± 0.0037 mg/L
Results (mg/L)
Laboratory
19 3 8 9 4 5 15 18 14 1 2 11 10 6 17 7 12 13 16 20 22 Md RA SV


z-Scores: S1 - 1,4-Dichlorobenzene
Standard Deviation for Proficiency Assessment 0.0037 mg/L (Equivalent to 15% CV)
z-Score
Laboratory
19 3 8 9 4 5 15 18 14 1 2 11 10 6 17

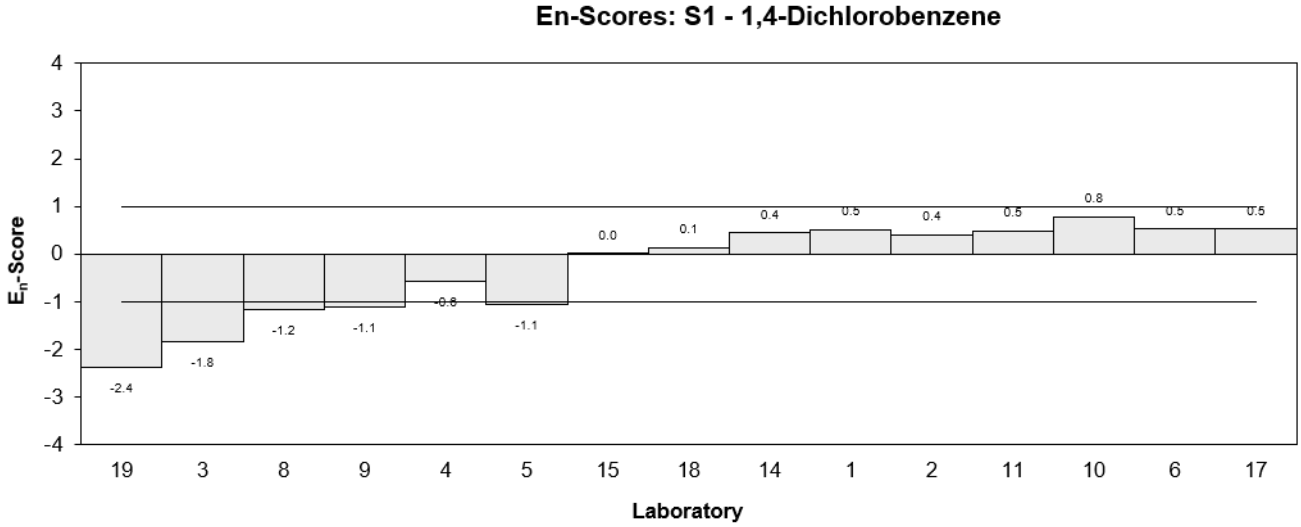

En-Scores: S1 - 1,4-Dichlorobenzene
En-Score
Laboratory
19 3 8 9 4 5 15 18 14 1 2 11 10 6 17

Figure 4

Table 11

Sample Details

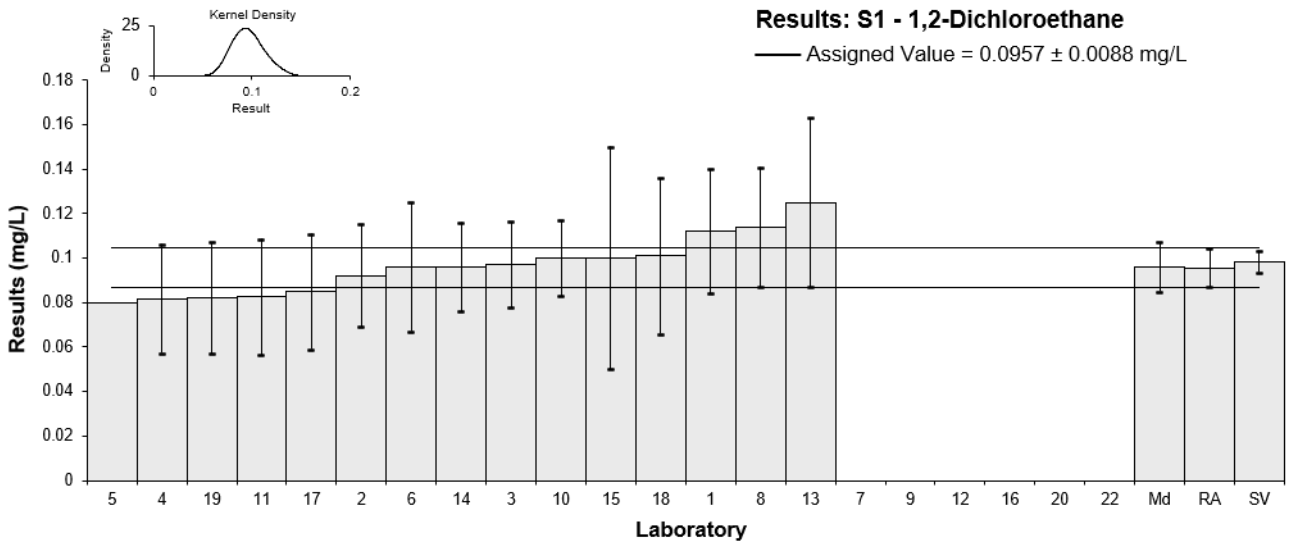
Sample No.	S1
Matrix	Potable Water
Analyte	1,2-Dichloroethane
Unit	mg/L

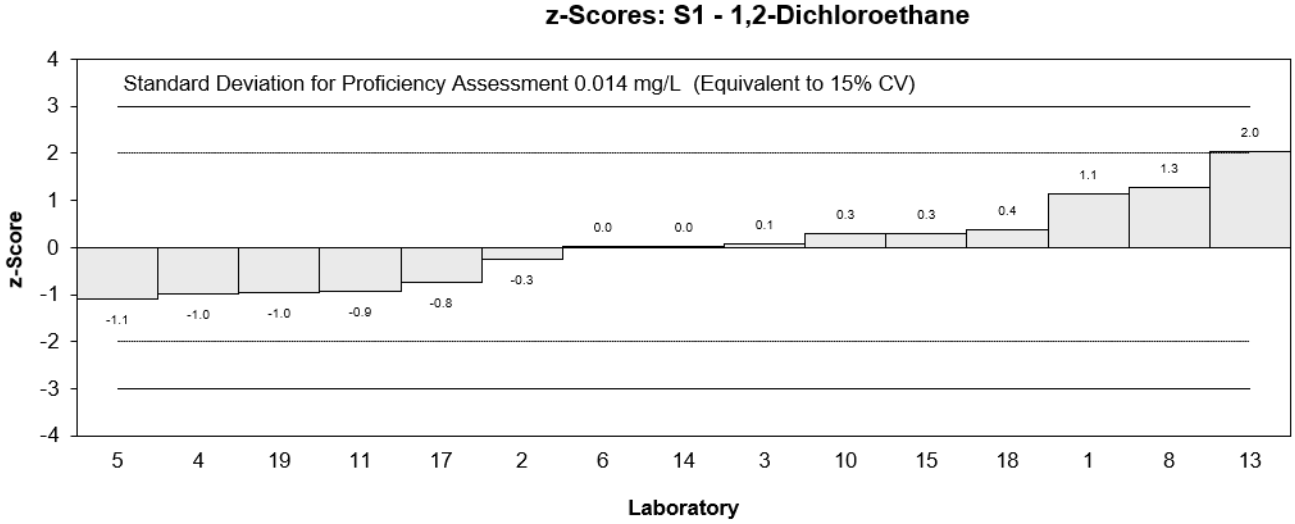
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.112	0.028	1.14	0.56
2	0.0921	0.023	-0.25	-0.15
3	0.097	0.0194	0.09	0.06
4	0.0817	0.02451	-0.98	-0.54
5	0.08	NR	-1.09	-1.78
6	0.096	0.029	0.02	0.01
7	NS	NS		
8	0.114	0.027	1.27	0.64
9	<0.001	NR		
10	0.0999	0.0170	0.29	0.22
11	0.0825	0.026	-0.92	-0.48
12	NT	NT		
13	0.125	0.038	2.04	0.75
14	0.096	0.02	0.02	0.01
15	0.10	0.050	0.30	0.08
16	NT	NT		
17	0.085	0.026	-0.75	-0.39
18	0.101	0.035	0.37	0.15
19	0.082	0.025	-0.95	-0.52
20	NT	NT		
22	NS	NS		

Statistics

Assigned Value	0.0957	0.0088
Spike Value	0.0985	0.0049
Robust Average	0.0957	0.0088
Median	0.096	0.011
Mean	0.0963	
N	15	
Max	0.125	
Min	0.08	
Robust SD	0.014	
Robust CV	14%	


Kernel Density
Density
Result
Results: S1 - 1,2-Dichloroethane
Assigned Value = 0.0957 ± 0.0088 mg/L
Results (mg/L)
Laboratory
5 4 19 11 17 2 6 14 3 10 15 18 1 8 13 7 9 12 16 20 22 Md RA SV


z-Scores: S1 - 1,2-Dichloroethane
Standard Deviation for Proficiency Assessment 0.014 mg/L (Equivalent to 15% CV)
z-Score
-1.1 -1.0 -1.0 -0.9 -0.8 -0.3 0.0 0.0 0.1 0.3 0.3 0.4 1.1 1.3 2.0
Laboratory
5 4 19 11 17 2 6 14 3 10 15 18 1 8 13

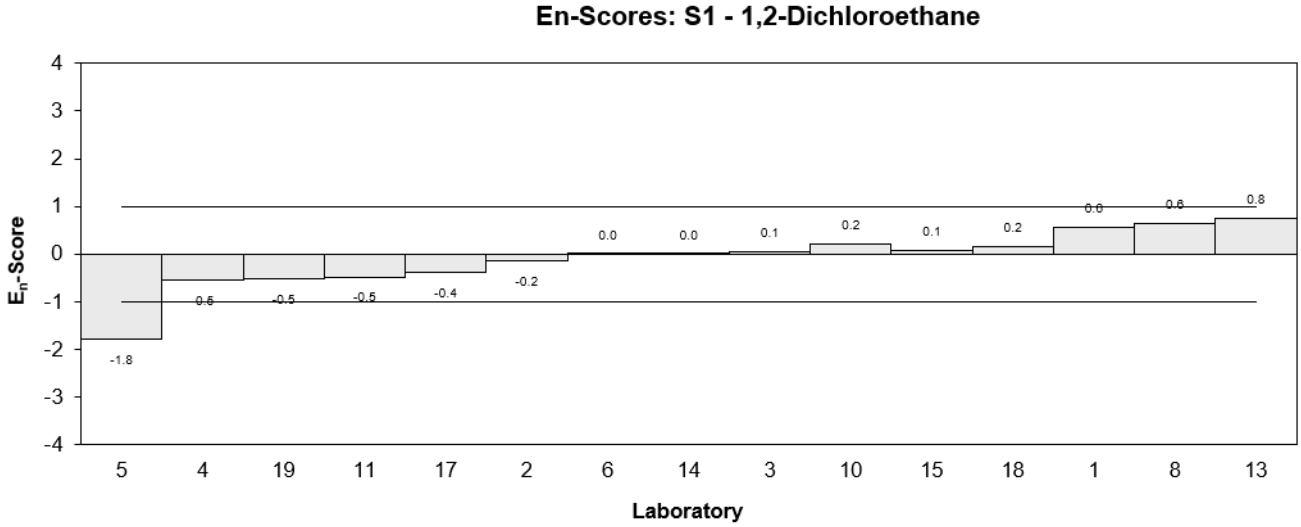

En-Scores: S1 - 1,2-Dichloroethane
En-Score
-1.8 -0.6 -0.5 -0.5 -0.4 -0.2 0.0 0.0 0.1 0.2 0.1 0.2 0.6 0.6 0.8
Laboratory
5 4 19 11 17 2 6 14 3 10 15 18 1 8 13

Figure 5

Table 12

Sample Details

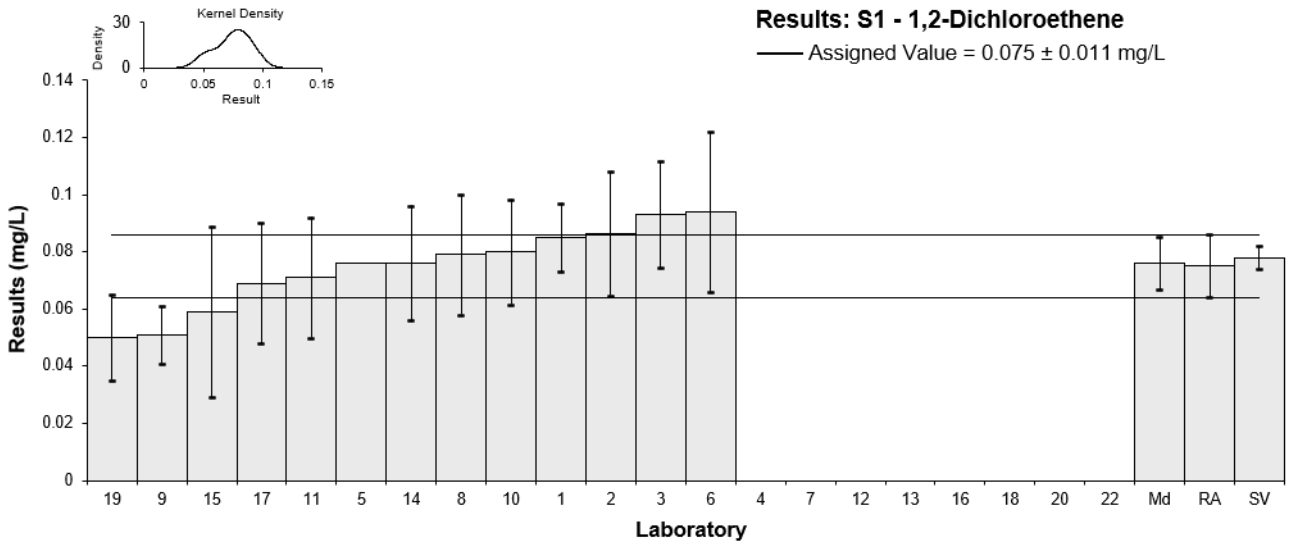
Sample No.	S1
Matrix	Potable Water
Analyte	1,2-Dichloroethene
Unit	mg/L

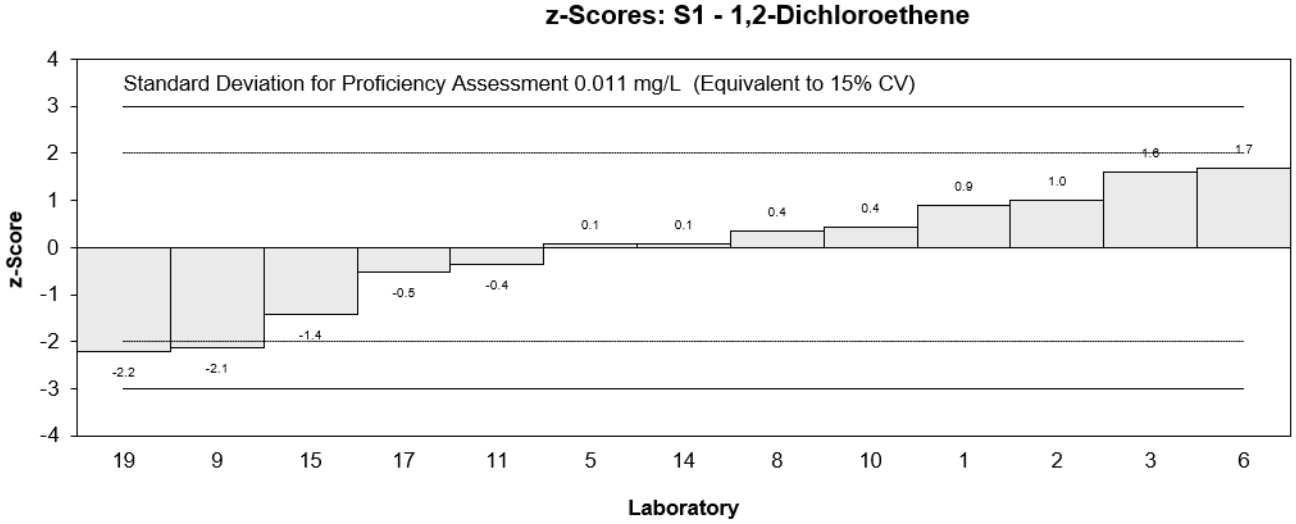
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.085	0.012	0.89	0.61
2	0.0864	0.0216	1.01	0.47
3	0.093	0.0186	1.60	0.83
4	NT	NT		
5	0.076	NR	0.09	0.09
6	0.094	0.028	1.69	0.63
7	NS	NS		
8	0.079	0.021	0.36	0.17
9	0.051	0.010	-2.13	-1.61
10	0.0799	0.0184	0.44	0.23
11	0.071	0.021	-0.36	-0.17
12	NT	NT		
13	<0.004	NR		
14	0.076	0.02	0.09	0.04
15	0.059	0.030	-1.42	-0.50
16	NT	NT		
17	0.069	0.021	-0.53	-0.25
18	NT	NT		
19	0.05	0.015	-2.22	-1.34
20	NT	NT		
22	NS	NS		

Statistics

Assigned Value	0.075	0.011
Spike Value	0.0780	0.0039
Robust Average	0.075	0.011
Median	0.0760	0.0093
Mean	0.0746	
N	13	
Max	0.094	
Min	0.05	
Robust SD	0.016	
Robust CV	22%	


Kernel Density
Density
Result
Results: S1 - 1,2-Dichloroethene
Assigned Value = 0.075 ± 0.011 mg/L
Results (mg/L)
Laboratory
19 9 15 17 11 5 14 8 10 1 2 3 6 4 7 12 13 16 18 20 22 Md RA SV


z-Scores: S1 - 1,2-Dichloroethene
Standard Deviation for Proficiency Assessment 0.011 mg/L (Equivalent to 15% CV)
z-Score
Laboratory
19 9 15 17 11 5 14 8 10 1 2 3 6
-2.2 -2.1 -1.4 -0.5 -0.4 0.1 0.1 0.4 0.4 0.9 1.0 1.6 1.7

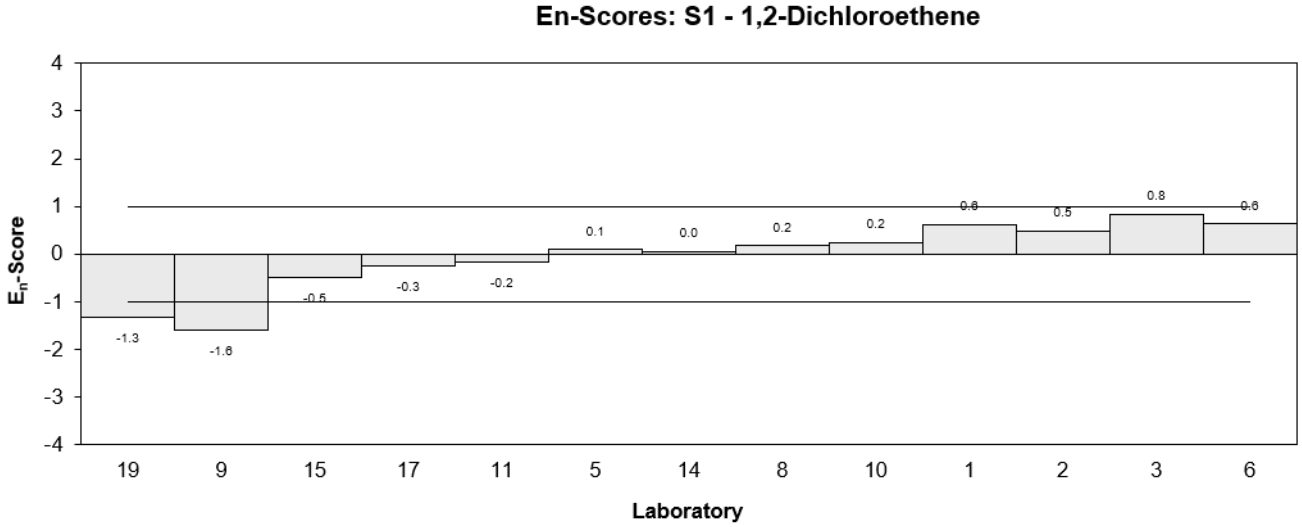

En-Scores: S1 - 1,2-Dichloroethene
En-Score
Laboratory
19 9 15 17 11 5 14 8 10 1 2 3 6
-1.3 -1.6 -0.5 -0.3 -0.2 0.1 0.0 0.2 0.2 0.6 0.5 0.8 0.6

Figure 6

Table 13

Sample Details

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

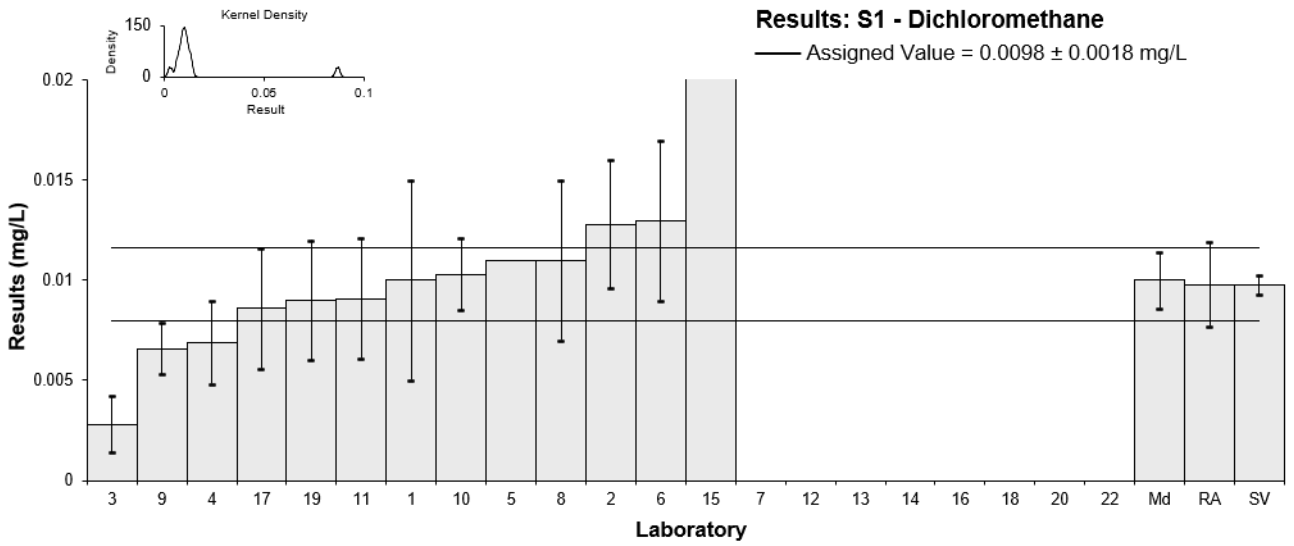
Participant Results

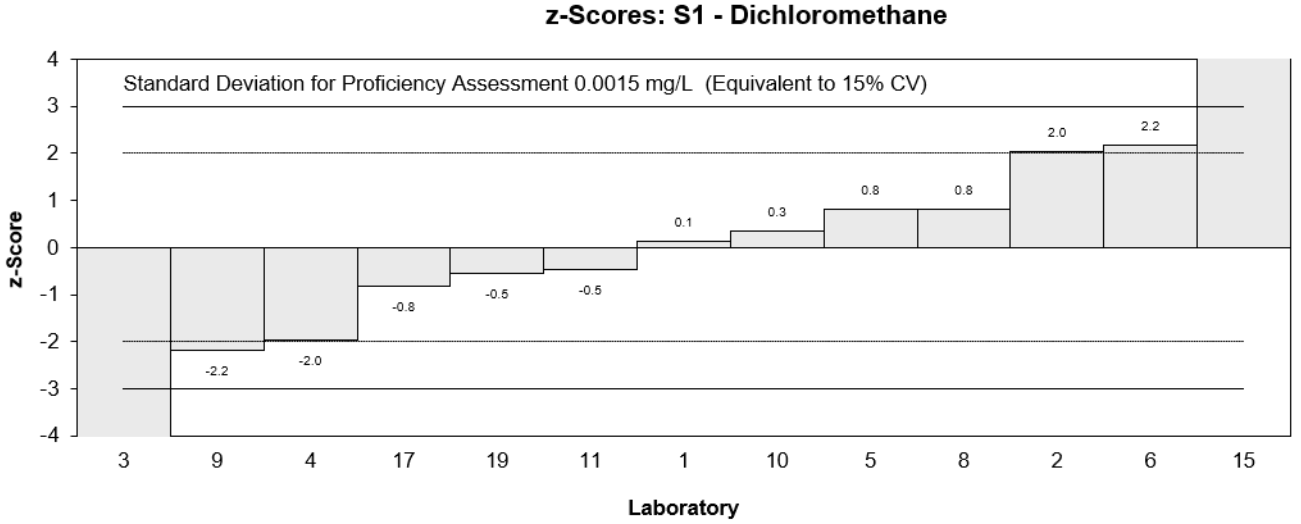
Lab. Code	Result	Uncertainty	z	E_n
1	0.01	0.005	0.14	0.04
2	0.0128	0.0032	2.04	0.82
3*	0.0028	0.0014	-4.76	-3.07
4	0.0069	0.00207	-1.97	-1.06
5	0.011	NR	0.82	0.67
6	0.013	0.004	2.18	0.73
7	NS	NS		
8	0.011	0.004	0.82	0.27
9	0.0066	0.0013	-2.18	-1.44
10	0.0103	0.0018	0.34	0.20
11	0.0091	0.003	-0.48	-0.20
12	NT	NT		
13	NT	NT		
14	NT	NT		
15*	0.087	0.044	52.52	1.75
16	NT	NT		
17	0.0086	0.003	-0.82	-0.34
18	<0.010	0.0067		
19	0.009	0.003	-0.54	-0.23
20	NT	NT		
22	NS	NS		

* Outlier, see Section 4.2

Statistics

Assigned Value	0.0098	0.0018
Spike Value	0.00977	0.00049
Robust Average	0.0098	0.0021
Median	0.0100	0.0014
Mean	0.0152	
N	13	
Max	0.087	
Min	0.0028	
Robust SD	0.003	
Robust CV	30%	


Kernel Density
Density
150
0
0
0.05
0.1
Result
Results: S1 - Dichloromethane
Assigned Value = 0.0098 ± 0.0018 mg/L
Results (mg/L)
0.02
0.015
0.01
0.005
0
3 9 4 17 19 11 1 10 5 8 2 6 15 7 12 13 14 16 18 20 22 Md RA SV
Laboratory


z-Scores: S1 - Dichloromethane
Standard Deviation for Proficiency Assessment 0.0015 mg/L (Equivalent to 15% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-2.2
-2.0
-0.8
-0.6
-0.5
0.1
0.3
0.8
0.8
2.0
2.2
3 9 4 17 19 11 1 10 5 8 2 6 15
Laboratory

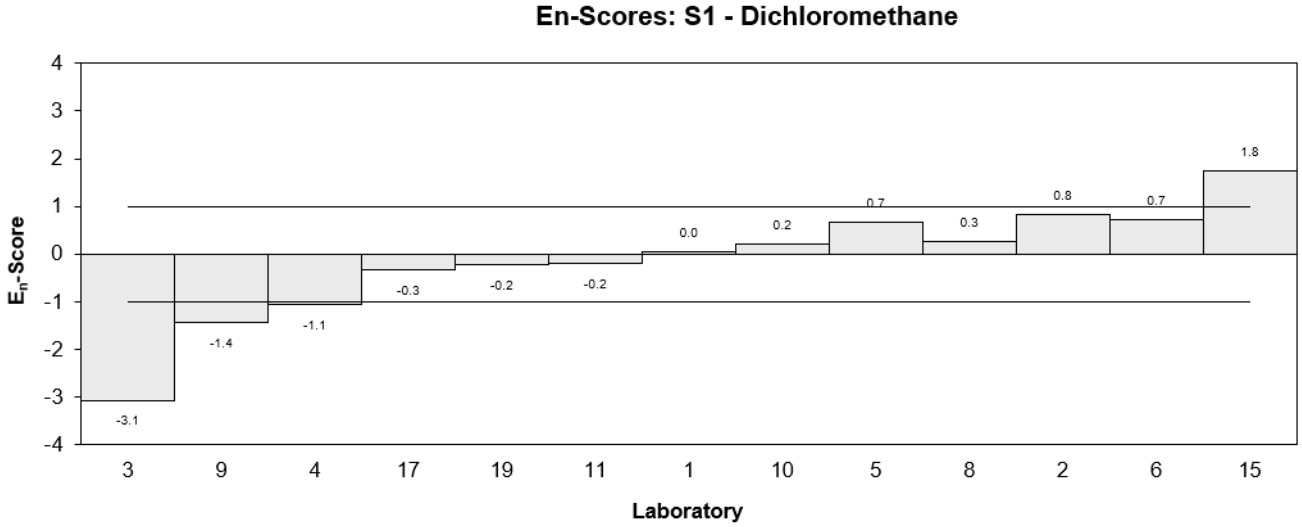

En-Scores: S1 - Dichloromethane
En-Score
4
3
2
1
0
-1
-2
-3
-4
-3.1
-1.4
-1.1
-0.3
-0.2
-0.2
0.0
0.2
0.7
0.3
0.8
0.7
1.8
3 9 4 17 19 11 1 10 5 8 2 6 15
Laboratory

Figure 7

Table 14

Sample Details

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

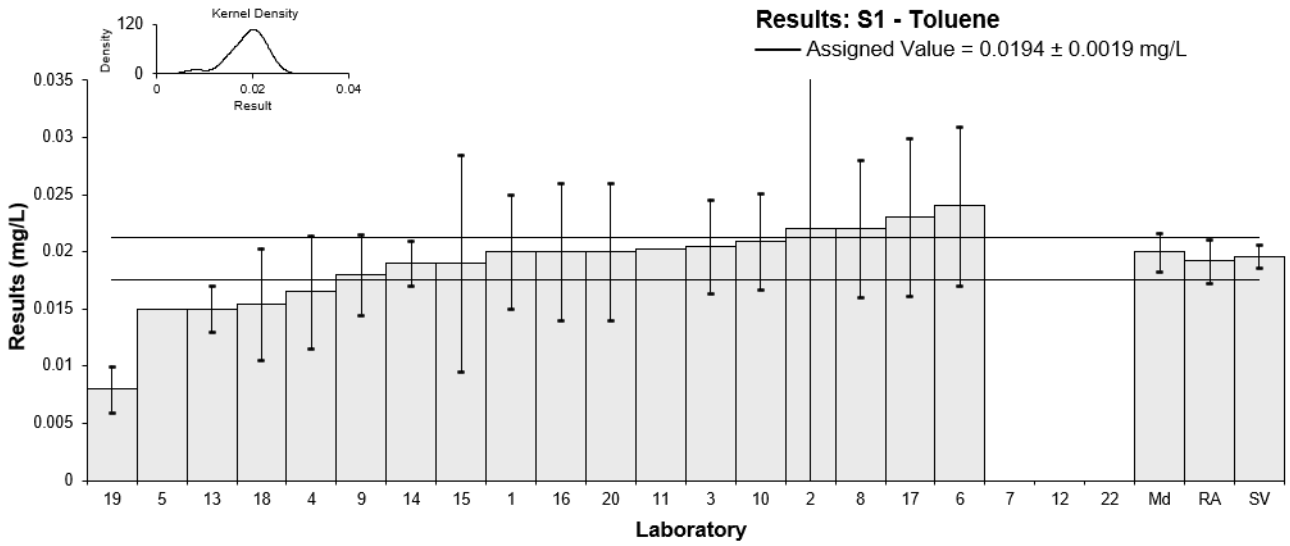
Participant Results

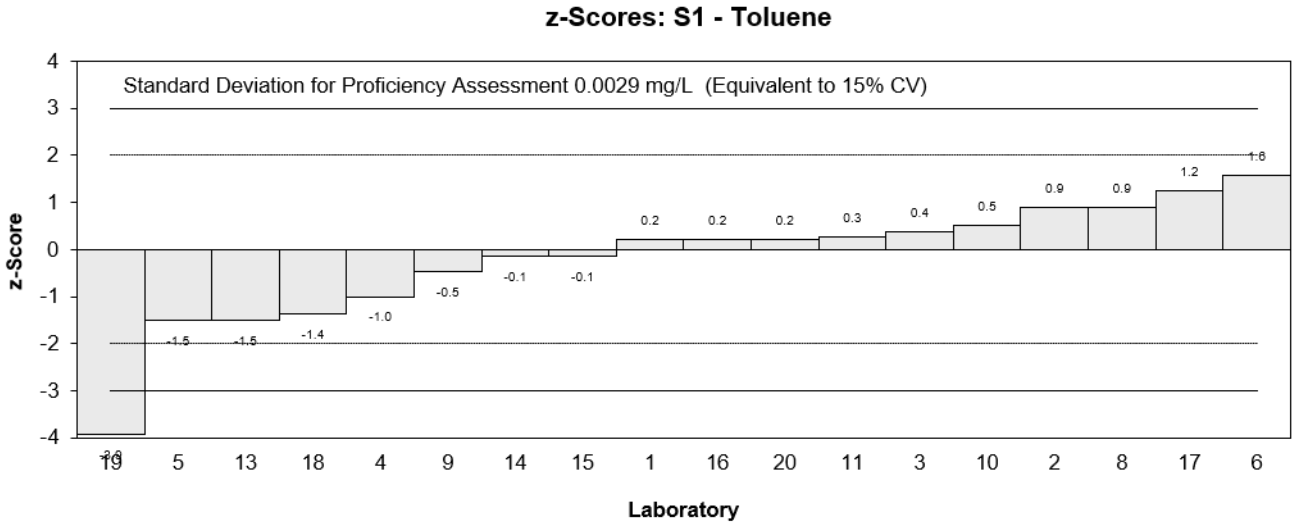
Lab. Code	Result	Uncertainty	z	E_n
1	0.02	0.005	0.21	0.11
2	0.022	0.055	0.89	0.05
3	0.0205	0.0041	0.38	0.24
4	0.0165	0.00495	-1.00	-0.55
5	0.015	NR	-1.51	-2.32
6	0.024	0.007	1.58	0.63
7	NS	NS		
8	0.022	0.006	0.89	0.41
9	0.018	0.0035	-0.48	-0.35
10	0.0209	0.0042	0.52	0.33
11	0.0202	NR	0.27	0.42
12	NT	NT		
13	0.015	0.002	-1.51	-1.59
14	0.019	0.002	-0.14	-0.14
15	0.019	0.0095	-0.14	-0.04
16	0.02	0.006	0.21	0.10
17	0.023	0.0069	1.24	0.50
18	0.0154	0.0049	-1.37	-0.76
19*	0.008	0.002	-3.92	-4.13
20	0.02	0.006	0.21	0.10
22	NS	NS		

* Outlier, see Section 4.2

Statistics

Assigned Value	0.0194	0.0019
Spike Value	0.0196	0.0010
Robust Average	0.0192	0.0019
Median	0.0200	0.0017
Mean	0.0188	
N	18	
Max	0.024	
Min	0.008	
Robust SD	0.0033	
Robust CV	17%	


Kernel Density
Density
120
0
0
0.02
0.04
Result
Results: S1 - Toluene
Assigned Value = 0.0194 ± 0.0019 mg/L
Results (mg/L)
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
19 5 13 18 4 9 14 15 1 16 20 11 3 10 2 8 17 6 7 12 22 Md RA SV
Laboratory


z-Scores: S1 - Toluene
Standard Deviation for Proficiency Assessment 0.0029 mg/L (Equivalent to 15% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-2.6
-1.5
-1.5
-1.4
-1.0
-0.5
-0.1
-0.1
0.2
0.2
0.2
0.3
0.4
0.5
0.9
0.9
1.2
1.6
19 5 13 18 4 9 14 15 1 16 20 11 3 10 2 8 17 6
Laboratory

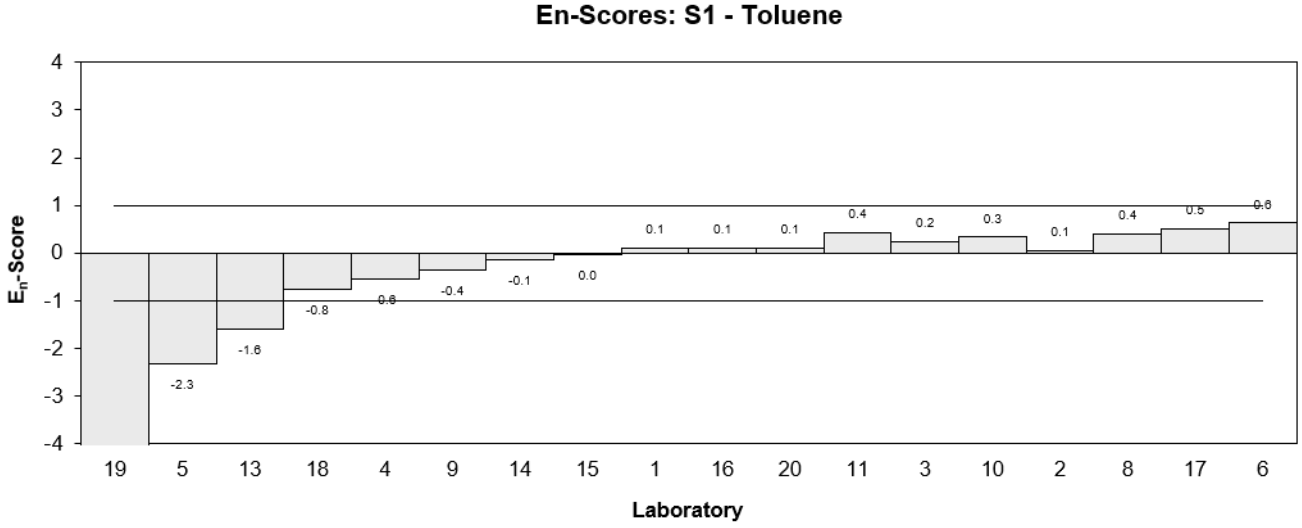

En-Scores: S1 - Toluene
En-Score
4
3
2
1
0
-1
-2
-3
-4
-2.3
-1.6
-0.8
-0.6
-0.4
-0.1
0.0
0.1
0.1
0.1
0.4
0.2
0.3
0.1
0.4
0.5
0.6
19 5 13 18 4 9 14 15 1 16 20 11 3 10 2 8 17 6
Laboratory

Figure 8

Table 15

Sample Details

Sample No.	S1
Matrix	Potable Water
Analyte	Trihalomethanes (Total)
Unit	mg/L

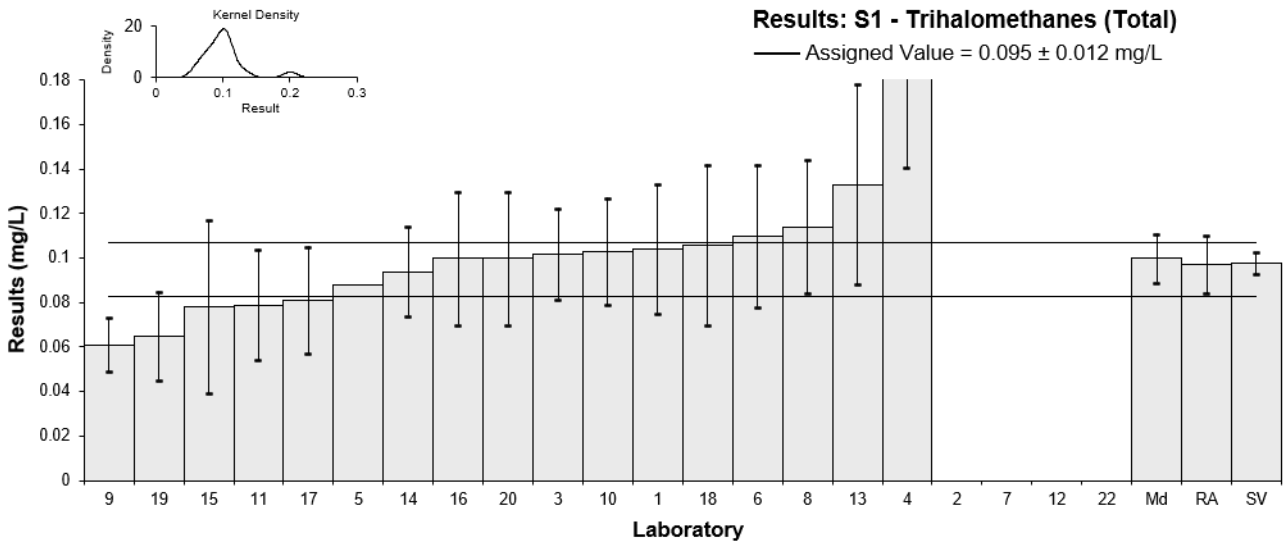
Participant Results

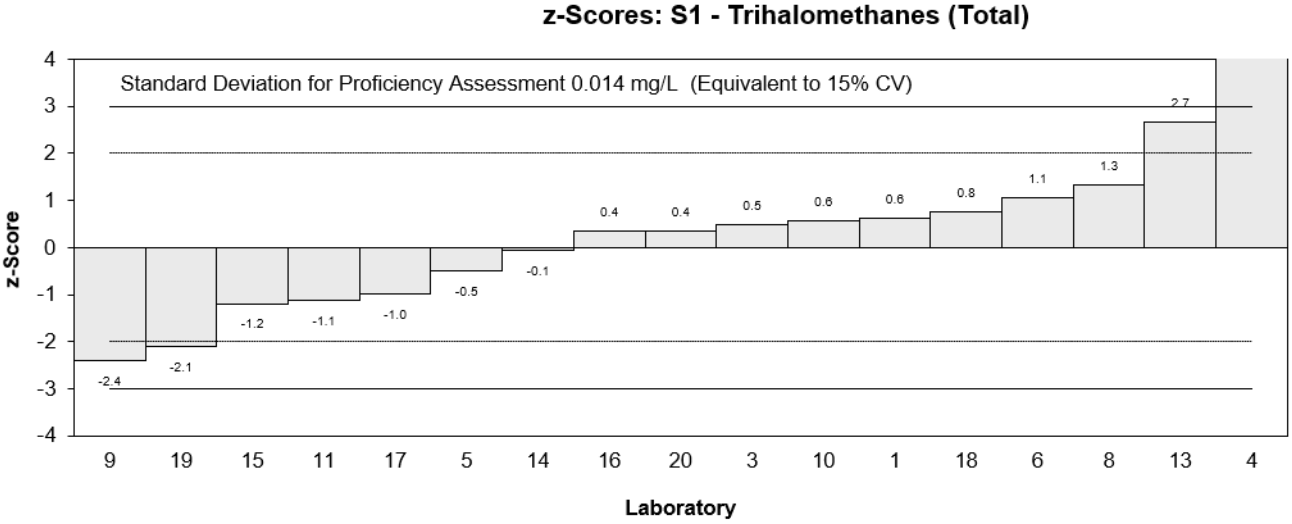
Lab. Code	Result	Uncertainty	z	E_n
1	0.104	0.029	0.63	0.29
2	NT	NT		
3	0.102	0.0204	0.49	0.30
4*	0.201	0.0603	7.44	1.72
5	0.088	NR	-0.49	-0.58
6	0.11	0.032	1.05	0.44
7	NS	NS		
8	0.114	0.03	1.33	0.59
9	0.061	0.012	-2.39	-2.00
10	0.103	0.024	0.56	0.30
11	0.079	0.025	-1.12	-0.58
12	NT	NT		
13	0.133	0.045	2.67	0.82
14	0.094	0.02	-0.07	-0.04
15	0.078	0.039	-1.19	-0.42
16	0.1	0.03	0.35	0.15
17	0.081	0.024	-0.98	-0.52
18	0.106	0.036	0.77	0.29
19	0.065	0.02	-2.11	-1.29
20	0.1	0.03	0.35	0.15
22	NS	NS		

* Outlier, see Section 4.2

Statistics

Assigned Value	0.095	0.012
Spike Value	0.0977	0.0049
Robust Average	0.097	0.013
Median	0.100	0.011
Mean	0.101	
N	17	
Max	0.201	
Min	0.061	
Robust SD	0.022	
Robust CV	22%	


Kernel Density
Density
Result
Results: S1 - Trihalomethanes (Total)
Assigned Value = 0.095 ± 0.012 mg/L
Results (mg/L)
Laboratory
9 19 15 11 17 5 14 16 20 3 10 1 18 6 8 13 4 2 7 12 22 Md RA SV


z-Scores: S1 - Trihalomethanes (Total)
Standard Deviation for Proficiency Assessment 0.014 mg/L (Equivalent to 15% CV)
z-Score
Laboratory
9 19 15 11 17 5 14 16 20 3 10 1 18 6 8 13 4
-2.4 -2.1 -1.2 -1.1 -1.0 -0.5 -0.1 0.4 0.4 0.5 0.6 0.6 0.8 1.1 1.3 2.7

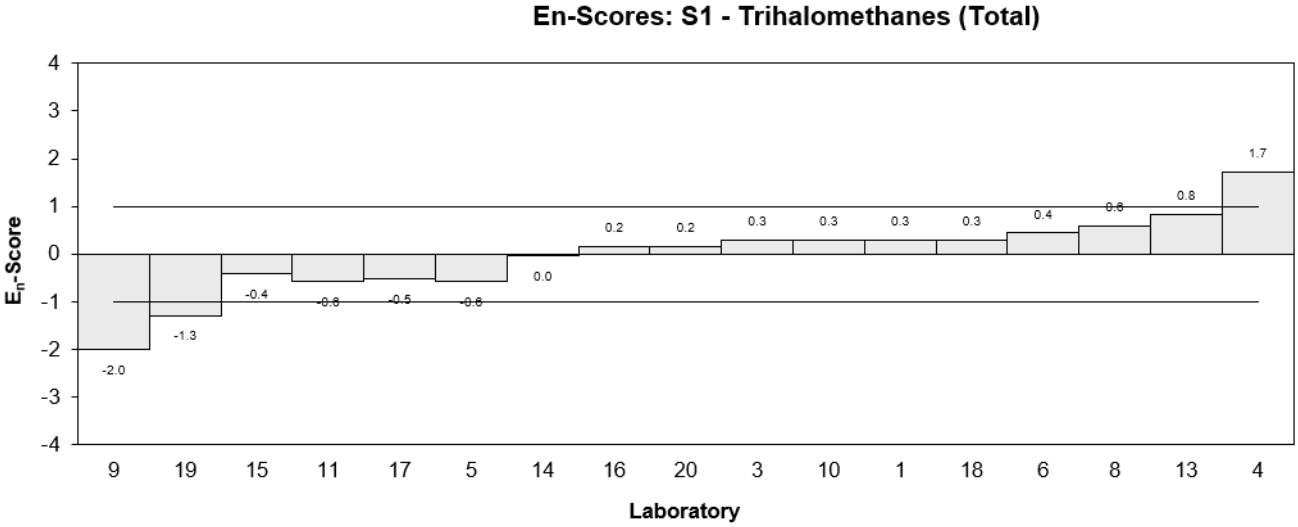

En-Scores: S1 - Trihalomethanes (Total)
En-Score
Laboratory
9 19 15 11 17 5 14 16 20 3 10 1 18 6 8 13 4
-2.0 -1.3 -0.4 -0.6 -0.5 -0.6 0.0 0.2 0.2 0.3 0.3 0.3 0.3 0.4 0.6 0.8 1.7

Figure 9

Table 16

Sample Details

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

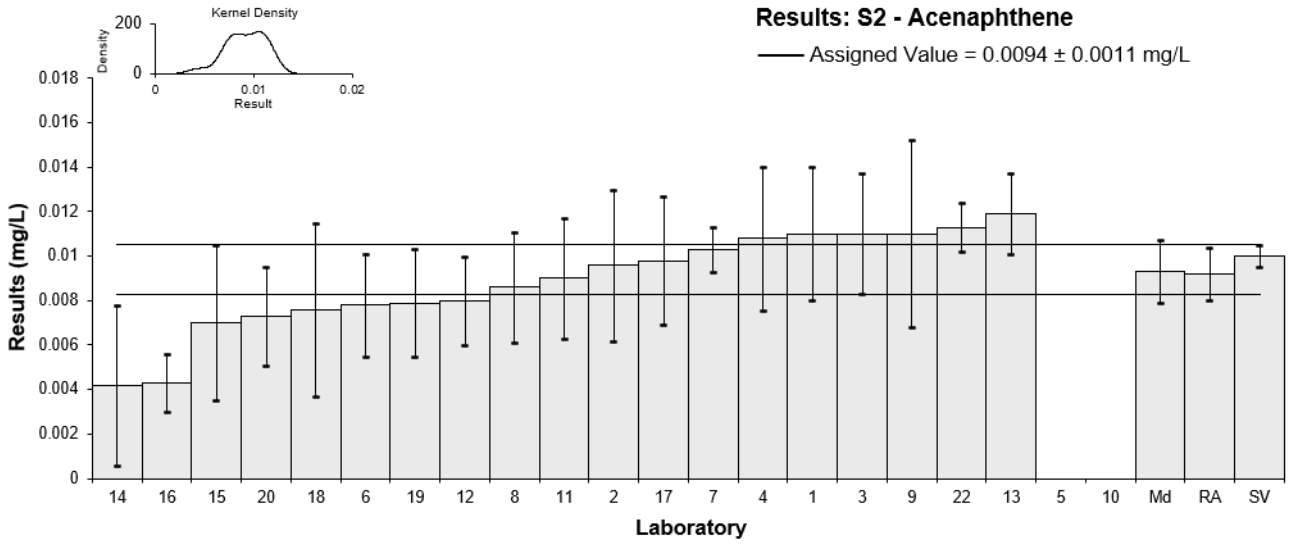
Participant Results

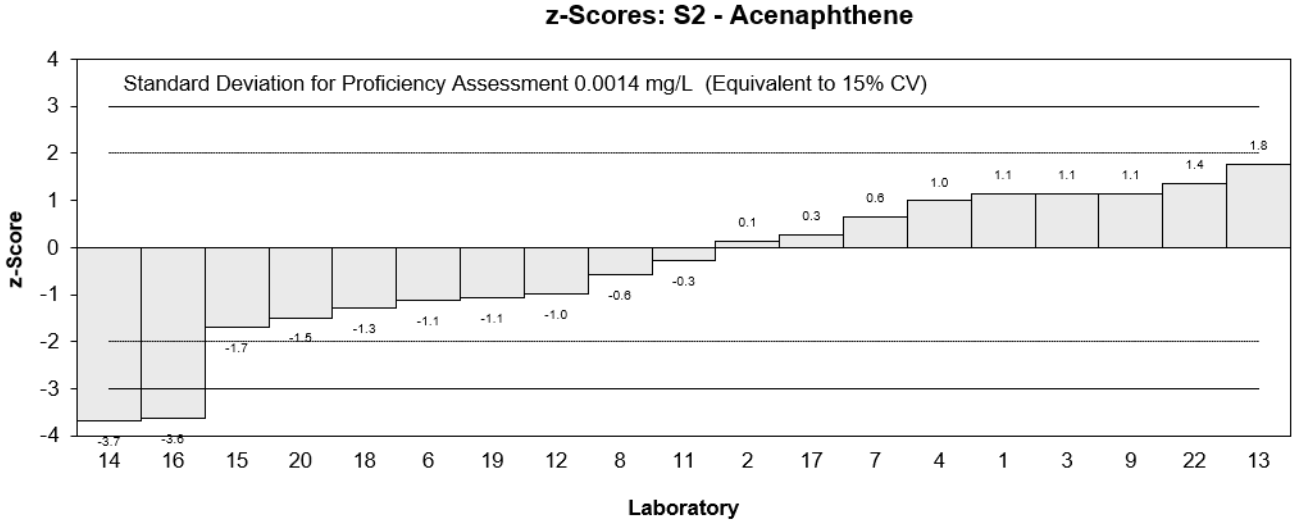
Lab. Code	Result	Uncertainty	z	E_n
1	0.011	0.003	1.13	0.50
2	0.0096	0.0034	0.14	0.06
3	0.011	0.0027	1.13	0.55
4	0.0108	0.00324	0.99	0.41
5	NT	NT		
6	0.0078	0.0023	-1.13	-0.63
7	0.0103	0.001	0.64	0.61
8	0.0086	0.0025	-0.57	-0.29
9	0.011	0.0042	1.13	0.37
10	NS	NS		
11	0.009	0.0027	-0.28	-0.14
12	0.008	0.002	-0.99	-0.61
13	0.0119	0.0018	1.77	1.19
14**	0.0042	0.0036	-3.69	-1.38
15	0.007	0.0035	-1.70	-0.65
16*	0.0043	0.0013	-3.62	-2.99
17	0.0098	0.0029	0.28	0.13
18	0.0076	0.0039	-1.28	-0.44
19	0.0079	0.0024	-1.06	-0.57
20	0.0073	0.0022	-1.49	-0.85
22	0.0113	0.0011	1.35	1.22

* Outlier, see Section 4.2; ** Excluded Result, see Section 6.1

Statistics

Assigned Value	0.0094	0.0011
Spike Value	0.0100	0.0005
Robust Average	0.0092	0.0012
Median	0.0093	0.0014
Mean	0.00912	
N	18	
Max	0.0119	
Min	0.0043	
Robust SD	0.002	
Robust CV	21%	


Kernel Density
Density
Result
Results: S2 - Acenaphthene
Assigned Value = 0.0094 ± 0.0011 mg/L
Results (mg/L)
Laboratory
14 16 15 20 18 6 19 12 8 11 2 17 7 4 1 3 9 22 13 5 10 Md RA SV


z-Scores: S2 - Acenaphthene
Standard Deviation for Proficiency Assessment 0.0014 mg/L (Equivalent to 15% CV)
z-Score
Laboratory
14 16 15 20 18 6 19 12 8 11 2 17 7 4 1 3 9 22 13
-3.7 -3.6 -1.7 -1.5 -1.3 -1.1 -1.1 -1.0 -0.6 -0.3 0.1 0.3 0.6 1.0 1.1 1.1 1.1 1.4 1.8

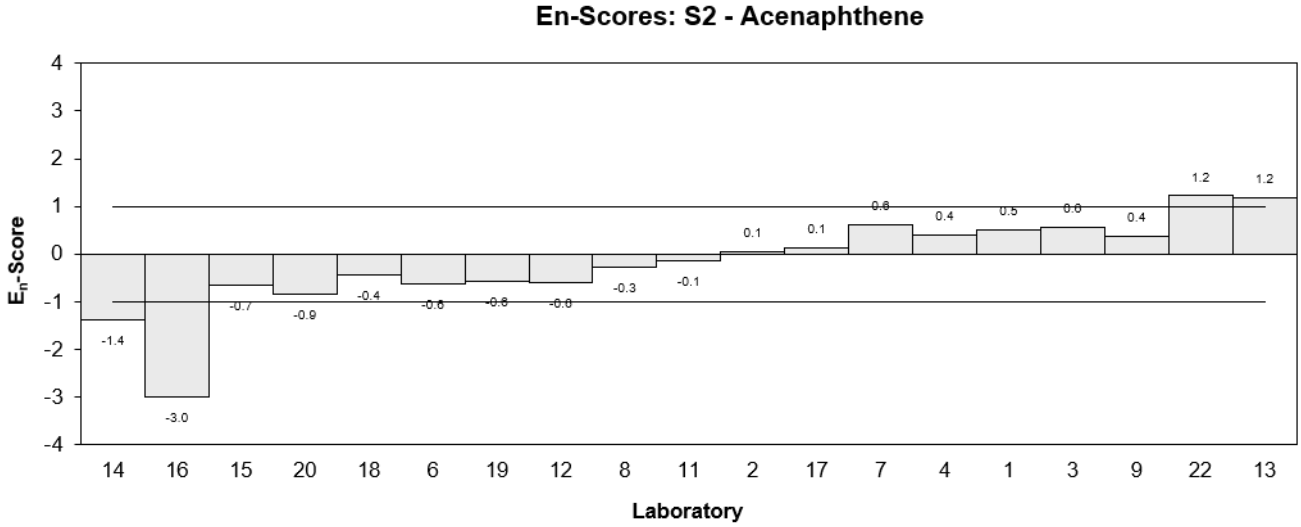

En-Scores: S2 - Acenaphthene
En-Score
Laboratory
14 16 15 20 18 6 19 12 8 11 2 17 7 4 1 3 9 22 13
-1.4 -3.0 -0.7 -0.9 -0.4 -0.6 -0.6 -0.6 -0.3 -0.1 0.1 0.1 0.6 0.4 0.5 0.6 0.4 1.2 1.2

Figure 10

Table 17

Sample Details

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

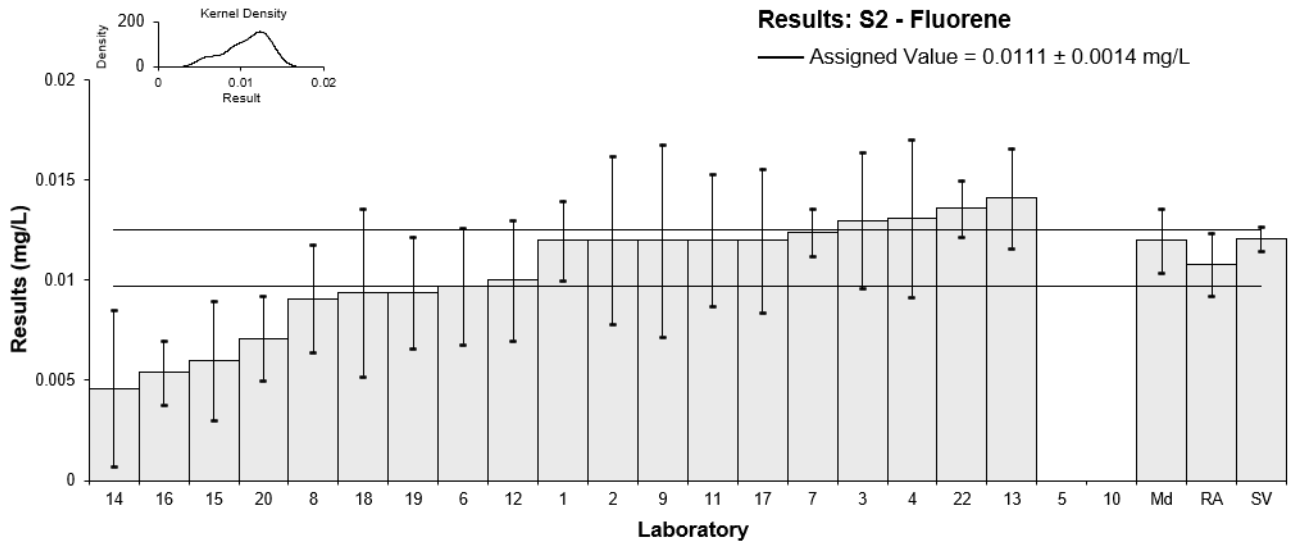
Participant Results

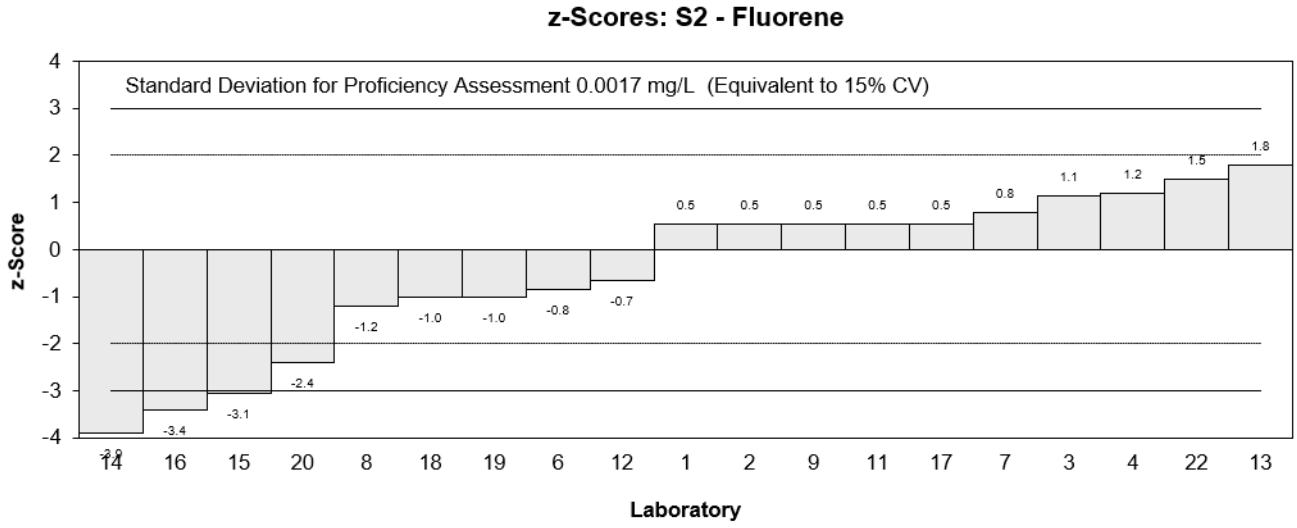
Lab. Code	Result	Uncertainty	z	E_n
1	0.012	0.002	0.54	0.37
2	0.012	0.0042	0.54	0.20
3	0.013	0.0034	1.14	0.52
4	0.0131	0.00393	1.20	0.48
5	NT	NT		
6	0.0097	0.0029	-0.84	-0.43
7	0.0124	0.0012	0.78	0.71
8	0.0091	0.0027	-1.20	-0.66
9	0.012	0.0048	0.54	0.18
10	NS	NS		
11	0.012	0.0033	0.54	0.25
12	0.01	0.003	-0.66	-0.33
13	0.0141	0.0025	1.80	1.05
14**	0.0046	0.0039	-3.90	-1.57
15	0.006	0.003	-3.06	-1.54
16*	0.0054	0.0016	-3.42	-2.68
17	0.012	0.0036	0.54	0.23
18	0.0094	0.0042	-1.02	-0.38
19	0.0094	0.0028	-1.02	-0.54
20	0.0071	0.0021	-2.40	-1.58
22	0.0136	0.0014	1.50	1.26

* Outlier, see Section 4.2; ** Excluded Result, see Section 6.1

Statistics

Assigned Value	0.0111	0.0014
Spike Value	0.0121	0.0006
Robust Average	0.0108	0.0016
Median	0.0120	0.0016
Mean	0.0107	
N	18	
Max	0.0141	
Min	0.0054	
Robust SD	0.0026	
Robust CV	24%	


Kernel Density
Density
200
0
0
0.01
0.02
Result
Results: S2 - Fluorene
Assigned Value = 0.0111 ± 0.0014 mg/L
Results (mg/L)
0.02
0.015
0.01
0.005
0
14 16 15 20 8 18 19 6 12 1 2 9 11 17 7 3 4 22 13 5 10 Md RA SV
Laboratory


z-Scores: S2 - Fluorene
Standard Deviation for Proficiency Assessment 0.0017 mg/L (Equivalent to 15% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-3.8
-3.4
-3.1
-2.4
-1.2
-1.0
-1.0
-0.8
-0.7
0.5
0.5
0.5
0.5
0.5
0.8
1.1
1.2
1.5
1.8
14 16 15 20 8 18 19 6 12 1 2 9 11 17 7 3 4 22 13
Laboratory

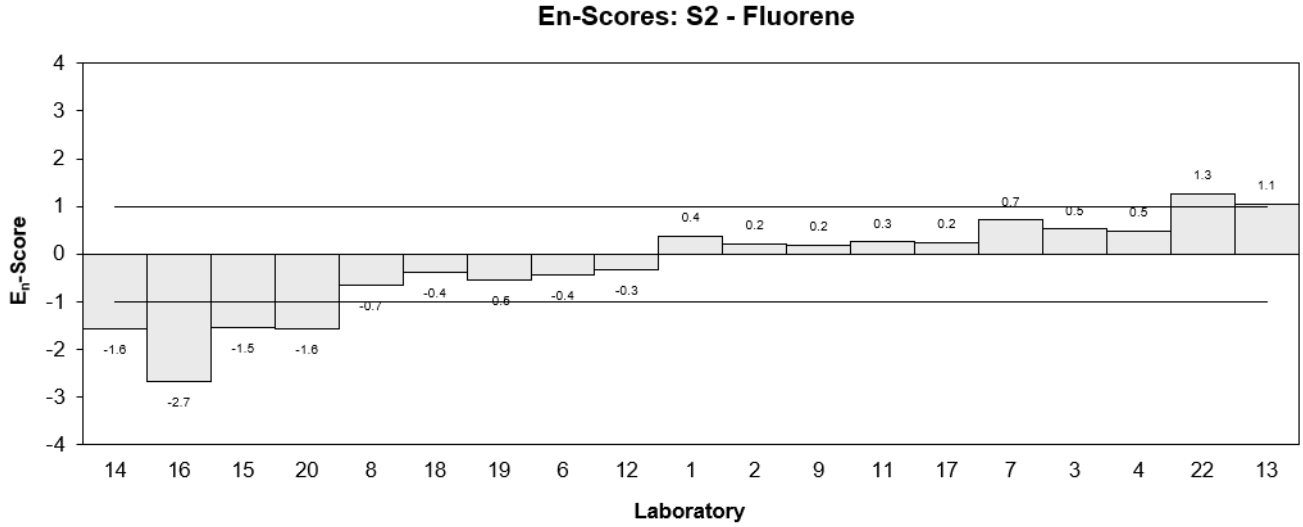

En-Scores: S2 - Fluorene
En-Score
4
3
2
1
0
-1
-2
-3
-4
-1.6
-2.7
-1.5
-1.6
-0.7
-0.4
-0.5
-0.4
-0.3
0.4
0.2
0.2
0.3
0.2
0.7
0.5
0.5
1.3
1.1
14 16 15 20 8 18 19 6 12 1 2 9 11 17 7 3 4 22 13
Laboratory

Figure 11

Table 18

Sample Details

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

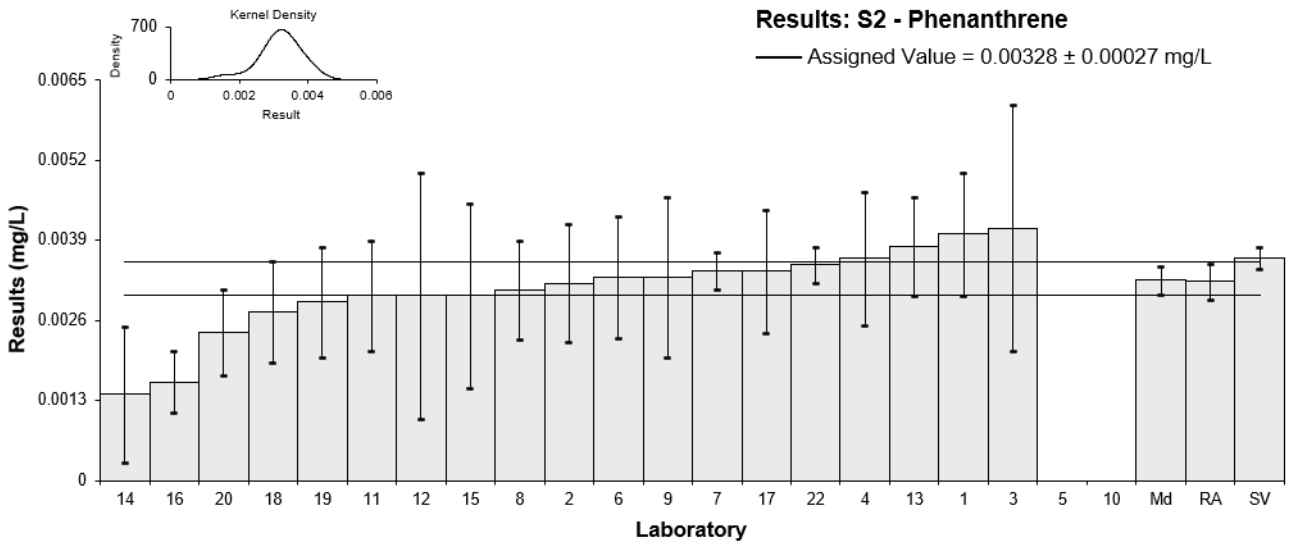
Participant Results

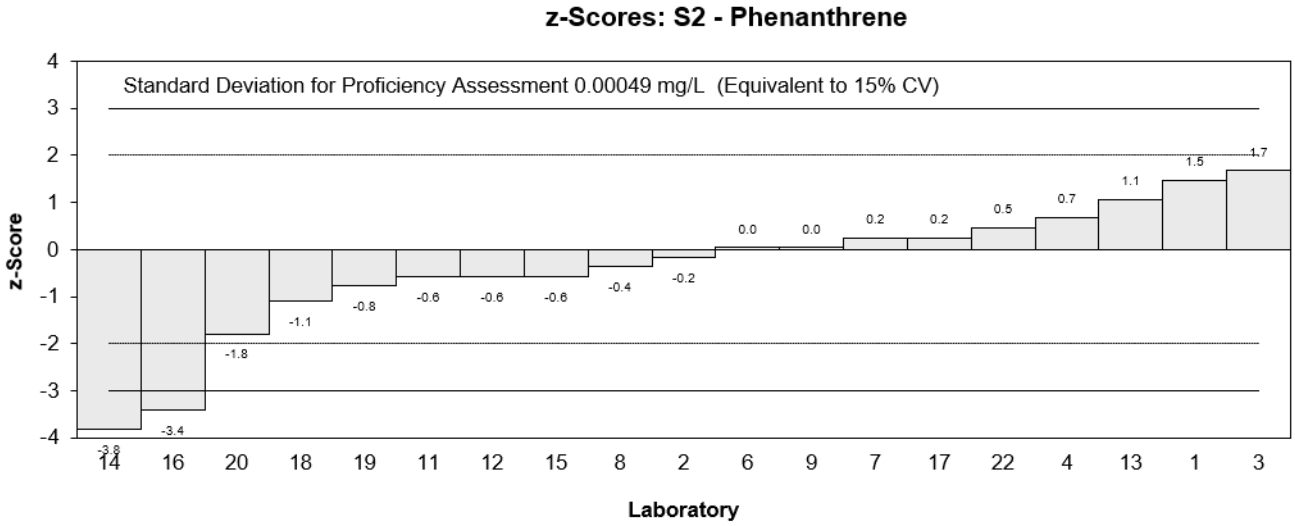
Lab. Code	Result	Uncertainty	z	E_n
1	0.004	0.001	1.46	0.70
2	0.0032	0.00096	-0.16	-0.08
3	0.0041	0.0020	1.67	0.41
4	0.00361	0.001083	0.67	0.30
5	NT	NT		
6	0.0033	0.00098	0.04	0.02
7	0.0034	0.0003	0.24	0.30
8	0.0031	0.0008	-0.37	-0.21
9	0.0033	0.0013	0.04	0.02
10	NS	NS		
11	0.003	0.0009	-0.57	-0.30
12	0.003	0.002	-0.57	-0.14
13	0.0038	0.0008	1.06	0.62
14**	0.0014	0.0011	-3.82	-1.66
15	0.003	0.0015	-0.57	-0.18
16*	0.0016	0.0005	-3.41	-2.96
17	0.0034	0.0010	0.24	0.12
18	0.00274	0.00083	-1.10	-0.62
19	0.0029	0.0009	-0.77	-0.40
20	0.0024	0.0007	-1.79	-1.17
22	0.0035	0.0003	0.45	0.55

* Outlier, see Section 4.2; ** Excluded Result, see Section 6.1

Statistics

Assigned Value	0.00328	0.00027
Spike Value	0.00361	0.00018
Robust Average	0.00323	0.00030
Median	0.00325	0.00022
Mean	0.00319	
N	18	
Max	0.0041	
Min	0.0016	
Robust SD	0.00051	
Robust CV	16%	


Kernel Density
Density
700
0
0
0.002
0.004
0.006
Result
Results: S2 - Phenanthrene
Assigned Value = 0.00328 ± 0.00027 mg/L
Results (mg/L)
0.0065
0.0052
0.0039
0.0026
0.0013
0
14 16 20 18 19 11 12 15 8 2 6 9 7 17 22 4 13 1 3 5 10 Md RA SV
Laboratory


z-Scores: S2 - Phenanthrene
Standard Deviation for Proficiency Assessment 0.00049 mg/L (Equivalent to 15% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-3.8
-3.4
-1.8
-1.1
-0.8
-0.6
-0.6
-0.6
-0.4
-0.2
0.0
0.0
0.2
0.2
0.5
0.7
1.1
1.5
1.7
14 16 20 18 19 11 12 15 8 2 6 9 7 17 22 4 13 1 3
Laboratory

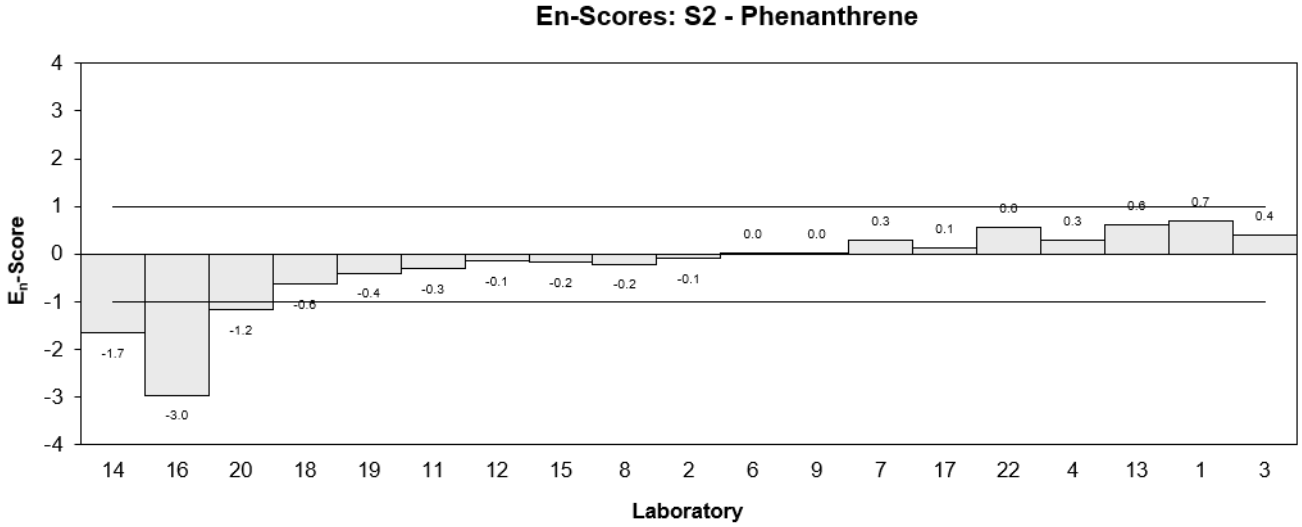

En-Scores: S2 - Phenanthrene
En-Score
4
3
2
1
0
-1
-2
-3
-4
-1.7
-3.0
-1.2
-0.6
-0.4
-0.3
-0.1
-0.2
-0.2
-0.1
0.0
0.0
0.3
0.1
0.6
0.3
0.6
0.7
0.4
14 16 20 18 19 11 12 15 8 2 6 9 7 17 22 4 13 1 3
Laboratory

Figure 12

Table 19

Sample Details

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

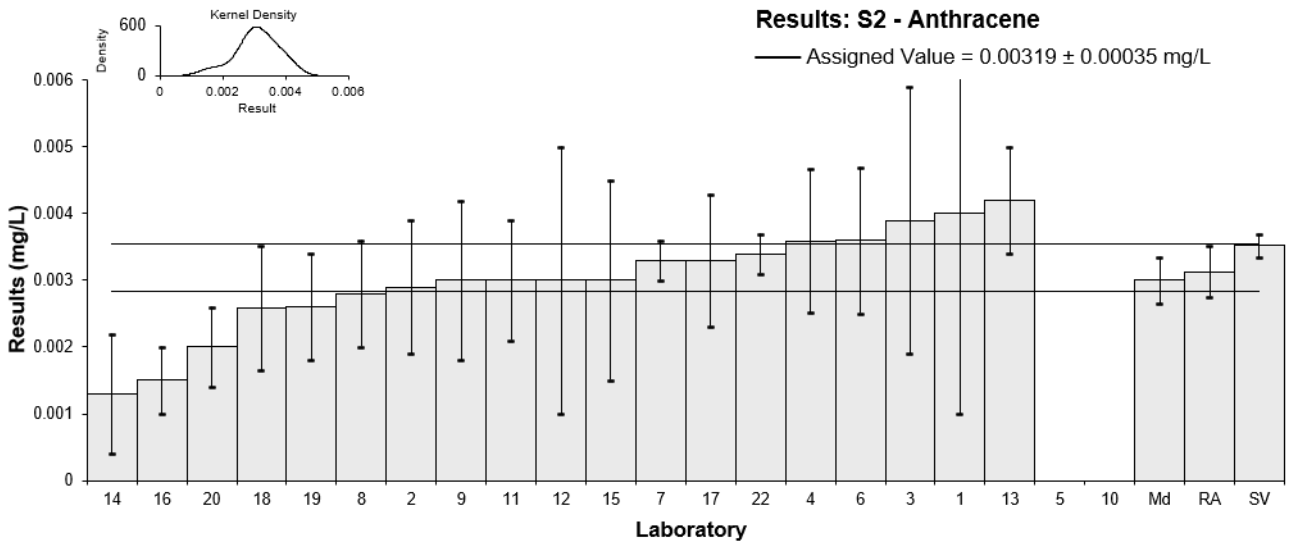
Participant Results

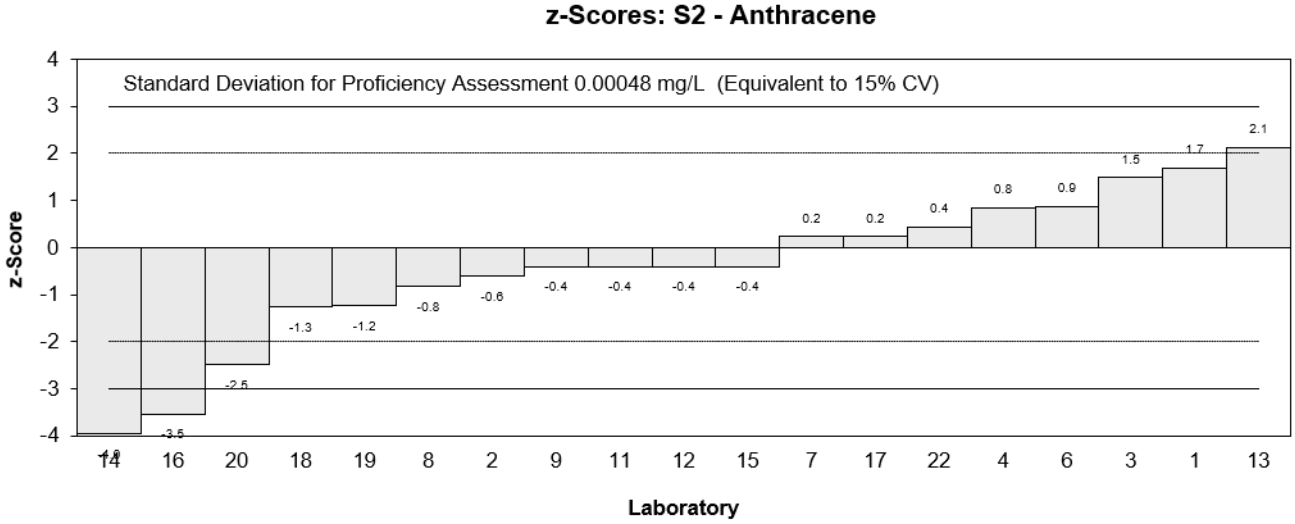
Lab. Code	Result	Uncertainty	z	E_n
1	0.004	0.003	1.69	0.27
2	0.0029	0.001	-0.61	-0.27
3	0.0039	0.0020	1.48	0.35
4	0.00359	0.001077	0.84	0.35
5	NT	NT		
6	0.0036	0.0011	0.86	0.36
7	0.0033	0.0003	0.23	0.24
8	0.0028	0.0008	-0.82	-0.45
9	0.0030	0.0012	-0.40	-0.15
10	NS	NS		
11	0.003	0.0009	-0.40	-0.20
12	0.003	0.002	-0.40	-0.09
13	0.0042	0.0008	2.11	1.16
14**	0.0013	0.0009	-3.95	-1.96
15	0.003	0.0015	-0.40	-0.12
16*	0.0015	0.0005	-3.53	-2.77
17	0.0033	0.00099	0.23	0.10
18	0.00258	0.00093	-1.27	-0.61
19	0.0026	0.0008	-1.23	-0.68
20	0.002	0.0006	-2.49	-1.71
22	0.0034	0.0003	0.44	0.46

* Outlier, see Section 4.2; ** Excluded Result, see Section 6.1

Statistics

Assigned Value	0.00319	0.00035
Spike Value	0.00352	0.00018
Robust Average	0.00313	0.00038
Median	0.00300	0.00035
Mean	0.00309	
N	18	
Max	0.0042	
Min	0.0015	
Robust SD	0.00064	
Robust CV	21%	


Kernel Density
Density
600
0
0
0.002
0.004
0.006
Result
Results: S2 - Anthracene
Assigned Value = 0.00319 ± 0.00035 mg/L
Results (mg/L)
0.006
0.005
0.004
0.003
0.002
0.001
0
14 16 20 18 19 8 2 9 11 12 15 7 17 22 4 6 3 1 13 5 10 Md RA SV
Laboratory


z-Scores: S2 - Anthracene
Standard Deviation for Proficiency Assessment 0.00048 mg/L (Equivalent to 15% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-4.0
-3.5
-2.5
-1.3
-1.2
-0.8
-0.6
-0.4
-0.4
-0.4
-0.4
0.2
0.2
0.4
0.8
0.9
1.5
1.7
2.1
14 16 20 18 19 8 2 9 11 12 15 7 17 22 4 6 3 1 13
Laboratory

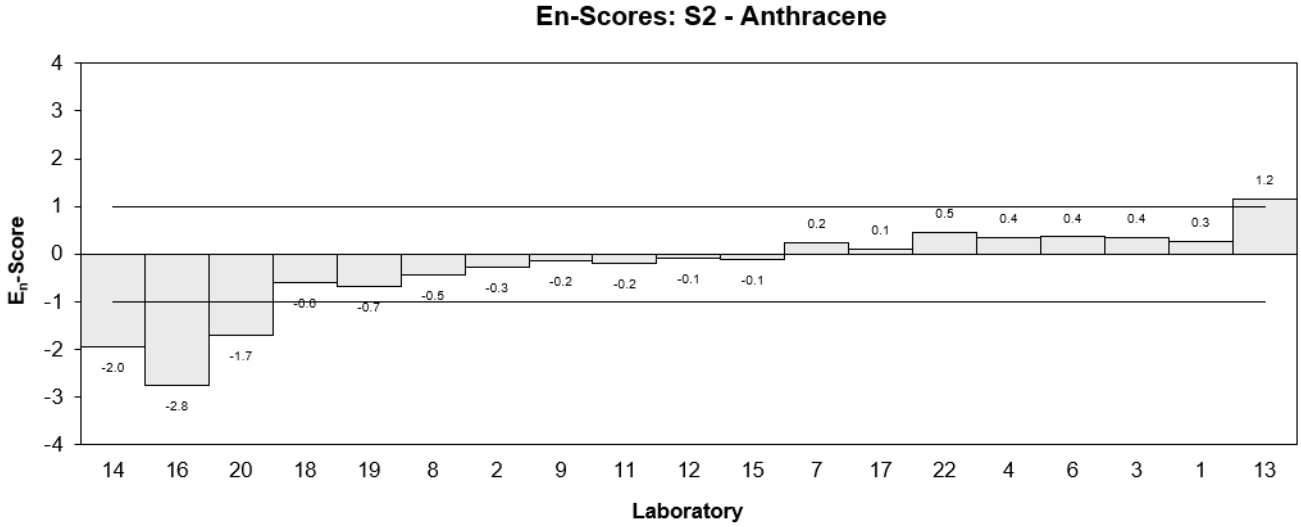

En-Scores: S2 - Anthracene
En-Score
4
3
2
1
0
-1
-2
-3
-4
-2.0
-2.8
-1.7
-0.6
-0.7
-0.5
-0.3
-0.2
-0.2
-0.1
-0.1
0.2
0.1
0.5
0.4
0.4
0.4
0.3
1.2
14 16 20 18 19 8 2 9 11 12 15 7 17 22 4 6 3 1 13
Laboratory

Figure 13

Table 20

Sample Details

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

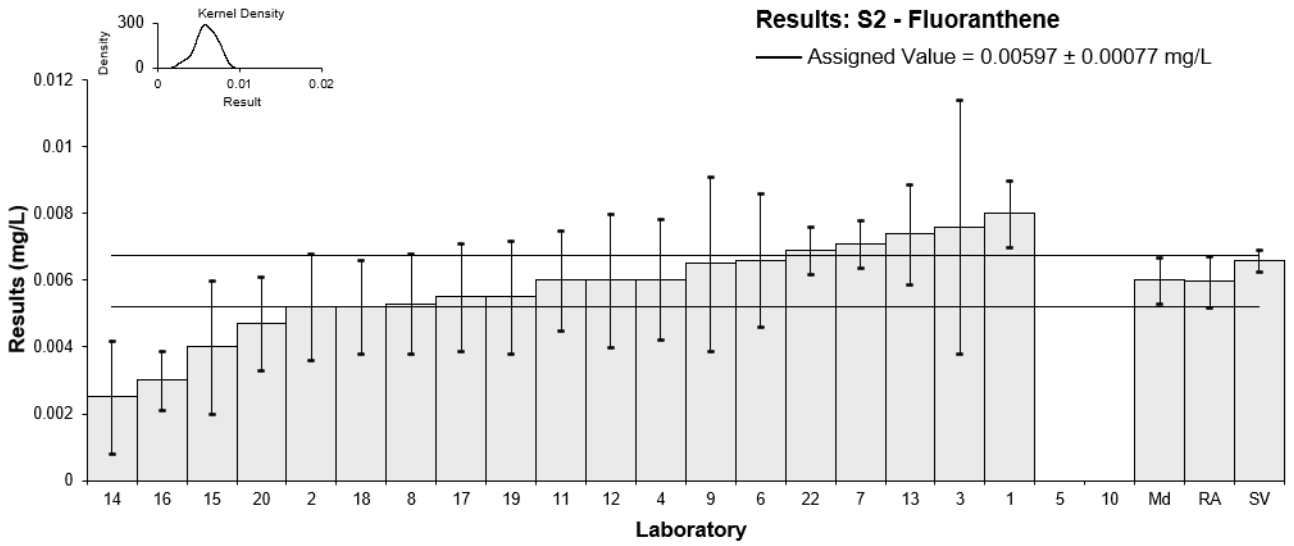
Participant Results

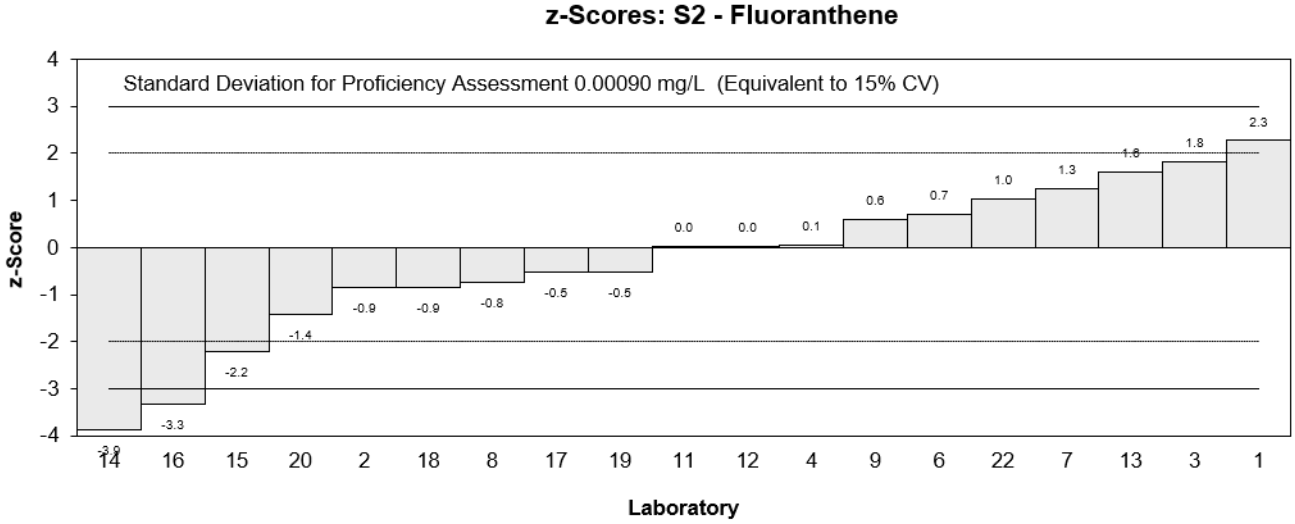
Lab. Code	Result	Uncertainty	z	E_n
1	0.008	0.001	2.27	1.61
2	0.0052	0.0016	-0.86	-0.43
3	0.0076	0.0038	1.82	0.42
4	0.00602	0.001806	0.06	0.03
5	NT	NT		
6	0.0066	0.002	0.70	0.29
7	0.0071	0.0007	1.26	1.09
8	0.0053	0.0015	-0.75	-0.40
9	0.0065	0.0026	0.59	0.20
10	NS	NS		
11	0.006	0.0015	0.03	0.02
12	0.006	0.002	0.03	0.01
13	0.0074	0.0015	1.60	0.85
14**	0.0025	0.0017	-3.87	-1.86
15	0.004	0.002	-2.20	-0.92
16	0.003	0.0009	-3.32	-2.51
17	0.0055	0.0016	-0.52	-0.26
18	0.0052	0.0014	-0.86	-0.48
19	0.0055	0.0017	-0.52	-0.25
20	0.0047	0.0014	-1.42	-0.79
22	0.0069	0.0007	1.04	0.89

** Excluded Result, see Section 6.1

Statistics

Assigned Value	0.00597	0.00077
Spike Value	0.00661	0.00033
Robust Average	0.00597	0.00077
Median	0.00600	0.00070
Mean	0.00592	
N	18	
Max	0.008	
Min	0.003	
Robust SD	0.0013	
Robust CV	22%	


Kernel Density
Density
Result
Results: S2 - Fluoranthene
Assigned Value = 0.00597 ± 0.00077 mg/L
Results (mg/L)
Laboratory
14 16 15 20 2 18 8 17 19 11 12 4 9 6 22 7 13 3 1 5 10 Md RA SV


z-Scores: S2 - Fluoranthene
Standard Deviation for Proficiency Assessment 0.00090 mg/L (Equivalent to 15% CV)
z-Score
Laboratory
14 16 15 20 2 18 8 17 19 11 12 4 9 6 22 7 13 3 1

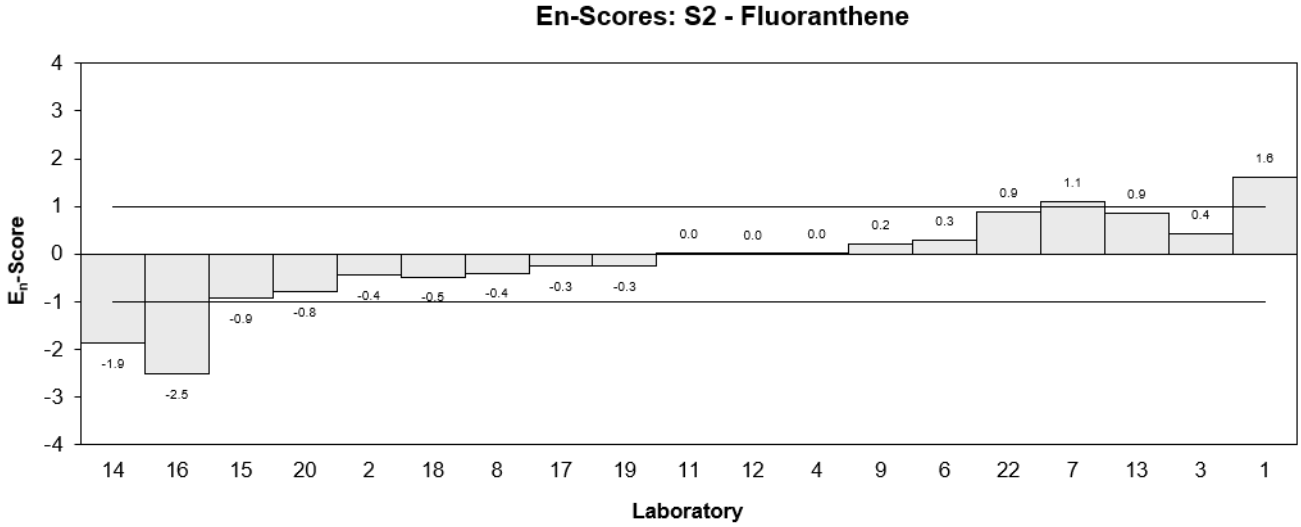

En-Scores: S2 - Fluoranthene
En-Score
Laboratory
14 16 15 20 2 18 8 17 19 11 12 4 9 6 22 7 13 3 1

Figure 14

Table 21

Sample Details

Sample No.	S2
Matrix	Potable Water
Analyte	Benz[a]anthracene
Unit	mg/L

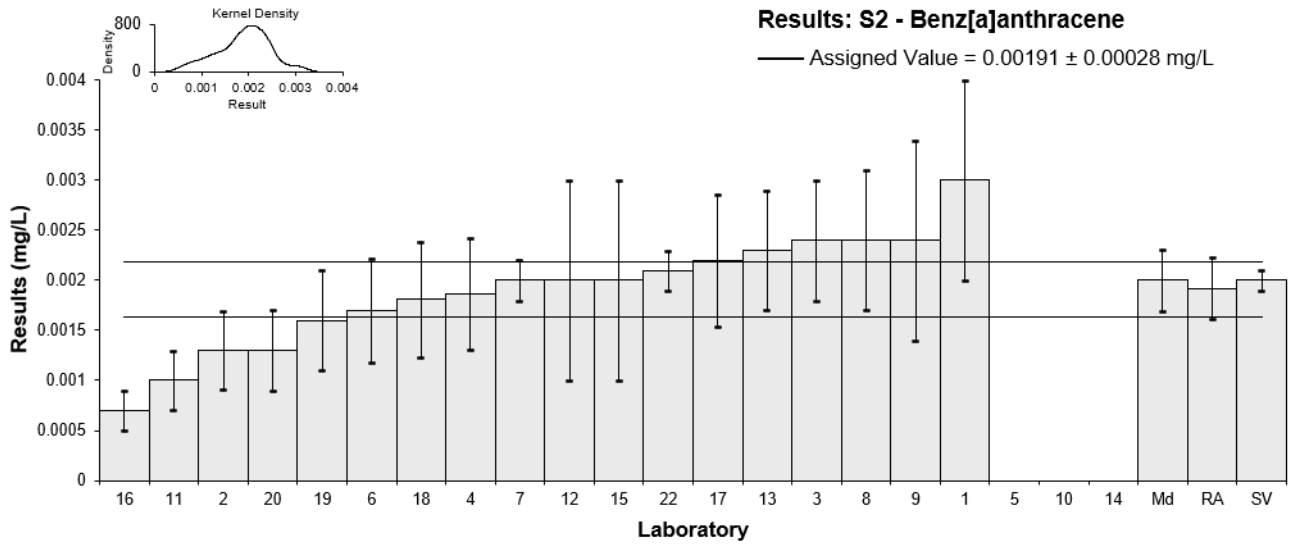
Participant Results

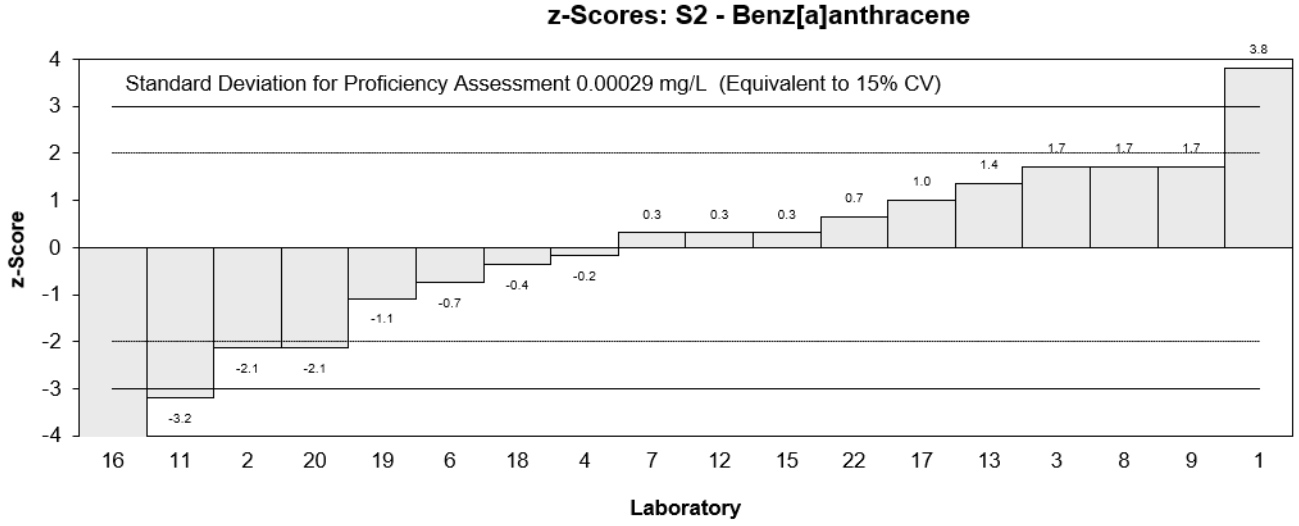
Lab. Code	Result	Uncertainty	z	E_n
1*	0.003	0.001	3.80	1.05
2	0.0013	0.00039	-2.13	-1.27
3	0.0024	0.0006	1.71	0.74
4	0.00186	0.000558	-0.17	-0.08
5	NT	NT		
6	0.0017	0.00052	-0.73	-0.36
7	0.002	0.0002	0.31	0.26
8	0.0024	0.0007	1.71	0.65
9	0.0024	0.0010	1.71	0.47
10	NS	NS		
11	0.001	0.0003	-3.18	-2.22
12	0.002	0.001	0.31	0.09
13	0.0023	0.0006	1.36	0.59
14	<0.0010	0.0008		
15	0.002	0.001	0.31	0.09
16*	0.0007	0.0002	-4.22	-3.52
17	0.0022	0.00066	1.01	0.40
18	0.00181	0.00058	-0.35	-0.16
19	0.0016	0.0005	-1.08	-0.54
20	0.0013	0.0004	-2.13	-1.25
22	0.0021	0.0002	0.66	0.55

* Outlier, see Section 4.2

Statistics

Assigned Value	0.00191	0.00028
Spike Value	0.00200	0.00010
Robust Average	0.00192	0.00031
Median	0.00200	0.00031
Mean	0.00189	
N	18	
Max	0.003	
Min	0.0007	
Robust SD	0.00052	
Robust CV	27%	


Kernel Density
Density
800
0
0
0.001
0.002
0.003
0.004
Result
Results: S2 - Benz[a]anthracene
Assigned Value = 0.00191 ± 0.00028 mg/L
Results (mg/L)
0.004
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
16 11 2 20 19 6 18 4 7 12 15 22 17 13 3 8 9 1 5 10 14 Md RA SV
Laboratory


z-Scores: S2 - Benz[a]anthracene
Standard Deviation for Proficiency Assessment 0.00029 mg/L (Equivalent to 15% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-3.2
-2.1
-2.1
-1.1
-0.7
-0.4
-0.2
0.3
0.3
0.3
0.7
1.0
1.4
1.7
1.7
1.7
3.8
16 11 2 20 19 6 18 4 7 12 15 22 17 13 3 8 9 1
Laboratory

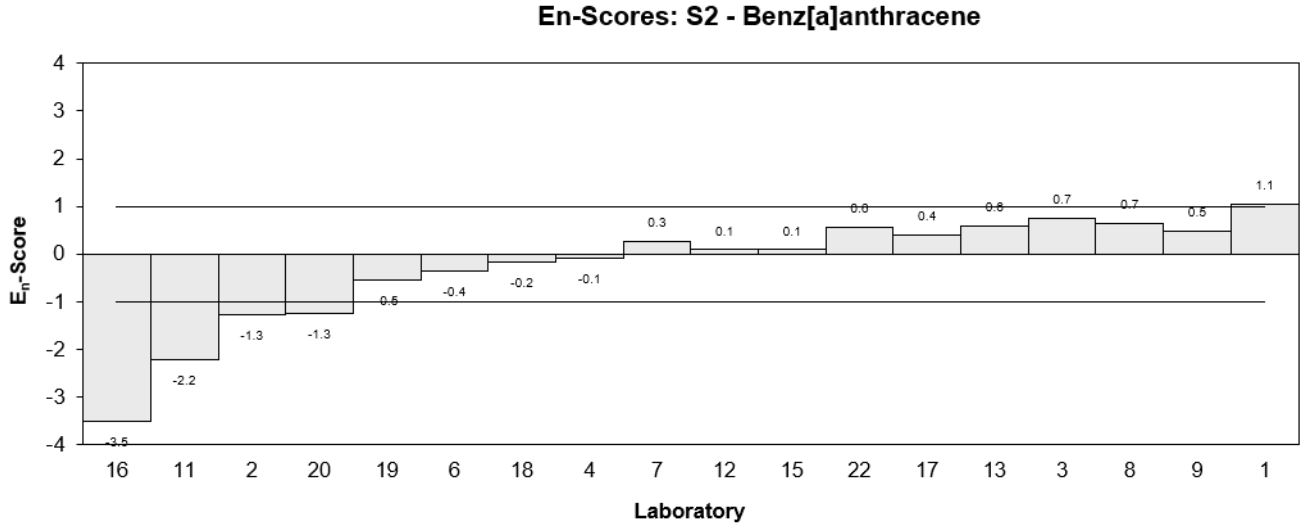

En-Scores: S2 - Benz[a]anthracene
En-Score
4
3
2
1
0
-1
-2
-3
-4
-3.5
-2.2
-1.3
-1.3
-0.5
-0.4
-0.2
-0.1
0.3
0.1
0.1
0.6
0.4
0.6
0.7
0.7
0.5
1.1
16 11 2 20 19 6 18 4 7 12 15 22 17 13 3 8 9 1
Laboratory

Figure 15

Table 22

Sample Details

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

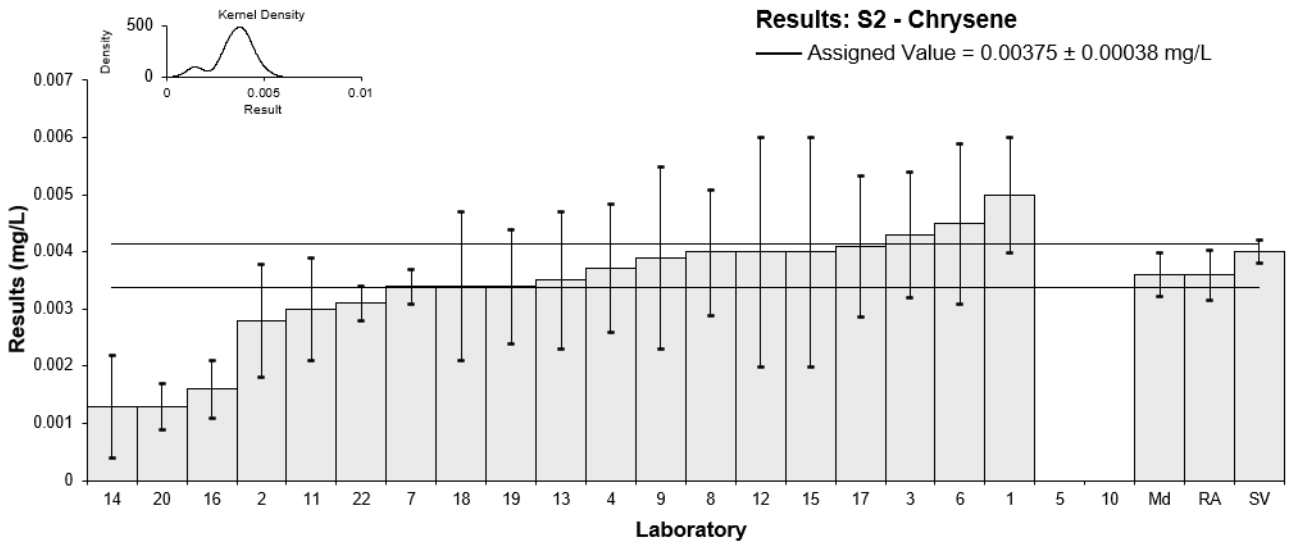
Participant Results

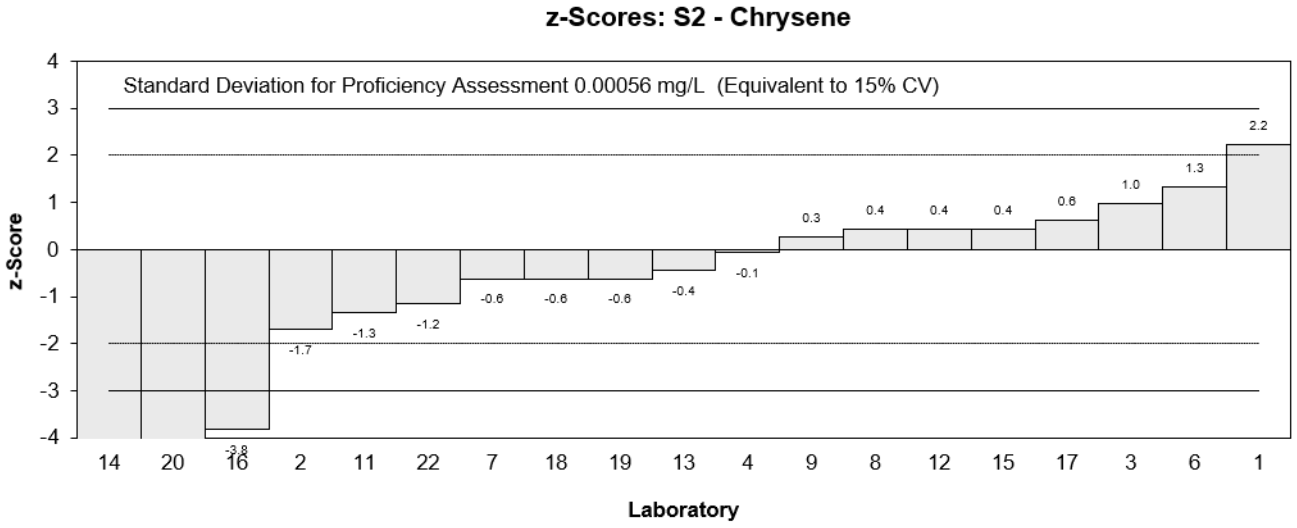
Lab. Code	Result	Uncertainty	z	E_n
1	0.005	0.001	2.22	1.17
2	0.0028	0.00098	-1.69	-0.90
3	0.0043	0.0011	0.98	0.47
4	0.00372	0.001116	-0.05	-0.03
5	NT	NT		
6	0.0045	0.0014	1.33	0.52
7	0.0034	0.0003	-0.62	-0.72
8	0.004	0.0011	0.44	0.21
9	0.0039	0.0016	0.27	0.09
10	NS	NS		
11	0.003	0.0009	-1.33	-0.77
12	0.004	0.002	0.44	0.12
13	0.0035	0.0012	-0.44	-0.20
14**	0.0013	0.0009	-4.36	-2.51
15	0.004	0.002	0.44	0.12
16*	0.0016	0.0005	-3.82	-3.42
17	0.0041	0.00123	0.62	0.27
18	0.0034	0.0013	-0.62	-0.26
19	0.0034	0.0010	-0.62	-0.33
20*	0.0013	0.0004	-4.36	-4.44
22	0.0031	0.0003	-1.16	-1.34

* Outlier, see Section 4.2; ** Excluded Result, see Section 6.1

Statistics

Assigned Value	0.00375	0.00038
Spike Value	0.00401	0.00020
Robust Average	0.00360	0.00043
Median	0.00361	0.00038
Mean	0.00350	
N	18	
Max	0.005	
Min	0.0013	
Robust SD	0.00073	
Robust CV	20%	


Kernel Density
Density
500
0
0
0.005
0.01
Result
Results: S2 - Chrysene
Assigned Value = 0.00375 ± 0.00038 mg/L
Results (mg/L)
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
14 20 16 2 11 22 7 18 19 13 4 9 8 12 15 17 3 6 1 5 10 Md RA SV
Laboratory


z-Scores: S2 - Chrysene
Standard Deviation for Proficiency Assessment 0.00056 mg/L (Equivalent to 15% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-1.7
-3.8
-1.3
-1.2
-0.6
-0.6
-0.6
-0.4
-0.1
0.3
0.4
0.4
0.4
0.6
1.0
1.3
2.2
14 20 16 2 11 22 7 18 19 13 4 9 8 12 15 17 3 6 1
Laboratory

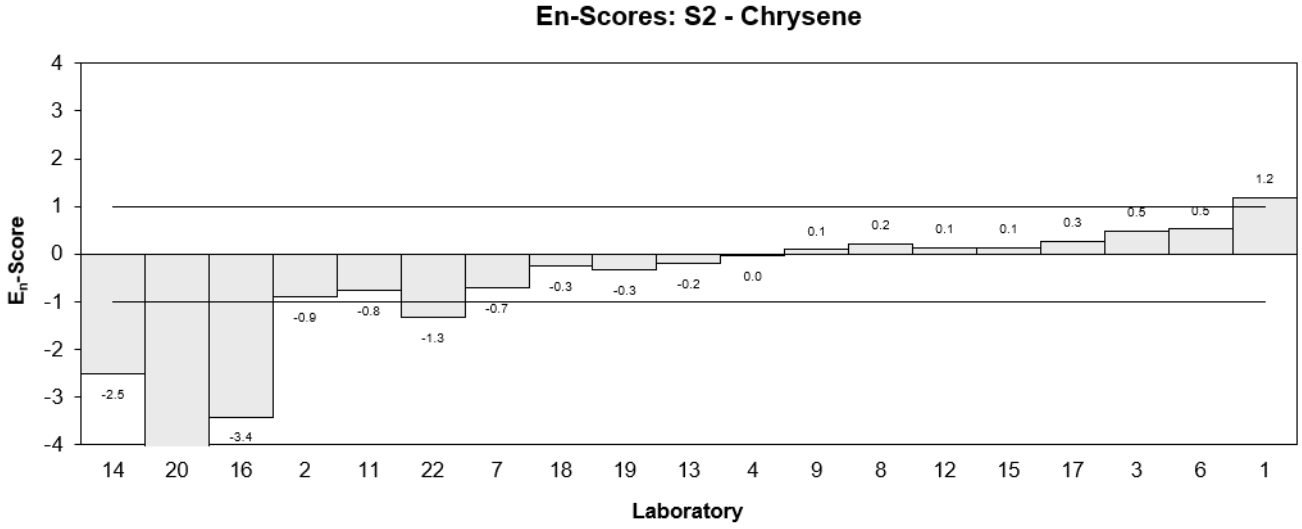

En-Scores: S2 - Chrysene
En-Score
4
3
2
1
0
-1
-2
-3
-4
-2.5
-3.4
-0.9
-0.8
-1.3
-0.7
-0.3
-0.3
-0.2
0.0
0.1
0.2
0.1
0.1
0.3
0.5
0.5
1.2
14 20 16 2 11 22 7 18 19 13 4 9 8 12 15 17 3 6 1
Laboratory

Figure 16

Table 23

Sample Details

Sample No.	S2
Matrix	Potable Water
Analyte	Benzo[b]fluoranthene
Unit	mg/L

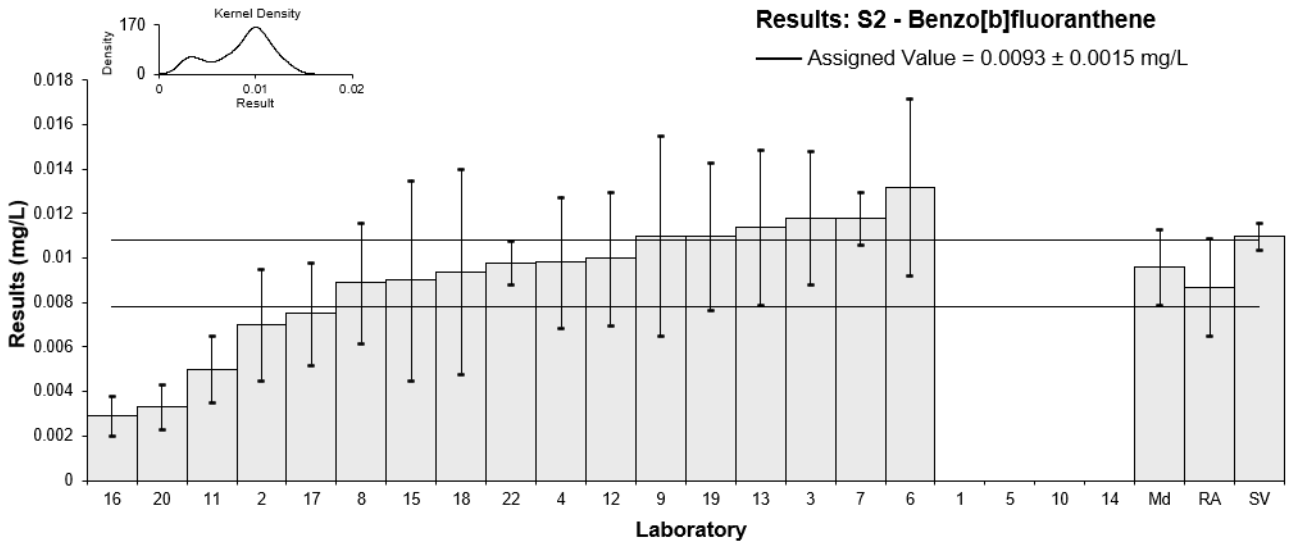
Participant Results

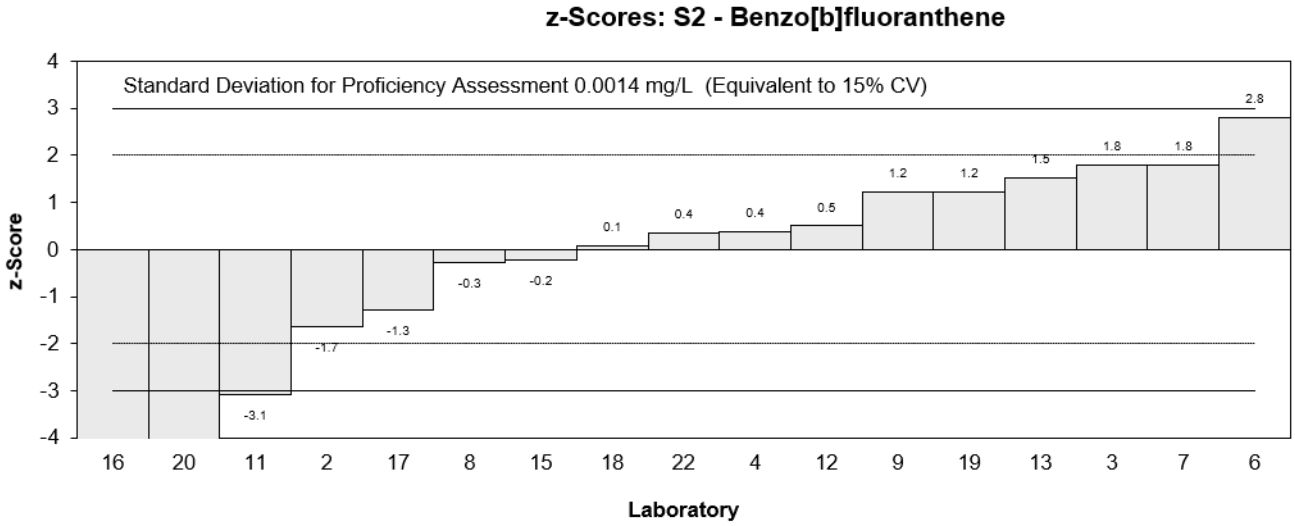
Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	0.007	0.0025	-1.65	-0.79
3**	0.0118	0.0030	1.79	0.75
4	0.00982	0.002946	0.37	0.16
5	NT	NT		
6*	0.0132	0.004	2.80	0.91
7	0.0118	0.0012	1.79	1.30
8	0.0089	0.0027	-0.29	-0.13
9	0.011	0.0045	1.22	0.36
10	NS	NS		
11	0.005	0.0015	-3.08	-2.03
12	0.01	0.003	0.50	0.21
13**	0.0114	0.0035	1.51	0.55
14	NT	NT		
15**	0.009	0.0045	-0.22	-0.06
16*	0.0029	0.0009	-4.59	-3.66
17	0.0075	0.0023	-1.29	-0.66
18	0.0094	0.0046	0.07	0.02
19	0.011	0.0033	1.22	0.47
20*	0.0033	0.001	-4.30	-3.33
22	0.0098	0.001	0.36	0.28

* Outlier, see Section 4.2; ** Excluded Result, see Section 6.1

Statistics

Assigned Value	0.0093	0.0015
Spike Value	0.0110	0.0006
Robust Average	0.0087	0.0022
Median	0.0096	0.0017
Mean	0.00862	
N	14	
Max	0.0132	
Min	0.0029	
Robust SD	0.0034	
Robust CV	39%	


Kernel Density
Density
170
0
0
0.01
0.02
Result
Results: S2 - Benzo[b]fluoranthene
Assigned Value = 0.0093 ± 0.0015 mg/L
Results (mg/L)
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
16 20 11 2 17 8 15 18 22 4 12 9 19 13 3 7 6 1 5 10 14 Md RA SV
Laboratory


z-Scores: S2 - Benzo[b]fluoranthene
Standard Deviation for Proficiency Assessment 0.0014 mg/L (Equivalent to 15% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-3.1
-1.7
-1.3
-0.3
-0.2
0.1
0.4
0.4
0.5
1.2
1.2
1.5
1.8
1.8
2.8
16 20 11 2 17 8 15 18 22 4 12 9 19 13 3 7 6
Laboratory

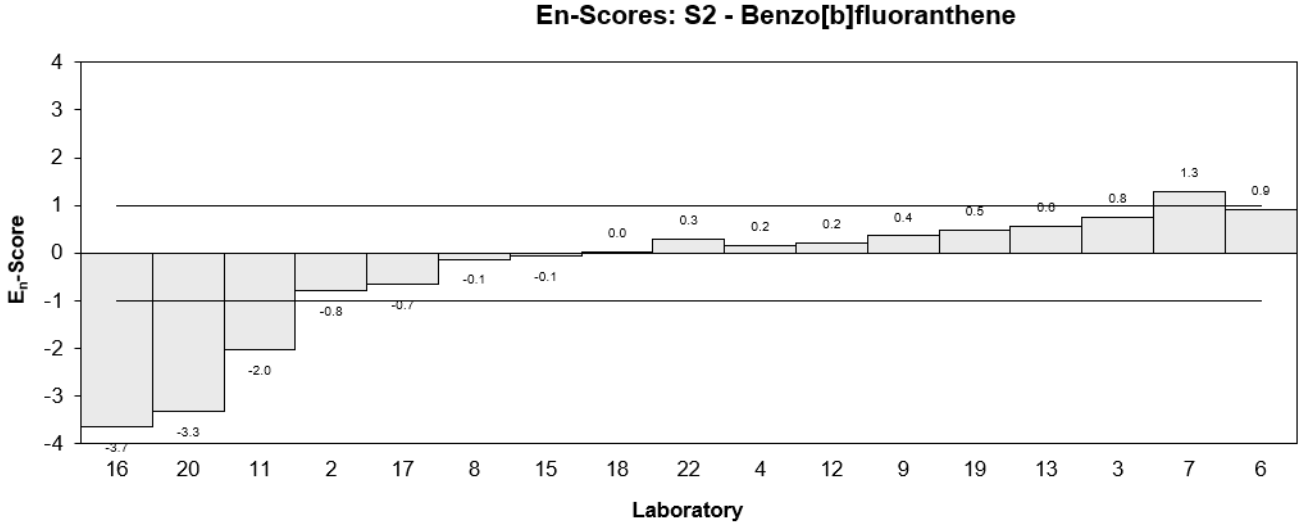

En-Scores: S2 - Benzo[b]fluoranthene
En-Score
4
3
2
1
0
-1
-2
-3
-4
-3.7
-3.3
-2.0
-0.8
-0.7
-0.1
-0.1
0.0
0.3
0.2
0.2
0.4
0.5
0.6
0.8
1.3
0.9
16 20 11 2 17 8 15 18 22 4 12 9 19 13 3 7 6
Laboratory

Figure 17

Table 24

Sample Details

Sample No.	S2
Matrix	Potable Water
Analyte	Benzo[a]pyrene
Unit	mg/L

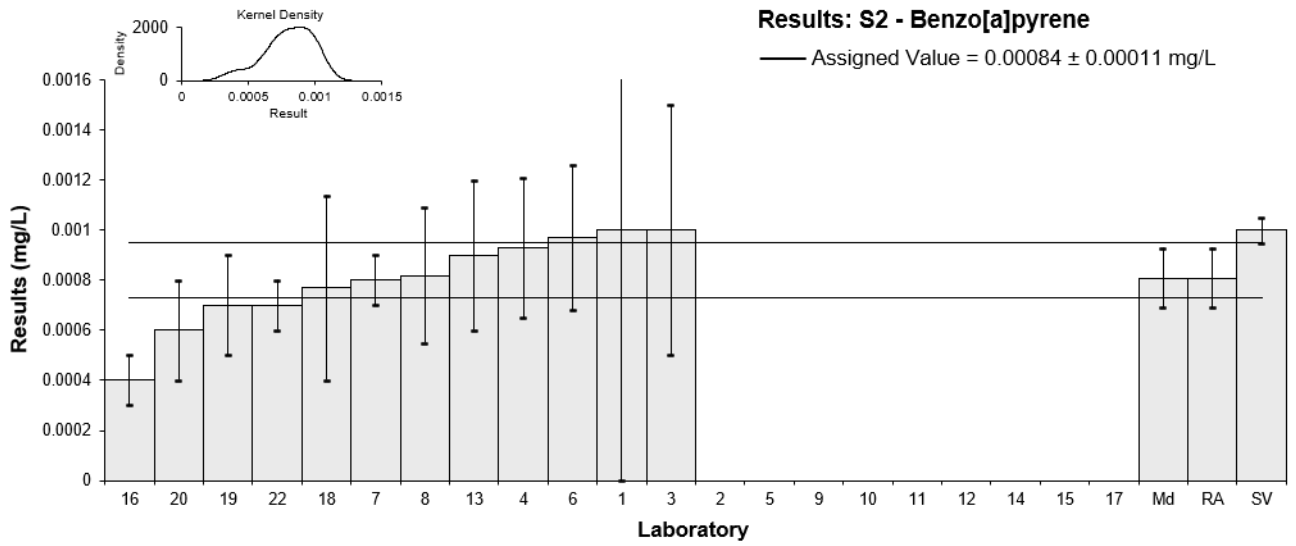
Participant Results

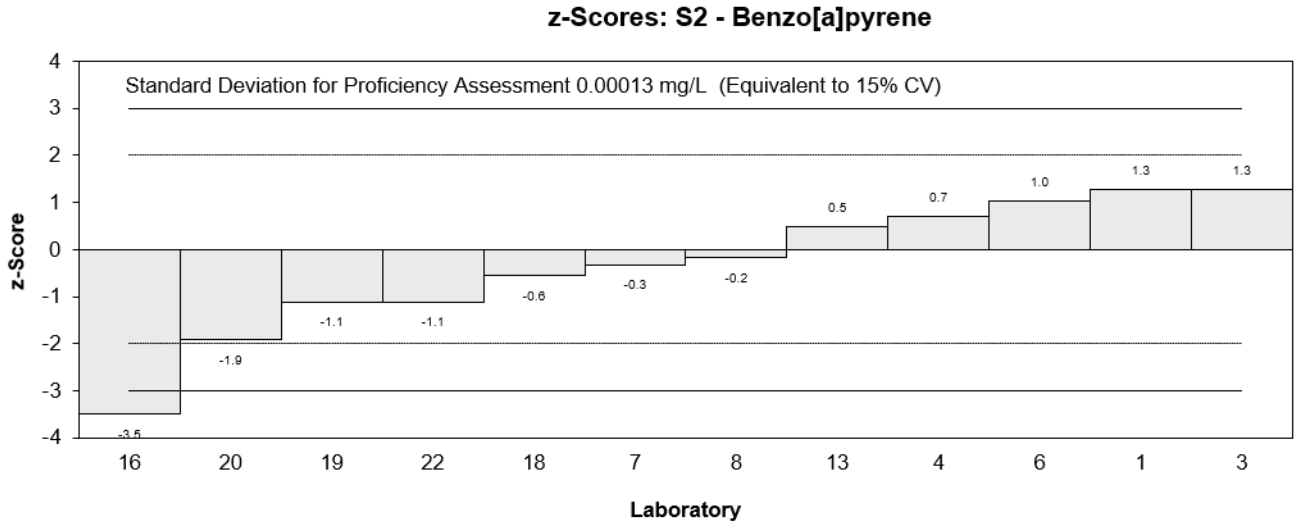
Lab. Code	Result	Uncertainty	z	E_n
1	0.001	0.001	1.27	0.16
2	<0.001	NR		
3	0.001	0.0005	1.27	0.31
4	0.00093	0.000279	0.71	0.30
5	NT	NT		
6	0.00097	0.00029	1.03	0.42
7	0.0008	0.0001	-0.32	-0.27
8	0.00082	0.00027	-0.16	-0.07
9	<0.005	NR		
10	NS	NS		
11	< 0.001	NR		
12	<0.001	0.001		
13	0.0009	0.0003	0.48	0.19
14	<0.0005	0.0005		
15	<0.00002	NR		
16*	0.0004	0.0001	-3.49	-2.96
17	< 0.001	NR		
18	0.00077	0.00037	-0.56	-0.18
19	0.0007	0.0002	-1.11	-0.61
20	0.0006	0.0002	-1.90	-1.05
22	0.0007	0.0001	-1.11	-0.94

* Outlier, see Section 4.2

Statistics

Assigned Value	0.00084	0.00011
Spike Value	0.00100	0.00005
Robust Average	0.00081	0.00012
Median	0.00081	0.00012
Mean	0.000799	
N	12	
Max	0.001	
Min	0.0004	
Robust SD	0.00017	
Robust CV	21%	


Kernel Density
Density
2000
0
0
0.0005
0.001
0.0015
Result
Results: S2 - Benzo[a]pyrene
Assigned Value = 0.00084 ± 0.00011 mg/L
Results (mg/L)
0.0016
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
16 20 19 22 18 7 8 13 4 6 1 3 2 5 9 10 11 12 14 15 17 Md RA SV
Laboratory


z-Scores: S2 - Benzo[a]pyrene
Standard Deviation for Proficiency Assessment 0.00013 mg/L (Equivalent to 15% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-3.5
-1.9
-1.1
-1.1
-0.6
-0.3
-0.2
0.5
0.7
1.0
1.3
1.3
16 20 19 22 18 7 8 13 4 6 1 3
Laboratory

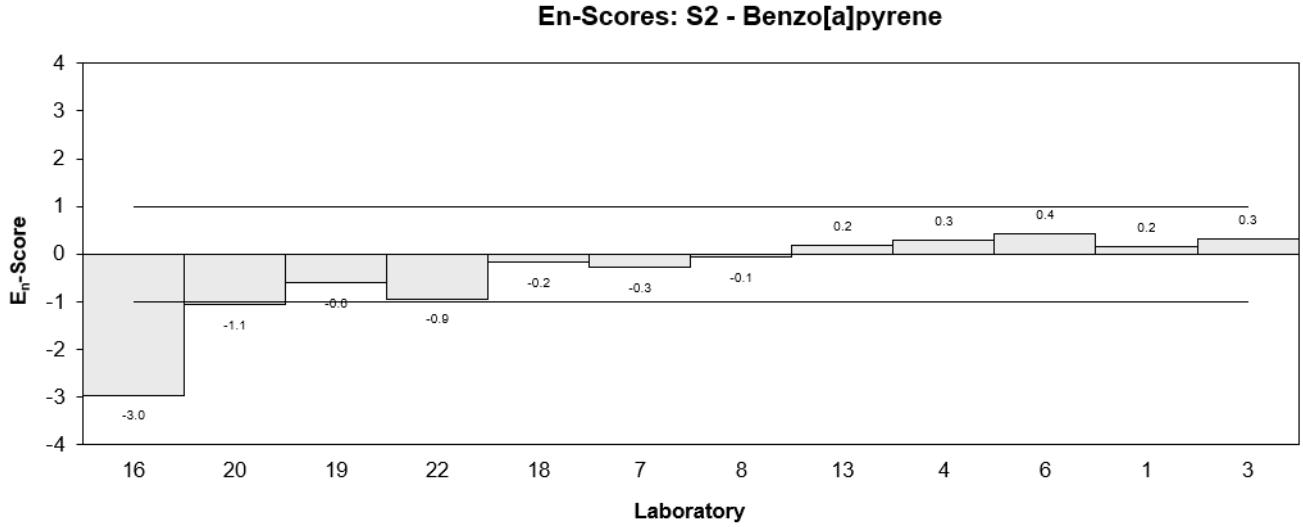

En-Scores: S2 - Benzo[a]pyrene
En-Score
4
3
2
1
0
-1
-2
-3
-4
-3.0
-1.1
-0.6
-0.9
-0.2
-0.3
-0.1
0.2
0.3
0.4
0.2
0.3
16 20 19 22 18 7 8 13 4 6 1 3
Laboratory

Figure 18

Table 25

Sample Details

Sample No.	S2
Matrix	Potable Water
Analyte	Benzo[g,h,i]perylene
Unit	mg/L

Participant Results

Lab. Code	Result	Uncertainty
1	0.024	0.001
2	0.007	0.0021
3	0.014	0.0035
4	0.0178	0.00534
5	NT	NT
6	0.017	0.0051
7	0.0082	0.0008
8	0.011	0.0033
9	0.021	0.0085
10	NS	NS
11	0.004	0.0012
12	0.017	0.005
13	0.0224	0.0089
14**	0.0054	0.0043
15	0.008	0.004
16	0.0033	0.001
17	0.0041	0.00123
18	0.0161	0.0084
19	0.016	0.0048
20	0.0027	0.0008
22	0.0086	0.0009

** Excluded Result, see Section 6.1

Statistics

Assigned Value	Not Set	
Spike Value	0.0200	0.0010
Robust Average	0.0123	0.0046
Median	0.0125	0.0043
Mean	0.0123	
N	18	
Max	0.024	
Min	0.0027	
Robust SD	0.0078	
Robust CV	63%	

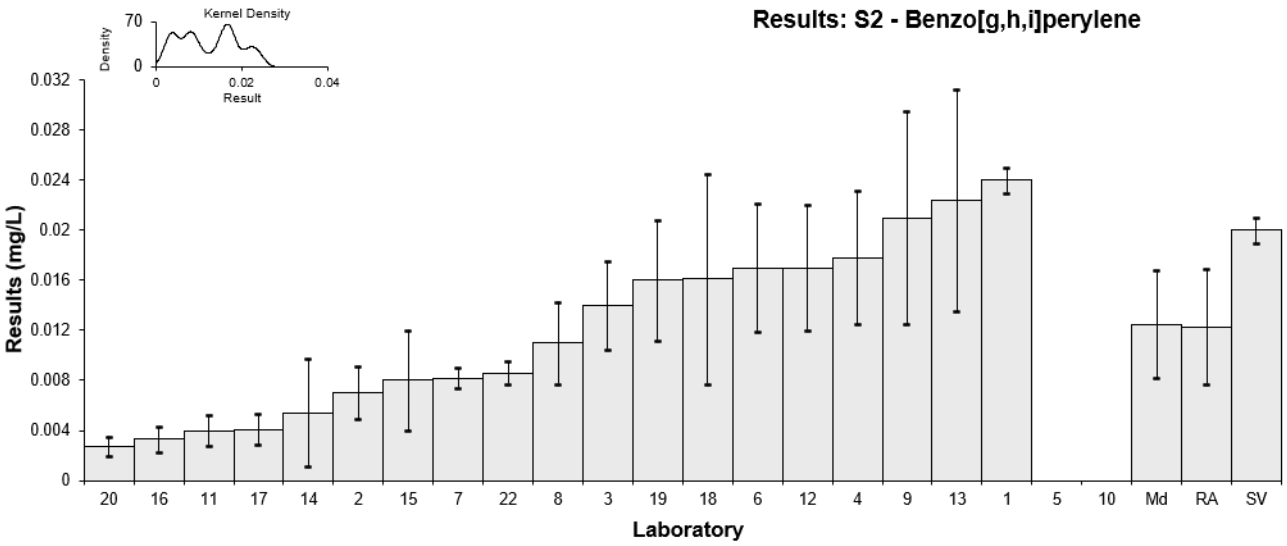

Results: S2 - Benzo[g,h,i]perylene
Kernel Density
Density
70
0
0
0.02
0.04
Result
Results (mg/L)
0.032
0.028
0.024
0.02
0.016
0.012
0.008
0.004
0
20
16
11
17
14
2
15
7
22
8
3
19
18
6
12
4
9
13
1
5
10
Md
RA
SV
Laboratory

Figure 19

Table 26

Sample Details

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

Participant Results

Lab. Code	Result	Uncertainty
1	0.01	0.004
2	0.0066	0.0013
3	0.021	0.00412
4	0.0134	0.00402
5	NT	NT
6	0.0062	0.0019
7	NS	NS
8	0.012	0.004
9	0.010	0.0040
10	NS	NS
11	0.006	0.0018
12	0.015	0.003
13	<0.05	NR
14	<0.0010	0.001
15	0.03	0.015
16	0.007	0.002
17	0.0073	0.0022
18	0.0098	NR
19	0.011	0.004
20	0.0017	0.0005
22	NS	NS

Statistics

Assigned Value	Not Set	
Spike Value	0.0203	0.0010
Robust Average	0.0101	0.0032
Median	0.0100	0.0033
Mean	0.0111	
N	15	
Max	0.03	
Min	0.0017	
Robust SD	0.005	
Robust CV	49%	

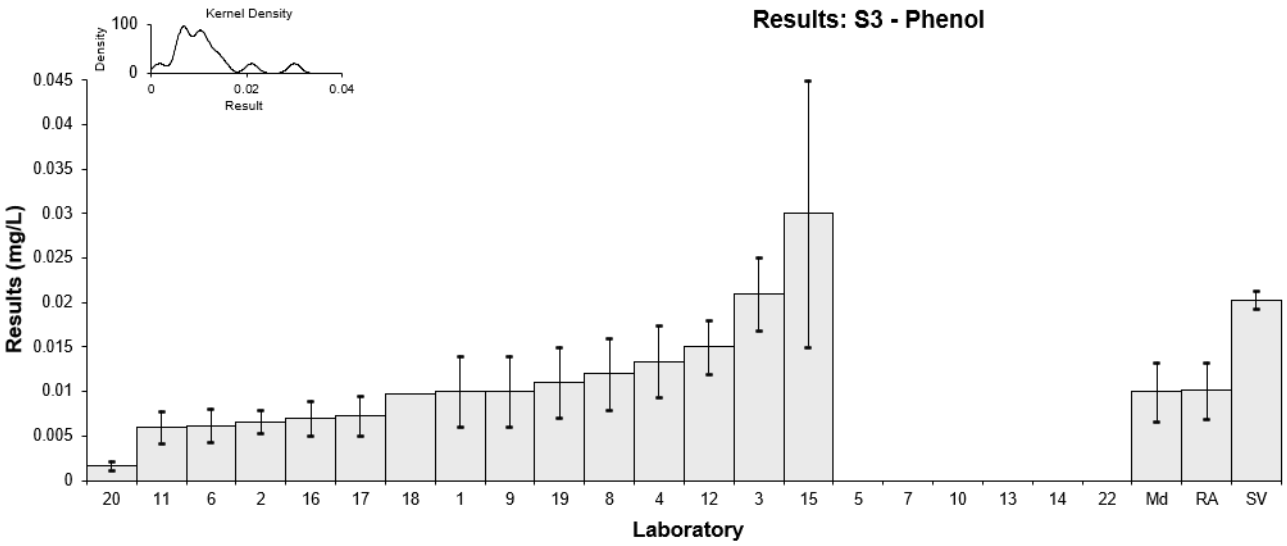

Results: S3 - Phenol
Kernel Density
Density
100
0
0
0.02
0.04
Result
Results (mg/L)
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
20
11
6
2
16
17
18
1
9
19
8
4
12
3
15
5
7
10
13
14
22
Md
RA
SV
Laboratory

Figure 20

Table 27

Sample Details

Sample No.	S3
Matrix	Potable Water
Analyte	2-Methylphenol
Unit	mg/L

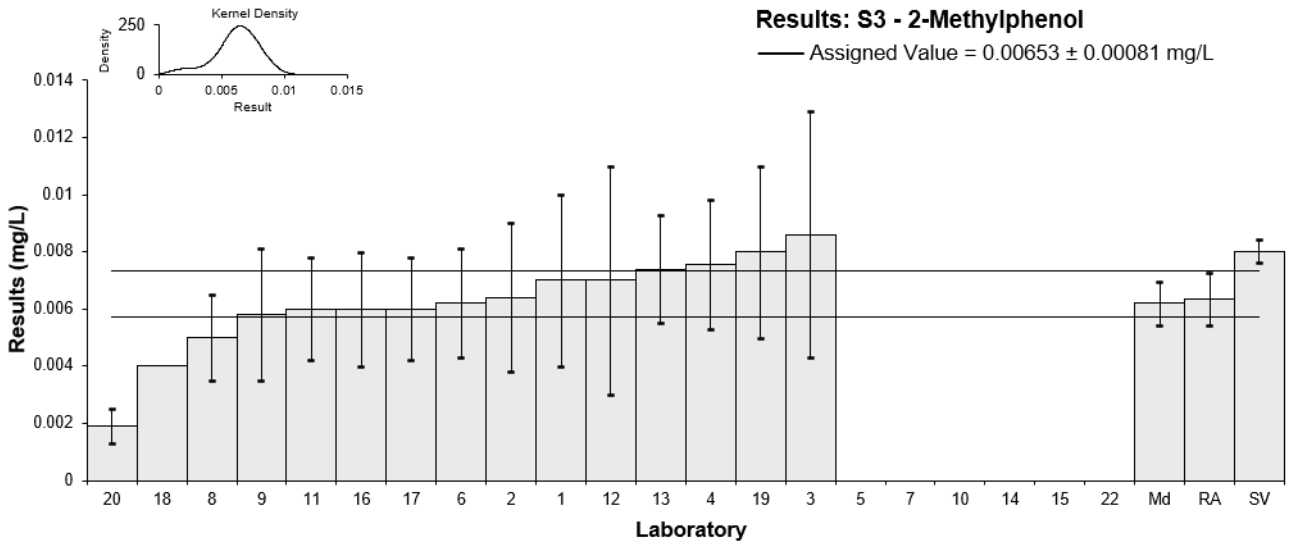
Participant Results

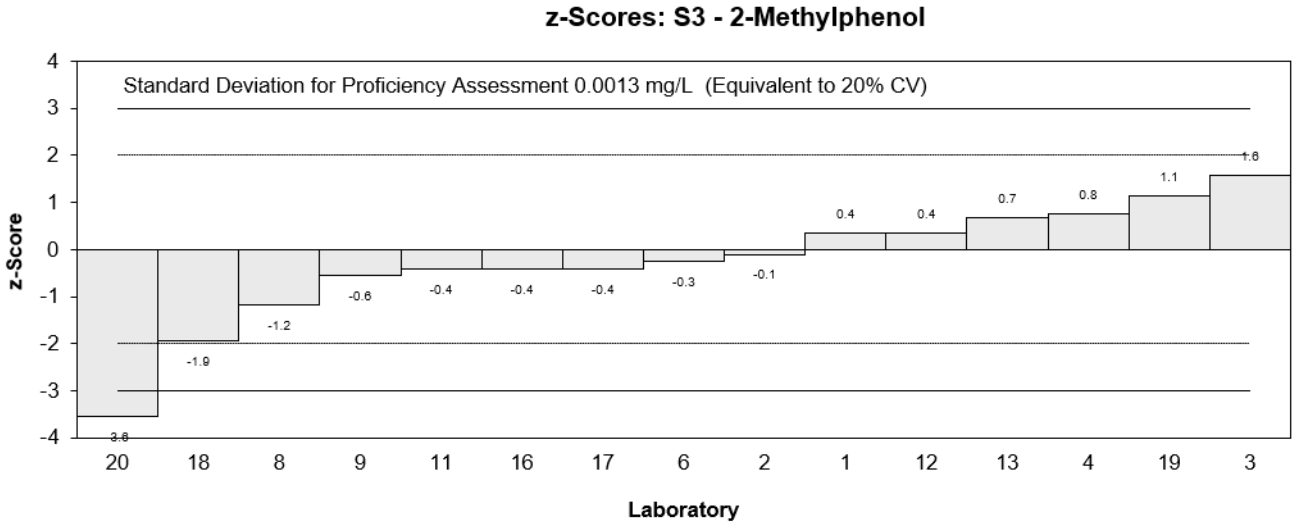
Lab. Code	Result	Uncertainty	z	E_n
1	0.007	0.003	0.36	0.15
2	0.0064	0.0026	-0.10	-0.05
3	0.0086	0.004312429	1.58	0.47
4	0.00754	0.002262	0.77	0.42
5	NT	NT		
6	0.0062	0.0019	-0.25	-0.16
7	NS	NS		
8	0.005	0.0015	-1.17	-0.90
9	0.0058	0.0023	-0.56	-0.30
10	NS	NS		
11	0.006	0.0018	-0.41	-0.27
12	0.007	0.004	0.36	0.12
13	0.0074	0.0019	0.67	0.42
14	<0.0010	0.001		
15	<0.01	NR		
16	0.006	0.002	-0.41	-0.25
17	0.0060	0.0018	-0.41	-0.27
18	0.004	NR	-1.94	-3.12
19	0.008	0.003	1.13	0.47
20*	0.0019	0.0006	-3.55	-4.59
22	NS	NS		

* Outlier, see Section 4.2

Statistics

Assigned Value	0.00653	0.00081
Spike Value	0.00802	0.00040
Robust Average	0.00635	0.00093
Median	0.00620	0.00077
Mean	0.00619	
N	15	
Max	0.0086	
Min	0.0019	
Robust SD	0.0014	
Robust CV	23%	


Kernel Density
Density
250
0
0
0.005
0.01
0.015
Result
Results: S3 - 2-Methylphenol
Assigned Value = 0.00653 ± 0.00081 mg/L
Results (mg/L)
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
20 18 8 9 11 16 17 6 2 1 12 13 4 19 3 5 7 10 14 15 22 Md RA SV
Laboratory


z-Scores: S3 - 2-Methylphenol
Standard Deviation for Proficiency Assessment 0.0013 mg/L (Equivalent to 20% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-3.6
-1.9
-1.2
-0.6
-0.4
-0.4
-0.4
-0.3
-0.1
0.4
0.4
0.7
0.8
1.1
1.6
20 18 8 9 11 16 17 6 2 1 12 13 4 19 3
Laboratory

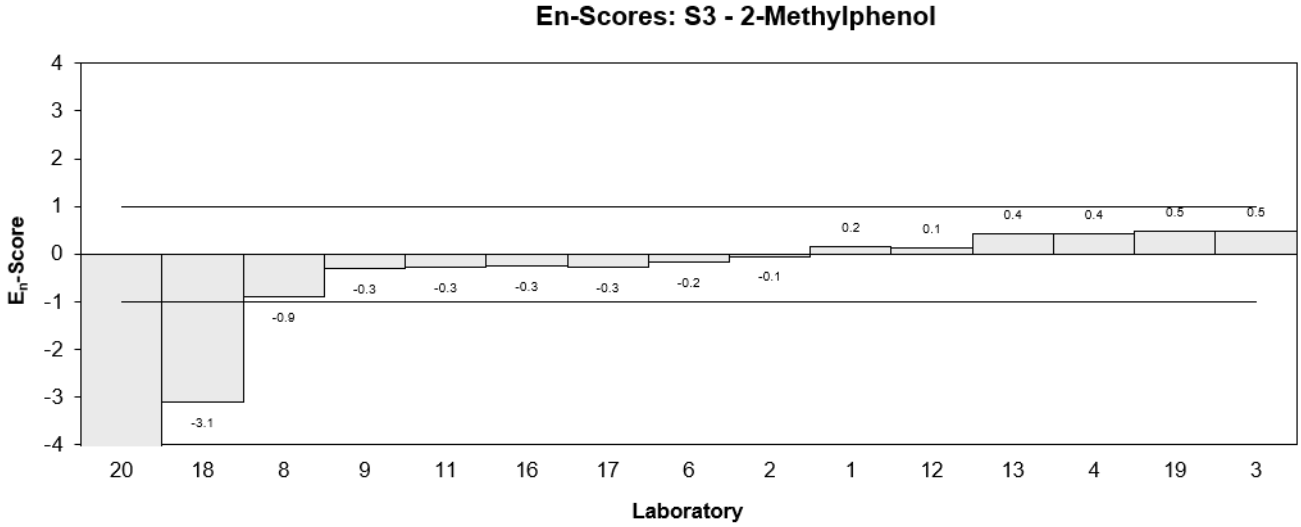

En-Scores: S3 - 2-Methylphenol
En-Score
4
3
2
1
0
-1
-2
-3
-4
-3.1
-0.9
-0.3
-0.3
-0.3
-0.3
-0.2
-0.1
0.2
0.1
0.4
0.4
0.5
0.5
20 18 8 9 11 16 17 6 2 1 12 13 4 19 3
Laboratory

Figure 21

Table 28

Sample Details

Sample No.	S3
Matrix	Potable Water
Analyte	3 & 4-Methylphenols (Total)
Unit	mg/L

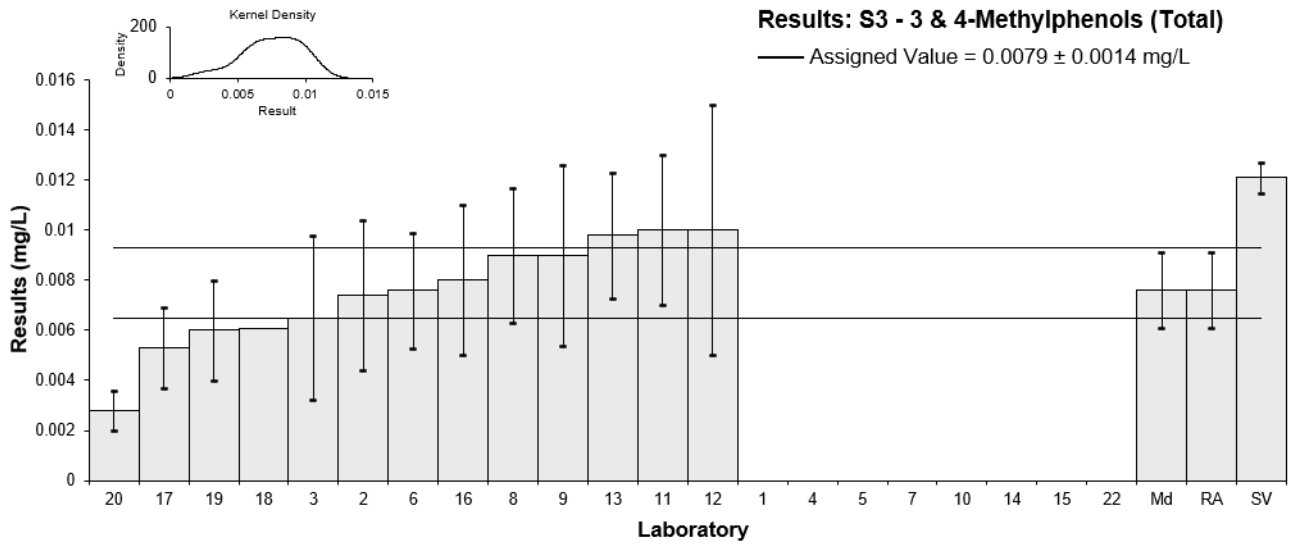
Participant Results

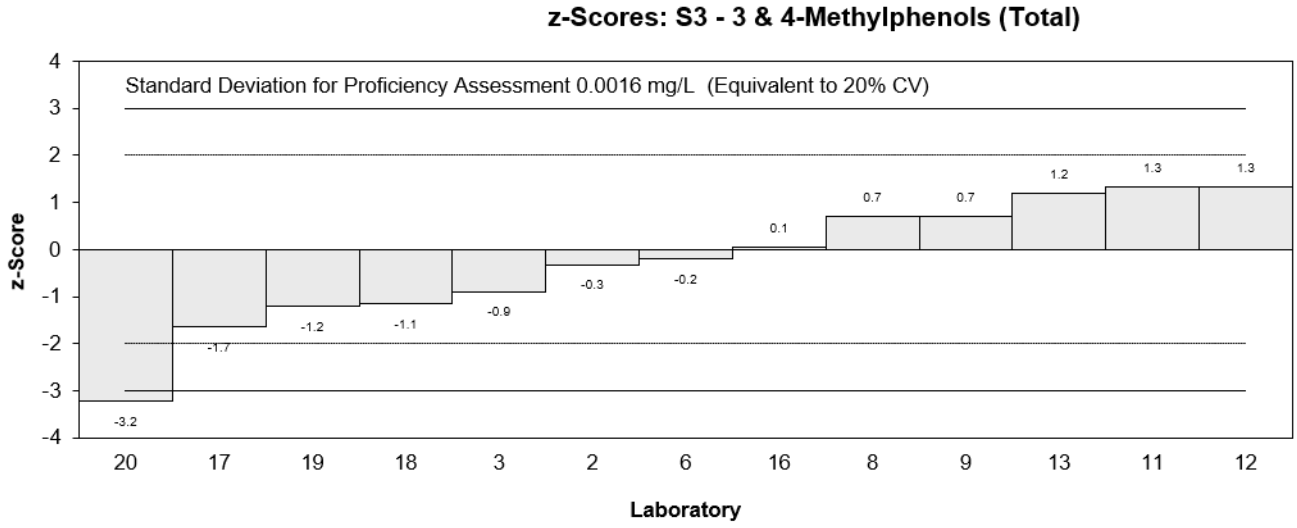
Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	0.0074	0.003	-0.32	-0.15
3	0.0065	0.003268885	-0.89	-0.39
4	NT	NT		
5	NT	NT		
6	0.0076	0.0023	-0.19	-0.11
7	NS	NS		
8	0.009	0.0027	0.70	0.36
9	0.0090	0.0036	0.70	0.28
10	NS	NS		
11	0.010	0.003	1.33	0.63
12	0.01	0.005	1.33	0.40
13	0.0098	0.0025	1.20	0.66
14	<0.0020	0.002		
15	<0.01	NR		
16	0.008	0.003	0.06	0.03
17	0.0053	0.0016	-1.65	-1.22
18	0.0061	NR	-1.14	-1.29
19	0.006	0.002	-1.20	-0.78
20*	0.0028	0.0008	-3.23	-3.16
22	NS	NS		

* Outlier, see Section 4.2

Statistics

Assigned Value	0.0079	0.0014
Spike Value	0.0121	0.0006
Robust Average	0.0076	0.0015
Median	0.0076	0.0015
Mean	0.00750	
N	13	
Max	0.01	
Min	0.0028	
Robust SD	0.0021	
Robust CV	28%	


Kernel Density
Density
200
0
0
0.005
0.01
0.015
Result
Results: S3 - 3 & 4-Methylphenols (Total)
Assigned Value = 0.0079 ± 0.0014 mg/L
Results (mg/L)
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
20 17 19 18 3 2 6 16 8 9 13 11 12 1 4 5 7 10 14 15 22 Md RA SV
Laboratory


z-Scores: S3 - 3 & 4-Methylphenols (Total)
Standard Deviation for Proficiency Assessment 0.0016 mg/L (Equivalent to 20% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-3.2
-1.7
-1.2
-1.1
-0.9
-0.3
-0.2
0.1
0.7
0.7
1.2
1.3
1.3
20 17 19 18 3 2 6 16 8 9 13 11 12
Laboratory

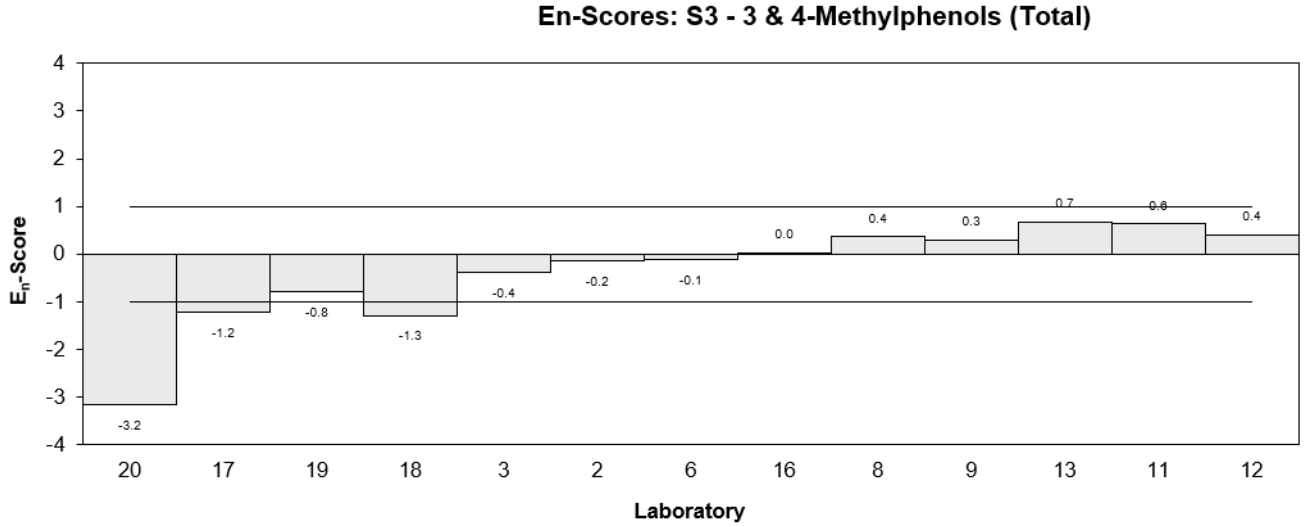

En-Scores: S3 - 3 & 4-Methylphenols (Total)
En-Score
4
3
2
1
0
-1
-2
-3
-4
-3.2
-1.2
-0.8
-1.3
-0.4
-0.2
-0.1
0.0
0.4
0.3
0.7
0.6
0.4
20 17 19 18 3 2 6 16 8 9 13 11 12
Laboratory

Figure 22

Table 29

Sample Details

Sample No.	S3
Matrix	Potable Water
Analyte	2-Nitrophenol
Unit	mg/L

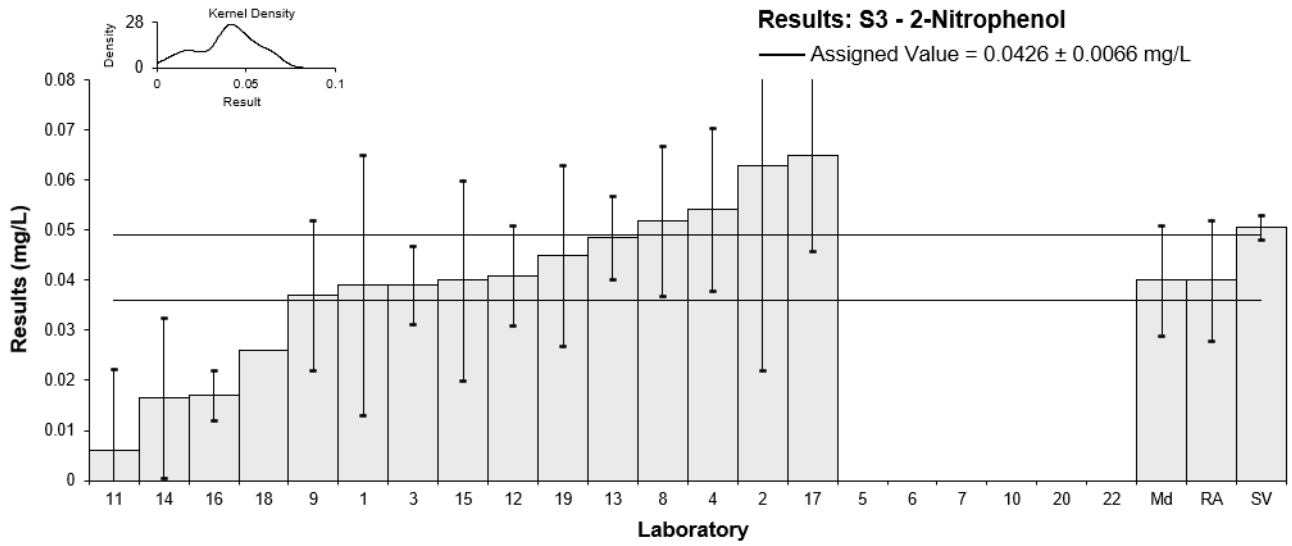
Participant Results

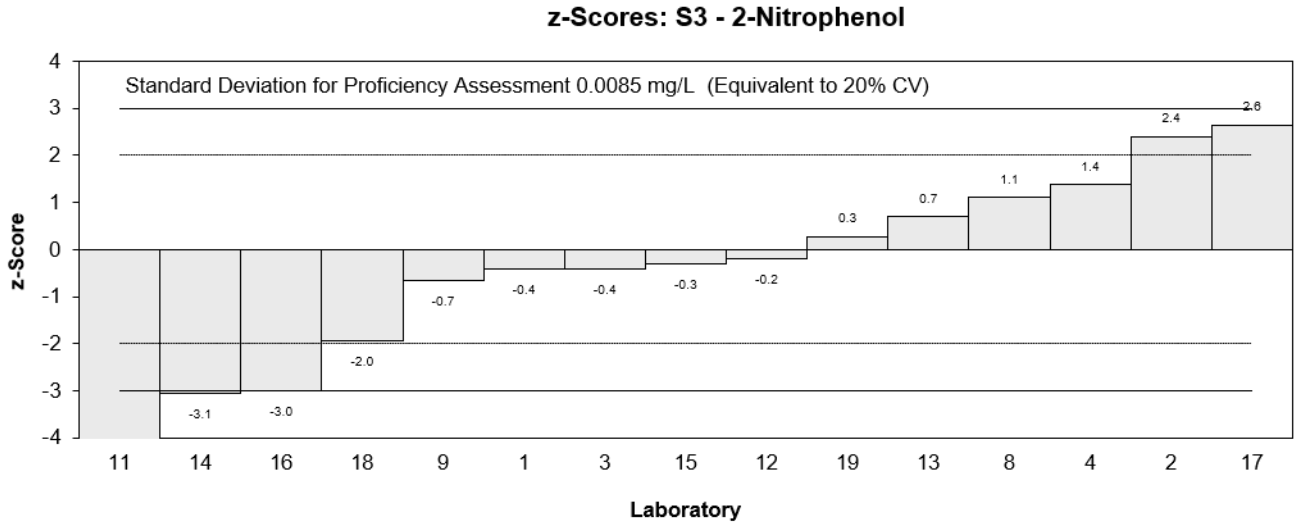
Lab. Code	Result	Uncertainty	z	E_n
1	0.039	0.026	-0.42	-0.13
2*	0.063	0.041	2.39	0.49
3	0.039	0.007786531	-0.42	-0.35
4	0.0543	0.01629	1.37	0.67
5	NT	NT		
6	< 0.01	NR		
7	NS	NS		
8	0.052	0.015	1.10	0.57
9	0.037	0.015	-0.66	-0.34
10	NS	NS		
11*	0.006	0.0162	-4.30	-2.09
12	0.041	0.01	-0.19	-0.13
13	0.0485	0.0083	0.69	0.56
14*	0.0165	0.016	-3.06	-1.51
15	0.04	0.02	-0.31	-0.12
16*	0.017	0.005	-3.00	-3.09
17*	0.065	0.019	2.63	1.11
18	0.026	NR	-1.95	-2.52
19	0.045	0.018	0.28	0.13
20	<0.0001	NR		
22	NS	NS		

* Outlier, see Section 4.2

Statistics

Assigned Value	0.0426	0.0066
Spike Value	0.0506	0.0025
Robust Average	0.040	0.012
Median	0.040	0.011
Mean	0.0393	
N	15	
Max	0.065	
Min	0.006	
Robust SD	0.018	
Robust CV	46%	


Kernel Density
Density
28
0
0
0.05
0.1
Result
Results: S3 - 2-Nitrophenol
Assigned Value = 0.0426 ± 0.0066 mg/L
Results (mg/L)
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
11 14 16 18 9 1 3 15 12 19 13 8 4 2 17 5 6 7 10 20 22 Md RA SV
Laboratory


z-Scores: S3 - 2-Nitrophenol
Standard Deviation for Proficiency Assessment 0.0085 mg/L (Equivalent to 20% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-3.1
-3.0
-2.0
-0.7
-0.4
-0.4
-0.3
-0.2
0.3
0.7
1.1
1.4
2.4
2.6
11 14 16 18 9 1 3 15 12 19 13 8 4 2 17
Laboratory

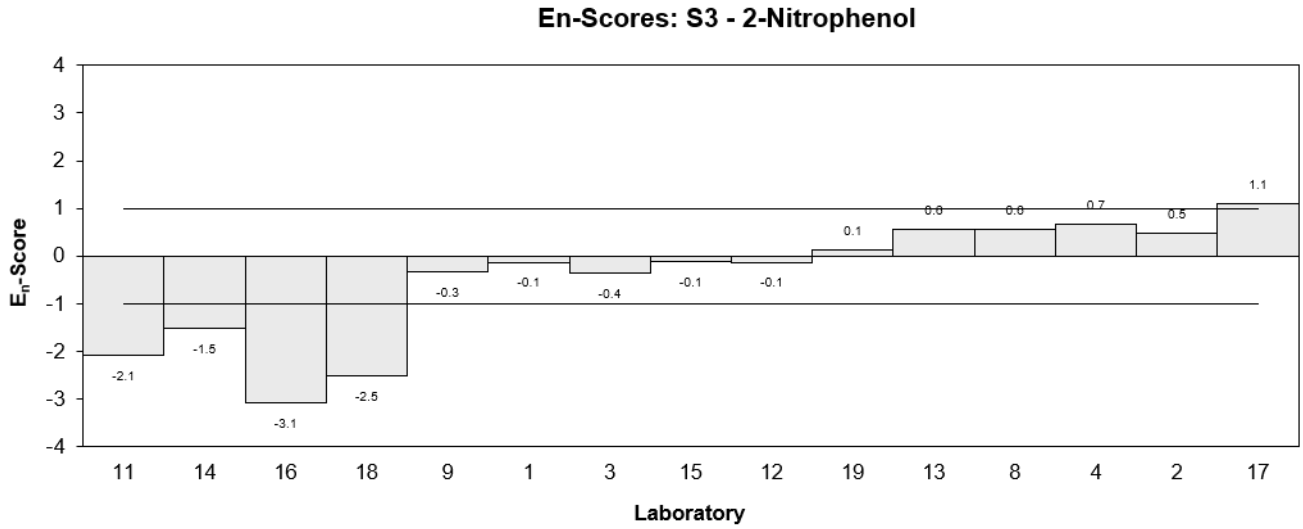

En-Scores: S3 - 2-Nitrophenol
En-Score
4
3
2
1
0
-1
-2
-3
-4
-2.1
-1.5
-3.1
-2.5
-0.3
-0.1
-0.4
-0.1
-0.1
0.1
0.6
0.6
0.7
0.5
1.1
11 14 16 18 9 1 3 15 12 19 13 8 4 2 17
Laboratory

Figure 23

Table 30

Sample Details

Sample No.	S3
Matrix	Potable Water
Analyte	4-Nitrophenol
Unit	mg/L

Participant Results

Lab. Code	Result	Uncertainty
1	NT	NT
2	<0.03	NR
3	0.021	0.004292327
4	NT	NT
5	NT	NT
6	< 0.03	0.0014
7	NS	NS
8	NT	NT
9	0.016	0.0063
10	NS	NS
11	0.016	0.0048
12	0.04	0.01
13	<0.02	NR
14	NT	NT
15	0.03	0.015
16	<0.0001	NR
17	0.013	0.0039
18	NT	NT
19	0.025	0.01
20	<0.0001	NR
22	NS	NS

Statistics

Assigned Value	Not Set	
Spike Value	0.0504	0.0025
Robust Average	0.0227	0.0095
Median	0.0210	0.0070
Mean	0.0230	
N	7	
Max	0.04	
Min	0.013	
Robust SD	0.01	
Robust CV	44%	

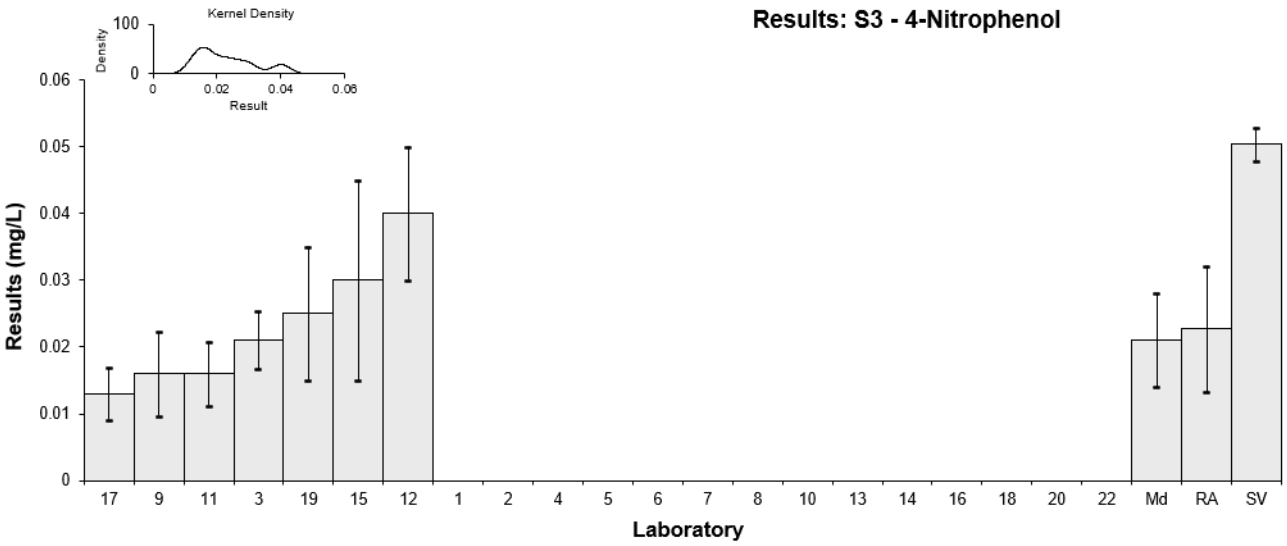

Results: S3 - 4-Nitrophenol
Kernel Density
Density
100
0
0
0.02
0.04
0.06
Result
Results (mg/L)
0.06
0.05
0.04
0.03
0.02
0.01
0
17
9
11
3
19
15
12
1
2
4
5
6
7
8
10
13
14
16
18
20
22
Md
RA
SV
Laboratory

Figure 24

Table 31

Sample Details

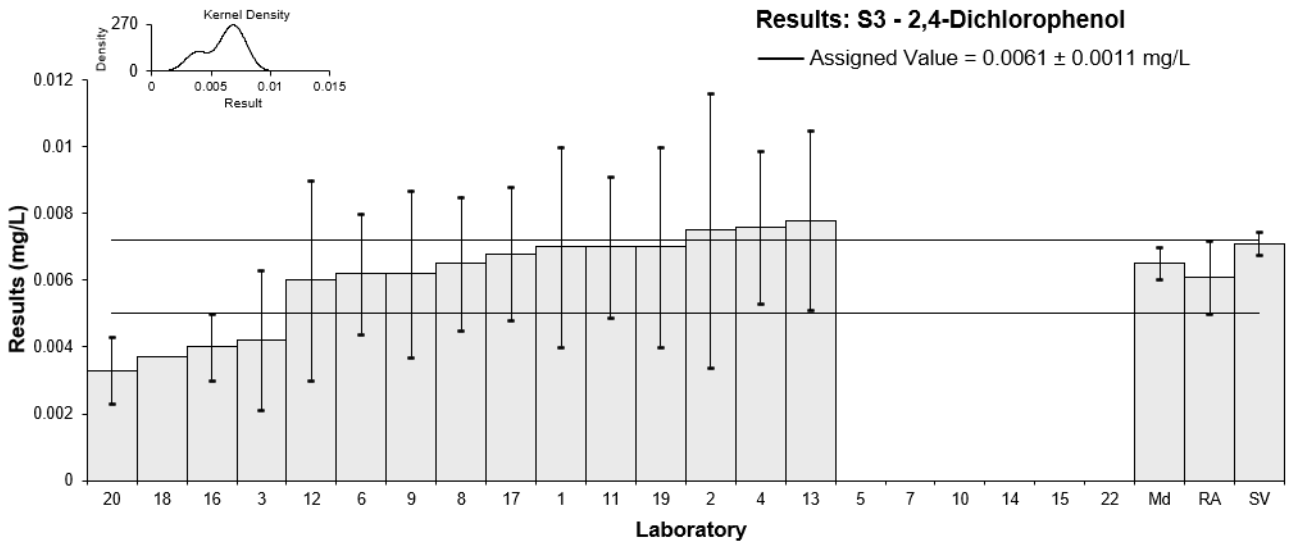
Sample No.	S3
Matrix	Potable Water
Analyte	2,4-Dichlorophenol
Unit	mg/L

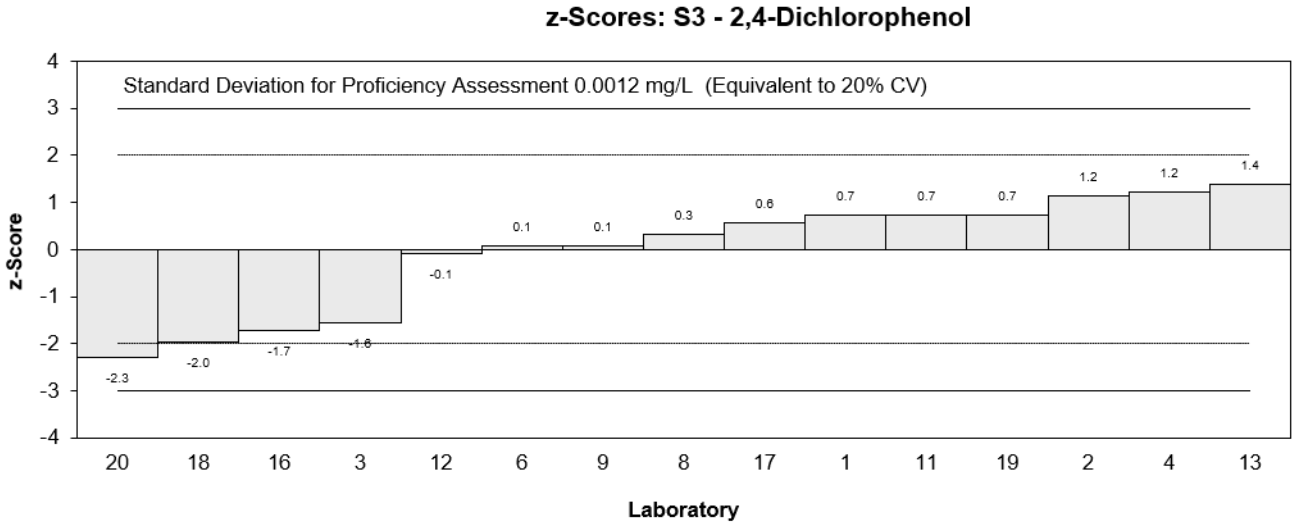
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.007	0.003	0.74	0.28
2	0.0075	0.0041	1.15	0.33
3	0.0042	0.002095473	-1.56	-0.80
4	0.00760	0.00228	1.23	0.59
5	NT	NT		
6	0.0062	0.0018	0.08	0.05
7	NS	NS		
8	0.0065	0.002	0.33	0.18
9	0.0062	0.0025	0.08	0.04
10	NS	NS		
11	0.007	0.0021	0.74	0.38
12	0.006	0.003	-0.08	-0.03
13	0.0078	0.0027	1.39	0.58
14	<0.0010	0.001		
15	<0.01	NR		
16	0.004	0.001	-1.72	-1.41
17	0.0068	0.0020	0.57	0.31
18	0.0037	NR	-1.97	-2.18
19	0.007	0.003	0.74	0.28
20	0.0033	0.001	-2.30	-1.88
22	NS	NS		

Statistics

Assigned Value	0.0061	0.0011
Spike Value	0.00710	0.00035
Robust Average	0.0061	0.0011
Median	0.00650	0.00048
Mean	0.00605	
N	15	
Max	0.0078	
Min	0.0033	
Robust SD	0.0017	
Robust CV	28%	


Kernel Density
Density
270
0
0
0.005
0.01
0.015
Result
Results: S3 - 2,4-Dichlorophenol
Assigned Value = 0.0061 ± 0.0011 mg/L
Results (mg/L)
0.012
0.01
0.008
0.006
0.004
0.002
0
20 18 16 3 12 6 9 8 17 1 11 19 2 4 13 5 7 10 14 15 22 Md RA SV
Laboratory


z-Scores: S3 - 2,4-Dichlorophenol
Standard Deviation for Proficiency Assessment 0.0012 mg/L (Equivalent to 20% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-2.3
-2.0
-1.7
-1.6
-0.1
0.1
0.1
0.3
0.6
0.7
0.7
0.7
1.2
1.2
1.4
20 18 16 3 12 6 9 8 17 1 11 19 2 4 13
Laboratory

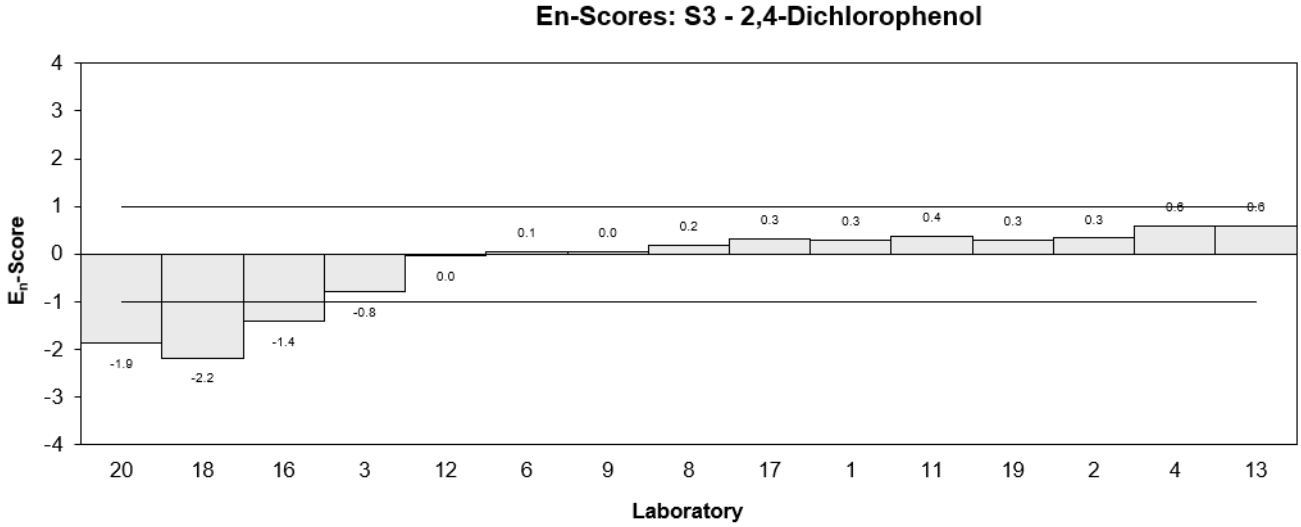

En-Scores: S3 - 2,4-Dichlorophenol
En-Score
4
3
2
1
0
-1
-2
-3
-4
-1.9
-2.2
-1.4
-0.8
0.0
0.1
0.0
0.2
0.3
0.3
0.4
0.3
0.3
0.6
0.6
20 18 16 3 12 6 9 8 17 1 11 19 2 4 13
Laboratory

Figure 25

Table 32

Sample Details

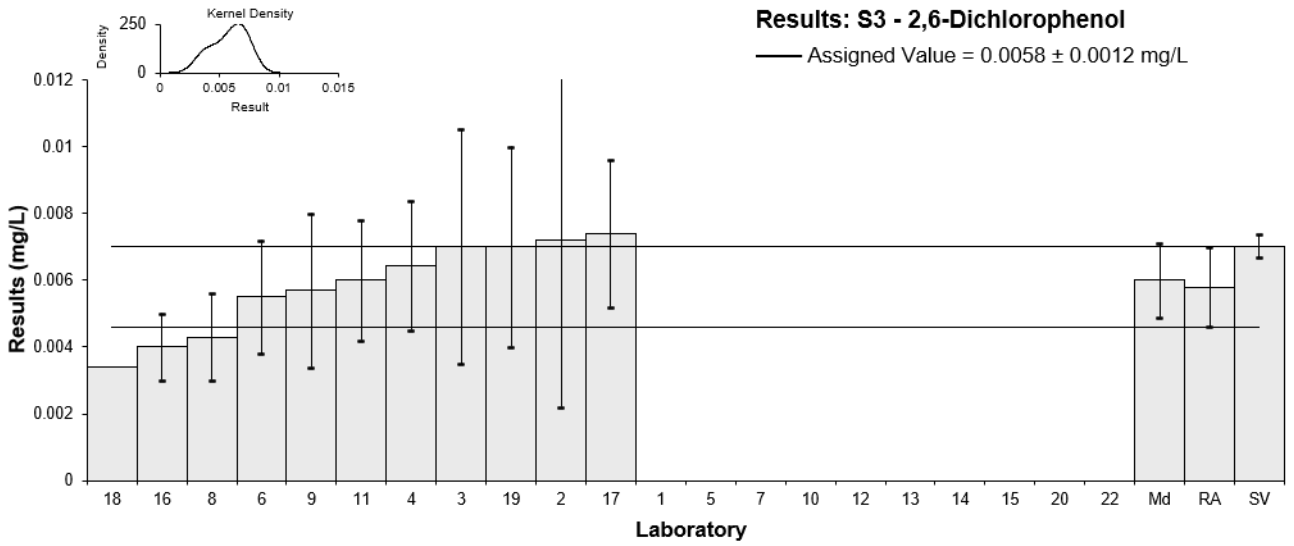
Sample No.	S3
Matrix	Potable Water
Analyte	2,6-Dichlorophenol
Unit	mg/L

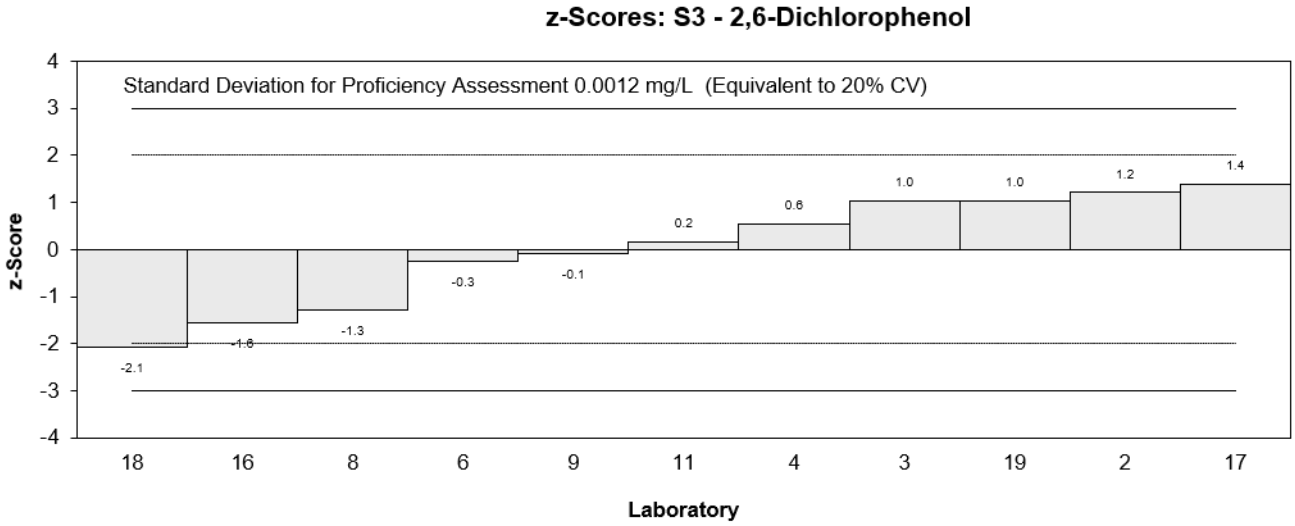
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	0.0072	0.005	1.21	0.27
3	0.0070	0.003517259	1.03	0.32
4	0.00644	0.001932	0.55	0.28
5	NT	NT		
6	0.0055	0.0017	-0.26	-0.14
7	NS	NS		
8	0.0043	0.0013	-1.29	-0.85
9	0.0057	0.0023	-0.09	-0.04
10	NS	NS		
11	0.006	0.0018	0.17	0.09
12	<0.006	0.006		
13	<0.02	NR		
14	<0.0010	0.0009		
15	<0.01	NR		
16	0.004	0.001	-1.55	-1.15
17	0.0074	0.0022	1.38	0.64
18	0.0034	NR	-2.07	-2.00
19	0.007	0.003	1.03	0.37
20	<0.0001	NR		
22	NS	NS		

Statistics

Assigned Value	0.0058	0.0012
Spike Value	0.00703	0.00035
Robust Average	0.0058	0.0012
Median	0.0060	0.0011
Mean	0.00581	
N	11	
Max	0.0074	
Min	0.0034	
Robust SD	0.0016	
Robust CV	27%	


Kernel Density
Density
250
0
0
0.005
0.01
0.015
Result
Results: S3 - 2,6-Dichlorophenol
Assigned Value = 0.0058 ± 0.0012 mg/L
Results (mg/L)
0.012
0.01
0.008
0.006
0.004
0.002
0
18 16 8 6 9 11 4 3 19 2 17 1 5 7 10 12 13 14 15 20 22 Md RA SV
Laboratory


z-Scores: S3 - 2,6-Dichlorophenol
Standard Deviation for Proficiency Assessment 0.0012 mg/L (Equivalent to 20% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-2.1
-1.6
-1.3
-0.3
-0.1
0.2
0.6
1.0
1.0
1.2
1.4
18 16 8 6 9 11 4 3 19 2 17
Laboratory

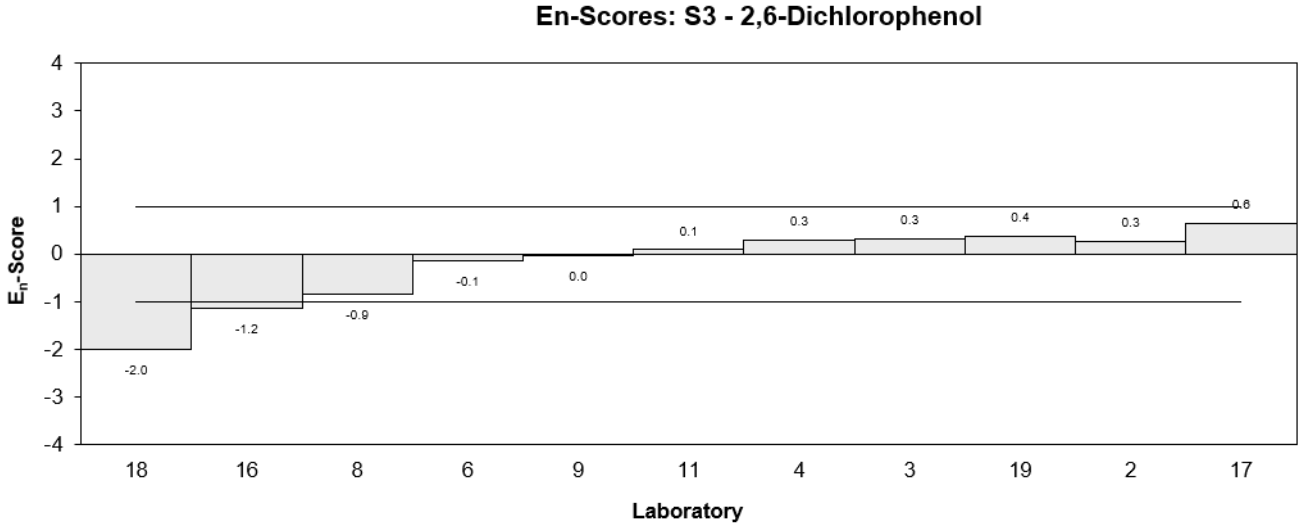

En-Scores: S3 - 2,6-Dichlorophenol
En-Score
4
3
2
1
0
-1
-2
-3
-4
-2.0
-1.2
-0.9
-0.1
0.0
0.1
0.3
0.3
0.4
0.3
0.6
18 16 8 6 9 11 4 3 19 2 17
Laboratory

Figure 26

Table 33

Sample Details

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

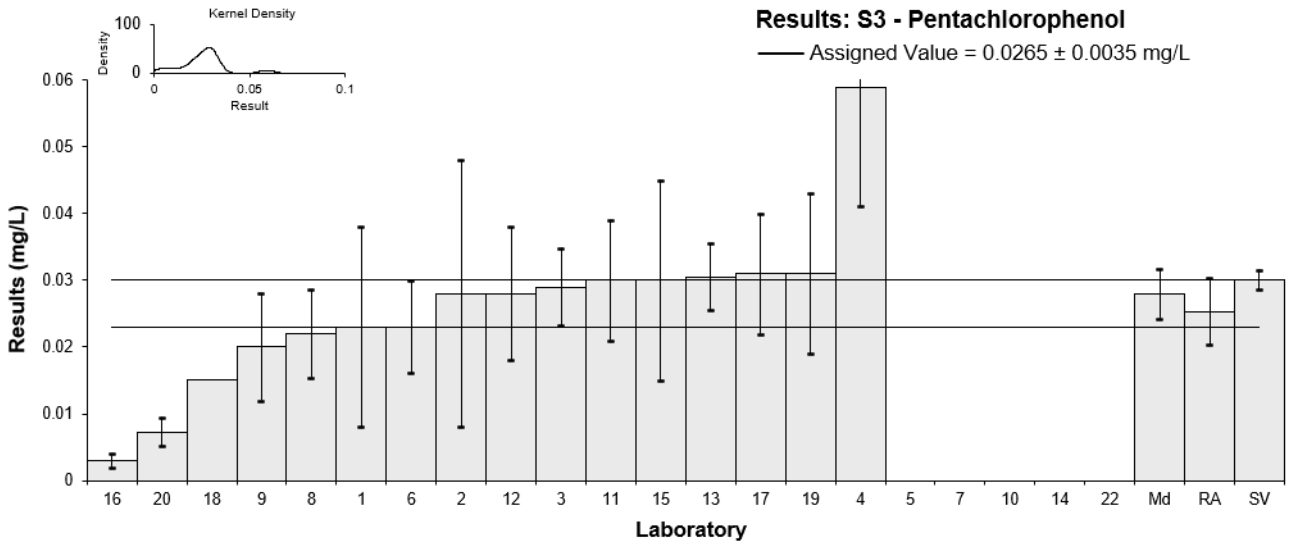
Participant Results

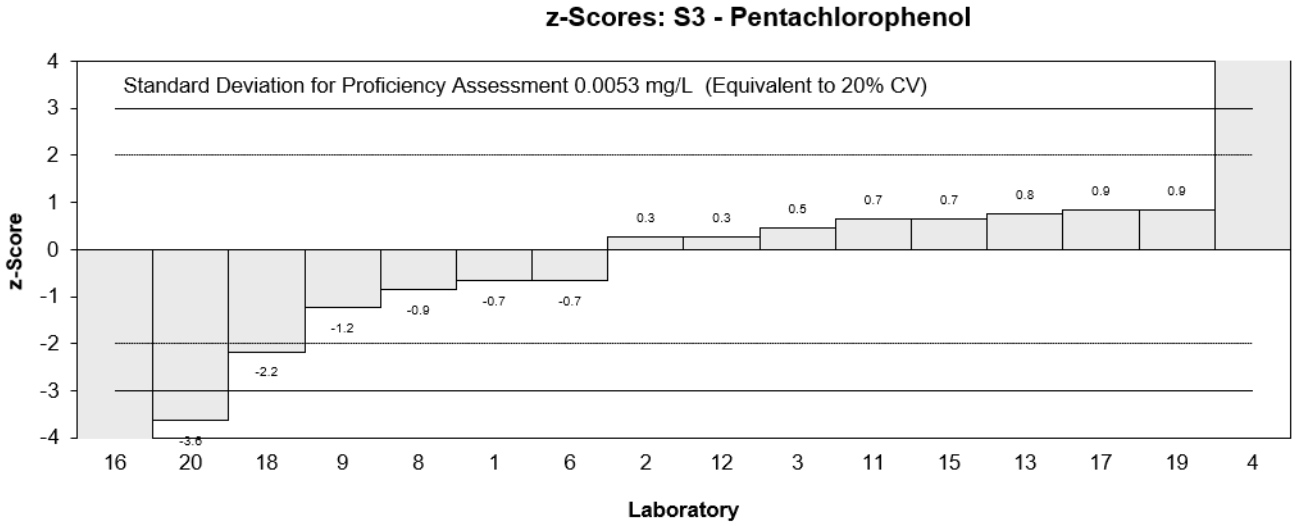
Lab. Code	Result	Uncertainty	z	E_n
1	0.023	0.015	-0.66	-0.23
2	0.028	0.02	0.28	0.07
3	0.029	0.005816021	0.47	0.37
4*	0.0589	0.01767	6.11	1.80
5	NT	NT		
6	0.023	0.0069	-0.66	-0.45
7	NS	NS		
8	0.022	0.0066	-0.85	-0.60
9	0.020	0.0080	-1.23	-0.74
10	NS	NS		
11	0.030	0.009	0.66	0.36
12	0.028	0.01	0.28	0.14
13	0.0305	0.005	0.75	0.66
14	<0.0020	0.002		
15	0.03	0.015	0.66	0.23
16*	0.003	0.001	-4.43	-6.46
17	0.031	0.009	0.85	0.47
18	0.015	NR	-2.17	-3.29
19	0.031	0.012	0.85	0.36
20*	0.0073	0.0022	-3.62	-4.64
22	NS	NS		

* Outlier, see Section 4.2

Statistics

Assigned Value	0.0265	0.0035
Spike Value	0.0301	0.0015
Robust Average	0.0253	0.0050
Median	0.0280	0.0037
Mean	0.0256	
N	16	
Max	0.0589	
Min	0.003	
Robust SD	0.0081	
Robust CV	32%	


Kernel Density
Density
100
0
0
0.05
0.1
Result
Results: S3 - Pentachlorophenol
Assigned Value = 0.0265 ± 0.0035 mg/L
Results (mg/L)
0.06
0.05
0.04
0.03
0.02
0.01
0
16 20 18 9 8 1 6 2 12 3 11 15 13 17 19 4 5 7 10 14 22 Md RA SV
Laboratory


z-Scores: S3 - Pentachlorophenol
Standard Deviation for Proficiency Assessment 0.0053 mg/L (Equivalent to 20% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-3.6
-2.2
-1.2
-0.9
-0.7
-0.7
0.3
0.3
0.5
0.7
0.7
0.8
0.9
0.9
16 20 18 9 8 1 6 2 12 3 11 15 13 17 19 4
Laboratory

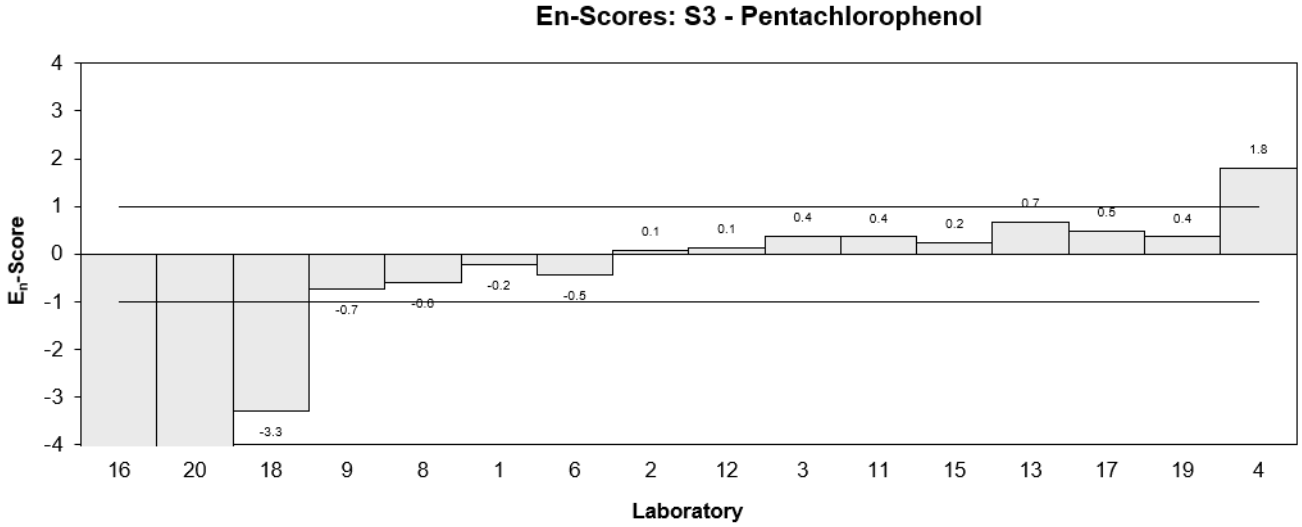

En-Scores: S3 - Pentachlorophenol
En-Score
4
3
2
1
0
-1
-2
-3
-4
-3.3
-0.7
-0.6
-0.2
-0.5
0.1
0.1
0.4
0.4
0.2
0.7
0.5
0.4
1.8
16 20 18 9 8 1 6 2 12 3 11 15 13 17 19 4
Laboratory

Figure 27

6 DISCUSSION OF RESULTS

6.1 Assigned Value

The assigned values for all scored analytes were the robust averages of participants' results. Results less than 50% or greater than 150% of the robust average were excluded from the calculation of each assigned value.[3,4] The robust averages and associated expanded uncertainties were calculated using the procedure described in ISO 13528.[6] The calculation of the expanded uncertainty for robust averages is presented in Appendix 3, using 1,2-dichloroethene in Sample S1 as an example.

The following participants commented that they reported results for multiple analytes as opposed to the named analyte only (Table 34). These results were excluded from the robust average calculations to avoid unfair scoring, as they may bias the assigned value. They were also excluded from the calculation of all summary statistics.

Table 34 Results Reported for Multiple Analytes

Lab. Code	Sample	Results Sheet Analyte	Analytes Reported by Participant
3	S2	Benzo[b]fluoranthene	Benzo[b]fluoranthene, Benzo[j]fluoranthene, and Benzo[k]fluoranthene
13	S1	1,3-dichlorobenzene	1,2-dichlorobenzene, 1,3-dichlorobenzene and 1,4-dichlorobenzene
13	S2	Benzo[b]fluoranthene	Benzo[b]fluoranthene and Benzo[k]fluoranthene
15	S2	Benzo[b]fluoranthene	Benzo[b]fluoranthene and Benzo[k]fluoranthene

The results reported by Laboratory 14 in Sample S2 were consistently lower than the assigned value by approximately the same factor. To avoid unfair scoring, these results were also excluded from the robust average calculations as they would bias the assigned value. They were also excluded from the calculation of all summary statistics.

No assigned values were set for benzo[g,h,i]perylene in Sample S2, and phenol and 4-nitrophenol in Sample S3, due to high variability of the reported results and/or poor recovery of the spiked analyte.

The ratios of the assigned values to spiked values are presented in Table 35. For scored analytes, assigned values were within the range of 65% to 100% of the spiked values, which is similar to ratios observed in previous NMIA PT studies for organic compounds in water.

Traceability: The consensus of participants' results is not traceable to any external reference, so although expressed in SI units, metrological traceability has not been established.

Table 35 Ratio of Assigned Value to Spiked Value

Sample	Analyte	Assigned Value / Spiked Value (%)
S1	Carbon tetrachloride	99
S1	1,3-dichlorobenzene	88
S1	1,4-dichlorobenzene	84
S1	1,2-dichloroethane	97
S1	1,2-dichloroethene	96
S1	Dichloromethane	100
S1	Toluene	99
S1	Trihalomethanes (Total)	97

Sample	Analyte	Assigned Value / Spiked Value (%)
S2	Acenaphthene	94
S2	Fluorene	92
S2	Phenanthrene	91
S2	Anthracene	91
S2	Fluoranthene	90
S2	Benz[a]anthracene	96
S2	Chrysene	94
S2	Benzo[b]fluoranthene	85
S2	Benzo[a]pyrene	84
S2	Benzo[g,h,i]perylene	62*
S3	Phenol	50*
S3	2-Methylphenol	81
S3	3 & 4-Methylphenols (Total)	65
S3	2-Nitrophenol	84
S3	4-Nitrophenol	45*
S3	2,4-Dichlorophenol	86
S3	2,6-Dichlorophenol	83
S3	Pentachlorophenol	88

*Calculated using the robust average (assigned value not set).

6.2 Measurement Uncertainty Reported by Participants

Participants were asked to report an evaluation of the expanded MU associated with their results and the basis of this evaluation. It is a requirement of ISO/IEC 17025 that laboratories have procedures to evaluate and report the uncertainty of chemical measurements.[8]

Of 408 numeric results submitted for the analytes of interest in this study, 391 (96%) were reported with an expanded MU. Participants used a wide variety of procedures to evaluate their uncertainty (Tables 5 and 6).

Laboratories 5, 11, 13, and 18 did not report an evaluation of MU for some or all of their results. Laboratory 5 reported that they were not accredited to ISO/IEC 17025, however the other participants reported being accredited.

The magnitude of reported relative uncertainties was within the range of 4.2% to 270%. In general, an expanded relative uncertainty of less than 15% may be unrealistically small for routine analysis, while over 50% may be too large to be fit-for-purpose. In this study, 332 (85%) relative uncertainties were between 15% and 50%; 28 relative uncertainties were less than 15%, and 31 relative uncertainties were greater than 50%.

The following participants may need to review the procedure they used to evaluate their uncertainties, or review if an error was made when reporting:

- Laboratory 1 reported a wide range of relative uncertainties, ranging from 4% to 100%.
- Laboratory 2 reported relative uncertainties ranging from 20% to 71% for all analytes except for S1 toluene where they reported a relative uncertainty of 250%.

- Laboratory 7 reported relative uncertainties all less than 15%, which may be unrealistically small for routine analysis.
- Laboratory 11 reported relative uncertainties ranging from 25% to 33% for all analytes except for S3 2-nitrophenol where they reported a relative uncertainty of 270%.
- Laboratory 14 reported a wide range of relative uncertainties, ranging from 11% to 97%.
- Laboratory 22 reported relative uncertainties all less than 15%, which may be unrealistically small for routine analysis.

Participants were requested to report the coverage factor associated with their uncertainties (Table 5). Most participants reported using a coverage factor of k = 2.

Uncertainties associated with results returning an acceptable z-score but a not acceptable E_n-score may have been underestimated.

Laboratories 6, 12, 14, and 18 attached evaluations of MU to non-value results reported. An evaluation of uncertainty expressed as a value should not be attached to a non-value result.[9]

In some cases, the results were reported with an inappropriate number of significant figures. Including too many significant figures may inaccurately reflect the precision of measurements. The recommended format is to write the uncertainty to no more than two significant figures, and then write the result with the corresponding number of decimal places. For example, instead of 0.00754 ± 0.002262 mg/L, report this as 0.0075 ± 0.0023 mg/L.[9]

6.3 z-Score

The z-score compares the participant's deviation from the assigned value based on the standard deviation for proficiency assessment (SDPA). The SDPA defines acceptable performance in a PT study. SDPAs equivalent to 15% (Samples S1 VOCs and S2 PAHs) and 20% (Sample S3 phenols) were used to calculate z-scores in this study. Unlike the standard deviation based on between-laboratory CV, setting the SDPA as a realistic value enables z-scores to be used as reference value points for assessment of individual laboratory performance, independent of the group's performance.

Table 35 presents the CVs predicted by the Thompson-Horwitz equation, the between-laboratory CVs, and SDPAs (as PCVs) for scored analytes.[7] Table 37 presents the CVs predicted by the Thompson-Horwitz equation and the between-laboratory CVs for non-scored analytes.[7]

Table 36 Comparison of Between-Laboratory CVs, Thompson-Horwitz CVs, and SDPAs for Scored Analytes

Sample	Analyte	Numeric Results Reported*	Assigned Value (mg/L)	Between-Laboratory CV* (%)	Thompson-Horwitz CV (%)	SDPA (as PCV, %)
S1	Carbon tetrachloride	15	0.0585	24	22	15
S1	1,3-dichlorobenzene	13	0.0257	22	22	15
S1	1,4-dichlorobenzene	14	0.0249	22	22	15
S1	1,2-dichloroethane	15	0.0957	14	22	15
S1	1,2-dichloroethene	13	0.075	22	22	15
S1	Dichloromethane	11	0.0098	24	22	15
S1	Toluene	17	0.0194	16	22	15

Sample	Analyte	Numeric Results Reported*	Assigned Value (mg/L)	Between-Laboratory CV* (%)	Thompson-Horwitz CV (%)	SDPA (as PCV, %)
S1	Trihalomethanes (Total)	16	0.095	20	22	15
S2	Acenaphthene	17	0.0094	19	22	15
S2	Fluorene	17	0.0111	20	22	15
S2	Phenanthrene	17	0.00328	14	22	15
S2	Anthracene	17	0.00319	18	22	15
S2	Fluoranthene	18	0.00597	22	22	15
S2	Benz[a]anthracene	16	0.00191	23	22	15
S2	Chrysene	16	0.00375	16	22	15
S2	Benzo[b]fluoranthene	11	0.0093	21	22	15
S2	Benzo[a]pyrene	11	0.00084	18	22	15
S3	2-Methylphenol	14	0.00653	18	22	20
S3	3 & 4-Methylphenols (Total)	12	0.0079	24	22	20
S3	2-Nitrophenol	10	0.0426	20	22	20
S3	2,4-Dichlorophenol	15	0.0061	28	22	20
S3	2,6-Dichlorophenol	11	0.0058	27	22	20
S3	Pentachlorophenol	13	0.0265	19	22	20

*Values exclude outliers if applicable. Shaded cells represent between-laboratory CVs higher than both the SDPA and the Thompson-Horwitz CV.

Table 37 Comparison of Between-Laboratory CVs and Thompson-Horwitz CVs for Non-Scored Analytes

Sample	Analyte	Numeric Results Reported	Consensus Value* (mg/L)	Between-Laboratory CV (%)	Thompson-Horwitz CV (%)
S2	Benzo[g,h,i]perylene	18	0.0123	63	22
S3	Phenol	15	0.0101	49	22
S3	4-Nitrophenol	7	0.0227	44	22

*Robust average (assigned value not set).

Of 367 results for which z-scores were calculated, 301 (82%) returned a score of $|z| \leq 2.0$, indicating an acceptable performance.

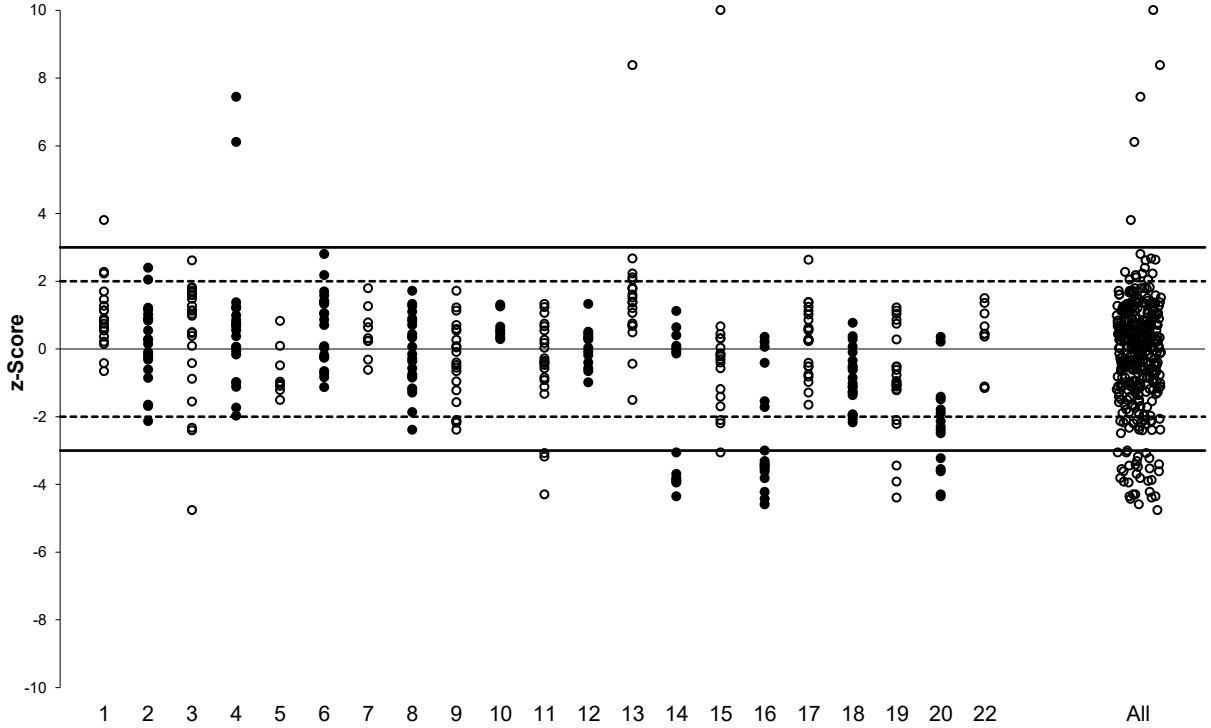
Laboratories 3 and 8 reported numeric results for all 23 scored analytes. No participant returned acceptable z-scores for all scored analytes. Laboratory 8 returned the highest number of acceptable z-scores (22 out of 23).

Laboratory 12 analysed Samples S2 and S3 only and returned acceptable z-scores for all scored analytes they reported results for (13).

Laboratories 5 and 10 analysed Sample S1 only and returned acceptable z-scores for all scored analytes (8).

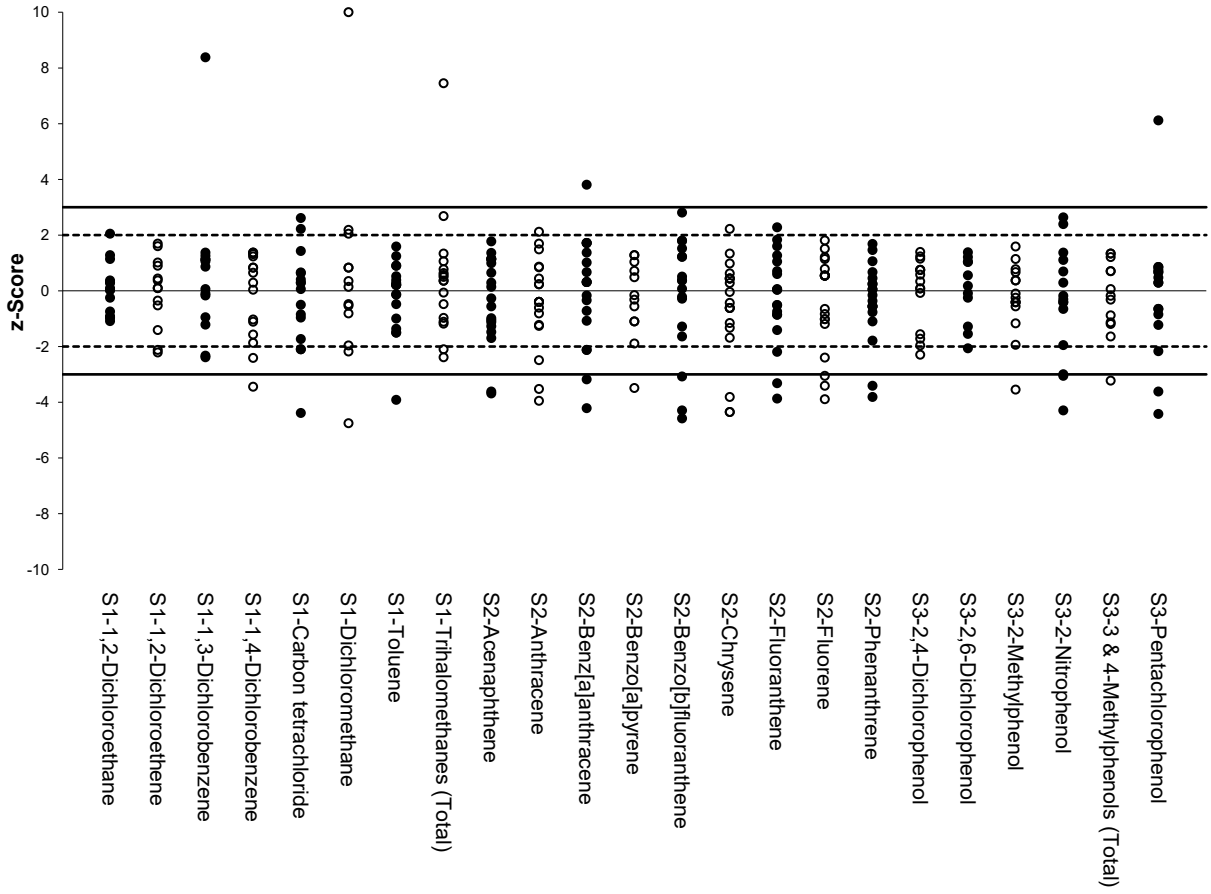
Laboratories 7 and 22 analysed Sample S2 only and returned acceptable z-scores for all scored analytes (9).

The dispersal of z-scores is presented by laboratory in Figure 28, and by analyte in Figure 29.



z-Scores greater than 10.0 have been plotted at 10.0.

Figure 28 z-Score Dispersal by Laboratory



z-Scores greater than 10.0 have been plotted at 10.0.

Figure 29 z-Score Dispersal by Analyte

6.4 E_n-Score

The E_n-score indicates how closely a result agrees with the assigned value, taking into consideration the respective uncertainties. E_n-Scores can be interpreted in conjunction with z-scores, as a not acceptable E_n-score can either be caused by issues with measurement, an inappropriate evaluation of measurement uncertainty, or both.

Where a participant did not report a measurement uncertainty with a result, an expanded uncertainty of zero (0) was used to calculate the E_n-score.

Of 367 results for which E_n-scores were calculated, 285 (78%) returned an acceptable score of $|E_n| < 1.0$, indicating agreement of the participant's result with the assigned value within their respective expanded uncertainties.

Three participants received acceptable E_n-scores for all scored analytes they reported results for: Laboratories 6 (22), 12 (13), and 10 (8).

The dispersal of E_n-scores by laboratory is presented in Figure 30.

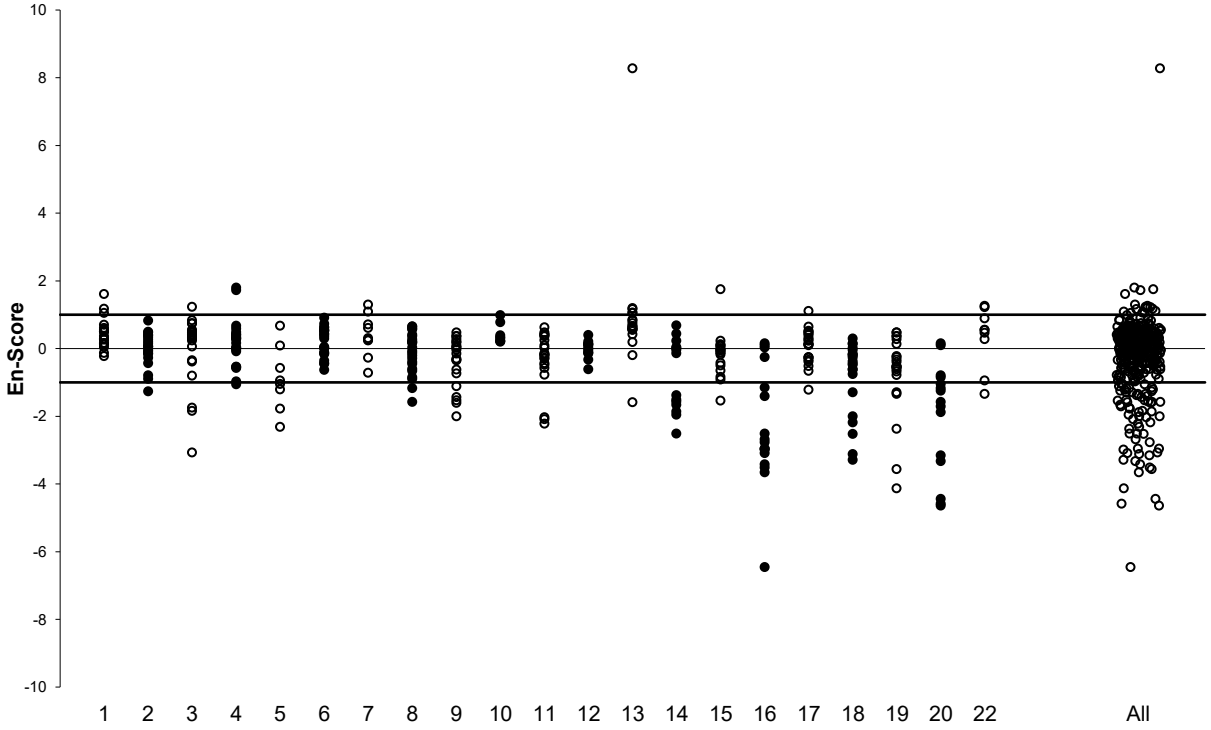


Figure 30 E_n-Score Dispersal by Laboratory

6.5 False Negatives

Table 38 presents false negative results. These are analytes present in the samples which a participant tested for but did not report a numeric result. This includes 'Not Reported' results, or those that were reported as a 'less than' result ($< x$) when the assigned value, less its expanded uncertainty, was greater than the participant's limit of reporting (LOR).

For analytes where no assigned value was set, results have only been considered to be false negatives if no value was reported, or if the consensus value and spiked value, less their respective expanded uncertainties, were both greater than the participants' LOR.

Table 38 False Negatives

Lab. Code	Sample	Analyte	Assigned Value (mg/L)	Consensus Value* (mg/L)	Spiked Value (mg/L)	Result (mg/L)
6	S3	2-Nitrophenol	0.0426	N/A	0.0506	< 0.01
9	S1	1,2-dichloroethane	0.0957	N/A	0.0985	<0.001
13	S1	1,2-dichloroethene	0.075	N/A	0.078	<0.004
14	S2	Benz[a]anthracene	0.00191	N/A	0.00200	<0.0010
14	S2	Benzo[a]pyrene	0.00084	N/A	0.00100	<0.0005
14	S3	Phenol	Not Set	0.0101	0.0203	<0.0010
14	S3	2-Methylphenol	0.00653	N/A	0.00802	<0.0010
14	S3	3 & 4-Methylphenols (total)	0.0079	N/A	0.0121	<0.0020
14	S3	2,4-Dichlorophenol	0.0061	N/A	0.00710	<0.0010
14	S3	2,6-Dichlorophenol	0.0058	N/A	0.00703	<0.0010
14	S3	Pentachlorophenol	0.0265	N/A	0.0301	<0.0020
15	S2	Benzo[a]pyrene	0.00084	N/A	0.00100	<0.00002
16	S3	4-Nitrophenol	Not Set	0.0227	0.0504	<0.0001
19	S1	1,3-dichlorobenzene	0.0257	N/A	0.0293	<0.001
20	S3	2-Nitrophenol	0.0426	N/A	0.0506	<0.0001
20	S3	4-Nitrophenol	0.00227	N/A	0.0504	<0.0001
20	S3	2,6-Dichlorophenol	0.0058	N/A	0.00703	<0.0001

* Robust average (assigned value not set).

6.6 Reporting of Additional Analytes

Additional analytes reported by participants are presented in Table 39.

Two participants detected 2,3,4,6-tetrachlorophenol at trace levels in Sample S3. This may have been an impurity present in the pentachlorophenol standard spiked into this sample.[10]

Table 39 Additional Analytes Reported by Participants

Lab. Code	Sample	Analyte	Result (mg/L)	Uncertainty (mg/L)
3	S1	Vinyl Chloride	0.0043	0.00215
4	S3	2,3,4,6-Tetrachlorophenol	0.00031	0.000093
6	S2	Pyrene	0.00004	0.00001
18	S3	2,3,4,6-Tetrachlorophenol	0.00019	NR
19	S1	1,2-dichlorobenzene	0.013	0.004

6.7 Fitness for Purpose of Results – Australian Drinking Water Guidelines

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

The spiked values for analytes in this study, together with the corresponding ADWG guideline values, are presented in Table 1.

The ADWG specifies that comparison of results against the guideline value 'should occur at the level of one significant figure (s.f.)'.[5] The consequence is that any rounded value less than or equal to the guideline value does not exceed the guideline, while any rounded value greater than the guideline value exceeds the guideline.[5]

More generally, when a test result is used to determine whether a sample complies with an upper control limit, the measurement uncertainty of that result is critical. ISO/IEC 17025 defines a decision rule for such assessments as a 'rule that describes how measurement uncertainty is accounted for when stating conformity with a specified requirement'.[8] To determine whether a sample meets a regulatory limit, considering the reported result and its associated uncertainty, decision rules generally provide three possible outcomes: Pass, Fail, or Inconclusive when further testing may be required (Figure 31).[11]

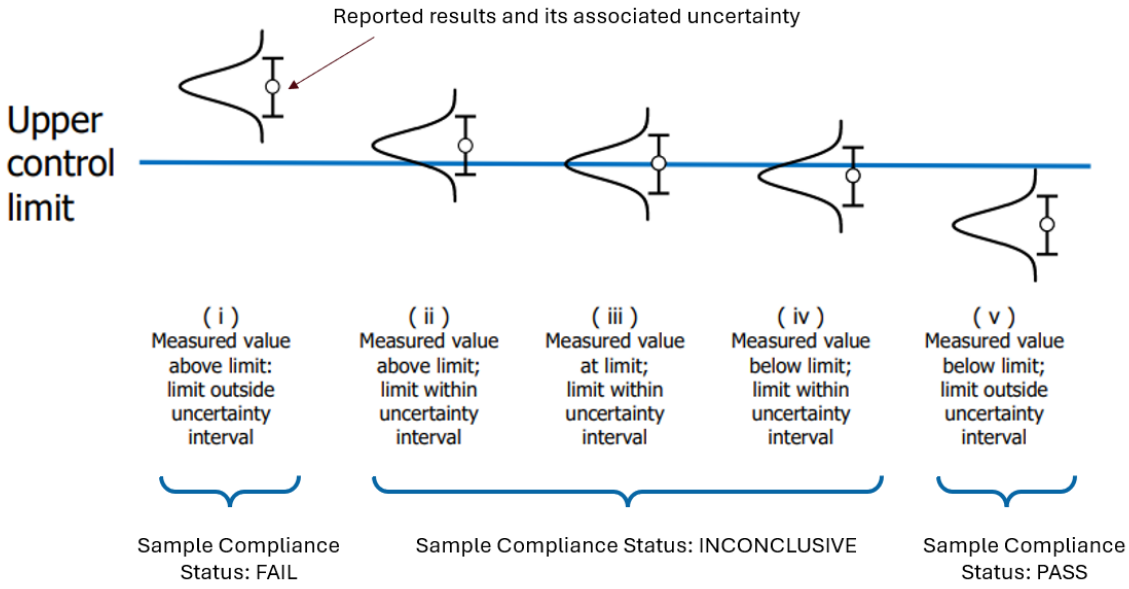


Image adapted from: Eurachem/CITAC Guide Use of Uncertainty Information in Compliance Assessment[11]

Figure 31 Assessment of Compliance with an Upper Limit

Figures 32 to 42 show comparisons of the actual (with uncertainty) and rounded spiked value (SV), assigned value (AV) and participants' results, as well as the guidelines (ADWG or ADWG (H) for health-based; ADWG (A) for aesthetic-based). Only numeric results have been included.

Of the 164 results assessed against the Australian Drinking Water Guidelines, 154 (94%) correctly reflected whether the sample exceeded the guideline(s) or not.

All results reported for carbon tetrachloride, 1,4-dichlorobenzene, 1,2-dichloroethane in Sample S1, and 2,4-dichlorophenol in Sample S3, correctly indicated compliance or non-compliance with the ADWG, inclusive of uncertainties.

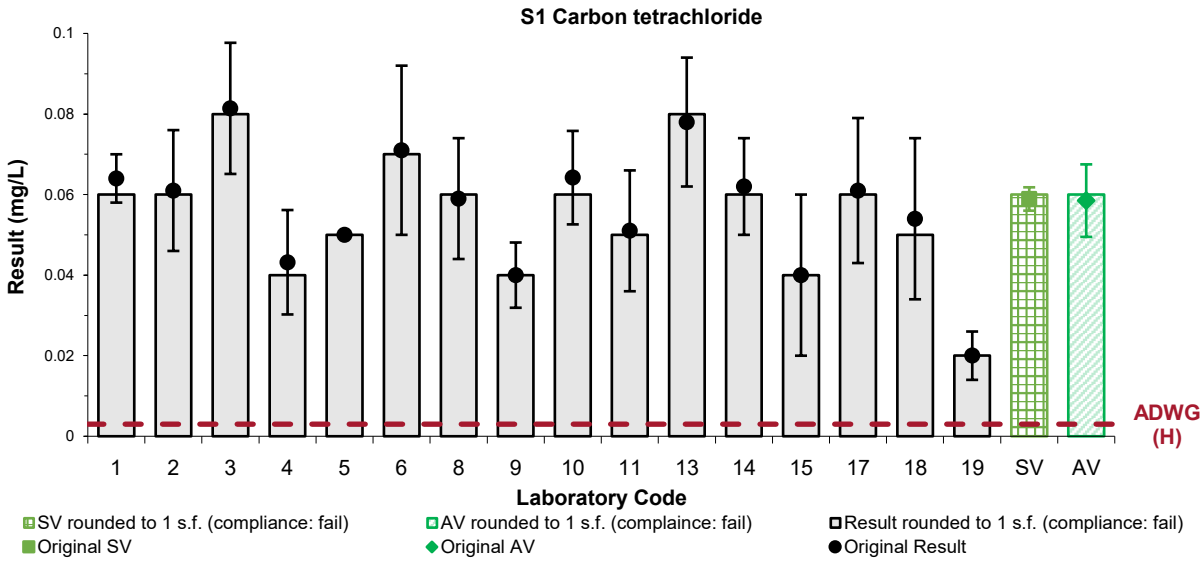


Figure 32 Sample S1 Carbon Tetrachloride Results and Guideline Value

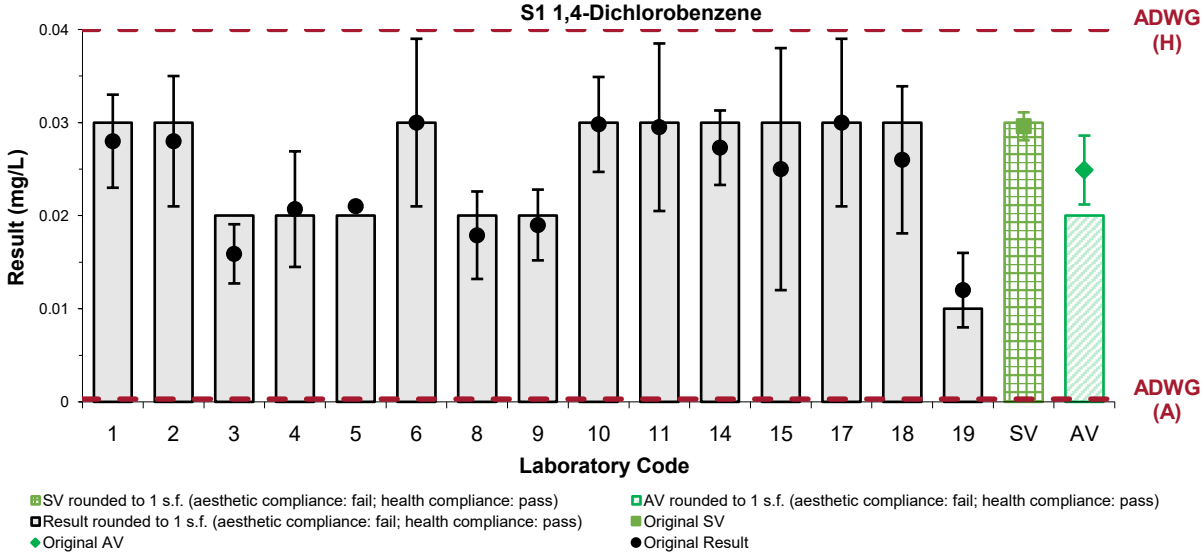


Figure 33 Sample S1 1,4-Dichlorobenzene Results and Guideline Values

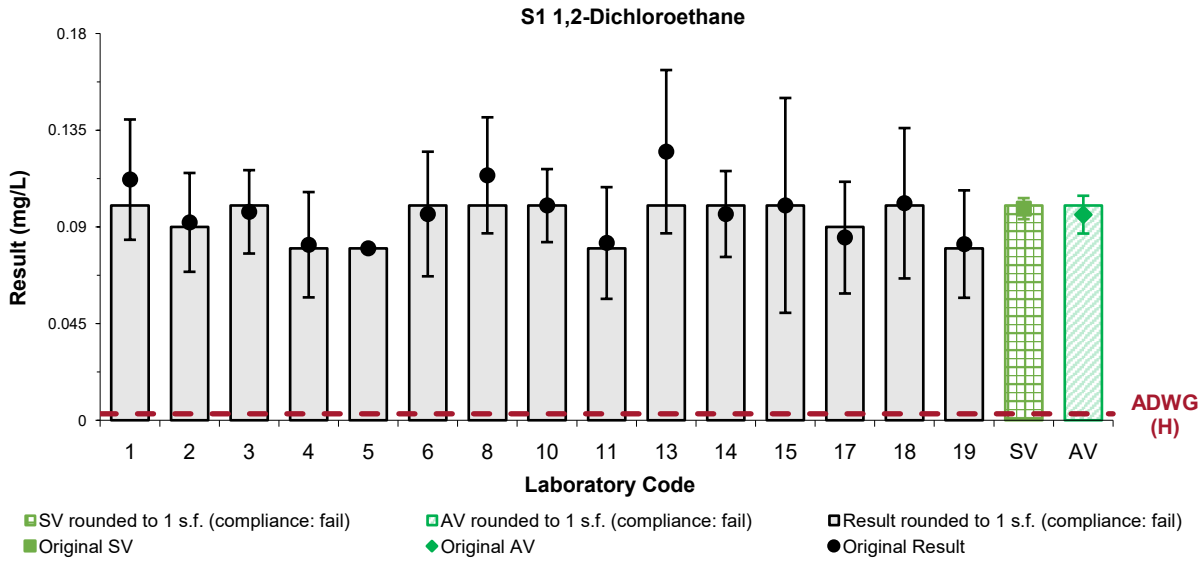
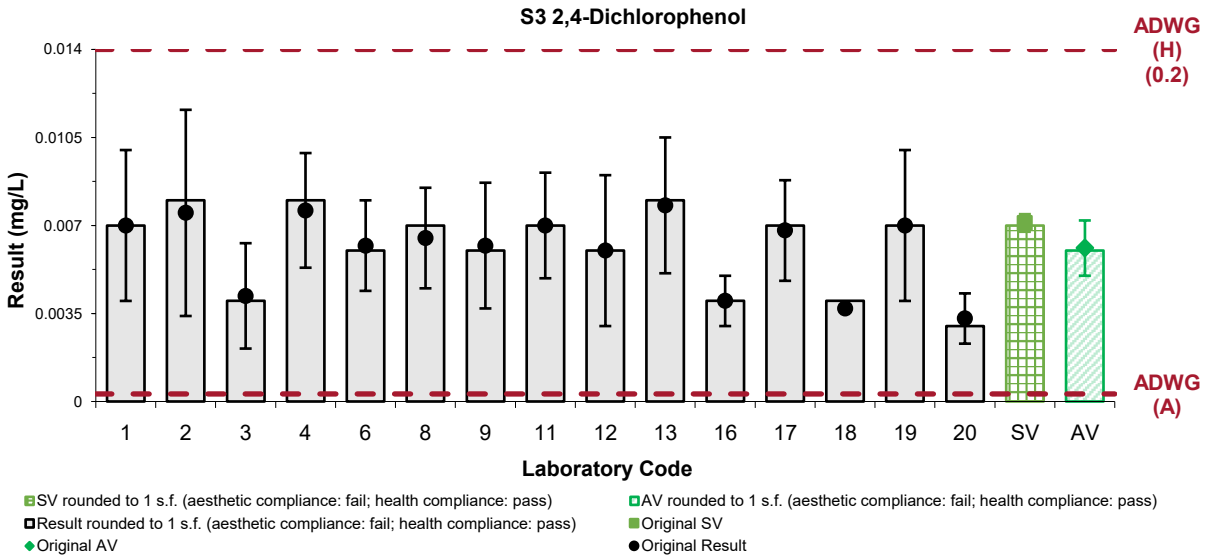


Figure 34 Sample S1 1,2-Dichloroethane Results and Guideline Value



ADWG (H) has been scaled to fit the chart; original value in parentheses.

Figure 35 Sample S3 2,4-Dichlorophenol Results and Guideline Values

1,3-Dichlorobenzene This was spiked at above the aesthetic ADWG, and the assigned value reflected this analyte's non-compliance. Laboratories 3, 5, 8, and 9 reported values that, when rounded to one significant figure, returned results at the ADWG, and therefore incorrectly indicated sample compliance.

When taking uncertainty into consideration, the results reported by Laboratories 4, 15, and 18 spanned the ADWG, even though their results were correctly above the ADWG. In particular, Laboratory 15 reported a relative uncertainty of 52%. This is likely an overestimate, and in this case, their result could have deemed the sample status to be inconclusive, leading to unnecessary further testing.

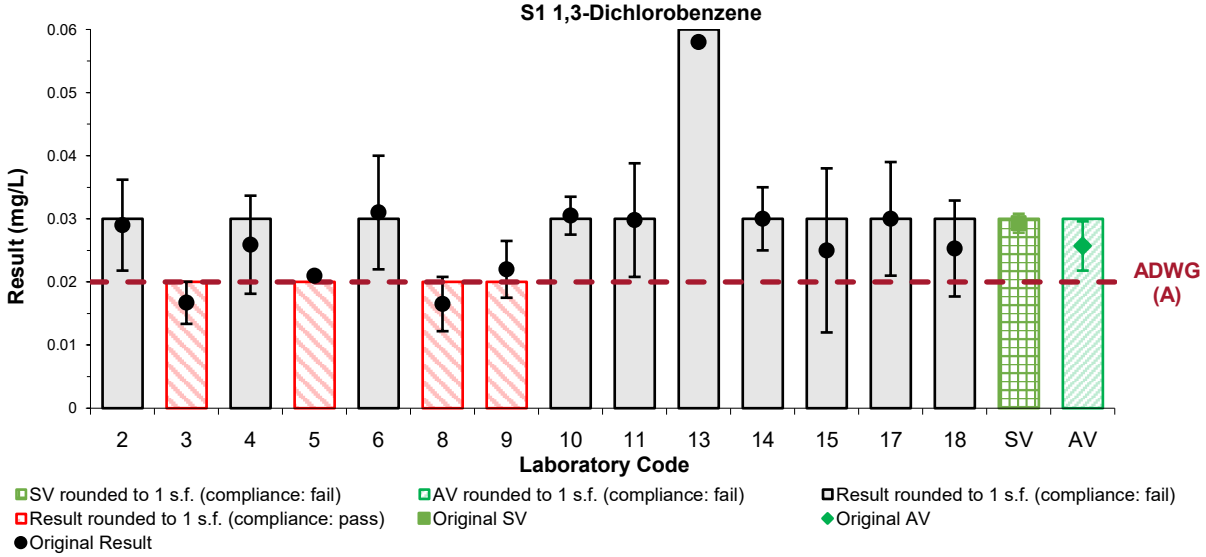


Figure 36 Sample S1 1,3-Dichlorobenzene Results and Guideline Value

1,2-Dichloroethene was also spiked at above the aesthetic ADWG, and the assigned value reflected this analyte's non-compliance. Laboratories 9, 15, and 19 reported values that, when rounded to one significant figure, returned results at or below the ADWG, and therefore incorrectly indicated sample compliance.

Laboratories 8, 11, 14, and 17 reported results that were correctly above the ADWG, however, their uncertainties spanned the guideline value, leading to inconclusive sample status. These participants reported reasonable relative uncertainties, and so their inconclusive result is due to a combination of their small (but still acceptable) negative bias, and how close the sample was to the ADWG.

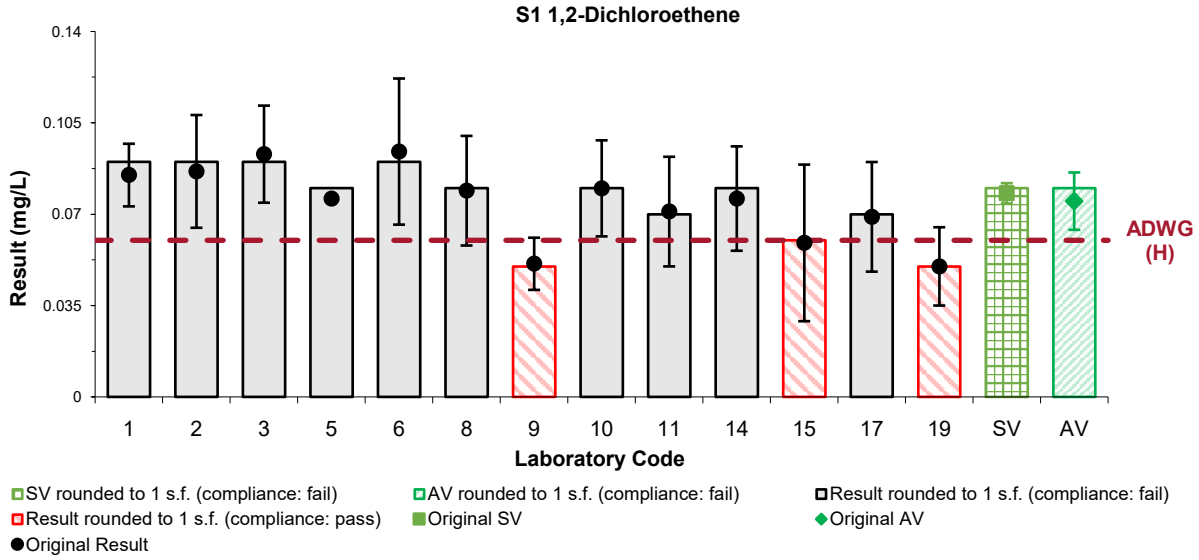
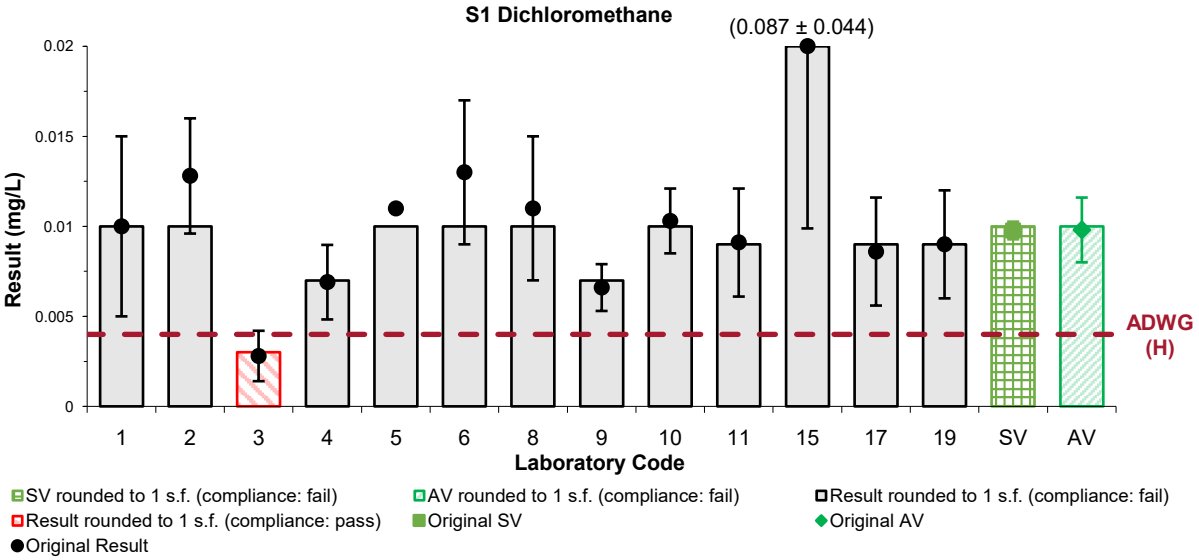


Figure 37 Sample S1 1,2-Dichloroethene Results and Guideline Value

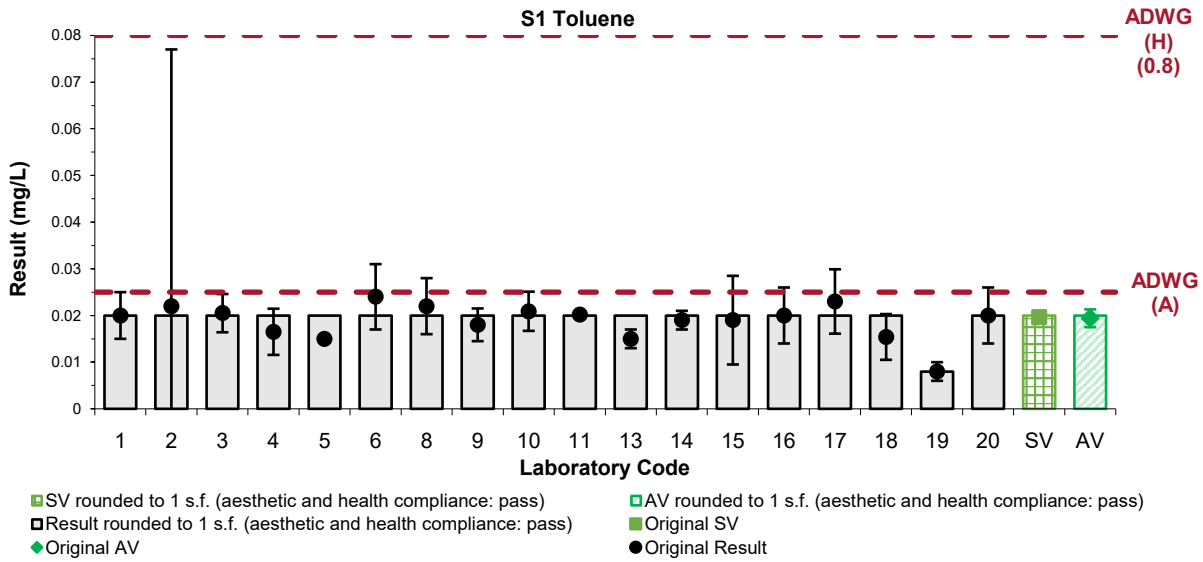
Dichloromethane was not challenging for most participants. The sample was prepared to be not compliant with the ADWG. Only Laboratory 3 reported a result that was below the ADWG.



Result from Laboratory 15 has been scaled to fit the chart; original results in parentheses.

Figure 38 Sample S1 Dichloromethane Results and Guideline Value

Toluene All participants correctly reported a result that was below the ADWG, when rounded to one significant figure. However, Laboratories 2, 6, 8, 10, 15, 16, 17, and 20 reported uncertainties that spanned the aesthetic ADWG. In particular, the relative uncertainty of Laboratory 2's result was 250%, which is too large to be fit-for-purpose. For the other participants, uncertainties were generally reasonable, and the uncertainty spanned the guideline because the sample concentration was close to the guideline level.



ADWG (H) has been scaled to fit the chart; original value in parentheses.

Figure 39 Sample S1 Toluene Results and Guideline Values

Trihalomethanes (Total) was prepared at less than half of the ADWG. While all reported results were below the guideline, Laboratory 4 reported an uncertainty that spanned the guideline. This was due to their result having a significant positive bias.

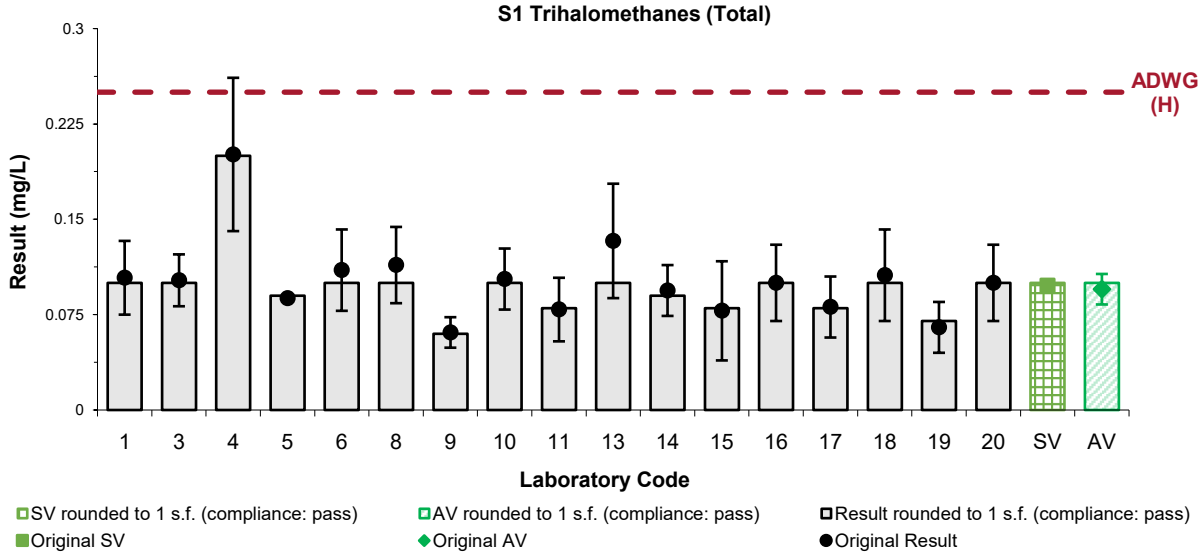


Figure 40 Sample S1 Trihalomethanes (Total) Results and Guideline Value

Benzo[a]pyrene All results were correctly above the guideline. However, Laboratory 1 reported a relative uncertainty of 100%, leading to an inconclusive sample status. This could have led to unnecessary further testing.

Pentachlorophenol The spiked and assigned values were significantly higher than the ADWG. However, Laboratories 16 and 20 reported results below the guideline, resulting in an incorrect compliance status.

Additionally, Laboratories 1 and 2 had uncertainties spanning the ADWG. Both participants reported large relative uncertainties (65% and 71% respectively). In this case, these were not fit-for-purpose, as they led to inconclusive compliance statuses.

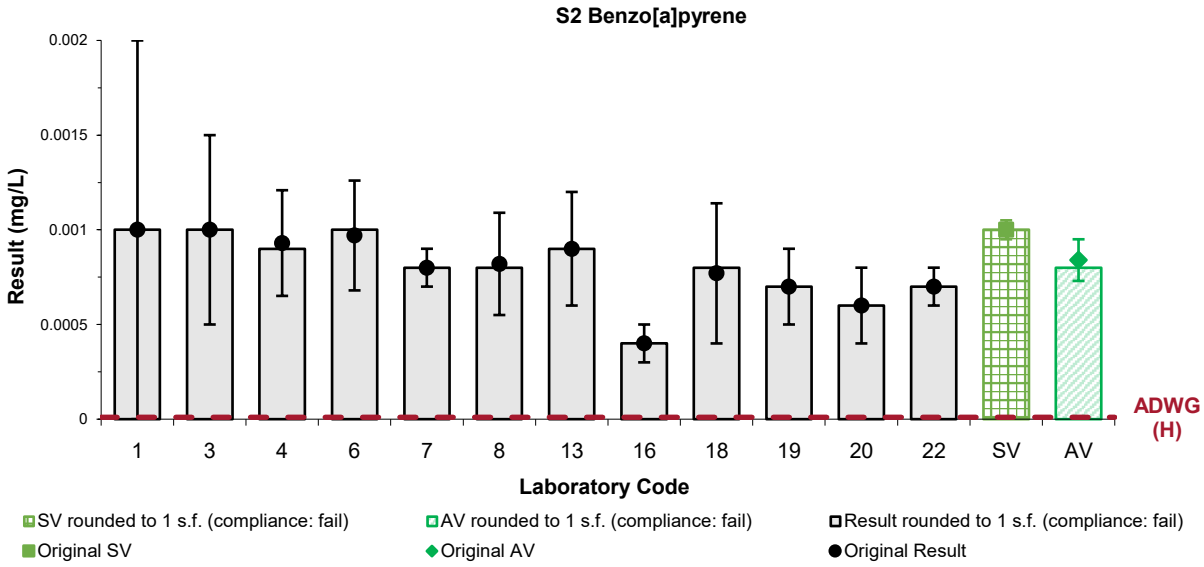


Figure 41 Sample S2 Benzo[a]pyrene Results and Guideline Value

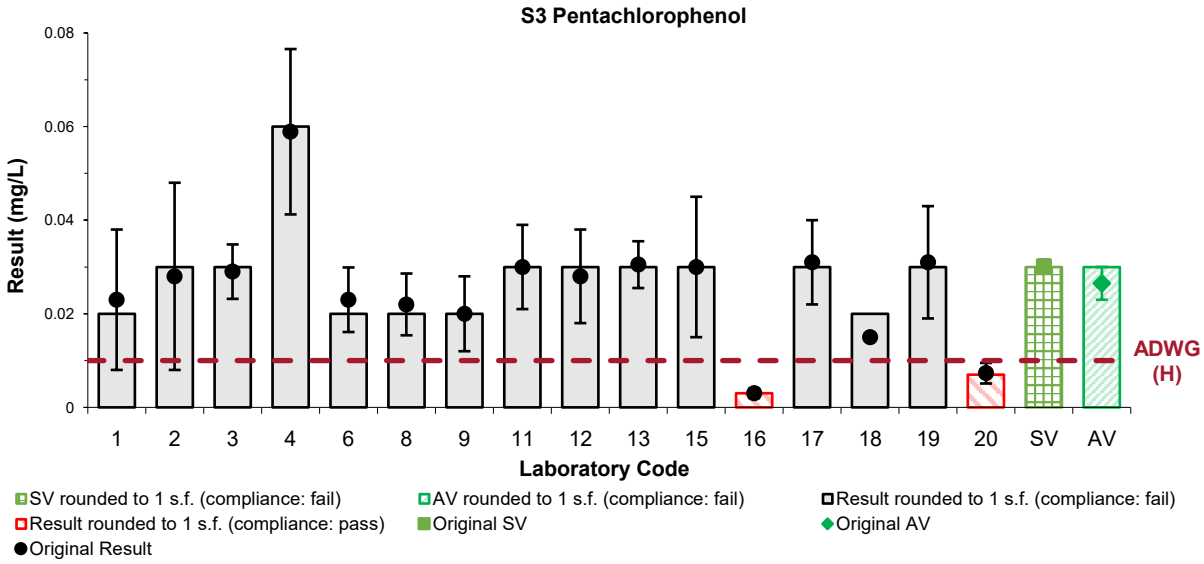


Figure 42 Sample S3 Pentachlorophenol Results and Guideline Value

6.8 Participants' Analytical Methods

Participants used a variety of analytical methods for the test samples (Appendix 4).

Results excluded from Section 5 have also been excluded from this section, so as to not bias the discussion of the analytical methods used.

Sample S1 VOCs

For Sample S1, participants were provided 2 x 42 mL vials. Participants reported test portions of 5 mL, 10 mL, or the whole vial (42 mL). There was no correlation observed in this study for using different volumes (Figure 43).

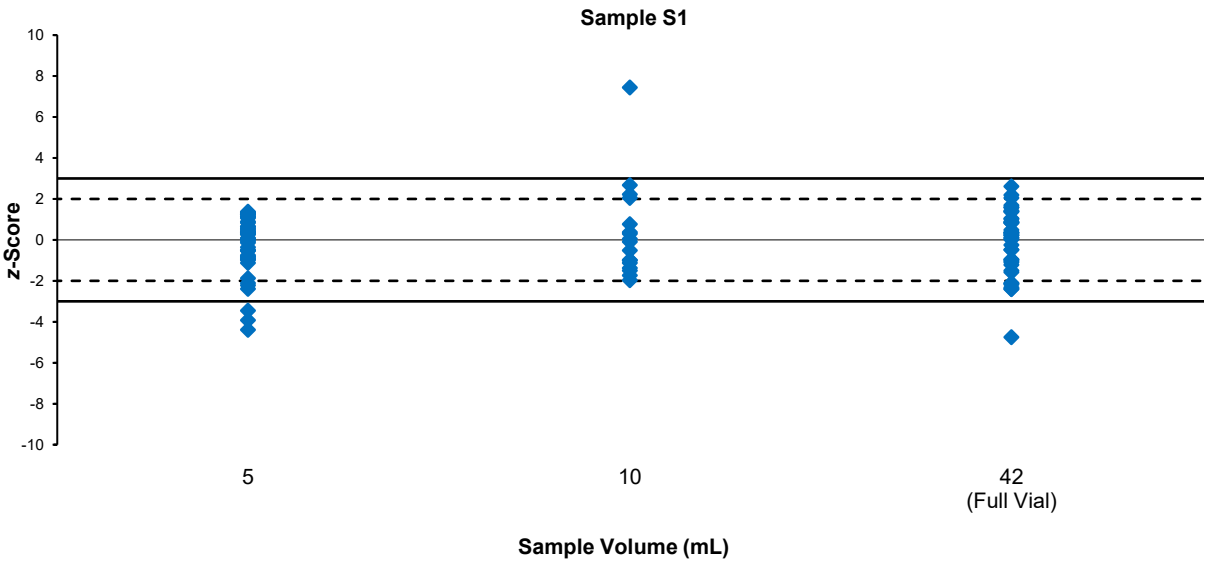


Figure 43 Sample S1 z-Score vs Sample Volume

All participants used either:

- Purge-and-trap (P&T) gas chromatography (GC) coupled to mass spectrometry (MS);
- P&T GC coupled to tandem mass spectrometry (MS/MS); or
- Headspace (HS) GC-MS.

The most common methodology employed was P&T GC-MS, using an undiluted sample, with no blank correction.

A comparison of z-scores versus methodology employed for Sample S1 is presented in Figure 44. There was no significant difference between participants using different instrumental techniques. One participant reported that they used a 10-fold dilution as part of their method, and this participant returned varied results; this participant may need to verify that their procedure is being performed consistently.

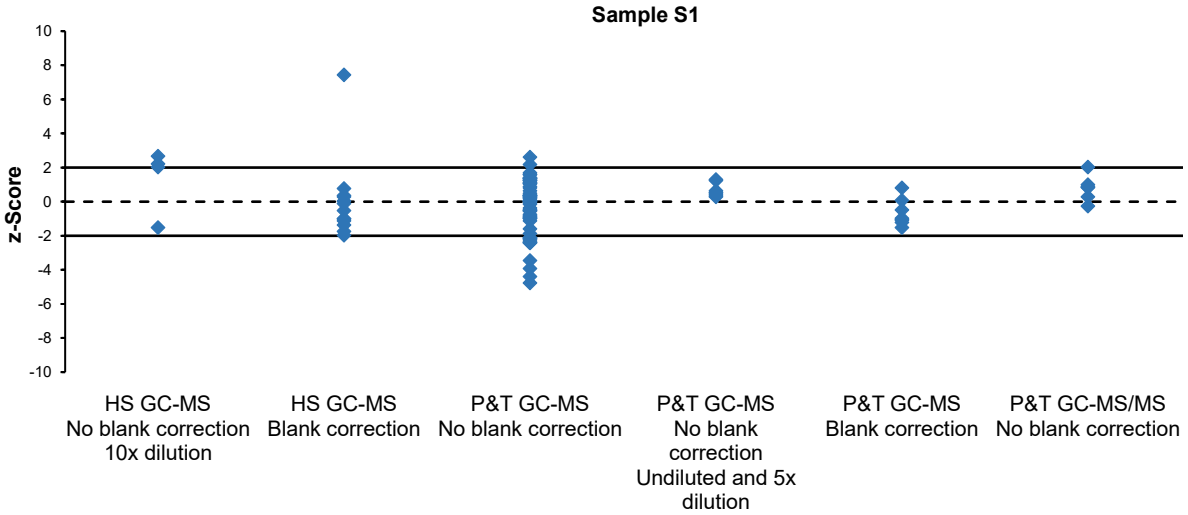


Figure 44 Sample S1 z-Score vs Methodology

1,3-Dichlorobenzene and **1,4-dichlorobenzene**. Participants were requested to report for these analytes separately. Laboratory 13 reported that their result for 1,3-dichlorobenzene was the total of 1,2-dichlorobenzene, 1,3-dichlorobenzene, and 1,4-dichlorobenzene. Laboratory 13's reported result for 1,3-dichlorobenzene was approximately equal to the sum of the two

analytes that were spiked into the sample. Therefore, this participant was able to quantify the total concentration these analytes, even if they were unable to distinguish and quantify them individually.

Sample S2 PAHs

For Sample S2, participants were given the choice of either 1 x 500 mL bottle or 3 x 100 mL bottles, depending on what suited their laboratory's method best. Participants reported test portions ranging from 35 mL to the whole bottle.

A comparison of z-scores and sample volume used for scored analytes is presented in Figure 45. There was no correlation evident.

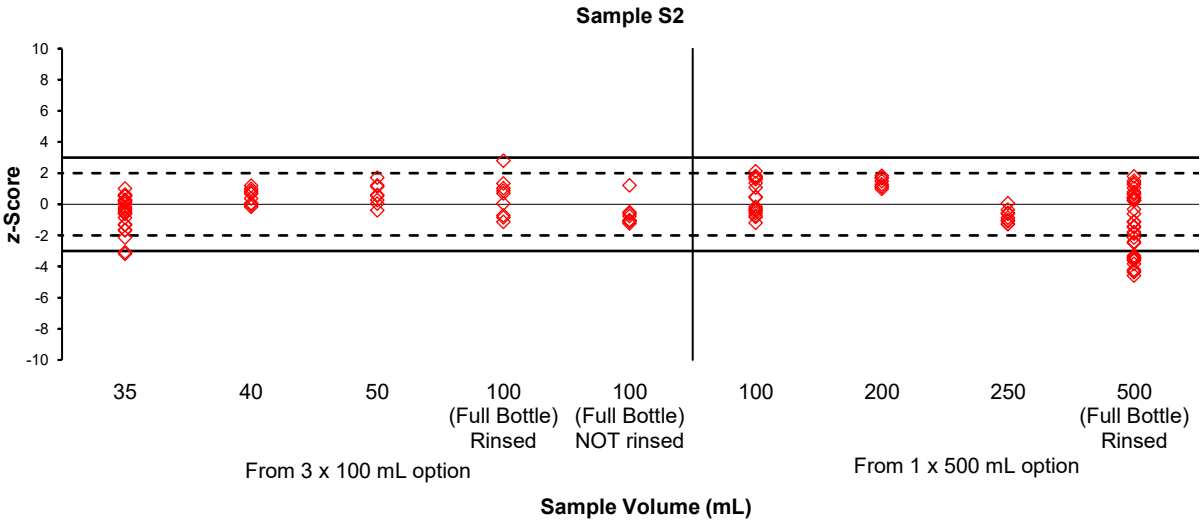


Figure 45 Sample S2 z-Score vs Sample Volume

Most participants used liquid-liquid extraction (LLE). The extraction solvents used included:

- Carbon disulfide (CS2);
- Dichloromethane (DCM);
- Ethyl acetate (EtOAc);
- Methanol (MeOH);
- Hexane (HEX); or
- Combinations of the above solvents.

Two participants used solid-phase extraction (SPE) reverse phase (RP), either by itself, or as a clean-up step after LLE. All participants used either GC-MS or GC-MS/MS for analysis.

The most common methodology employed was LLE with DCM, using GC-MS/MS for analysis (Figure 46).

Two participants used DCM/EtOAc/MeOH as their extraction reagent. These participants returned results that were biased low. They may need to review if the addition of methanol has reduced the extraction efficiency of the PAHs.

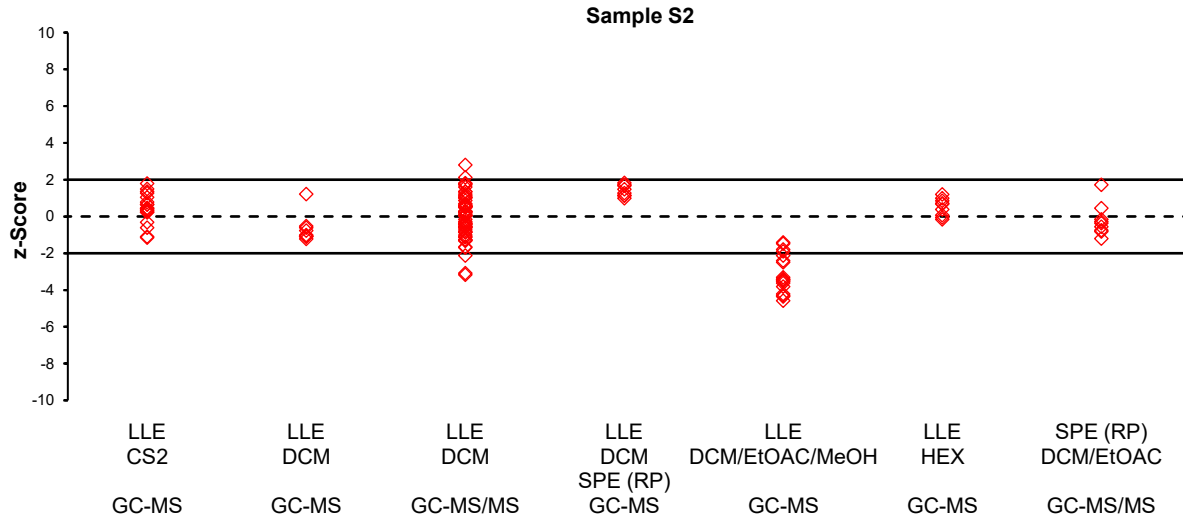


Figure 46 Sample S2 *z*-Score vs Methodology

Benzo[b]fluoranthene and **benzo[k]fluoranthene** Participants were requested to report for these two analytes separately, and in this study, only benzo[b]fluoranthene was spiked. Several participants reported that they could not distinguish between these compounds, and in one instance, the additional analyte benzo[j]fluoranthene as well. This is likely due to their close elution times on GC.[12] The US EPA Priority Pollutant List specifies these two analytes separately,[13] so laboratories should consider modifying their methodology so that they can report for the two compounds separately. In future studies, the PT results sheet may be updated to allow participants to report benzo[b]fluoranthene and benzo[k]fluoranthene separately, and/or together.

Benzo[g,h,i]perylene significantly challenged participants. This study was the first NMIA PT study to include this high molecular weight PAH in water. The reported results were highly variable (robust between-laboratory CV = 63%), and there was relatively poor recovery of the spiked analyte compared with the other PAH analytes (robust average / spiked value = 62%). There was no clear trend when considering participants' sample volumes (Figure 47) or methodology employed (Figure 48).

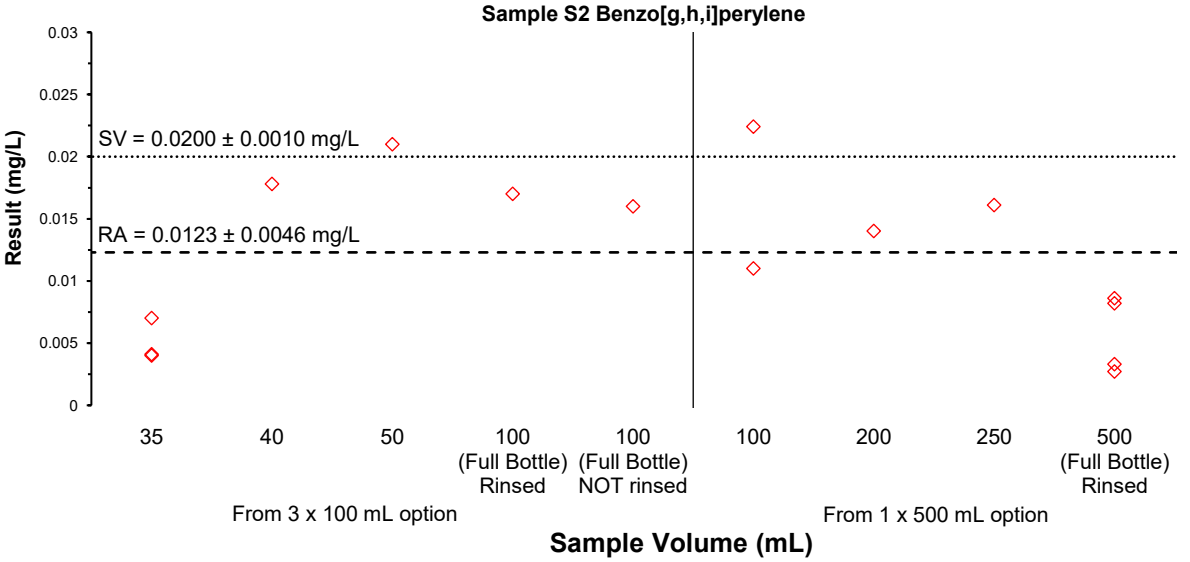


Figure 47 Sample S2 Benzo[g,h,i]perylene Result vs Sample Volume

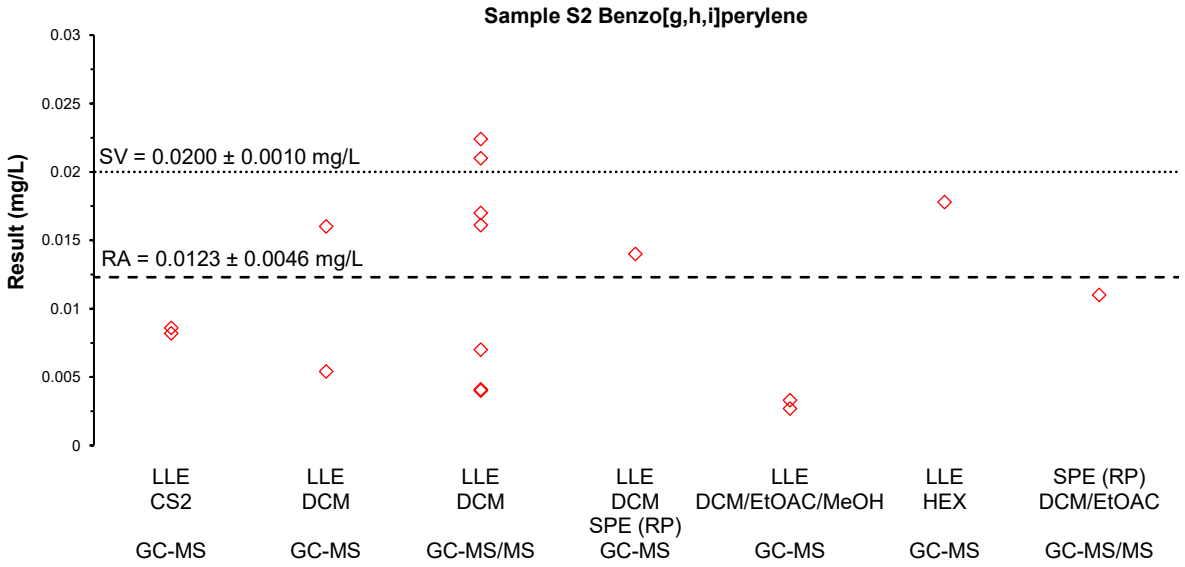


Figure 48 Sample S2 Benzo[g,h,i]perylene Result vs Methodology

Sample S3 Phenols

For Sample S3, participants were provided 2 x 100 mL bottles. Participants reported test portions ranging from 15 mL to the whole bottle. A comparison of z-scores versus sample volume used for scored analytes is presented in Figure 49. There was no evident correlation observed.

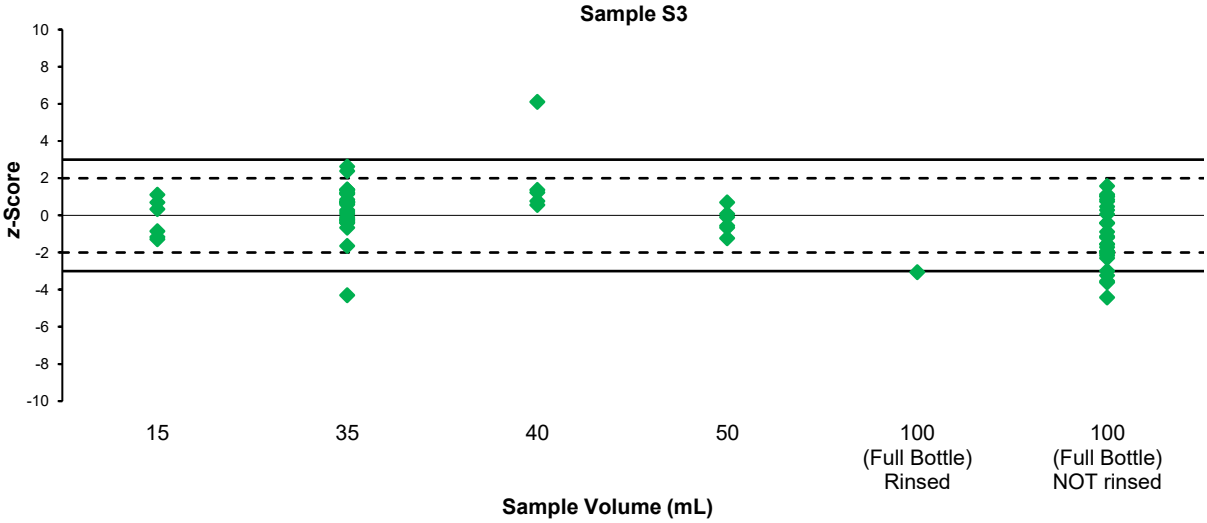


Figure 49 Sample S3 z-Score vs Sample Volume

pH adjustment may be required to ensure complete extraction of the phenols from the water matrix.[12] In this study, some participants who did not adjust the pH returned negatively biased results (Figure 50).

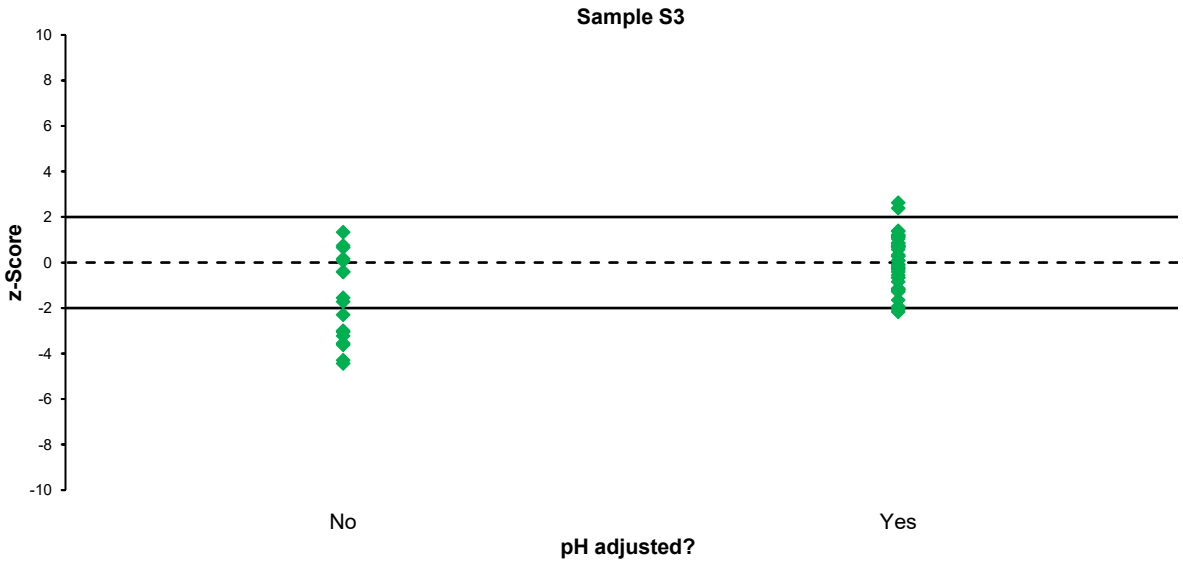


Figure 50 Sample S3 z-Score vs pH Adjustment

Most participants used liquid-liquid extraction (LLE) with either DCM only or DCM/EtOAc/MeOH; one participant used solid-phase microextraction (SPME) instead. All participants used either GC-MS or GC-MS/MS for analysis.

The most common methodology employed was LLE with DCM, using GC-MS/MS for analysis (Figure 51).

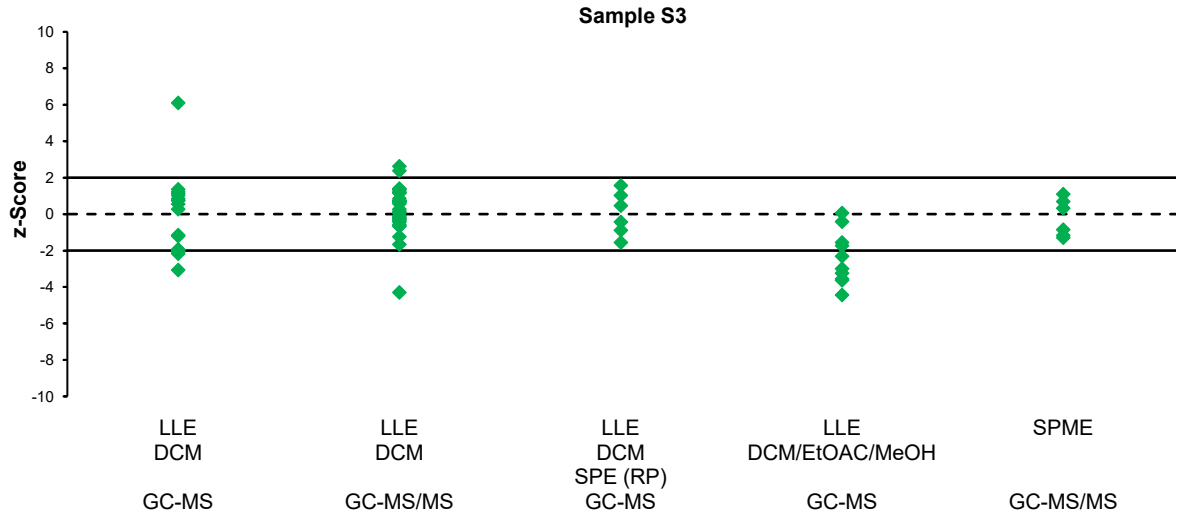


Figure 51 Sample S3 z-Score vs Methodology

Phenol and **4-Nitrophenol** These analytes were challenging for participants. No assigned value could be set for either due to high variability between reported results and poor recovery of the spiked analyte. Participants used a wide range of methodologies, and the results were not compatible with each other (Figures 52 to 55).

Participants who adjusted the pH on average returned results that had a better recovery of the spiked analyte (Figures 56 and 57).

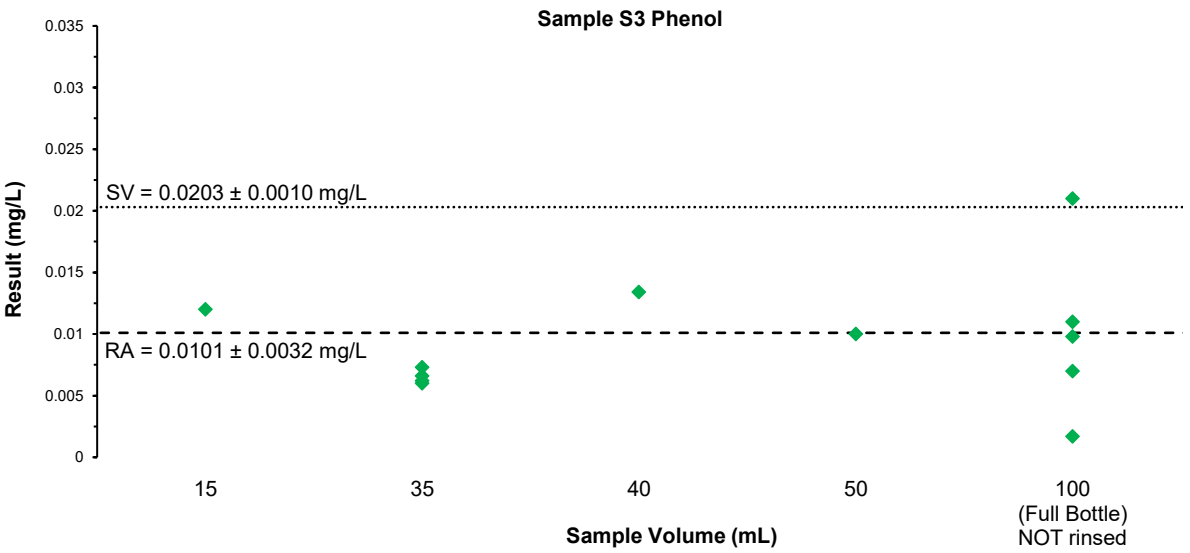


Figure 52 Sample S3 Phenol Result vs Sample Volume

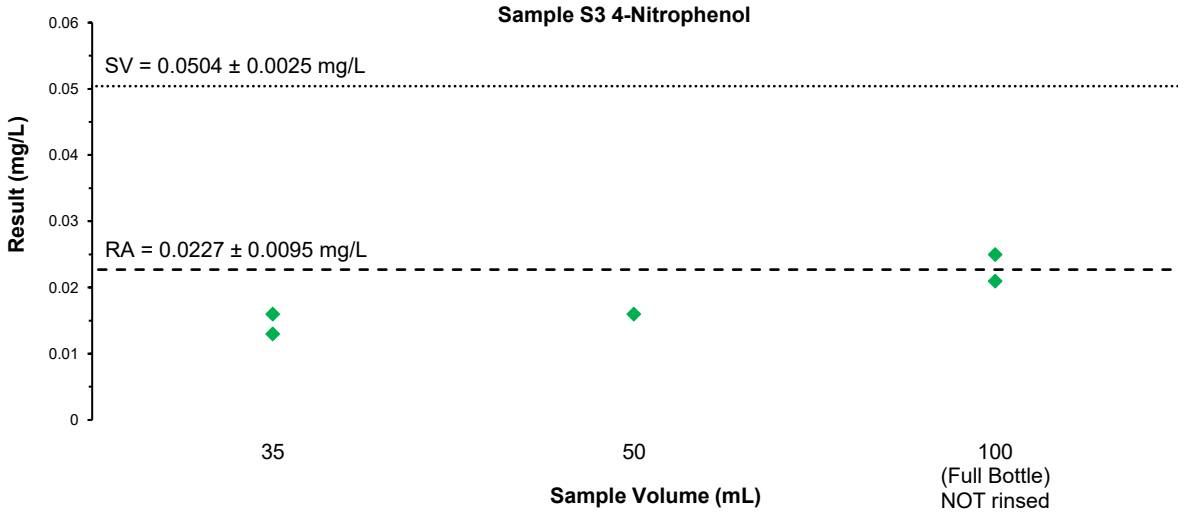


Figure 53 Sample S3 4-Nitrophenol Result vs Sample Volume

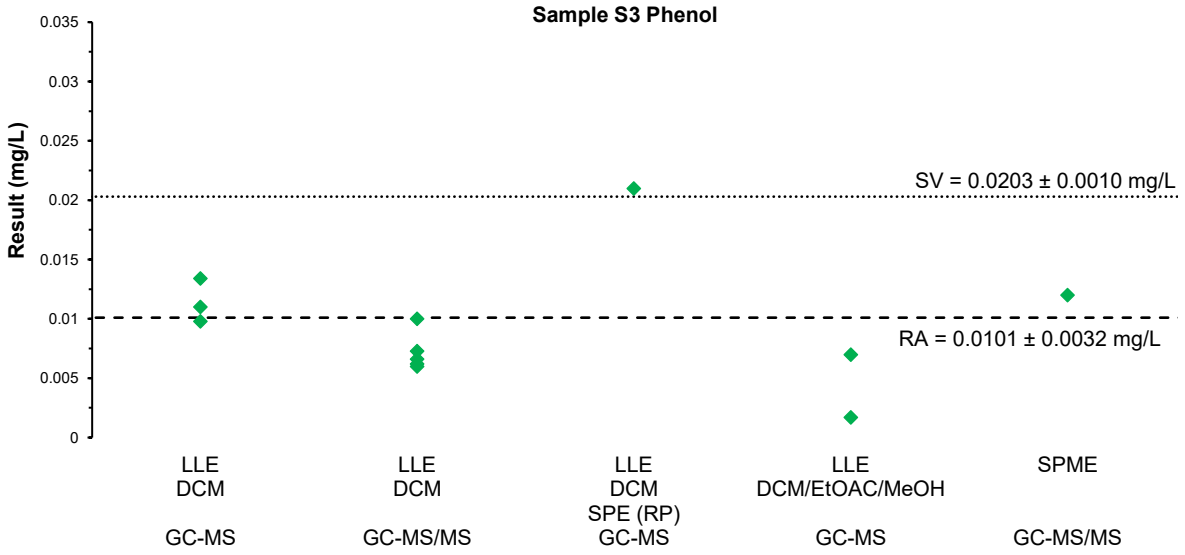


Figure 54 Sample S3 Phenol Result vs Methodology

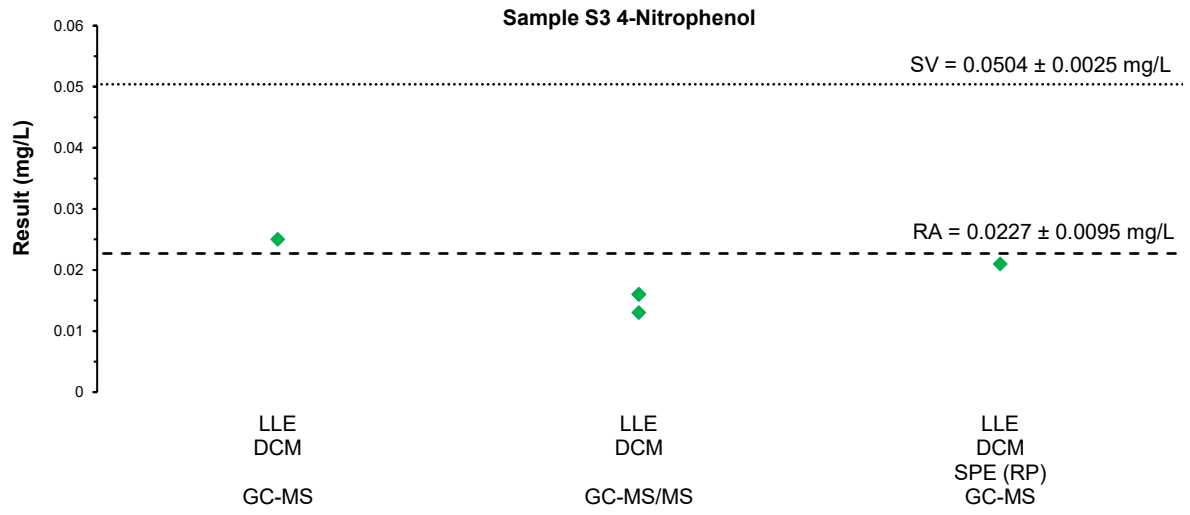


Figure 55 Sample S3 4-Nitrophenol Result vs Methodology

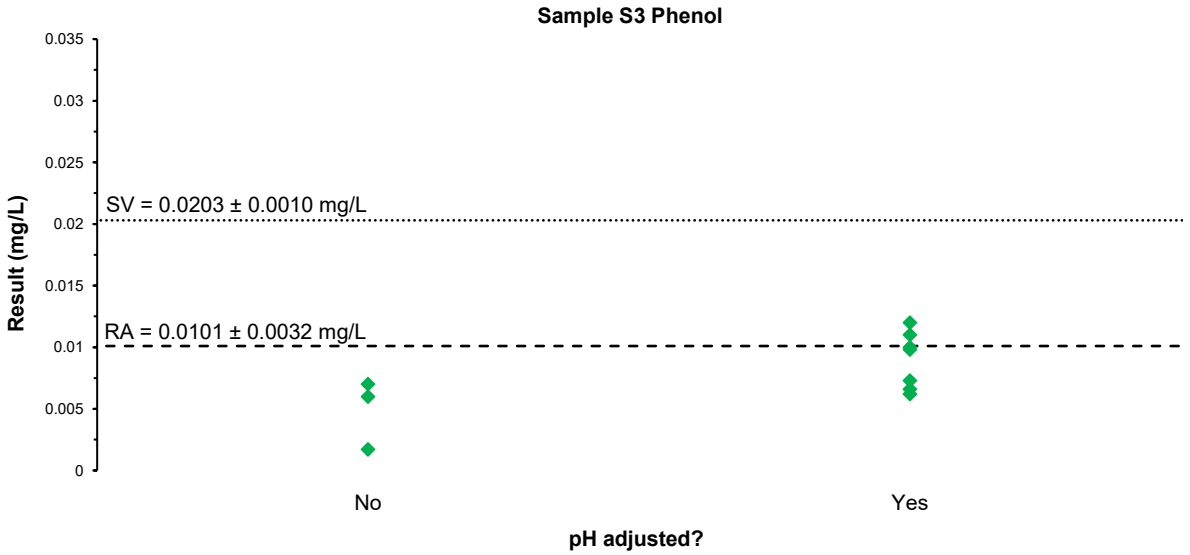


Figure 56 Sample S3 Phenol Result vs pH Adjustment

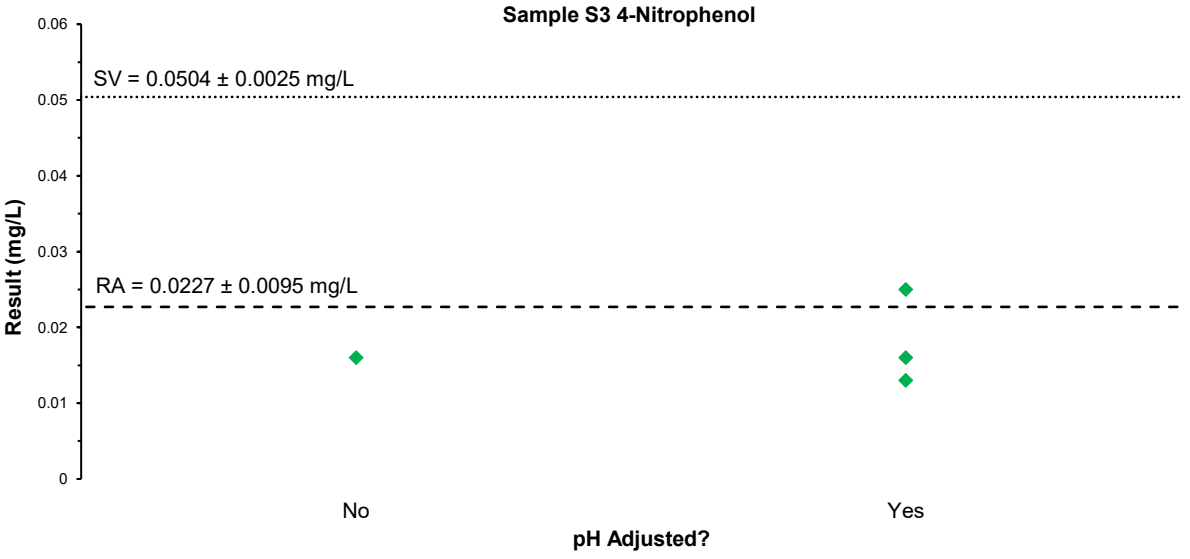


Figure 57 Sample S3 4-Nitrophenol Result vs pH Adjustment

6.9 Certified Reference Materials

Participants were requested to indicate whether certified standards or matrix reference materials had been used as part of the quality assurance for their analysis.

Fourteen participants reported using certified standards, and one participant reported using both certified standards and matrix reference materials. The following were listed:

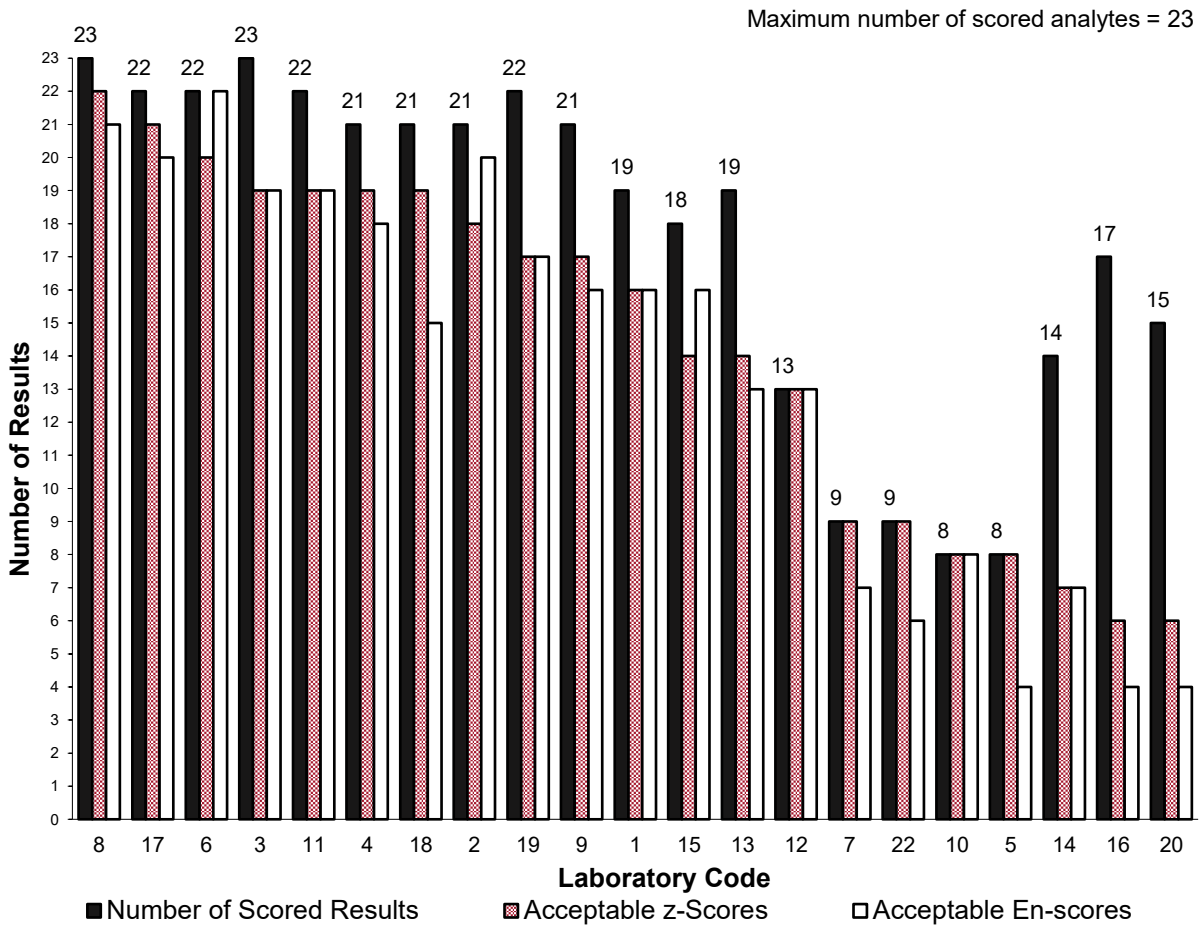
- Accustandard (e.g. M-502, Z-014G, M-8041)
- Restek (e.g. 30432, 31011)
- Merck / Sigma Aldrich (e.g. CRM47505, CRM47993)
- PM Separations

These materials may or may not meet the internationally recognised definition of a certified reference material:

> '***reference material***, *accompanied by documentation issued by an authoritative body and providing one or more specified property values with associated uncertainties and traceabilities, using valid procedures*'[14]

6.10 Summary of Participants' Results and Performances

Summaries of participants' results and performances in this PT study are presented in Tables 40 to 42, and Figure 58.



Laboratory 12 analysed Samples S2 and S3 only (maximum of 15 scored analytes). Laboratories 5 and 10 analysed Sample S1 only (maximum of 8 scored analytes). Laboratories 7 and 22 analysed Sample S2 only (maximum of 9 scored analytes).

Figure 58 Summary of Participants' Performance

Table 40 Summary of Participants' Results for Sample S1*

Lab. Code	Carbon tetrachloride	1,3-dichlorobenzene	1,4-dichlorobenzene	1,2-dichloroethane	1,2-dichloroethene	Dichloromethane	Toluene	Trihalomethanes (Total)
AV	0.0585	0.0257	0.0249	0.0957	0.075	0.0098	0.0194	0.095
1	0.064	NT	0.028	0.112	0.085	0.01	0.02	0.104
2	0.061	0.029	0.028	0.0921	0.0864	0.0128	0.022	NT
3	0.0814	0.0167	0.0159	0.097	0.093	0.0028	0.0205	0.102
4	0.0432	0.0259	0.0207	0.0817	NT	0.0069	0.0165	0.201
5	0.05	0.021	0.021	0.08	0.076	0.011	0.015	0.088
6	0.071	0.031	0.030	0.096	0.094	0.013	0.024	0.11
7	NS	NS	NS	NS	NS	NS	NS	NS
8	0.059	0.0165	0.0179	0.114	0.079	0.011	0.022	0.114
9	0.040	0.022	0.019	<0.001	0.051	0.0066	0.018	0.061
10	0.0642	0.0305	0.0298	0.0999	0.0799	0.0103	0.0209	0.103
11	0.051	0.0298	0.0295	0.0825	0.071	0.0091	0.0202	0.079
12	NT	NT	NT	NT	NT	NT	NT	NT
13	0.078	0.058	NT	0.125	<0.004	NT	0.015	0.133
14	0.062	0.03	0.0273	0.096	0.076	NT	0.019	0.094
15	0.040	0.025	0.025	0.10	0.059	0.087	0.019	0.078
16	NT	NT	NT	NT	NT	NT	0.02	0.1
17	0.061	0.030	0.030	0.085	0.069	0.0086	0.023	0.081
18	0.054	0.0253	0.026	0.101	NT	<0.010	0.0154	0.106
19	0.02	<0.001	0.012	0.082	0.05	0.009	0.008	0.065
20	NT	NT	NT	NT	NT	NT	0.02	0.1
22	NS	NS	NS	NS	NS	NS	NS	NS

*All values are in units of mg/L. AV = Assigned Value, NS = Not Supplied, NT = Not Tested. Shaded cells are results which returned a questionable or not acceptable z-score.

Table 41 Summary of Participants' Results for Sample S2*

Lab. Code	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Benz[a]anthracene	Chrysene	Benzo[b]fluoranthene	Benzo[a]pyrene	Benzo[g,h,i]perylene
AV	0.0094	0.0111	0.00328	0.00319	0.00597	0.00191	0.00375	0.0093	0.00084	Not Set
1	0.011	0.012	0.004	0.004	0.008	0.003	0.005	NT	0.001	0.024
2	0.0096	0.012	0.0032	0.0029	0.0052	0.0013	0.0028	0.007	<0.001	0.007
3	0.011	0.013	0.0041	0.0039	0.0076	0.0024	0.0043	0.0118	0.001	0.014
4	0.0108	0.0131	0.00361	0.00359	0.00602	0.00186	0.00372	0.00982	0.00093	0.0178
5	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
6	0.0078	0.0097	0.0033	0.0036	0.0066	0.0017	0.0045	0.0132	0.00097	0.017
7	0.0103	0.0124	0.0034	0.0033	0.0071	0.002	0.0034	0.0118	0.0008	0.0082
8	0.0086	0.0091	0.0031	0.0028	0.0053	0.0024	0.004	0.0089	0.00082	0.011
9	0.011	0.012	0.0033	0.0030	0.0065	0.0024	0.0039	0.011	<0.005	0.021
10	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
11	0.009	0.012	0.003	0.003	0.006	0.001	0.003	0.005	< 0.001	0.004
12	0.008	0.01	0.003	0.003	0.006	0.002	0.004	0.01	<0.001	0.017
13	0.0119	0.0141	0.0038	0.0042	0.0074	0.0023	0.0035	0.0114	0.0009	0.0224
14	0.0042	0.0046	0.0014	0.0013	0.0025	<0.0010	0.0013	NT	<0.0005	0.0054
15	0.007	0.006	0.003	0.003	0.004	0.002	0.004	0.009	<0.00002	0.008
16	0.0043	0.0054	0.0016	0.0015	0.003	0.0007	0.0016	0.0029	0.0004	0.0033
17	0.0098	0.012	0.0034	0.0033	0.0055	0.0022	0.0041	0.0075	< 0.001	0.0041
18	0.0076	0.0094	0.00274	0.00258	0.0052	0.00181	0.0034	0.0094	0.00077	0.0161
19	0.0079	0.0094	0.0029	0.0026	0.0055	0.0016	0.0034	0.011	0.0007	0.016
20	0.0073	0.0071	0.0024	0.002	0.0047	0.0013	0.0013	0.0033	0.0006	0.0027
22	0.0113	0.0136	0.0035	0.0034	0.0069	0.0021	0.0031	0.0098	0.0007	0.0086

*All values are in units of mg/L. AV = Assigned Value, NS = Not Supplied, NT = Not Tested. Shaded cells are results which returned a questionable or not acceptable z-score.

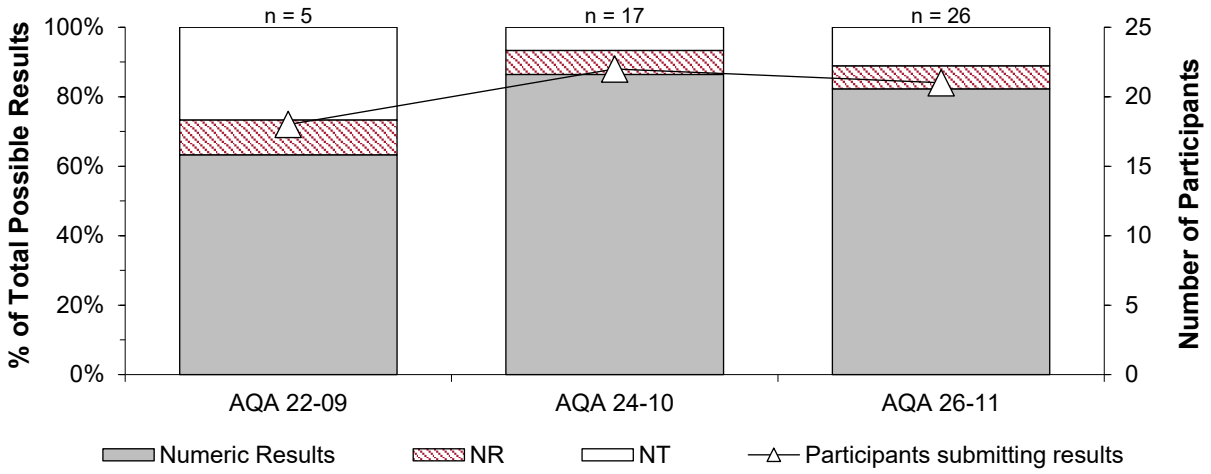
Table 42 Summary of Participants' Results for Sample S3*

Lab. Code	Phenol	2-Methylphenol	3 & 4-Methylphenols (total)	2-Nitrophenol	4-Nitrophenol	2,4-Dichlorophenol	2,6-Dichlorophenol	Pentachlorophenol
AV	Not Set	0.00653	0.0079	0.0426	Not Set	0.0061	0.0058	0.0265
1	0.01	0.007	NT	0.039	NT	0.007	NT	0.023
2	0.0066	0.0064	0.0074	0.063	<0.03	0.0075	0.0072	0.028
3	0.021	0.0086	0.0065	0.039	0.021	0.0042	0.0070	0.029
4	0.0134	0.00754	NT	0.0543	NT	0.00760	0.00644	0.0589
5	NT	NT	NT	NT	NT	NT	NT	NT
6	0.0062	0.0062	0.0076	< 0.01	< 0.03	0.0062	0.0055	0.023
7	NS	NS	NS	NS	NS	NS	NS	NS
8	0.012	0.005	0.009	0.052	NT	0.0065	0.0043	0.022
9	0.010	0.0058	0.0090	0.037	0.016	0.0062	0.0057	0.020
10	NS	NS	NS	NS	NS	NS	NS	NS
11	0.006	0.006	0.010	0.006	0.016	0.007	0.006	0.030
12	0.015	0.007	0.01	0.041	0.04	0.006	<0.006	0.028
13	<0.05	0.0074	0.0098	0.0485	<0.02	0.0078	<0.02	0.0305
14	<0.0010	<0.0010	<0.0020	0.0165	NT	<0.0010	<0.0010	<0.0020
15	0.03	<0.01	<0.01	0.04	0.03	<0.01	<0.01	0.03
16	0.007	0.006	0.008	0.017	<0.0001	0.004	0.004	0.003
17	0.0073	0.0060	0.0053	0.065	0.013	0.0068	0.0074	0.031
18	0.0098	0.004	0.0061	0.026	NT	0.0037	0.0034	0.015
19	0.011	0.008	0.006	0.045	0.025	0.007	0.007	0.031
20	0.0017	0.0019	0.0028	<0.0001	<0.0001	0.0033	<0.0001	0.0073
22	NS	NS	NS	NS	NS	NS	NS	NS

*All values are in units of mg/L. AV = Assigned Value, NS = Not Supplied, NT = Not Tested. Shaded cells are results which returned a questionable or not acceptable z-score.

6.11 Comparison with Previous Organic Compounds in Potable Water PT Studies

AQA 26-11 is the third NMIA PT study to include organic compounds in potable water. A summary of the participation and reported results in NMIA organic compounds in potable water studies is presented in Figure 59. Although more analytes are being assessed, the proportion of numeric results reported has increased substantially compared to the first study in 2022. This reflects improvements in the range of analytes laboratories are testing for.



n = number of spiked analytes

Figure 59 Summary of Participation and Reported Results in NMIA Organic Compounds in Potable Water PT Studies

A summary of the acceptable performance obtained by participants in NMIA organic compounds in potable water studies is presented in Figure 60. Over this period, the average proportion of acceptable z-scores and E_n-scores was 90% and 81% respectively.

The proportion of acceptable scores was lower than in previous studies. This may be due to the lower analyte concentrations in this study, which may have posed a greater analytical challenge for participants.

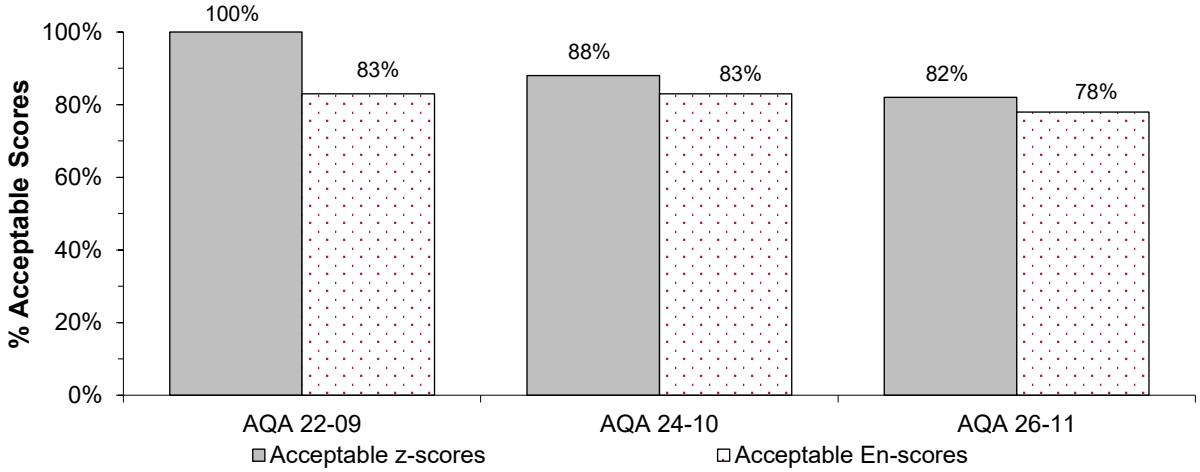


Figure 60 Acceptable z-Scores and E_n-Scores in NMIA Organic Compounds in Potable Water PT Studies

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

As discussed in Section 6.2, it is a requirement of ISO/IEC 17025 that laboratories report their uncertainties.[8] Figure 61 presents a summary of the relative uncertainties as reported by participants in NMIA organic compounds in potable water studies. Over this period, the vast majority of numeric results were reported with uncertainties. Most relative uncertainties were between 15% and 50%. However, an average of 27% of relative uncertainties in each study were outside this range; these may have been unrealistically small or too large to be fit-for-purpose.

This study had the lowest proportion of results reported without a MU, reflecting improved uncertainty reporting practices by laboratories.

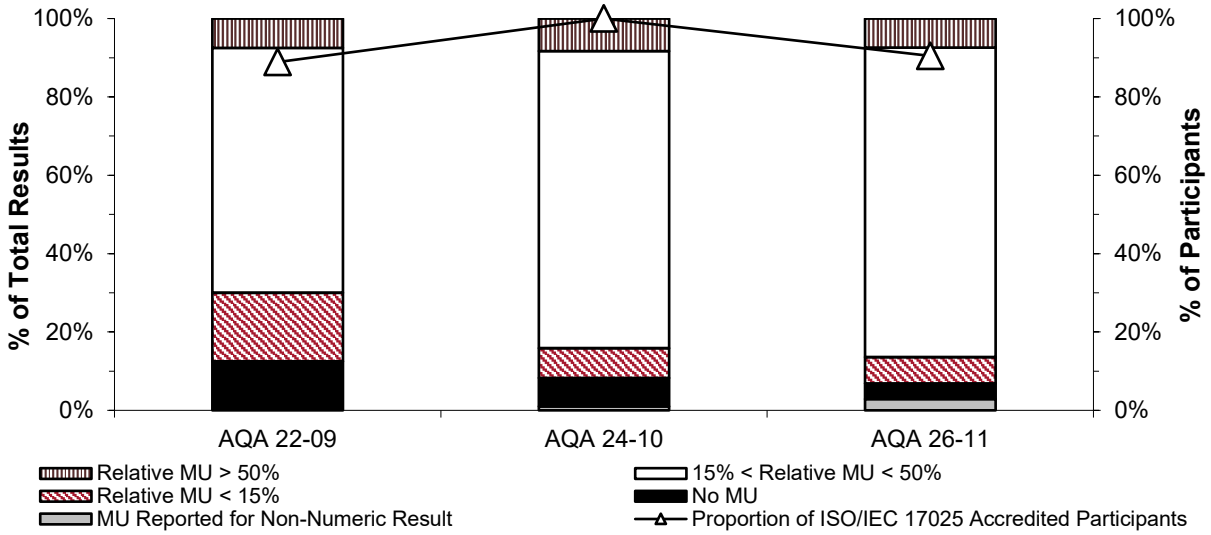


Figure 61 Summary of Participants' Relative Uncertainties for NMIA Organic Compounds in Potable Water PT Studies

7 REFERENCES

Please note that for all undated references, the latest edition of the referenced document (including any amendments) applies.

[1] ISO/IEC 17043, *Conformity assessment — General requirements for the competence of proficiency testing providers.*

[2] Commonwealth of Australia, Department of Industry, Science and Resources, NMIA, 2026, *Study Protocol for Proficiency Testing,* viewed August 2026, <https://www.industry.gov.au/sites/default/files/2020-10/cpt_study_protocol.pdf>

[3] Commonwealth of Australia, Department of Industry, Science and Resources, NMIA, 2025, *Chemical Proficiency Testing Statistical Manual*, viewed August 2026, <https://www.industry.gov.au/sites/default/files/2019-07/cpt_statistical_manual.pdf>

[4] Thompson, M., Ellison, S.L.R. and Wood, R., 2006, 'The International Harmonized Protocol for the Proficiency Testing of Analytical Chemistry Laboratories', *Pure Appl. Chem.,* vol 78, pp 145–196.

[5] Commonwealth of Australia, NHMRC, NRMMC, 2025, *National Water Quality Management Strategy Australian Drinking Water Guidelines 6 2011*, Version 4.0.

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

[7] Thompson, M., 2000, 'Recent Trends in Inter-laboratory Precision at ppb and sub-ppb Concentrations in Relation to Fitness for Purpose Criteria in Proficiency Testing', *Analyst*, vol 125, pp 385–386.

[8] ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories.*

[9] Eurachem/CITAC Guide CG 4, QUAM:2012.P1, *Quantifying Uncertainty in Analytical Measurement*, 3rd ed., viewed August 2026, <http://www.eurachem.org/images/stories/Guides/pdf/QUAM2012_P1.pdf>

[10] IARC, 2016, *IARC Monographs on the Evaluation Of Carcinogenic Risks To Humans Volume 117 Pentachlorophenol and Some Related Compounds*.

[11] Eurachem/CITAC Guide, 2021, *Use of Uncertainty Information in Compliance Assessment*, 2nd ed., viewed August 2026, <https://www.eurachem.org/images/stories/Guides/pdf/MUC2021_P1_EN.pdf >

[12] US EPA, 2018, *Method 8270E Semivolatile Organic Compounds by Gas Chromatography / Mass Spectrometry*, Revision 6.

[13] US EPA, 2014, *Priority Pollutant List*.

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

APPENDIX 1 SAMPLE PREPARATION

Tap water (potable water) was collected and autoclaved. This was used as the starting matrix for all samples.

Sample S1 VOCs

Autoclaved potable water was dispensed into headspace vials. A composite spike solution of various VOCs was prepared and then dispensed into each of the vials. The vials were then labelled, shrink-wrapped, and stored in a refrigerator at 4 °C until sample dispatch.

Sample S2 PAHs

Autoclaved potable water was dispensed into 500 mL and 100 mL amber glass bottles. A composite spike solution of various PAHs was prepared and then dispensed into each of the bottles. The bottles were then labelled, shrink-wrapped, and stored in a refrigerator at 4 °C until sample dispatch.

Sample S3 Phenols

Autoclaved potable water was dispensed into amber glass bottles. A composite spike solution of various phenols was prepared and then dispensed into each of the bottles. The bottles were then labelled, shrink-wrapped, and stored in a refrigerator at 4 °C until sample dispatch.

APPENDIX 2 ASSESSMENT OF HOMOGENEITY AND STABILITY

A2.1 Homogeneity

No homogeneity testing was conducted as the samples were prepared using a process previously demonstrated to produce sufficiently homogeneous samples. The results of this study also gave no reason to question the samples' homogeneity.

A2.2 Stability

No stability testing was conducted as the samples were prepared, stored, and dispatched using a process previously demonstrated to produce sufficiently stable samples.

After preparation and before dispatch, the samples were stored at 4 °C. For dispatch, samples were packaged into insulated polystyrene foam boxes with cooler bricks. All samples were delivered within 2 days, and the results of this study gave no reason to question the samples' transport stability over this period.

APPENDIX 3 ROBUST AVERAGE AND ASSOCIATED UNCERTAINTY, z-SCORE AND E_n-SCORE CALCULATIONS

A3.1 Robust Average and Associated Uncertainty

Robust averages were calculated using the procedure described in ISO 13528.[6] The associated uncertainties were evaluated as according to Equation 4.

$$u_{rob\ av} = \frac{1.25 \times S_{rob\ av}}{\sqrt{p}} \qquad \textit{Equation 4}$$

where:

$u_{rob\ av}$	is the standard uncertainty of the robust average
$S_{rob\ av}$	is the standard deviation of the robust average
p	is the 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 43.

Table 43 Uncertainty of Robust Average for Sample S1 1,2-Dichloroethene

Number of results (p)	13
Robust Average	0.075 mg/L
$S_{rob\ av}$	0.016 mg/L
$u_{rob\ av}$	0.0055 mg/L
k	2
$U_{rob\ av}$	0.011 mg/L

Therefore, the robust average for Sample S1 1,2-dichloroethene is 0.075 ± 0.011 mg/L.

A3.2 z-Score and E_n-Score Calculation

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

A worked example is set out below in Table 44, using the result reported by Laboratory 8 for Sample S1 1,2-dichloroethene.

Table 44 z-Score and E_n-Score for Sample S1 1,2-Dichloroethene Result Reported by Laboratory 8

Participant Result (mg/L)	Assigned Value (mg/L)	Standard Deviation for Proficiency Assessment	z-Score	E_n-Score
0.079 ± 0.021	0.075 ± 0.011	15% as PCV, or: 0.15 × 0.075 = 0.01125 mg/L	$z = \frac{0.079 - 0.075}{0.01125} = 0.36$	$E_n = \frac{0.079 - 0.075}{\sqrt{0.021^2 + 0.011^2}} = 0.17$

APPENDIX 4 PARTICIPANTS' TEST METHODS

Table 45 Measurement Methods and Instrument Techniques for Sample S1 VOCs

Lab. Code	Sample Volume Analysed (mL)	Blank Subtracted/Corrected?	Dilution? If yes, please write the dilution factor.	Please specify the internal standard/s used	When was the internal standard added?	Measurement Technique
2	40	No		Fluorobenzene, Chlorobenzene-d5,1,4-Dichlorobenzene d4		P&T GC-MS/MS
3	44mL	No		Toluene D8	After sample extraction, before instrument analysis	P&T GC-MS
4	10	Yes	NA	Fluorobenzene-(IS), Chlorobenzene-d5-(IS)	Before sample extraction	Headspace GC-MS
5	42ml Vial	Yes		Chlorobenzene-d5, 1,4-Dichlorobenzene-d4 Fluorobenzene	After sample extraction, before instrument analysis	P&T GC-MS
6	40	No	1	Fluorobenzene, Chlorobenzene-d5, 1.4-Dichlorobenzene-d4	Before sample extraction	P&T GC-MS
8	5	No	no	d6-benzene,d8-toluene, d10-ethybenzene	Before sample extraction	P&T GC-MS
9	44	No		Pentafluorobenzene, difluorobenzene, d5-Chlorobenzene, d5-1,4-Dichlorobenzene	After sample extraction, before instrument analysis	P&T GC-MS
10	5	No	Undiluted and 5x dilution	Fluorobenzene & 1,2-Dichlorobenzene-d4	Before sample extraction	P&T GC-MS
11	5mL	No	No	Fluorobenzene	After sample extraction, before instrument analysis	P&T GC-MS
13	10 mL	No	10	1,2-Dichloroethane-D4 and Toluene-D8	Before sample extraction	Headspace GC-MS
14	5	No			After sample extraction, before instrument analysis	P&T GC-MS
16	40	No	No	524.3 Internal Standard/Surrogate Mix 2000ug/mL(Restek)	Before sample extraction	P&T GC-MS
17	5	No	No	FluoroBenzene, Chlorobenzene-d5, 1,4-Dichlorobenzene-d4	Before sample extraction	P&T GC-MS

Lab. Code	Sample Volume Analysed (mL)	Blank Subtracted/Corrected?	Dilution? If yes, please write the dilution factor.	Please specify the internal standard/s used	When was the internal standard added?	Measurement Technique
18	10	Yes	No	Pentafluorobenzene, 1,4-difluorobenzene & Chlorobenzene-d5	Before sample extraction	Headspace GC-MS
19	5mL	No	No	1,4-dichlorobenzene-d4, fluorobenzene, chlorobenzene-d5	After sample extraction, before instrument analysis	P&T GC-MS
20	40	No	No	524.3 Internal Standard/Surrogate Mix 2000ug/mL(Restek)	Before sample extraction	P&T GC-MS

Table 46 Measurement Methods and Instrument Techniques for Sample S1 VOCs – Additional Information

Lab. Code	Methodology Additional Information
3	1,2-Dichloroethene has been reported as a sum of cis-1,2-dichloroethene and trans-1,2-dichloroethene.
5	Method is currently undergoing validation. MU not yet established using long term QC.
13	1,3-dichlorobenzene result is total of 1,2-dichlorobenzene, 1,3-dichlorobenzene and 1,4-dichlorobenzene
15	Chloroform was the only THM > LOR. 1,2-Dichloroethene is reported as sum of both cis and trans isomers. The number of decimal places has been adjusted to show 2 significant figures. Detected 2-Butanone (MEK) at 0.091 mg/L. Detected Undecane, not quantified.
16	We run 2 separate methods- one for THM compounds and one for BTEX compounds
20	We run 2 separate methods- one for THM compounds and one for BTEX compounds

Table 47 Measurement Methods and Instrument Techniques for Sample S2 PAHs

Lab. Code	Sample Volume Analysed (mL)	Was the whole bottle used? If yes, was the bottle rinsed?	Extraction Technique	Extraction Solvent	Extraction Time (min)	Extraction Volume and Number of Steps (if staggered extraction)	Extract Concentration Technique	Extract Concentration Time (min)	Extract Concentration Temperature (°C)	Extract Clean-Up
2	35		Liquid-Liquid	DCM	10	2ml x 1				
3	200	No	Liquid-Liquid	Dichloromethane	10		Evaporation under nitrogen	20	40	SPE (Reverse Phase)
4	40	No	Liquid-Liquid	Hexane	NA	0.5mL final V	Evaporation under nitrogen	NA	35	NA
6	100	Yes, bottle rinsed	Liquid-Liquid	DCM	3	30 mL & 2	Evaporation under nitrogen	30	35	NO
7	500	Yes, bottle rinsed	Liquid-Liquid	CS2	3 x 1 minute	10 ml x 3	Evaporation under nitrogen	30 minutes		
8	100	No	SPE (Reverse Phase)	DCM:EtOAC 1:1		5ml x 2	Evaporation under nitrogen		40	None
9	50	No	Liquid-Liquid	DCM	60	2	Water bath		68	None
11	35	Yes, bottle rinsed	Liquid-Liquid	DCM	30	1 x 35 mL	Evaporation under nitrogen	30	45	None
13	100 mL	No	Liquid-Liquid	DCM	2 mins shaking	20 mL, 3 times	Rotavapped		38	None
14	100	Yes, bottle rinsed	Liquid-Liquid	DCM	6 (total)	3 x 6 mL	Evaporation under nitrogen		40	No
16	500mL	Yes, bottle rinsed	Liquid-Liquid	DCM / Ethyl Acetate / Methanol	Approx 30mins	~15mL, 10 steps	Evaporation under nitrogen	~ 25mins	35C	
17	35	No	Liquid-Liquid	DCM	10	2 mL x1	None	NA	NA	None
18	250	No	Liquid-Liquid	Dichloromethane	45	Step 1:10mls, step 2: 5mls and step 3: 5mls	Evaporation under nitrogen	Not set	40	N/A
19	100 mL	Yes, bottle NOT rinsed	Liquid-Liquid	DCM	30	30 mL, 3x	Evaporation under nitrogen	30	35	

Lab. Code	Sample Volume Analysed (mL)	Was the whole bottle used? If yes, was the bottle rinsed?	Extraction Technique	Extraction Solvent	Extraction Time (min)	Extraction Volume and Number of Steps (if staggered extraction)	Extract Concentration Technique	Extract Concentration Time (min)	Extract Concentration Temperature (°C)	Extract Clean-Up
20	500mL	Yes, bottle rinsed	Liquid-Liquid	DCM / Ethyl Acetate / Methanol	Approx 30mins	~15mL, 10 steps	Evaporation under nitrogen	~ 25mins	35C	
22	500	Yes, bottle rinsed	Liquid-Liquid	CS2	3 x 1 minute	10 ml x 3	Evaporation under nitrogen	30 minutes		

Table 48 Measurement Methods and Instrument Techniques for Sample S2 PAHs (continued)

Lab. Code	Type of Internal Standard Used	Please specify the internal standard/s used	When was the internal standard added?	Measurement Technique
2	PAHs		After sample extraction, before instrument analysis	GC-MS/MS
3	PAHs		After sample extraction, before instrument analysis	GC-MS
4	PAHs	Naphthalene-d8, Acenaphthene-d10, Phenanthrene-d10, Chrysene-d12	Before sample extraction	GC-MS
6	PAHs	Naphthalene-d8, Acenaphthene-d10, Chrysene-d12, Perylene-d12	After sample extraction, before instrument analysis	GC-MS/MS
7	PAHs		Before sample extraction	GC-MS
8	PAHs	d8-naphthalene, d10-acenaphthene, d10-phenanthrene, d12-chrysene, perylene-d12	Before sample extraction	GC-MS/MS
9	PAHs	Naphthalene-d8, Acenaphthalene-d10, Phenanthrene-d10, Chrysene-d12, Perylene-d12	Before sample extraction	GC-MS/MS
11	PAHs	Naphthalen-D8, Acenaphthlene-D10, Chrysene-D12, Perylene-D12	After sample extraction, before instrument analysis	GC-MS/MS
13	PAHs	Phenanthrene d10	Before sample extraction	GC-MS/MS
14	PAHs	Various	After sample extraction, before instrument analysis	GC-MS
16		Method 525.2 Internal Std Mix	After sample extraction, before instrument analysis	GC-MS
17	PAHs	1,4-Dichlorobenzene-D4, Naphthalene-D8, Acenaphthene-D10, Chrysene-D12, Perylene-D12, Bromonitrobenzene	After sample extraction, before instrument analysis	GC-MS/MS
18	Deuterated PAHs	In-house OC/PAH ISTD mix	After sample extraction, before instrument analysis	GC-MS/MS

Lab. Code	Type of Internal Standard Used	Please specify the internal standard/s used	When was the internal standard added?	Measurement Technique
19	PAHs	d8-naphthalene, d10-acenaphthene, d10-phenanthrene, d12-chrysene, d12-perylene	After sample extraction, before instrument analysis	GC-MS
20		Method 525.2 Internal Std Mix	After sample extraction, before instrument analysis	GC-MS
22	PAHs		Before sample extraction	GC-MS

Table 49 Measurement Methods and Instrument Techniques for Sample S2 PAHs – Additional Information

Lab. Code	Methodology Additional Information
1	Benzo(b,k)fluoranthene: 0.015mg/L ± 0.003mg/L
3	Laboratory method is unable to report Benzo[b]fluoranthene and Benzo[k]fluoranthene individually. Reported result for Benzo[b]fluoranthene is reported as Benzo[b,j,k]fluoranthene. As Laboratory LOR is higher than lowest spiking level, all analytes not detected above laboratory LOR has been marked as NT to avoid receiving false negative results for <LOR detection.
13	The result reported for Benzo[b]fluoranthene is total of Benzo[b]fluoranthene and Benzo[k]fluoranthene.
15	Benzo(b)fluoranthene and Benzo(k)fluoranthene reported as the sum of both isomers.
16	Slight overflow of sample during extraction process which gave surrogate recovery results on the lower side of our acceptance criteria

Table 50 Measurement Methods and Instrument Techniques for Sample S3 Phenols

Lab. Code	Sample Volume Analysed (mL)	Was the whole bottle used? If yes, was the bottle rinsed?	Extraction Technique	pH adjustment? If yes, what pH?	Was the sample derivatised?	Derivatisation Agent Used	Extraction Solvent	Extraction Time (min)	Extraction Volume and Number of Steps (if staggered extraction)
2	35		Liquid-Liquid	Yes			DCM	3	2ML X 1
3	200	No	Liquid-Liquid				Dichloromethane	10	
4	40	No	Liquid-Liquid	NA	No	NA	DCM	NA	3x5mL
6	35	No	Liquid-Liquid	YES, pH< 2	NO	NO	DCM	10	2 mL & 1
8	15	No	SPME	2	No			30	
9	50	No	Liquid-Liquid	Yes, acidified but not measured pH. 100% sulfuric acid	No		DCM	60	2
11	35	Yes, bottle rinsed	Liquid-Liquid	No	No	N/A	DCM	30	1 x 35 mL
13	35	No	Liquid-Liquid	Yes	No		DCM	20 mins	2 mL, once
14	100	Yes, bottle rinsed	Liquid-Liquid	No	No		DCM	6 (total)	3 x 6mL
16	200mL	Yes, bottle NOT rinsed	Liquid-Liquid	No	No		DCM / Ethyl Acetate / Methanol	Approx 30mins	~15mL, 10 steps
17	35	No	Liquid-Liquid	Yes, < 2	No	None	DCM	10	2 mL x1
18	100	No	Liquid-Liquid	Yes, <2 pH	Yes	Acetic Anhydride	Dichloromethane	180	20ml
19	100	Yes, bottle NOT rinsed	Liquid-Liquid	yes, pH 2	No		DCM	30	30 mL, 3x
20	200mL	Yes, bottle NOT rinsed	Liquid-Liquid	No	No		DCM / Ethyl Acetate / Methanol	Approx 30mins	~15mL, 10 steps

Table 51 Measurement Methods and Instrument Techniques for Sample S3 Phenols (continued)

Lab. Code	Extract Concentration Technique	Extract Concentration Time (min)	Extract Concentration Temperature (°C)	Extract Clean-Up	Type of Internal Standard Used	Please specify the internal standard/s used	When was the internal standard added?	Measurement Technique
2					Phenol		After sample extraction, before instrument analysis	GC-MS/MS
3	Evaporation under nitrogen	20	40	SPE (Reverse Phase)	Phenol		After sample extraction, before instrument analysis	GC-MS
4	Evaporation under nitrogen	NA	40		Phenol	1,4-Dichlorobenzene-d4, Naphthalene-d8, Acenaphthene-d10	Before sample extraction	GC-MS
6	NO	NO	NO	NO		1,4-Dichlorobenzene-d4	After sample extraction, before instrument analysis	GC-MS/MS
8					Phenol	tribromophenol	Before sample extraction	GC-MS/MS
9	Water bath		68	No	PAHs	Naphthalene-d8, Acenaphthalene-d10, Phenanthrene-d10, Chrysene-d12, Perylene-d12	Before sample extraction	GC-MS/MS
11	Evaporation under nitrogen	30	45	None	Phenol	1,4 - Dichlorobenzene	After sample extraction, before instrument analysis	GC-MS/MS
13	None				PAHs and VOCs		After sample extraction, before instrument analysis	GC-MS/MS
14	Evaporation under nitrogen		40	No	Phenol	Various	After sample extraction, before instrument analysis	GC-MS
16	Evaporation under nitrogen	~ 25mins	35C			Method 525.2 Internal Std Mix	After sample extraction, before instrument analysis	GC-MS
17	None	NA	NA	None	PAHs	1,4-Dichlorobenzene-D4, Naphthalene-D8, Acenaphthene-D10, Chrysene-D12, Perylene-D12, Bromonitrobenzene	After sample extraction, before instrument analysis	GC-MS/MS

Lab. Code	Extract Concentration Technique	Extract Concentration Time (min)	Extract Concentration Temperature (°C)	Extract Clean-Up	Type of Internal Standard Used	Please specify the internal standard/s used	When was the internal standard added?	Measurement Technique
18	Evaporation under nitrogen	Not set	40	N/A	Phenol	2,4,6-Tribromobiphenyl	After sample extraction, before instrument analysis	GC-MS
19	Evaporation under nitrogen	30	35		PAHs	d8-naphthalene, d10-acenaphthene, d10-phenanthrene, d12-chrysene, d12-perylene	After sample extraction, before instrument analysis	GC-MS
20	Evaporation under nitrogen	~ 25mins	35C			Method 525.2 Internal Std Mix	After sample extraction, before instrument analysis	GC-MS

Table 52 Measurement Methods and Instrument Techniques for Sample S3 Phenols – Additional Information

Lab. Code	Methodology Additional Information
3	As Laboratory LOR is higher than lowest spiking level, all analytes not detected above laboratory LOR has been marked as NT to avoid receiving false negative results for <LOR detection.
18	The sample extract is solvent exchanged into Methanol and acetylated.
19	Registered for S3 phenols late.

APPENDIX 5 ACRONYMS AND ABBREVIATIONS

ADWG	Australian Drinking Water Guidelines
ADWG (A)	ADWG Aesthetic Guideline Value
ADWG (H)	ADWG Health-Based Guideline Value
AV	Assigned Value
CITAC	Cooperation on International Traceability in Analytical Chemistry
CRM	Certified Reference Material
CS2	Carbon disulfide
CV	Coefficient of Variation
DCM	Dichloromethane
EtOAc	Ethyl Acetate
GC	Gas Chromatography
GUM	Guide to the Expression of Uncertainty in Measurement
HEX	Hexane
HS	Headspace
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
k	Coverage Factor
LLE	Liquid-Liquid Extraction
LOR	Limit of Reporting
Max	Maximum
Md	Median
MeOH	Methanol
Min	Minimum
MS	Mass Spectrometry
MS/MS	Tandem Mass Spectrometry
MU	Measurement Uncertainty
N	Number of numeric results
NATA	National Association of Testing Authorities, Australia
NMIA	National Measurement Institute Australia
NR	Not Reported
NS	Not Supplied
NT	Not Tested
P&T	Purge-and-Trap
PAH	Polycyclic Aromatic Hydrocarbon

PCV	Performance Coefficient of Variation
PT	Proficiency Testing
RA	Robust Average
RM	Reference Material
s.f.	Significant Figures
SD	Standard Deviation
SDPA	Standard Deviation for Proficiency Assessment
SI	International System of Units
SPE	Solid-Phase Extraction
SPE (RP)	Solid-Phase Extraction (Reverse Phase)
SPME	Solid-Phase Microextraction
SS	Spiked Samples
SV	Spiked Value (or formulated concentration of a PT sample)
U	Expanded Uncertainty
VOC	Volatile Organic Compound

END OF REPORT