



Plasticity – 2022 (112)

Proficiency Testing Program Report



WORLD RECOGNISED
ACCREDITATION

Accredited for compliance with ISO/IEC 17043

Copyright: LabSmart Services.

Report

This report is available on the LabSmart Services website. The issue of this proficiency report was authorised by Jeffrey Mulholland, General Manager, LabSmart Services, in June 2023.

Contact Details

Email: jeffm@labsmartservices.com.au
Mobile: 0439 208 406

Program Coordinator

The program coordinator for this program was Shantelle Popple, with assistance from Jeffrey Mulholland, LabSmart Services.

Contact Details

Email: shantellep@labsmartservices.com.au
Mobile: 0439 208 406

Please note that any technical questions regarding this program are to be directed to the program coordinator.

Z-scores Summary

A z-scores summary for this program was issued in December 2022. This technical report supersedes the z-scores summary.

Accredited Proficiency Testing Provider

LabSmart Services is accredited by NATA to **ISO/IEC 17043**, Conformity assessment – General requirements for proficiency testing. Accreditation number 20650. The accreditation provides additional assurance to participants of the quality and importance we place on our proficiency testing programs.

Confidentiality

All information, including test results, are treated confidentially. The proficiency testing report does not identify either companies or individuals. Each participant is issued a unique identifying code during enrolment that is used in the report to ensure confidentiality of performance.

LabSmart Services

Please see our website for further details. www.labsmartservices.com.au

Copyright

This work is copyrighted. No part of this publication may be reproduced in any form, transmitted or stored in any repository (e.g. mechanical, digital, electronic or photographic) without prior written permission of LabSmart Services. Please contact LabSmart Services should you wish to reproduce any part of this report.

Amendment History

Reports may be downloaded from the LabSmart Services website.
Version 1 – Issued 20 June 2023

Contents

1. Program Aim	4
2. Performance.....	5
2.1. Identified Outliers	5
2.2. Program Summary	6
3. Technical Comment	8
3.1 Test Methods.....	8
3.2 Liquid Limit & Plastic Limit.....	8
3.3 Plasticity Index	12
3.4 Linear Shrinkage	12
3.5 Reproducibility & Repeatability.....	13
4. Statistics: Z-Score & Graph.....	16
5. Program Information.....	32
5.1 Z-Score Summary	32
5.2 Program Design	32
5.3 Sample Preparation.....	35
5.4 Packaging and Instructions	35
5.5 Quarantine	35
5.6 Sample Dispatch	35
5.7 Homogeneity Testing	37
5.8 Participation.....	37
5.9 Statistics.....	37
5.10 Non-statistical Matters.....	40
6. Summary of Participants Results	41
Appendix A: Instructions for testers.....	43
Appendix B: Results Log.....	45

1. Program Aim

The proficiency program was conducted in November/December 2022 with 36 participants from around Australia. The program involved the performance of the following four tests.

- AS 1289 3.1.1 Determination of the liquid limit of a soil – Four-point Casagrande method
- AS 1289 3.2.1 Determination of the plastic limit of a soil – Standard method
- AS 1289 3.3.1 Calculation of the plasticity index of a soil
- AS 1289 3.4.1 Determination of the linear shrinkage of a soil – Standard method

Testing to the relevant sections of AS 1289 was preferred, but other equivalent methods were accepted.

The program provides confidence in the construction materials testing industry regarding the competency of participants (and the industry) to perform these tests. Each participant's performance is statistically assessed and used as a measure of competency relative to all those who participated. Other measures of performance are also used.

This report has been prepared using robust statistics. Information regarding the conduct and design of the program can be found in section 5.9.

A comprehensive technical comment (section 3) is provided to assist participants in improving the overall performance of these tests. In addition, test data has been reviewed for consistency, and additional feedback regarding aspects of the test is provided.

A Z-score summary was issued to participants on the 22nd of December 2022 to facilitate early feedback on performance.

2. Performance

2.1. Identified Outliers

There were 10 outliers identified across the tests performed. These outliers were spread across 9 participants; this represented 26% of the 34 participants who returned results in the proficiency testing program (Table 1).

Participant's test results are tabulated in section 4, along with the robust statistics and a z-score graph. The z-score indicates how far away a participant is from the program's median value. A z-score of zero indicates a strong consensus with respect to all other participants and represents a very good outcome. The z-score graph gives a quick visual indication of how a result compares to others in the program.

Outliers are where a z-score value is greater than 3 or less than -3. It is recommended that participants with outliers investigate their performance of the test. Participants with outliers are detailed in Table 1.

Those participants with z-scores greater than 2 or less than -2 may wish to review their testing methodology. Only participants identified as having inconsistencies with their information supplied or having a z-score approaching 3 (i.e. outside ± 2.75) have been specifically identified under review in Table 1 as feedback.

More detail on the robust statistics used can be found in section 5.9

Technical comments and feedback in section 3 are provided to assist participants to investigate or review their results as well as those seeking to improve their testing performance.

Table 1: Participants identified where Investigation, Review or Follow up is warranted

Test	Sample	Units	Investigate [#]	Review
Liquid Limit	A	%	W2	Q2
	B		K6, F2	F7
Plastic Limit	A	%	U4	-
	B		-	-
Plasticity Index	A	%	Q2	W2
	B		-	-
Linear Shrinkage	A	%	S3, A7, N6	-
	B		K6, F7	-

[#] Identified statistical outliers

2.2. Program Summary

Overall, a satisfactory level of testing was achieved by the majority of the 34 participants. There were 9 participants identified as having a statistical outlier (26%).

Table 2 summarises the statistics from the proficiency program. The normalised IQR is an estimation of the standard deviation. The ranges shown for each test result exclude outliers.

The variation in results observed was similar to previous proficiency testing programs. Laboratories and their clients need to be aware that as the magnitude of Liquid Limit (LL), Plastic Limit (PL) and Plasticity Index (PI) increases, the consistency between laboratories decreases.

Overall, the level of competency displayed by participants is within program expectations.

Table 2: Summary of program statistics. Results have been rounded.

Sample	Test	Number of Results	Units	Median	Normalised IQR	% CV	Range*
A	Liquid Limit	34	%	63	5.1	8.1	26.9
	Plastic Limit	34	%	24	2.0	8.5	6.0
	Plasticity Index	34	%	39	5.0	12.8	22.0
	Linear Shrinkage	34	%	11	2.1	19.8	8.8
B	Liquid Limit	33	%	51	2.2	4.4	12.2
	Plastic Limit	33	%	20	2.2	11.1	11.0
	Plasticity Index	33	%	31	3.7	12.0	17.0
	Linear Shrinkage	32	%	12	1.4	11.9	6.1

* Range excludes outlier

3. Technical Comment

The performance of participants was good, with a similar number of outliers to previous programs.

It is difficult to compare the spread or variation in results obtained between samples A and B because these, to some extent, reflect the material properties and the characteristics of the program (see section 5.9.2). The variation in testing and other program statistics appeared to be about the same as in previous plasticity programs.

3.1 Test Methods

Based on the information supplied by participants (on their 'Result Log' sheet), All participants tested to the nominated test methods.

3.2 Liquid Limit & Plastic Limit

These two tests have a qualitative element; hence, tester competency and material type significantly affect the results obtained. Also, some soil materials require more skill/experience to obtain reliable results than other materials.

Because of the qualitative nature of the tests, different proficiency testing programs with varying materials of soil and operator skills yield quite different outcomes in terms of the number of outliers and reproducibility of the test results. See "Reproducibility & Repeatability" below for more detail.

The variation (s.d) in results observed in this program was similar to those from previous LabSmart Services proficiency testing programs. Table 3 shows the results for the same material from five different programs. It is a strong indicator that the standard of testing within the industry is consistent. It should be noted that a larger spread (variation) of results will normally result in fewer outliers being detected.

It is interesting to note that for both liquid and plastic limit, there are two main components associated with the variation in results:

- (1) Determination of moisture content, and
- (2) Determination of the endpoint of the test (qualitative).

The variation associated with (1) is small, i.e. < 0.2% (based on moisture content proficiency programs), while for (2), it is skill-related and makes up one of the biggest sources of variation.

There were 4 participants (**W2, U4, K6 & F2**) identified as having at least one outlier across either Liquid Limit and/or Plastic Limit (See Table 1).

There are too many aspects of these two tests to list here that, if incorrectly performed, can affect the outcome. As proficiency samples should be retained until the program report is issued, it is recommended that those with outliers use the retained material to repeat the test. It may help to have another technician/supervisor observe the test while you do so.

Calculation of Plastic Limit

LabSmart services ask for additional information so we can recalculate all participant's results. When LabSmart recalculated each participant's 'Plastic Limit' using the supplied moisture contents, only one participant was flagged as having discrepancies. Participant **N2** was identified as rounding down instead of up in LabSmart services.

There were no participants identified as having a difference greater than 2% between the two submitted moisture contents for the plastic limit on either Sample A or Sample B. As per AS 1289.3.2.1 'if the results from the two determinations differ by more than 2% moisture content, repeat the test'.

Curing

Approximately 47% of the participants reported using distilled water, 2% reported using potable water, and all others reported using tap water. The test method accepts the usage of most water types, provided that they are potable (i.e., safe to drink). Not all “tap” water fits this requirement. The method also indicates that some ‘marginal’ potable water may influence test results.

While participants used a large range of curing times, all participants reported using curing times greater than 48 hours. Beyond this, there is no consistency in the period of curing used by participants; see sections 6.1 & 6.2 for a breakdown of participants’ curing times.

Table 3: Comparison of program statistics between the current program and other programs where the same material was used. (Sample A in this program)

Liquid Limit						
Program	Number of Results	Units	Median	Normalised IQR	CV (%)	Range
2022(112)	34	%	63.00	5.10	8.1	26.8
2021(105)	35	%	68.0	5.19	7.6	9.0
2020(92)	34	%	67.6	3.89	5.8	15.0
2019(87)	27	%	69.0	4.82	7.0	19.0
2018(79)	36	%	67.5	4.83	6.9	26.0
Plastic Limit						
Program	Number of Results	Units	Median	Normalised IQR	CV (%)	Range
2022(112)	34	%	24.00	2.04	8.5	6.00
2021(105)	35	%	26.0	2.22	8.6	8.5
2020(92)	34	%	24.5	2.84	11.6	14.0
2019(87)	26	%	25.0	2.97	11.9	9.0
2018(79)	37	%	25.0	3.71	12.0	12.0
Plasticity Index						
Program	Number of Results	Units	Median	Normalised IQR	CV (%)	Range
2022(112)	34	%	39.00	5.00	12.8	22.0
2021(105)	35	%	42.0	6.30	15.0	27.0
2020(92)	34	%	42.0	6.49	15.4	28.0
2019(87)	27	%	43.0	7.04	16.4	22.0
2018(79)	36	%	40.0	5.19	13.0	20.0
Linear Shrinkage						
Program	Number of Results	Units	Median	Normalised IQR	CV (%)	Range
2022(112)	34	%	10.5	2.08	19.8	8.80
2021(105)	35	%	11.0	2.78	25.3	12.0
2020(92)	34	%	11.0	2.76	25.1	11.0
2019(87)	26	%	10.8	2.50	23.3	7.9
2018(79)	37	%	10.5	2.59	24.7	9.5

*Range excludes outliers.

3.3 Plasticity Index

There was 1 participant (**Q2**) identified as having an outlier for Plasticity Index (See Table 1). The 'Plasticity Index' is derived from both the 'Liquid Limit' and 'Plastic Limit' values. An outlier in either of these values does not automatically give rise to an outlier in the 'Plasticity Index' value. Similarly, a 'Plasticity Index' result may be an outlier without there being an outlier in either the 'Liquid Limit' or 'Plastic Limit' values.

Calculations

A check was conducted to ensure the data received was valid; this was done by comparing the submitted Plasticity Index result against the additional data submitted. Most of the variation observed was small and within rounding requirements.

3.4 Linear Shrinkage

Five outliers were identified for 'Linear Shrinkage' across both samples used in this proficiency program (**S3, A7, N6, K6 & F7**).

The variation in testing observed in Sample A's 'Linear Shrinkage' (Table 3) fell in line with previous proficiency programs that used the same material.

Two participants used moulds shorter than the preferred length of 250mm stated in the standard but still above the 100mm minimum permitted length. The shorter moulds did not appear to affect the results in this instance. See sections 6.1 and 6.2.

As seen in the results tabulated in section 6, participants provided a range of descriptions relating to the type of shrinkage observed. As noted in previous proficiency testing programs, the description of shrinkage is not a reliable basis for comparison, as it is a highly qualitative measure. More guidance is needed by the test method to ensure higher consistency across the industry.

3.5 Reproducibility & Repeatability

Two different samples were provided for this program.

This program does not generate any repeatability estimates. It is expected that in-house repeat testing (using the same sample, equipment and person) should lead to a decrease in the spread of results than the reproducibility estimates given by these proficiency testing programs. The homogeneity test results give an indication of repeatability to be expected (section 5.7).

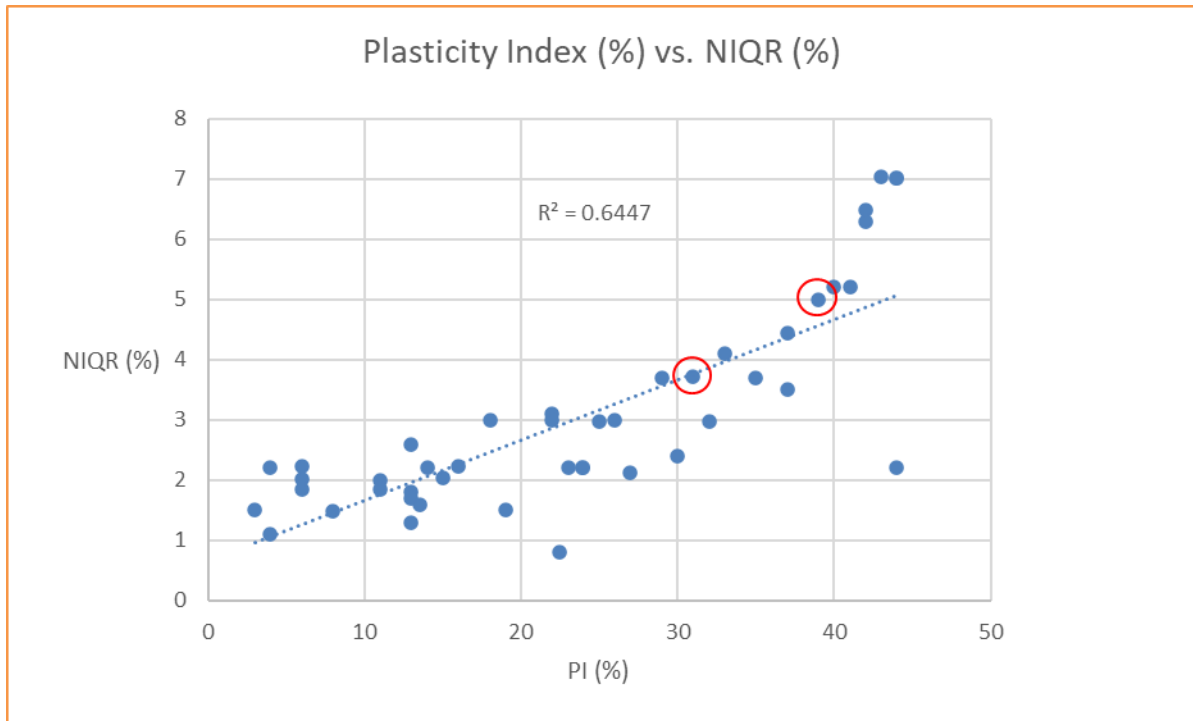
While the proficiency program provides an estimate of reproducibility, it should be noted that it is indicative only. The reproducibility generated is affected by the material selected and the skill level of those in the program.

The 'Plasticity Index' is a reasonable overall measure and reflects the average skill level.

The Normalised IQR (NIQR) shown for the 'Plasticity Index' (Table 2) are generally within what has been historically observed in prior proficiency programs (by LSS and others). A trend exists between the PI value and the associated variation (NIQR). Increasing the magnitude of PI (and/or PL / LL) increases the NIQR (and range). Graph 1 shows the PI(%) vs NIQR across a range of programs dating back to 2006; the results from this program are circled in red.

As shown in Graph 1, as the value of the 'Plasticity Index' increases, the reproducibility between laboratories tends to increase (A linear trend line is also shown).

Graph 1: Plasticity Index (%) versus NIQR (%)



This page has been left blank intentionally

4. Statistics: Z-Score & Graph

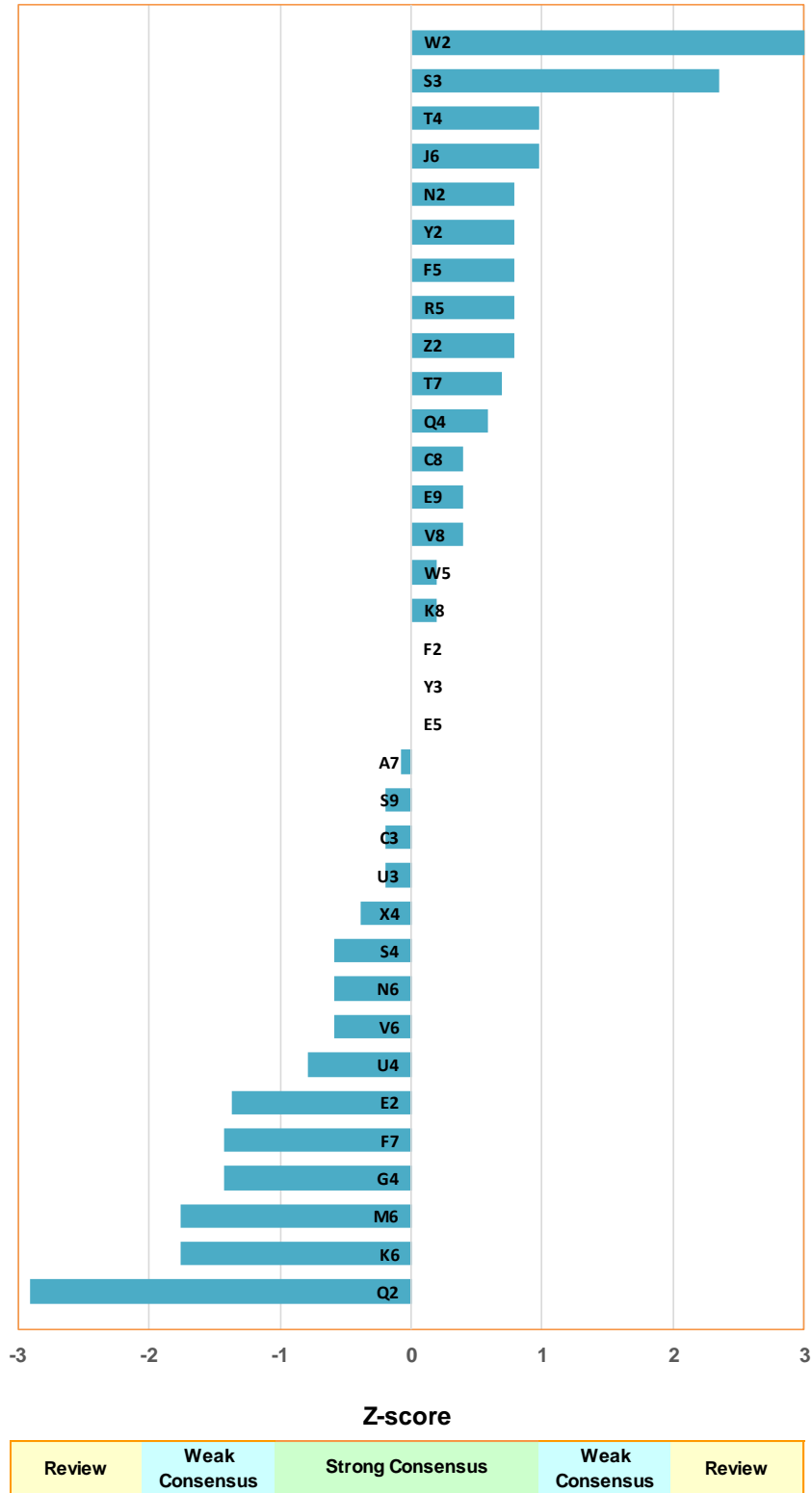
Sample A - Liquid Limit: Z - Scores

Code	Test Result %	Z Score	Code	Test Result %	Z Score
S3	75	2.35	E5	63	0.00
N2	67	0.78	X4	61	-0.39
C8	65	0.39	J6	68	0.98
M6	54	-1.77	V6	60	-0.59
Q2	48.13	-2.92	R5	67	0.78
E2	56	-1.37	Z2	67	0.78
S4	60	-0.59	N9		
E9	65	0.39	U4	59	-0.78
S9	62	-0.20			
W5	64	0.20			
C3	62	-0.20			
A7	62.6	-0.08			
V8	65	0.39			
Y2	67	0.78			
K6	54	-1.77			
T4	68	0.98			
Q4	66	0.59			
F7	55.72	-1.43			
G4	55.71	-1.43			
N6	60	-0.59			
W2	79	3.14 #			
F2	63.0	0.00			
F5	67	0.78			
Y3	63	0.00			
T7	66.51	0.69			
Z5					
U3	62	-0.20			
K8	64	0.20			

Statistic	Value
Number of results	34
Median	63.00
Median MU	1.09
First Quartile	60.00
Third Quartile	66.88
IQR	6.88
Normalised IQR	5.10
CV (%)	8.1
Minimum	48.13 (48.13)
Maximum	75.00 (79.00)
Range	26.87 (30.87)

Note: A # indicates an outlier where the z-score obtained is either greater than 3 or less than -3. Codes for all participants are shown. The results column shows a blank entry or 'NR' for those participants that did not submit a result for this test. Results in **green** have been calculated by the program coordinator. An R indicates an abnormal result rejected by the program coordinator. Minimum, Maximum and Range are calculated with outliers excluded, those in brackets include outliers.

Sample A - Liquid Limit: Z - Score Graph



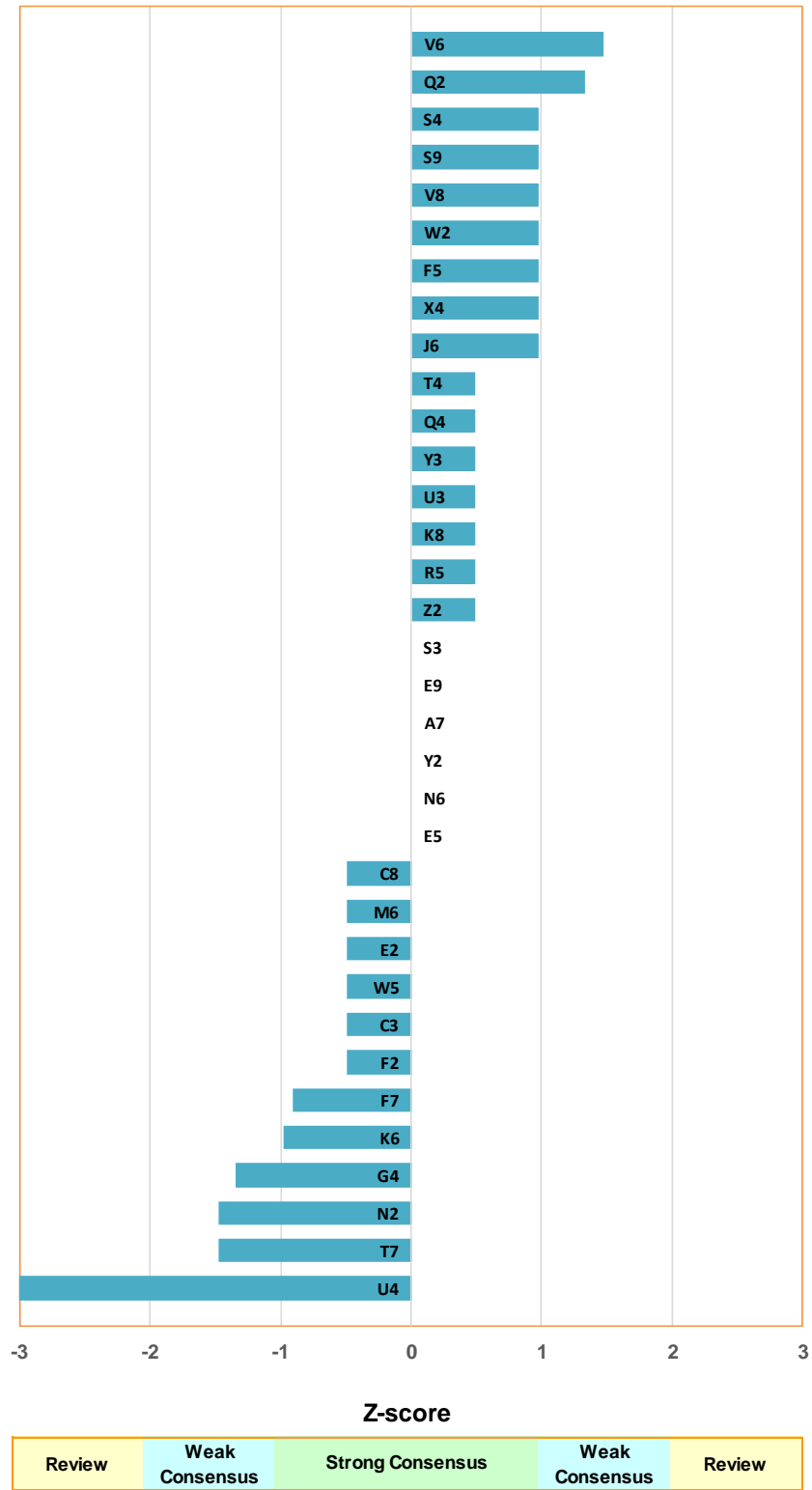
Sample A - Plastic Limit: Z - Scores

Code	Test Result %	Z Score	Code	Test Result %	Z Score
S3	24	0.00	E5	24	0.00
N2	21	-1.47	X4	26	0.98
C8	23	-0.49	J6	26	0.98
M6	23	-0.49	V6	27	1.47
Q2	26.71	1.33	R5	25	0.49
E2	23	-0.49	Z2	25	0.49
S4	26	0.98	N9		
E9	24	0.00	U4	16	-3.92 #
S9	26	0.98			
W5	23	-0.49			
C3	23	-0.49			
A7	24	0.00			
V8	26	0.98			
Y2	24	0.00			
K6	22	-0.98			
T4	25	0.49			
Q4	25	0.49			
F7	22.15	-0.91			
G4	21.26	-1.34			
N6	24	0.00			
W2	26	0.98			
F2	23.0	-0.49			
F5	26.0	0.98			
Y3	25	0.49			
T7	21	-1.47			
Z5					
U3	25	0.49			
K8	25	0.49			

Statistic	Value
Number of results	34
Median	24.00
Median MU	0.44
First Quartile	23.00
Third Quartile	25.75
IQR	2.75
Normalised IQR	2.04
CV (%)	8.5
Minimum	21.00 (16.00)
Maximum	27.00 (27.00)
Range	6.00 (11.00)

Note: A # indicates an outlier where the z-score obtained is either greater than 3 or less than -3. Codes for all participants are shown. The results column shows a blank entry or 'NR' for those participants that did not submit a result for this test. Results in **green** have been calculated by the program coordinator. An R indicates an abnormal result rejected by the program coordinator. Minimum, Maximum and Range are calculated with outliers excluded, those in brackets include outliers.

Sample A - Plastic Limit: Z - Score Graph



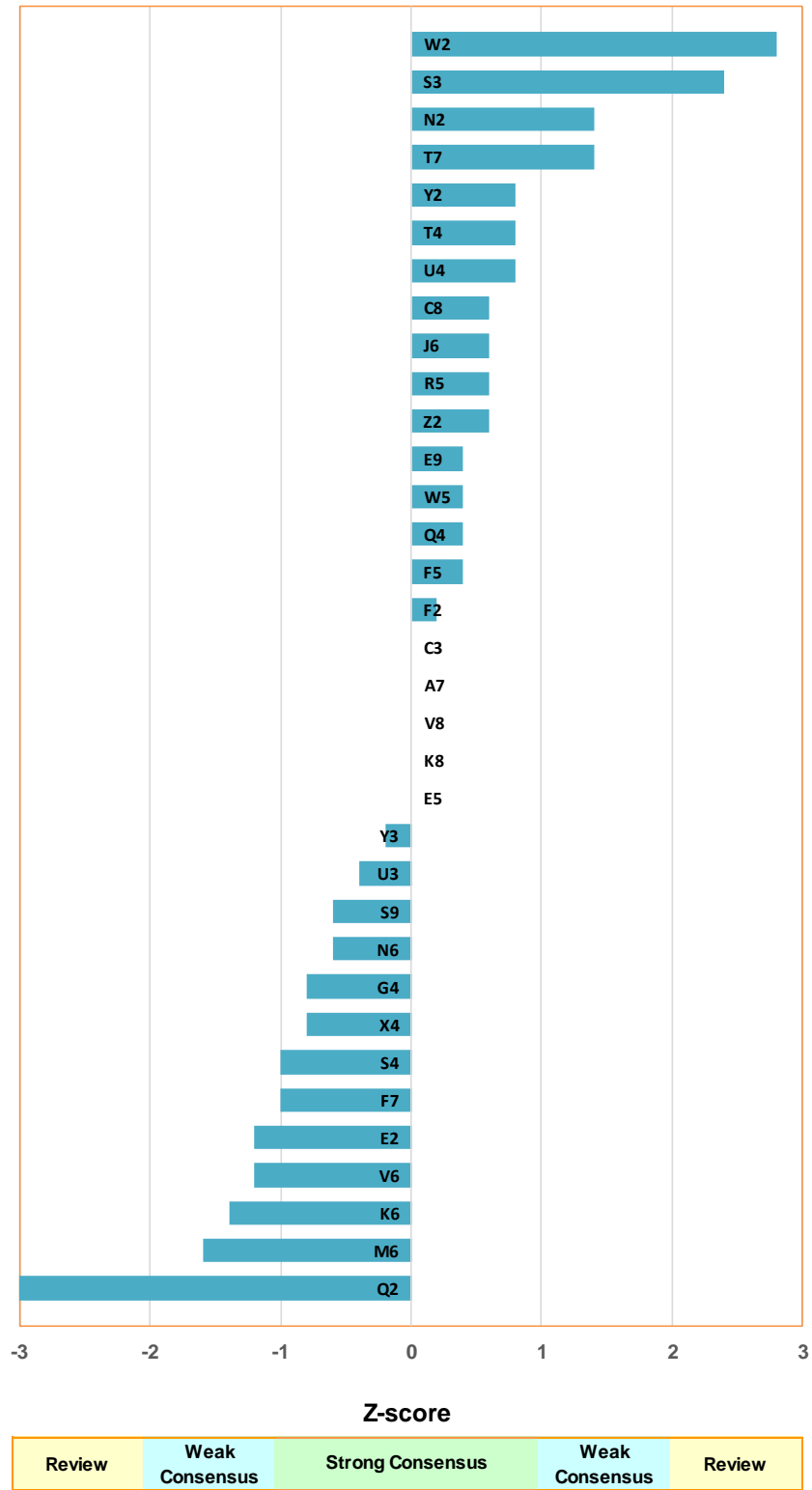
Sample A - Plasticity Index: Z - Scores

Code	Test Result %	Z Score	Code	Test Result %	Z Score
S3	51	2.40	E5	39	0.00
N2	46	1.40	X4	35	-0.80
C8	42	0.60	J6	42	0.60
M6	31	-1.60	V6	33	-1.20
Q2	21.00	-3.60 #	R5	42	0.60
E2	33	-1.20	Z2	42	0.60
S4	34	-1.00	N9		
E9	41	0.40	U4	43	0.80
S9	36	-0.60			
W5	41	0.40			
C3	39	0.00			
A7	39	0.00			
V8	39	0.00			
Y2	43	0.80			
K6	32	-1.40			
T4	43	0.80			
Q4	41	0.40			
F7	34	-1.00			
G4	35.00	-0.80			
N6	36	-0.60			
W2	53	2.80			
F2	40.0	0.20			
F5	41	0.40			
Y3	38	-0.20			
T7	46	1.40			
Z5					
U3	37	-0.40			
K8	39	0.00			

Statistic	Value
Number of results	34
Median	39.00
Median MU	1.07
First Quartile	35.25
Third Quartile	42.00
IQR	6.75
Normalised IQR	5.00
CV (%)	12.8
Minimum	31.00 (21.00)
Maximum	53.00 (53.00)
Range	22.00 (32.00)

Note: A # indicates an outlier where the z-score obtained is either greater than 3 or less than -3. Codes for all participants are shown. The results column shows a blank entry or 'NR' for those participants that did not submit a result for this test. Results in green have been calculated by the program coordinator. An R indicates an abnormal result rejected by the program coordinator. Minimum, Maximum and Range are calculated with outliers excluded, those in brackets include outliers.

Sample A - Plasticity Index: Z - Score Graph



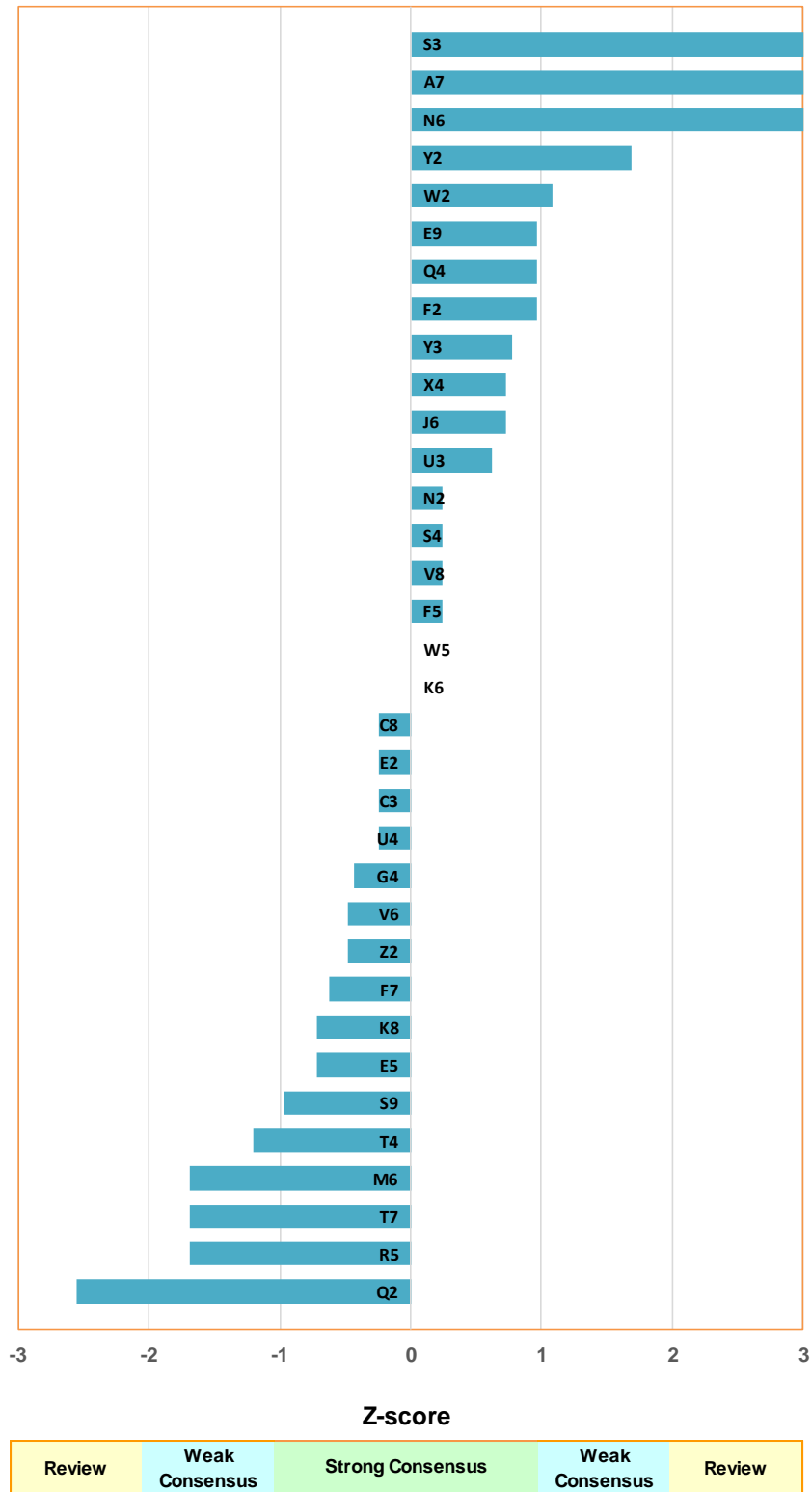
Sample A - Linear Shrinkage: Z - Scores

Code	Test Result %	Z Score	Code	Test Result %	Z Score
S3	18.5	3.85 #	E5	9.0	-0.72
N2	11.0	0.24	X4	12.0	0.72
C8	10	-0.24	J6	12.0	0.72
M6	7.0	-1.69	V6	9.5	-0.48
Q2	5.2	-2.55	R5	7	-1.69
E2	10.0	-0.24	Z2	9.5	-0.48
S4	11.0	0.24	N9		
E9	12.5	0.96	U4	10	-0.24
S9	8.5	-0.96			
W5	10.5	0.00			
C3	10	-0.24			
A7	18.5	3.85 #			
V8	11	0.24			
Y2	14.0	1.69			
K6	10.5	0.00			
T4	8.0	-1.20			
Q4	12.5	0.96			
F7	9.2	-0.63			
G4	9.6	-0.43			
N6	17.0	3.13 #			
W2	12.74	1.08			
F2	12.5	0.96			
F5	11.0	0.24			
Y3	12.1	0.77			
T7	7.0	-1.69			
Z5					
U3	11.8	0.63			
K8	9.0	-0.72			

Statistic	Value
Number of results	34
Median	10.50
Median MU	0.44
First Quartile	9.28
Third Quartile	12.08
IQR	2.80
Normalised IQR	2.08
CV (%)	19.8
Minimum	5.20 (5.20)
Maximum	14.00 (18.50)
Range	8.80 (13.30)

Note: A # indicates an outlier where the z-score obtained is either greater than 3 or less than -3. Codes for all participants are shown. The results column shows a blank entry or 'NR' for those participants that did not submit a result for this test. Results in green have been calculated by the program coordinator. An R indicates an abnormal result rejected by the program coordinator. Minimum, Maximum and Range are calculated with outliers excluded, those in brackets include outliers.

Sample A - Linear Shrinkage: Z - Score Graph



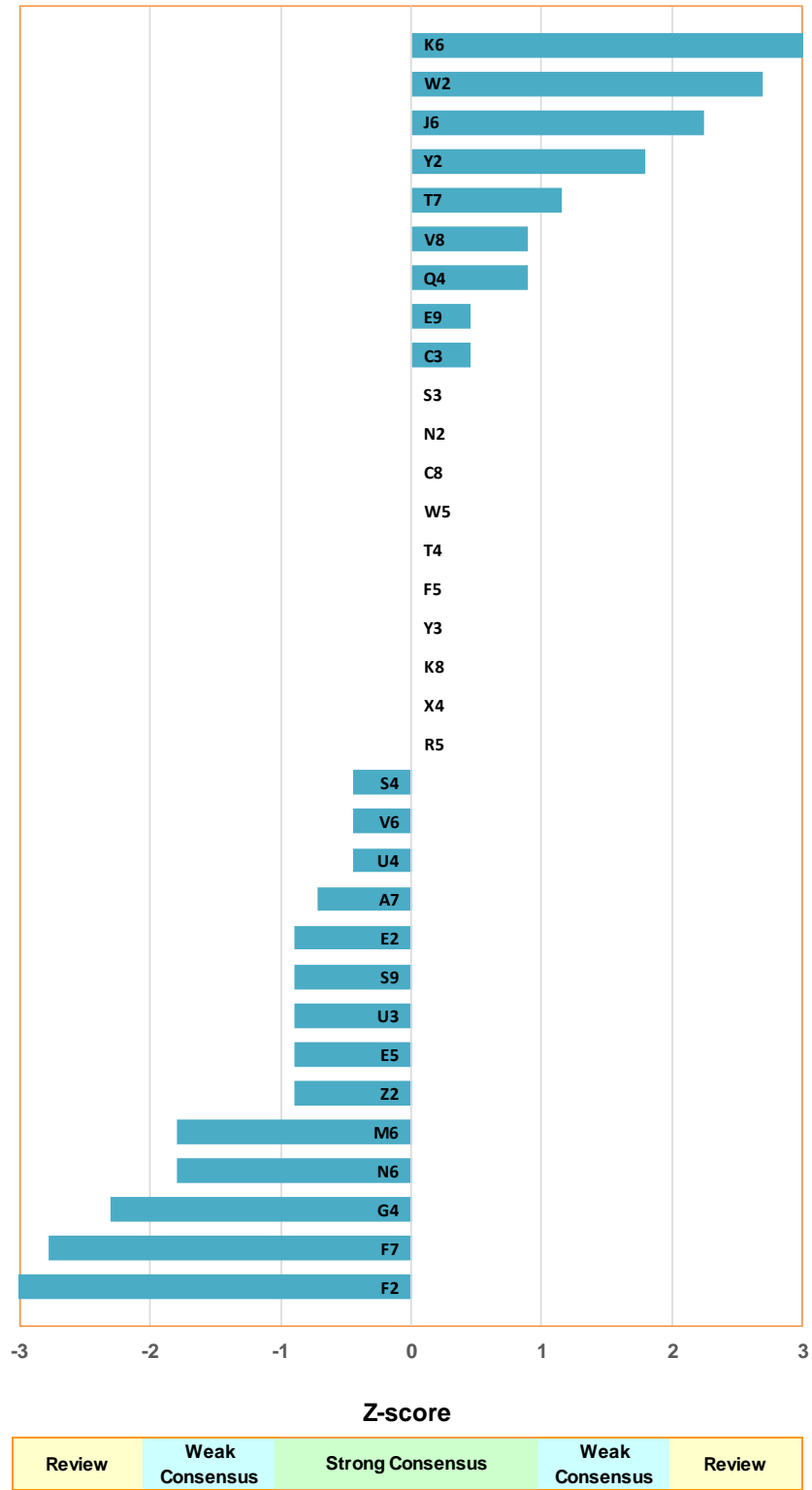
Sample B - Liquid Limit: Z - Scores

Code	Test Result %	Z Score	Code	Test Result %	Z Score
S3	51	0.00	E5	49	-0.90
N2	51	0.00	X4	51	0.00
C8	51	0.00	J6	56	2.25
M6	47	-1.80	V6	50	-0.45
Q2	NR		R5	51	0.00
E2	49	-0.90	Z2	49	-0.90
S4	50	-0.45	N9		
E9	52	0.45	U4	50	-0.45
S9	49	-0.90			
W5	51	0.00			
C3	52	0.45			
A7	49.4	-0.72			
V8	53	0.90			
Y2	55	1.80			
K6	65	6.30 #			
T4	51	0.00			
Q4	53	0.90			
F7	44.82	-2.78			
G4	45.86	-2.31			
N6	47	-1.80			
W2	57	2.70			
F2	43.76	-3.26 #			
F5	51	0.00			
Y3	51	0.00			
T7	53.56	1.15			
Z5					
U3	49	-0.90			
K8	51	0.00			

Statistic	Value
Number of results	33
Median	51.00
Median MU	0.48
First Quartile	49.00
Third Quartile	52.00
IQR	3.00
Normalised IQR	2.22
CV (%)	4.4
Minimum	44.82 (43.76)
Maximum	57.00 (65.00)
Range	12.18 (21.24)

Note: A # indicates an outlier where the z-score obtained is either greater than 3 or less than -3. Codes for all participants are shown. The results column shows a blank entry or 'NR' for those participants that did not submit a result for this test. Results in green have been calculated by the program coordinator. An R indicates an abnormal result rejected by the program coordinator. Minimum, Maximum and Range are calculated with outliers excluded, those in brackets include outliers.

Sample B - Liquid Limit: Z - Score Graph



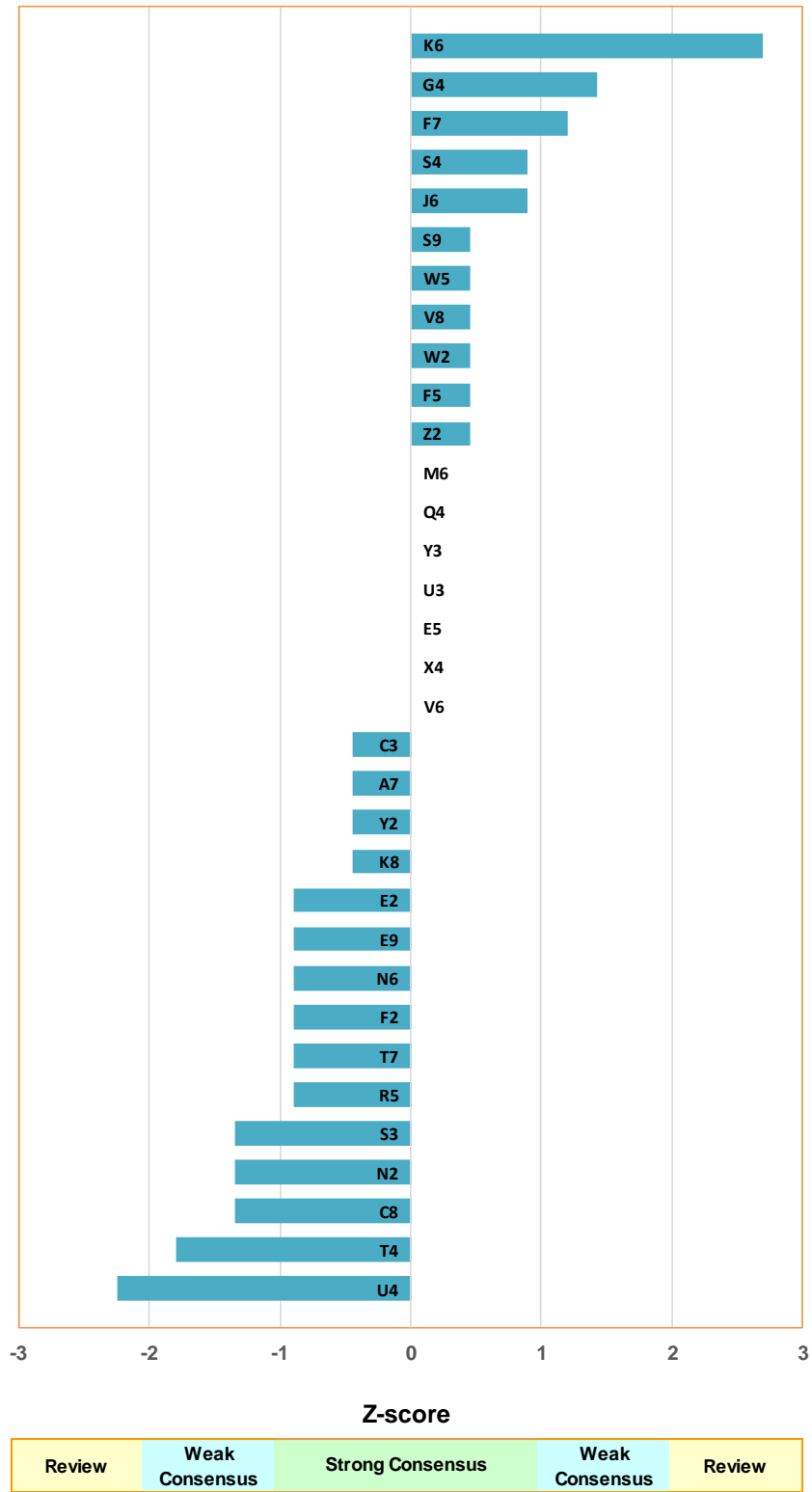
Sample B - Plastic Limit: Z - Scores

Code	Test Result %	Z Score	Code	Test Result %	Z Score
S3	17	-1.35	E5	20	0.00
N2	17	-1.35	X4	20	0.00
C8	17	-1.35	J6	22	0.90
M6	20	0.00	V6	20	0.00
Q2	NR		R5	18	-0.90
E2	18	-0.90	Z2	21	0.45
S4	22	0.90	N9		
E9	18	-0.90	U4	15	-2.25
S9	21	0.45			
W5	21	0.45			
C3	19	-0.45			
A7	19	-0.45			
V8	21	0.45			
Y2	19	-0.45			
K6	26	2.70			
T4	16	-1.80			
Q4	20	0.00			
F7	22.67	1.20			
G4	23.17	1.43			
N6	18	-0.90			
W2	21	0.45			
F2	18.0	-0.90			
F5	21.0	0.45			
Y3	20	0.00			
T7	18	-0.90			
Z5					
U3	20	0.00			
K8	19	-0.45			

Statistic	Value
Number of results	33
Median	20.00
Median MU	0.48
First Quartile	18.00
Third Quartile	21.00
IQR	3.00
Normalised IQR	2.22
CV (%)	11.1
Minimum	15.00 ()
Maximum	26.00 ()
Range	11.00 ()

Note: A # indicates an outlier where the z-score obtained is either greater than 3 or less than -3. Codes for all participants are shown. The results column shows a blank entry or 'NR' for those participants that did not submit a result for this test. Results in green have been calculated by the program coordinator. An R indicates an abnormal result rejected by the program coordinator. Minimum, Maximum and Range are calculated with outliers excluded, those in brackets include outliers.

Sample B - Plastic Limit: Z - Score Graph



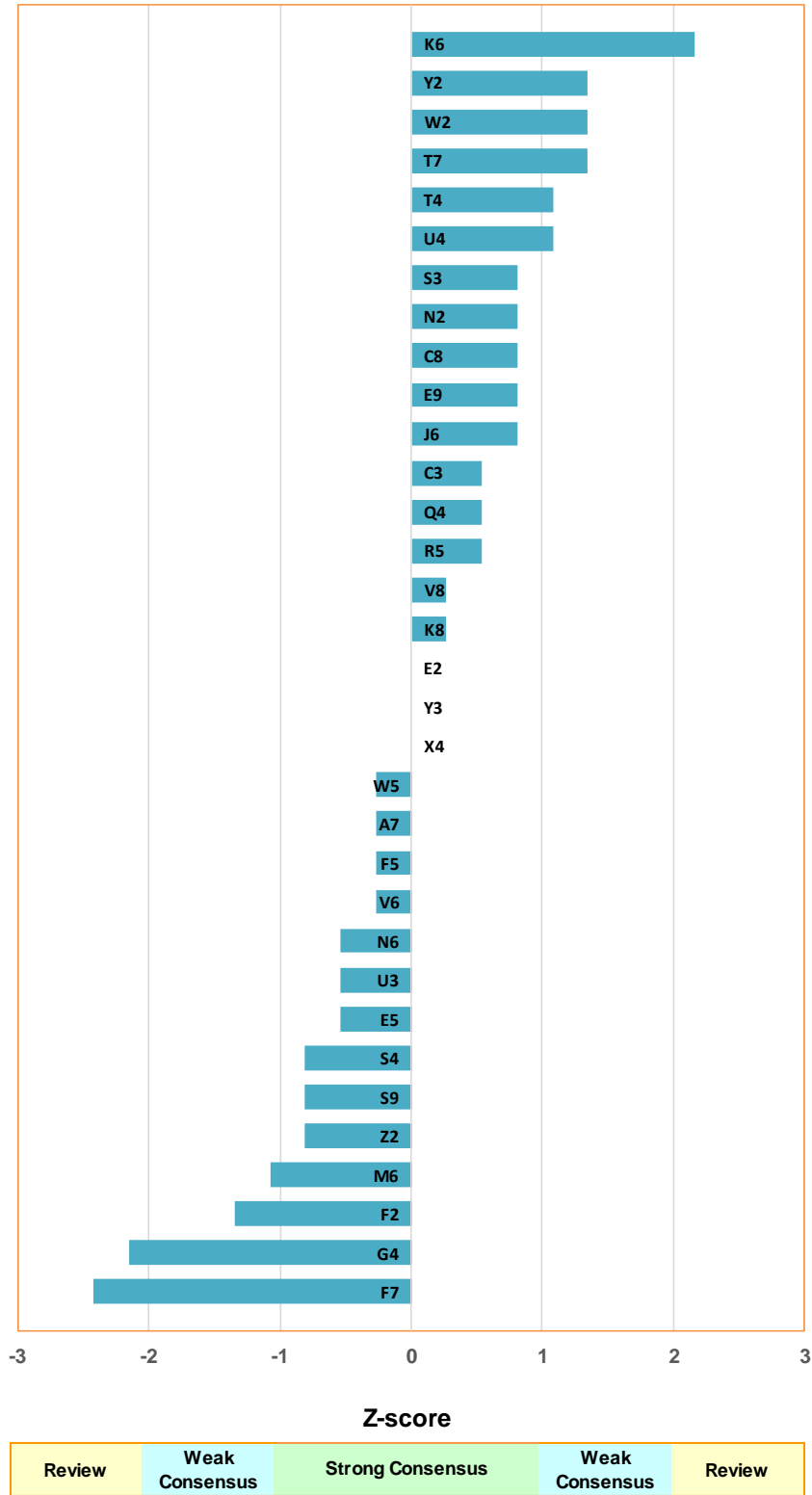
Sample B - Plasticity Index: Z - Scores

Code	Test Result %	Z Score	Code	Test Result %	Z Score
S3	34	0.81	E5	29	-0.54
N2	34	0.81	X4	31	0.00
C8	34	0.81	J6	34	0.81
M6	27	-1.08	V6	30	-0.27
Q2	NR		R5	33	0.54
E2	31	0.00	Z2	28	-0.81
S4	28	-0.81	N9		
E9	34	0.81	U4	35	1.08
S9	28	-0.81			
W5	30	-0.27			
C3	33	0.54			
A7	30	-0.27			
V8	32	0.27			
Y2	36	1.35			
K6	39	2.16			
T4	35	1.08			
Q4	33	0.54			
F7	22	-2.43			
G4	23.00	-2.16			
N6	29	-0.54			
W2	36	1.35			
F2	26.0	-1.35			
F5	30	-0.27			
Y3	31	0.00			
T7	36	1.35			
Z5					
U3	29	-0.54			
K8	32	0.27			

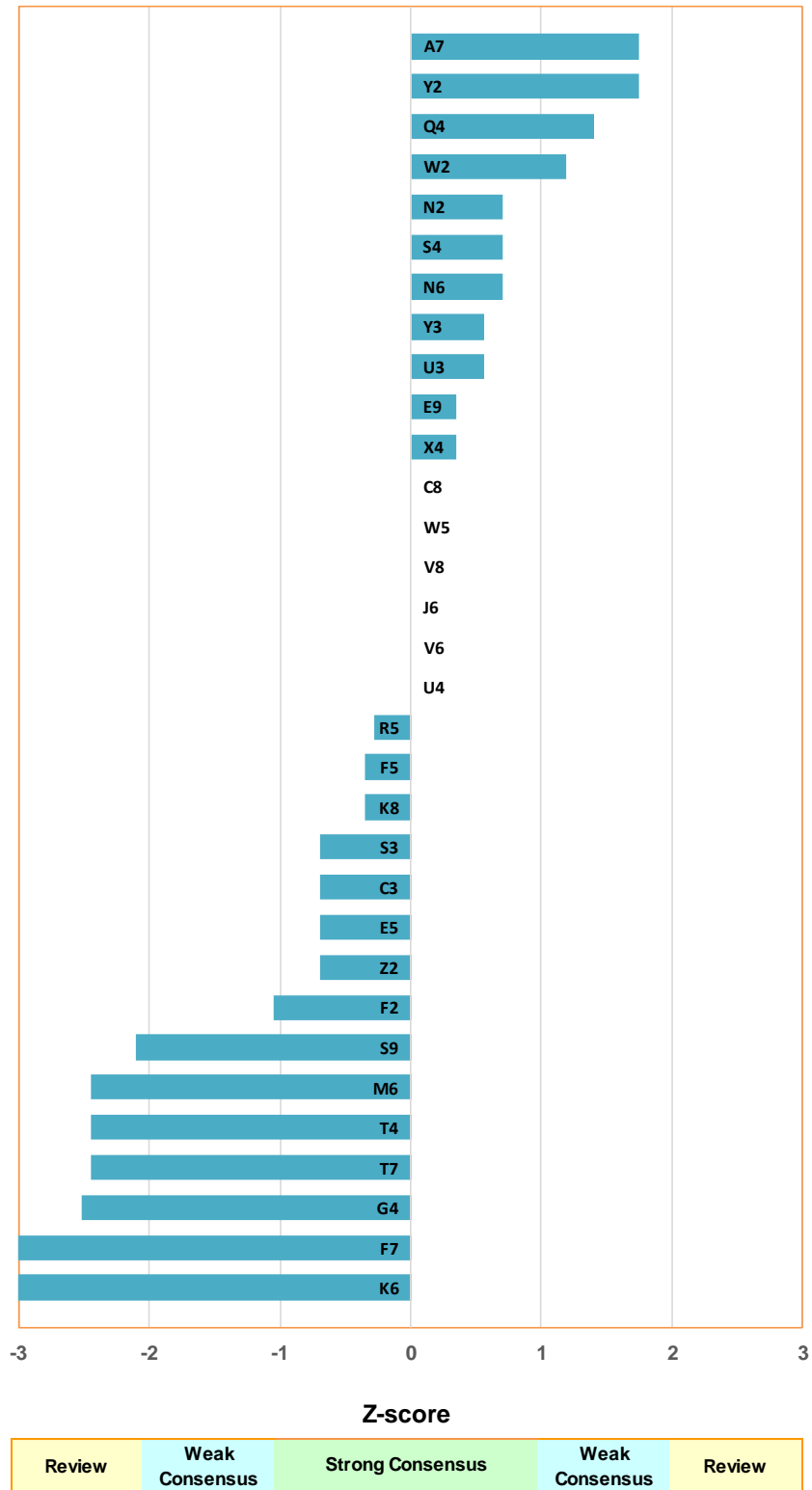
Statistic	Value
Number of results	33
Median	31.00
Median MU	0.81
First Quartile	29.00
Third Quartile	34.00
IQR	5.00
Normalised IQR	3.71
CV (%)	12.0
Minimum	22.00 ()
Maximum	39.00 ()
Range	17.00 ()

Note: A # indicates an outlier where the z-score obtained is either greater than 3 or less than -3. Codes for all participants are shown. The results column shows a blank entry or 'NR' for those participants that did not submit a result for this test. Results in green have been calculated by the program coordinator. An R indicates an abnormal result rejected by the program coordinator. Minimum, Maximum and Range are calculated with outliers excluded, those in brackets include outliers.

Sample B - Plasticity Index: Z - Score Graph



Sample B - Linear Shrinkage: Z - Score Graph



5. Program Information

5.1 Z-Score Summary

The proficiency program was conducted in November/December 2022. A 'Z-score Summary' was issued on 22nd December 2022. The summary was e-mailed to participants and is intended as an early indicator of participant performance. The proficiency testing program report supersedes the 'Z-score Summary'. Further information can be found in section 5.9, 'Statistics'.

5.2 Program Design

5.2.1 Design

The program has been designed to cover some of the tests associated with soil classification. The preferred methods are shown below, but other equivalent methods were also acceptable.

- AS 1289 3.1.1 Liquid Limit
- AS 1289 3.2.1 Plastic Limit
- AS 1289 3.3.1 Plasticity Index
- AS 1289 3.3.1 Linear Shrinkage

The program is held annually. The test requires a minimum skill level from participants, and adherence to the test method is essential for consistent test results.

The level of experience/skill needed to perform these tests is expected to present a reasonable assessment of the overall competency of the tester and industry performance.

The program was designed to provide technical feedback regarding performance and possible performance improvements. Other considerations involving the design of the program are detailed below.

5.2.2 Selection of material used in the program

The tests in this proficiency program depend on the participant's skill and experience. In addition, certain types of materials require more knowledge to obtain consistent results than others. A processed naturally occurring material is used to reduce the variability associated with “in-situ” soils and to be able to select the plasticity required by the program.

Materials are selected for each program to mirror the range of materials encountered in practice. This program provides two samples with results in the range that laboratories would commonly test.

One sample from a previous program is chosen to give continuity in comparing participant performance across programs.

5.2.3 Role of proficiency testing

The determination of outliers is an important task of this proficiency program. A secondary function is to provide feedback to help those with outliers identify possible areas to investigate and assist all participants in improving.

In addition to the statistics, proficiency programs often obtain other information not normally available in a final report. It allows for a better understanding of the testing and can provide information that can lead to improvements in the testing process or test method.

Proficiency testing enables participants to measure competency against others. It is also a measure of staff performance and the equipment used. Apart from ‘measurement uncertainty’, it is the most useful tool a laboratory has in better understanding the performance of a test.

5.2.4 Participant assessment

The assessment of each participant is based on a z-score that is related to the program consensus value (median); this is used to determine any statistical outliers. Compliance with proficiency program requirements, including the correct calculation of results and adherence to program and test method requirements, may also be used as part of the assessment process. Participants may also be asked to investigate any discrepancies detected with the paperwork submitted. See section 5.10 for further details.

5.2.5 Reporting of results – Significant figures

The number of decimal places (significant figures) reported for a test has a bearing on the statistical analysis and, therefore, the interpretation of the results. There is a need to strike a balance between what is desirable from a statistical viewpoint and how the results are used in practice.

Too few decimal places (e.g. due to rounding) can cause an increase in the observed spread of results. Increasing the number of decimal places (with respect to normal reporting) can distort the observed spread of results compared to that encountered in actual practice. Large numbers of similar, rounded results can also cause a distortion in the analysis.

For this program, it was decided that the benefits of using additional decimal places would not significantly improve the aim of the proficiency testing program.

Participant's results were analysed as received regardless of whether there were 'more or less' significant figures than the number indicated by the test method.

5.2.6 Additional information requested

This program requested additional information, as detailed in section 6, that may not usually be reported. However, the additional information is consistent with the performance of the test and the records the test method requires laboratories to maintain. The additional information is used to interpret participant's performance and assist with providing technical comments, including feedback on outliers and possible participant improvement.

5.2.7 Data checks

As often observed, 'operator errors' can occur in the result calculation process. Every participant's results were verified as reasonable. 'Plastic Limit' and 'Plasticity Index' calculations were recalculated. However, checks are only as accurate as the raw data supplied by each participant. These checks also help ensure that the data is comparable. Any inconsistencies identified during this process are identified as possible feedback for participant improvement. In some cases, inconsistencies identified may need to be investigated by participants.

5.3 Sample Preparation

Two different materials were selected for the program of a homogeneous appearance. The dried material was then mixed to ensure, as far as possible, a homogeneous material throughout. Samples were drawn from the two materials and sealed in Ziploc plastic bags to form lots (A & B). The sample quantities used were approximately 480g.

A unique program code was assigned to each program sample. Each participant received a program sample randomly drawn from each lot. Additionally, ten samples were drawn from both samples (A & B) and tested for homogeneity.

5.4 Packaging and Instructions

Participants received one box (sealed); inside were two samples sealed in separate plastic bags marked Sample A and B. Instructions and a 'results log' sheet were enclosed, as detailed in Appendix A & B. Participants were instructed to test according to the nominated test method and report to the accuracy indicated on the 'results log' sheet or test method.

5.5 Quarantine

Samples sent to Western Australia (WA) are subject to quarantine regulations that may require treatment of the material before importation into WA. Samples sent to WA may be heat-treated, and compliance certificates are enclosed with samples if undertaken. Additionally, where necessary additional information regarding the handling and preparation of the sample may be included.

5.6 Sample Dispatch

Samples were dispatched to participants on 9th November 2022 using Pack and Send Couriers. Dispatched samples are tracked from dispatch to delivery for each participant by LabSmart Services.

Table 4: Homogeneity results – Sample A

Code	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Linear Shrinkage (%)
H1	70	23	47	8.5
H2	70	23	47	10.0
H3	67	22	45	9.5
H4	69	24	45	9.5
H5	69	24	45	7.5
H6	70	23	47	9.0
H7	69	22	47	10.0
H8	68	23	45	9.0
H9	67	23	44	9.5
H10	69	23	46	7.0
Average	68.8	23.0	45.8	9.0
SD	1.14	0.67	1.14	1.01
Max	70	24	47	10
Min	67	22	44	7
Range	3	2	3	3
CV (%)	1.65	2.90	2.48	11.31

Table 5: Homogeneity results – Sample B

Code	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Linear Shrinkage (%)
H11	52	19	33	7.0
H12	52	20	32	8.0
H13	53	19	34	9.0
H14	52	19	33	9.0
H15	52	19	33	6.5
H16	56	18	38	10.0
H17	56	19	37	9.5
H18	56	18	38	9.0
H19	53	18	35	10.0
H20	54	19	35	8.5
Average	53.6	18.8	34.8	8.7
SD	1.78	0.63	2.20	1.18
Max	56	20	38	10.0
Min	52	18	32	6.5
Range	4	2	6	3.5
CV (%)	3.31	3.36	6.32	13.64

5.7 Homogeneity Testing

Analysis of the homogeneity testing results (Table 4 & Table 5) indicated that the variability associated with the proficiency samples was satisfactory. The results supplied in this report are rounded to reporting requirements. The homogeneity assessment provides confidence that any outliers identified in the program represent statistically valid outliers.

5.8 Participation

Thirty-six participants entered the program. The nominated date for participants to return their results was 9th December 2022. Two participants did not return any results in time to be included in this report.

5.9 Statistics

Z-Scores were calculated for each test and used to assess the variability of each participant relative to the consensus median. A corresponding z-score graph was produced for each test.

Using median and quartiles reduces the effect that outliers have on the statistics and other influences. Therefore, z-scores provide a more realistic or robust method of assessment.

Some results were reported by participants to more decimal places than requested as part of the proficiency program and by others to fewer decimal places. In all instances, test results have been used as submitted by participants.

A z-score is one way of measuring the degree of consensus with respect to the grouped test results. The z-scores used in this report approximate standard deviations. For each test, a z-score graph is included. Use the graph to visually check how you compare statistically to other participants.

The following bar (Figure 1) is shown at the bottom of each graph. This helps to quickly visualise where each participant's result falls.



Figure 1: Z-score interpretation bar

For example:

- A **strong consensus** (i.e. agreement) means that your test result is close, i.e. within 1 standard deviation of the median.
- A **weak consensus** means that your test result is satisfactory and is within 2 standard deviations of the median.

If you have obtained a test result that is outside 2 standard deviations, then it may be worth **reviewing** your testing processes to ensure that all aspects are satisfactory. Only those obtaining a z-score approaching 3 (i.e. outside the 2.75 range) have been highlighted in the report for review.

If you have obtained a test result that is outside 3 standard deviations, then you will need to investigate your testing processes to ensure that all aspects are satisfactory.

Further details on the statistics used in this proficiency program can be obtained from LabSmart Services or by downloading the 'Participant Guide' from the LabSmart Services website.

5.9.1 Z-score Summary

A "Z-Scores Summary" is issued soon after most results are received. It gives participants early feedback as to any program outliers. The summary is usually available on the LabSmart Services website up until the final report is issued. The final report supersedes the z-score summary.

The final report contains detailed technical feedback regarding the performance of tests and revised z-scores. Including late results or corrections is at the discretion of the program coordinator. This may change some of the z-scores slightly in some instances, but generally, the performance outcome remains the same. If there is any impact, it will be discussed within section 5.1 of the report.

5.9.2 Comparing statistics from one program to another

The statistics generated from one proficiency program are not usually comparable to those from another proficiency testing program. Only very general comparisons may be possible. The reason statistics from one program may not be compared to another is due to the range of variables that differ from one proficiency program to another.

These variables include:

- Type of material selected
- The number of participants
- Experience of participants
- Test methodology variations
- Equipment used
- Test methods used
- Experience of supervisors
- Range of organisations involved
- Program design and the statistics employed

The program outcome represents a 'snapshot' of the competency within the industry and hence provides an overview of the industry. The more participants involved in a proficiency program at a given time, the more representative the overview.

5.9.3 Measurement uncertainty

The statistics detailed in this program do not replace the need for laboratories to separately calculate measurement uncertainties associated with each test when required by the client or NATA. The proficiency program does give information useful for calculating the MU and 'bench marking' the MU calculated.

5.9.4 Metrological traceability

The assigned median value used in this proficiency testing program is derived from participant performance and is not metrologically traceable.

5.10 Non-statistical Matters

One of the issues proficiency testing providers faces is what to do with an incorrect result even if its z-score is satisfactory. In many cases, they cannot be detected but still can have a significant impact on the statistics calculated. This can cause biased (or unfair) outcomes for other participants.

To limit the effect erroneous results have on a program, additional information is requested to allow the main results to be recalculated. In some cases, results shown to be erroneous may be rejected for inclusion in the program. If the result does not add any statistical bias, it is left in the program.

The result, however, is incorrect even though it may have a satisfactory z-score. To highlight that the participant needs to investigate erroneous results, it is considered a 'non-statistical' matter.

This may also be applied to non-compliance to program requirements, e.g. incorrect reporting of results, etc., or incorrect partial calculations/data.

Non-statistical matters were not used as part of the assessment process for this program.

6. Summary of Participants Results

6.1 Test Results Summary - Sample A

Row N°	Code	Cure Time hr	Liquid Limit %	Plastic Limit %			Plasticity Index %	Water	Mould Length mm	Shrinkage	Linear Shrinkage %	
				Cure Time hr	1	2						Report
1	S3	96.6	75	96.6	23.6	24.1	24	51	Tap	250	Curling	18.5
2	N2	8 days	67	8 days	21.7	21.3	21	46	Tap	250	Cracking	11
3	C8	7 days	65	7 days	22.6	22.6	23	42	Tap	250	Cracking	10
4	M6	48	54	48	23.2	23.4	23	31	Tap	150	Curling	7
5	Q2	49	48.13	49	26.61	26.82	26.71	21	Tap	250		5.2
6	E2	168	56	220	23.04	23.02	23	33	Distilled	250	Curling	10
7	S4	Approx 76	60	Approx 27	26.4	24.8	26	34	Distilled	125	No change	11
8	E9	48	65	48	23.79	23.68	24	41	Tap	250	No change	12.5
9	S9	50	62	50	26.21	25.92	26	36	Distilled	250	No change	8.5
10	W5	73	64	96	22.94	22.88	23	41	Distilled	250	Curling	10.5
11	C3	1:03 - 29/1	62	1:03 - 29/1	23.32	23.28	23	39	Tap	0.00 - 22	No change	10
12	A7	48	62.6	48	24.4	23.9	24	39	Tap	50.0) 18.	Curling	18.5
13	V8	48	65	48	26.4	26.3	26	39	Tap	125.1		11
14	Y2	163	67	163	23.71	23.78	24	43	Distilled	250	Curling	14
15	K6	50	54	50	21.95	22.09	22	32	Distilled	250	Cracking	10.5
16	T4	90.5	68	90.5	25.12	24.71	25	43	Tap	250	No change	8
17	Q4	96	66	96	25.14	25.12	25	41	Tap	249.9	No change	12.5
18	F7	48.25	55.72	48	22.12	22.17	22.15	34	Distilled	250	No change	9.2
19	G4	48	55.71	48	21.34	21.17	21.26	35	Tap	250	No change	9.6
20	N6	164	60	169	24.05	23.11	24	36	Distilled	250.1	Curling	17
21	W2	60	79	61	25.98	25.81	26	53	Tap	250	No change	12.74
22	F2	49.5	63	49.5	23.28	23.17	23	40	Tap	250	No change	12.5
23	F5	72	67	72	26.3	25.3	26	41	Tap	250	No change	11
24	Y3	104	63	104	25.5	25.4	25	38	Distilled	250	No change	12.1
25	T7	159	66.51	159	20.14	21.53	21	46	Distilled	250	Curling	7
26	Z5											
27	U3	48	62	48	25.53	25.13	25	37	Distilled	249.9	No change	11.8
28	K8	48	64	48	25.49	25.45	25	39	Distilled	250	Curling	9
29	E5	48	63	48	23.76	23.54	24	39	Distilled	250	Cracking	9
30	X4	10 days	61	6 days	25.8	26.3	26	35	Distilled	250	No change	12
31	J6	72	68	72	25.92	25.89	26	42	Distilled	250.4	No change	12
32	V6	48	60	48	27.32	27.42	27	33	Distilled	250	Curling	9.5
33	R5	48	67	48	25.42	24.37	25	42	Tap	250		7
34	Z2	48	67	48	25.27	25.3	25	42	Potable	250	no change	9.5
35	N9											
36	U4	1/11 to 30/1	59	1/11 to 30/1	16.4	16.3	16	43	Tap	250	No change	10

NOTES: A blank or NR show s w here result not completed or completed incorrectly.

	Australian standard methods used unless show n otherw ise above.
	Indicates Qild main roads methods used.
	Used AS 1289.3.9.1
	Used AS 1289.3.3.2
	Used AS 1289.3.1.2

6.2 Test Results Summary - Sample B

Row N°	Code	Cure Time hr	Liquid Limit %	Plastic Limit %				Plasticity Index %	Water	Mould Length mm	Shrinkage	Linear Shrinkage %
				Cure Time hr	1	2	Report					
1	S3	98.2	51	98.2	17.15	17.42	17	34	Tap	250	No change	11
2	N2	8 days	51	8 days	17.3	17.2	17	34	Tap	250	No change	13
3	C8	8 days	51	8 days	17	16.9	17	34	Tap	250	Cracking	12
4	M6	48	47	48	19.9	19.8	20	27	Tap	150	Curling	8.5
5	Q2	NR	NR	NR	NR	NR	NR	NR	Tap	NR		NR
6	E2	168	49	196	18.28	18.27	18	31	Distilled	NR		NR
7	S4	Approx 78	50	Approx 27	21.7	21.6	22	28	Distilled	125	No change	13
8	E9	48	52	48	18.06	18.14	18	34	Tap	250	No change	12.5
9	S9	51	49	51	20.99	21.24	21	28	Distilled	250	No change	9
10	W5	77	51	96	20.58	20.46	21	30	Distilled	250	Curling	12
11	C3	37 - 29/11/	52	37 - 29/11/	19.2	19.05	19	33	Tap	50.0 - 223	No change	11
12	A7	48	49.4	48	19.6	19.2	19	30	Tap	250.0) 14	Curling	14.5
13	V8	48	53	48	21.4	21.4	21	32	Tap	125.1		12
14	Y2	162	55	162	18.84	19.81	19	36	Distilled	250	No change	14.5
15	K6	55	65	55	26.24	26.02	26	39	Distilled	250	No change	7.5
16	T4	97.5	51	97.5	15.76	15.34	16	35	Tap	250	Cracking	8.5
17	Q4	168	53	168	20	20.36	20	33	Tap	249.9	No change	14
18	F7	48.4	44.82	48	22.57	22.77	22.67	22	Distilled	250	Cracking	7.6
19	G4	48	45.86	48	23.09	23.25	23.17	23	Tap	250	Cracking	8.4
20	N6	170	47	170	17.36	17.8	18	29	Distilled	250	No change	13
21	W2	60	57	61	20.57	20.53	21	36	Tap	250	No change	13.7
22	F2	53	43.76	53	18	18.21	18	26	Tap	250	No change	10.5
23	F5	72	51	72	21	20.6	21	30	Tap	250.1	No change	11.5
24	Y3	104	51	104	20	19.8	20	31	Distilled	250	No change	12.8
25	T7	50	53.56	50	17.31	17.78	18	36	Distilled	250	Cracking	8.5
26	Z5											
27	U3	48	49	48	20.28	20.37	20	29	Distilled	249.8	No change	12.8
28	K8	48	51	48	19.02	19.39	19	32	Distilled	250	Cracking	11.5
29	E5	48	49	48	20.18	20.07	20	29	Distilled	250	Cracking	11
30	X4	10 days	51	6 days	20.3	20.1	20	31	Distilled	251	No change	12.5
31	J6	72	56	72	21.4	22.1	22	34	Distilled	250.4	No change	12
32	V6	48	50	48	20.37	20.32	20	30	Distilled	250	No change	12
33	R5	48	51	48	18.67	18.07	18	33	Tap	250		11.6
34	Z2	48	49	48	21.65	20.75	21	28	Potable	250	no change	11
35	N9											
36	U4	1/11 to 30/1	50	1/11 to 30/1	15.5	15.3	15	35	Tap	250	No change	12

NOTES: A blank or NR show s w here result not completed or completed incorrectly.

- Australian standard methods used unless shown otherwise above.
- Indicates Qld main roads methods used.
- Used AS 1289.3.9.1
- Used AS 1289.3.3.2
- Used AS 1289.3.1.2

Appendix A: Instructions for testers

LabSmart Services

Proficiency Testing Program

Soil - Plasticity – 2022 (112)

INSTRUCTIONS FOR TESTER

1. Please check that the package you have received contains the following:
 - Results Log
 - Sealed plastic bag tagged 'Sample A'
 - Sealed plastic bag tagged 'Sample B'

Contact LabSmart Services if the sample bags are damaged or any item is missing.
2. *When can I start testing?* As soon as you have [read these instructions carefully](#) and your supervisor has indicated that you may do so.
3. *How long do I have to do the testing?* You need to have the results back to LabSmart Services by the **9th December 2022**.
4. For condition of sample' put 'good' if all is satisfactory or if not a comment such as 'box badly damaged', 'sample A bag leaking' etc.
5. Due to the possibility of segregation during transit **mix each sample prior to testing**.
6. Use AS 1289 test methods unless you are unable to do so. Complete those tests that you are able to perform. You may perform a test even if you are not NATA accredited for the test.
7. Conduct the following tests.
 - AS 1289 3.1.1 – Liquid limit – 4 point Casagrande
 - AS 1289 3.2.1 – Plastic limit
 - AS 1289 3.3.1 – Plasticity index
 - AS 1289 3.4.1 – Linear shrinkage
8. If another test method is used write method on log sheet in the space below the nominated AS method. Strikeout method not applicable.
9. A cure time of at least **48** hours is suggested.
10. For each test record the result on the enclosed "Results Log". Report each result according to the reporting requirements of the test method.
11. **Please include a copy of each 4 point Liquid Limit graph.**
12. *Have a query?* Contact Shantelle Popple or Jeffrey Mulholland on **0439 208 406**

13. E-mail the “Result Log” to LabSmart Services by **9th December 2022**

✉ E-mail: info@labsmartservices.com.au

14. The Laboratory Manager or person responsible for checking should sign the log sheet to indicate that it has been checked.
15. If more than one technician is involved in the testing then please ensure that the laboratory's records indicate which technician did which sample.
16. The Following testing it is recommended that the entire sample be retained until the proficiency testing technical report for this program has been issued.
17. Please retain the completed “Results Log” as this contains your participation code that will identify your results in the technical report covering the proficiency testing program. It is also recommended that a copy of completed worksheets be kept with the results log in your proficiency file.
18. Proficiency testing can also form part of a laboratories training records for the technician who performed the test.

Thank you for participating in this proficiency program.



Appendix B: Results Log

LabSmart

Services

Plasticity Proficiency Testing Program– 2022 (112)

RESULTS LOG

Laboratory: XXXXXXXXXXXXXXXX Participation Code: XX

☞ Please E-mail the completed results log by 9th December 2022

E-mail: info@labsmartservices.com.au

TEST METHOD	RESULTS					
	Sample A			Sample B		
Date received						
Condition of sample received						
Colour of sample						
AS 1289 3.1.1 (Liquid Limit)	Please attach the 4 point Liquid Limit graph for each sample to results sheet.					
	Cure Time					
	Results					
AS 1289 3.2.1 (Plastic Limit)	Cure Time					
	Results	1	2	Reported	1	2
AS 1289 3.3.1 (Plasticity Index)	Results					
AS 1289 3.4.1 (Linear Shrinkage)	Length of shrinkage mould (mm)					
	Results					
Describe Shrinkage i.e. curling, cracking, crumbling, no change						
Type of water used (e.g. tap, distilled etc)						
Name of tester						
Date tested						

COMMENTS:

.....

.....

Supervisor Name *(Please Print)*

Signature

Date

In signing the above I acknowledge that the above results are approved and have been checked. I will also ensure that the results are kept confidential both internal and external to the laboratory until the issue of the final technical report covering this program.

Thank you for participating. Please retain a copy of this sheet for your records.

Blank -112 Plasticity 2022- Results Log V2022.1.docx