**The National Marine Biological Analytical Quality Control Scheme**

**www.nmbaqcs.org**

# Particle Size Results – PS54

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## PARTICLE SIZE EXERCISE DETAILS

**Particle Size (PS) #54**

**Type/Contents/Origin/Pre-treatments:** **~965g Gravel (aggregate source) @ various prescribed ½ phi categories**

| Phi category | Approximate weight in grams |
|---|---|
| -4.0 to -3.5 | 20 |
| -3.5 to -3.0 | 450 |
| -3.0 to -2.5 | 450 |
| -2.5 to -2.0 | 40 |
| -2.0 to -1.5 | 5 |

**Circulated:** **18/12/2014**

**Completion Date:** **06/02/2015**

**Number of Subscribing Laboratories:** **15**

**Number of Participating Laboratories:** **13**

**Number of Results Received:** **14***

* One sample from PSA_2113 was stored frozen on arrival, due to lack of information on storage and to samples arriving during Christmas break. A replacement sample was later provided, which was not frozen. PSA_2113 is the non-frozen sample and PSA_2113_a is the data from the frozen sample.

**Table 1. Summary of the methodology and sieve metadata information received from participating laboratories and replicate analysis laboratory for the fifty-forth particle size distribution - PS54.**

| Benchmark | Method | Sieves used | Phi; sieve mesh | | Total Weight (g) | Laser used |
|---|---|---|---|---|---|---|
| | | | Weight (g) < 0.00; >1 mm | Weight (g) > 0.00; <1 mm | | |
| REPLICATE 1 | NMBAQC | ☑ | 954.59 | 0.00 | 954.59 | ☒ |
| REPLICATE 2 | NMBAQC | ☑ | 957.44 | 0.00 | 957.44 | ☒ |
| REPLICATE 3 | NMBAQC | ☑ | 957.07 | 0.00 | 957.07 | ☒ |
| REPLICATE 4 | NMBAQC | ☑ | 957.26 | 0.00 | 957.26 | ☒ |
| REPLICATE 5 | NMBAQC | ☑ | 957.44 | 0.00 | 957.44 | ☒ |
| BM AVERAGE | NMBAQC | ☑ | 956.76 | 0.00 | 956.76 | ☒ |

| Participant | Method | Sieves used | Phi; sieve mesh | | Total Weight (g) | Laser used |
|---|---|---|---|---|---|---|
| | | | Weight (g) < 0.00; >1 mm | Weight (g) > 0.00; <1 mm | | |
| PSA_2101 | NMBAQC | ☑ | 957.25 | 0.32 | 957.57 | ☒ |
| PSA_2102 | NMBAQC | ☑ | 955.67 | 0.00 | 955.67 | ☒ |
| PSA_2103 | NMBAQC | ☑ | 956.38 | 0.00 | 956.38 | ☒ |
| PSA_2105 | NMBAQC | ☑ | 954.59 | 0.00 | 954.59 | ☒ |
| PSA_2106 | NMBAQC | ☑ | 956.67 | 0.00 | 956.67 | ☒ |
| PSA_2107 | NMBAQC | ☑ | 956.30 | 0.41 | 956.71 | ☒ |
| PSA_2108 | NMBAQC[1] | ☑ | 955.77 | 0.16 | 955.93 | ☒ |
| PSA_2109 | OTHER | ☑ | 956.49 | 0.22 | 956.71 | ☒ |
| PSA_2110 | NMBAQC | ☑ | 954.51 | 0.44 | 954.95 | ☒ |
| PSA_2111 | NMBAQC | ☑ | 958.07 | 0.00 | 958.07 | ☒ |
| PSA_2112 | NMBAQC | ☑ | 956.26 | 0.01 | 956.27 | ☒ |
| PSA_2113 | NMBAQC | ☑ | 956.67 | 0.36 | 957.03 | ☒ |
| PSA_2113_a | NMBAQC | ☑ | 956.54 | 0.24 | 956.78 | ☒ |
| PSA_2114 | NMBAQC | ☑ | 955.90 | 0.32 | 956.22 | ☒ |

**Key to methods**

NMBAQC - NMBAQC PSA SOP for supporting biological data

NMBAQC[1] - NMBAQC PSA SOP for supporting biological data - incorporating BS1377: 1990 Parts 1-2 (sieving)

**Table 2. Summary of the particle size information received from participating laboratories and replicate analysis laboratory for the fifty-forth particle size distribution - PS54.**

**Benchmark Data**

| Sample | % Gravel | % Sand | % Silt/Clay | Sediment Description (Post analysis) | Summary Data APEM verification | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | % Gravel | | % Sand | | % Silt/Clay | | Sediment Description (Post analysis) | |
| REPLICATE 1 | 100.0 | 0.0 | 0.0 | Gravel | ☑ | 100.0 | ☑ | 0.0 | ☑ | 0.0 | ☑ | Gravel |
| REPLICATE 2 | 100.0 | 0.0 | 0.0 | Gravel | ☑ | 100.0 | ☑ | 0.0 | ☑ | 0.0 | ☑ | Gravel |
| REPLICATE 3 | 100.0 | 0.0 | 0.0 | Gravel | ☑ | 100.0 | ☑ | 0.0 | ☑ | 0.0 | ☑ | Gravel |
| REPLICATE 4 | 100.0 | 0.0 | 0.0 | Gravel | ☑ | 100.0 | ☑ | 0.0 | ☑ | 0.0 | ☑ | Gravel |
| REPLICATE 5 | 100.0 | 0.0 | 0.0 | Gravel | ☑ | 100.0 | ☑ | 0.0 | ☑ | 0.0 | ☑ | Gravel |
| REP AVERAGE | 100.0 | 0.0 | 0.0 | Gravel | ☑ | 100.0 | ☑ | 0.0 | ☑ | 0.0 | ☑ | Gravel |

**Participant Data**

| Lab | % Gravel | % Sand | % Silt/Clay | Sediment Description (Post analysis) | Summary Data APEM verification | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | % Gravel | | % Sand | | % Silt/Clay | | Sediment Description (Post analysis) | |
| PSA_2101 | 99.96 | 0.04 | 0.00 | Gravel | ☑ | 99.96 | ☑ | 0.04 | ☑ | 0.00 | ☑ | Gravel |
| PSA_2102 | 100 | 0 | 0 | Gravel | ☑ | 100 | ☑ | 0 | ☑ | 0 | ☑ | Gravel |
| PSA_2103 | 100 | 0 | 0 | Gravel | ☑ | 100 | ☑ | 0 | ☑ | 0 | ☑ | Gravel |
| PSA_2105 | 100 | 0 | 0 | Gravel | ☑ | 100 | ☑ | 0 | ☑ | 0 | ☑ | Gravel |
| PSA_2106 | 100 | 0 | 0 | Medium Gravel | ☑ | 100 | ☑ | 0 | ☑ | 0 | ☒ | Gravel |
| PSA_2107 | 100 | 0 | 0 | Gravel | ☑ | 100 | ☑ | 0 | ☑ | 0 | ☑ | Gravel |
| PSA_2108 | 99.98 | 0.02 | 0.00 | Gravel | ☑ | 99.98 | ☑ | 0.02 | ☑ | 0.00 | ☑ | Gravel |
| PSA_2109 | 100 | 0 | 0 | Gravel | ☑ | 100 | ☑ | 0 | ☑ | 0 | ☑ | Gravel |
| PSA_2110 | 100 | 0 | 0 | Gravel | ☑ | 100 | ☑ | 0 | ☑ | 0 | ☑ | Gravel |
| PSA_2111 | 100 | 0 | 0 | Gravel | ☑ | 100 | ☑ | 0 | ☑ | 0 | ☑ | Gravel |
| PSA_2112 | 100 | 0 | 0 | Medium Gravel | ☑ | 100 | ☑ | 0 | ☑ | 0 | ☒ | Gravel |
| PSA_2113 | 100 | 0 | 0 | Gravel | ☑ | 100 | ☑ | 0 | ☑ | 0 | ☑ | Gravel |
| PSA_2113_a | 100 | 0 | 0 | Gravel | ☑ | 100 | ☑ | 0 | ☑ | 0 | ☑ | Gravel |
| PSA_2114 | 100 | 0 | 0 | Gravel | ☑ | 100 | ☑ | 0 | ☑ | 0 | ☑ | Gravel |

- -Data not provided

☑ - Participant calculations of % Gravel, % Sand and % Silt/Clay are correct based on the final data submitted

☒ - Participant calculation different from APEM calculation using GRADISTAT on final merged data

**Figure 1. Particle size distribution curves resulting from analysis of 5 replicate samples of sediment distibuted as PS54 (Benchmark Data).**

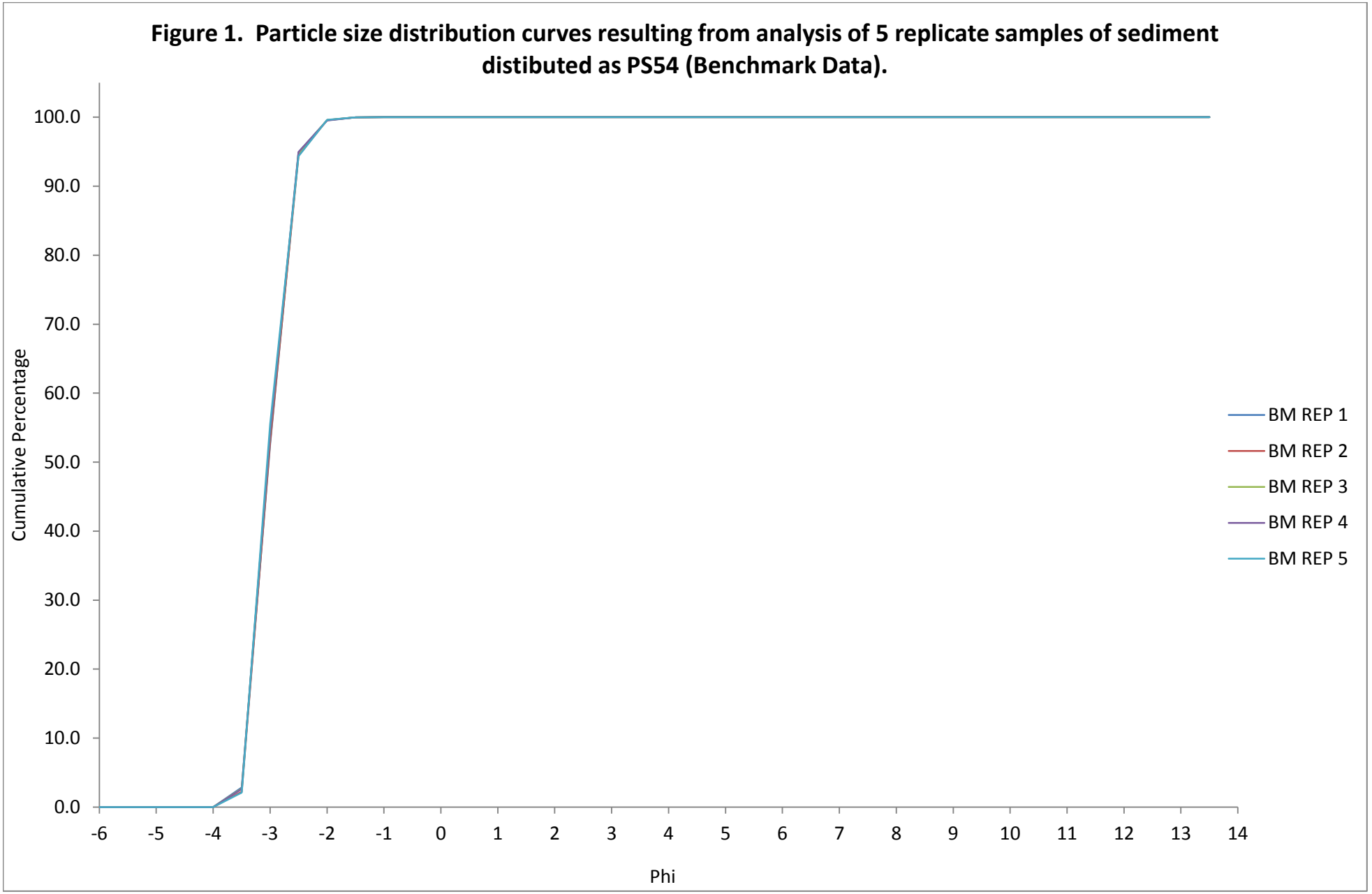


**Figure 2a. Particle size distribution curves from all participating laboratories for sediment distributed as PS54.**

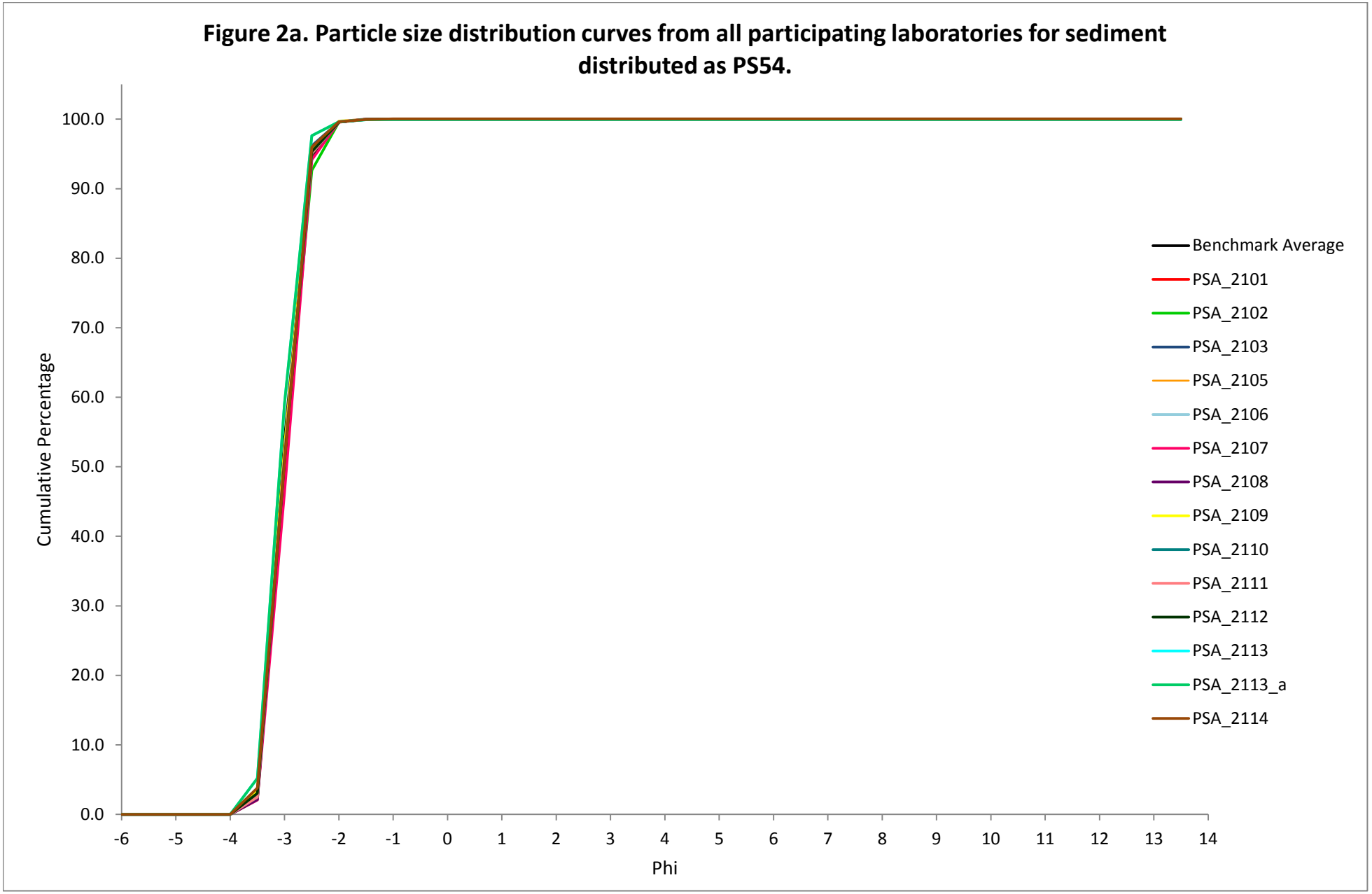


**Figure 2b. Particle size distribution curves from all participating laboratories for sediment distributed as PS54 (-4ϕ to -1ϕ).**

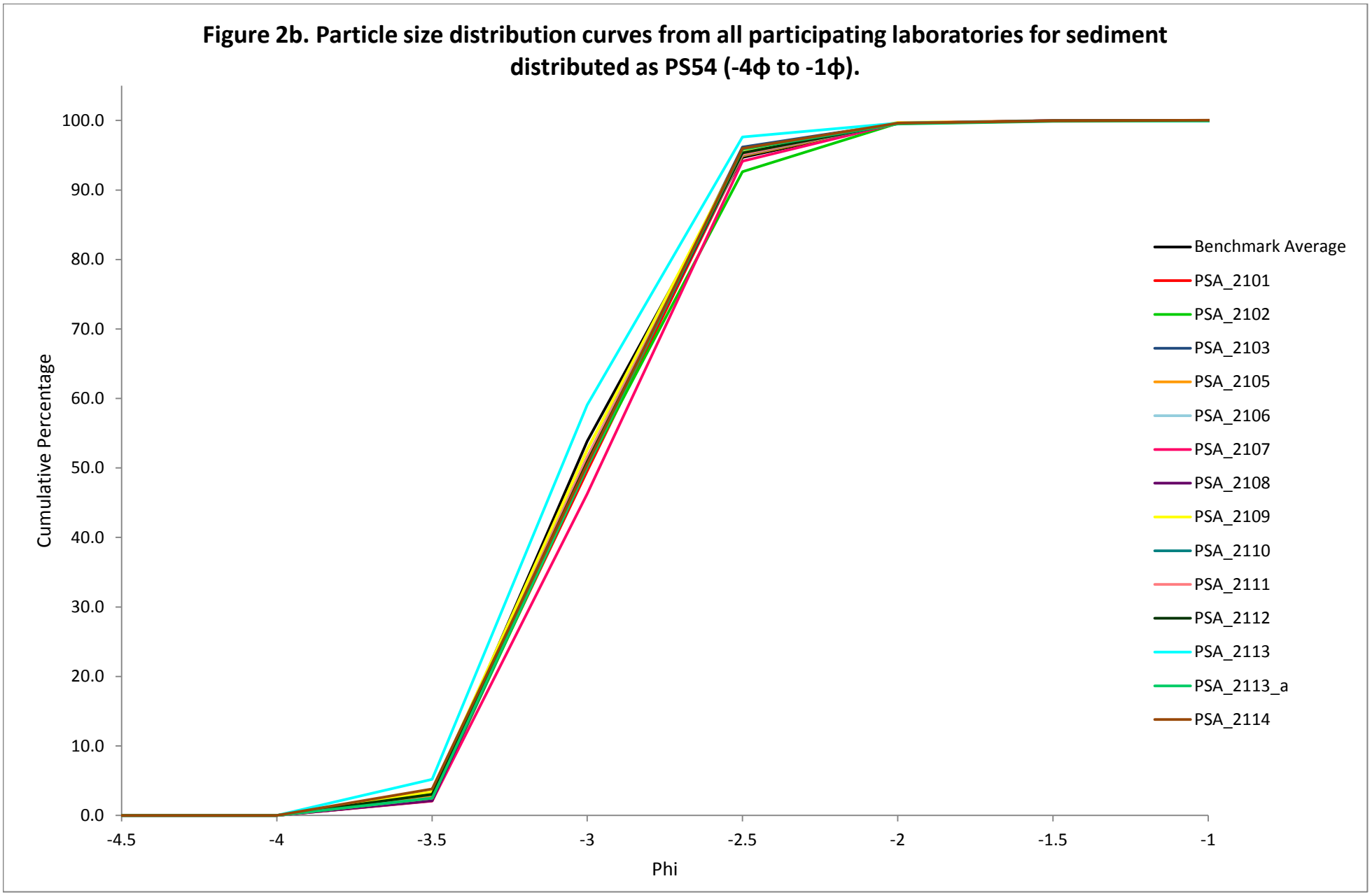
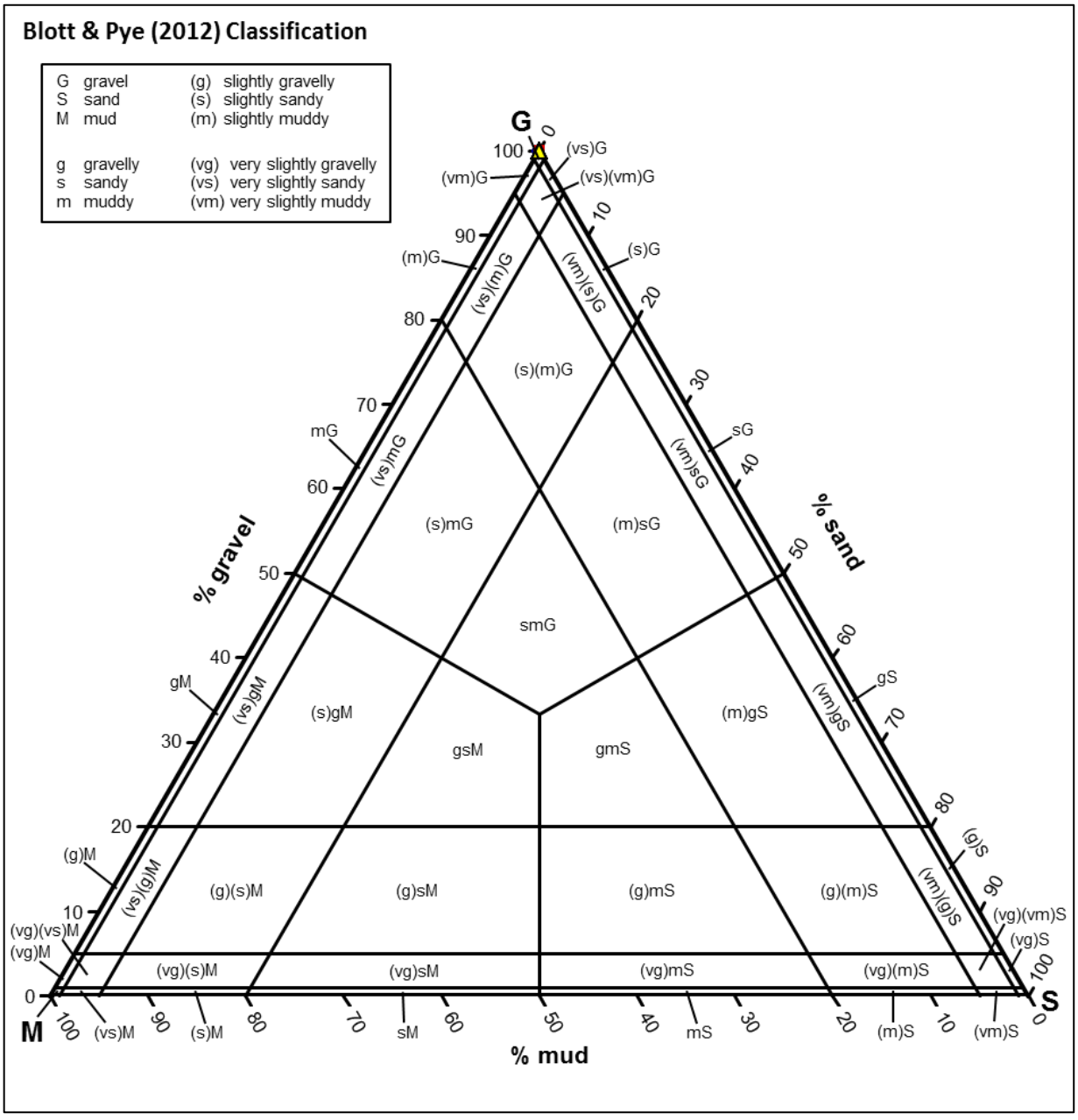


**Figure 3. Particle size ternary diagram for PS54, including the Benchmark replicates and all participating laboratories for Gravel, Sand and Mud.**




* All participating laboratories and the benchmark data fall into the Gravel category.

**Laboratory**

| | | | |
|---|---|---|---|
| Benchmark Average | PSA_2105 | PSA_2109 | PSA_2113 |
| PSA_2101 | PSA_2106 | PSA_2110 | PSA_2113_a |
| PSA_2102 | PSA_2107 | PSA_2111 | PSA_2114 |
| PSA_2103 | PSA_2108 | PSA_2112 | |

**Figure 4. Bar chart showing the percentage very fine gravel, fine gravel and medium gravel recorded by each participating laboratory and the benchmark average for PS54.**

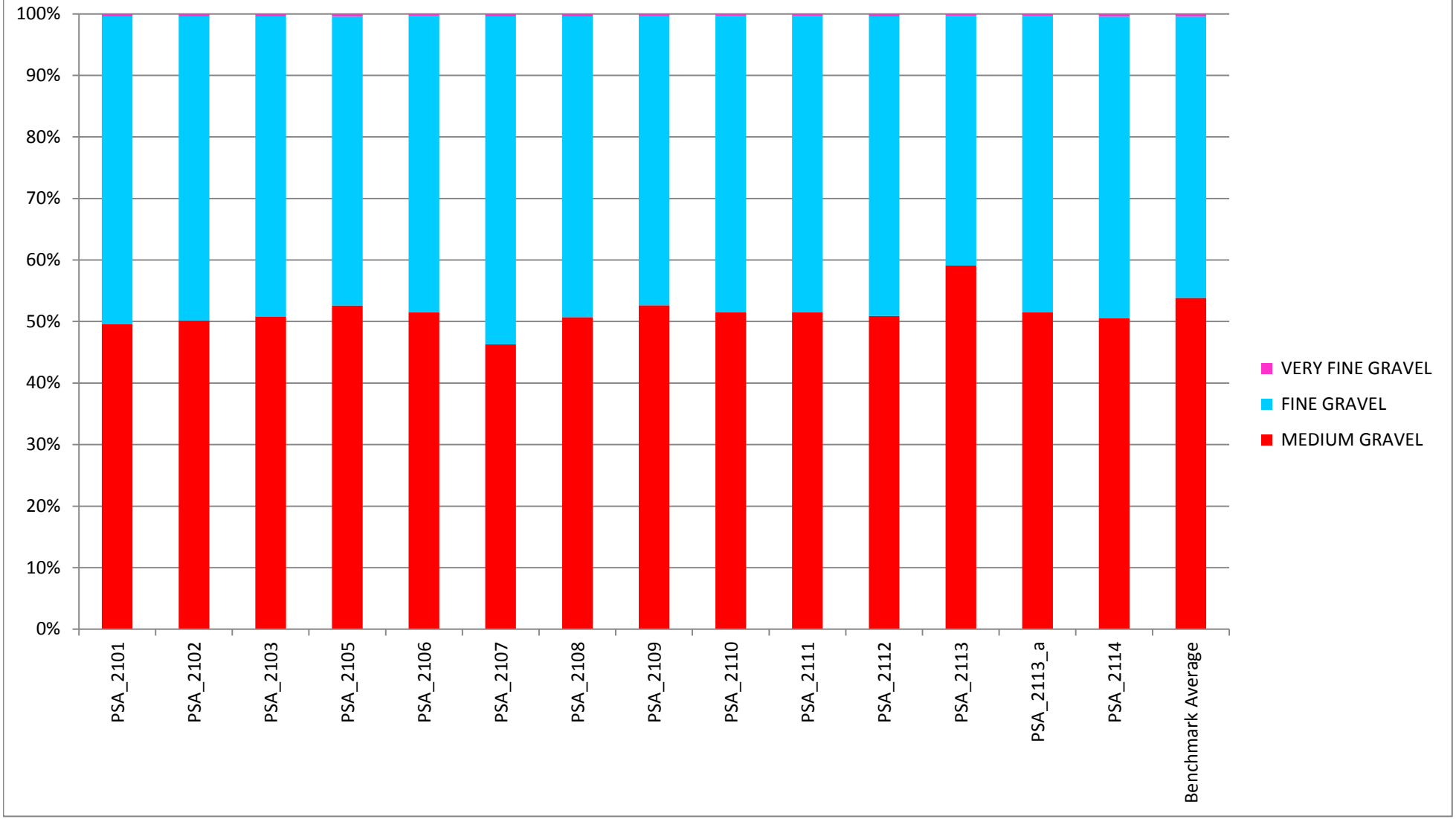


**Table 3. Summary of z-scores for each phi-interval for PS54; data from all participating laboratories included in mean and standard deviation calculations.**

| | Phi-interval | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | -6.50 to -6.00 | -6.00 to -5.50 | -5.50 to -5.00 | -5.00 to -4.50 | -4.50 to -4.00 | -4.00 to -3.50 | -3.50 to -3.00 | -3.00 to -2.50 | -2.50 to -2.00 | -2.00 to -1.50 | -1.50 to -1.00 | -1.00 to -0.50 | -0.50 to 0.00 | 0.00 to 0.50 | 0.50 to 1.00 | 1.00 to 1.50 | 1.50 to 2.00 | 2.00 to 2.50 | 2.50 to 3.00 | 3.00 to 3.50 |
| Benchmark Average | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.45 | 1.27 | -1.34 | 0.53 | 0.82 | -0.11 | -0.54 | -0.59 | -0.26 | -0.35 | -0.37 | -0.35 | -0.32 | -0.34 | -0.36 |
| PSA_2101 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.02 | -0.87 | 0.81 | 0.05 | 0.56 | -0.63 | 0.06 | 0.18 | 3.61 | -0.35 | -0.37 | -0.35 | -0.32 | -0.34 | -0.36 |
| PSA_2102 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.94 | -0.23 | -0.62 | 2.46 | 0.51 | -0.22 | -0.24 | -0.57 | -0.26 | -0.35 | -0.37 | -0.35 | -0.32 | -0.34 | -0.36 |
| PSA_2103 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.35 | -0.42 | 0.69 | -0.86 | 0.41 | 0.15 | -0.24 | 0.95 | -0.26 | -0.35 | -0.37 | -0.35 | -0.32 | -0.34 | -0.36 |
| PSA_2105 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.01 | 0.53 | -0.67 | 0.28 | 1.31 | 0.07 | -0.54 | -0.59 | -0.26 | -0.35 | -0.37 | -0.35 | -0.32 | -0.34 | -0.36 |
| PSA_2106 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.45 | 0.20 | 0.09 | -0.20 | -0.56 | -0.67 | -0.54 | -0.59 | -0.26 | -0.35 | -0.37 | -0.35 | -0.32 | -0.34 | -0.36 |
| PSA_2107 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.99 | -2.01 | 1.80 | 1.04 | 0.94 | -0.67 | 0.96 | -0.59 | -0.26 | -0.35 | -0.37 | -0.35 | -0.32 | -0.34 | -0.36 |
| PSA_2108 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.93 | 0.01 | 0.28 | 0.07 | 0.32 | -0.15 | -0.54 | -0.05 | -0.19 | 3.27 | 2.91 | 3.27 | 0.74 | 1.01 | 3.21 |
| PSA_2109 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.63 | 0.30 | -0.31 | -0.34 | -2.44 | -0.21 | -0.54 | -0.36 | -0.26 | 1.30 | 1.93 | 1.31 | 3.48 | 3.39 | 1.43 |
| PSA_2110 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.46 | 0.17 | -0.10 | 0.21 | -0.34 | -0.67 | -0.54 | -0.59 | -0.26 | -0.35 | -0.37 | -0.35 | -0.32 | -0.34 | -0.36 |
| PSA_2111 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.46 | 0.18 | -0.09 | 0.21 | -0.33 | -0.67 | -0.54 | -0.59 | -0.26 | -0.35 | -0.37 | -0.35 | -0.32 | -0.34 | -0.36 |
| PSA_2112 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.20 | -0.33 | 0.28 | -0.06 | 0.60 | -0.42 | -0.39 | -0.21 | -0.26 | -0.35 | -0.37 | -0.35 | -0.32 | -0.34 | -0.36 |
| PSA_2113 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.89 | 2.43 | -2.35 | -2.18 | -1.33 | -0.06 | 1.10 | 1.34 | -0.26 | -0.35 | -0.37 | -0.35 | -0.32 | -0.34 | -0.36 |
| PSA_2113_a | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.49 | -0.40 | 0.82 | -0.61 | 0.52 | 1.01 | 3.05 | 2.88 | -0.26 | -0.35 | -0.37 | -0.35 | -0.32 | -0.34 | -0.36 |
| PSA_2114 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.14 | -0.84 | 0.71 | -0.62 | -1.00 | 3.24 | -0.54 | -0.59 | -0.26 | -0.35 | -0.37 | -0.35 | -0.32 | -0.34 | -0.36 |
| $\bar{x}$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.8733 | 48.5819 | 43.8270 | 4.3231 | 0.3652 | 0.0171 | 0.0038 | 0.0016 | 0.0023 | 0.0001 | 0.0001 | 0.0005 | 0.0007 | 0.0008 | 0.0001 |
| $s$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.8099 | 2.1768 | 2.2396 | 1.0723 | 0.0451 | 0.0256 | 0.0070 | 0.0027 | 0.0086 | 0.0003 | 0.0003 | 0.0014 | 0.0022 | 0.0022 | 0.0004 |

z<-1.96 or z >1.96

All laboratories recorded zero therefore mean and standard deviation equal zero.

**Table 3. Summary of z-scores for each phi-interval for PS54; data from all participating laboratories included in mean and standard deviation calculations.**

| | Phi-interval | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3.50 to 4.00 | 4.00 to 4.50 | 4.50 to 5.00 | 5.00 to 5.50 | 5.50 to 6.00 | 6.00 to 6.50 | 6.50 to 7.00 | 7.00 to 7.50 | 7.50 to 8.00 | 8.00 to 8.50 | 8.50 to 9.00 | 9.00 to 9.50 | 9.50 to 10.00 | 10.00 to 10.50 | 10.50 to 11.00 | 11.00 to 11.50 | 11.50 to 12.00 | 12.00 to 12.50 | 12.50 to 13.00 | 13.00 to 13.50 |
| Benchmark Average | -0.37 | -0.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2101 | -0.37 | -0.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2102 | -0.37 | -0.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2103 | -0.37 | -0.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2105 | -0.37 | -0.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2106 | -0.37 | -0.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2107 | -0.37 | -0.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2108 | 3.03 | 1.17 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2109 | 1.75 | 3.33 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2110 | -0.37 | -0.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2111 | -0.37 | -0.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2112 | -0.37 | -0.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2113 | -0.37 | -0.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2113_a | -0.37 | -0.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2114 | -0.37 | -0.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| $\bar{x}$ | 0.0001 | 0.0002 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| $s$ | 0.0002 | 0.0005 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

z<-1.96 or z >1.96

All laboratories recorded zero therefore mean and standard deviation equal zero.

**Figure 5. Summary of z-scores at each half phi-interval for the Benchmark Average for PS54.**

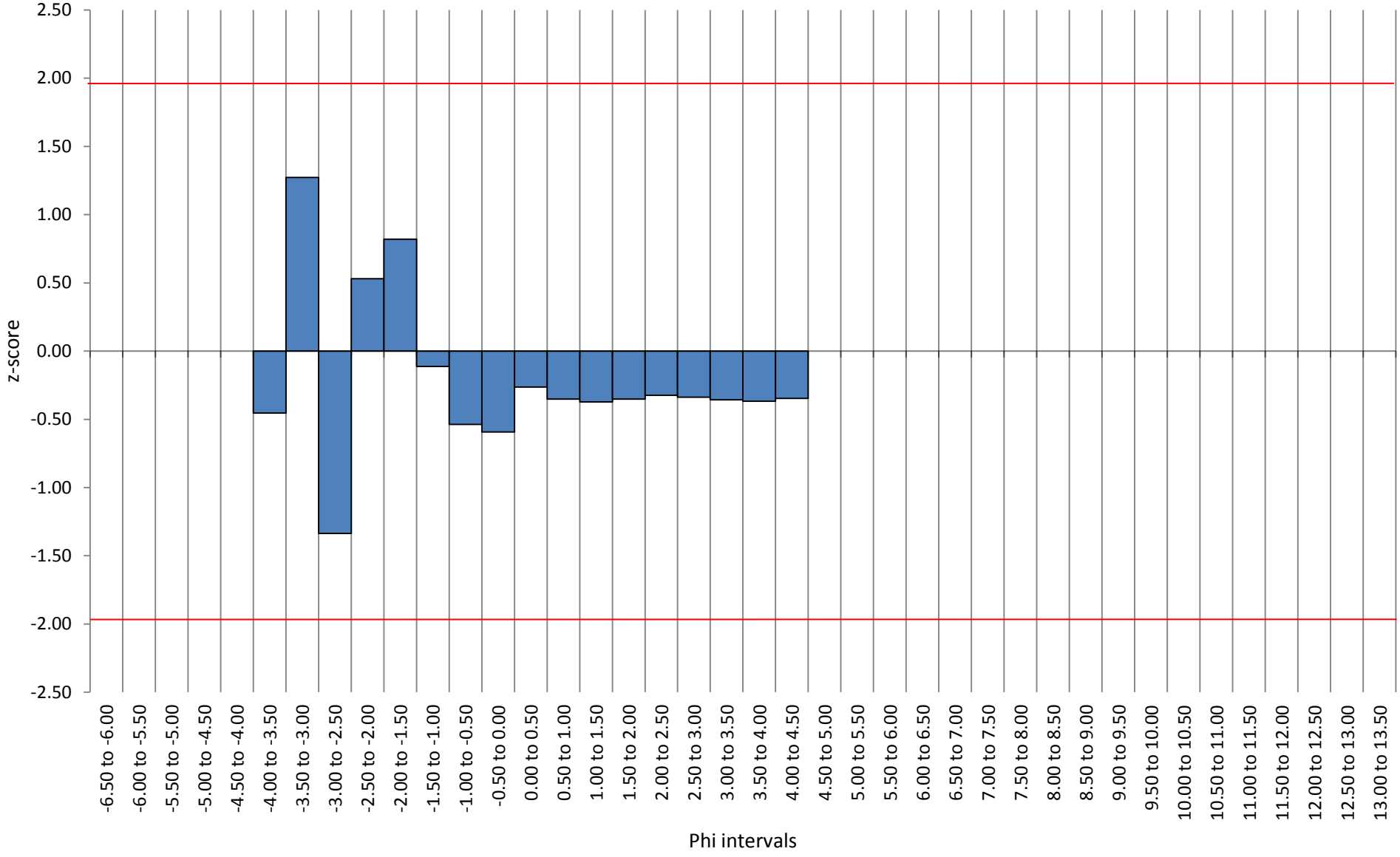
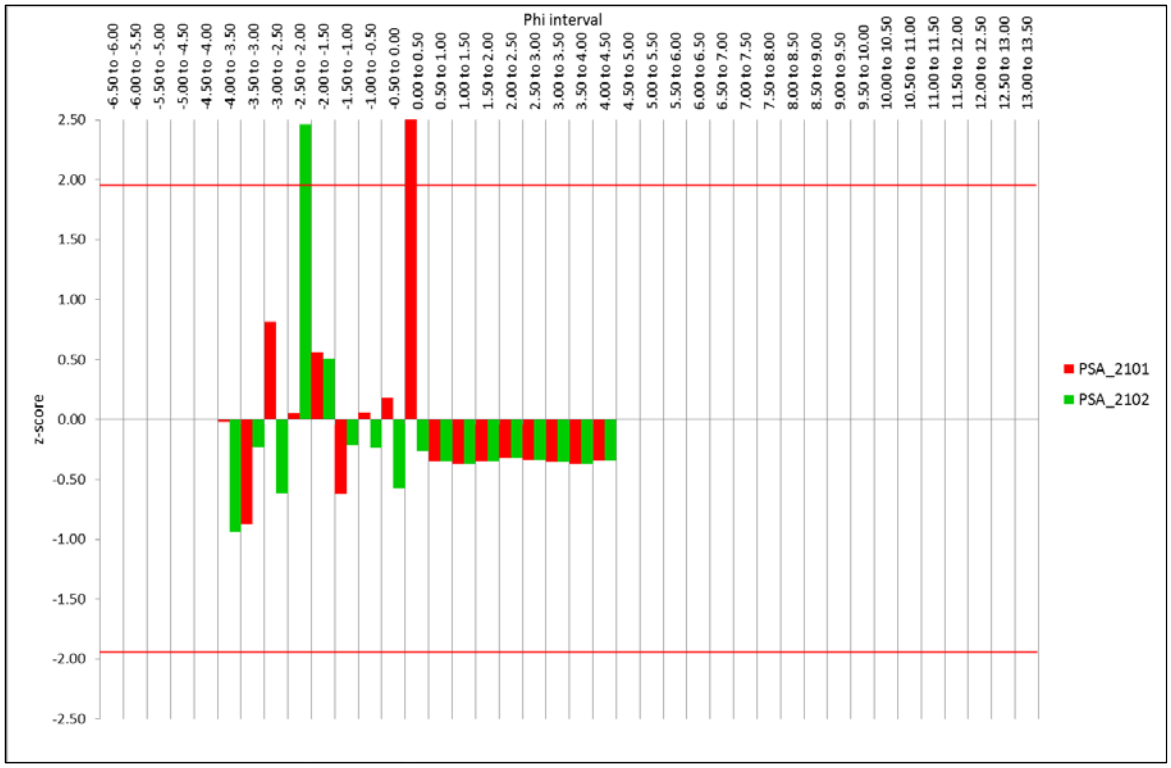


**Figure 6. Summary of z-scores in each half phi-interval for PS54 for a) PSA_2101 and PSA_2102 and b) PSA_2103 and PSA_2105**

a)




b)

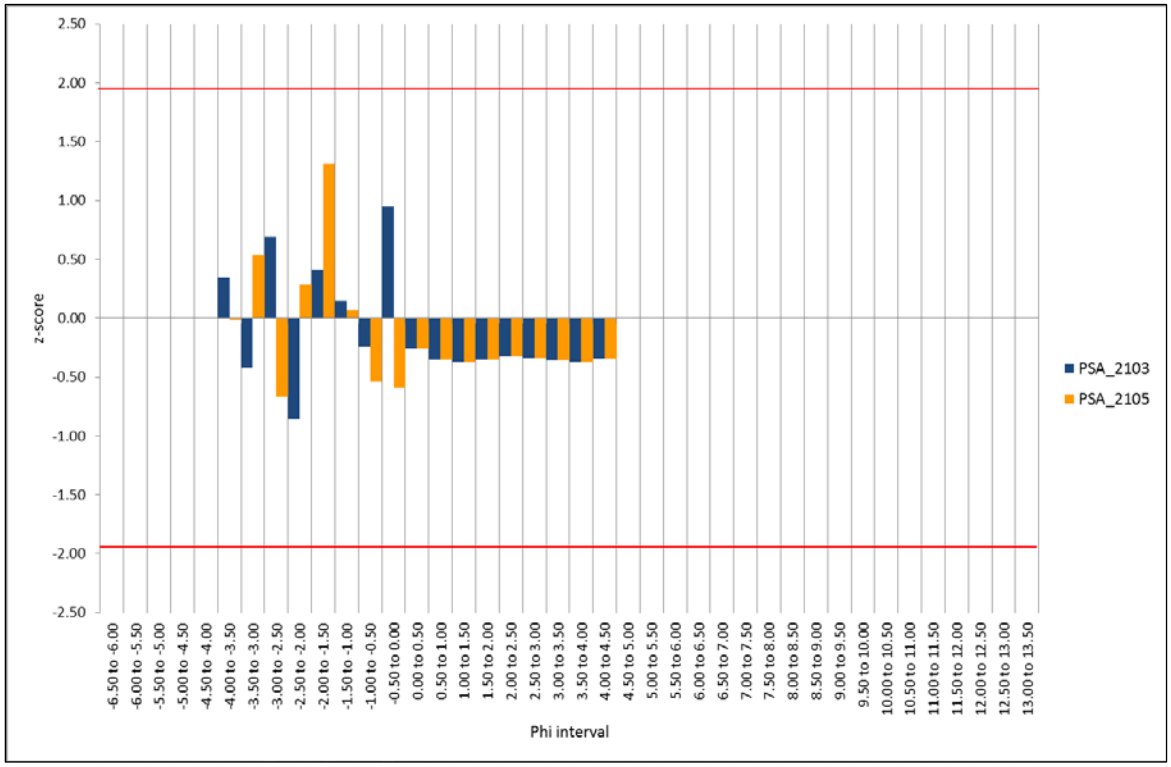
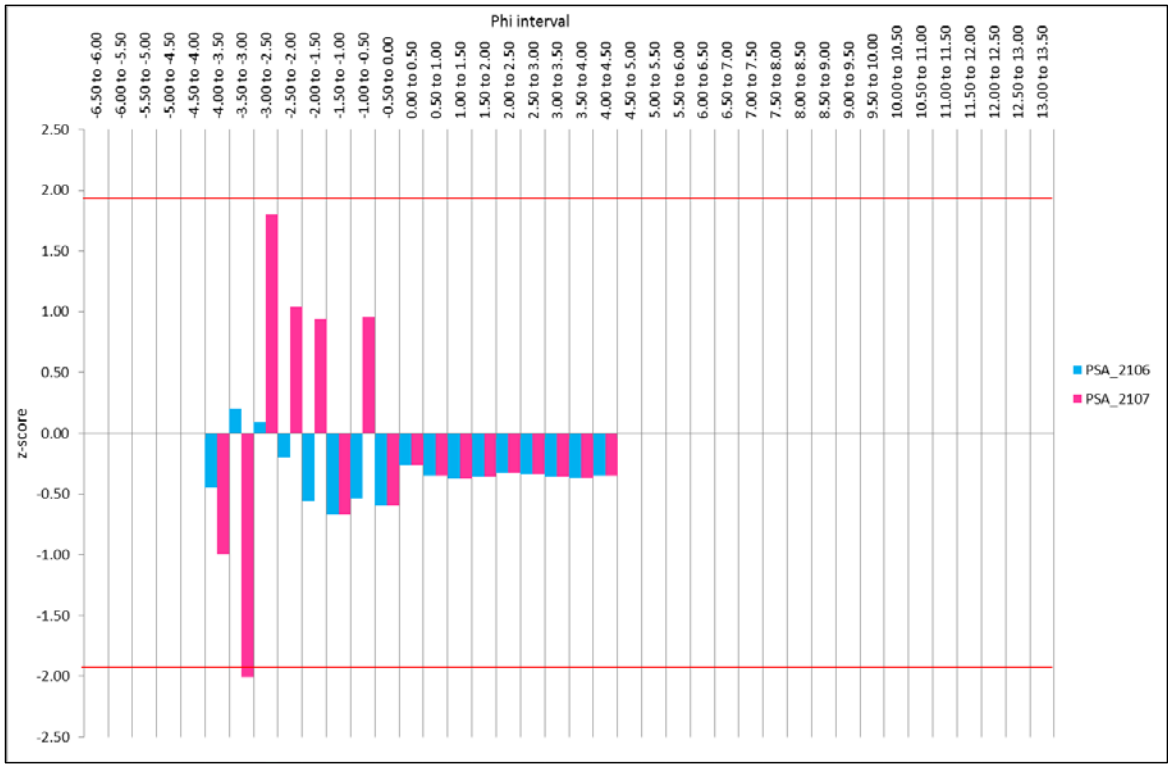


**Figure 7. Summary of z-scores in each half phi-interval for PS54 for a) PSA_2106 and PSA_2107 and b) PSA_2108 and PSA_2109**

a)




b)

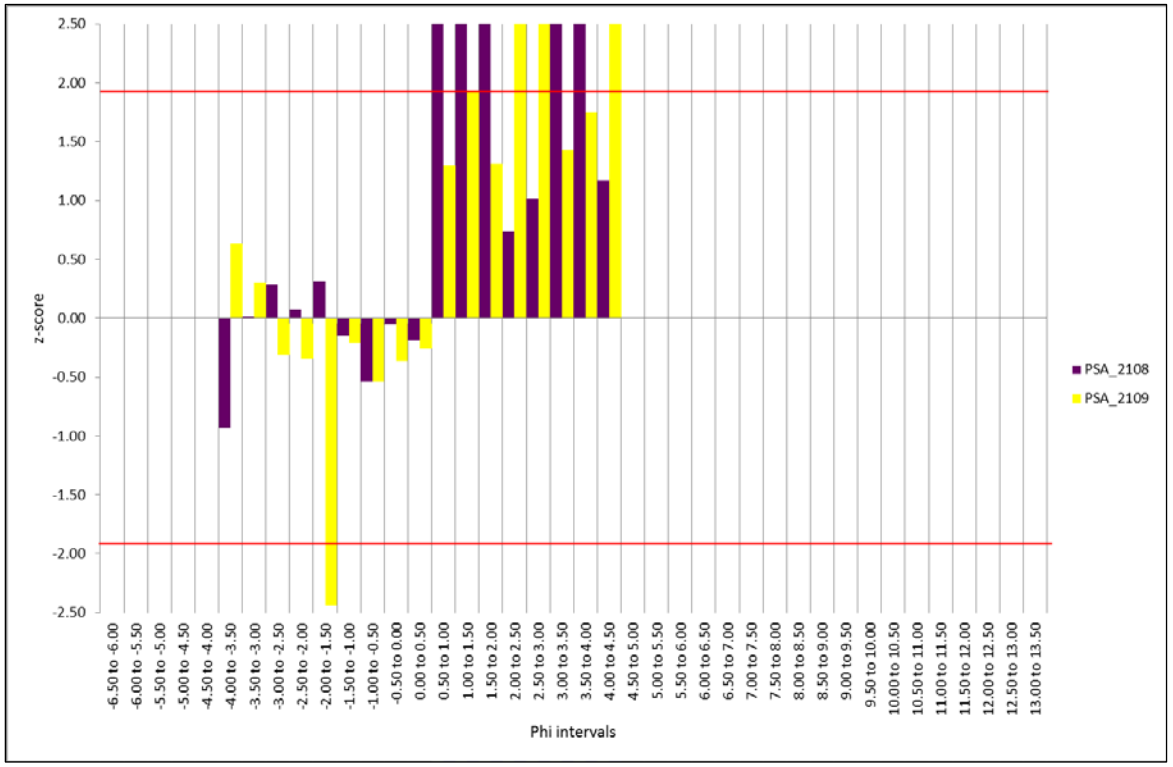
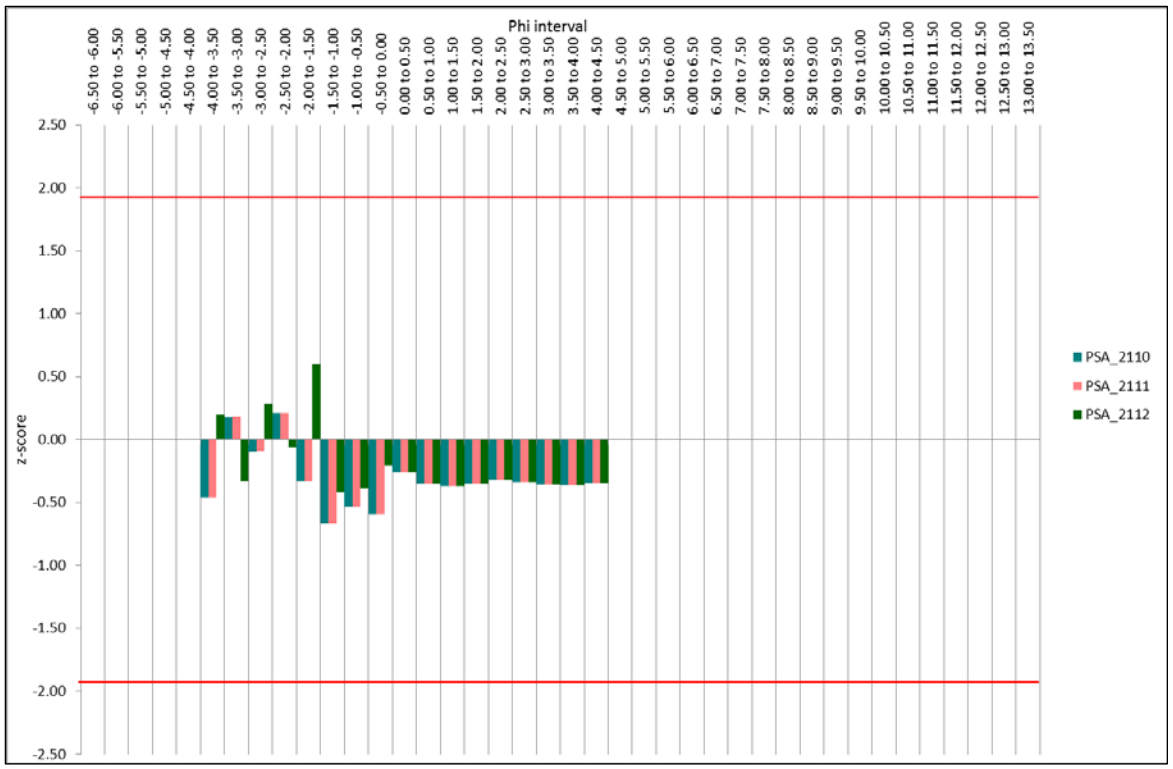


**Figure 8. Summary of z-scores in each half phi-interval for PS54 for a) PSA_2110, PSA_2111 and PSA_2112 and b) PSA_2113, PSA_2113_a and PSA_2114**

a)




b)

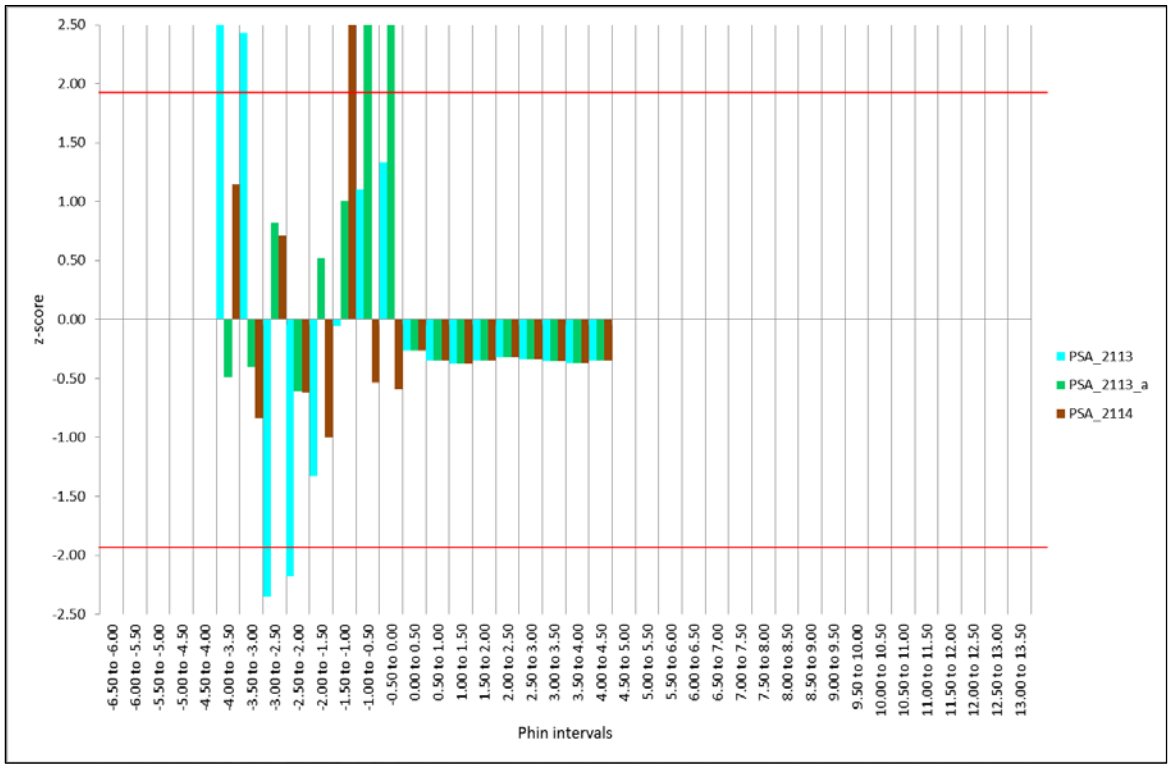
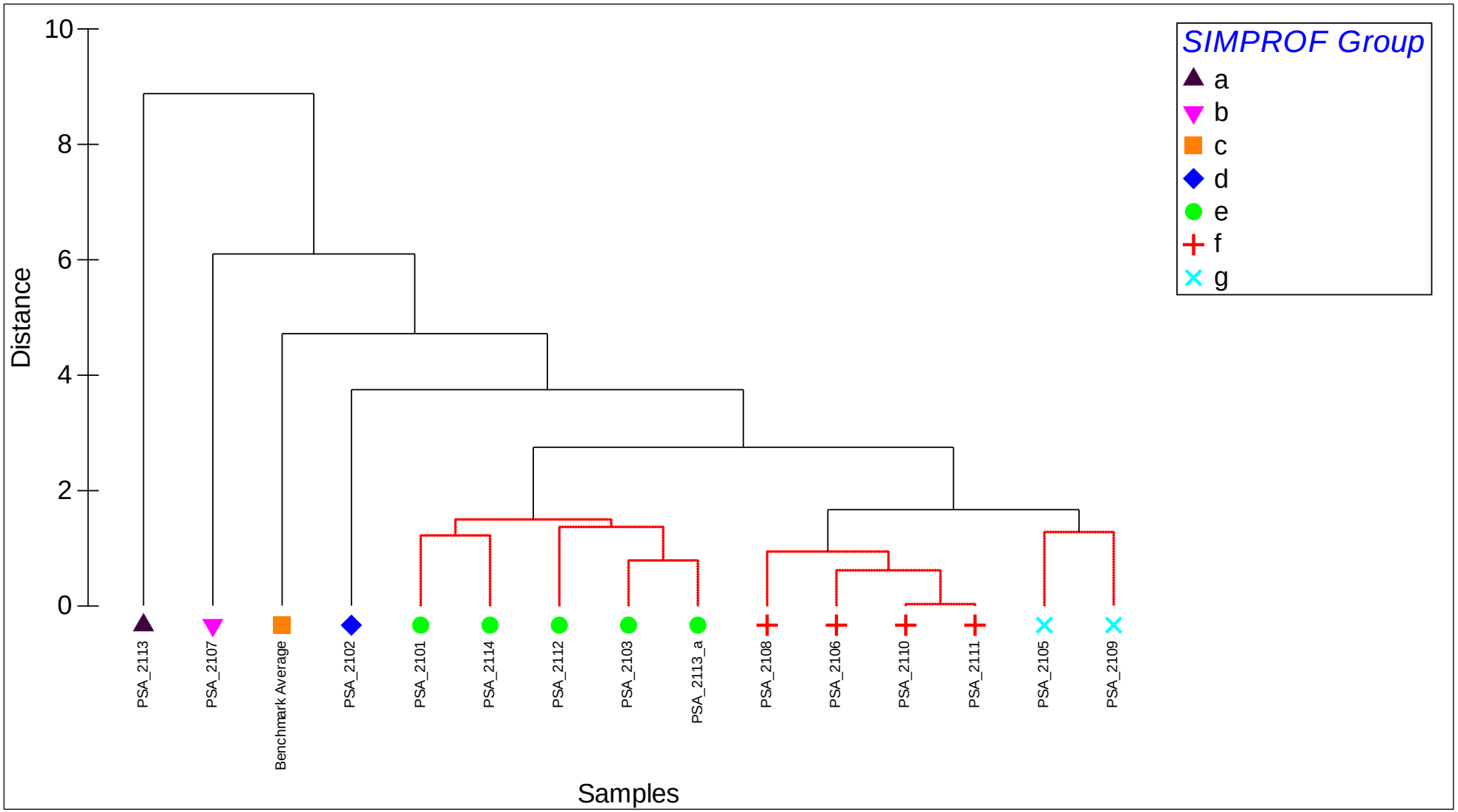


**Figure 9. Cluster dendrogram of PS54 including all participating laboratories, with the benchmark replicates averaged.**



## Results of SIMPROF testing on PSA Ring test PS54 data

Data was entered into PRIMER v.6.1.13 in half-phi intervals; any missing data was entered as zero. The data did not need to be transformed as all data was on a similar percentage scale. A Euclidean distance matrix was created from the data. The Euclidian distance between two samples is (labs) j and k, is defined algebraically as;

$$d_{jk} = \sqrt{\sum_{i=1}^{p} (y_{ij} - y_{ik})^2}$$

From this distance matrix cluster analysis was carried out. The most commonly used clustering methods are hierarchical agglomerative methods. These use a similarity or distance matrix as there starting point and successively fuse the samples into groups and the groups into larger clusters, starting with the highest mutual similarities then gradually lowering the similarity level at which groups are formed. The result of a hierarchical clustering is represented by a dendrogram (Figure 9), with the X axis representing the full set of samples (labs) and the y axis defining the similarity at which two samples or groups are considered to have fused (Clarke &Warwick, 2001)[1].

A similarity profile routine, SIMPROF was run on the data in conjunction with the cluster analysis. Similarity profile analysis examines whether the similarities observed in the data are smaller and/or larger than those expected by chance. The red SIMPROF lines on the dendrogram (Figure 9) indicate that labs cannot be distinguished from each other at the 5% significance level; black lines indicate labs that can be distinguished from each other.

The cluster analysis separates the labs into 7 SIMPROF cluster groups, 4 of these groups compromise a single lab.

Figure 4 shows that cluster group a (PSA_2113) recorded a higher percentage of medium gravel compared to other laboratories and cluster group b (PSA_2107) recorded a lower percentage of medium gravel.

The benchmark data (cluster group c) recorded the second highest percentage of medium gravel at 53.9. This was 1.3% more than the next highest PSA_2105 which fell into cluster group 9 along with PSA2109.

Figures 2a and 2b show that all laboratories and the benchmark data follow a similar cumulative percentage curve, whilst Figure 3 shows that all laboratories and benchmark data fall into the Gravel category on the particle size ternary diagram.

[1] Clarke, K.R. & Warwick,R.M. (2001). Changes in Marine Communities; an approach to statistical analysis and interpretation. 2nd Ed. PRIMER-E Ltd. Plymouth.

## Appendices

**Appendix 1. Final Merged Data sheets as supplied by participating laboratories for PS54 (arranged by Lab Code).**

**NMBAQCS - PS Exercise Data Workbook (Page 2 - Final Merged Data Submission)**

Return to APEM Ltd. by 06-02-15

| | |
|---|---|
| Exercise Code: | PS54 |
| LabCode: | PSA_2101 |
| Sample Code: | PS542101 |

| Phi interval (explicit) + sieve mesh (theoretical sieves shown in brackets) | Volume/Weight (mark as "0" for not analysed or no material) |
|---|---|
| *-6.50 to -6.00; 63 mm* | **0.00** |
| *-6.00 to -5.50; 45 mm* | **0.00** |
| *-5.50 to -5.00; 31.5 mm* | **0.00** |
| *-5.00 to -4.50; 22.4 mm* | **0.00** |
| *-4.50 to -4.00; 16 mm* | **0.00** |
| *-4.00 to -3.50; 11.2 mm* | **2.86** |
| *-3.50 to -3.00; 8 mm* | **46.69** |
| *-3.00 to -2.50; 5.6 mm* | **45.65** |
| *-2.50 to -2.00; 4 mm* | **4.38** |
| *-2.00 to -1.50; 2.8 mm* | **0.39** |
| *-1.50 to -1.00; 2 mm* | **0.00** |
| *-1.00 to -0.50; 1.4 mm* | **0.00** |
| *-0.50 to 0.00; 1 mm* | **0.00** |
| *0.00 to 0.50; (707 µm)* | 0.03 |
| *0.50 to 1.00; (500 µm)* | 0.00 |
| *1.00 to 1.50; (353.6 µm)* | 0.00 |
| *1.50 to 2.00; (250 µm)* | 0.00 |
| *2.00 to 2.50; (176.8 µm)* | 0.00 |
| *2.50 to 3.00; (125 µm)* | 0.00 |
| *3.00 to 3.50; (88.39 µm)* | 0.00 |
| *3.50 to 4.00; (62.5 µm)* | 0.00 |
| *4.00 to 4.50; (44.19 µm)* | 0.00 |
| *4.50 to 5.00; (31.25 µm)* | 0.00 |
| *5.00 to 5.50; (22.097 µm)* | 0.00 |
| *5.50 to 6.00; (15.625 µm)* | 0.00 |
| *6.00 to 6.50; (11.049 µm)* | 0.00 |
| *6.50 to 7.00; (7.813 µm)* | 0.00 |
| *7.00 to 7.50; (5.524 µm)* | 0.00 |
| *7.50 to 8.00; (3.906 µm)* | 0.00 |
| *8.00 to 8.50; (2.762 µm)* | 0.00 |
| *8.50 to 9.00; (1.953 µm)* | 0.00 |
| *9.00 to 9.50; (1.381 µm)* | 0.00 |
| *9.50 to 10.00; (0.977 µm)* | 0.00 |
| *10.00 to 10.50; (0.691 µm)* | 0.00 |
| *10.50 to 11.00; (0.488 µm)* | 0.00 |
| *11.00 to 11.50; (0.345 µm)* | 0.00 |
| *11.50 to 12.00; (0.244 µm)* | 0.00 |
| *12.00 to 12.50; (0.173 µm)* | 0.00 |
| *12.50 to 13.00; (0.122 µm)* | 0.00 |
| *13.00 to 13.50; (0.086 µm)* | 0.00 |

**Appendix 1. Final Merged Data sheets as supplied by participating laboratories for PS54 (arranged by Lab Code).**

**NMBAQCS - PS Exercise Data Workbook (Page 2 - Final Merged Data Submission)**

Return to APEM Ltd. by 06-02-15

| | |
|---|---|
| **Exercise Code:** | **PS54** |
| **LabCode:** | **PSA_2102** |
| **Sample Code:** | **PS542102** |

| Phi interval (explicit) + sieve mesh (theoretical sieves shown in brackets) | Volume/Weight (mark as "0" for not analysed or no material) |
|---|---|
| *-6.50 to -6.00; 63 mm* | **0.0000** |
| *-6.00 to -5.50; 45 mm* | **0.0000** |
| *-5.50 to -5.00; 31.5 mm* | **0.0000** |
| *-5.00 to -4.50; 22.4 mm* | **0.0000** |
| *-4.50 to -4.00; 16 mm* | **0.0000** |
| *-4.00 to -3.50; 11.2 mm* | **2.1137** |
| *-3.50 to -3.00; 8 mm* | **48.0762** |
| *-3.00 to -2.50; 5.6 mm* | **42.4425** |
| *-2.50 to -2.00; 4 mm* | **6.9658** |
| *-2.00 to -1.50; 2.8 mm* | **0.3882** |
| *-1.50 to -1.00; 2 mm* | **0.0115** |
| *-1.00 to -0.50; 1.4 mm* | **0.0021** |
| *-0.50 to 0.00; 1 mm* | **0.0001** |
| *0.00 to 0.50; (707 µm)* | 0.0000 |
| *0.50 to 1.00; (500 µm)* | 0.0000 |
| *1.00 to 1.50; (353.6 µm)* | 0.0000 |
| *1.50 to 2.00; (250 µm)* | 0.0000 |
| *2.00 to 2.50; (176.8 µm)* | 0.0000 |
| *2.50 to 3.00; (125 µm)* | 0.0000 |
| *3.00 to 3.50; (88.39 µm)* | 0.0000 |
| *3.50 to 4.00; (62.5 µm)* | 0.0000 |
| *4.00 to 4.50; (44.19 µm)* | 0.0000 |
| *4.50 to 5.00; (31.25 µm)* | 0.0000 |
| *5.00 to 5.50; (22.097 µm)* | 0.0000 |
| *5.50 to 6.00; (15.625 µm)* | 0.0000 |
| *6.00 to 6.50; (11.049 µm)* | 0.0000 |
| *6.50 to 7.00; (7.813 µm)* | 0.0000 |
| *7.00 to 7.50; (5.524 µm)* | 0.0000 |
| *7.50 to 8.00; (3.906 µm)* | 0.0000 |
| *8.00 to 8.50; (2.762 µm)* | 0.0000 |
| *8.50 to 9.00; (1.953 µm)* | 0.0000 |
| *9.00 to 9.50; (1.381 µm)* | 0.0000 |
| *9.50 to 10.00; (0.977 µm)* | 0.0000 |
| *10.00 to 10.50; (0.691 µm)* | 0.0000 |
| *10.50 to 11.00; (0.488 µm)* | 0.0000 |
| *11.00 to 11.50; (0.345 µm)* | 0.0000 |
| *11.50 to 12.00; (0.244 µm)* | 0.0000 |
| *12.00 to 12.50; (0.173 µm)* | 0.0000 |
| *12.50 to 13.00; (0.122 µm)* | 0.0000 |
| *13.00 to 13.50; (0.086 µm)* | 0.0000 |

**Appendix 1. Final Merged Data sheets as supplied by participating laboratories for PS54 (arranged by Lab Code).**

**NMBAQCS - PS Exercise Data Workbook (Page 2 - Final Merged Data Submission)**

Return to APEM Ltd. by 06-02-15

| | |
|---|---|
| Exercise Code: | PS54 |
| LabCode: | PSA_2103 |
| Sample Code: | PS542103 |

| Phi interval (explicit) + sieve mesh (theoretical sieves shown in brackets) | Volume/Weight (mark as "0" for not analysed or no material) |
|---|---|
| *-6.50 to -6.00; 63 mm* | **0.0000** |
| *-6.00 to -5.50; 45 mm* | **0.0000** |
| *-5.50 to -5.00; 31.5 mm* | **0.0000** |
| *-5.00 to -4.50; 22.4 mm* | **0.0000** |
| *-4.50 to -4.00; 16 mm* | **0.0000** |
| *-4.00 to -3.50; 11.2 mm* | **30.1600** |
| *-3.50 to -3.00; 8 mm* | **455.8000** |
| *-3.00 to -2.50; 5.6 mm* | **433.9300** |
| *-2.50 to -2.00; 4 mm* | **32.5600** |
| *-2.00 to -1.50; 2.8 mm* | **3.6700** |
| *-1.50 to -1.00; 2 mm* | **0.2000** |
| *-1.00 to -0.50; 1.4 mm* | **0.0200** |
| *-0.50 to 0.00; 1 mm* | **0.0400** |
| *0.00 to 0.50; (707 µm)* | 0.0000 |
| *0.50 to 1.00; (500 µm)* | 0.0000 |
| *1.00 to 1.50; (353.6 µm)* | 0.0000 |
| *1.50 to 2.00; (250 µm)* | 0.0000 |
| *2.00 to 2.50; (176.8 µm)* | 0.0000 |
| *2.50 to 3.00; (125 µm)* | 0.0000 |
| *3.00 to 3.50; (88.39 µm)* | 0.0000 |
| *3.50 to 4.00; (62.5 µm)* | 0.0000 |
| *4.00 to 4.50; (44.19 µm)* | 0.0000 |
| *4.50 to 5.00; (31.25 µm)* | 0.0000 |
| *5.00 to 5.50; (22.097 µm)* | 0.0000 |
| *5.50 to 6.00; (15.625 µm)* | 0.0000 |
| *6.00 to 6.50; (11.049 µm)* | 0.0000 |
| *6.50 to 7.00; (7.813 µm)* | 0.0000 |
| *7.00 to 7.50; (5.524 µm)* | 0.0000 |
| *7.50 to 8.00; (3.906 µm)* | 0.0000 |
| *8.00 to 8.50; (2.762 µm)* | 0.0000 |
| *8.50 to 9.00; (1.953 µm)* | 0.0000 |
| *9.00 to 9.50; (1.381 µm)* | 0.0000 |
| *9.50 to 10.00; (0.977 µm)* | 0.0000 |
| *10.00 to 10.50; (0.691 µm)* | 0.0000 |
| *10.50 to 11.00; (0.488 µm)* | 0.0000 |
| *11.00 to 11.50; (0.345 µm)* | 0.0000 |
| *11.50 to 12.00; (0.244 µm)* | 0.0000 |
| *12.00 to 12.50; (0.173 µm)* | 0.0000 |
| *12.50 to 13.00; (0.122 µm)* | 0.0000 |
| *13.00 to 13.50; (0.086 µm)* | 0.0000 |

**Appendix 1. Final Merged Data sheets as supplied by participating laboratories for PS54 (arranged by Lab Code).**

**NMBAQCS - PS Exercise Data Workbook (Page 2 - Final Merged Data Submission)**

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| | |
|---|---|
| Exercise Code: | PS54 |
| LabCode: | PSA_2105 |
| Sample Code: | PS542105 |

| Phi interval (explicit) + sieve mesh (theoretical sieves shown in brackets) | Volume/Weight (mark as "0" for not analysed or no material) |
|---|---|
| *-6.50 to -6.00; 63 mm* | **0.0000** |
| *-6.00 to -5.50; 45 mm* | **0.0000** |
| *-5.50 to -5.00; 31.5 mm* | **0.0000** |
| *-5.00 to -4.50; 22.4 mm* | **0.0000** |
| *-4.50 to -4.00; 16 mm* | **0.0000** |
| *-4.00 to -3.50; 11.2 mm* | **2.8630** |
| *-3.50 to -3.00; 8 mm* | **49.7439** |
| *-3.00 to -2.50; 5.6 mm* | **42.3260** |
| *-2.50 to -2.00; 4 mm* | **4.6240** |
| *-2.00 to -1.50; 2.8 mm* | **0.4243** |
| *-1.50 to -1.00; 2 mm* | **0.0189** |
| *-1.00 to -0.50; 1.4 mm* | **0.0000** |
| *-0.50 to 0.00; 1 mm* | **0.0000** |
| *0.00 to 0.50; (707 µm)* | 0.0000 |
| *0.50 to 1.00; (500 µm)* | 0.0000 |
| *1.00 to 1.50; (353.6 µm)* | 0.0000 |
| *1.50 to 2.00; (250 µm)* | 0.0000 |
| *2.00 to 2.50; (176.8 µm)* | 0.0000 |
| *2.50 to 3.00; (125 µm)* | 0.0000 |
| *3.00 to 3.50; (88.39 µm)* | 0.0000 |
| *3.50 to 4.00; (62.5 µm)* | 0.0000 |
| *4.00 to 4.50; (44.19 µm)* | 0.0000 |
| *4.50 to 5.00; (31.25 µm)* | 0.0000 |
| *5.00 to 5.50; (22.097 µm)* | 0.0000 |
| *5.50 to 6.00; (15.625 µm)* | 0.0000 |
| *6.00 to 6.50; (11.049 µm)* | 0.0000 |
| *6.50 to 7.00; (7.813 µm)* | 0.0000 |
| *7.00 to 7.50; (5.524 µm)* | 0.0000 |
| *7.50 to 8.00; (3.906 µm)* | 0.0000 |
| *8.00 to 8.50; (2.762 µm)* | 0.0000 |
| *8.50 to 9.00; (1.953 µm)* | 0.0000 |
| *9.00 to 9.50; (1.381 µm)* | 0.0000 |
| *9.50 to 10.00; (0.977 µm)* | 0.0000 |
| *10.00 to 10.50; (0.691 µm)* | 0.0000 |
| *10.50 to 11.00; (0.488 µm)* | 0.0000 |
| *11.00 to 11.50; (0.345 µm)* | 0.0000 |
| *11.50 to 12.00; (0.244 µm)* | 0.0000 |
| *12.00 to 12.50; (0.173 µm)* | 0.0000 |
| *12.50 to 13.00; (0.122 µm)* | 0.0000 |
| *13.00 to 13.50; (0.086 µm)* | 0.0000 |

**Appendix 1. Final Merged Data sheets as supplied by participating laboratories for PS54 (arranged by Lab Code).**

**NMBAQCS - PS Exercise Data Workbook (Page 2 - Final Merged Data Submission)**

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| | |
|---|---|
| Exercise Code: | PS54 |
| LabCode: | PSA_2106 |
| Sample Code: | PS542106 |

| Phi interval (explicit) + sieve mesh (theoretical sieves shown in brackets) | Volume/Weight (mark as "0" for not analysed or no material) |
|---|---|
| *-6.50 to -6.00; 63 mm* | **0.0000** |
| *-6.00 to -5.50; 45 mm* | **0.0000** |
| *-5.50 to -5.00; 31.5 mm* | **0.0000** |
| *-5.00 to -4.50; 22.4 mm* | **0.0000** |
| *-4.50 to -4.00; 16 mm* | **0.0000** |
| *-4.00 to -3.50; 11.2 mm* | **2.5100** |
| *-3.50 to -3.00; 8 mm* | **49.0200** |
| *-3.00 to -2.50; 5.6 mm* | **44.0300** |
| *-2.50 to -2.00; 4 mm* | **4.1100** |
| *-2.00 to -1.50; 2.8 mm* | **0.3400** |
| *-1.50 to -1.00; 2 mm* | **0.0000** |
| *-1.00 to -0.50; 1.4 mm* | **0.0000** |
| *-0.50 to 0.00; 1 mm* | **0.0000** |
| *0.00 to 0.50; (707 µm)* | 0.0000 |
| *0.50 to 1.00; (500 µm)* | 0.0000 |
| *1.00 to 1.50; (353.6 µm)* | 0.0000 |
| *1.50 to 2.00; (250 µm)* | 0.0000 |
| *2.00 to 2.50; (176.8 µm)* | 0.0000 |
| *2.50 to 3.00; (125 µm)* | 0.0000 |
| *3.00 to 3.50; (88.39 µm)* | 0.0000 |
| *3.50 to 4.00; (62.5 µm)* | 0.0000 |
| *4.00 to 4.50; (44.19 µm)* | 0.0000 |
| *4.50 to 5.00; (31.25 µm)* | 0.0000 |
| *5.00 to 5.50; (22.097 µm)* | 0.0000 |
| *5.50 to 6.00; (15.625 µm)* | 0.0000 |
| *6.00 to 6.50; (11.049 µm)* | 0.0000 |
| *6.50 to 7.00; (7.813 µm)* | 0.0000 |
| *7.00 to 7.50; (5.524 µm)* | 0.0000 |
| *7.50 to 8.00; (3.906 µm)* | 0.0000 |
| *8.00 to 8.50; (2.762 µm)* | 0.0000 |
| *8.50 to 9.00; (1.953 µm)* | 0.0000 |
| *9.00 to 9.50; (1.381 µm)* | 0.0000 |
| *9.50 to 10.00; (0.977 µm)* | 0.0000 |
| *10.00 to 10.50; (0.691 µm)* | 0.0000 |
| *10.50 to 11.00; (0.488 µm)* | 0.0000 |
| *11.00 to 11.50; (0.345 µm)* | 0.0000 |
| *11.50 to 12.00; (0.244 µm)* | 0.0000 |
| *12.00 to 12.50; (0.173 µm)* | 0.0000 |
| *12.50 to 13.00; (0.122 µm)* | 0.0000 |
| *13.00 to 13.50; (0.086 µm)* | 0.0000 |

**Appendix 1. Final Merged Data sheets as supplied by participating laboratories for PS54 (arranged by Lab Code).**

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| | |
|---|---|
| **Exercise Code:** | **PS54** |
| **LabCode:** | **PSA_2107** |
| **Sample Code:** | **PS542107** |

| Phi interval (explicit) + sieve mesh (theoretical sieves shown in brackets) | Volume/Weight (mark as "0" for not analysed or no material) |
|---|---|
| *-6.50 to -6.00; 63 mm* | **0.0000** |
| *-6.00 to -5.50; 45 mm* | **0.0000** |
| *-5.50 to -5.00; 31.5 mm* | **0.0000** |
| *-5.00 to -4.50; 22.4 mm* | **0.0000** |
| *-4.50 to -4.00; 16 mm* | **0.0000** |
| *-4.00 to -3.50; 11.2 mm* | **2.0696** |
| *-3.50 to -3.00; 8 mm* | **44.2140** |
| *-3.00 to -2.50; 5.6 mm* | **47.8619** |
| *-2.50 to -2.00; 4 mm* | **5.4353** |
| *-2.00 to -1.50; 2.8 mm* | **0.4076** |
| *-1.50 to -1.00; 2 mm* | **0.0000** |
| *-1.00 to -0.50; 1.4 mm* | **0.0105** |
| *-0.50 to 0.00; 1 mm* | **0.0000** |
| *0.00 to 0.50; (707 µm)* | 0.0000 |
| *0.50 to 1.00; (500 µm)* | 0.0000 |
| *1.00 to 1.50; (353.6 µm)* | 0.0000 |
| *1.50 to 2.00; (250 µm)* | 0.0000 |
| *2.00 to 2.50; (176.8 µm)* | 0.0000 |
| *2.50 to 3.00; (125 µm)* | 0.0000 |
| *3.00 to 3.50; (88.39 µm)* | 0.0000 |
| *3.50 to 4.00; (62.5 µm)* | 0.0000 |
| *4.00 to 4.50; (44.19 µm)* | 0.0000 |
| *4.50 to 5.00; (31.25 µm)* | 0.0000 |
| *5.00 to 5.50; (22.097 µm)* | 0.0000 |
| *5.50 to 6.00; (15.625 µm)* | 0.0000 |
| *6.00 to 6.50; (11.049 µm)* | 0.0000 |
| *6.50 to 7.00; (7.813 µm)* | 0.0000 |
| *7.00 to 7.50; (5.524 µm)* | 0.0000 |
| *7.50 to 8.00; (3.906 µm)* | 0.0000 |
| *8.00 to 8.50; (2.762 µm)* | 0.0000 |
| *8.50 to 9.00; (1.953 µm)* | 0.0000 |
| *9.00 to 9.50; (1.381 µm)* | 0.0000 |
| *9.50 to 10.00; (0.977 µm)* | 0.0000 |
| *10.00 to 10.50; (0.691 µm)* | 0.0000 |
| *10.50 to 11.00; (0.488 µm)* | 0.0000 |
| *11.00 to 11.50; (0.345 µm)* | 0.0000 |
| *11.50 to 12.00; (0.244 µm)* | 0.0000 |
| *12.00 to 12.50; (0.173 µm)* | 0.0000 |
| *12.50 to 13.00; (0.122 µm)* | 0.0000 |
| *13.00 to 13.50; (0.086 µm)* | 0.0000 |

**Appendix 1. Final Merged Data sheets as supplied by participating laboratories for PS54 (arranged by Lab Code).**

**NMBAQCS - PS Exercise Data Workbook (Page 2 - Final Merged Data Submission)**

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| | |
|---|---|
| **Exercise Code:** | **PS54** |
| **LabCode:** | **PSA_2108** |
| **Sample Code:** | **PS542108** |

| Phi interval (explicit) + sieve mesh (theoretical sieves shown in brackets) | Volume (mark as "0" for not analysed or no material) |
|---|---|
| *-6.50 to -6.00; 63 mm* | **0.0000** |
| *-6.00 to -5.50; 45 mm* | **0.0000** |
| *-5.50 to -5.00; 31.5 mm* | **0.0000** |
| *-5.00 to -4.50; 22.4 mm* | **0.0000** |
| *-4.50 to -4.00; 16 mm* | **0.0000** |
| *-4.00 to -3.50; 11.2 mm* | **2.1183** |
| *-3.50 to -3.00; 8 mm* | **48.6036** |
| *-3.00 to -2.50; 5.6 mm* | **44.4646** |
| *-2.50 to -2.00; 4 mm* | **4.4031** |
| *-2.00 to -1.50; 2.8 mm* | **0.3795** |
| *-1.50 to -1.00; 2 mm* | **0.0133** |
| *-1.00 to -0.50; 1.4 mm* | **0.0000** |
| *-0.50 to 0.00; 1 mm* | **0.0015** |
| *0.00 to 0.50; (707 µm)* | 0.0006 |
| *0.50 to 1.00; (500 µm)* | 0.0012 |
| *1.00 to 1.50; (353.6 µm)* | 0.0010 |
| *1.50 to 2.00; (250 µm)* | 0.0052 |
| *2.00 to 2.50; (176.8 µm)* | 0.0023 |
| *2.50 to 3.00; (125 µm)* | 0.0030 |
| *3.00 to 3.50; (88.39 µm)* | 0.0013 |
| *3.50 to 4.00; (62.5 µm)* | 0.0008 |
| *4.00 to 13.50; (44.19 - 0.086 µm) (Pan)* | 0.0007 |

**Appendix 1. Final Merged Data sheets as supplied by participating laboratories for PS54 (arranged by Lab Code).**

**NMBAQCS - PS Exercise Data Workbook (Page 2 - Final Merged Data Submission)**

Return to APEM Ltd. by 06-02-15

| | |
|---|---|
| Exercise Code: | PS54 |
| LabCode: | PSA_2109 |
| Sample Code: | PS542109 |

| Phi interval (explicit) + sieve mesh (theoretical sieves shown in brackets) | Volume/Weight (mark as "0" for not analysed or no material) |
|---|---|
| *-6.50 to -6.00; 63 mm* | **0.0000** |
| *-6.00 to -5.50; 45 mm* | **0.0000** |
| *-5.50 to -5.00; 31.5 mm* | **0.0000** |
| *-5.00 to -4.50; 22.4 mm* | **0.0000** |
| *-4.50 to -4.00; 16 mm* | **0.0000** |
| *-4.00 to -3.50; 11.2 mm* | **32.3950** |
| *-3.50 to -3.00; 8 mm* | **471.1370** |
| *-3.00 to -2.50; 5.6 mm* | **412.5520** |
| *-2.50 to -2.00; 4 mm* | **37.8470** |
| *-2.00 to -1.50; 2.8 mm* | **2.4410** |
| *-1.50 to -1.00; 2 mm* | **0.1130** |
| *-1.00 to -0.50; 1.4 mm* | **0.0000** |
| *-0.50 to 0.00; 1 mm* | **0.0060** |
| *0.00 to 0.50; (707 µm)* | 0.0000 |
| *0.50 to 1.00; (500 µm)* | 0.0050 |
| *1.00 to 1.50; (353.6 µm)* | 0.0070 |
| *1.50 to 2.00; (250 µm)* | 0.0230 |
| *2.00 to 2.50; (176.8 µm)* | 0.0790 |
| *2.50 to 3.00; (125 µm)* | 0.0800 |
| *3.00 to 3.50; (88.39 µm)* | 0.0060 |
| *3.50 to 4.00; (62.5 µm)* | 0.0050 |
| *4.00 to 4.50; (44.19 µm)* | 0.0170 |
| *4.50 to 5.00; (31.25 µm)* | 0.0000 |
| *5.00 to 5.50; (22.097 µm)* | 0.0000 |
| *5.50 to 6.00; (15.625 µm)* | 0.0000 |
| *6.00 to 6.50; (11.049 µm)* | 0.0000 |
| *6.50 to 7.00; (7.813 µm)* | 0.0000 |
| *7.00 to 7.50; (5.524 µm)* | 0.0000 |
| *7.50 to 8.00; (3.906 µm)* | 0.0000 |
| *8.00 to 8.50; (2.762 µm)* | 0.0000 |
| *8.50 to 9.00; (1.953 µm)* | 0.0000 |
| *9.00 to 9.50; (1.381 µm)* | 0.0000 |
| *9.50 to 10.00; (0.977 µm)* | 0.0000 |
| *10.00 to 10.50; (0.691 µm)* | 0.0000 |
| *10.50 to 11.00; (0.488 µm)* | 0.0000 |
| *11.00 to 11.50; (0.345 µm)* | 0.0000 |
| *11.50 to 12.00; (0.244 µm)* | 0.0000 |
| *12.00 to 12.50; (0.173 µm)* | 0.0000 |
| *12.50 to 13.00; (0.122 µm)* | 0.0000 |
| *13.00 to 13.50; (0.086 µm)* | 0.0000 |

**Appendix 1. Final Merged Data sheets as supplied by participating laboratories for PS54 (arranged by Lab Code).**

**NMBAQCS - PS Exercise Data Workbook (Page 2 - Final Merged Data Submission)**

Return to APEM Ltd. by 06-02-15

| | |
|---|---|
| **Exercise Code:** | **PS54** |
| **LabCode:** | **PSA_2110** |
| **Sample Code:** | **PS542110** |

| Phi interval (explicit) + sieve mesh (theoretical sieves shown in brackets) | Volume/Weight (mark as "0" for not analysed or no material) |
|---|---|
| *-6.50 to -6.00; 63 mm* | **0.0000** |
| *-6.00 to -5.50; 45 mm* | **0.0000** |
| *-5.50 to -5.00; 31.5 mm* | **0.0000** |
| *-5.00 to -4.50; 22.4 mm* | **0.0000** |
| *-4.50 to -4.00; 16 mm* | **0.0000** |
| *-4.00 to -3.50; 11.2 mm* | **2.5000** |
| *-3.50 to -3.00; 8 mm* | **48.9600** |
| *-3.00 to -2.50; 5.6 mm* | **43.6000** |
| *-2.50 to -2.00; 4 mm* | **4.5500** |
| *-2.00 to -1.50; 2.8 mm* | **0.3500** |
| *-1.50 to -1.00; 2 mm* | **0.0000** |
| *-1.00 to -0.50; 1.4 mm* | **0.0000** |
| *-0.50 to 0.00; 1 mm* | **0.0000** |
| *0.00 to 0.50; (707 µm)* | 0.0000 |
| *0.50 to 1.00; (500 µm)* | 0.0000 |
| *1.00 to 1.50; (353.6 µm)* | 0.0000 |
| *1.50 to 2.00; (250 µm)* | 0.0000 |
| *2.00 to 2.50; (176.8 µm)* | 0.0000 |
| *2.50 to 3.00; (125 µm)* | 0.0000 |
| *3.00 to 3.50; (88.39 µm)* | 0.0000 |
| *3.50 to 4.00; (62.5 µm)* | 0.0000 |
| *4.00 to 4.50; (44.19 µm)* | 0.0000 |
| *4.50 to 5.00; (31.25 µm)* | 0.0000 |
| *5.00 to 5.50; (22.097 µm)* | 0.0000 |
| *5.50 to 6.00; (15.625 µm)* | 0.0000 |
| *6.00 to 6.50; (11.049 µm)* | 0.0000 |
| *6.50 to 7.00; (7.813 µm)* | 0.0000 |
| *7.00 to 7.50; (5.524 µm)* | 0.0000 |
| *7.50 to 8.00; (3.906 µm)* | 0.0000 |
| *8.00 to 8.50; (2.762 µm)* | 0.0000 |
| *8.50 to 9.00; (1.953 µm)* | 0.0000 |
| *9.00 to 9.50; (1.381 µm)* | 0.0000 |
| *9.50 to 10.00; (0.977 µm)* | 0.0000 |
| *10.00 to 10.50; (0.691 µm)* | 0.0000 |
| *10.50 to 11.00; (0.488 µm)* | 0.0000 |
| *11.00 to 11.50; (0.345 µm)* | 0.0000 |
| *11.50 to 12.00; (0.244 µm)* | 0.0000 |
| *12.00 to 12.50; (0.173 µm)* | 0.0000 |
| *12.50 to 13.00; (0.122 µm)* | 0.0000 |
| *13.00 to 13.50; (0.086 µm)* | 0.0000 |

**Appendix 1. Final Merged Data sheets as supplied by participating laboratories for PS54 (arranged by Lab Code).**

**NMBAQCS - PS Exercise Data Workbook (Page 2 - Final Merged Data Submission)**

Return to APEM Ltd. by 06-02-15

| | |
|---|---|
| Exercise Code: | PS54 |
| LabCode: | PSA_2111 |
| Sample Code: | PS542111 |

| Phi interval (explicit) + sieve mesh (theoretical sieves shown in brackets) | Volume/Weight (mark as "0" for not analysed or no material) |
|---|---|
| *-6.50 to -6.00; 63 mm* | **0.0000** |
| *-6.00 to -5.50; 45 mm* | **0.0000** |
| *-5.50 to -5.00; 31.5 mm* | **0.0000** |
| *-5.00 to -4.50; 22.4 mm* | **0.0000** |
| *-4.50 to -4.00; 16 mm* | **0.0000** |
| *-4.00 to -3.50; 11.2 mm* | **21.0667** |
| *-3.50 to -3.00; 8 mm* | **440.7667** |
| *-3.00 to -2.50; 5.6 mm* | **445.0667** |
| *-2.50 to -2.00; 4 mm* | **46.1667** |
| *-2.00 to -1.50; 2.8 mm* | **5.0000** |
| *-1.50 to -1.00; 2 mm* | **0.0000** |
| *-1.00 to -0.50; 1.4 mm* | **0.0000** |
| *-0.50 to 0.00; 1 mm* | **0.0000** |
| *0.00 to 0.50; (707 µm)* | 0.0000 |
| *0.50 to 1.00; (500 µm)* | 0.0000 |
| *1.00 to 1.50; (353.6 µm)* | 0.0000 |
| *1.50 to 2.00; (250 µm)* | 0.0000 |
| *2.00 to 2.50; (176.8 µm)* | 0.0000 |
| *2.50 to 3.00; (125 µm)* | 0.0000 |
| *3.00 to 3.50; (88.39 µm)* | 0.0000 |
| *3.50 to 4.00; (62.5 µm)* | 0.0000 |
| *4.00 to 4.50; (44.19 µm)* | 0.0000 |
| *4.50 to 5.00; (31.25 µm)* | 0.0000 |
| *5.00 to 5.50; (22.097 µm)* | 0.0000 |
| *5.50 to 6.00; (15.625 µm)* | 0.0000 |
| *6.00 to 6.50; (11.049 µm)* | 0.0000 |
| *6.50 to 7.00; (7.813 µm)* | 0.0000 |
| *7.00 to 7.50; (5.524 µm)* | 0.0000 |
| *7.50 to 8.00; (3.906 µm)* | 0.0000 |
| *8.00 to 8.50; (2.762 µm)* | 0.0000 |
| *8.50 to 9.00; (1.953 µm)* | 0.0000 |
| *9.00 to 9.50; (1.381 µm)* | 0.0000 |
| *9.50 to 10.00; (0.977 µm)* | 0.0000 |
| *10.00 to 10.50; (0.691 µm)* | 0.0000 |
| *10.50 to 11.00; (0.488 µm)* | 0.0000 |
| *11.00 to 11.50; (0.345 µm)* | 0.0000 |
| *11.50 to 12.00; (0.244 µm)* | 0.0000 |
| *12.00 to 12.50; (0.173 µm)* | 0.0000 |
| *12.50 to 13.00; (0.122 µm)* | 0.0000 |
| *13.00 to 13.50; (0.086 µm)* | 0.0000 |

**Appendix 1. Final Merged Data sheets as supplied by participating laboratories for PS54 (arranged by Lab Code).**

**NMBAQCS - PS Exercise Data Workbook (Page 2 - Final Merged Data Submission)**

Return to APEM Ltd. by 06-02-15

| | |
|---|---|
| **Exercise Code:** | **PS54** |
| **LabCode:** | **PSA_2112** |
| **Sample Code:** | **PS542112** |

| Phi interval (explicit) + sieve mesh (theoretical sieves shown in brackets) | Volume/Weight (mark as "0" for not analysed or no material) |
|---|---|
| *-6.50 to -6.00; 63 mm* | **0.0000** |
| *-6.00 to -5.50; 45 mm* | **0.0000** |
| *-5.50 to -5.00; 31.5 mm* | **0.0000** |
| *-5.00 to -4.50; 22.4 mm* | **0.0000** |
| *-4.50 to -4.00; 16 mm* | **0.0000** |
| *-4.00 to -3.50; 11.2 mm* | **29.0300** |
| *-3.50 to -3.00; 8 mm* | **457.6000** |
| *-3.00 to -2.50; 5.6 mm* | **425.1000** |
| *-2.50 to -2.00; 4 mm* | **40.7000** |
| *-2.00 to -1.50; 2.8 mm* | **3.7500** |
| *-1.50 to -1.00; 2 mm* | **0.0600** |
| *-1.00 to -0.50; 1.4 mm* | **0.0100** |
| *-0.50 to 0.00; 1 mm* | **0.0100** |
| *0.00 to 0.50; (707 µm)* | 0.0000 |
| *0.50 to 1.00; (500 µm)* | 0.0000 |
| *1.00 to 1.50; (353.6 µm)* | 0.0000 |
| *1.50 to 2.00; (250 µm)* | 0.0000 |
| *2.00 to 2.50; (176.8 µm)* | 0.0000 |
| *2.50 to 3.00; (125 µm)* | 0.0000 |
| *3.00 to 3.50; (88.39 µm)* | 0.0000 |
| *3.50 to 4.00; (62.5 µm)* | 0.0000 |
| *4.00 to 4.50; (44.19 µm)* | 0.0000 |
| *4.50 to 5.00; (31.25 µm)* | 0.0000 |
| *5.00 to 5.50; (22.097 µm)* | 0.0000 |
| *5.50 to 6.00; (15.625 µm)* | 0.0000 |
| *6.00 to 6.50; (11.049 µm)* | 0.0000 |
| *6.50 to 7.00; (7.813 µm)* | 0.0000 |
| *7.00 to 7.50; (5.524 µm)* | 0.0000 |
| *7.50 to 8.00; (3.906 µm)* | 0.0000 |
| *8.00 to 8.50; (2.762 µm)* | 0.0000 |
| *8.50 to 9.00; (1.953 µm)* | 0.0000 |
| *9.00 to 9.50; (1.381 µm)* | 0.0000 |
| *9.50 to 10.00; (0.977 µm)* | 0.0000 |
| *10.00 to 10.50; (0.691 µm)* | 0.0000 |
| *10.50 to 11.00; (0.488 µm)* | 0.0000 |
| *11.00 to 11.50; (0.345 µm)* | 0.0000 |
| *11.50 to 12.00; (0.244 µm)* | 0.0000 |
| *12.00 to 12.50; (0.173 µm)* | 0.0000 |
| *12.50 to 13.00; (0.122 µm)* | 0.0000 |
| *13.00 to 13.50; (0.086 µm)* | 0.0000 |

**Appendix 1. Final Merged Data sheets as supplied by participating laboratories for PS54 (arranged by Lab Code).**

**NMBAQCS - PS Exercise Data Workbook (Page 2 - Final Merged Data Submission)**

Return to APEM Ltd. by 06-02-15

| | |
|---|---|
| Exercise Code: | PS54 |
| LabCode: | PSA_2113 |
| Sample Code: | PS542113 |

| Phi interval (explicit) + sieve mesh (theoretical sieves shown in brackets) | Volume/Weight (mark as "0" for not analysed or no material) |
|---|---|
| *-6.50 to -6.00; 63 mm* | **0.0000** |
| *-6.00 to -5.50; 45 mm* | **0.0000** |
| *-5.50 to -5.00; 31.5 mm* | **0.0000** |
| *-5.00 to -4.50; 22.4 mm* | **0.0000** |
| *-4.50 to -4.00; 16 mm* | **0.0000** |
| *-4.00 to -3.50; 11.2 mm* | **5.2099** |
| *-3.50 to -3.00; 8 mm* | **53.8719** |
| *-3.00 to -2.50; 5.6 mm* | **38.5557** |
| *-2.50 to -2.00; 4 mm* | **1.9874** |
| *-2.00 to -1.50; 2.8 mm* | **0.3051** |
| *-1.50 to -1.00; 2 mm* | **0.0157** |
| *-1.00 to -0.50; 1.4 mm* | **0.0115** |
| *-0.50 to 0.00; 1 mm* | **0.0052** |
| *0.00 to 0.50; (707 µm)* | 0.0000 |
| *0.50 to 1.00; (500 µm)* | 0.0000 |
| *1.00 to 1.50; (353.6 µm)* | 0.0000 |
| *1.50 to 2.00; (250 µm)* | 0.0000 |
| *2.00 to 2.50; (176.8 µm)* | 0.0000 |
| *2.50 to 3.00; (125 µm)* | 0.0000 |
| *3.00 to 3.50; (88.39 µm)* | 0.0000 |
| *3.50 to 4.00; (62.5 µm)* | 0.0000 |
| *4.00 to 4.50; (44.19 µm)* | 0.0000 |
| *4.50 to 5.00; (31.25 µm)* | 0.0000 |
| *5.00 to 5.50; (22.097 µm)* | 0.0000 |
| *5.50 to 6.00; (15.625 µm)* | 0.0000 |
| *6.00 to 6.50; (11.049 µm)* | 0.0000 |
| *6.50 to 7.00; (7.813 µm)* | 0.0000 |
| *7.00 to 7.50; (5.524 µm)* | 0.0000 |
| *7.50 to 8.00; (3.906 µm)* | 0.0000 |
| *8.00 to 8.50; (2.762 µm)* | 0.0000 |
| *8.50 to 9.00; (1.953 µm)* | 0.0000 |
| *9.00 to 9.50; (1.381 µm)* | 0.0000 |
| *9.50 to 10.00; (0.977 µm)* | 0.0000 |
| *10.00 to 10.50; (0.691 µm)* | 0.0000 |
| *10.50 to 11.00; (0.488 µm)* | 0.0000 |
| *11.00 to 11.50; (0.345 µm)* | 0.0000 |
| *11.50 to 12.00; (0.244 µm)* | 0.0000 |
| *12.00 to 12.50; (0.173 µm)* | 0.0000 |
| *12.50 to 13.00; (0.122 µm)* | 0.0000 |
| *13.00 to 13.50; (0.086 µm)* | 0.0000 |

**Appendix 1. Final Merged Data sheets as supplied by participating laboratories for PS54 (arranged by Lab Code).**

**NMBAQCS - PS Exercise Data Workbook (Page 2 - Final Merged Data Submission)**

Return to APEM Ltd. by 06-02-15

| | |
|---|---|
| **Exercise Code:** | **PS54** |
| **LabCode:** | **PSA_2113_a** |
| **Sample Code:** | **PS542113_a** |

| Phi interval (explicit) + sieve mesh (theoretical sieves shown in brackets) | Volume/Weight (mark as "0" for not analysed or no material) |
|---|---|
| *-6.50 to -6.00; 63 mm* | **0.0000** |
| *-6.00 to -5.50; 45 mm* | **0.0000** |
| *-5.50 to -5.00; 31.5 mm* | **0.0000** |
| *-5.00 to -4.50; 22.4 mm* | **0.0000** |
| *-4.50 to -4.00; 16 mm* | **0.0000** |
| *-4.00 to -3.50; 11.2 mm* | **2.4760** |
| *-3.50 to -3.00; 8 mm* | **47.7048** |
| *-3.00 to -2.50; 5.6 mm* | **45.6573** |
| *-2.50 to -2.00; 4 mm* | **3.6706** |
| *-2.00 to -1.50; 2.8 mm* | **0.3888** |
| *-1.50 to -1.00; 2 mm* | **0.0429** |
| *-1.00 to -0.50; 1.4 mm* | **0.0251** |
| *-0.50 to 0.00; 1 mm* | **0.0094** |
| *0.00 to 0.50; (707 µm)* | 0.0000 |
| *0.50 to 1.00; (500 µm)* | 0.0000 |
| *1.00 to 1.50; (353.6 µm)* | 0.0000 |
| *1.50 to 2.00; (250 µm)* | 0.0000 |
| *2.00 to 2.50; (176.8 µm)* | 0.0000 |
| *2.50 to 3.00; (125 µm)* | 0.0000 |
| *3.00 to 3.50; (88.39 µm)* | 0.0000 |
| *3.50 to 4.00; (62.5 µm)* | 0.0000 |
| *4.00 to 4.50; (44.19 µm)* | 0.0000 |
| *4.50 to 5.00; (31.25 µm)* | 0.0000 |
| *5.00 to 5.50; (22.097 µm)* | 0.0000 |
| *5.50 to 6.00; (15.625 µm)* | 0.0000 |
| *6.00 to 6.50; (11.049 µm)* | 0.0000 |
| *6.50 to 7.00; (7.813 µm)* | 0.0000 |
| *7.00 to 7.50; (5.524 µm)* | 0.0000 |
| *7.50 to 8.00; (3.906 µm)* | 0.0000 |
| *8.00 to 8.50; (2.762 µm)* | 0.0000 |
| *8.50 to 9.00; (1.953 µm)* | 0.0000 |
| *9.00 to 9.50; (1.381 µm)* | 0.0000 |
| *9.50 to 10.00; (0.977 µm)* | 0.0000 |
| *10.00 to 10.50; (0.691 µm)* | 0.0000 |
| *10.50 to 11.00; (0.488 µm)* | 0.0000 |
| *11.00 to 11.50; (0.345 µm)* | 0.0000 |
| *11.50 to 12.00; (0.244 µm)* | 0.0000 |
| *12.00 to 12.50; (0.173 µm)* | 0.0000 |
| *12.50 to 13.00; (0.122 µm)* | 0.0000 |
| *13.00 to 13.50; (0.086 µm)* | 0.0000 |

**Appendix 1. Final Merged Data sheets as supplied by participating laboratories for PS54 (arranged by Lab Code).**

**NMBAQCS - PS Exercise Data Workbook (Page 2 - Final Merged Data Submission)**

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| | |
|---|---|
| Exercise Code: | PS54 |
| LabCode: | PSA_2114 |
| Sample Code: | PS542114 |

| Phi interval (explicit) + sieve mesh (theoretical sieves shown in brackets) | Volume/Weight (mark as "0" for not analysed or no material) |
|---|---|
| *-6.50 to -6.00; 63 mm* | **0.0000** |
| *-6.00 to -5.50; 45 mm* | **0.0000** |
| *-5.50 to -5.00; 31.5 mm* | **0.0000** |
| *-5.00 to -4.50; 22.4 mm* | **0.0000** |
| *-4.50 to -4.00; 16 mm* | **0.0000** |
| *-4.00 to -3.50; 11.2 mm* | **3.8000** |
| *-3.50 to -3.00; 8 mm* | **46.7600** |
| *-3.00 to -2.50; 5.6 mm* | **45.4200** |
| *-2.50 to -2.00; 4 mm* | **3.6600** |
| *-2.00 to -1.50; 2.8 mm* | **0.3200** |
| *-1.50 to -1.00; 2 mm* | **0.1000** |
| *-1.00 to -0.50; 1.4 mm* | **0.0000** |
| *-0.50 to 0.00; 1 mm* | **0.0000** |
| *0.00 to 0.50; (707 µm)* | 0.0000 |
| *0.50 to 1.00; (500 µm)* | 0.0000 |
| *1.00 to 1.50; (353.6 µm)* | 0.0000 |
| *1.50 to 2.00; (250 µm)* | 0.0000 |
| *2.00 to 2.50; (176.8 µm)* | 0.0000 |
| *2.50 to 3.00; (125 µm)* | 0.0000 |
| *3.00 to 3.50; (88.39 µm)* | 0.0000 |
| *3.50 to 4.00; (62.5 µm)* | 0.0000 |
| *4.00 to 4.50; (44.19 µm)* | 0.0000 |
| *4.50 to 5.00; (31.25 µm)* | 0.0000 |
| *5.00 to 5.50; (22.097 µm)* | 0.0000 |
| *5.50 to 6.00; (15.625 µm)* | 0.0000 |
| *6.00 to 6.50; (11.049 µm)* | 0.0000 |
| *6.50 to 7.00; (7.813 µm)* | 0.0000 |
| *7.00 to 7.50; (5.524 µm)* | 0.0000 |
| *7.50 to 8.00; (3.906 µm)* | 0.0000 |
| *8.00 to 8.50; (2.762 µm)* | 0.0000 |
| *8.50 to 9.00; (1.953 µm)* | 0.0000 |
| *9.00 to 9.50; (1.381 µm)* | 0.0000 |
| *9.50 to 10.00; (0.977 µm)* | 0.0000 |
| *10.00 to 10.50; (0.691 µm)* | 0.0000 |
| *10.50 to 11.00; (0.488 µm)* | 0.0000 |
| *11.00 to 11.50; (0.345 µm)* | 0.0000 |
| *11.50 to 12.00; (0.244 µm)* | 0.0000 |
| *12.00 to 12.50; (0.173 µm)* | 0.0000 |
| *12.50 to 13.00; (0.122 µm)* | 0.0000 |
| *13.00 to 13.50; (0.086 µm)* | 0.0000 |

**Appendix 1. Final Merged Data sheets as supplied by participating laboratories for PS54 (arranged by Lab Code).**

**NMBAQCS - PS Exercise Data Workbook (Page 2 - Final Merged Data Submission)**

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| | |
|---|---|
| Exercise Code: | PS54 |
| LabCode: | PSA_BENCHMARK REPLICATE 1 |
| Sample Code: | PS5421 BM REP 1 |

| Phi interval (explicit) + sieve mesh (theoretical sieves shown in brackets) | Volume/Weight (mark as "0" for not analysed or no material) |
|---|---|
| *-6.50 to -6.00; 63 mm* | **0.0000** |
| *-6.00 to -5.50; 45 mm* | **0.0000** |
| *-5.50 to -5.00; 31.5 mm* | **0.0000** |
| *-5.00 to -4.50; 22.4 mm* | **0.0000** |
| *-4.50 to -4.00; 16 mm* | **0.0000** |
| *-4.00 to -3.50; 11.2 mm* | **2.8630** |
| *-3.50 to -3.00; 8 mm* | **49.7439** |
| *-3.00 to -2.50; 5.6 mm* | **42.3260** |
| *-2.50 to -2.00; 4 mm* | **4.6240** |
| *-2.00 to -1.50; 2.8 mm* | **0.4243** |
| *-1.50 to -1.00; 2 mm* | **0.0189** |
| *-1.00 to -0.50; 1.4 mm* | **0.0000** |
| *-0.50 to 0.00; 1 mm* | **0.0000** |
| *0.00 to 0.50; (707 µm)* | 0.0000 |
| *0.50 to 1.00; (500 µm)* | 0.0000 |
| *1.00 to 1.50; (353.6 µm)* | 0.0000 |
| *1.50 to 2.00; (250 µm)* | 0.0000 |
| *2.00 to 2.50; (176.8 µm)* | 0.0000 |
| *2.50 to 3.00; (125 µm)* | 0.0000 |
| *3.00 to 3.50; (88.39 µm)* | 0.0000 |
| *3.50 to 4.00; (62.5 µm)* | 0.0000 |
| *4.00 to 4.50; (44.19 µm)* | 0.0000 |
| *4.50 to 5.00; (31.25 µm)* | 0.0000 |
| *5.00 to 5.50; (22.097 µm)* | 0.0000 |
| *5.50 to 6.00; (15.625 µm)* | 0.0000 |
| *6.00 to 6.50; (11.049 µm)* | 0.0000 |
| *6.50 to 7.00; (7.813 µm)* | 0.0000 |
| *7.00 to 7.50; (5.524 µm)* | 0.0000 |
| *7.50 to 8.00; (3.906 µm)* | 0.0000 |
| *8.00 to 8.50; (2.762 µm)* | 0.0000 |
| *8.50 to 9.00; (1.953 µm)* | 0.0000 |
| *9.00 to 9.50; (1.381 µm)* | 0.0000 |
| *9.50 to 10.00; (0.977 µm)* | 0.0000 |
| *10.00 to 10.50; (0.691 µm)* | 0.0000 |
| *10.50 to 11.00; (0.488 µm)* | 0.0000 |
| *11.00 to 11.50; (0.345 µm)* | 0.0000 |
| *11.50 to 12.00; (0.244 µm)* | 0.0000 |
| *12.00 to 12.50; (0.173 µm)* | 0.0000 |
| *12.50 to 13.00; (0.122 µm)* | 0.0000 |
| *13.00 to 13.50; (0.086 µm)* | 0.0000 |

**Appendix 1. Final Merged Data sheets as supplied by participating laboratories for PS54 (arranged by Lab Code).**

**NMBAQCS - PS Exercise Data Workbook (Page 2 - Final Merged Data Submission)**

Return to APEM Ltd. by 06-02-15

| | |
|---|---|
| Exercise Code: | PS54 |
| LabCode: | PSA_BENCHMARK REPLICATE 2 |
| Sample Code: | PS5421 BM REP 2 |

| Phi interval (explicit) + sieve mesh (theoretical sieves shown in brackets) | Volume/Weight (mark as "0" for not analysed or no material) |
|---|---|
| *-6.50 to -6.00; 63 mm* | **0.0000** |
| *-6.00 to -5.50; 45 mm* | **0.0000** |
| *-5.50 to -5.00; 31.5 mm* | **0.0000** |
| *-5.00 to -4.50; 22.4 mm* | **0.0000** |
| *-4.50 to -4.00; 16 mm* | **0.0000** |
| *-4.00 to -3.50; 11.2 mm* | **2.2435** |
| *-3.50 to -3.00; 8 mm* | **50.7050** |
| *-3.00 to -2.50; 5.6 mm* | **41.4919** |
| *-2.50 to -2.00; 4 mm* | **5.1617** |
| *-2.00 to -1.50; 2.8 mm* | **0.3844** |
| *-1.50 to -1.00; 2 mm* | **0.0136** |
| *-1.00 to -0.50; 1.4 mm* | **0.0000** |
| *-0.50 to 0.00; 1 mm* | **0.0000** |
| *0.00 to 0.50; (707 µm)* | 0.0000 |
| *0.50 to 1.00; (500 µm)* | 0.0000 |
| *1.00 to 1.50; (353.6 µm)* | 0.0000 |
| *1.50 to 2.00; (250 µm)* | 0.0000 |
| *2.00 to 2.50; (176.8 µm)* | 0.0000 |
| *2.50 to 3.00; (125 µm)* | 0.0000 |
| *3.00 to 3.50; (88.39 µm)* | 0.0000 |
| *3.50 to 4.00; (62.5 µm)* | 0.0000 |
| *4.00 to 4.50; (44.19 µm)* | 0.0000 |
| *4.50 to 5.00; (31.25 µm)* | 0.0000 |
| *5.00 to 5.50; (22.097 µm)* | 0.0000 |
| *5.50 to 6.00; (15.625 µm)* | 0.0000 |
| *6.00 to 6.50; (11.049 µm)* | 0.0000 |
| *6.50 to 7.00; (7.813 µm)* | 0.0000 |
| *7.00 to 7.50; (5.524 µm)* | 0.0000 |
| *7.50 to 8.00; (3.906 µm)* | 0.0000 |
| *8.00 to 8.50; (2.762 µm)* | 0.0000 |
| *8.50 to 9.00; (1.953 µm)* | 0.0000 |
| *9.00 to 9.50; (1.381 µm)* | 0.0000 |
| *9.50 to 10.00; (0.977 µm)* | 0.0000 |
| *10.00 to 10.50; (0.691 µm)* | 0.0000 |
| *10.50 to 11.00; (0.488 µm)* | 0.0000 |
| *11.00 to 11.50; (0.345 µm)* | 0.0000 |
| *11.50 to 12.00; (0.244 µm)* | 0.0000 |
| *12.00 to 12.50; (0.173 µm)* | 0.0000 |
| *12.50 to 13.00; (0.122 µm)* | 0.0000 |
| *13.00 to 13.50; (0.086 µm)* | 0.0000 |

**Appendix 1. Final Merged Data sheets as supplied by participating laboratories for PS54 (arranged by Lab Code).**

**NMBAQCS - PS Exercise Data Workbook (Page 2 - Final Merged Data Submission)**

Return to APEM Ltd. by 06-02-15

| | |
|---|---|
| Exercise Code: | PS54 |
| LabCode: | PSA_BENCHMARK REPLICATE 3 |
| Sample Code: | PS5421 BM REP 3 |

| Phi interval (explicit) + sieve mesh (theoretical sieves shown in brackets) | Volume/Weight (mark as "0" for not analysed or no material) |
|---|---|
| *-6.50 to -6.00; 63 mm* | **0.0000** |
| *-6.00 to -5.50; 45 mm* | **0.0000** |
| *-5.50 to -5.00; 31.5 mm* | **0.0000** |
| *-5.00 to -4.50; 22.4 mm* | **0.0000** |
| *-4.50 to -4.00; 16 mm* | **0.0000** |
| *-4.00 to -3.50; 11.2 mm* | **2.6947** |
| *-3.50 to -3.00; 8 mm* | **51.2826** |
| *-3.00 to -2.50; 5.6 mm* | **40.7985** |
| *-2.50 to -2.00; 4 mm* | **4.8231** |
| *-2.00 to -1.50; 2.8 mm* | **0.3866** |
| *-1.50 to -1.00; 2 mm* | **0.0146** |
| *-1.00 to -0.50; 1.4 mm* | **0.0000** |
| *-0.50 to 0.00; 1 mm* | **0.0000** |
| *0.00 to 0.50; (707 µm)* | 0.0000 |
| *0.50 to 1.00; (500 µm)* | 0.0000 |
| *1.00 to 1.50; (353.6 µm)* | 0.0000 |
| *1.50 to 2.00; (250 µm)* | 0.0000 |
| *2.00 to 2.50; (176.8 µm)* | 0.0000 |
| *2.50 to 3.00; (125 µm)* | 0.0000 |
| *3.00 to 3.50; (88.39 µm)* | 0.0000 |
| *3.50 to 4.00; (62.5 µm)* | 0.0000 |
| *4.00 to 4.50; (44.19 µm)* | 0.0000 |
| *4.50 to 5.00; (31.25 µm)* | 0.0000 |
| *5.00 to 5.50; (22.097 µm)* | 0.0000 |
| *5.50 to 6.00; (15.625 µm)* | 0.0000 |
| *6.00 to 6.50; (11.049 µm)* | 0.0000 |
| *6.50 to 7.00; (7.813 µm)* | 0.0000 |
| *7.00 to 7.50; (5.524 µm)* | 0.0000 |
| *7.50 to 8.00; (3.906 µm)* | 0.0000 |
| *8.00 to 8.50; (2.762 µm)* | 0.0000 |
| *8.50 to 9.00; (1.953 µm)* | 0.0000 |
| *9.00 to 9.50; (1.381 µm)* | 0.0000 |
| *9.50 to 10.00; (0.977 µm)* | 0.0000 |
| *10.00 to 10.50; (0.691 µm)* | 0.0000 |
| *10.50 to 11.00; (0.488 µm)* | 0.0000 |
| *11.00 to 11.50; (0.345 µm)* | 0.0000 |
| *11.50 to 12.00; (0.244 µm)* | 0.0000 |
| *12.00 to 12.50; (0.173 µm)* | 0.0000 |
| *12.50 to 13.00; (0.122 µm)* | 0.0000 |
| *13.00 to 13.50; (0.086 µm)* | 0.0000 |

**Appendix 1. Final Merged Data sheets as supplied by participating laboratories for PS54 (arranged by Lab Code).**

**NMBAQCS - PS Exercise Data Workbook (Page 2 - Final Merged Data Submission)**

Return to APEM Ltd. by 06-02-15

| | |
|---|---|
| Exercise Code: | PS54 |
| LabCode: | PSA_BENCHMARK REPLICATE 4 |
| Sample Code: | PS5421 BM REP 4 |

| Phi interval (explicit) + sieve mesh (theoretical sieves shown in brackets) | Volume/Weight (mark as "0" for not analysed or no material) |
|---|---|
| *-6.50 to -6.00; 63 mm* | **0.0000** |
| *-6.00 to -5.50; 45 mm* | **0.0000** |
| *-5.50 to -5.00; 31.5 mm* | **0.0000** |
| *-5.00 to -4.50; 22.4 mm* | **0.0000** |
| *-4.50 to -4.00; 16 mm* | **0.0000** |
| *-4.00 to -3.50; 11.2 mm* | **2.6252** |
| *-3.50 to -3.00; 8 mm* | **51.6234** |
| *-3.00 to -2.50; 5.6 mm* | **40.7193** |
| *-2.50 to -2.00; 4 mm* | **4.5776** |
| *-2.00 to -1.50; 2.8 mm* | **0.4408** |
| *-1.50 to -1.00; 2 mm* | **0.0136** |
| *-1.00 to -0.50; 1.4 mm* | **0.0000** |
| *-0.50 to 0.00; 1 mm* | **0.0000** |
| *0.00 to 0.50; (707 µm)* | 0.0000 |
| *0.50 to 1.00; (500 µm)* | 0.0000 |
| *1.00 to 1.50; (353.6 µm)* | 0.0000 |
| *1.50 to 2.00; (250 µm)* | 0.0000 |
| *2.00 to 2.50; (176.8 µm)* | 0.0000 |
| *2.50 to 3.00; (125 µm)* | 0.0000 |
| *3.00 to 3.50; (88.39 µm)* | 0.0000 |
| *3.50 to 4.00; (62.5 µm)* | 0.0000 |
| *4.00 to 4.50; (44.19 µm)* | 0.0000 |
| *4.50 to 5.00; (31.25 µm)* | 0.0000 |
| *5.00 to 5.50; (22.097 µm)* | 0.0000 |
| *5.50 to 6.00; (15.625 µm)* | 0.0000 |
| *6.00 to 6.50; (11.049 µm)* | 0.0000 |
| *6.50 to 7.00; (7.813 µm)* | 0.0000 |
| *7.00 to 7.50; (5.524 µm)* | 0.0000 |
| *7.50 to 8.00; (3.906 µm)* | 0.0000 |
| *8.00 to 8.50; (2.762 µm)* | 0.0000 |
| *8.50 to 9.00; (1.953 µm)* | 0.0000 |
| *9.00 to 9.50; (1.381 µm)* | 0.0000 |
| *9.50 to 10.00; (0.977 µm)* | 0.0000 |
| *10.00 to 10.50; (0.691 µm)* | 0.0000 |
| *10.50 to 11.00; (0.488 µm)* | 0.0000 |
| *11.00 to 11.50; (0.345 µm)* | 0.0000 |
| *11.50 to 12.00; (0.244 µm)* | 0.0000 |
| *12.00 to 12.50; (0.173 µm)* | 0.0000 |
| *12.50 to 13.00; (0.122 µm)* | 0.0000 |
| *13.00 to 13.50; (0.086 µm)* | 0.0000 |

**Appendix 1. Final Merged Data sheets as supplied by participating laboratories for PS54 (arranged by Lab Code).**

**NMBAQCS - PS Exercise Data Workbook (Page 2 - Final Merged Data Submission)**

Return to APEM Ltd. by 06-02-15

| | |
|---|---|
| Exercise Code: | PS54 |
| LabCode: | PSA_BENCHMARK REPLICATE 5 |
| Sample Code: | PS5421 BM REP 5 |

| Phi interval (explicit) + sieve mesh (theoretical sieves shown in brackets) | Volume/Weight (mark as "0" for not analysed or no material) |
|---|---|
| *-6.50 to -6.00; 63 mm* | **0.0000** |
| *-6.00 to -5.50; 45 mm* | **0.0000** |
| *-5.50 to -5.00; 31.5 mm* | **0.0000** |
| *-5.00 to -4.50; 22.4 mm* | **0.0000** |
| *-4.50 to -4.00; 16 mm* | **0.0000** |
| *-4.00 to -3.50; 11.2 mm* | **2.1035** |
| *-3.50 to -3.00; 8 mm* | **53.4007** |
| *-3.00 to -2.50; 5.6 mm* | **38.8327** |
| *-2.50 to -2.00; 4 mm* | **5.2776** |
| *-2.00 to -1.50; 2.8 mm* | **0.3750** |
| *-1.50 to -1.00; 2 mm* | **0.0104** |
| *-1.00 to -0.50; 1.4 mm* | **0.0000** |
| *-0.50 to 0.00; 1 mm* | **0.0000** |
| *0.00 to 0.50; (707 µm)* | 0.0000 |
| *0.50 to 1.00; (500 µm)* | 0.0000 |
| *1.00 to 1.50; (353.6 µm)* | 0.0000 |
| *1.50 to 2.00; (250 µm)* | 0.0000 |
| *2.00 to 2.50; (176.8 µm)* | 0.0000 |
| *2.50 to 3.00; (125 µm)* | 0.0000 |
| *3.00 to 3.50; (88.39 µm)* | 0.0000 |
| *3.50 to 4.00; (62.5 µm)* | 0.0000 |
| *4.00 to 4.50; (44.19 µm)* | 0.0000 |
| *4.50 to 5.00; (31.25 µm)* | 0.0000 |
| *5.00 to 5.50; (22.097 µm)* | 0.0000 |
| *5.50 to 6.00; (15.625 µm)* | 0.0000 |
| *6.00 to 6.50; (11.049 µm)* | 0.0000 |
| *6.50 to 7.00; (7.813 µm)* | 0.0000 |
| *7.00 to 7.50; (5.524 µm)* | 0.0000 |
| *7.50 to 8.00; (3.906 µm)* | 0.0000 |
| *8.00 to 8.50; (2.762 µm)* | 0.0000 |
| *8.50 to 9.00; (1.953 µm)* | 0.0000 |
| *9.00 to 9.50; (1.381 µm)* | 0.0000 |
| *9.50 to 10.00; (0.977 µm)* | 0.0000 |
| *10.00 to 10.50; (0.691 µm)* | 0.0000 |
| *10.50 to 11.00; (0.488 µm)* | 0.0000 |
| *11.00 to 11.50; (0.345 µm)* | 0.0000 |
| *11.50 to 12.00; (0.244 µm)* | 0.0000 |
| *12.00 to 12.50; (0.173 µm)* | 0.0000 |
| *12.50 to 13.00; (0.122 µm)* | 0.0000 |
| *13.00 to 13.50; (0.086 µm)* | 0.0000 |

**Appendix 2. z-score calculations at each half phi-interval for participating laboratories and the benchmark average for PS54.**

| | Phi interval | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | -6.50 to -6.00 | -6.00 to -5.50 | -5.50 to -5.00 | -5.00 to -4.50 | -4.50 to -4.00 | -4.00 to -3.50 | z-score | -3.50 to -3.00 | z-score | -3.00 to -2.50 | z-score | -2.50 to -2.00 | z-score | -2.00 to -1.50 | z-score |
| Benchmark Average | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.506 | -0.45 | 51.351 | 1.27 | 40.834 | -1.34 | 4.893 | 0.53 | 0.402 | 0.82 |
| PSA_2101 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.856 | -0.02 | 46.686 | -0.87 | 45.648 | 0.81 | 4.379 | 0.05 | 0.391 | 0.56 |
| PSA_2102 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.114 | -0.94 | 48.076 | -0.23 | 42.442 | -0.62 | 6.966 | 2.46 | 0.388 | 0.51 |
| PSA_2103 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.154 | 0.35 | 47.659 | -0.42 | 45.372 | 0.69 | 3.405 | -0.86 | 0.384 | 0.41 |
| PSA_2105 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.863 | -0.01 | 49.744 | 0.53 | 42.326 | -0.67 | 4.624 | 0.28 | 0.424 | 1.31 |
| PSA_2106 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.510 | -0.45 | 49.020 | 0.20 | 44.030 | 0.09 | 4.110 | -0.20 | 0.340 | -0.56 |
| PSA_2107 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.070 | -0.99 | 44.214 | -2.01 | 47.862 | 1.80 | 5.435 | 1.04 | 0.408 | 0.94 |
| PSA_2108 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.118 | -0.93 | 48.604 | 0.01 | 44.465 | 0.28 | 4.403 | 0.07 | 0.380 | 0.32 |
| PSA_2109 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.386 | 0.63 | 49.245 | 0.30 | 43.122 | -0.31 | 3.956 | -0.34 | 0.255 | -2.44 |
| PSA_2110 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.500 | -0.46 | 48.960 | 0.17 | 43.600 | -0.10 | 4.550 | 0.21 | 0.350 | -0.34 |
| PSA_2111 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.501 | -0.46 | 48.980 | 0.18 | 43.617 | -0.09 | 4.552 | 0.21 | 0.350 | -0.33 |
| PSA_2112 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.036 | 0.20 | 47.853 | -0.33 | 44.454 | 0.28 | 4.256 | -0.06 | 0.392 | 0.60 |
| PSA_2113 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.210 | 2.89 | 53.872 | 2.43 | 38.556 | -2.35 | 1.987 | -2.18 | 0.305 | -1.33 |
| PSA_2113_a | | | | | | 2.476 | -0.49 | 47.705 | -0.40 | 45.657 | 0.82 | 3.671 | -0.61 | 0.389 | 0.52 |
| PSA_2114 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.800 | 1.14 | 46.760 | -0.84 | 45.420 | 0.71 | 3.660 | -0.62 | 0.320 | -1.00 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MEAN | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.8733 | 48.5819 | 43.8270 | 4.3231 | 0.3652 |
| STANDARD DEVIATION | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.8099 | 2.1768 | 2.2396 | 1.0723 | 0.0451 |

All labs recorded zero therefore the mean and standard deviation were also zero.

z<-1.96 or z >1.96

**Appendix 2. z-score calculations at each half phi-interval for participating laboratories and the benchmark average for PS54.**

| | Phi interval | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | -1.50 to -1.00 | z-score | -1.00 to -0.50 | z-score | -0.50 to 0.00 | z-score | 0.00 to 0.50 | z-score | 0.50 to 1.00 | z-score | 1.00 to 1.50 | z-score | 1.50 to 2.00 | z-score | 2.00 to 2.50 | z-score |
| Benchmark Average | 0.014 | -0.11 | 0.000 | -0.54 | 0.000 | -0.59 | 0.000 | -0.26 | 0.000 | -0.35 | 0.000 | -0.37 | 0.000 | -0.35 | 0.000 | -0.32 |
| PSA_2101 | 0.001 | -0.63 | 0.004 | 0.06 | 0.002 | 0.18 | 0.033 | 3.61 | 0.000 | -0.35 | 0.000 | -0.37 | 0.000 | -0.35 | 0.000 | -0.32 |
| PSA_2102 | 0.012 | -0.22 | 0.002 | -0.24 | 0.000 | -0.57 | 0.000 | -0.26 | 0.000 | -0.35 | 0.000 | -0.37 | 0.000 | -0.35 | 0.000 | -0.32 |
| PSA_2103 | 0.021 | 0.15 | 0.002 | -0.24 | 0.004 | 0.95 | 0.000 | -0.26 | 0.000 | -0.35 | 0.000 | -0.37 | 0.000 | -0.35 | 0.000 | -0.32 |
| PSA_2105 | 0.019 | 0.07 | 0.000 | -0.54 | 0.000 | -0.59 | 0.000 | -0.26 | 0.000 | -0.35 | 0.000 | -0.37 | 0.000 | -0.35 | 0.000 | -0.32 |
| PSA_2106 | 0.000 | -0.67 | 0.000 | -0.54 | 0.000 | -0.59 | 0.000 | -0.26 | 0.000 | -0.35 | 0.000 | -0.37 | 0.000 | -0.35 | 0.000 | -0.32 |
| PSA_2107 | 0.000 | -0.67 | 0.010 | 0.96 | 0.000 | -0.59 | 0.000 | -0.26 | 0.000 | -0.35 | 0.000 | -0.37 | 0.000 | -0.35 | 0.000 | -0.32 |
| PSA_2108 | 0.013 | -0.15 | 0.000 | -0.54 | 0.001 | -0.05 | 0.001 | -0.19 | 0.001 | 3.27 | 0.001 | 2.91 | 0.005 | 3.27 | 0.002 | 0.74 |
| PSA_2109 | 0.012 | -0.21 | 0.000 | -0.54 | 0.001 | -0.36 | 0.000 | -0.26 | 0.001 | 1.30 | 0.001 | 1.93 | 0.002 | 1.31 | 0.008 | 3.48 |
| PSA_2110 | 0.000 | -0.67 | 0.000 | -0.54 | 0.000 | -0.59 | 0.000 | -0.26 | 0.000 | -0.35 | 0.000 | -0.37 | 0.000 | -0.35 | 0.000 | -0.32 |
| PSA_2111 | 0.000 | -0.67 | 0.000 | -0.54 | 0.000 | -0.59 | 0.000 | -0.26 | 0.000 | -0.35 | 0.000 | -0.37 | 0.000 | -0.35 | 0.000 | -0.32 |
| PSA_2112 | 0.006 | -0.42 | 0.001 | -0.39 | 0.001 | -0.21 | 0.000 | -0.26 | 0.000 | -0.35 | 0.000 | -0.37 | 0.000 | -0.35 | 0.000 | -0.32 |
| PSA_2113 | 0.016 | -0.06 | 0.011 | 1.10 | 0.005 | 1.34 | 0.000 | -0.26 | 0.000 | -0.35 | 0.000 | -0.37 | 0.000 | -0.35 | 0.000 | -0.32 |
| PSA_2113_a | 0.043 | 1.01 | 0.025 | 3.05 | 0.009 | 2.88 | 0.000 | -0.26 | 0.000 | -0.35 | 0.000 | -0.37 | 0.000 | -0.35 | 0.000 | -0.32 |
| PSA_2114 | 0.100 | 3.24 | 0.000 | -0.54 | 0.000 | -0.59 | 0.000 | -0.26 | 0.000 | -0.35 | 0.000 | -0.37 | 0.000 | -0.35 | 0.000 | -0.32 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| MEAN | 0.0171 | 0.0038 | 0.0016 | 0.0023 | 0.0001 | 0.0001 | 0.0005 | 0.0007 |
| STANDARD DEVIATION | 0.0256 | 0.0070 | 0.0027 | 0.0086 | 0.0003 | 0.0003 | 0.0014 | 0.0022 |

z<-1.96 or z >1.96

**Appendix 2. z-score calculations at each half phi-interval for participating laboratories and the benchmark average for PS54.**

| | Phi interval | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2.50 to 3.00 | z-score | 3.00 to 3.50 | z-score | 3.50 to 4.00 | z-score | 4.00 to 4.50 | z-score | 4.50 to 5.00 | 5.00 to 5.50 | 5.50 to 6.00 | 6.00 to 6.50 | 6.50 to 7.00 | 7.00 to 7.50 | 7.50 to 8.00 | 8.00 to 8.50 |
| Benchmark Average | 0.000 | -0.34 | 0.000 | -0.36 | 0.000 | -0.37 | 0.000 | -0.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2101 | 0.000 | -0.34 | 0.000 | -0.36 | 0.000 | -0.37 | 0.000 | -0.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2102 | 0.000 | -0.34 | 0.000 | -0.36 | 0.000 | -0.37 | 0.000 | -0.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2103 | 0.000 | -0.34 | 0.000 | -0.36 | 0.000 | -0.37 | 0.000 | -0.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2105 | 0.000 | -0.34 | 0.000 | -0.36 | 0.000 | -0.37 | 0.000 | -0.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2106 | 0.000 | -0.34 | 0.000 | -0.36 | 0.000 | -0.37 | 0.000 | -0.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2107 | 0.000 | -0.34 | 0.000 | -0.36 | 0.000 | -0.37 | 0.000 | -0.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2108 | 0.003 | 1.01 | 0.001 | 3.21 | 0.001 | 3.03 | 0.001 | 1.17 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2109 | 0.008 | 3.39 | 0.001 | 1.43 | 0.001 | 1.75 | 0.002 | 3.33 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2110 | 0.000 | -0.34 | 0.000 | -0.36 | 0.000 | -0.37 | 0.000 | -0.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2111 | 0.000 | -0.34 | 0.000 | -0.36 | 0.000 | -0.37 | 0.000 | -0.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2112 | 0.000 | -0.34 | 0.000 | -0.36 | 0.000 | -0.37 | 0.000 | -0.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2113 | 0.000 | -0.34 | 0.000 | -0.36 | 0.000 | -0.37 | 0.000 | -0.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2113_a | 0.000 | -0.34 | 0.000 | -0.36 | 0.000 | -0.37 | 0.000 | -0.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2114 | 0.000 | -0.34 | 0.000 | -0.36 | 0.000 | -0.37 | 0.000 | -0.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MEAN | 0.0008 | | 0.0001 | | 0.0001 | | 0.0002 | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STANDARD DEVIATION | 0.0022 | | 0.0004 | | 0.0002 | | 0.0005 | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

All labs recorded zero therefore the mean and standard deviation were also zero.

z<-1.96 or z >1.96

**Appendix 2. z-score calculations at each half phi-interval for participating laboratories and the benchmark average for PS54.**

| | Phi interval | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 8.50 to 9.00 | 9.00 to 9.50 | 9.50 to 10.00 | 10.00 to 10.50 | 10.50 to 11.00 | 11.00 to 11.50 | 11.50 to 12.00 | 12.00 to 12.50 | 12.50 to 13.00 | 13.00 to 13.50 |
| Benchmark Average | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2101 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2102 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2103 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2105 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2106 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2107 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2108 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2109 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2110 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2111 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2112 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2113 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2113_a | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PSA_2114 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MEAN | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STANDARD DEVIATION | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

All labs recorded zero therefore the mean and standard deviation were also zero.