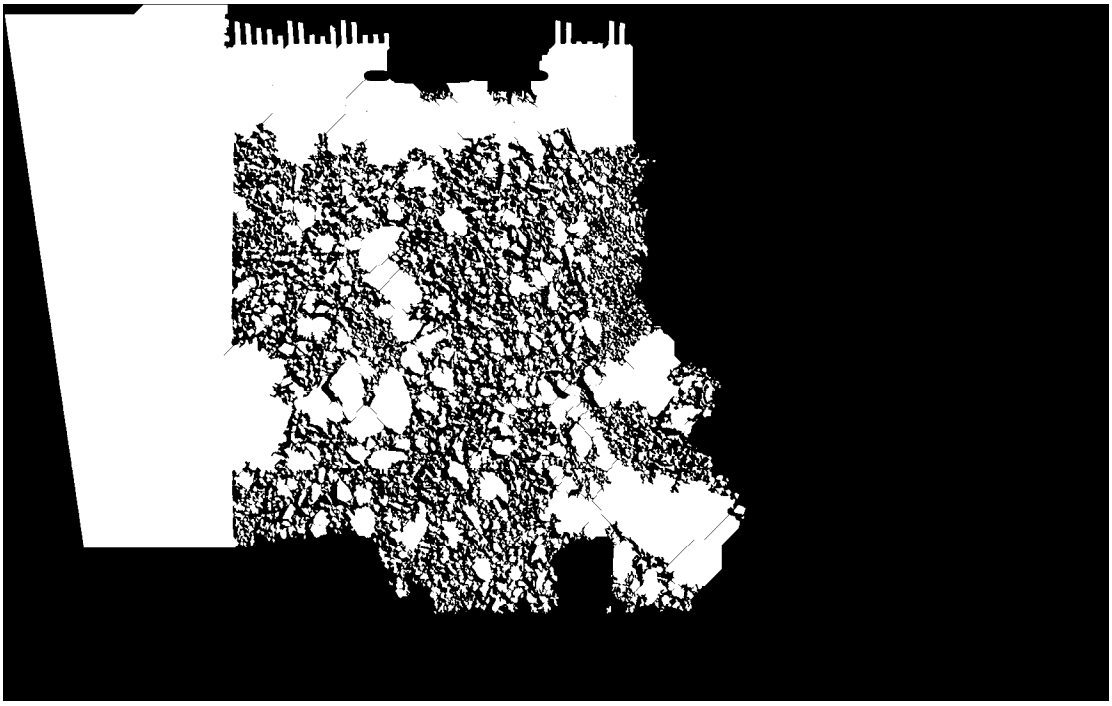
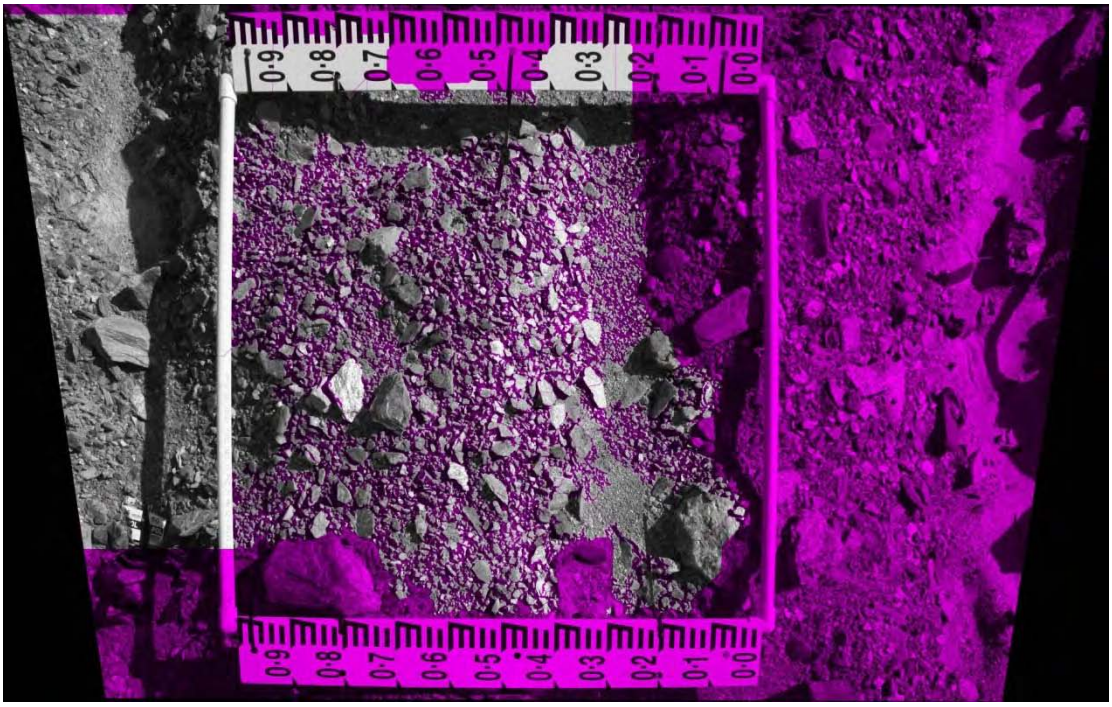
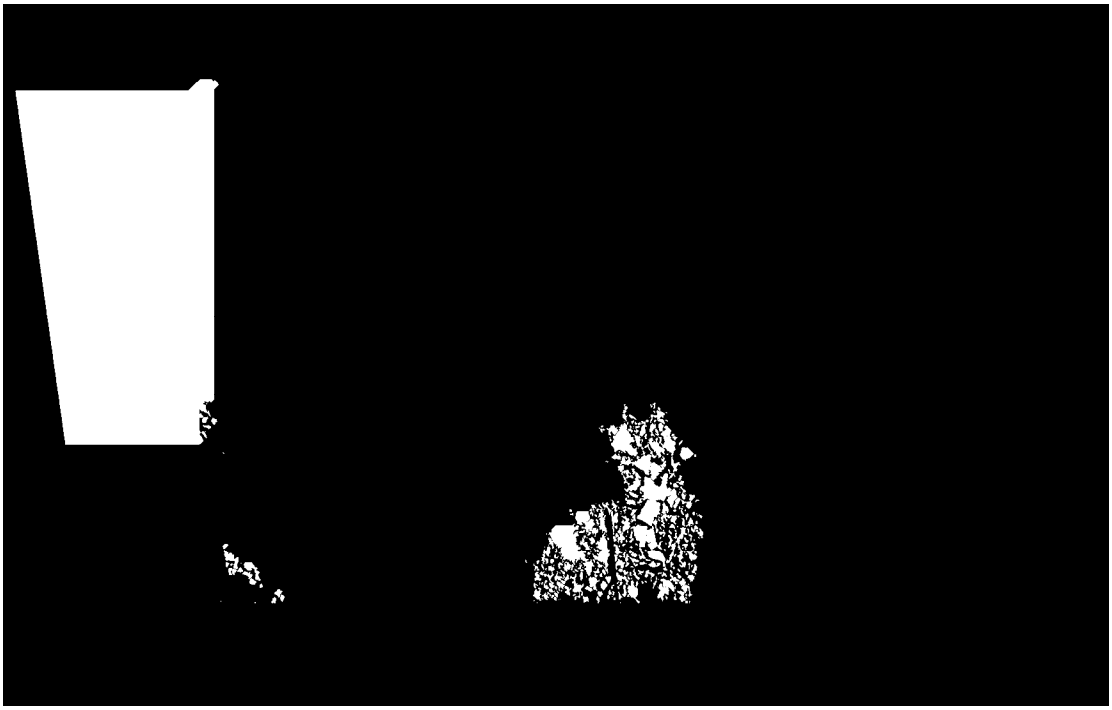


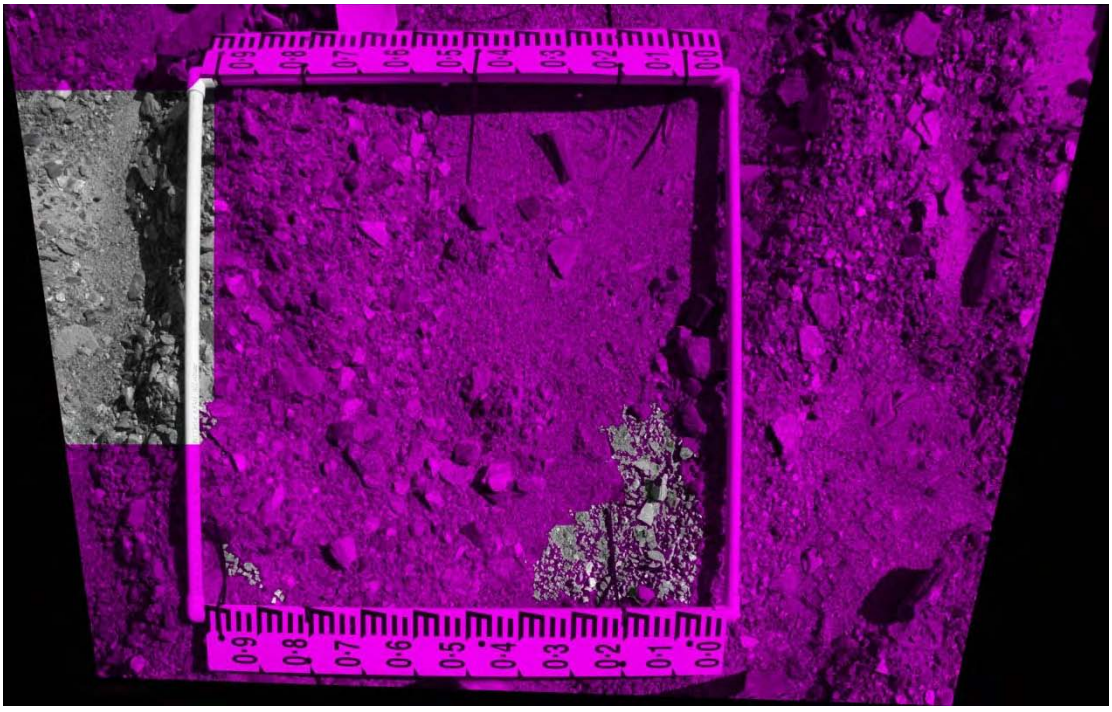
Surface material sample EWLS site 13 showing image of grains that have been selected.



Surface material sample EWLS site 13 final image of grains selected overlying the transformed greyscale image. This final image has problems to the left side of the 1 m square and has determined it as two large particles and not been able to determine any of the individual particles at all. At the top of the image it has also depicted the scale bars as particles. The particles in the middle of the image have been reasonably well determined. However these better determinations can not be separated from the other less well determined particles.



Surface material sample EWLS site 18 showing image of grains that have been selected.



Surface material sample ELWS site 18 final image of grains selected overlying the transformed greyscale image. This image has not determined very many particles at all. It has determined a large particle outside of the square but has not been able to determine many particles within the 1 m square.

4.3 Particle size results

4.3.1 Combined sieve and hydrometer particle size results

The gravel and fine earth percentages and the total sample masses are shown in Table 1. The cumulative frequency data for the bulk surface material samples are shown in Appendix 2.

Table 1 Total sample mass and percentages less than and greater than 2 mm for the 24 surface material samples collected on the Trial Landform

Sample name	% Sample > 2 mm	% Sample < 2 mm	% Sample < 63 µm	Total Sample Mass (g)
EWLS 2 BR	62.6	37.4	8.9	6211
EWLS 2 TR	72.5	27.5	6.7	6109
EWLS 5 BR	70.8	29.2	4.3	8456
EWLS 5 TR	78.7	21.3	4.5	7414
EWLS 6 BR	57.6	42.4	9.7	6894
EWLS 6 TR	56.4	43.6	12.1	6488
EWLS 9 BR	67.3	32.7	7.5	5796
EWLS 9 TR	70.0	30.0	4.8	7106
EWLS 13 BR	60.9	39.1	9.6	5508
EWLS 13 TR	57.4	42.6	11.5	5190
EWLS 15 BR1	65.2	34.8	8.5	6821
EWLS 15 BR2	57.2	42.8	10.2	6049
EWLS 16 BR1	60.0	40.0	10.2	5285
EWLS 16 BR2	60.9	39.1	10.2	4955
EWLS 18 BR	60.8	39.2	10.0	5743
EWLS 18 TR	59.1	40.9	8.5	4864
EWLS 23 BR	63.2	36.8	8.6	6078
EWLS 23 TR	65.9	34.1	9.5	7312
EWLS 25 BR	66.5	33.5	9.0	9422
EWLS 25 TR	63.8	36.2	11.5	5880
EWLS 28 BR	69.2	30.8	7.4	3922
EWLS 28 TR	57.1	42.9	10.4	6517
EWLS 30 BR1	50.4	49.6	20.9	5807
EWLS 30 BR2	60.8	39.2	14.7	4920
Minimum Values	50.4	21.3	20.9	3922
Maximum Values	78.7	49.6	4.3	9422
Average Value	63.1	36.9	9.6	6198

The gravel percentage in all 24 samples was greater than 50% ranging from 50.4% to 78.7%. This illustrates the coarse nature of the material (predominantly waste rock) that has been used in the construction of the trial landform.

The particle size analysis determined that the percentage < 63 µm ranged from 4.3% to 20.9%, with an average of 9.6%, for the 24 samples.

4.3.2 Digital Gravelometer™ particle size results

The Digital Gravelometer™ calculated cumulative frequency data for each of the 12 samples. It was only able to distinguish particle sizes greater than 0.5 ϕ (0.7 mm). The cumulative frequency data for each of the 12 samples are shown in Appendix 3.

4.4 Grain size statistics

4.4.1 Bulk surface material sample grain size results

The grain size statistics for each of the 24 bulk surface samples collected in 2009 were calculated and the values are shown on Table 2. The graphic mean (ϕ) ranges from -3.63 ϕ (12.38 mm) to -0.98 ϕ (1.07 mm) with an average of -1.97 ϕ (4.44 mm).

Table 2 Graphic grain size statistics for the surface samples collected on the trial landform in 2009

Sample name	Graphic Mean(ϕ)	Graphic Mean(mm)	Inclusive Graphic Standard Deviation (ϕ)	Inclusive Graphic Skewness	Graphic Kurtosis	Transformed Kurtosis
EWLS2 BR	-1.89	3.71	3.89	0.23	0.86	0.46
EWLS2 TR	-2.71	6.54	3.66	0.42	0.87	0.47
EWLS5 BR	-3.55	11.71	3.67	0.30	0.92	0.48
EWLS5 TR	-3.63	12.38	3.35	0.56	0.96	0.49
EWLS6 BR	-1.82	3.53	3.98	0.10	1.01	0.50
EWLS6 TR	-0.98	1.97	3.82	0.29	0.96	0.49
EWLS9 BR	-2.25	4.76	3.60	0.35	0.80	0.45
EWLS9 TR	-2.66	6.32	3.47	0.24	0.85	0.46
EWLS13 BR	-1.93	3.81	4.11	0.23	0.87	0.46
EWLS13 TR	-1.35	2.55	4.37	0.26	1.03	0.51
EWLS15 BR1	-2.28	4.86	3.98	0.32	0.92	0.48
EWLS15 BR2	-1.15	2.22	3.70	0.32	1.03	0.51
EWLS16 BR1	-1.58	2.99	4.06	0.28	0.95	0.49
EWLS16 BR2	-1.67	3.18	4.15	0.32	0.88	0.47
EWLS18 BR	-1.70	3.25	3.90	0.28	0.89	0.47
EWLS18 TR	-1.37	2.58	3.61	0.30	1.00	0.50
EWLS23 BR	-2.26	4.79	4.14	0.27	0.81	0.45
EWLS23 TR	-2.30	4.92	4.53	0.39	0.93	0.49
EWLS25 BR	-2.74	6.68	4.81	0.18	0.94	0.49
EWLS25 TR	-1.50	2.83	4.08	0.41	1.10	0.52
EWLS28 BR	-2.37	5.17	3.71	0.36	0.80	0.44
EWLS28 TR	-1.30	2.46	4.03	0.26	0.96	0.49
EWLS30 BR1	-0.99	1.99	3.82	0.40	1.24	0.55
EWLS30 BR2	-1.47	2.10	4.26	0.35	1.13	0.53
Min Value	-0.98	1.97	3.35	0.10	0.80	0.44
Max Value	-3.63	12.38	4.81	0.56	1.24	0.55
Average Value	-1.97	4.44	3.94	0.30	0.94	0.48

4.4.2 Digital Gravelometer™ grain size statistics

The Digital Gravelometer™ calculated grain size statistics (except for Transformed Kurtosis) for each of the 12 surface images taken in 2009 and the results are summarised in Table 3.The Digital Gravelometerr™ did not report Transformed Kurtosis and it has not been calculated separately for this report. The graphic mean (ϕ) ranges from -2.34 ϕ (5.06 mm) to -1.80 ϕ (3.48 mm) with an average of -2.04 ϕ (-4.12 mm).

Table 3 Graphic grain size statistics for the surface images taken on the trial landform in 2009 and processed by the Digital Gravelometer™

Site	Graphic Mean (ϕ)	Graphic Mean (mm)	Inclusive Graphic Standard Deviation (ϕ)	Inclusive Graphic Skewness	Graphic Kurtosis
EWLS2	-1.92	3.79	1.20	0.13	1.22
EWLS5	-2.07	4.21	1.31	0.15	1.16
EWLS6	-2.34	5.06	1.33	0.14	1.36
EWLS9	-1.92	3.80	1.22	0.14	1.20
EWLS13	-2.23	4.68	1.32	0.16	1.25
EWLS15	-1.95	3.86	1.27	0.10	1.21
EWLS16	-2.10	4.28	1.76	0.17	1.24
EWLS18	-2.19	4.56	1.38	0.18	1.19
EWLS23	-1.80	3.48	1.14	0.06	1.24
EWLS25	-1.92	3.79	1.27	0.01	1.21
EWLS28	-2.08	4.24	1.26	0.10	1.22
EWLS30	-1.90	3.72	1.22	0.07	1.24
Min Value	-1.80	3.48	1.14	0.01	1.16
Max Value	-2.34	5.06	1.76	0.18	1.36
Average Value	-2.04	4.12	1.31	0.12	1.23

4.5 Statistical differences in grain size statistics

There are three hypotheses tested in this section:

Hypothesis 1: There is no difference in grain size statistics of bulk surface material samples collected between the rip lines and the top of the mound created by ripping that were analysed by the combined sieve and hydrometer method.,

Hypothesis 2: There is no difference in grain size statistics of bulk surface material samples collected from the waste rock and the waste rock mixed with lateritic material that were analysed by the combined sieve and hydrometer method.

Hypothesis 3: There is no difference in grain size statistics of samples analysed by the combined sieve and hydrometer method and by the Digital Gravelometer™.

4.5.1 Differences in grain size statistics between samples from top of mound created by ripping and those from between the rip lines

The data for each grain size statistic were normally distributed for both between the rip lines and the top of the mound created by ripping. The variances of each grain size statistic from each environment were equal ($p < 0.05$). The two-sample t-test for equal variance showed that there were no significant differences in graphic grain size statistics for samples collected from both surface treatments.

4.5.2 Differences in grain size statistics between waste rock and waste rock mixed with lateritic material

The grain size statistics data for waste rock and waste rock mixed with lateritic material were all normally distributed. The variances were also equal for graphic mean size, inclusive graphic standard deviation, graphic kurtosis and transformed kurtosis ($p = 0.05$). The variances were not equal for inclusive graphic skewness. The two-sample t-test for equal variances showed that there were no significant differences for graphic kurtosis and transformed kurtosis. The Mann-Whitney test also showed no significant difference for inclusive graphic skewness. However, the two-sample t-test for unequal variances showed that there was a significant difference for graphic mean size and inclusive graphic standard deviation.

4.5.3 Differences in grain size statistics for samples analysed by the combined hydrometer and sieve method and Digital Gravelometer™

The Digital Gravelometer™ calculated one set of graphic particle size statistics for each of the twelve surface samples. To enable comparison with the results for the two samples collected at each site for combined sieve and hydrometer analysis, the two samples were combined by adding the masses for each particle size interval and then recalculating the percentage in each of the size intervals using the total combined mass. It was demonstrated above that there was no significant difference in graphic grain size statistics for the two surface treatments. As the Digital Gravelometer™ was only able to identify to a size of 0.5 ϕ (0.7 mm), a decision was made to only compare the gravel fractions (> 2.0 mm) obtained by the two techniques. The grain size statistics for both methods were recalculated for > 2.0 mm only and are shown in Appendix 4.

The data for each grain size statistic for the combined particle size results and the Digital Gravelometer™ were all normally distributed. The variances of each grain size statistic for the combined particle size results and the Digital Gravelometer™ were not equal, except for graphic kurtosis and transformed kurtosis ($p = 0.05$). The two-sample t-test using unequal variances showed that there were significant differences for graphic mean size, inclusive graphic standard deviation & inclusive graphic skewness. A Mann-Whitney test revealed that there was a significant difference for kurtosis and transformed kurtosis between the combined particle size results and the Digital Gravelometer™. Clearly there is a significant difference in graphic grain size statistics between combined particle size results and the Digital Gravelometer ™. As a result, no further analysis of vertical photographs has been undertaken of surface material on the trial landform by the Digital Gravelometer ™.

5 Discussion and conclusions

Twenty-four bulk surface material samples from 12 sites were collected in 2009 from the trial landform. At each site, where possible, samples were collected from between the rip lines and also from the top of mounds created by ripping. No samples were collected for particle size analysis in 2010. Digital photographs were taken in both 2009 and 2010 at each sample site. These photos indicate that the holes produced by sample collection in 2009 had been infilled with fine material by 2010. In each set of photos common rocks were numbered to show if they were still in the same place in 2010. Mostly the rocks were in the same place but in some instances the rocks had moved because of people walking across the sites undertaking activities such as spraying for weeds, collecting Radon cups, accessing moisture probe data loggers and taking photos. There were also some grasses growing at the sample sites. It is recommended to continue taking these photos annually to keep a record of rock movement

and potential rock break down, keep a track of any armouring and also to keep a track of vegetation growth and development.

Cheetham et al (2008) investigated and compared several methods (laser diffraction, X-ray diffraction, scanning electron microscopy and combined sieve/hydrometer) for quantifying particle size distribution and found that in a sand-dominated fluvial environment the results obtained from the combined sieve and hydrometer method and laser diffraction were comparable. These results were based on similar sample preparation and applied to sand dominated fluvial sediments and did not take into account the gravel fraction of the sample. The results presented in this study have a very high percent of gravels present (generally angular clasts) and it was not appropriate to use laser diffraction in this study.

The Digital Gravelometer™ should be able to determine the larger particle sizes that were impossible to physically collect due to their size (ie >500 mm b-axis diameter). However, in practice it was found that it was unable to identify the larger rocks and often amalgamated separate clasts into a single large clast. The Digital Gravelometer™ was developed for use in fluvial environments to measure well rounded clasts on bars in gravel bed streams that usually have a relatively flat surface. The topography of the trial landform was much more uneven due to the rip lines and mounds. This unevenness and the 1 m^2 grid boundary and bordering plate markers that was used for the photographs created shadows that caused the Digital Gravelometer™ to have problems determining the individual particles that were present. Shadows were often grouped, artificially creating large clasts. There were also instances where different markings, textures or laminations in the rocks, such as quartz veins in a larger rock, were misidentified by the Digital Gravelometer™ as different clasts.

The Digital Gravelometer™ was unable to identify smaller particles (silt and clay) and often grouped these much smaller particles into one much larger clast, probably because the particles were all the same colour. The fine material in some cases was identified from the image as one single rock rather than lots of fine material (< 1.00 mm). This was further compounded by the presence of mica schist that was highly reflective Fluvial environments have rounded clasts as the gravels are rolled and bounced along the river bed. The particles on the trail landform were much more angular (the result of blasting in the pit) and have had no fluvial transport to make them less angular. It was expected that the Digital Gravelometer™ would be better able to distinguish large particles as it was unable to determine the smaller sized particles. For the gravel fractions only (Appendix4), the graphic grain size statistics for the Digital Gravelometer™ are smaller than for the particle size results.

The particle size analysis results are much more reliable than those obtained from the Digital Gravelometer™ for the following reasons:

- The combined sieve & hydrometer method is better able to determine the full range of particle sizes.
- The Digital Gravelometer™ is unduly influenced by the unevenness of the ground which creates shadows which are measured as individual clasts.
- The Digital Gravelometer™ had problems distinguishing the smaller particles and often aggregated the smaller particles into one large particle.
- The Digital Gravelometer™ had problems recognising individual angular clasts of waste rock.

Soils in the Gulungul Creek catchment immediately to the west of Ranger mine were sampled in 2006 as part of a large project looking at the impacts of Cyclone Monica, which passed

through the area in April 2006 (Saynor et al 2009). Detailed particle size analyses were undertaken on samples collected from the catchment. Results of 12 samples collected from Woodland and Open woodland vegetation communities that are indicative of the type of soils on the natural surrounding Koolpinyah surface showed that the gravel fractions ranged from 0.0 % to 45.6 % with 6 of the samples having a gravel percentage less than 5 %. This indicates that the surface material on the trial landform (predominantly waste rock) is much coarser than on the surrounding Koolpinyah surface.

Although the particle size results are more reliable than provided by the photographic image analysis, the particle size results will under estimate the amount of large particles > 500 mm in diameter because it was not physically possible to collect a large enough sample that was representative of the whole surface (Figure 8). It was hoped that the Digital Gravelometer™ might assist with the determination of larger particles but this was not the case. The Digital Gravelometer™ was used on photos that were taken prior to knowing the correct sample methodology. It was developed for fluvial environments but it does not work on the uneven ripped surface composed of angular rocks on the trial landform.

5.1 Further work

The sample sites should be photographed each year to track gross changes that are occurring in surface morphology. Samples should also be collected in 2014 and 2019 (or before if rehabilitation of the site occurs earlier) for detailed particle size analysis to determine whether there has been significant weathering and breakdown of gravel clasts. The mounds created by ripping should also be observed to see if they change over time. Although no actual measurements were made of the height of these mounds, observations should be made to see if the mounds noticeably reduce in height or disappear entirely. In a study on the southern waste rock dump which comprised waste rock only, the rip lines and mounds were still evident 11 years after *Eucalyptus miniata* trees were planted (Figure 9).

Figure 8 Large Boulder on the Trial Landform with a mobile phone for scale

Figure 9 *Eucalyptus miniata* trees showing growth in the waste rock dump substrate to 2006. The trees were planted in February 1995. The rip lines are still quite evident and many of the rocks are still competent.

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Appendix 1 Nutrient sample sites

Excel spread sheet of nutrient sample sites collected by Earth Water Life Sciences on 19 March 2009, supplied by Phil Hickey (EWL) 27 March 2009. Shaded rows are the sites sampled by ***eriss*** for particle size analysis.

EWLS	GDA/MGA zone 53		GDA94		Ranger mine Grid	
Site no	X	Y	Long	Lat	Mine_grd_X	Mine_grd_Y
1	271445	8597238	132.895451	-12.6808	7766	10980
2	271456	8597252	132.895554	-12.6807	7776	10994
3	271470	8597284	132.895685	-12.6804	7787	11027
4	271518	8597316	132.896129	-12.6801	7832	11063
5	271547	8597330	132.896397	-12.68	7860	11079
6	271592	8597304	132.896809	-12.6802	7907	11057
7	271585	8597276	132.896743	-12.6805	7902	11029
8	271563	8597228	132.896537	-12.6809	7884	10979
9	271523	8597208	132.896167	-12.6811	7846	10956
10	271495	8597206	132.895909	-12.6811	7818	10952
11	271648	8597106	132.89731	-12.682	7979	10864
12	271664	8597056	132.897453	-12.6825	7999	10816
13	271699	8597072	132.897777	-12.6823	8032	10835
14	271680	8597096	132.897604	-12.6821	8011	10857
15	271649	8597060	132.897316	-12.6825	7983	10819
16	271685	8597136	132.897653	-12.6818	8013	10897
17	271726	8597072	132.898025	-12.6824	8059	10837
18	271761	8597148	132.898353	-12.6817	8088	10915
19	271733	8597140	132.898095	-12.6817	8061	10905
20	271748	8597120	132.898231	-12.6819	8077	10886
21	271652	8597172	132.897352	-12.6814	7977	10930
22	271676	8597210	132.897575	-12.6811	7998	10970
23	271688	8597230	132.897687	-12.6809	8009	10991
24	271622	8597232	132.89708	-12.6809	7943	10988
25	271619	8597208	132.897051	-12.6811	7942	10964
26	271599	8597174	132.896864	-12.6814	7924	10928
27	271603	8597160	132.8969	-12.6815	7930	10915
28	271566	8597138	132.896558	-12.6817	7894	10890
29	271585	8597100	132.89673	-12.6821	7916	10853
30	271622	8597116	132.897071	-12.6819	7952	10872

Appendix 2 Grain size cumulative frequency data for the 24 surface samples on which particle size analysis was completed

Surface material sample site EWLS2 cumulative frequency data

EWLS2 between rip lines (EWLS2 BR)			EWLS2 top of mound created by ripping (EWLS2 TR)		
Phi (Φ)	**Size (mm)**	**Cumulative Percentage**	**Phi (Φ)**	**Size (mm)**	**Cumulative Percentage**
-7.0	128	0.00	-7.0	128	0.00
-6.0	64	14.23	-6.0	64	18.38
-5.0	32	22.48	-5.0	32	33.76
-4	16	32.33	-4	16	48.06
-3.25	9.5	40.92	-3.25	9.5	53.34
-2	4	53.93	-2	4	65.70
-1.5	2.8	58.68	-1.5	2.8	69.12
-1	2	62.63	-1	2	72.52
-0.5	1.4	66.26	-0.5	1.4	74.38
0	1	68.97	0	1	76.15
0.5	0.71	71.70	0.5	0.71	78.17
1	0.5	74.81	1	0.5	80.58
1.5	0.355	77.64	1.5	0.355	82.86
2	0.25	80.90	2	0.25	85.45
2.5	0.18	84.09	2.5	0.18	87.97
3	0.125	86.78	3	0.125	90.11
3.5	0.09	89.25	3.5	0.09	92.04
4	0.063	91.07	4	0.063	93.30
4.64	0.04	94.24	4.64	0.04	95.75
5.76	0.0184	95.37	5.76	0.0185	96.33
6.26	0.0130	95.87	6.26	0.0131	96.91
7.06	0.0075	96.62	7.05	0.0075	97.49
7.85	0.0043	96.87	7.84	0.0044	98.07
8.64	0.0025	97.12	8.63	0.0025	98.26
9.05	0.0019	97.50	9.05	0.0019	98.65
14.00	0.0011	100.00	14.00	0.0011	100.00

Graphic grain size statistics of Folk and Ward (1957) and Folk (1974, 1980)

Site	Graphic Mean (ϕ)	Graphic Mean (mm)	Inclusive Graphic Standard Deviation (ϕ)	Inclusive Graphic Skewness	Graphic Kurtosis	Transformed Kurtosis
EWLS2 BR	-1.89	3.71	3.89	0.23	0.86	0.46
EWLS2 TR	-2.71	6.54	3.66	0.42	0.87	0.47

Textural classification of surface material samples after Folk (1954, 1974, 1980)

Site	Method	Textural class
EWLS2 BR	Detailed Particle Size Analysis	Muddy Medium Sandy Pebbly Gravel
EWLS2 TR	Detailed Particle Size Analysis	Muddy Medium Sandy Pebbly Gravel

Surface material sample at site EWLS5 cumulative frequency data

EWLS5 between rip lines (EWLS5 BR)			EWLS5 top of mound created by ripping (EWLS5 TR)		
Phi (Φ)	Size (mm)	Cumulative Percentage	Phi (Φ)	Size (mm)	Cumulative Percentage
-8.0	256	0.00	-8.0	256	0.00
-7.0	128	19.10	-7.0	128	0.00
-6.0	64	29.31	-6.0	64	33.28
-5.0	32	43.65	-5.0	32	48.47
-4	16	51.04	-4	16	56.24
-3.25	9.5	59.31	-3.25	9.5	63.72
-2	4	70.82	-2	4	73.36
-1.5	2.8	74.15	-1.5	2.8	76.17
-1	2	76.83	-1	2	78.73
-0.5	1.4	79.35	-0.5	1.4	80.74
0	1	81.33	0	1	82.47
0.5	0.71	83.35	0.5	0.71	84.19
1	0.5	85.69	1	0.5	86.16
1.5	0.355	87.72	1.5	0.355	87.88
2	0.25	89.90	2	0.25	89.79
2.5	0.18	91.85	2.5	0.18	91.61
3	0.125	93.31	3	0.125	93.10
3.5	0.09	94.80	3.5	0.09	94.54
4	0.063	95.70	4	0.063	95.47
4.64	0.04	97.32	4.64	0.04	97.21
5.76	0.0184	97.64	5.76	0.0185	97.51
6.26	0.0130	98.11	6.26	0.0131	97.95
7.06	0.0075	98.42	7.05	0.0075	98.09
7.85	0.0043	98.74	7.84	0.0044	98.68
8.64	0.0025	98.74	8.63	0.0025	98.83
9.05	0.0019	99.05	9.05	0.0019	99.12
14.00	0.0011	100.00	14.00	0.0011	100.00

Graphic grain size statistics of Folk and Ward (1957) and Folk (1974, 1980)

Site	Graphic Mean (ϕ)	Graphic Mean (mm)	Inclusive Graphic Standard Deviation (ϕ)	Inclusive Graphic Skewness	Graphic Kurtosis	Transformed Kurtosis
EWLS5 BR	-3.55	11.71	3.67	0.30	0.92	0.48
EWLS5 TR	-3.63	12.38	3.35	0.56	0.96	0.49

Textural classification for surface material samples Folk (1954, 1974, 1980)

Site	Method	Textural class
EWLS5 BR	Detailed Particle Size Analysis	Muddy Medium Sandy Pebbly Gravel
EWLS5 TR	Detailed Particle Size Analysis	Muddy Medium Sandy Pebbly Gravel

Surface material sample at site EWLS6 cumulative frequency data

EWLS6 between rip lines (EWLS6 BR)			EWLS6 top of mound created by ripping (EWLS6 TR)		
Phi (Φ)	**Size (mm)**	**Cumulative Percentage**	**Phi (Φ)**	**Size (mm)**	**Cumulative Percentage**
-7.0	128	0.00	-7.0	128	0
-6.0	64	16.19	-6.0	64	3.62
-5.0	32	20.28	-5.0	32	10.54
-4	16	26.55	-4	16	21.00
-3.25	9.5	34.43	-3.25	9.5	31.04
-2	4	47.57	-2	4	46.08
-1.5	2.8	52.81	-1.5	2.8	50.88
-1	2	57.57	-1	2	56.36
-0.5	1.4	63.09	-0.5	1.4	60.10
0	1	67.91	0	1	63.30
0.5	0.71	71.99	0.5	0.71	66.62
1	0.5	76.11	1	0.5	70.34
1.5	0.355	79.42	1.5	0.355	73.60
2	0.25	82.33	2	0.25	77.04
2.5	0.18	84.94	2.5	0.18	80.34
3	0.125	87.57	3	0.125	83.27
3.5	0.09	88.82	3.5	0.09	85.97
4	0.063	90.30	4	0.063	87.89
4.64	0.04	94.30	4.64	0.04	92.10
5.76	0.0184	94.94	5.76	0.0185	93.23
6.26	0.0130	95.25	6.26	0.0131	94.36
7.06	0.0075	95.73	7.05	0.0075	95.21
7.85	0.0043	96.20	7.84	0.0044	96.05
8.64	0.0025	96.36	8.63	0.0025	96.33
9.05	0.0019	96.68	9.05	0.0019	96.90
14.00	0.0011	100.00	14.00	0.0011	100.00

Graphic grain size statistics of Folk and Ward (1957) and Folk (1974, 1980)

Site	Graphic Mean (ϕ)	Graphic Mean (mm)	Inclusive Graphic Standard Deviation (ϕ)	Inclusive Graphic Skewness	Graphic Kurtosis	Transformed Kurtosis
EWLS6 BR	-1.82	3.53	3.98	0.10	1.01	0.50
EWLS6 TR	-0.98	1.97	3.82	0.29	0.96	0.49

Textural classification for surface material samples Folk (1954, 1974, 1980)

Site	Method	Textural class
EWLS6 BR	Detailed Particle Size Analysis	Muddy Coarse Sandy Pebbly Gravel
EWLS6 TR	Detailed Particle Size Analysis	Muddy Medium Sandy Pebbly Gravel

Surface material sample at site EWLS9 cumulative frequency data

EWLS9 between rip lines (EWLS9 BR)			EWLS9 top of mound created by ripping (EWLS9 TR)		
Phi (Φ)	**Size (mm)**	**Cumulative Percentage**	**Phi (Φ)**	**Size (mm)**	**Cumulative Percentage**
-7.0	128	0.00	-7.0	128	0.00
-6.0	64	9.06	-6.0	64	19.10
-5.0	32	31.95	-5.0	32	30.23
-4	16	39.46	-4	16	37.92
-3.25	9.5	48.19	-3.25	9.5	47.90
-2	4	59.94	-2	4	62.28
-1.5	2.8	63.79	-1.5	2.8	66.45
-1	2	67.31	-1	2	69.95
-0.5	1.4	70.77	-0.5	1.4	74.04
0	1	73.36	0	1	77.21
0.5	0.71	75.73	0.5	0.71	79.98
1	0.5	78.54	1	0.5	82.81
1.5	0.355	81.17	1.5	0.355	85.24
2	0.25	83.96	2	0.25	87.79
2.5	0.18	86.74	2.5	0.18	90.21
3	0.125	89.09	3	0.125	92.23
3.5	0.09	91.03	3.5	0.09	94.00
4	0.063	92.50	4	0.063	95.16
4.64	0.04	95.15	4.64	0.04	97.39
5.76	0.0184	95.55	5.76	0.0185	97.82
6.26	0.0130	96.09	6.26	0.0131	98.26
7.06	0.0075	96.36	7.05	0.0075	98.69
7.85	0.0043	96.77	7.84	0.0044	99.13
8.64	0.0025	97.17	8.63	0.0025	99.35
9.05	0.0019	97.57	9.05	0.0019	99.56
14.00	0.0011	100.00	14.00	0.0011	100.00

Graphic grain size statistics of Folk and Ward (1957) and Folk (1974, 1980)

Site	Graphic Mean (ϕ)	Graphic Mean (mm)	Inclusive Graphic Standard Deviation (ϕ)	Inclusive Graphic Skewness	Graphic Kurtosis	Transformed Kurtosis
EWLS9 BR	-2.25	4.76	3.60	0.35	0.80	0.45
EWLS9 TR	-2.66	6.32	3.47	0.24	0.85	0.46

Textural classification for surface material samples Folk (1954, 1974, 1980)

Site	Method	Textural class
EWLS9 BR	Detailed Particle Size Analysis	Muddy Medium Sandy Pebbly Gravel
EWLS9 TR	Detailed Particle Size Analysis	Muddy Coarse Sandy Pebbly Gravel

Surface material sample at site EWLS13 cumulative frequency data

EWLS13 between rip lines (EWLS13 BR)			EWLS13 top of mound created by ripping (EWLS13 TR)		
Phi (Φ)	**Size (mm)**	**Cumulative Percentage**	**Phi (Φ)**	**Size (mm)**	**Cumulative Percentage**
-7.0	128	0.00	-7.0	128	0.00
-6.0	64	16.43	-6.0	64	8.27
-5.0	32	24.86	-5.0	32	19.67
-4	16	32.56	-4	16	27.17
-3.25	9.5	40.95	-3.25	9.5	34.48
-2	4	52.96	-2	4	47.75
-1.5	2.8	57.07	-1.5	2.8	52.10
-1	2	60.87	-1	2	57.37
-0.5	1.4	64.72	-0.5	1.4	60.58
0	1	68.05	0	1	63.59
0.5	0.71	70.80	0.5	0.71	66.71
1	0.5	74.06	1	0.5	70.35
1.5	0.355	77.22	1.5	0.355	73.61
2	0.25	80.51	2	0.25	77.40
2.5	0.18	83.71	2.5	0.18	80.99
3	0.125	86.39	3	0.125	83.95
3.5	0.09	88.69	3.5	0.09	86.66
4	0.063	90.43	4	0.063	88.52
4.64	0.04	93.66	4.64	0.04	91.70
5.76	0.0184	94.22	5.76	0.0185	92.45
6.26	0.0130	95.00	6.26	0.0131	93.23
7.06	0.0075	95.31	7.05	0.0075	93.73
7.85	0.0043	95.63	7.84	0.0044	94.24
8.64	0.0025	96.25	8.63	0.0025	94.92
9.05	0.0019	96.56	9.05	0.0019	95.77
14.00	0.0011	100.00	14.00	0.0011	100.00

Graphic grain size statistics of Folk and Ward (1957) and Folk (1974, 1980)

Site	Graphic Mean (ϕ)	Graphic Mean (mm)	Inclusive Graphic Standard Deviation (ϕ)	Inclusive Graphic Skewness	Graphic Kurtosis	Transformed Kurtosis
EWLS13 BR	-1.93	3.81	4.11	0.23	0.87	0.46
EWLS13 TR	-1.35	2.55	4.37	0.26	1.03	0.51

Textural classification for surface material samples Folk (1954, 1974, 1980)

Site	Method	Textural class
EWLS13 BR	Detailed Particle Size Analysis	Muddy Medium Sandy Pebbly Gravel
EWLS13 TR	Detailed Particle Size Analysis	Muddy Medium Sandy Pebbly Gravel

Surface material sample at site EWLS15 cumulative frequency data

EWLS15 between rip lines (EWLS15 BR1)			EWLS15 between rip lines (EWLS15 BR2)		
Phi (Φ)	**Size (mm)**	**Cumulative Percentage**	**Phi (Φ)**	**Size (mm)**	**Cumulative Percentage**
-7.0	128	0.00	-7.0	128	0.00
-6.0	64	17.42	-6.0	64	0.00
-5.0	32	25.40	-5.0	32	9.79
-4	16	35.28	-4	16	20.97
-3.25	9.5	47.54	-3.25	9.5	31.49
-2	4	57.82	-2	4	47.51
-1.5	2.8	61.28	-1.5	2.8	51.90
-1	2	65.20	-1	2	57.23
-0.5	1.4	68.66	-0.5	1.4	61.81
0	1	71.85	0	1	65.64
0.5	0.71	74.53	0.5	0.71	69.15
1	0.5	77.56	1	0.5	72.91
1.5	0.355	80.22	1.5	0.355	76.06
2	0.25	83.00	2	0.25	79.53
2.5	0.18	85.68	2.5	0.18	82.85
3	0.125	88.05	3	0.125	85.42
3.5	0.09	89.94	3.5	0.09	88.05
4	0.063	91.46	4	0.063	89.80
4.64	0.04	94.37	4.64	0.04	93.14
5.76	0.0184	94.88	5.76	0.0185	93.74
6.26	0.0130	95.46	6.26	0.0131	94.48
7.06	0.0075	95.83	7.05	0.0075	94.93
7.85	0.0043	96.21	7.84	0.0044	95.68
8.64	0.0025	96.59	8.63	0.0025	95.83
9.05	0.0019	96.97	9.05	0.0019	96.12
14.00	0.0011	100.00	14.00	0.0011	100.00

Graphic grain size statistics of Folk and Ward (1957) and Folk (1974, 1980)

Site	**Graphic Mean (ϕ)**	**Graphic Mean (mm)**	**Inclusive Graphic Standard Deviation (ϕ)**	**Inclusive Graphic Skewness**	**Graphic Kurtosis**	**Transformed Kurtosis**
EWLS15 BR	-2.28	4.86	3.98	0.32	0.92	0.48
EWLS15 TR	-1.15	2.22	3.70	0.32	1.03	0.51

Textural classification for surface material samples Folk (1954, 1974, 1980)

Site	**Method**	**Textural class**
EWLS15 BR	Detailed Particle Size Analysis	Muddy Medium Sandy Pebbly Gravel
EWLS15 TR	Detailed Particle Size Analysis	Muddy Medium Sandy Pebbly Gravel

Surface material sample at site EWLS16 cumulative frequency data

EWLS16 between rip lines (EWLS16 BR1)			EWLS16 between rip lines (EWLS16 BR2)		
Phi (Φ)	**Size (mm)**	**Cumulative Percentage**	**Phi (Φ)**	**Size (mm)**	**Cumulative Percentage**
-7.0	128	0.00	-7.0	128	0.00
-6.0	64	6.61	-6.0	64	7.47
-5.0	32	20.59	-5.0	32	26.83
-4	16	31.96	-4	16	36.41
-3.25	9.5	33.25	-3.25	9.5	42.51
-2	4	50.91	-2	4	52.74
-1.5	2.8	55.18	-1.5	2.8	56.40
-1	2	60.02	-1	2	60.89
-0.5	1.4	63.55	-0.5	1.4	64.31
0	1	66.91	0	1	67.54
0.5	0.71	70.11	0.5	0.71	70.58
1	0.5	73.52	1	0.5	73.94
1.5	0.355	76.56	1.5	0.355	77.00
2	0.25	80.00	2	0.25	80.22
2.5	0.18	83.26	2.5	0.18	77.05
3	0.125	85.84	3	0.125	86.00
3.5	0.09	88.28	3.5	0.09	88.20
4	0.063	89.80	4	0.063	89.85
4.64	0.04	92.84	4.64	0.04	92.78
5.76	0.0184	93.51	5.76	0.0185	93.40
6.26	0.0130	94.33	6.26	0.0131	94.03
7.06	0.0075	94.73	7.05	0.0075	94.97
7.85	0.0043	95.41	7.84	0.0044	95.60
8.64	0.0025	95.81	8.63	0.0025	95.92
9.05	0.0019	96.22	9.05	0.0019	96.54
14.00	0.0011	100.00	14.00	0.0011	100.00

Graphic grain size statistics of Folk and Ward (1957) and Folk (1974, 1980)

Site	Graphic Mean (ϕ)	Graphic Mean (mm)	Inclusive Graphic Standard Deviation (ϕ)	Inclusive Graphic Skewness	Graphic Kurtosis	Transformed Kurtosis
EWLS16 BR	-1.58	2.99	4.06	0.28	0.95	0.49
EWLS16 TR	-1.67	3.18	4.15	0.32	0.88	0.47

Textural classification for surface material samples Folk (1954, 1974, 1980)

Site	Method	Textural class
EWLS16 BR	Detailed Particle Size Analysis	Muddy Medium Sandy Pebbly Gravel
EWLS16 TR	Detailed Particle Size Analysis	Muddy Medium Sandy Pebbly Gravel

Surface material sample at site EWLS18 cumulative frequency data

EWLS18 between rip lines (EWLS18 BR)			EWLS18 top of mound created by ripping (EWLS18 TR)		
Phi (Φ)	**Size (mm)**	**Cumulative Percentage**	**Phi (Φ)**	**Size (mm)**	**Cumulative Percentage**
-7.0	128	0.00	-7.0	128	0.00
-6.0	64	6.34	-6.0	64	0.00
-5.0	32	22.69	-5.0	32	12.40
-4	16	31.88	-4	16	23.16
-3.25	9.5	39.47	-3.25	9.5	33.07
-2	4	52.38	-2	4	48.54
-1.5	2.8	56.71	-1.5	2.8	53.92
-1	2	60.84	-1	2	59.10
-0.5	1.4	64.55	-0.5	1.4	63.47
0	1	67.83	0	1	67.30
0.5	0.71	71.13	0.5	0.71	70.59
1	0.5	74.59	1	0.5	74.32
1.5	0.355	77.60	1.5	0.355	77.64
2	0.25	80.84	2	0.25	81.11
2.5	0.18	83.88	2.5	0.18	84.55
3	0.125	86.31	3	0.125	87.52
3.5	0.09	88.55	3.5	0.09	89.68
4	0.063	90.05	4	0.063	91.54
4.64	0.04	93.56	4.64	0.04	93.73
5.76	0.0184	94.15	5.76	0.0185	93.73
6.26	0.0130	94.73	6.26	0.0131	94.78
7.06	0.0075	95.90	7.05	0.0075	95.47
7.85	0.0043	96.49	7.84	0.0044	96.17
8.64	0.0025	96.78	8.63	0.0025	96.52
9.05	0.0019	97.07	9.05	0.0019	97.21
14.00	0.0011	100.00	14.00	0.0011	100.00

Graphic grain size statistics of Folk and Ward (1957) and Folk (1974, 1980)

Site	Graphic Mean (ϕ)	Graphic Mean (mm)	Inclusive Graphic Standard Deviation (ϕ)	Inclusive Graphic Skewness	Graphic Kurtosis	Transformed Kurtosis
EWLS18 BR	-1.70	3.25	3.90	0.28	0.89	0.47
EWLS18 TR	-1.37	2.58	3.61	0.30	1.00	0.50

Textural classification for surface material samples Folk (1954, 1974, 1980)

Site	Method	Textural class
EWLS18 BR	Detailed Particle Size Analysis	Muddy Medium Sandy Pebbly Gravel
EWLS18 TR	Detailed Particle Size Analysis	Muddy Medium Sandy Pebbly Gravel

Surface material sample at site EWLS23 cumulative frequency data

EWLS23 between rip lines (EWLS23 BR)			EWLS23 top of mound created by ripping (EWLS23 TR)		
Phi (Φ)	**Size (mm)**	**Cumulative Percentage**	**Phi (Φ)**	**Size (mm)**	**Cumulative Percentage**
-7.0	128	0.00	-7.0	128	0.00
-6.0	64	24.14	-6.0	64	23.06
-5.0	32	32.19	-5.0	32	32.47
-4	16	38.78	-4	16	42.00
-3.25	9.5	45.60	-3.25	9.5	48.45
-2	4	55.78	-2	4	58.08
-1.5	2.8	59.23	-1.5	2.8	61.63
-1	2	63.22	-1	2	65.94
-0.5	1.4	66.92	-0.5	1.4	68.29
0	1	70.05	0	1	70.77
0.5	0.71	73.18	0.5	0.71	72.96
1	0.5	76.47	1	0.5	75.69
1.5	0.355	79.34	1.5	0.355	78.32
2	0.25	82.47	2	0.25	81.27
2.5	0.18	85.44	2.5	0.18	84.21
3	0.125	87.91	3	0.125	86.81
3.5	0.09	89.99	3.5	0.09	88.87
4	0.063	91.45	4	0.063	90.47
4.64	0.04	94.19	4.64	0.04	92.52
5.76	0.0184	94.34	5.76	0.0185	92.64
6.26	0.0130	94.92	6.26	0.0131	93.54
7.06	0.0075	95.65	7.05	0.0075	94.50
7.85	0.0043	95.94	7.84	0.0044	94.68
8.64	0.0025	96.23	8.63	0.0025	95.02
9.05	0.0019	96.37	9.05	0.0019	95.81
14.00	0.0011	100.00	14.00	0.0011	100.00

Graphic grain size statistics of Folk and Ward (1957) and Folk (1974, 1980)

Site	Graphic Mean (ϕ)	Graphic Mean (mm)	Inclusive Graphic Standard Deviation (ϕ)	Inclusive Graphic Skewness	Graphic Kurtosis	Transformed Kurtosis
EWLS23 BR	-2.26	4.79	4.14	0.27	0.81	0.45
EWLS23 TR	-2.30	4.92	4.53	0.39	0.93	0.49

Textural classification for surface material samples Folk (1954, 1974, 1980)

Site	Method	Textural class
EWLS23 BR	Detailed Particle Size Analysis	Muddy Medium Sandy Pebbly Gravel
EWLS23 TR	Detailed Particle Size Analysis	Muddy Medium Sandy Pebbly Gravel

Surface material sample at site EWLS25 cumulative frequency data

EWLS25 between rip lines (EWLS25 BR)			EWLS25 top of mound created by ripping (EWLS25 TR)		
Phi (Φ)	Size (mm)	Cumulative Percentage	Phi (Φ)	Size (mm)	Cumulative Percentage
-8.0	256	0.00	-8.0	256	0.00
-7.0	128	26.26	-7.0	128	0.00
-6.0	64	26.26	-6.0	64	4.99
-5.0	32	29.90	-5.0	32	14.44
-4	16	36.66	-4	16	29.02
-3.25	9.5	44.42	-3.25	9.5	39.16
-2	4	57.24	-2	4	53.83
-1.5	2.8	62.21	-1.5	2.8	58.38
-1	2	66.48	-1	2	63.81
-0.5	1.4	70.59	-0.5	1.4	66.24
0	1	74.27	0	1	69.13
0.5	0.71	77.12	0.5	0.71	71.67
1	0.5	80.00	1	0.5	74.71
1.5	0.355	82.35	1.5	0.355	77.40
2	0.25	84.63	2	0.25	80.21
2.5	0.18	86.71	2.5	0.18	82.92
3	0.125	88.50	3	0.125	85.24
3.5	0.09	89.94	3.5	0.09	87.06
4	0.063	91.03	4	0.063	88.46
4.64	0.04	92.61	4.64	0.04	91.36
5.76	0.0184	93.13	5.76	0.0185	91.84
6.26	0.0130	93.93	6.26	0.0131	92.80
7.06	0.0075	94.19	7.05	0.0075	94.00
7.85	0.0043	94.72	7.84	0.0044	94.72
8.64	0.0025	94.98	8.63	0.0025	95.20
9.05	0.0019	95.91	9.05	0.0019	95.68
14.00	0.0011	100.00	14.00	0.0011	100.00

Graphic grain size statistics of Folk and Ward (1957) and Folk (1974, 1980)

Site	Graphic Mean (ϕ)	Graphic Mean (mm)	Inclusive Graphic Standard Deviation (ϕ)	Inclusive Graphic Skewness	Graphic Kurtosis	Transformed Kurtosis
EWLS25 BR	-2.74	6.68	4.81	0.18	0.94	0.49
EWLS25 TR	-1.50	2.83	4.08	0.41	1.10	0.52

Textural classification for surface material samples Folk (1954, 1974, 1980)

Site	Method	Textural class
EWLS25 BR	Detailed Particle Size Analysis	Muddy Medium Sandy Pebbly Gravel
EWLS25 TR	Detailed Particle Size Analysis	Muddy Medium Sandy Pebbly Gravel

Surface material sample at site EWLS28 cumulative frequency data

EWLS28 between rip lines (EWLS28 BR)			EWLS28 top of mound created by ripping (EWLS28 TR)		
Phi (Φ)	**Size (mm)**	**Cumulative Percentage**	**Phi (Φ)**	**Size (mm)**	**Cumulative Percentage**
-7.0	128	0.00	-7.0	128	0.00
-6.0	64	14.39	-6.0	64	4.83
-5.0	32	33.84	-5.0	32	17.09
-4	16	41.78	-4	16	24.88
-3.25	9.5	49.86	-3.25	9.5	35.03
-2	4	61.60	-2	4	47.82
-1.5	2.8	65.50	-1.5	2.8	52.02
-1	2	69.22	-1	2	57.06
-0.5	1.4	71.43	-0.5	1.4	60.39
0	1	73.53	0	1	63.31
0.5	0.71	75.63	0.5	0.71	66.13
1	0.5	78.27	1	0.5	69.74
1.5	0.355	80.91	1.5	0.355	73.15
2	0.25	83.79	2	0.25	77.06
2.5	0.18	86.59	2.5	0.18	81.09
3	0.125	89.05	3	0.125	84.55
3.5	0.09	91.08	3.5	0.09	87.42
4	0.063	92.59	4	0.063	89.60
4.64	0.04	94.99	4.64	0.04	92.86
5.76	0.0184	95.25	5.76	0.0185	93.27
6.26	0.0130	95.78	6.26	0.0131	93.96
7.06	0.0075	96.04	7.05	0.0075	94.78
7.85	0.0043	96.44	7.84	0.0044	95.33
8.64	0.0025	96.57	8.63	0.0025	95.60
9.05	0.0019	97.23	9.05	0.0019	95.74
14.00	0.0011	100.00	14.00	0.0011	100.00

Graphic grain size statistics of Folk and Ward (1957) and Folk (1974, 1980)

Site	Graphic Mean (ϕ)	Graphic Mean (mm)	Inclusive Graphic Standard Deviation (ϕ)	Inclusive Graphic Skewness	Graphic Kurtosis	Transformed Kurtosis
EWLS28 BR	-2.37	5.17	3.71	0.36	0.80	0.44
EWLS28 TR	-1.30	2.46	4.03	0.26	0.96	0.49

Textural classification for surface material samples Folk (1954, 1974, 1980)

Site	Method	Textural class
EWLS28 BR	Detailed Particle Size Analysis	Muddy Medium Sandy Pebbly Gravel
EWLS28 TR	Detailed Particle Size Analysis	Muddy Medium Sandy Pebbly Gravel

Surface material sample at site EWLS30 cumulative frequency data

EWLS30 between rip lines (EWLS30 BR1)			EWLS30 between rip lines (EWLS30 TR2)		
Phi (Φ)	**Size (mm)**	**Cumulative Percentage**	**Phi (Φ)**	**Size (mm)**	**Cumulative Percentage**
-7.0	128	0.00	-7.0	128	0.00
-6.0	64	0.00	-6.0	64	3.74
-5.0	32	5.45	-5.0	32	17.20
-4	16	13.29	-4	16	26.65
-3.25	9.5	23.47	-3.25	9.5	34.60
-2	4	39.68	-2	4	47.35
-1.5	2.8	45.10	-1.5	2.8	52.08
-1	2	50.43	-1	2	56.75
-0.5	1.4	54.05	-0.5	1.4	60.12
0	1	57.26	0	1	63.31
0.5	0.71	60.11	0.5	0.71	66.31
1	0.5	63.41	1	0.5	69.63
1.5	0.355	66.41	1.5	0.355	72.64
2	0.25	69.63	2	0.25	75.82
2.5	0.18	72.77	2.5	0.18	72.69
3	0.125	75.37	3	0.125	81.52
3.5	0.09	77.53	3.5	0.09	83.69
4	0.063	79.13	4	0.063	85.32
4.64	0.04	91.77	4.64	0.04	91.94
5.76	0.0184	92.39	5.76	0.0185	92.25
6.26	0.0130	92.86	6.26	0.0131	93.18
7.06	0.0075	93.79	7.05	0.0075	93.80
7.85	0.0043	94.41	7.84	0.0044	94.58
8.64	0.0025	94.57	8.63	0.0025	94.89
9.05	0.0019	95.03	9.05	0.0019	95.35
14.00	0.0011	100.00	14.00	0.0011	100.00

Graphic grain size statistics of Folk and Ward (1957) and Folk (1974, 1980)

Site	Graphic Mean (ϕ)	Graphic Mean (mm)	Inclusive Graphic Standard Deviation (ϕ)	Inclusive Graphic Skewness	Graphic Kurtosis	Transformed Kurtosis
EWLS30 BR	-0.20	1.15	4.15	0.37	0.95	0.49
EWLS30 TR	-1.07	2.10	4.39	0.33	0.99	0.50

Textural classification for surface material samples Folk (1954, 1974, 1980)

Site	Method	Textural class
EWLS30 BR	Detailed Particle Size Analysis	Muddy Medium Sandy Pebbly Gravel
EWLS30 TR	Detailed Particle Size Analysis	Muddy Medium Sandy Pebbly Gravel

Appendix 3 Cumulative frequency data from Digital Gravelometer™ for each of the 12 surface sample sites

The grain size statistics have been taken from the Digital Gravelometer™ results.

EWLS Site 2 – cumulative frequency data from Digital Gravelometer™

8 images were assessed and aggregated

Phi (Φ)	Size (mm)	Count in class	Cumulative Percentage
-9.5	724	2	0.01
-9	512	2	0.01
-8.5	362	1	0.01
-8	256	8	0.03
-7.5	181	21	0.09
-7	128	39	0.19
-6.5	90.5	96	0.43
-6	64	120	0.73
-5.5	45.3	151	1.12
-5	32	301	1.88
-4.5	22.6	575	3.34
-4	16	1486	7.12
-3.5	11.3	3401	15.75
-3	8	5758	30.37
-2.5	5.7	7313	48.94
-2	4	6767	66.13
-1.5	2.83	5446	79.96
-1	2	2831	87.15
-0.5	1.41	1604	91.22
0	1	108	91.50
0.5	0.71	3349	100.00

Graphic grain size statistics of Folk and Ward (1957) and Folk (1974, 1980)

Site	Graphic Mean (ϕ)	Graphic Mean (mm)	Inclusive Graphic Standard Deviation (ϕ)	Inclusive Graphic Skewness	Graphic Kurtosis
EWLS2	-1.92	3.79	1.20	0.13	1.22

EWLS Site 5 – cumulative frequency data from Digital Gravelometer™

5 images were assessed and aggregated

Phi (Φ)	Size (mm)	Count in class	Cumulative Percentage
-8.5	362	5	0.02
-8	256	6	0.05
-7.5	181	16	0.13
-7	128	21	0.24
-6.5	90.5	32	0.39
-6	64	99	0.88
-5.5	45.3	207	1.90
-5	32	247	3.12
-4.5	22.6	487	5.52
-4	16	1044	10.67
-3.5	11.3	2335	22.19
-3	8	3194	37.94
-2.5	5.7	3660	56.00
-2	4	2842	70.01
-1.5	2.83	2062	80.18
-1	2	1260	86.40
-0.5	1.41	737	90.03
0	1	53	90.29
0.5	0.71	1968	100.00

Graphic grain size statistics of Folk and Ward (1957) and Folk (1974, 1980)

Site	Graphic Mean (ϕ)	Graphic Mean (mm)	Inclusive Graphic Standard Deviation (ϕ)	Inclusive Graphic Skewness	Graphic Kurtosis
EWLS5	-2.07	4.21	1.31	0.15	1.16

EWLS Site 6 – cumulative frequency data from Digital Gravelometer™

4 images were assessed and aggregated

Phi (Φ)	Size (mm)	Count in class	Cumulative Percentage
-9	512	2	0.03
-8.5	362	9	0.18
-8	256	10	0.34
-7.5	181	18	0.62
-7	128	11	0.80
-6.5	90.5	21	1.14
-6	64	41	1.79
-5.5	45.3	67	2.87
-5	32	106	4.56
-4.5	22.6	216	8.02
-4	16	468	15.52
-3.5	11.3	795	28.25
-3	8	1165	46.91
-2.5	5.7	1087	64.32
-2	4	817	77.40
-1.5	2.83	523	85.78
-1	2	255	89.86
-0.5	1.41	193	92.95
0	1	8	93.08
0.5	0.71	432	100.00

Graphic grain size statistics of Folk and Ward (1957) and Folk (1974, 1980)

Site	Graphic Mean (ϕ)	Graphic Mean (mm)	Inclusive Graphic Standard Deviation (ϕ)	Inclusive Graphic Skewness	Graphic Kurtosis
EWLS6	-2.34	5.06	1.33	0.14	1.36

EWLS Site 9 – cumulative frequency data from Digital Gravelometer™

6 images were assessed and aggregated

Phi (Φ)	Size (mm)	Count in class	Cumulative Percentage
-8	256	0.05	0.05
-7.5	181	0.13	0.19
-7	128	0.08	0.27
-6.5	90.5	0.19	0.46
-6	64	0.29	0.75
-5.5	45.3	0.55	1.30
-5	32	0.78	2.08
-4.5	22.6	1.50	3.58
-4	16	3.99	7.57
-3.5	11.3	8.68	16.25
-3	8	14.04	30.29
-2.5	5.7	19.27	49.57
-2	4	16.75	66.32
-1.5	2.83	12.71	79.03
-1	2	7.29	86.32
-0.5	1.41	3.85	90.17
0	1	0.32	90.49
0.5	0.71	9.51	100.00

Graphic grain size statistics of Folk and Ward (1957) and Folk (1974, 1980)

Site	Graphic Mean (ϕ)	Graphic Mean (mm)	Inclusive Graphic Standard Deviation (ϕ)	Inclusive Graphic Skewness	Graphic Kurtosis
EWLS9	-1.92	3.8	1.22	0.14	1.2

EWLS Site 13 – cumulative frequency data from Digital Gravelometer™

6 images were assessed and aggregated

Phi (Φ)	Size (mm)	Count in class	Cumulative Percentage
-10	1024	1	0.01
-9.5	724	0	0.01
-9	512	9	0.05
-8.5	362	2	0.06
-8	256	7	0.10
-7.5	181	9	0.14
-7	128	20	0.25
-6.5	90.5	40	0.45
-6	64	89	0.90
-5.5	45.3	153	1.69
-5	32	312	3.28
-4.5	22.6	611	6.40
-4	16	1312	13.11
-3.5	11.3	2590	26.35
-3	8	3333	43.38
-2.5	5.7	3425	60.89
-2	4	2585	74.10
-1.5	2.83	1953	84.08
-1	2	1092	89.66
-0.5	1.41	620	92.83
0	1	44	93.05
0.5	0.71	1359	100.00

Graphic grain size statistics of Folk and Ward (1957) and Folk (1974, 1980)

Site	Graphic Mean (ϕ)	Graphic Mean (mm)	Inclusive Graphic Standard Deviation (ϕ)	Inclusive Graphic Skewness	Graphic Kurtosis
EWLS13	-2.23	4.68	1.32	0.16	1.25

EWLS Site 15 – cumulative frequency data from Digital Gravelometer™

6 images were assessed and aggregated

Phi (Φ)	Size (mm)	Count in class	Cumulative Percentage
-9	512	4	0.01
-8.5	362	7	0.04
-8	256	10	0.08
-7.5	181	15	0.13
-7	128	41	0.28
-6.5	90.5	81	0.58
-6	64	80	0.87
-5.5	45.3	160	1.45
-5	32	373	2.81
-4.5	22.6	526	4.73
-4	16	1219	9.18
-3.5	11.3	2437	18.08
-3	8	3848	32.12
-2.5	5.7	4829	49.74
-2	4	4496	66.15
-1.5	2.83	3720	79.72
-1	2	2022	87.10
-0.5	1.41	745	89.82
0	1	376	91.19
0.5	0.71	2413	100.00

Graphic grain size statistics of Folk and Ward (1957) and Folk (1974, 1980)

Site	Graphic Mean (ϕ)	Graphic Mean (mm)	Inclusive Graphic Standard Deviation (ϕ)	Inclusive Graphic Skewness	Graphic Kurtosis
EWLS15	-1.95	3.86	1.27	0.10	1.21

EWLS Site 16 – cumulative frequency data from Digital Gravelometer™

5 images were assessed and aggregated

Phi (Φ)	Size (mm)	Count in class	Cumulative Percentage
-9.5	724	2	0.01
-9	512	8	0.04
-8.5	362	1	0.05
-8	256	7	0.08
-7.5	181	18	0.16
-7	128	31	0.29
-6.5	90.5	3	0.31
-6	64	30	0.44
-5.5	45.3	88	0.83
-5	32	279	2.05
-4.5	22.6	593	4.66
-4	16	1230	10.07
-3.5	11.3	2524	21.17
-3	8	3772	37.75
-2.5	5.7	4296	56.64
-2	4	3391	71.55
-1.5	2.83	2542	82.73
-1	2	1403	88.90
-0.5	1.41	529	91.22
0	1	249	92.32
0.5	0.71	1747	100.00

Graphic grain size statistics of Folk and Ward (1957) and Folk (1974, 1980)

Site	Graphic Mean (ϕ)	Graphic Mean (mm)	Inclusive Graphic Standard Deviation (ϕ)	Inclusive Graphic Skewness	Graphic Kurtosis
EWLS16	-2.10	4.28	1.76	0.17	1.24

EWLS Site 18 – cumulative frequency data from Digital Gravelometer™

4 images were assessed and aggregated

Phi (Φ)	Size (mm)	Count in class	Cumulative Percentage
-9	512	4	0.12
-8.5	362	1	0.15
-8	256	3	0.24
-7.5	181	2	0.29
-7	128	6	0.47
-6.5	90.5	4	0.59
-6	64	10	0.88
-5.5	45.3	34	1.88
-5	32	54	3.47
-4.5	22.6	125	7.15
-4	16	238	14.15
-3.5	11.3	423	26.60
-3	8	573	43.45
-2.5	5.7	550	59.64
-2	4	440	72.58
-1.5	2.83	308	81.64
-1	2	209	87.79
-0.5	1.41	102	90.79
0	1	41	92.00
0.5	0.71	272	100.00

Graphic grain size statistics of Folk and Ward (1957) and Folk (1974, 1980)

Site	Graphic Mean (ϕ)	Graphic Mean (mm)	Inclusive Graphic Standard Deviation (ϕ)	Inclusive Graphic Skewness	Graphic Kurtosis
EWLS18	-2.19	4.56	1.38	0.18	1.19

EWLS Site 23 – cumulative frequency data from Digital Gravelometer™

5 images were assessed and aggregated

Phi (Φ)	Size (mm)	Count in class	Cumulative Percentage
-9.5	724	4	0.01
-9	512	3	0.03
-8.5	362	0	0.03
-8	256	0	0.03
-7.5	181	5	0.04
-7	128	17	0.11
-6.5	90.5	34	0.23
-6	64	22	0.32
-5.5	45.3	49	0.50
-5	32	145	1.04
-4.5	22.6	352	2.34
-4	16	864	5.55
-3.5	11.3	1880	12.52
-3	8	3478	25.43
-2.5	5.7	4583	42.43
-2	4	4975	60.89
-1.5	2.83	4835	78.83
-1	2	2374	87.64
-0.5	1.41	1142	91.88
0	1	81	92.18
0.5	0.71	2107	100.00

Graphic grain size statistics of Folk and Ward (1957) and Folk (1974, 1980)

Site	Graphic Mean (ϕ)	Graphic Mean (mm)	Inclusive Graphic Standard Deviation (ϕ)	Inclusive Graphic Skewness	Graphic Kurtosis
EWLS23	-1.80	3.49	1.14	0.06	1.24

EWLS Site 25 – cumulative frequency data from Digital Gravelometer™

2 images were assessed and aggregated

Phi (Φ)	Size (mm)	Count in class	Cumulative Percentage
-9.5	724	1	0.01
-9	512	0	0.01
-8.5	362	3	0.05
-8	256	3	0.08
-7.5	181	5	0.14
-7	128	8	0.23
-6.5	90.5	5	0.29
-6	64	16	0.47
-5.5	45.3	50	1.04
-5	32	121	2.42
-4.5	22.6	211	4.84
-4	16	402	9.44
-3.5	11.3	768	18.22
-3	8	1062	30.36
-2.5	5.7	1379	46.13
-2	4	1451	62.73
-1.5	2.83	1440	79.20
-1	2	669	86.85
-0.5	1.41	354	90.90
0	1	18	91.10
0.5	0.71	778	100.00

Graphic grain size statistics of Folk and Ward (1957) and Folk (1974, 1980)

Site	Graphic Mean (ϕ)	Graphic Mean (mm)	Inclusive Graphic Standard Deviation (ϕ)	Inclusive Graphic Skewness	Graphic Kurtosis
EWLS25	-1.92	3.79	1.27	0.01	1.21

EWLS Site 28 – cumulative frequency data from Digital Gravelometer™

4 images were assessed and aggregated

Phi (Φ)	Size (mm)	Count in class	Cumulative Percentage
-9	512	4	0.02
-8.5	362	4	0.04
-8	256	4	0.06
-7.5	181	0	0.06
-7	128	8	0.10
-6.5	90.5	22	0.22
-6	64	36	0.41
-5.5	45.3	110	0.98
-5	32	265	2.35
-4.5	22.6	487	4.88
-4	16	1098	10.58
-3.5	11.3	2045	21.20
-3	8	2905	36.28
-2.5	5.7	3338	53.62
-2	4	3111	69.77
-1.5	2.83	2487	82.68
-1	2	1140	88.60
-0.5	1.41	672	92.09
0	1	44	92.32
0.5	0.71	1479	100.00

Graphic grain size statistics of Folk and Ward (1957) and Folk (1974, 1980)

Site	Graphic Mean (ϕ)	Graphic Mean (mm)	Inclusive Graphic Standard Deviation (ϕ)	Inclusive Graphic Skewness	Graphic Kurtosis
EWLS28	-2.08	4.24	1.26	0.10	1.22

EWLS Site 30 – cumulative frequency data from Digital Gravelometer™

6 images were assessed and aggregated

Phi (Φ)	Size (mm)	Count in class	Cumulative Percentage
-9.5	724	4	0.01
-9	512	1	0.02
-8.5	362	0	0.02
-8	256	5	0.03
-7.5	181	7	0.06
-7	128	37	0.18
-6.5	90.5	57	0.37
-6	64	73	0.61
-5.5	45.3	153	1.12
-5	32	318	2.18
-4.5	22.6	595	4.17
-4	16	1043	7.64
-3.5	11.3	2407	15.66
-3	8	4074	29.24
-2.5	5.7	5242	46.71
-2	4	5281	64.31
-1.5	2.83	4592	79.61
-1	2	2234	87.05
-0.5	1.41	1205	91.07
0	1	88	91.36
0.5	0.71	2592	100.00

Graphic grain size statistics of Folk and Ward (1957) and Folk (1974, 1980)

Site	Graphic Mean (ϕ)	Graphic Mean (mm)	Inclusive Graphic Standard Deviation (ϕ)	Inclusive Graphic Skewness	Graphic Kurtosis
EWLS30	-1.90	3.72	1.22	0.07	1.24

Appendix 4 Graphic grain size statistics for the gravel fraction

Graphic grain size statistics for the gravel fraction (> 2.0 mm) for the combined top of rip mound and between rip lines surface samples collected on the trial landform in 2009 and the 2009 images analysed by Digital Gravelometer™.

Graphic grain size statistics for the gravel fraction of combined (top of rip mound and between rip lines) surface material samples in 2009

Sample name	Graphic Mean(ϕ)	Graphic Mean(mm)	Inclusive Graphic Standard Deviation (ϕ)	Inclusive Graphic Skewness	Graphic Kurtosis	Transformed Kurtosis
EWLS2	-4.39	20.93	1.82	0.13	0.72	0.42
EWLS5	-5.05	33.2	1.92	0.29	0.80	0.45
EWLS6	-3.87	14.61	1.87	-0.16	0.78	0.44
EWLS9	-4.38	20.77	1.78	0.15	0.74	0.42
EWLS13	-4.12	17.39	1.87	-0.03	0.70	0.41
EWLS15	-3.97	15.7	1.76	-0.07	0.83	0.45
EWLS16	-4.10	17.16	1.73	0.19	0.73	0.42
EWLS18	-4.02	16.18	1.70	0.09	0.75	0.43
EWLS25	-4.63	24.81	1.88	0.29	0.69	0.41
EWLS24	-4.51	22.83	2.29	-0.19	0.68	0.40
EWLS28	-4.02	16.18	1.75	0.02	0.76	0.43
EWLS30	-3.50	11.32	1.55	-0.08	0.78	0.44
Min Value	-5.05	11.32	1.55	-0.19	0.68	0.40
Max Value	-3.50	33.20	2.29	0.29	0.83	0.45
Average Value	-4.22	19.69	1.84	0.05	0.75	0.43

Graphic grain size statistics of the gravel fraction determined by the Digital Gravelometer™ for 2009 images

Sample name	Graphic Mean(ϕ)	Graphic Mean(mm)	Inclusive Graphic Standard Deviation (ϕ)	Inclusive Graphic Skewness	Graphic Kurtosis	Transformed Kurtosis
EWLS2	-2.66	6.34	0.93	-0.08	0.99	0.50
EWLS5	-2.86	7.28	1.01	-0.06	1.04	0.51
EWLS6	-3.07	8.38	1.03	-0.07	1.07	0.52
EWLS9	-2.69	6.44	0.94	-0.08	1.01	0.50
EWLS13	-2.95	7.73	1.02	-0.04	1.00	0.50
EWLS15	-2.72	6.57	1.00	-0.11	1.01	0.50
EWLS16	-2.83	7.12	0.97	-0.05	1.00	0.50
EWLS18	-2.98	7.87	1.05	-0.03	1.01	0.50
EWLS25	-2.52	5.72	0.89	-0.13	0.95	0.49
EWLS24	-2.67	6.38	1.02	-0.17	0.95	0.49
EWLS28	-2.81	7	0.99	-0.09	0.96	0.49
EWLS30	-2.64	6.22	0.96	-0.13	1.00	0.50
Min Value	-3.07	5.72	0.89	-0.17	0.95	0.49
Max Value	-2.52	8.38	1.05	-0.03	1.07	0.52
Average Value	-2.78	6.94	0.98	-0.09	1.00	0.50